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Corrigendum

In the October 1996 issue, page 283, "Comet C/1996 Q1 (Tabur)", the observation on 1996 10 13.40 by observer NAG02 is to be deleted.

Infrared Observations of Comets*

Robert D. Gehrz

Department of Astronomy, University of Minnesota

Comets are the "Rosetta Stone" of the solar system; they contain all the refractory and volatile materials that were present in the primitive solar nebula, 4.7 billion years ago during the epoch of formation of the comet nuclei. That material, frozen in its original state for aeons, is released by solar heating to form the comae and tails of comets during the time around perihelion passage, where its composition can be studied by present-day astronomers. Because the thermal emission from comets is primarily emitted in the spectral region 2-30 μm, infrared observations of comets play an especially important role in efforts to reconstruct an accurate picture of the processes that led to the formation of the planets. Infrared observations can be used to determine the composition, mineral structure, and size distribution of cometary dust grains that were the repository for a large fraction of the heavy elements produced by previous generations of massive stars, supernovae, and novae that contributed their ejecta to the solar system. Spectral peculiarities of some of the prominent infrared dust emission features record the processes to which condensable elements were subjected during the formation of the solar system. Infrared studies also provide a basis for defining the relationships between comet grains, grains formed in the outflows of evolved stars, and grains in the interstellar medium. Near-infrared line emission and scattering reveal information about the gas and ice content of cometary material. Variable activity in the infrared dust emission from comets during perihelion passage is related to the physical structure of their nuclei, and observations of the activity provide insight about the physical conditions under which these small bodies were formed.

The historical record of infrared observations of comets originated in the infancy of the field with the measurement of the 1.65- to 10-μm spectrum of the bright comet C/1965 S1 (Ikeya-Seki; O.S. 1965 VIII = 1965f) by infrared pioneers E. E. Becklin and J. A. Westphal [1966]. Maas *et al.* [1970] were the first to demonstrate that infrared observations could be useful for determining the mineralogy of comet dust by detecting the 10-μm silicate-emission peak in the spectrum of comet C/1969 Y1 (Bennett; O.S. 1970 II = 1969i).

E. P. Ney [1974, 1982] was the first infrared astronomer to conduct long-term systematic studies of the temporal development of the infrared spectra of a significant sample of bright comets. His observations and those of subsequent observers demonstrated the importance of infrared observations in determining the mineralogy of comet grains, in specifying the size of the grains, and in assessing physical characteristics of the structure of comet nuclei. The importance of infrared observations in comet research was clearly demonstrated during the recent apparition of comet 1P/Halley (O.S. 1986 III), when extensive temporal infrared photometric, imaging, and spectroscopic coverage was obtained [see Hanner 1988 and the references therein].

Some of the major questions about the physics of comets that are being addressed by current infrared studies of comets are those related to:

1) The structure and activity of comet nuclei: How can infrared measures of activity be used to reconstruct information about the structure and composition of the nucleus? What role does nuclear rotation play in variations of the activity of some comets, and in the distribution of material within the inner coma? How heterogeneous are comet nuclei in composition and physical structure? Do the nuclei of pristine and periodic comets differ in any substantial way?

2) The structure of comet comae and tails: How are grains of different sizes and mineral compositions distributed in the comae, tails, and anti-tails of comets? What is the origin of the large particles in the comet trails detected by IRAS? How do jets affect the coma surface brightness distribution?

3) The properties of comet grains: Why do some comets show silicate-emission features, while others do not? How many comets show the structure in their 10-μm silicate features due to crystalline olivine and enstatite grains? What is the meaning of the time-variable structure and strength of emission features in some comets? Are excess grain temperature (superheat), grain albedo, and silicate-emission strength a function of heliocentric distance? Are comet grains altered by heating at small heliocentric distances?

Table 1 lists the photometric quantities that are measured by infrared observations and the physical parameters that can be derived from them. In section 1.1.1, we use the example of comet C/1973 E1 (Kohoutek; O.S. 1973 XII = 1973f) to show how the photometric properties typically manifest themselves in the spectrum of a comet. Section 1.1.2 outlines how the photometric quantities can be used to derive physical parameters describing behavior of comet comae and nuclei. Finally, we discuss the equipment and techniques used to measure and calibrate the infrared photometric quantities in section 1.1.3. In this work, we have liberally consulted previous extensive reviews and compendia of optical-infrared measurements of comets by Ney [1982], Hanner [1988], Encrenaz and Knacke [1991], Hanner and Tokunaga [1991], Jewitt [1991], Weaver *et al.* [1991], Yeomans and Wimberly [1991], and Gehrz and Ney [1992]. The reader is commended to these sources for more detailed discussions of selected topics.

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* This article was written for the *ICQ Guide to Observing Comets*, and appears in the first edition of that publication, pp. 117-132.

Table 1: Photometric properties and Physical Parameters of Comets from Infrared Measurements Assuming the Standard Model

PARAMETERS (units)	DEFINITION	RELATIONSHIPS (units of variables as specified in column one[1])
$r(cm)$	heliocentric distance	From ephemerides
Δ (cm)	geocentric distance	From ephemerides
θ (deg)	Scattering (Sun-comet-Earth) angle	From ephemerides
$\lambda(\mu m)$	wavelength	Selected by observer
ϕ $(arcseconds)$	Photometer diaphragm diameter	Selected by observer
ψ $(arcseconds)$	Angular distance between source and reference beams	Selected by observer
$f_\lambda(\phi,\psi)(W\ cm^{-2}\mu m^{-1})$	Apparent flux in ϕ for a throw ψ	Measured quantity
$f_\lambda(\phi)$	Apparent flux in ϕ corrected for emission in the reference beam	$f_\lambda(\theta) = 4\psi(4\psi - \phi)f_\lambda(\phi,\psi)$
$f_\lambda(r',\Delta',\phi')$	Predicted apparent flux for the comet at r' and Δ' in a diaphragm ϕ'	$f_\lambda(r',\Delta',\phi') = (\phi'/\phi)(r/r')^4(\Delta/\Delta')\cdot f_\lambda(r,\Delta,\phi)$ (see Gehrz and Ney 1992)
$(\lambda f_\lambda)_{max}$ $(W\ cm^{-2})$	(λf_λ) in ϕ at Planckian maximum	Inspection of V/IR spectral energy distribution (SED)
f $(W\ cm^{-2})$	Total apparent flux in ϕ	$f = \int_0^\infty f_\lambda(\phi)d\lambda = 1.3586\ (\lambda f_\lambda)_{max}$
Q_a, Q_e	Planck mean absorption, emission coefficient	See Gilman (1974)
T_{BB} (K)	Temperature of a black sphere at r	$T_{BB} = 278\ r^{-1/2}$; r in AU
T_{gr} (K)	Observed Grain Temperature	$T_{gr} = (L_\odot Q_a/1\pi\sigma r^2 Q_e)^{1/4} = 278\ r_A^{-1/2}(Q_a/Q_e)^{1/4}$
S	Superheat (Temperature excess)	$S = T_{gr}/T_{BB} = (Q_a/Q_e)^{1/4}$
$f(\theta)$	Ratio of the scattered to the thermal radiation	$f(\theta) = f_{scatt}(\theta)/f_{IR}(\theta) = [\lambda f_\lambda(\theta)]_{max,scatt}/[\lambda f_\lambda(\theta)]_{max,IR}$
$A(\theta)$	Bolometric Albedo at θ	$A(\theta) = f(\theta)/[1+ f(\theta)]$
A	Mean Bolometric Albedo	$A = \pi^{-1}\int_0^\pi A(\theta)d\theta$
$\Delta m_{9.7}$ $(mags)$	9.7μm silicate emission feature excess	Measured off IR SED at $\lambda = 9.7\mu m$
dM_D/dt $(g\ s^{-1})$	Dust mass loss rate	$dM_D/dt = 7\times10^{21}r^2\Delta\phi^{-1}(\lambda f_\lambda)_{max,IR}$; r and Δ in AU
grain, gas composition	See Table 1a	IR emission features and spectral lines

[1] Unless otherwise noted in column three

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1.1.1. Photometric quantities derivable from the infrared spectra of comets

Figure 1 shows the 0.5- to 18-μm spectra of the coma, tail, and anti-tail of comet C/1973 E1 (Kohoutek) [Ney 1974]. Because a spectrum is also a plot of the amount of energy emitted at each wavelength, we often use the term "energy distribution" in the discussion that follows when the spectrum is being used primarily to determine quantities related to energy balance. An important characteristic of the scattered and thermal energy distributions of comets is that they follow the spectral shape of a blackbody (a body that is a perfect absorber and emitter). The blackbody energy distribution $f_\lambda = 2\pi hc^2\lambda^{-5}[\exp(hc/\lambda kt) - 1]^{-1}$ is called the Planck function after Max Planck, who showed that its characteristic shape can be theoretically predicted from the laws of quantum mechanics. The position in wavelength of the peak of the curve, called the Planckian maximum, was shown by Wien to be related to the temperature of the blackbody. Wien's law is $\lambda_{max}T = 2898$ μm K for the f_λ function, and $\lambda_{max}T = 3670$ μm K for the λf_λ function. Evaluation of the energetics of comet emission is especially straightforward when the quantity λf_λ is plotted as a function of the wavelength, λ, as shown in section 1.1.2. It should be noted that plots of λf_λ ***versus*** λ and plots of λf_ν ***versus*** frequency $\nu = c/\lambda$ are equivalent. As discussed in section 1.1.3, the flux f_λ is a quantity that can be directly derived from measurements of comets and standard stars, and it is multiplied by λ to produce the quantity λf_λ plotted in Figure 1.

The scattered solar component of the spectrum is caused by sunlight reflected by dust grains in the coma and tails. This component can be examined by combining observations from the visual and near-infrared regions. The total power (W/cm^2) in the scattered radiation delivered to an observer viewing the comet at a scattering angle θ (the sun-comet-earth angle)[2] is measured by the quantity $[\lambda f_\lambda(\theta)]_{max,scat}$, defined by the Planckian maximum of the scattered radiation component (see Table 1). Usually, *VRIJHK* photometry or spectrophotometry will suffice to specify this quantity. This scattered component essentially measures the θ dependence of the albedo, $A(\theta)$, of the comet grains — a measure of their physical size and structure.

Thermal emission from the coma, tail, and anti-tail — produced by the re-radiation of the sunlight absorbed by dust grains — is evaluated by measurements from 3 to 30 μm and beyond. It is evident from Figure 1 that the energy distributions of these structures can contain both a blackbody-continuum-radiation component and broad emission features. The continuum is believed to be caused by an amorphous-carbon-dust component. The total power emitted by the carbon-dust-component of the coma at scattering angle θ is measured by the quantity $[\lambda f_\lambda(\theta)]_{max,IR}$, the peak of the Planckian maximum of the continuum-radiation component (see Table 1). Additional power contributed by other

[2] equivalent to the phase angle, usually represented in the *ICQ* and *IAU Circulars* by β.

dust emission features (see the following paragraph) is usually negligible. The total thermal-infrared power is essentially a measure of the dust mass-loss rate dM_{gr}/dt from the nucleus, and can be highly variable. Grain temperature T_{gr} is measured by the wavelength λ_{max} of the peak of the continuum component, using Wien's law. Grain size can be inferred from measurements of this quantity, as we show below. Figure 1 shows that the coma and tail have a much higher temperature than the temperature T_{BB} expected for a black sphere at the same heliocentric distance. This temperature excess, which is termed "superheat", is an indication that these components are made of very small grains. The temperature of the anti-tail is roughly T_{BB}, showing that it is made of very large grains that are efficient radiators. The relationship between grain size and superheat is discussed explicitly in section 1.1.2.1.

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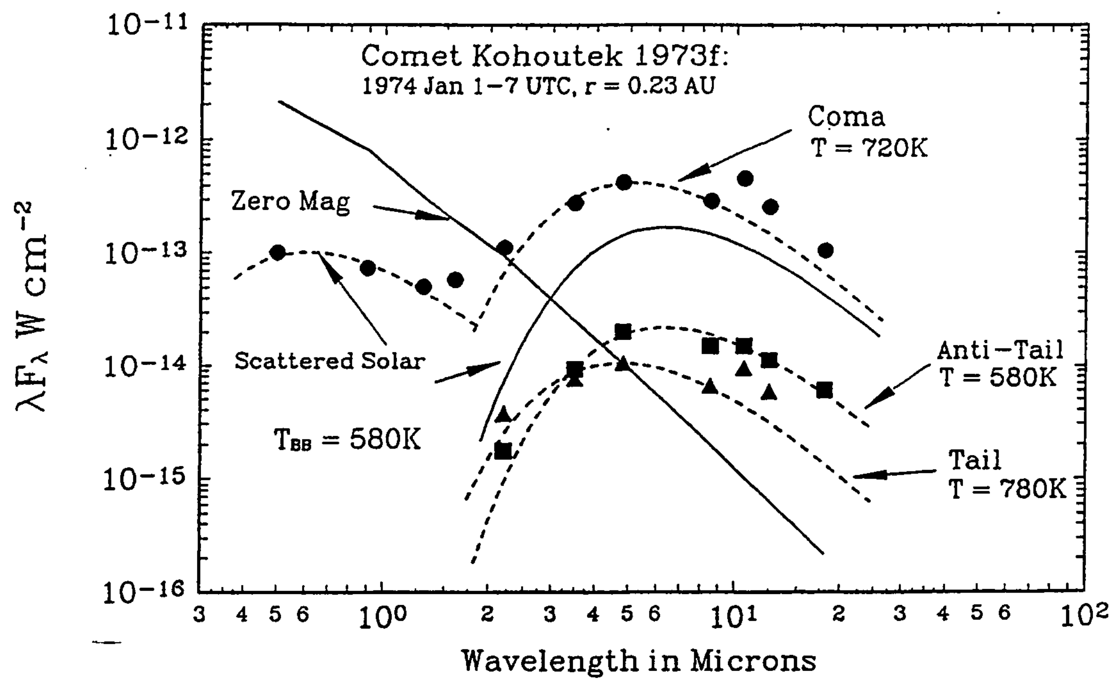

Figure 1. The spectra of the coma, tail, and anti-tail of comet C/1973 E1 (Kohoutek; O.S. 1973 XII = 1973f), showing the various characteristics of cometary emission that can be investigated using infrared observing techniques. Data are from Ney [1974]. The scattered solar component can be compared with the thermal emission to give the albedo. The superheat (temperature excess) of the coma and tail over the black-sphere temperature (T_{BB}) are an indication of the presence of small grains in these components. The low temperature of the anti-tail shows that it is made of large grains. The excess emission in the tail and coma at 10 and 20 μm is caused by emission from small silicate grains.

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Broad emission features due to small dust grains are often present in comet spectra, and several of these are evident in the spectra of the tail and coma of comet C/1973 E1 (Kohoutek). Silicate grains can produce strong emission features at 10 and 20 μm caused by the stretching and bending vibrational modes in the SiO_2 molecular bonds, and the Si-C stretch vibration of silicon carbide can produce a feature at 11.3 μm [see Woolf and Ney 1969]. Hydrocarbon emission features in the region 3.2-3.5 μm may be caused by stretch vibrations of the C-H bonds of polycyclic aromatic hydrocarbons (PAHs) or types of hydrogenated hydrocarbons as discussed by Allamandola [1984] and Allamandola *et al.* [1987]. The infrared spectral emission features observed from gas and dust in 1P/Halley and C/1986 P1 (Wilson) are listed in Table A. The strength and shape of these features can be used to deduce the mineral composition of comet grains. For example, structure in the 10-μm silicate-emission feature has been interpreted as indicating the presence of the crystalline silicate minerals olivine and enstatite in the grains of some comets [see Hanner 1988; and Hanner *et al.* 1990, 1994a, 1994b].

A very important objective of infrared monitoring of comets is to track activity patterns through long-term temporal observations. Analysis of these variational patterns can be used to infer information about both the physical structure and the rotation rate of the nucleus. Gehrz and Ney [1992] and Gehrz *et al.* [1995] found that the thermal flux from 1P/Halley's coma varied by factors of almost 10 compared to the canonically expected behavior on time scales as short as several hours and as long as several days. The activity variations they observed included significant changes in the grain temperature and albedo, as well as in the shape and strength of the 10-μm silicate-emission feature. Many of the changes were consistent with the hypothesis that jets of small particles can be released by insolation as the nucleus tumbles. Recently Fomenkova *et al.* [1995] showed how time-sequences of infrared images can be used to deduce the rotation rate of a comet nucleus through measurements of the positions of prominent jets.

Table A. Infrared Spectral Features and Emission Lines Observed in Comets 1P/Halley and C/1986 P1 (Wilson)[3]

λ *in* μm	PROBABLE SOURCE
1-2.5	CN, H_2O
2.63	H_2O gas?
2.7	H_2O gas, other unknown molecules
2.8	OH
3.0	NH_3, HCN, H_2O ice
3.15	unidentified
3.29	hydrocarbon grain constituent (PAH?)
3.36	CH stretch in grains
3.52	CH stretch in grains
3.6	H_2CO
4.3	CO_2
4.44	CN
4.6	CO
4.84	OCS
5.2	unidentified
6.8	carbonates
9.7	amorphous silicate dust grains
9.8, 10.5, 11.3	crystallyne silicate (Olivine and Pyroxene?)
12.2	unidentified
20	amorphous silicate dust grains
23.8	Olinene?
26.7	unidentified
28.4	Olivine?
34.5	Olivine?
40	Olivine?

[3] After data presented in Campins and Tokunaga 1988

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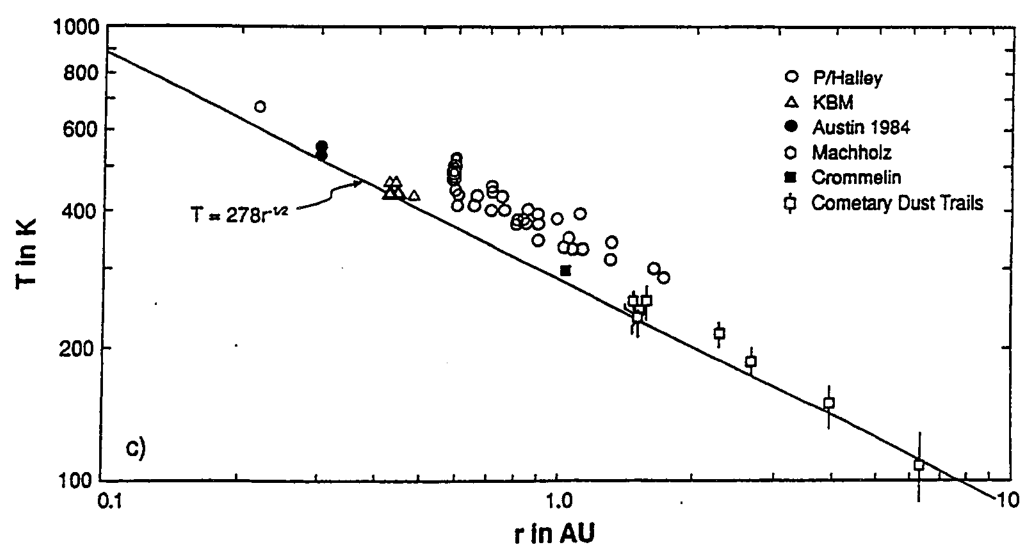

Figure 2. The observed coma continuum temperature, T_{gr}, plotted as a function of heliocentric distance for a sample of recent bright comets. Comet 1P/Halley's grains were superheated. It is also evident that T_{BB} defines the lower limit to the temperature of comet grains. "KBM" indicates comet C/1975 N1 (Kobayashi-Berger-Milon), "Austin 1984" indicates comet C/1984 N1, "Machholz" indicates comet C/1985 K1, "Crommelin" indicates comet 27P, and the dust trails refer to those found by IRAS. Figure from Gehrz and Ney [1992], reproduced by permission of Icarus.

1.1.2. Derivation of physical properties of comet comae and nuclei from photometric quantities

A straightforward way to gain an elementary understanding of the relationships between measurable infrared photometric quantities and the physical parameters of comets is to consider the steady-state model of nuclear activity [Jewitt 1991; Gehrz and Ney 1992]. For this case, both the scattered and thermal emission from the coma is caused by dust grains ablated from the nucleus at a constant rate dN/dt grains/sec that flow away from the nucleus at constant velocity V_o. Although molecular emission is observed in the infrared as mentioned above, the total energy in this emission is insignificant compared to the dust scattering and emission. We ignore molecular emission in the discussion that follows. Although the standard model does not necessarily apply to periods of high, irregular activity, there are many occasions when a comet has been in a steady state for a long-enough period of time to be adequately characterized by this model. We outline below an analysis deriving some important physical characteristics of the steady-state model. This analysis, originally presented in more detail by Gehrz and Ney [1992], assumes that infrared energy distributions measure the properties of the "optically important" grains. These are defined as the grains that dominate the scattered and emitted radiation. Based upon existing ground- and space-based measurements of the grain-size distribution in comet comae, Jewitt and Meech [1986] and Jewitt [1991] showed that the effective grain radius a for the optically-important grains can be determined by assuming that the differential grain distribution follows a power law of the form $n(a)da = Ka^{-m}da$, where $n(a)$ is the number density of grains of radius a in number of grains cm^{-3}. If, as suggested by existing data, there is a lower limit a_{min} to the grain radius, the mean grain radius of the optically-important grains can be shown to be between $2a_{min}$ and $3a_{min}$, and where m lies between 3 and 4.5 [Gehrz and Ney 1992]. The parameters derived below are defined and their units are given in Table 1.

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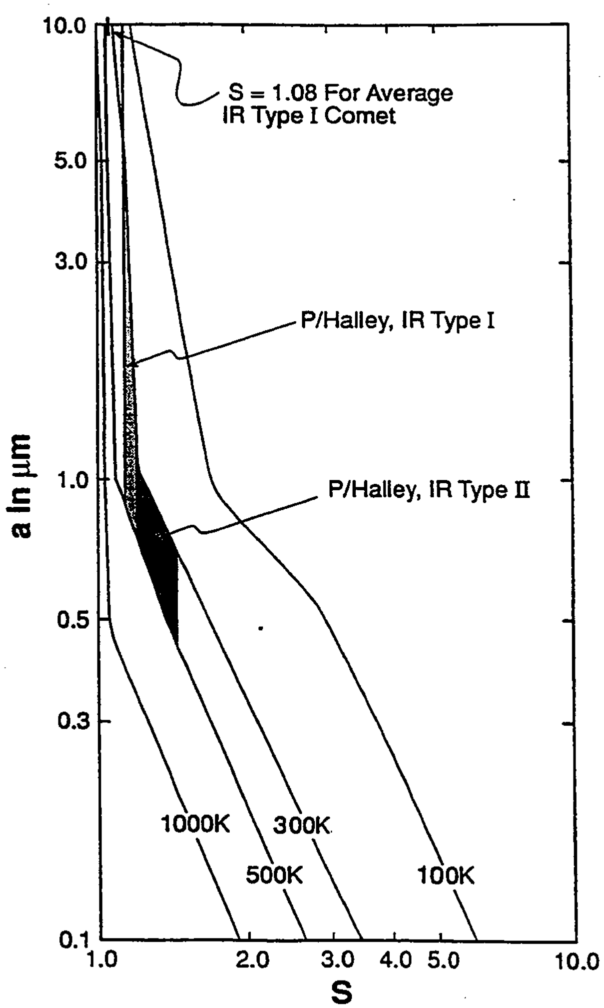

Figure 3. The superheat, S, plotted as a function of grain radius, a, and temperature, T_{gr}, for small carbon grains illuminated by the solar radiation field, assuming that the sun has an effective temperature of 5800 K. Figure from Gehrz and Ney [1992], reproduced by permission of Icarus.

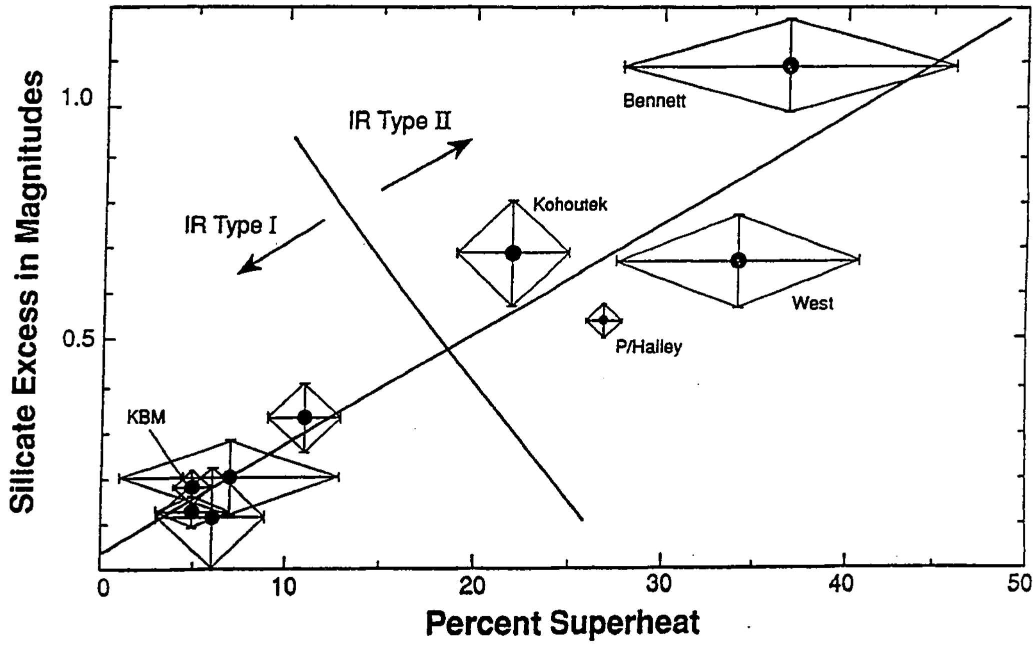

Figure 4. Silicate-emission feature strength (in magnitudes) plotted as a function of percent superheat ([S − 1] × 100) for recent bright comets. They are correlated, as would be expected, on theoretical grounds. Note that "KBM" indicates comet C/1975 N1 (Kobayashi-Berger-Milon), "Kohoutek" indicates comet C/1973 E1, "Bennett" indicates C/1969 Y1, and "West" indicates comet C/1975 V1. Figure from Gehrz and Ney [1992], reproduced by permission of Icarus.

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1.1.2.1. Superheat and silicate emission features: their relationship to grain size

Many comets have a coma-grain temperature considerably higher than the black-sphere temperature appropriate to the comet's heliocentric distance, probably because the coma grains are too small to radiate effectively. A quantitative relationship between the grain radius, a, and the grain temperature, $T_{\rm gr}$, results from equating the power absorbed by the grain from insolation[4] to the power emitted by the grain in the infrared:

$$\frac{L_\odot}{4\pi r^2 \pi a^2 Q_a} = 4\pi a^2 Q_e \sigma T_{\rm gr}^4, \tag{1}$$

where r is the heliocentric distance in cm, a is the grain radius in cm, $L_\odot = 3.826 \times 10^{33}$ erg/s is the solar luminosity, $\sigma = 5.6696 \times 10^{-5}$ erg cm^{-2} deg^{-4} is the Stefan-Boltzmann constant, and $Q_a(a,T)$ and $Q_e(a,T)$ are the Planck mean absorption and emission coefficients. Q_a is the absorption efficiency of the grain averaged over the spectrum of the illuminating source (the sun), and Q_e is the thermal emission efficiency of the grain at $T_{\rm gr}$. Solving equation (1) for the grain temperature yields

$$T_{gr} = \left[\frac{L_\odot Q_a}{16\pi\sigma r^2 Q_e}\right]^{1/4}, \tag{2}$$

which gives the black-sphere temperature,

$$T_{BB} = \frac{278}{\sqrt{r}} \text{ deg K}, \tag{3}$$

in the case when $Q_a = Q_e = 1$, where r in equation (3) is the heliocentric distance expressed in AU (1 AU = 1.4960 × 10^{13} cm).

The black-sphere condition defines the temperature that would be expected for rather large grains that have a very low reflectivity, and therefore T_{BB} is also expected to define the lower limit to the temperature of comet grains. For small grains ($Q_e < Q_a$), the grain temperature must be higher than the black-sphere temperature when the grain is in radiative equilibrium. The grain temperatures for a sample of recent bright comets and comet tails are shown in Figure

[4] absorbed by the grain from sunlight

2. The temperature excess can be quantified by defining the superheat $S = T_{gr}/T_{BB}$ as the ratio of the grain temperature to the temperature of a perfectly-conducting black sphere at the same heliocentric distance. Assuming that the infrared color temperature of the grains measures the physical temperature of the grain T_{gr}, it is seen that S measures the fourth root of the ratio of Q_a to Q_e:

$$S = \frac{T_{gr}}{T_{BB}} = \left[\frac{Q_a}{Q_e}\right]^{1/4}, \tag{4}$$

where the right-hand side is unity for large grains, and becomes progressively larger as the grain size decreases (see Figure 3). The physical grain temperature and the grain-color temperature are equivalent in cases where the grain emissivity does not vary significantly over the spectral region that is used to define the color temperature. The strength of the 10- and 20-μm silicate features is also an indicator of grain size. As discussed by Gehrz and Ney [1992], the features should be strongest for grains that are much smaller than a few microns in radius, and should become very weak for grains that approach or exceed radii of 10 μm. This has been confirmed for the 10-μm silicate-emission feature in laboratory experiments conducted by Rose [1979].

Since the arguments that we have outlined above show that both S and silicate-emission strength should increase as grain size decreases, one might expect that S and silicate-emission strength should be correlated in comets. Figure 4 shows that this is, indeed, the case.

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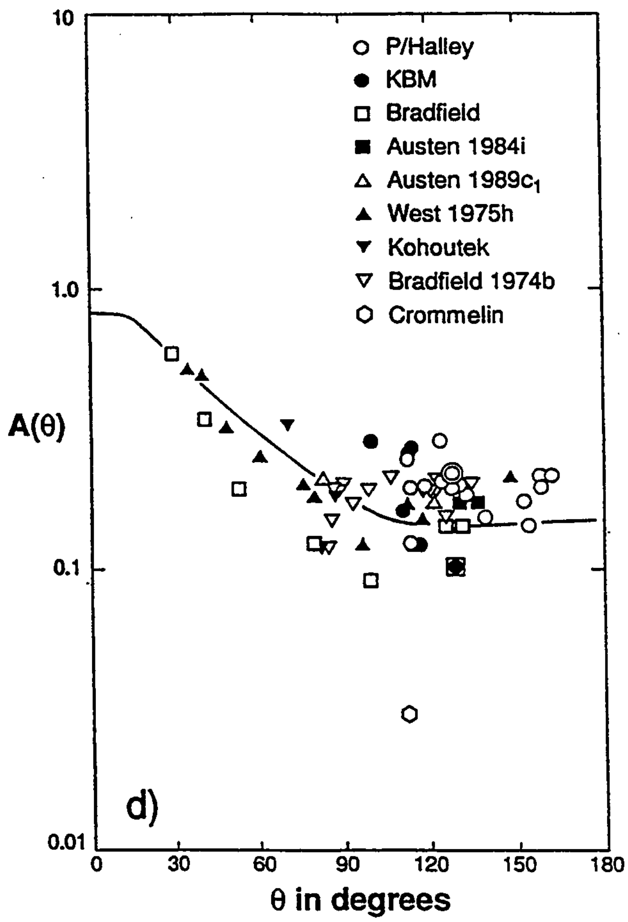

Figure 5. The albedo of comet grains as a function of scattering angle, as measured by the ratio of the scattered to the re-emitted (absorbed) radiation. The forward scattering peak and shape of the curve show that the grains are fluffy aggregates. Note that "KBM" indicates comet C/1975 N1 (Kobayashi-Berger-Milon), "Kohoutek" indicates comet C/1973 E1, "Bradfield" indicates C/1980 Y1, "Bradfield 1974b" indicates comet C/1974 C1, "Crommelin" indicates comet 27P, "Austen 1984i" indicates comet C/1984 N1 (Austin), "Austen 1989c₁" indicates comet C/1989 X1 (Austin), and "West 1975h" indicates comet C/1975 V1. Figure from Gehrz and Ney [1992], reproduced by permission of Icarus.

1.1.2.2. Total power in the scattered and thermal energy distributions

The determination of the total power f radiated by a blackbody (see Table 1) is particularly straightforward when the continuum emission from the dust approximates that of a blackbody. This is essentially true for all comets, since emission features contribute a negligible amount to the total power in either the scattered or thermal energy distributions. In this case, the ratio of the maximum of the λf_λ function to the total blackbody emission f is given by

$$\frac{(\lambda f_\lambda)_{\max}}{f} = \frac{2\pi hc^2}{\sigma(\lambda_m T)^4}\left[\frac{1}{e^{hc/k(\lambda_m T)}-1}\right] = \frac{1}{1.3586}, \tag{5}$$

where λ_m is the wavelength of maximum emission in λf_λ; $\lambda_m T = 0.3670$ cm deg is Wien's law for λf_λ; $h = 6.262 \times 10^{-27}$ c.g.s.; $c = 2.9979 \times 10^{10}$ cm/s, $\sigma = 5.6696 \times 10^{-5}$ c.g.s.; and $k = 1.3806 \times 10^{-16}$ c.g.s. Thus, for example, the apparent infrared intensity f_{IR} of the coma is given by

$$f_{IR} = 1.3586(\lambda f_\lambda)_{\mathrm{max,IR}}, \tag{6}$$

where $(\lambda f_\lambda)_{\mathrm{max,IR}}$ is the observed apparent emission maximum of the thermal-infrared continuum.

1.1.2.3. Albedo of comet dust and the structure of the grains

The bolometric (total-power) albedo, A, for a comet's coma is a measure of the ratio of the light scattered by the grains to that absorbed and re-emitted; A can be defined by the relationship

$$\frac{f_{scat}}{f_{IR}} = \frac{A}{1-A}, \tag{7}$$

where the left-hand side is the ratio of the energy scattered in all directions to the total energy absorbed from the sun; f_{scat} is the observed scattered power (in units of W cm^{-2}) integrated over all scattering angles, and f_{IR} (in W cm^{-2}) is the observed thermal emission due to re-radiation of the absorbed radiation. For small grains, f_{scat} must be derived from measurements of the visible/near-infrared energy distribution of the coma at all scattering (sun-comet-Earth) angles, because the scattering function is strongly angle-dependent (see Figure 5). This can be accomplished to some extent for any given comet by observing it at as many phase angles as possible, as the viewing aspect changes during the orbit. In practice, since no single comet necessarily presents all scattering angles, the "typical" comet scattering function shown in Figure 5 must be obtained by piecing together measurements of many comets. It can be seen that much more data are still required for scattering angles near 0° and 180°. The sunlight that is absorbed and re-emitted in the infrared by the grains as f_{IR} can be determined by measurements of the thermal-infrared energy distribution of the coma. The albedo, $A(\theta)$ for a scattering angle θ is defined by analogy to equation (7), above, as

$$A(\theta) = \frac{f(\theta)}{1+f(\theta)}, \tag{8}$$

where:

$$f(\theta) = \frac{f_{scatt}(\theta)}{f_{IR}(\theta)} = \frac{[\lambda f_\lambda(\theta)]_{\mathrm{max,scat}}}{[\lambda f_\lambda(\theta)]_{\mathrm{max,IR}}}. \tag{9}$$

In equation (9), $f_{scat}(\theta)$ and $f_{IR}(\theta)$ are the integrated apparent intensities of the scattered and thermal energy distributions of the coma, respectively, for the scattering angle θ.

The mean bolometric albedo, A, averaged over all scattering angles is then given by

$$A = \frac{1}{\pi}\int_0^\pi A(\theta)\mathrm{d}\theta. \tag{10}$$

Since the scattered and thermal energy distributions of comets can be closely approximated by blackbody energy distributions, the result obtained in section 1.1.2.2 (above) can be used to determine $f_{scat}(\theta)$ and $f_{IR}(\theta)$ from the directly measurable quantities $[\lambda f_\lambda]_{\mathrm{max,scat}}$ and $[\lambda f_\lambda]_{\mathrm{max,IR}}$. The $A(\theta)$ curve defined by infrared observations of a number of comets (see Figure 5) shows that there is a fairly strong forward scattering peak near $\theta \approx 0°$ and is consistent with the interpretation that the grains are fluffy aggregates [Gehrz and Ney 1992].

1.1.2.4. Dependence of a comet's apparent infrared luminosity on r, Δ, and beam size

For a coma that is optically thin to thermal infrared radiation, as is always the case in the thermal infrared, the apparent infrared intensity f_{IR} of a coma composed of N dust grains is:

$$f_{IR} = \frac{L_{IR}}{4\pi\Delta^2} = \frac{4\pi N a^2 Q_e \sigma T_{gr}^4}{4\pi\Delta^2} = \frac{N a^2 Q_e \sigma T_{gr}^4}{\Delta^2}, \tag{11}$$

where L_{IR} is the coma luminosity. Assuming an isotropic grain distribution for a spherically symmetric coma within a radius $\mathbf{R}$ of the nucleus, then N is given by

$$N = 4\pi \int_0^R n(\mathbf{R})\mathbf{R}^2 \mathrm{d}\mathbf{R} = \frac{\mathrm{d}N}{\mathrm{d}t}t = \frac{\mathrm{d}N}{\mathrm{d}t}\frac{\mathbf{R}}{V_o}, \tag{12}$$

where $t = \mathbf{R}/V_o$ is the time required for grains to flow at constant velocity V_o out to radius $\mathbf{R}$, and $n(\mathbf{R})$ is the radial number density distribution of grains in the coma. It therefore follows that the radial grain density distribution for the steady-state model must be

$$n(\mathbf{R}) = \frac{1}{4\pi\mathbf{R}^2 V_o}\frac{\mathrm{d}N}{dt}. \tag{13}$$

Integrating $n(\mathbf{R})$ over the cylindrical volume V of the coma that is intercepted by a photometer beam of angular diameter ϕ, to obtain the number N_ϕ of grains emitting into the beam, yields — with the help of equation (11) — an apparent infrared intensity $f_{\phi,IR}$ in the beam of

$$f_{\phi,IR} = \frac{a^2 Q_e \sigma T_{gr}^4}{\Delta^2} N_\phi = \frac{a^2 Q_e \sigma T_{gr}^4}{\Delta^2} \iiint_V n(\mathbf{R})\mathrm{d}^3\mathbf{R} = \left[\frac{\pi a^2 Q_e \sigma T_{gr}^4}{4V_o}\right]\frac{\phi}{\Delta}\frac{dN}{dt}, \tag{14}$$

where the result on the extreme-right-hand side is for the case where the angular diameter of the beam is much smaller than the angular diameter of the coma. It can be seen from equation (14) that $f_{\phi,IR} \propto \phi/\Delta$, leading to the correction terms specified in Table 1 and discussed in section 1.1.3.7, below.

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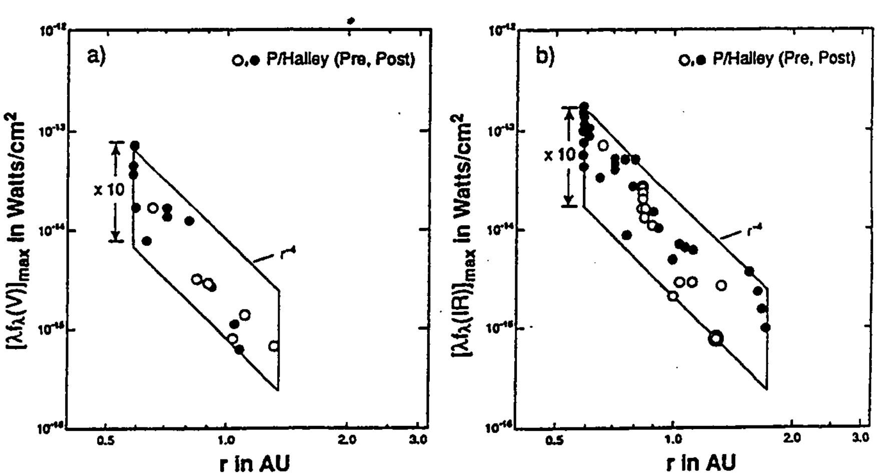

Figure 6. The activity of the nucleus of 1P/Halley as a function of heliocentric distance at visible (a) and infrared (b) wavelengths, as measured by variations of the apparent intensities $[\lambda f_\lambda(V)]_{max} = (\lambda f_\lambda)_{max,scat}$ and $[\lambda f_\lambda(IR)]_{max} = (\lambda f_\lambda)_{max,IR}$, respectively. Figure from Gehrz and Ney [1992], reproduced by permission of Icarus.

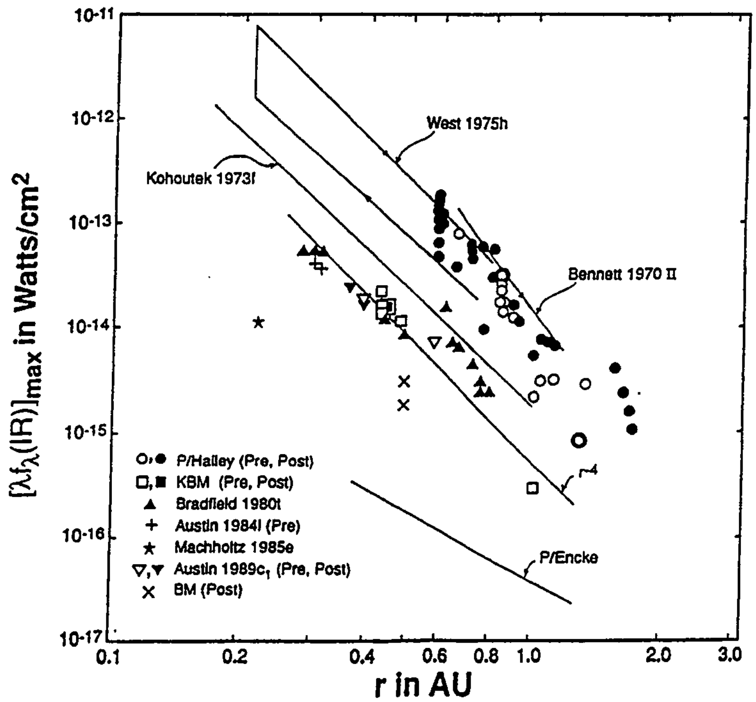

Figure 7. The infrared activity of the nuclei recent bright comets as a function of heliocentric distance, as measured by variations in the quantity $[\lambda f_\lambda(IR)]_{max} = (\lambda f_\lambda)_{max,IR}$. Figure from Gehrz and Ney [1992], reproduced by permission of Icarus.

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1.1.2.5. Activity in comet nuclei

The apparent infrared intensity $f_{\phi,IR}$ of an optically-thin cometary coma in a beam of angular diameter ϕ radians that is much smaller than the angular extent of the coma is

$$f_{\phi,IR} = 1.3586(\lambda f_\lambda)_{\mathrm{max,IR}} = \left[\frac{\pi a^2 Q_e \sigma T_{gr}^4}{4V_\mathrm{o}}\right]\frac{\phi}{\Delta}\frac{\mathrm{d}N}{\mathrm{d}t} = \left[\frac{a^2 Q_a L_\odot}{64 V_\mathrm{o}}\right]\frac{\phi}{r^2\Delta}\frac{\mathrm{d}N}{\mathrm{d}t}. \quad (15)$$

If the grain production rate as a function of r, $\mathrm{d}N(r)/\mathrm{d}t$, is directly proportional to the insolation of the nucleus:

$$\frac{\mathrm{d}N(r)}{\mathrm{d}t} = \frac{\mathrm{d}N(q)}{\mathrm{d}t}\left[\frac{q}{r}\right]^2, \quad (16)$$

where q is the perihelion distance and $\mathrm{d}N(q)/\mathrm{d}t$ is the grain production rate in grains/sec at perihelion. Therefore, the apparent coma intensity is

$$f_{\phi,IR} = \left[\frac{a^2 Q_a L_\odot}{64 V_\mathrm{o}}\right]\frac{\phi q}{r^4\Delta}\frac{\mathrm{d}N(q)}{\mathrm{d}t} \propto \frac{\phi}{r^4\Delta}. \quad (17)$$

In cases where the luminosity of the coma is generated by emission from very small silicate grains, for which $Q_e \propto a$, the apparent infrared intensity of the coma is directly proportional to the total mass, M_{gr}, of the grains:

$$f_{\phi,IR} \propto \frac{M_{gr}\phi}{r^4\Delta}. \quad (18)$$

From equation (18), it is apparent that the approximation quantified in equation (16) implies a dependence of r^{-4} for both the scattered and thermal energy distributions of comets. The quantity $[\lambda f_\lambda]_{max,IR}$ is a better measure of a comet's intrinsic brightness than is $[\lambda f_\lambda]_{max,scat}$ because of the rather strong variation in albedo with phase angle (see Figure 5). Figures 6 and 7 summarize the activity of the nuclei of 1P/Halley and other recent bright comets. Clearly, the activity in most comets is proportional to r^{-4} as predicted by the theory outlined above both preceding and following perihelion passage. There are, as noted elsewhere in this review, substantial superimposed variations for some comets due to nuclear activity that is most probably associated with nuclear rotation.

1.1.2.6. Dust mass-loss rates of comet nuclei

The dust mass-loss rate dM_D/dt caused by the ablation of dN/dt grains/sec from a comet nucleus, assuming that each grain has a density ρ_{gr} and radius a, is

$$\frac{dM_D}{dt} = m_{gr}\frac{dN}{dt} = \frac{4\pi}{3}\rho_{gr}a^3\frac{dN}{dt} \tag{19}$$

where $m_{gr} = 4\pi\rho_{gr}a^3/3$ is the mass of a single grain. From the discussion above, it follows that

$$\frac{dM_D}{dt} = [1.3586(\lambda f_\lambda)_{\rm max,IR}]\frac{256\pi}{3}\frac{a\rho_{gr}}{L_\odot Q_a}V_o\frac{r^2\Delta}{\phi}, \tag{20}$$

where V_o is the grain ejection velocity and $(\lambda f_\lambda)_{\rm max,IR}$ is obtained by correcting the observed intensity for diaphragm-size and reference beam throw effects (see Table 1). Grains accelerated to terminal velocity by momentum coupling to the gas will have V_o given by

$$V_o = 5\times 10^4\left[\frac{T_{BB}}{278}\right]^{1/2} = \frac{5\times 10^4}{r^{1/4}}\ {\rm cm/s} \approx 0.5\,{\rm km/s}, \tag{21}$$

Since V_o depends only weakly upon r [expressed in equation (21) in AU], we henceforth use $V_o \approx 0.5$ km/s. Assuming that $a \approx 1\ \mu$m $= 10^{-4}$ cm $= 1000$ nm, $\rho_{gr} \leq 1$ g/cm^{-3}, and $Q_a = 1$, then the dust mass-loss rate becomes

$$\frac{dM_D}{dt} = 7\times 10^{21}(\lambda f_\lambda)_{\rm max,IR}\frac{r^2\Delta}{\phi}\ {\rm g/s} \propto r^{-2}, \tag{22}$$

where r and Δ in equation (22) are expressed in units of AU. We emphasize that this mass-loss rate refers only to the emission from the optically-important particles. Since a considerable amount of the dust mass may be in large particles that do not contribute significantly to the infrared emission, the mass-loss rate given by equation (22) should be considered to be a lower limit.

1.1.3. Measurement and calibration of photometric and spectroscopic quantities

We describe in this section how typical infrared observations of the crucial quantities $(\lambda f_\lambda)_{scat}$, $(\lambda f_\lambda)_{IR}$, and their derivatives are obtained and calibrated using infrared photometers, spectrophotometers, and imagers. Until recently, state-of-the-art infrared instrumentation and infrared-optimized telescopes were sufficiently complex and costly as to be ordinarily beyond the resources of even the most wealthy amateur astronomers. From the founding of modern infrared astronomy in the early 1960s until well into the 1980s, most of the existing infrared instruments were constructed and used by a small handful of professionally-trained experimental physicists and astronomical instrumentation specialists. However, nearly all major national, and most large private, observatories now own and operate a fairly complete complement of infrared spectrophotometers, imagers, and imaging spectrometers. More readily than ever before, the non-specialist can gain access to robust and well-supported infrared instruments. The price of small CCD cameras that respond in the very near-infrared ($\lambda \leq 1.2\ \mu$m) is now so low that even many amateurs are acquiring them. We present here, as an aid to comet observers at all levels, a summary of the generic types infrared of instruments that are appropriate for various types of infrared observations, brief comments on the observational techniques that should be used for these observations, and tables providing typical calibration data required to reduce infrared measurements.

1.1.3.1. Basics of infrared telescopes and measurements

Sensitive infrared measurements, especially at wavelengths longer than 3 μm — where thermal (heat) emission is the dominant contribution to the background — must be obtained with telescopes and instrumentation that have been optimized to minimize thermal emission from the telescope and optics using techniques designed to facilitate the cancellation of background radiation from the telescope and the sky. Low and Rieke [1974] and Gehrz *et al.* [1992] have previously described infrared telescope, instrumentation, and observing techniques in detail, and we present here only a very brief summary of the essentials to guide the interested reader in consulting these more extensive discussions.

In general, infrared optimized telescopes have high-reflectivity, low-emissivity coatings on the optical surfaces to minimize thermal emission, and they have "chopping" secondary mirrors for canceling the telescope and sky background. A "chopping" secondary mirror is one that is mounted on a flexural-pivot hinge so that it can be moved back and forth (chopped) by means of a servo-motor system. The resulting motion causes the footprint, or "beam" seen by the detector to sweep across the sky. A field stop (Lyot stop) is an aperture that defines the focal ratio of an optical system by limiting the divergence angle of the rays that can be seen from the focal plane. In a telescope, this type of stop can be thought of as preventing an instrument in the focal plane from seeing either blank sky around the secondary mirror or any of the telescope structure that lies beyond the edge of the primary mirror. Cold Lyot stops in IR detection systems prevent the detectors from seeing any thermal emission from the sky around the secondary and from the telescope walls. The stop must be cold so that it does not emit thermal radiation onto the detector. A Lyot stop can be placed anywhere an image of the telescope's primary mirror (a "pupil" image) is formed, and it is a blackened aperture whose diameter is equal to that of the image of the primary.

Cooling is easily provided since all of the infrared detectors used in the observations described herein must be operated at either liquid-nitrogen or liquid-helium temperatures using a dewar (a vacuum-jacketed vessel, much like a thermos bottle, that is designed hold cold liquefied gases) that contains a window to facilitate the transmission of the light path to the detector. Since a pupil image is also uniformly illuminated, it is usually customary to place the infrared filters, which must also be cooled and uniformly illuminated, as close to the Lyot stop as possible. In cases where this is mechanically impossible due to space limitations, a second pupil image may have to be provided for the filters. Pupil images are formed where needed within the dewar using small lenses or mirrors placed in the optical path. A detector in the focal plane will view a beam upon the sky whose size is determined by the magnification of the optical system. Single detectors in infrared photometers typically have beams with angular diameters of 3″-20″. Gehrz, Grasdalen, and Hackwell [1992] have described infrared dewars (see their Figure 3) and cooled optical systems (see their Figure 4) in detail.

The usual background cancellation technique is to rock (chop) the secondary mirror about its pivot with a square-wave motion at a fixed frequency of f_o cycles per second, so that the detector alternately views two discrete sky positions called beam A and beam B. Each beam will nominally contain the same amount of background power. The detector alternately views each beam for a dwell-time, $t_o = 1/(2f_o)$ sec during a chop cycle, and the time actually required to move the secondary from one beam to the other is negligible compared to the dwell time, t_o. Typical values for f_o are 5 to 20 cps, and for t_o are therefore 0.025 to 0.1 sec. When an astronomical point source is placed in one of the beams (now designated the "source" beam), the power emitted by the source into that beam is added to the background power level. The background power in the other beam (now designated the "reference" beam) remains unaltered. A filtered synchronous amplifier tuned to the frequency f_o will detect the source signal as an AC signal that has a nominal phase angle of either 0° or 180° with respect to the initiation of the chop cycle, depending upon whether beam A or beam B is the source beam. Gehrz *et al.* [1992] have described the square-wave chopping process and the expected signal forms in detail (see their Figure 5). Under "Background Limited Incident Power" (BLIP) conditions, the detector noise is negligible compared to the noise on the signal due to the photon ("shot") noise in the background power. If the background power is negligible, the noise on the signal will be due to the intrinsic electrical noise of the detector and amplification systems. These two conditions are termed background-noise-limited and detector-noise-limited, respectively. If the two beams view the optics of the detection system and the telescope from slightly different aspects, the amount of residual thermal emission into each beam will be different for the two beam positions, and a "false" AC source signal will be produced whose phase remains constant when the astronomical source is switched from one beam to the other.

Data is typically obtained by taking a number of A-B, B-A beam-switched pairs. The source is first centered in beam A, so that beam B is the sky-reference beam, and the signal is integrated for a time t. The telescope is then moved so that the source is centered in beam B, with beam A becoming the sky-reference beam, and the signal is integrated for the same time interval. The second half of the A-B, B-A cycle is conducted by reversing the process. It can be shown that the A-B, B-A cycle eliminates the false AC signal component from the telescope to first order. Signal-to-noise is improved by statistically co-adding the results of many A-B, B-A pairs. Although the most accurate background cancellation can be obtained if the beams are tangent (that is, the angular distance, or "throw", between the beams is equal to their diameter), larger throws are needed for comets because they are extended sources of emission.

Chopped, beam-switched elimination of the telescope emission and sky background is essential for any infrared photometric, imaging, or spectroscopic observation where strong or variable background radiation is a significant issue. This includes almost any observations where the thermal background is high ($\lambda \geq 3$ μm), but can also apply to observations at shorter wavelengths where cancellation of rapid upper-atmospheric air-glow line-emission fluctuations is required. Correction of the data for the effects of atmospheric extinction (absorption) is described in section 1.1.3.6. Because the angular distance between the source and reference beams cannot be arbitrarily large, due to the mechanical limitations of chopping secondary mirrors, the reference beam may still fall on a portion of a source that has a large angular extent. This is almost always the case for comets, and we describe how to correct the source-beam flux for source emission in the reference beam in section 1.1.3.7, below.

1.1.3.2. Infrared photometry of comets

Infrared photometry may be defined as the measurement of monochromatic intensities using broad filter bandpasses, ordinarily with widths given by $30 \geq \lambda_o/\Delta\lambda \geq 1$, where λ_o is the effective wavelength of the center of the bandpass and $\Delta\lambda$ is the nominal Full Width of the bandpass at Half Maximum intensity (FWHM). Usually, individual cold thin-film interference filters are placed in the incident radiation beam by mounting them in a slide or wheel that is fastened to the cold work surface within the dewar. In computing λ_o, the instrumental transmission function, $\Phi(\lambda)$; the atmospheric transmission curve $\tau(\lambda)$; and the energy distribution of the source under observation, f_λ, must all be taken into account using

$$\lambda_o = \frac{\int_0^\infty \lambda\Phi(\lambda)\tau(\lambda)f_\lambda d\lambda}{\int_0^\infty \Phi(\lambda)\tau(\lambda)f_\lambda d\lambda}. \tag{23}$$

The function $\Phi(\lambda)$ includes the transmission function of the filters, the transmission efficiency of the telescope/instrument optical system, and the response curve of the detector. Bolometers (total energy detectors) are the detector of choice for ground-based photometric measurements of comet infrared-energy distributions, because they have a quantum efficiency ≈ 1 from V (0.55 μm) to 33 μm and have detector noises lower than the BLIP noise for photometric bandpasses. The most popular of these in the 1990s are the Ga:Ge and Ga:Si devices available through Infrared Laboratories, Inc., in Tucson, AZ. Photoconductive and photovoltaic solid-state detectors are used in some photometric systems, but these have a long-wavelength cutoff beyond which they do not respond because the photon energy is too low to move carriers into the conduction band; they also have lower quantum efficiency and a less-uniform response curve than bolometers. Photoconductors have an additional noise factor of $2^{1/2}$ compared to bolometers, because of the random recombination of electron-hole pairs as the carriers are de-excited. In:Sb detectors can be used from 1 to 5 μm, and As:Si are useful in the 7- to 20-μm region. Hg:Cd:Te detectors are an alternative for the 1- to 2.5-μm systems.

Several standard sets of photometric filters are currently in use for ground-based observations. Table 2 summarizes the effective wavelengths and FWHM bandpasses of the three systems that are now used for almost all infrared observations of comets. The absolute flux densities for a zero-magnitude star at the top of the earth's atmosphere are given in Table 3. For interpolating the fluxes given in column 3 of Table 3 to obtain zero-magnitude fluxes to within a few percent accuracy at other effective wavelengths between 1.2 and 33 μm on the Minnesota/Wyoming system, one may use the relationship:

$$F_\lambda = \left[\frac{1.903 \times 10^{-12}}{\lambda^5}\right]\left[\frac{1}{e^{1.439/\lambda} - 1}\right], \tag{24}$$

where λ is in μm, F_λ has units of W cm^{-2} μm^{-1}, and F_λ and F_ν are related by

$$F_\nu = (3.33 \times 10^{11})\lambda^2 F_\lambda, \tag{25}$$

with F_ν in units of W m^{-2} Hz$^{-1/2}$. Several private and national infrared telescopes are equipped with state-of-the-art helium-cooled bolometers and with standard filters on the infrared photometric systems similar to those defined in Tables 2 and 3. The filter sets for these systems usually include V, R, I, J, H, K, M, various N (10-μm) and Q (20-μm) filters, and the IRTF "silicate filters" (which respond at λ_o = 7.8, 8.7, 9.8, 10.3, 11.6, and 12.5 μm, having bandwidths of $\approx$ 10 percent).

The magnitude of an unknown source may be calculated from a measurement of a standard star, using the fact that the magnitude difference between two stars whose apparent fluxes are $f_1(\lambda)$ and $f_2(\lambda)$ is given by

$$\Delta m = -2.5 \log\left[\frac{f_1}{f_2}\right], \tag{26}$$

The minus sign indicates that the magnitude of the brighter of the two stars has a smaller value than that of the fainter star. Stars brighter than magnitude zero have negative magnitudes. Table 4 lists the infrared magnitudes of the bright primary standard stars on the Wyoming photometric system. It should be noted that we have used the convention recently adopted by most infrared observers where Vega (α Lyrae) is arbitrarily defined to have an apparent magnitude of zero at all infrared wavelengths. The stars in Table 4 will be suitable for calibrating bolometer systems. These detectors, used on a 2- to 3-meter-class ground-based telescope, can typically measure (at a signal-to-noise level of 3 or better) magnitudes as faint as +10 at K, +5 at N, and +2 at Q. Bright comets inside r = 1.5 AU typically will be this bright in a beam or 5$''$ angular diameter centered on the coma. In:Sb spectrophotometers containing $JHKLL'M$ photometric filters and 1-percent resolution, 2- to 4-μm Circular Variable Filter Wheels (CVFWs) are much more sensitive than bolometers at wavelengths from 1 to 2.5 μm where the background power is negligible; they can measure objects with J–K magnitudes fainter than 15-17, depending upon telescope aperture size. The calibration of the InSb systems requires the use of a network of much fainter standards, and linearity issues must be addressed by observing standards having a brightness comparable to that of the unknown source. We give lists of selected intermediate brightness (Table 5) and faint (Table 6) United Kingdom Infrared Telescope (UKIRT) standards to facilitate near-infrared observations with In:Sb systems.

1.1.3.3. Infrared spectroscopy

Infrared spectroscopy is performed at higher resolutions than photometry, and is usually characterized by spectral resolutions of $10^6 \geq \lambda/\Delta\lambda \geq 30$. Moderate-resolution spectroscopy ($\lambda/\Delta\lambda \leq 100$) for $\lambda \leq 20$ μm is often accomplished using cooled circular variable thin-film interference filters (CVFs), for which the wavelength transmitted is a function of angle around the wheel. These are mounted within the dewar as described above for photometry, and are rotated in front of the detector to scan the wavelength interval of interest. Still-higher spectral resolutions, and applications beyond 20 μm, require the use of dispersive optical elements such as reflection gratings or prisms constructed of infrared-transmitting materials. The highest spectral resolutions ($\lambda/\Delta\lambda \geq 10^4$) require Michelson or Fabry-Perot interferometers and heterodyne detection techniques such as are used in radio astronomy. The detectors of choice for most infrared spectroscopic measurements are the photoconductive and photovoltaic detectors described in section 1.1.3.2 (above), since the thermal background is very low at these high resolutions. Despite their superiority at high backgrounds, bolometers suffer from excessive detector noise at lower backgrounds. The calibration data and stars cited in Tables 2-6 are also suitable for calibrating spectra, and the background removal techniques are basically the same as for photometry. In spectrometers that have large format arrays (see section 1.1.3.4, below), the spectra of both the source and sky can be obtained on a single frame along the slit. Even in this case, beam switched AB/BA pairs are usually required to eliminate variable background emission and telescope effects. Wavelength calibration can be obtained using telluric water, ozone, and CO absorption lines and numerous near-infrared airglow emission lines. Extinction corrections such as those described in section 1.1.3.6 can be fine-tuned by iteratively applying equation (27) to null out the telluric emission and absorption features. In general, spectroscopy of sufficiently high spectral resolution ($\lambda/\Delta\lambda$ = 50-100) to study the mineralogy of dust grains (using the 10-μm feature) limits such studies to bright comets that are near or inside r = 1 AU.

Table 2: Infrared Photometric Bandpasses Commonly in Use for Infrared Observations of Comets[1]

	Minnesota/Wyoming Systems						NASA IRTF System[2]		Arizona Systems[2]			
	Gehrz *et al.* 1974		Gehrz *et al.* 1992		Gehrz 1997 (This work)[3]		Tokunaga 1986		Johnson 1965		Campins *et al.* 1985	
Filter	λ_o (μm)	$\Delta\lambda_o$ (μm)	λ_o (μm)	$\Delta\lambda_o$ (μm)	λ_o (μm)	$\Delta\lambda_o$ (μm)	λ_o (μm)	$\Delta\lambda_o$ (μm)	λ_o (μm)	$\Delta\lambda_o$ (μm)	λ_o (μm)	$\Delta\lambda_o$ (μm)
R	-	-	0.9	0.2	-	-	-	-	-	-	-	-
J	-	-	1.2	0.2	-	-	1.2	0.3	1.25	0.37	1.26	0.20
H	-	-	1.6	0.3	-	-	1.6	0.3	-	-	1.60	0.36
K	2.3	0.7	2.2	0.4	-	-	2.2	0.4	2.2	0.6	2.22	0.52
L	3.6	1.2	3.6	1.2	-	-	3.55	1.05	3.5	1.0	3.54	0.97
L'	-	-	-	-	3.8	0.4	3.78	0.57	-	-	-	-
M	4.9	0.7	4.9	0.7	-	-	4.7	0.57	5.0	1.2	4.8	0.60
N	10.0	5.8	10.0	5.8	-	-	10.5	5.	10.2	5.6	10.6	5.
N7	-	-			7.91	0.76	-	-	-	-	-	-
N8	8.7	1.0	8.7	1.0	8.81	0.87	-	-	-	-	-	-
N9	-	-			9.80	0.95	-	-	-	-	-	-
N10	-	-			10.27	1.00	-	-	-	-	-	-
N11	11.4	2.0	11.4	2.0	11.70	1.11	-	-	-	-	-	-
N12	12.6	0.8	12.6	0.8	12.49	1.16	-	-	-	-	-	-
Q	19.5	5.8	19.5	5.8	18	5	20.6	9.	-	-	21.0	11.0
Q23	-	-	23	6	-	-	-	-	-	-	-	-
Q33	-	-	33	22	-	-	-	-	-	-	-	-

[1] Filter bandwidths are Full Width at Half Maximum (FWHM)
[2] As cited in Hanner and Tokunaga 1991
[3] The 6-filter NASA IRTF silicate interferrence filter set (λ_o = 7.91, 8.81, 9.80, 10.27, 11.70, and 12.49 μm) has been installed in several Minnesota/Wyoming Bolometers since June of 1987.

Table 3: Absolute Flux Densities for 0 Magnitude[1]

	Minnesota/Wyoming Systems[2]				IRTF/Arizona Systems[3]			
Filter	λ_0 (μm)	F_λ ($Wcm^{-2}\mu m^{-1}$)	F_ν ($Wm^{-2}Hz^{-1}$)	F_ν (Jy)[1]	λ_0 (μm)	F_λ ($Wcm^{-2}\mu m^{-1}$)	F_ν ($Wcm^{-2}\mu m^{-1}$)	F_ν (Jy)[1]
R	0.9	8.9×10^{-13}	2.40×10^{-23}	2405	-	-	-	-
J	1.2	3.3×10^{-13}	1.72×10^{-23}	1720	1.26	3.03×10^{-13}	1.60×10^{-23}	1600
H	1.6	1.2×10^{-13}	1.02×10^{-23}	1025	1.6	1.25×10^{-13}	1.07×10^{-23}	1067
K	2.2	4.2×10^{-14}	6.78×10^{-13}	678	2.2	4.11×10^{-14}	6.64×10^{-24}	664
K	2.3	3.39×10^{-14}	5.98×10^{-24}	598	-	-	-	-
L	3.6	6.43×10^{-15}	2.78×10^{-24}	278	3.54	6.83×10^{-15}	2.86×10^{-13}	286
L'	3.8	5.25×10^{-15}	2.53×10^{-24}	253	3.80	5.29×10^{-15}	2.55×10^{-24}	255
M	4.9	1.99×10^{-15}	1.59×10^{-24}	159	4.8	2.19×10^{-15}	1.68×10^{-24}	168
N	10.0	1.23×10^{-16}	4.10×10^{-25}	41.0	10.10	1.18×10^{-16}	4.02×10^{-16}	40.2
N7	7.91	3.08×10^{-16}	6.43×10^{-25}	64.3	-	-	-	-
N8	8.7	2.12×10^{-16}	5.35×10^{-25}	53.5	-	-	-	-
N8	8.81	2.02×10^{-16}	5.23×10^{-25}	52.3	-	-	-	-
N9	9.8	1.33×10^{-16}	4.26×10^{-25}	42.6	-	-	-	-
N10	10.27	1.11×10^{-16}	3.91×10^{-25}	39.1	-	-	-	-
N11	11.4	7.35×10^{-17}	3.19×10^{-25}	31.9	-	-	-	-
N11	11.70	6.63×10^{-17}	3.03×10^{-25}	30.3	-	-	-	-
N12	12.49	5.13×10^{-17}	2.76×10^{-25}	27.6	-	-	-	-
N12	12.6	4.96×10^{-17}	2.63×10^{-25}	26.3	-	-	-	-
Q	18	1.21×10^{-17}	1.31×10^{-25}	13.1	-	-	-	-
Q	19.5	8.84×10^{-18}	1.12×10^{-25}	11.2	20.0	7.88×10^{-18}	1.05×10^{-26}	10.5
Q23	23	4.58×10^{-18}	8.08×10^{-26}	8.08	-	-	-	-
Q33	33	1.09×10^{-18}	3.96×10^{-26}	3.96	-	-	-	-

[1] 1 Jy = $10^{-26}Wm^{-2}Hz^{-1}$
[2] Intrepolated using the flux scales given by Gehrz, Hackwell and Jones (1974) and Gehrz, Grasdalen, and Hackwell (1992)
[3] Calculated for the Vega fluxes and magnitudes given by Hanner and Tokunaga 1991

Table 4: Magnitudes of Selected Bright Infrared Standard Stars on the Minnesota/Wyoming Photometric System[1]

Filter	λ_o	*α Lyr*[2] A0V	*α Boo* K2IIIp	*α Tau* K5III	*β Peg* M2II-III	*β And* M0III	*β Gem* K0III	*μ UMa* M0III	*α Sco* M1Ib	*α CMa* A1V	*γ Cru* M3III
I	0.9	0.00	–1.67	–1.31	–0.40	–0.19	–0.11	+0.81	–1.70	–1.43	–
J	1.2	0.00	–2.17	–1.83	–1.09	–0.81	–0.48	–0.08	–3.10	–1.43	–
H	1.6	0.00	–2.91	–2.70	–2.07	–1.75	–1.05	–0.68	–3.80	–1.43	–
K	2.2	0.00	–3.00	–2.84	–2.24	–1.90	–1.12	–0.86	–3.80	–1.43	–3.08
K	2.3	0.00	–3.00	–2.84	–2.24	–1.90	–1.12	–0.86	–3.80	–1.43	–3.08
L	3.6	0.00	–3.11	–2.95	–2.43	–2.06	–1.18	–1.00	–4.10	–1.43	–3.24
L'	3.8	0.00	–3.11	–2.95	–2.43	–2.06	–1.18	–1.00	–4.10	–1.43	–3.24
M	4.9	0.00	–2.97	–2.78	–2.27	–1.86	–1.09	–0.75	–3.90	–1.43	–3.03
N	10.0	0.00	–3.12	–2.94	–2.48	–2.03	–1.16	–0.92	–	–1.43	–
N7	7.91	0.00	–3.12	–2.95	–2.43	–2.01	–1.19	–0.90	–	–1.43	–
N8	8.7	0.00	–3.13	–2.95	–2.43	–2.01	–1.19	–0.90	–4.30	–1.43	–3.26
N8	8.81	0.00	–3.13	–2.95	–2.44	–2.01	–1.19	–0.90	–4.30	–1.43	–3.26
N9	9.8	0.00	–3.13	–2.95	–2.47	–2.02	–1.19	–0.92	–4.80	–1.43	–3.39
N10	10.27	0.00	–3.13	–2.95	–2.49	–2.03	–1.19	–0.92	–4.80	–1.43	–3.40
N11	11.4	0.00	–3.19	–3.02	–2.54	–2.11	–1.19	–1.01	–4.80	–1.43	–3.44
N11	11.7	0.00	–3.19	–3.03	–2.55	–2.07	–1.19	–1.01	–4.80	–1.43	–4.35
N12	12.49	0.00	–3.20	–3.03	–2.55	–2.07	–1.17	–1.01	–4.80	–1.43	–3.51
N12	12.6	0.00	–3.20	–3.04	–2.56	–2.02	–1.16	–1.01	–4.80	–1.43	–3.52
Q	18.0	0.00	–3.17	–3.13	–2.77	–2.08	–1.16	–1.01	–4.80	–1.43	–3.40
Q	19.5	0.00	–3.17	–3.13	–2.77	–2.08	–1.21	–1.01	–4.80	–1.43	–3.40
Q23	23	0.00	–3.17	–3.13	–2.77	–2.08	–1.21	–1.01	–4.80	–1.43	–3.40
Q33	33	0.00	–3.17	–3.13	–2.77	–2.08	–1.21	–1.01	–4.80	–1.43	–3.40

[1] Magnitudes interpolated from data given by Gehrz and Ney (1972), Gehrz, Hackwell, and Jones (1974), Gehrz, Grasdalen, and Hackwell (1992), and Gehrz and Ney (unpublished).

[2] The currently accepted convention is to derive zero points for magnitude scales by assuming that the infrared colors of Vega (α Lyr) and other "average" A0 stars are all equal to zero, and to arbitrarily define Vega to be magnitude zero at all infrared wavelengths (see Bessell and Brett 1988). Normalization between systems can be made by comparing the magnitudes given for Vega. Magnitudes for Vega at 18-23 μm assume a negligible contribution from the debris disk in the small beams typically used in ground-based photometry.

Table 5: Magnitudes of Selected Faint Infrared Standard Stars Suitable for Calibrating InSb JKLL'M Photometers and Imagers

Star	Spectrum	*RA*(1950) h m s	δ(1950) ° ' ''	*J* (1.2 μm)	*H* (1.6 μm)	*K* (2.2 μm)	*L* (3.5 μm)	*L'* (3.8 μm)	*M* (4.8 μm)	Reference[2]
HD 1160	A0	00 13 23.1	+03 58 24	7.060	7.051	7.040	7.05	7.04	-	1, 3
HD 2811	A3 V	00 28 53 .0	–43 52 58	7.178	7.093	7.067	7.040	-	-	1, 3
BS 696	B2 Iae	02 21 43.1	+56 23 04	5.587	5.499	5.443	5.37	5.33	5.31	1, 3
HD 19904	A4 III-IV	03 08 49.1	–39 14 24	6.727	6.662	6.642	6.62	-	-	1, 3
HD 22686	A0	03 36 18.7	02 36 07	7.196	7.190	7.185	7.20	7.19	-	1,3
BS 1552	B2 III	04 48 32.4	+05 31 16	4.029	4.087	4.138	4.18	4.18	4.15	1, 3
HD 38921	A0 V	05 45 41.0	–38 14 51	7.572	7.551	7.536	7.53	-	-	1, 3
HD 40335	A0	05 55 37.6	+01 51 09	6.555	6.473	6.452	6.43	6.43	6.41	1, 3
BD+0°1694	K5	06 52 07.3	+00 00 52	5.750	4.857	4.606	4.43	4.43	-	1, 4
HD 75223	A1 V	08 45 29.8	–39 36 54	7.329	7.296	7.281	7.260	-	-	1, 3
HD 77281	A2	08 59 05.4	–01 16 45	7.111	7.052	7.031	7.00	7.06	6.97	1, 3
HD 84800	A2	09 45 35.9	+43 53 56	7.592	7.549	7.538	7.55	7.54	7.58	1, 3
HD 101452	A2	11 37 45.1	–38 52 09	7.018	6.890	6.848	6.81	-	-	1, 3
HD 106965	A2	12 15 24.0	+01 51 10	7.380	7.337	7.316	7.30	7.34	7.30	1, 3
HD 129655	A2	14 41 11.0	–02 17 38	6.826	6.724	6.692	6.67	6.68	-	1, 3
HD 130163	A0 V	14 44 36.2	–39 43 04	6.856	6.846	6.835	6.81	-	-	1,3
HD 136754	A0	15 19 24.3	+24 31 19	7.155	7.146	7.135	7.14	7.14	-	1, 3
HD 161743	B9 IV	17 45 31.8	–38 06 11	7.620	7.620	7.615	7.61	-	-	2, 3
HD 161903	A2	17 45 43.3	–01 47 34	7.172	7.059	7.023	6.99	7.01	7.14	1, 3
HD 162208	A0	17 46 20.7	+39 59 40	7.223	7.141	7.112	7.09	7.14	7.12	1, 3
BS 7773	B9.5 V	20 17 53.5	–12 55 04	4.825	4.859	4.859	4.86	4.86	-	1, 3
HD 201941	A2	21 10 13.6	+02 26 12	6.696	6.657	6.626	6.60	6.61	-	1, 3
HD 205772	A5 IV-V	21 35 33.6	–41 16 26	7.775	7.688	7.657	7.634	-	-	1, 3
BS 8541	B9 Iab	22 22 29.0	+49 13 21	4.305	4.267	4.235	4.23	4.22	4.22	1, 3
BS 8551	K0 III-IV	22 25 19.6	+04 26 39	2.956	2.378	2.312	2.25	2.24	2.32	1, 3

[2] 1) Walther 1996; 2) Elias et al. 1982; 3) spectral type from the Walther 1996; 4) spectral type from *SIMBAD*

Table 6: Magnitudes of Selected UKIRT Faint Infrared Standard Stars for Calibrating JHK Photometers and Imagers

Star	*RA*(1950)	δ(1950)	*J*	*H*	*K*
	h m s	° ″ ′	(1.2 μm)	(1.6 μm)	(2.2 μm)
FS 01	00 31 22.7	−12 24 29	13.429	13.048	12.967
FS 02	00 52 36.0	+00 26 58	10.713	10.504	10.466
FS 03	01 01 46.6	+03 57 34	12.600	12.725	12.822
FS 04	01 52 03.7	+00 28 20	10.556	10.304	10.264
FS 05	01 52 04.7	−07 00 47	12.335	12.340	12.342
FS06	02 27 39.2	+05 02 34	13.239	13.305	13.374
FS 07	02 54 47.2	+00 06 39	11.105	10.977	10.940
FS 08	02 55 12.9	+00 04 04	7.547	8.184	8.313
FS 09	02 55 38.8	+00 58 54	7.382	8.108	8.266
FS 10	03 46 17.4	−01 07 38	14.749	14.870	14.919
FS 11	04 50 25.4	−00 19 34	11.354	11.294	11.278
FS 12	05 49 34.8	+15 52 37	13.681	13.807	13.898
FS 13	5 54 33.8	+00 00 53	10.517	10.182	10.135
FS 14	07 21 41.2	−00 27 10	14.108	14.182	14.261
FS 15	08 48 2.9	+11 55 02	12.778	12.420	12.360
FS 16	08 48 31.0	+12 00 36	12.971	12.669	12.631
FS 17	08 48 35.4	+12 03 26	12.681	12.343	12.270
FS 19	10 31 14.5	−11 26 08	13.565	13.654	13.796
FS 20	11 05 27.6	−04 53 04	13.353	13.404	13.473
FS 21	11 34 27.6	+30 04 35	12.948	13.031	13.132
FS 33	12 54 35.1	+22 18 08	14.017	14.162	14.240
FS 23	13 39 25.7	+28 44 59	12.997	12.446	12.374
FS 24	14 37 33.3	+00 14 36	10.904	10.772	10.753
FS 25	15 35 59.9	+00 24 03	10.231	9.826	9.756
FS 26	16 34 26.3	−00 28 39	8.830	8.127	7.972
FS 27	16 38 54.2	+36 26 56	13.494	13.181	13.123
FS 35	18 24 44.5	+04 01 17	12.231	11.846	11.757
FS 34	20 39 41.9	−20 15 21	12.819	12.919	12.989
FS 29	21 49 53.0	+02 09 16	13.175	13.271	13.346
FS 30	22 39 11.3	+00 56 55	11.923	11.979	12.015
FS 31	23 09 50.4	+10 30 46	13.798	13.919	14.039
FS 32	23 13 38.2	−02 06 58	13.459	13.576	13.664

Magnitudes from Casali and Hawarden 1992

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1.1.3.4. Infrared imaging

As far as is known, the dust emission from comet comae and tails probably conforms to the area covered by the structures seen in visual light. It is merely the relatively low sensitivity of infrared detection systems that has prevented extensive studies of the distribution of infrared emission in the outer coma and tails. The situation is changing. Until the late 1980s, infrared images of extended sources such as comet comae and tails were constructed by scanning or point-wise mapping with a single detector. Recent advances in solid-state technology have fostered the industrial development of large-format infrared detector arrays of photoconductive and photovoltaic detectors suitable for the low-background conditions attending high-resolution infrared spectroscopy and narrow-band infrared photometry. Sensitive, high-quality In:Sb, As:Si, and Hg:Cd:Te array detectors are now widely available. They have formats of 16 × 64, 64 × 64, 128 × 128, and 256 × 256 pixels — and formats as large as 1024 × 1024 pixels are anticipated for the near-infrared in a few years. The stable of available arrays can cover the 1- to 20-μm spectral region. Some are charge-coupled devices (CCDs), but the best signal-to-noise is obtained with the Direct ReadOut (DRO) devices produced by the Aerojet Corporation, Rockwell International, and Santa Barbara Research Corporation (SBRC). Most of the funding for the development of these arrays came from military-related research funded by the United States' Department of Defense, but NASA's Space InfraRed Telescope Facility (SIRTF) Program has had a substantial impact on the most recent infrared array detector innovations.

Infrared array detectors are now available in infrared imaging cameras and spectrometers at many national (and some private) observatories. Data acquisition and calibration techniques using both imagers and imaging spectrometers follows the arguments outlined in sections 1.1.3.1, 1.1.3.2, and 1.1.3.3 (above), with several caveats. First, since the instrumental response over the spatial field-of-view may be affected by vignetting, adequate background removal requires the acquisition of observations of "flat" intensity fields. These can be obtained either by viewing blank sky or a uniformly-illuminated portion of the telescope dome. Second, the linearity of the response of the pixels must be determined by viewing a calibration lamp that illuminates the array at several light levels covering the dynamic range of the observations. Third, the dark-current (false signal due to creation of carriers in an unilluminated detector) may vary from pixel-to-pixel, so that dark "flats" must be obtained. The calibration sources cited in Tables 2-6 will suffice to deal with infrared imager and imaging-spectrometer data over the range of signal levels required to evaluate detector linearity.

1.1.3.5. Infrared polarimetry

Infrared polarimetry of comets can be a valuable technique for determining the physical properties of the coma and tail material. Since all of the grains and gas molecules in the coma have exactly the same scattering geometry with respect to the sun and earth, regardless of their distance from the nucleus, the percent polarization will be determined only by the size distribution and optical constants of the grains, and by the gas emission. The near-infrared covers the range from almost pure scattering in the J (1.22-μm) band to a combination of scattering and molecular-band emission in the K (2.2-μm) band, to predominately thermal dust emission in the L' (3.8-μm) band. Spectropolarimetry can be used to distinguish the contributions from the gas and dust in various emission features. Observations using both photometers and imagers equipped with wire-grid polarizers and half-wave plates have been employed in recent measurements [see Hanner and Tokunaga 1991]. Calibration and analysis of polarimetric data involves both flux calibration, using objects cited in Tables 2-6, and observations of standard stars whose intrinsic polarization is well known. A standard calibration technique to eliminate the instrumental and interstellar polarization from measurements of a comet is to measure the intrinsic polarizations of faint A-, F-, and G-type stars lying in the same direction in the sky, and whose interstellar polarization component should be nearly zero.

1.1.3.6. Correction for atmospheric extinction

First-order corrections for atmospheric extinction are ordinarily applied to infrared photometric measurements using the relationship

$$f_\lambda(1.00) = f_\lambda(x) \times 10^{0.4A_\lambda(x-1.00)}, \tag{27}$$

where $f_\lambda(1.00)$ is the apparent flux from the source that would be observed through the first airmass at the zenith, $f_\lambda(x)$ is the apparent flux observed for the source through x air masses, and A_λ is the extinction coefficient in magnitudes per airmass. Provided that observations are made at altitude angles above about 10°, the atmospheric path length can be determined with sufficient accuracy by assuming that the atmosphere is a plane parallel slab, so that x for an observation at an altitude angle θ_{alt} is given by:

$$x = \frac{1}{\sin\theta_{alt}}. \tag{28}$$

Note that equation (28) yields a value of 1.00 at the zenith ($\theta_{alt} = 90°$). The value of A_λ is ordinarily determined by repeated observations of the calibration standards during the night, as they rise and set. In the case of spectroscopic measurements, the corrections are somewhat more complex, since the atmospheric absorption is dominated by a plethora of atomic and molecular lines that are individually resolved at the higher spectral resolutions. The attenuation of a signal having a value at the top of the atmosphere of $f_\lambda(0)$ along a path length x can be written as

$$f_\lambda(x) = f_\lambda(0)e^{-\kappa_\lambda x}, \tag{29}$$

where $f_\lambda(x)$ is the signal observed at x, as determined by equation (28), and κ_λ is the linear absorption coefficient of the atmosphere as a function of wavelength in units of cm^{-1}. In principle, telluric absorption lines can be removed from a spectrum using equation (29). As in the case of photometry, κ_λ can be determined empirically by repeated observations of standard stars. Alternatively, one can use model-atmosphere calculations such as those described in Cohen *et al.* [1992] or measured values such as those available in Allen [1973].

Atmospheric absorption in the infrared can be highly variable between nights, and on time scales of several hours on any given night. Average extinction coefficients based on many nights of observing can be used as a last resort to obtain corrections, but it is always better to measure the extinction coefficients for each night upon which a comet is observed. The very best extinction compensation can be obtained when both the comet and the calibration star are measured at nearly the same airmass as closely in time as possible.

1.1.3.7. Normalization of photometric quantities for beam-size, throw, and distance

Comet comae and tails ordinarily have such a large angular extent that it is often mechanically impossible to throw the reference beam far enough from the source so that it falls on completely blank sky. Therefore, the standard beam-switching technique used for background cancellation also reduces the full signal that one would expect from a compact source, centered in the source beam, by the residual amount that an extended source emits into the reference beam. The reconstruction of the full source signal requires a detailed understanding of the surface brightness distribution of the source. We describe here the correction factors applicable to measurements centered on the coma of a comet that obeys the standard model (defined in section 1.1.2, above). The total emission from an optically-thin steady-state coma into a beam or pixel with angular diameter ϕ is proportional to the number of coma grains intercepted by the beam. We described this model in section 1.1.2, above, and concluded (see equation 14) that it leads to a ϕ^{+1} dependence of the coma brightness upon angular radius, and a Δ^{-1} dependence of the coma brightness on geocentric distance. Thus, it follows that the true intensity f_∞ that would be measured in ϕ for a throw sufficiently large for the reference beam to reach blank sky can be recovered from the apparent intensity, f_ψ, observed in ϕ with a throw of angular distance ψ by

$$f_\infty = \left[\frac{4\psi}{4\psi - \phi}\right] f_\psi. \tag{30}$$

The apparent intensities f_1 and f_2 measured in diaphragms with angular diameters ϕ_1 and ϕ_2 at geocentric distances Δ_1 and Δ_2 are related by

$$f_2 = \left[\frac{\phi_2 \Delta_1}{\phi_1 \Delta_2}\right] f_1. \tag{31}$$

Equations (30) and (31) are useful for normalizing measurements made at different times and/or with different detection systems, so that brightness variations caused by the intrinsic activity of the comet nucleus can be evaluated.

REFERENCES

Allamandola, L. J. (1984). in *Galactic and Extragalactic Infrared Spectroscopy*, ed. by M. F. Kessler and J. P. Phillips (Dordrecht: Reidel), 5.

Allamandola, L. J.; A. G. G. M. Tielens; and J. R. Barker (1987). in *Interstellar Processes*, ed. by D. J. Hollenbach and H. A. Thronson, Jr. (Dordrecht: Reidel), 471.

Allen, C. W. (1973). *Astrophysical Quantities*, 3rd ed. (London: Athlone Press).

Becklin, E. E.; and J. A. Westphal (1966). *A.J.* **145**, 445.

Bessell, M. S.; and J. M. Brett (1988). *P.A.S.P.* **100**, 1134.

Campins, H.; G. H. Rieke; and M. J. Lebofsky (1985). *A.J.* **90**, 896.

Campins, H.; and A. Tokunaga (1988). in Hanner (1988), 1-15.

Casali, M. M.; and T. G. Hawarden (1992). "Provisional Faint Standards on the UKIRT System", in *JCMT-UKIRT Newsletter*, No. 3, Aug.; see also the UKIRT Web site at `http://www.jach.hawaii.edu/UKIRT/astronomy/calib/faint_ stds.html`.

Cohen, M.; R. G. Walker; M. J. Barlow; and J. R. Deacon (1992). *A.J.* **104**, 1650.

Elias, J. H.; J. A. Frogel; K. Matthews; and G. Neugebauer (1982). *A.J.* **87**, 1029.

Encrenaz, T.; and R. Knacke (1991). in Newburn *et al.* (1991), **1**, 107.

Fomenkova, M. N.; B. Jones; R. Pina; R. Puetter; J. Sarmecanic; T. J. Jones; and R. D. Gehrz (1995). *A.J.* **110**, 1866.

Gehrz, R. D.; G. L. Grasdalen; and J. A. Hackwell (1992). in *The Encyclopedia of Physical Science and Technology* (New York: Academic Press), **2**, 125.

Gehrz, R. D.; J. H. Hackwell; and T. W. Jones (1974). *Ap.J.* **191**, 675.

Gehrz, R. D.; C. H. Johnson; S. D. Magnuson; and E. P. Ney (1995). *Icarus* **113**, 129.

Gehrz, R. D.; and E. P. Ney (1972). *PASP* **84**, 162.

Gehrz, R. D.; and E. P. Ney (1992). *Icarus* **100**, 162.

Gilman, R. C. (1974). *Ap.J. Suppl. Ser.* **28**, 397.

Hanner, M. S., ed. (1988). *Infrared Observations of Comets Halley and Wilson and Properties of the Grains* (NASA Conference Publication 3004). Washington, DC: NASA Scientific and Technical Information Division. 186 pages.

Hanner, M. S.; J. A. Hackwell; R. W. Russell; and D. K. Lynch (1994a). "Silicate Emission Feature in the Spectrum of Comet Mueller 1993a", *Icarus* **112**, 490.

Hanner, M. S.; D. K. Lynch; and R. W. Russell (1994b). *Ap.J.* **425**, 274.

Hanner, M. S.; R. L. Newburn; R. D. Gehrz; T. Harrison; E. P. Ney; and T. L. Hayward (1990). *Ap.J.* **348**, 312.

Hanner, M. S.; and A. T. Tokunaga (1991). "Infrared Techniques for Comet Observations", in Newburn *et al.* (1991), **1**, 67.

Jewitt, D. (1991). "Cometary Photometry", in Newburn *et al.* (1991), **1**, 19*ff.*

Jewitt, D.; and K. Meech (1986). *A.J.* **93**, 1542.

Johnson, H. L. (1965). *Comm. Lunar Plan. Lab.* **3**, 73.

Low, F. J.; and G. H. Rieke (1974). *Methods. Exp. Phys.* **12A**, 415.

Maas, R. W.; E. P. Ney; and N. J. Woolf (1970). *Ap.J.* **160**, L101.
Ney, E. P. (1974). *Ap.J.* **189**, L141.
Ney, E. P. (1982). "Optical and Infrared Observations of Bright Comets in the Range 0.5 μm to 20 μm", in Wilkening (1982), 323.
Rose, L. A. (1979). *Astrophys. Space Sci.* **65**, 47.
Tokunaga, A. T. (1986). *The NASA Infrared Telescope Facility Photometry Manual.*
Walther, D. (1996). in UKIRT Standards: Revised list MMC 3/3/92, see the UKIRT Homepage at http://www.jach.hawaii.edu/UKIRT/astronomy/calib/ukirt_ stds.html.
Weaver, H. A.; M. J. Mumma; and H. P. Larson (1991). in Newburn *et al.* (1991), **1**, 93.
Woolf, N. J.; and E. P. Ney (1969). *Ap.J.* **155**, L181.
Yeomans, D. K., and R. N. Wimberly (1991). in Newburn *et al.* (1991), **2**, 1281.

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DESIGNATIONS OF RECENT COMETS

Listed below, for handy reference, are the last 30 comets to have been given designations in the new system. The name, preceded by a star (⋆) if the comet was a new discovery (compared to a recovery from predictions of a previously-known short-period comet). Also given are such values as the orbital period (in years) for periodic comets, date of perihelion, T (month/date/year), and the perihelion distance (q, in AU). Four-digit numbers in the last column indicate the *IAU Circular* (4-digit number) containing the discovery/recovery or permanent-number announcement. Not included below are nine recently-discovered comets observed only with the ESA/NASA Solar and Heliospheric Observatory (SOHO) spacecraft that are presumed to be Kreutz sungrazers that are no longer in existence (*IAUC* 6653, 6669, 6676): C/1996 B3, C/1996 Q2, C/1996 Q3, C/1996 S3, C/1996 X1, C/1996 X2, C/1996 Y1, C/1997 B2, and C/1997 K1. [This list updates that in the January 1997 issue, p. 52.]

	New-Style Designation	*P*	*T*	*q*	*IAUC*
⋆	C/1995 Y1 (Hyakutake)		2/24/96	1.05	6279
⋆	P/1996 A1 (Jedicke)	19.3	8/15/95	4.1	6287
⋆	C/1996 B1 (Szczepanski)		2/6/96	1.45	6296
⋆	C/1996 B2 (Hyakutake)		5/1/96	0.23	6299
⋆	C/1996 E1 (NEAT)		7/27/96	1.36	6341
	125P/1996 F1 (Spacewatch)	5.6	7/14/96	1.54	6349
⋆	C/1996 J1 (Evans-Drinkwater)		12/30/96	1.30	6397
⋆	C/1996 N1 (Brewington)		8/3/96	0.93	6428
⋆	P/1996 N2 (Elst-Pizarro)	5.6	4/18/96	2.63	6456
	126P/1996 P1 (IRAS)	13.3	10/29/96	1.70	6446
⋆	C/1996 P2 (Russell-Watson)		3/1/96	2.01	6448
⋆	C/1996 Q1 (Tabur)		11/3/96	0.84	6455
⋆	C/1996 R1 (Hergenrother-Spahr)		8/29/96	1.90	6470
⋆	P/1996 R2 (Lagerkvist)	7.3	1/18/97	2.62	6473
⋆	C/1996 R3		5/30/96	1.8	6564
	127P/1996 S1 (Holt-Olmstead)	6.3	2/6/97	2.15	6475
	128P/1996 S2 (Shoemaker-Holt 1)	9.5	11/20/97	3.05	6477
	129P/1996 U1 (Shoemaker-Levy 3)	7.2	3/4/98	2.82	6494
⋆	C/1997 A1 (NEAT)		6/19/97	3.16	6532
⋆	P/1997 B1 (Kobayashi)	25.2	3/2/97	2.05	6553
⋆	C/1997 BA_6 (Spacewatch)		11/26/99	3.4	6561
⋆	P/1997 C1 (Gehrels)	17.4	1/29/96	3.6	6549
⋆	C/1997 D1 (Mueller)		10/11/97	2.25	6562
	55P/1997 E1 (Tempel-Tuttle)	33.2	2/27/98	0.98	6579
⋆	P/1997 G1 (Montani)	21.8	4/26/97	4.2	6622
⋆	C/1997 G2 (Montani)		4/15/98	3.1	6626
	130P/1997 H1 (McNaught-Hughes)	6.7	2/23/98	2.1	6640
⋆	C/1997 J1 (Mueller)		5/3/97	2.3	6642
⋆	C/1997 J2 (Meunier-Dupouy)		3/9/98	3.0	6648
⋆	C/1997 H2 (SOHO)		5/2/97	0.14	6650

Tabulation of Comet Observations

ERRORS AND PROBLEMS WITH CONTRIBUTED DATA

When a bright, well-observed comet such as C/1995 O1 (Hale-Bopp) comes along, many new observers suddenly appear. Some will continue to observe other comets, and others will not be heard from again; a few may even become among the best and most prolific observers of comets. So encouragement and help is often required, and this is one purpose of the *ICQ*.

But your Editor has been overwhelmed with correspondence in recent months — not only because of the large numbers of daily e-mail messages that each contain only 1 or 2 observations from a single observer, but also because of the return e-mail necessitated by errors in the sending of data. If one takes a "file" to be all of the data sent by a single contributor (whether an Observation Coordinator or a single observer) for a 3-month *ICQ* publication period, I would guess that around 90 percent of all such "files" contributed by e-mail for the *ICQ* have problems. These problems come in three ways: (a) column-formatting errors (where data are place in the wrong columns); (b) abbreviation/unit errors (where the wrong key letters or the wrong units are used); and (c) outright errors in the actual data. I estimate that roughly 50-60 percent of all such files actually have column-formatting errors, even from experienced contributors — which means that the data are *not* being properly checked before sending to the *ICQ*. Corresponding with so many contributors on so many problems is a huge reason why this issue is delayed by two months.

An especially big problem causing delays is that of the descriptive information; a quick perusal at the published descriptive information in the *iCQ* should immediately suggest that there are standard ways of providing this information, and yet many contributors ignore this fact. Descriptive information should be given chronologically, with the date spelled out and abbreviated (Jan., Feb., Mar., Apr., May, June, July, Aug., Sept., Oct., Nov., Dec.), with the year given for the first observation only per comet, and with the date given to 0.01 date (UT) as with the tabulated data. A colon then follows the date, with abbreviation standards along the lines of standard *ICQ*-coded abbrevations (see Keys in *ICQ Guide to Observing Comets* and on *ICQ* Web pages). Information within each date by a single observer is separated by commas, semi-colons, and parentheses, as appropriate (but never by periods, which indicate an end of the descriptive information by that particular observer on that particular date). Each observation ends with the observer's three-letter, 2-digit *ICQ* code given in square brackets, followed by a period. Start the next date of descriptive information on a new line. Things *not* to include in descriptive information: limiting naked-eye stellar magnitude; observing location; *suspected* faint tails, jets, and outer coma. Also, any tabulated information that lacks a magnitude estimate should *only* be included as descriptive information, unless the other categories (coma diameter, DC, tail length, *and* position angle) are all measured and available (if these four quantities are all available in the absence of m_1 data, it is permissable to include them on one line as a tabulated observation).

Observation Coordinators (OCs) need to check and double check every byte of data sent to the *ICQ*. I have said much about care and checking in the pages of the *ICQ* over the years, but this point can not be overstated: the quality of the entire archive depends on carefully checking all of the data at every step, whether at the telescope or contributing data to OCs or sending data to the *ICQ*. The number of simple errors that I find is alarming. This includes the wrong designation, the wrong year, month, date, or fraction of a date; this includes reference codes that do not exist, blatantly-wrong instrumentation (as with the 80-cm, 20× naked-eye data that I got recently), and wrong observer codes. We do our best to catch the problems beforehand, both via visual inspection and automatic computer programs to scan the data for obvious problems, with corrections made prior to publication both with and without consulting the contributors (as deemed appropriate); but many mistakes do get through in published form, and both contributors to and users of this archive need to be aware of this fact. Contributors need to understand that their efforts may be in vain if they do not take the time and care to check data and sort out problems before sending observations to the *ICQ*.

PROPER USE OF KEY LETTERS/ABBREVIATIONS, AND NEW ADDITIONS TO THE KEYS

An example of a subtle problem appears in the pages of this issue, one that I caught in the course of preparing these final pages for printing, therefore deciding to include the observations herein and remark on the problem: Under the "Key to Magnitude Methods", we have for some years listed the letter 'G', intended to indicated that eyeglasses were used to defocus comet and/or comparison stars; however, this is not really a "method" and has now been moved to the "Special Notes Key" (as we will probably do for a few more letters in the near future). One still needs to provide a method when noting code 'G', and none of the corresponding observations in this issue do this properly; I elected to keep the 'G' observations that appear in this issue because they were all made of C/1995 O1 when it was quite bright with a rather small coma, meaning that I assume they were all made with the VBM method (code 'B').

In connection with this, I have also added a related special-notes code, 'f', which denotes the use of a single 50-mm binocular lens to defocus the comet and comparison star, also used when C/1995 O1 was brighter than mag +1. Yet another special-notes key, '%', has been added to denote that a conversion was made for comparison stars from V to visual magnitude, using the B-V color and either the formula by Howard and Bailey (1980, *JBAA* **90**, 265) or that by Stanton (1981, *JAAVSO* **10**, 1), both of which are given in the first edition of the *ICQ Guide to Observing Comets*, page 65; when making such an application, the cited reference for comparison stars should also be used (meaning that really only actual catalogues can be used, as opposed to charts with magnitudes inscribed thereon).

With bright comets, some observers have attempted m_1 estimates visually either with camera lenses alone or a camera lens attached to a camera (viewing the comet and comparison stars on the camera's viewing screen); in such cases, for the standard *ICQ* tabulation, use instrument code letter 'A' for camera lens and insert a '0' (zero) under magnification, so that columns 44-47 read '   0'.

Again, time has not permitted observations contributed on paper to be entered into the computer; such observations should appear in the July issue. — *D. W. E. Green*

Descriptive Information, to complement the Tabulated Data (all times UT):

◇ *Comet 46P/Wirtanen* ⟹ 1997 Feb. 25.73: possible outburst of ~ 0.7 mag [BAR06]. Mar. 1.77: clear enhancement w/ Lumicon SB Filter [MEY]. Apr. 15.13: central cond. of mag 13.4 and dia. ~ 3″; coma, although strongly asymmetrical toward p.a. 85°, gave only a slight hint of the possible beginning of a short, recognizable tail [ROQ].

◇ *Comet 81P/Wild 2* ⟹ 1997 Jan. 13.16: extremely obvious object; strong cond.; faint outer coma opens towards WNW, possible tail; T Cnc AAVSO seq. (1986); star of mag 4.7 some 20′ away [PER01]. Jan. 15.02: comet easy, but star of mag 4.7 some 10′ away; T Cnc AAVSO seq. (1986) [PER01]. Feb. 1.08: "sequence AAVSO U Gem (this applies to all of my 81P obs." [GRA04]. Feb. 3.03: U Gem AAVSO seq.; central cond. not as sharp as two weeks ago, yet still quite strong, looking like a fuzzy star; tail pointing E suspected but not confirmed [PER01]. Feb. 3.49: w/ 25.4-cm L (71×), comet appeared very condensed; fainter using Swan Band filter [SEA]. Feb. 3.97: coma opens towards W (i.e., sunwards); comet close to star of mag 5.4; U Gem AAVSO seq. [PER01]. Feb. 3.97: circular coma with prominent central cond.; U Gem AAVSO seq. [VIT01]. Feb. 4.42: most light from a condensed central region of dia. ≈ 2′; this appeared to be surrounded by a fainter outer coma with a difficult-to-define boundary [SEA]. Feb. 5.47: comet near star; outer coma not visible and inner region appeared very small [SEA]. Feb. 9.02: with MM = S, m_1 = 10.2; outer coma edges ill-defined; looks more diffuse, still strong cond. but not so dominating; completely different from the relatively sharp-edged coma plus strong starlike central cond. seen in previous obs.; U Gem AAVSO seq. [PER01]. Feb. 9.96: coma edges ill-defined; still nearly starlike central cond.; U Gem AAVSO seq [PER01]. Feb. 10.91: photometry w/ 36-cm *f*/6.7 T + *V* filter + CCD [MIK]. Feb. 15.94: coma edges ill-defined; still 12th-mag, weak, nearly-starlike nucleus; moonlight, moon nearby; U Gem AAVSO seq.; coma could be as large as 2′.2 [PER01]. Feb. 27.94: U Gem AAVSO seq.; coma edges ill defined; very faint, 13th-mag starlike nucleus; central cond. like a globular cluster superimposed on a large diffuse coma [PER01]. Mar. 1.86: w/ 0.33-m L, m_2 = 13.8 [SZE02]. Mar. 3.46: estimate influenced by nearby star; w/ 25.4-cm L (114×), elongation or short tail in p.a. ≈ 110°; central cond. did not appear as sharply defined as it had in early Feb. [SEA]. Mar. 3.88: central cond. offset towards p.a. ~ 320°; fan-shaped outer coma suspected; U Gem AAVSO seq [PER01]. Mar. 9.83: w/ 20-cm T (166×), false nucleus of mag 13.5 in a well-condensed coma [KAM01]. Mar. 11.46 and 12.42: comet appeared fainter through Swan-band filter on Mar. 12 [SEA]. Mar. 11.79: elongated coma [MEY]. Mar. 31.88: comet involved with stars [PER01 and VIT01]. Apr. 1.80: at 230×, 8′ dust tail in p.a. 75° [SAR02]. Apr. 1.85: disk-like inner coma dia. 3′.5, fan-like outer coma dia. 6′ [BAR06]. Apr. 7.88: comet involved w/ 12th-mag star [BOU]. Apr. 29.90: coma opens towards ESE; very faint stellar pseudo-nucleus offset towards WNW; T Cnc AAVSO seq [PER01].

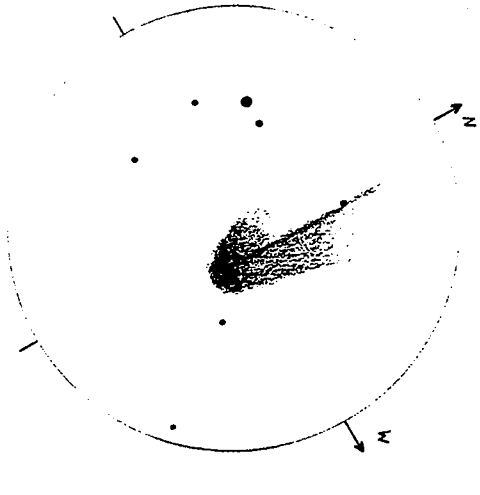
◇ *Comet 109P/Swift-Tuttle* ⟹ 1992 Nov. 27.78: w/ 10×50 B, m_1 = 4.8, 3′ coma, DC = 7, 0°.20 tail in p.a. 57° [DOH]. 1992 Nov. 28.77: w/ 15-cm *f*/2 T (25×), 3′ coma, DC = 5/, m_1 = 4.8 (MM = S), 0°.25 tail in p.a. 55° [DOH].

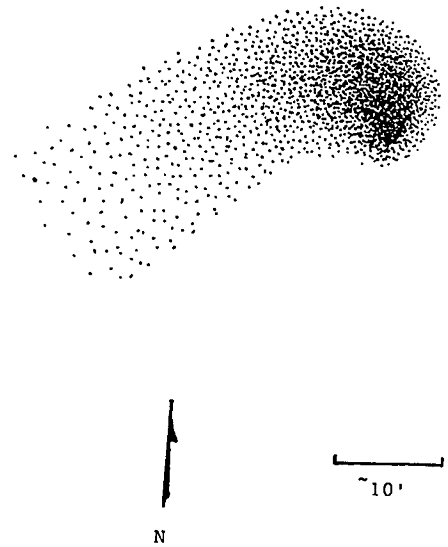
◇ *Comet 118P/Shoemaker-Levy 4* ⟹ 1997 Feb. 3.46: not seen using Swan Band filter [SEA].

◇ *Comet C/1995 O1 (Hale-Bopp)* ⟹ 1996 June 7.98: w/ 20-cm T (51×), m_1 = 7.6 (Ref: S); at 225×, $m_1 \simeq$ 8.3 [NIE01 = Detlev Niechoy, Goettingen, Germany]. June 9.03: w/ 20-cm T (170×), $m_1 \simeq$ 8.3 [NIE01]. June 14.01: w/ 20-cm T (51×), $m_1 \simeq$ 8.0 [NIE01]. June 15.01: w/ 20-cm T (51×), $m_1 \simeq$ 7.8 [NIE01]. July 15.98, 16.94, and 17.98: w/ 10×50 B, m_1 = 5.8, 5.5, and 5.7 (MM = S; Ref = *PPM Star Catalogue*, Röser and Bastian 1991, unacceptable for visual magnitude work); 20′ coma, DC = 3 [MCK]. Aug. 2.82: w/ 25.4-cm T, comet appears extremely condensed, w/ coma extending broadly towards the NNE [TAN02]. Aug. 3.81: fanned eastward [TAN02]. Aug. 10.85: w/ 20×70 B, broad tail 0°.6 long in p.a. 107° [TAN02]. Sept. 4.78: coma elongated toward the NE or NNE [TAN02]. Sept. 6.78: coma elongated toward E [TAN02]. Sept. 7.80: w/ 20×70 B, coma dia. 12′, DC = 5, coma fanned for 16′ toward p.a. 50° [TAN02]. Sept. 30.79: w/ 20×70 B, tail 0°.9 long in p.a. 71°; broad fan seen adjacent to the main tail, 0°.4 long in p.a. 43° [TAN02]. Oct. 8.78: w/ 20×70 B, 1°.2 tail in p.a. 70°; comet near 6th-mag star; bright appendage to tail, 0°.9 long in p.a. 83° [TAN02]. Oct. 16.45: three tails visible w/ a 20-cm *f*/9 L (45×) — 1°.4 long in p.a. 50°-55°, 1°.2 long in p.a. 85°-115°, and 40′ long in p.a. 85° [NAG04]. Nov. 4.41: four tails visible w/ a 20-cm *f*/9 L (45×) — 1°.25 long in p.a. 50°-55°, 1°.1 long in p.a. 95°-105°, 25′ long in p.a. 80°, and 40′ long in p.a. 100°-110° [NAG04]. Nov. 7.74: w/ 20×70 B, 1°.4 tail in p.a. 72° [TAN02]. Dec. 14.37: w/ 20.0 *f*/9 C (45×), coma dia. 3′.1, DC = 7, tail ~ 2° long [NAG04].

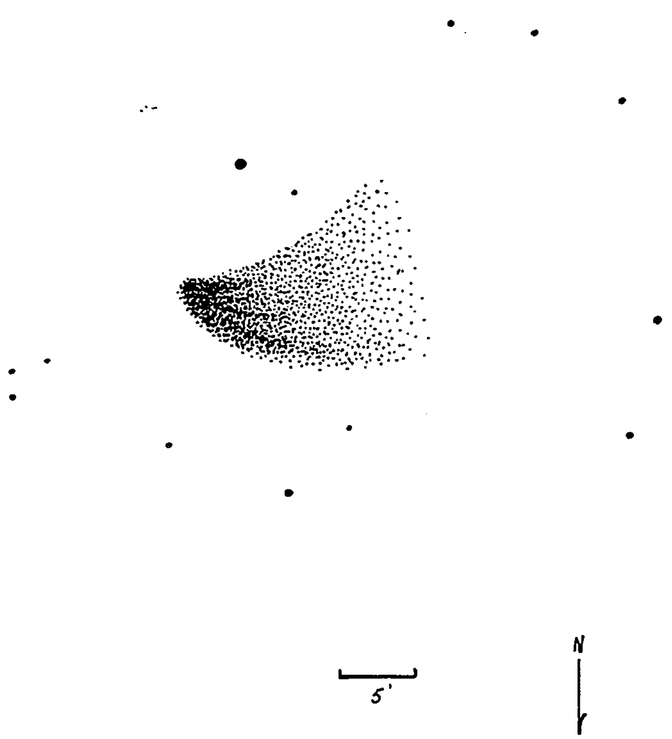
1997 Jan. 12.21: w/ 11×80 B, 0°.5 tail in p.a. 78° [ELT]. Jan. 16.27: w/ 13×60 B, $m_1 \simeq$ 4.5 (ref = AA), 3′ coma, DC = 6, 0°.5 tail in p.a. 345° [HEN]. Jan. 25.25: w/ 13×60 B, $m_1 \simeq$ 4.0 (ref = AA) [HEN]. Jan. 26.84: broad dust tail, 1°.0 long in p.a. 275° and 0°.8 long in p.a. 25° [SHI]. Jan. 30.84: broad dust tail, 1°.2 long in p.a. 265° and 0°.3 long in p.a. 10° [SHI].

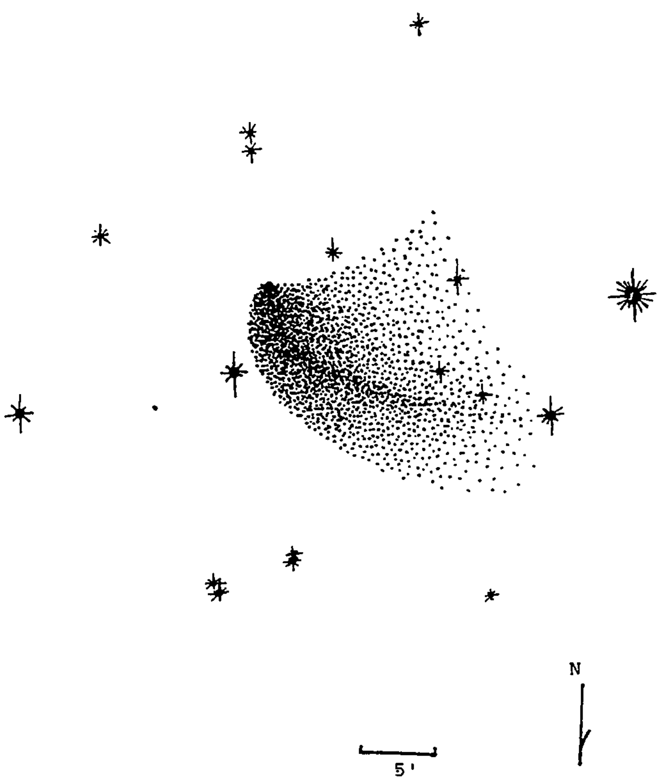
Feb. 1.23: w/ 25.6-cm *f*/5 L (84×), stellar nucleus of mag 6.8; main jets between p.a. 160° and 240°, curving towards p.a. 280°, w/ fainter narrow jet in p.a. 27° [BIV]. Feb. 1.23: "w/ 10×50 B, the m_2 refers the the bright, nearly-stellar central cond. (this applies to all of my m_2 estimates w/ 10×50 B); the comet remained visible until the true solar alt. was −5°.7 (civil twilight); w/ 25.4-cm L (108×), central cond. was detectable until solar alt. −3°.0" [GRA04]. Feb. 1.24 and 3.23: w/ 7×50 B, 15′ coma, DC = 7/, 4° tail [SKI]. Feb. 2.22-2.23: w/ 10×50 B, tail was clearly seen for ~ 1°, difficult after ~ 2°; there was also a shorter tail 0°.5-1°.0 long, oriented ~ 30° W of the main tail; the sunward part of

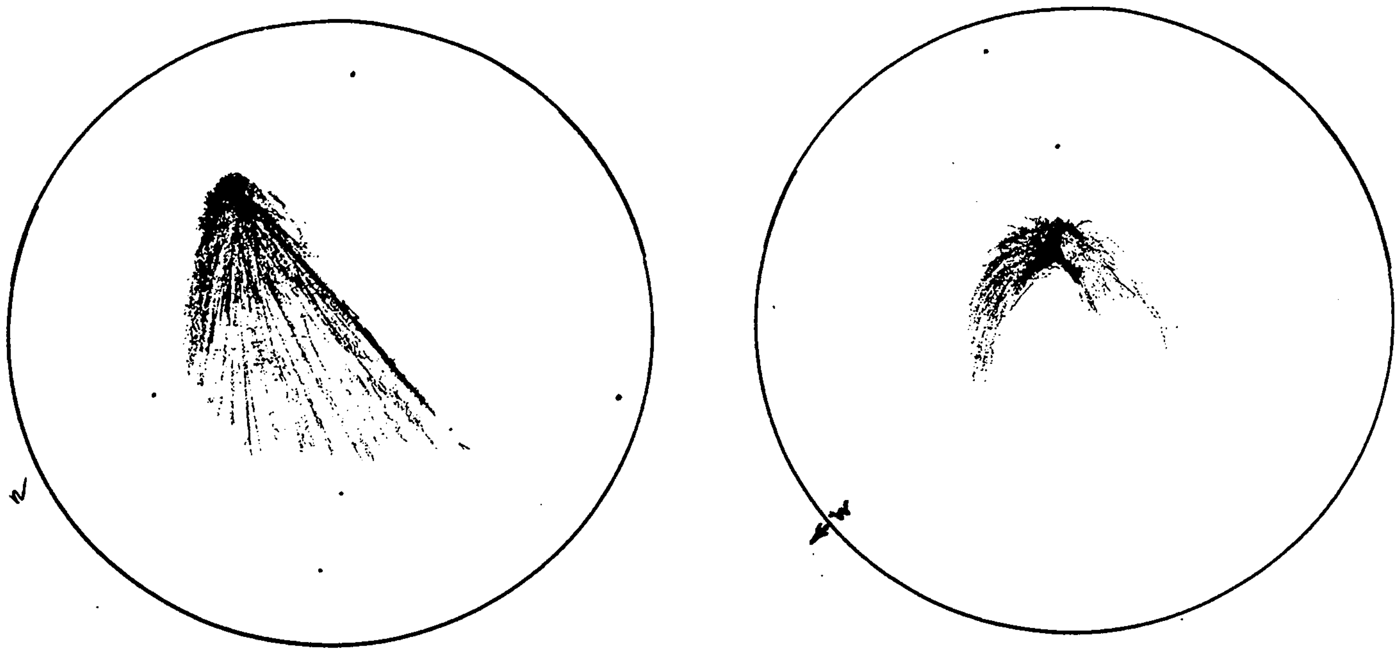




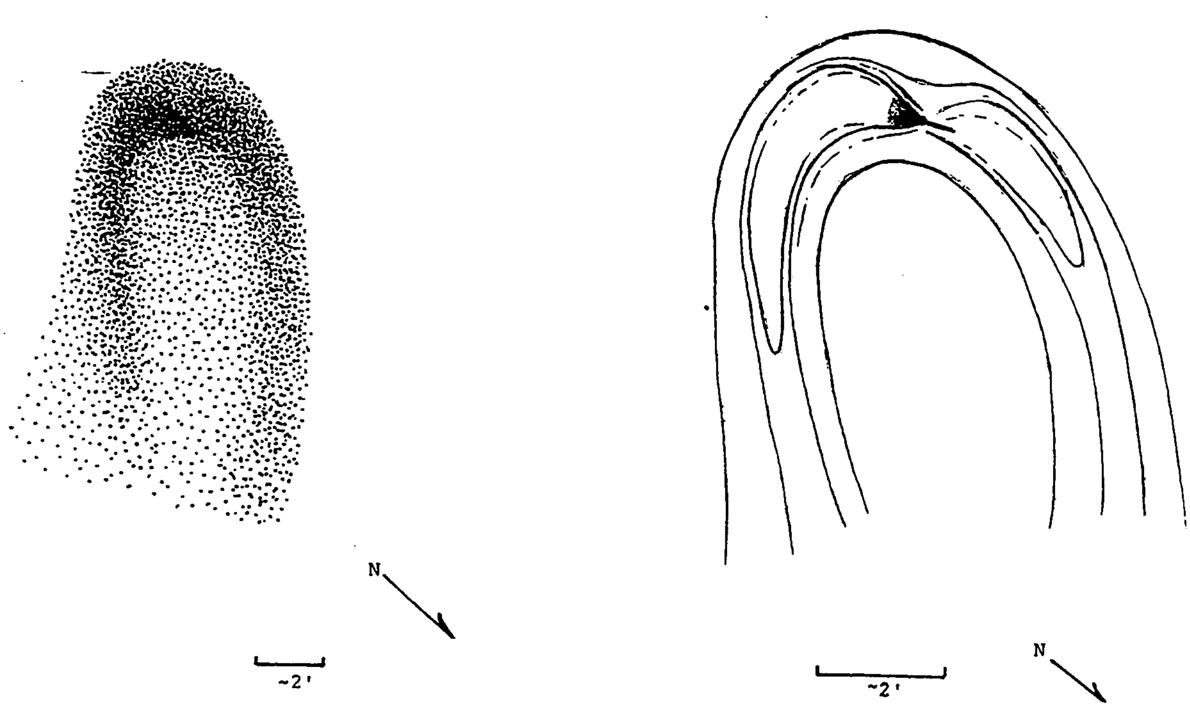
Four drawings of comet C/1995 O1 (Hale-Bopp) in 1996. Clockwise from upper left: **(1)** *Observation by Martin Lehký (Hradec Králové, Czech Republic) with a 20-cm refractor at 140× on 1996 June 7.96; the northward jet was some 8′ long.* **(2)** *Stipple drawing by John E. Bortle (Stormville, NY) with 10×50 and 20×100 binoculars on Aug. 11.10.* **(3)** *Drawing by Bortle on Sept. 15.04 with a 41-cm reflector at 70×.* **(4)** *Drawing by Bortle on 1996 Oct. 31.99 with a 41-cm reflector at 70×.*







Above: drawings of C/1995 O1 by Richard Didick (code DID) with a 25-cm f/4.5 L at 46× on 1997 Jan. 12 (left) and at 162× on Jan. 29.43 (right); the Jan. 29 drawing shows a field 10' across, and west is to the lower left. Below: stipple (left) and pseudo-isophoto-contour (right) drawings of C/1995 O1 by John Bortle (code BOR) from his visual observations with a 41-cm L (56×-114×) on Jan. 29.44.



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◇ *Comet C/1995 O1 (Hale-Bopp) [text continued from page 75]* ⟹

the coma had a parabolic outline; observing somewhat hampered by clouds and twilight [GRA04]. Feb. 2.23: in 7×50 B, DC = 8; besides faint 3° gas tail in p.a. 330°, very complex, broad dust tail; most material in a fan spanning p.a. 335°-290°, but maybe extending as far as p.a. 240° (longest 1°.4 in p.a. 315°) [BOU]. Feb. 2.49: tail was fan-shaped, w/ the first ~ 1° of tail spanning p.a. ~ 330°-270°; the main tail component was distinctly yellow in color, and may have

◇ *Comet C/1995 O1 (Hale-Bopp) [text continued from page 77]* ⟹
extended beyond the 3° listed; in 7×50 B, the head was roughly parabolic in outline, w/ the near-stellar central cond. offset slightly to the S side; moonlight [ADA03]. Feb. 3.13 and 5.14: w/ 8.0-cm *f*/10 R (40×), coma dia. 15'.6-16', DC = S7 [GER01]. Feb. 3.17: w/ naked eye, second tail 2° long, visible as a faint fan [MAN01]. Feb. 3.19: photometry w/ 180-mm-f.l. *f*/2.8 lens + *V* filter + CCD; two YF standard stars inside the comet field used [MIK]. Feb. 3.20 and 4.21: photometry w/ 90-mm-f.l. *f*/4 lens + *V* filter + ST-6 CCD; two YF standard stars inside the comet field used [MIK]. Feb. 3.20: diffuse dust tail in p.a. ~ 215°-320°, ion tail at least ~ 3° long in p.a. ~ 320°; w/ naked eye, straight tail ~ 12° long in p.a. ~ 330° [MIK]. Feb. 3.20: second tail 0°.6 in p.a. 300° [HOR02]. Feb. 3.23: w/ 7×50 B, 15' coma, DC = 7/, 4° tail [SKI]. Feb. 4.14: w/ 12×80 B, several ray-like extensions 1°.5-2° long visible in coma and tail [BAR06]. Feb. 4.18, 7.21, 8.19, and 10.19: photometry w/ 180-mm-f.l. *f*/2.8 lens + *V* filter + CCD; one YF standard star inside the comet field used [MIK]. Feb. 4.21: diffuse dust tail in p.a. ~ 215°-320°, ion tail at least ~ 3° long in p.a. ~ 320° [MIK]. Feb. 4.23: w/ 7×50 B, tail was at least 4° long; coma was parabolic; several jets seen near the central cond., and the central cond. and coma appeared yellowish against the bright morning sky; w/ naked eye, the comet was visible until solar alt. was −6°.9 [SKI]. Feb. 4.23: w/ 7×50 B, 15' coma, DC = 7, 4° tail [SKI]. Feb. 4.72: evening obs.; alt. 6°; comet was visible to naked eye [GRA04]. Feb. 4.88: image taken w/ 60-cm Y + CCD (two 5-sec exp. co-added) and enhanced w/ rotational gradient filter shows three bright jets in p.a. 31°, 166°, and 209°, and two faint ones in p.a. 88° and 320° [NAK01].

Feb. 5.19: a N component to the tail is seen (1°.3 long in p.a. 328°); w/ 20×70 B, two curving jets are seen issuing from the 'nucleus' (the N one is 6' long, while the other is 11' long) [TAN02]. Feb. 5.22: w/ naked eye, the comet was visible until solar alt. was −6°.9; w/ 7×50 B, 15' coma was parabolic, DC = 7/, 5° tail; the first 2° of the tail was fan-shaped and relatively bright, the rest of it was faint [SKI]. Feb. 5.23-5.24: w/ 10×50 B, the coma showed a parabolic outline in sunward direction; there was no clear distinction between coma and tail (the 'coma' size has been measured ⊥ to radius vector and through the central cond.); the first part of the tail was broad and fan-shaped [GRA04]. Feb. 6.19: N component to tail 1°.9 long in p.a. 325°; the two jets seen yesterday are visible (the N one is shorter and barely detectable; the S jet is very evident, measuring 21') [TAN02]. Feb. 6.22: w/ 10×50 B, the central cond. was bright and nearly stellar (dia. < 1'); the coma had a parabolic outline towards the sun; tail bright for 1°, the rest being faint; w/ 20.3-cm T (123×), two tail components were seen, the W part was strongly curved; in the central cond., there was a bright jet directed towards p.a. ~ 250° (clearly curved, apparently towards the W tail); there was an obvious darkness behind the inner coma and between the tail components [GRA04]. Feb. 6.22: w/ 7×50 B, 15' coma, DC = 7/, 5° tail [SKI]. Feb. 6.25: w/ 25.6-cm *f*/5 L (169×), stellar nucleus with bright material at 15" from p.a. 160° to 210°, giving a '?'-like shape; bright jets in p.a. 30°, 160°, 190°, and 210° [BIV]. Feb. 7.12: second 'dust' tail 1° in p.a. 300° [PLS]. Feb. 7.20: w/ 9×63 B, broad dust tail ~ 1°.0 long spanning p.a. 270°-330° and ion tail 3°.5 long in p.a. 327°; central cond. of mag ~ 4.5; w/ 9-cm T (56×), false nucleus of mag ~ 6 w/ a broad fan of bright material at p.a. 215° and a faint jet at p.a. ~ 25°; immediately behind the false nucleus the brightness of the coma dropped significantly; coma resembled a parabola [KAM01]. *(text continued on next page)*

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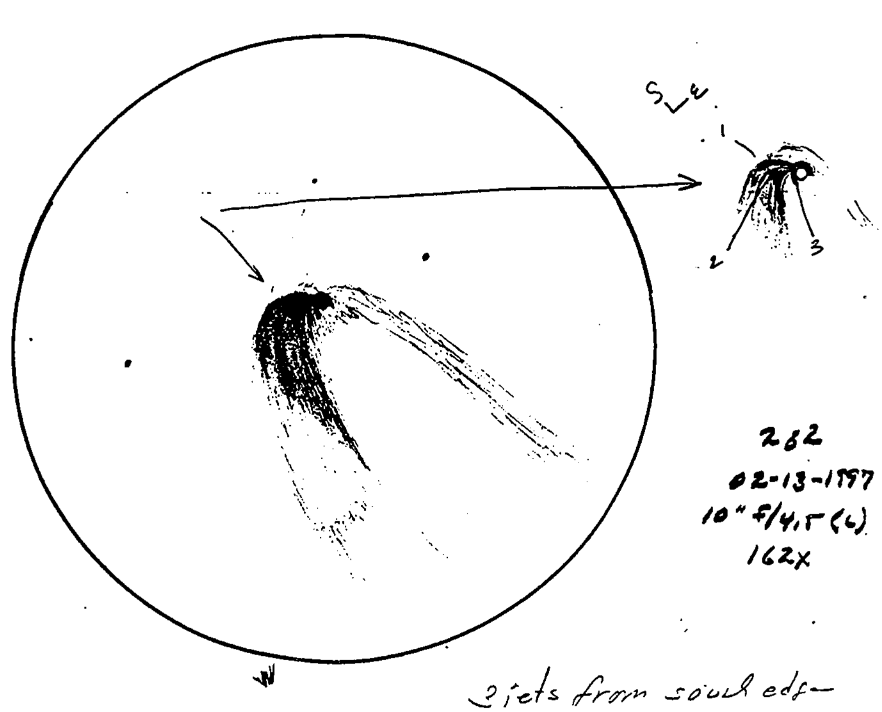
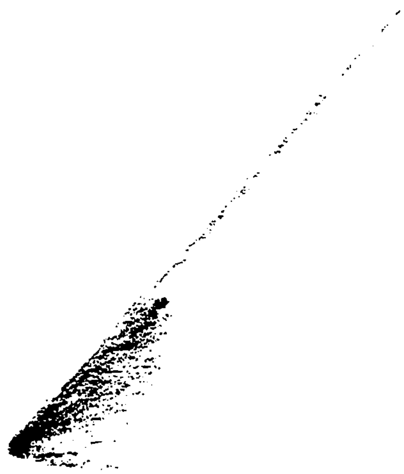
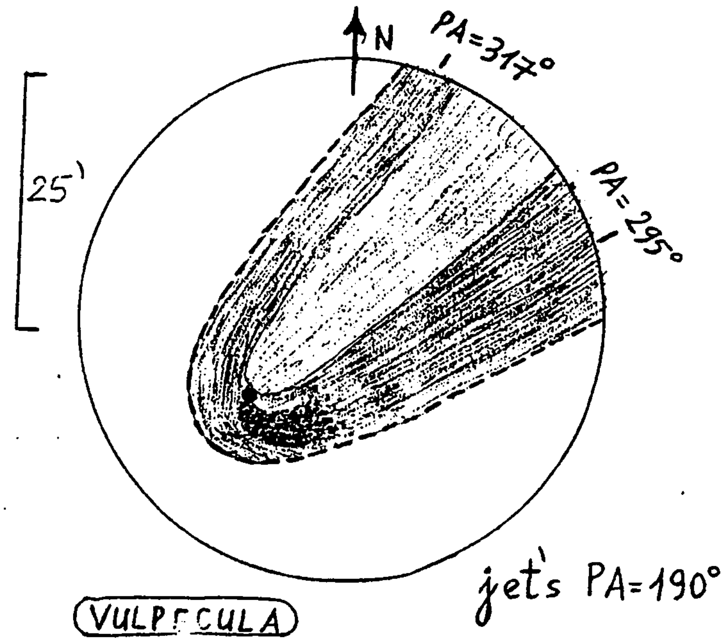
Below: drawing of comet C/1995 O1 by Richard Didick (Taunton, MA) with a 25-cm f/4.5 L (162×) on 1997 Feb. 13. West is to the lower left, and south is to the upper left.







Above: Drawings of C/1995 O1. At left is a sketch of the field seen in 7×35 B by Margareta Westlund (Uppsala, Sweden) at daybreak on 1997 Feb. 17.19. At right is a drawing on Feb. 17.18 by Attila Kósa-Kiss (Salonta, Romania), from his view through a 6.3-cm Zeiss R (52×).

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◇ *Comet C/1995 O1 (Hale-Bopp)* *[text continued from page 78]* ⟹
Feb. 7.21, 8.19, and 10.19: *V* CCD imaging w/ 180-mm-f.l. *f*/2.8 lens shows an ion tail at least ~ 3° long in p.a. ~ 320° and a diffuse fan-like dust tail in p.a. ~ 240°-320° [MIK]. Feb. 7.22: w/ 7×50 B, the tail was quite bright for 3°, certainly seen for 6°, and possibly visible to 7° [SKI]. Feb. 7.73: evening obs.; alt. 7°; w/ naked eye, comet was clearly visible, and despite similar viewing conditions much easier than during evening obs. in late Jan.; w/ 10×50 B, the comet was bluer and much brighter than nearby γ Sge [GRA04]. Feb. 8.17: w/ 12×80 B, 35′ coma, DC = S6 [BAR06]. Feb. 8.20: dust tail 1° in p.a. 280° [KYS]. Feb. 8.21: w/ naked eye, γ Sge was located close to the comet, but the objects were clearly separated; w/ 7×50 B, 15′ coma, DC ≐ 7/, 7° tail [SKI]. Feb. 8.22: in 7×50 B, DC = 8; besides 5° gas tail in p.a. 322°, very complex, broad dust tail; most material in a fan spanning p.a. 335°-275° (longest ~ 2°.0 in p.a. 305°) [BOU]. Feb. 8.22-8.24: w/ 10×50 B, two tails were seen, one being 0°.7 long in p.a. 276°; w/ 20.3-cm T (123×), there was a bright, fan-shaped jet directed from the bright central cond. at p.a. ~ 250° (its width was ~ 30° and it was curved towards the preceding tail component); a fainter and more diffuse jet was seen at nearly the opposite direction (p.a. ~ 60°); both tail components appeared strongly curved; there was an obvious darkness between the tail components (mean p.a. of this dark area was 325°); the central cond. was very small, but not quite stellar; the comet formed a beautiful pair w/ γ Sge, though the comet was much bluer than this red-orange star [GRA04]. Feb. 8.74: evening obs.; alt. 5°.5; w/ 10×50 B, the surface brightnesses of inner coma (excluding the bright central cond.) and inner tail (at ~ 0°.5 from central cond.) were estimated as ~ 14.0 and 17.5 mag/arcsec^2; as a comparison, the surface brightness of the central region of M31 was estimated as ~ 19.5 mag/arcsec^2; comet was clearly visible to naked eye [GRA04]. Feb. 9.17: w/ 12×80 B, star-like nucleus $m_2 \simeq 5$, fan-shaped dust tail more than 2° long in p.a. 300°-260° (brightest part in p.a. 290°) [MAN01]. Feb. 9.19: excellent conditions; the dust tail is shorter but wider, and extends for 2°.3 (its trailing edge points toward p.a. 293°); a short (0°.6) but very wide (spreading from p.a. 279° to 241°) fan is visible w/ averted vision; the two jets seen in the last few days are again visible in 20×70 B — they curve upwards to form the tail; the S jet is longest and most distinct, extending for 22′; also extending toward the SW is a wide and bright fountain [TAN02]. Feb. 9.26: in 25.3-cm L (58×), central cond. is a minute planetary-like disk near the resolution limit; from this disk emerges a very bright, extremely prominent fountain, strongly curving anti-clockwise into the tail; the coma has a distinct blue tint; the shape is somewhere between parabolic and pear-shaped; a bright envelope includes the fountain on its W side, the inner border of this envelope being sharply defined and passing through the false-nucleus; just inside of this envelope, there is a striking 'hollow'; the 2′-3′ fountain leaving the nucleus to the SW was still visible ~ 15 min before sunrise; the nucleus was lost 1 or 2 min before sunrise (at sunrise, γ Sge at m_v ~ 3.5 was still easy); with 9×34 B, DC = 8, parabolic hollow tail spanning p.a. 280°-335°; central cond. like a fuzzy star near focus of parabola [PER01]. Feb. 9.26: in 25.3-cm L f/5.6 (58×), a bright prominent fountain (initially to the WSW) was present, curving anti-clockwise back into the tail; both the fountain and the false-nucleus, were distinctly blue colored; this false nucleus looked like a very bright small disk with

◇ *Comet C/1995 O1 (Hale-Bopp) [text continued from page 79]* ⟹
well-defined limits; the coma had a near-parabolic shape and showed a slightly brighter zone (or envelope) surrounding and including the fountain and the false nucleus; a large teardrop-shaped area inside the coma was very dark (the outline of this area was quite contrasting, grazing the false-nucleus and the curved fountain); the dark area, though gradually not so well-defined, continues through the tail, making its outer parts seem more prominent [VIT01]. Feb. 9.74: evening obs.; alt. 6°; mag uncertain due to thin clouds, some auroral light, and corrections for extinction; w/ 7×50 B, DC = 8, 1°.5 tail [SKI]. Feb. 9.84: w/ 8×56 B, coma dia. 17′, DC = 8, tail > 5° long [OKA05]. Feb. 9.87: image taken w/ 60-cm Y + CCD (two 3-sec exp. co-added) and enhanced w/ rotational gradient filter shows three bright jets in p.a. 31°, 171°, and 219°, and two faint ones in p.a. 92° and 315° [NAK01].

Feb. 10.18: excellent conditions; the tail looks essentially the same as on Feb. 9; the dust tail extends for 2°.3, w/ its S edge now pointing toward p.a. 280°; the short fan is less pronounced today; the jets on both sides of the 'nucleus' give a 'U' shape to the coma; the S jet is 0°.5 long [TAN02]. Feb. 10.24: quite bright sky in nautical twilight (solar alt. −11°.6); w/ naked eye, comet was visible until solar alt. −6°.3; w/ 7×50 B, 15′ coma, DC = 7/, 2° tail [SKI]. Feb. 10.26: in 25.3-cm L *f*/5.6 (58×), the fountain seemed not so strongly curved than in previous obs.; next to central cond., there was clearly a small bright 'spot' towards N-NE; coma brightness definitely asymmetric, as a brighter zone incl. the fountain and the first deg/minutes of tail on its W side; in 9×34 B, the coma showed a very narrow parabolic shape, the central cond. being slightly offset towards SW; DC = 7; slight green tint [VIT01]. Feb. 11.18: w/ naked eye, 8° tail in p.a. 312°; the dust tail is best seen w/ 12×50 B and measures 4° in length (its trailing edge points toward p.a. 288°) [TAN02]. Feb. 11.21: poor sky w/ heavy cloud; w/ 10×50 B, DC = 7, 2° tail in p.a. 318° [GRA04]. Feb. 11.21: in 7×50 B, DC = 7-8; besides 5°.5 gas tail in p.a. 318°, broad dust tail spanning p.a. 325°-275° (longest ~ 1°.7 in p.a. 300°) [BOU]. Feb. 11.74: evening obs.; alt. 5°.5; comet clearly visible to naked eye [GRA04]. Feb. 11.74: evening obs.; alt. 6°; comet was clearly brighter and easier to see than two evenings ago; w/ 7×50 B, DC = 7/, 3° tail [SKI]. Feb. 11.79: w/ 20×125 B, coma dia. 20′, DC = 8, tail 0°.6 long in p.a. 310° [TOY]. Feb. 11.82: broad dust tail, 1°.5 long in p.a. 290° and 0°.8 long in p.a. 330° [SHI]. Feb. 12.06: w/ 11-cm L (32×), $m_2 \sim 6$ [IVA03]. Feb. 12.16: w/ 6.7-cm *f*/1.8 A, 1-min exp. on 100 ASA film shows narrow tail 3°.6 long in p.a. 324° and second fan-like tail 2°.0 long spanning p.a. 320°-300° [FIL05]. Feb. 12.18: dust tail stretches for 3° in p.a. 288°; ion tail glimpsed momentarily w/ the naked eye; the S jet is very evident; it seems to be the main source of the dust tail; obs. made through gaps in the clouds [TAN02]. Feb. 12.20:

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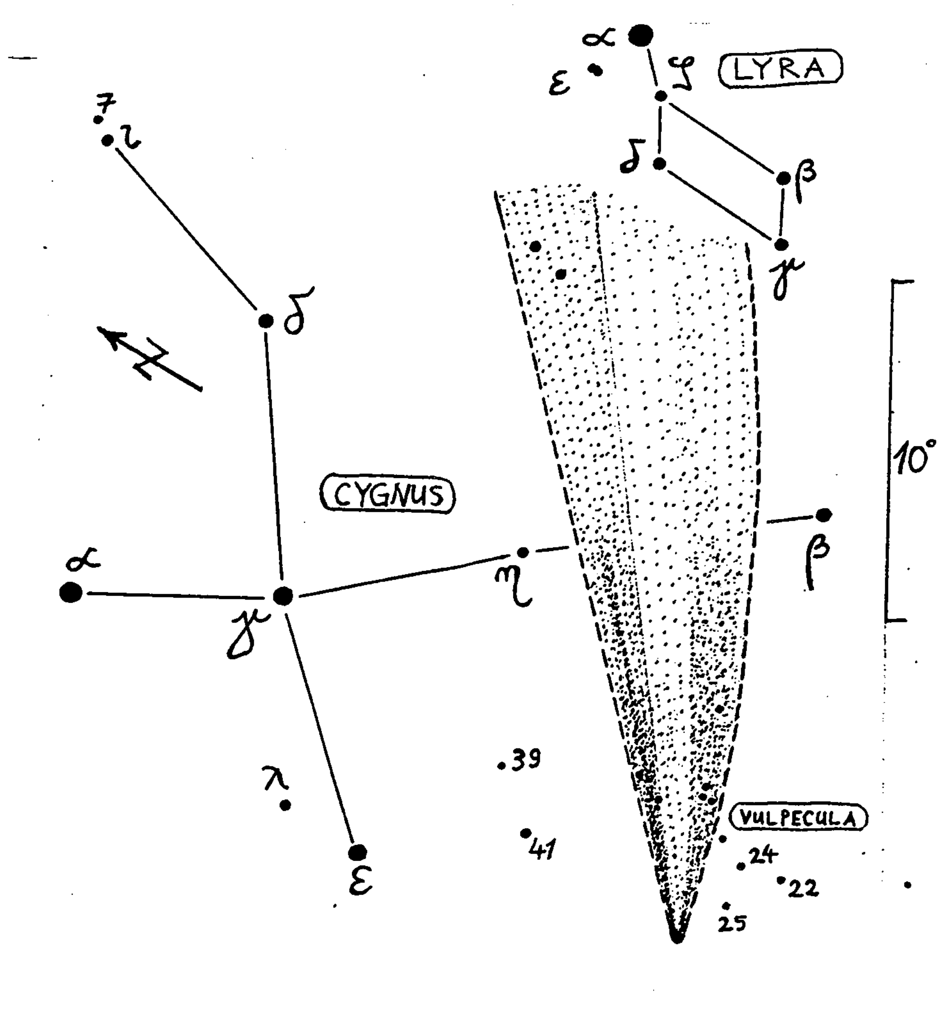
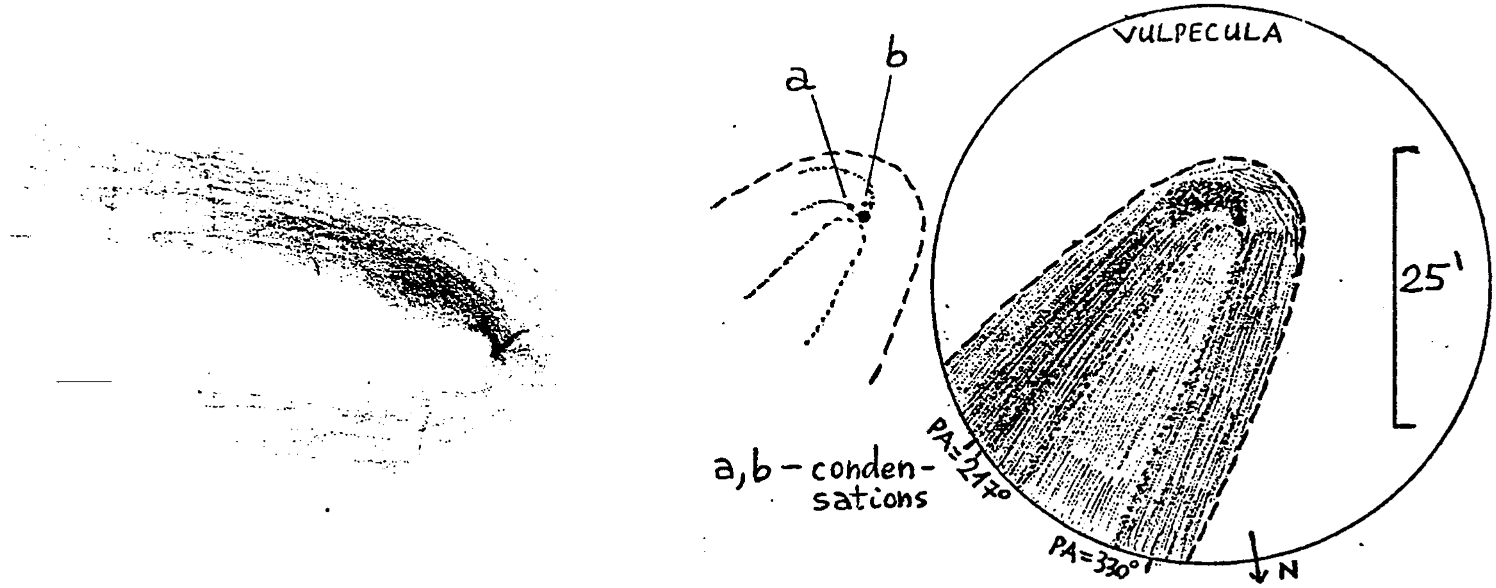
Below: drawing of comet C/1995 O1 by Atilla Kósa-Kiss (code KOS) on 1997 Feb. 17.18, using 7×50 B.





***Above:** Drawings of C/1995 O1. At left is a sketch of the field seen visually in a 25-cm f/4 L (44×) on 1997 Feb. 20.43 by Daniel W. E. Green from Middlesex County, MA; intensely bright jets emanated from the nuclear region into a very yellowish side of the coma (upward in this view), whereas the coma below the nucleus in this view (from whence the ion tail ran) was very blue in color. Ar right is a drawing by Atilla Kósa-Kiss made on Feb. 23.17 w/ a 6.3-cm Zeiss R (52×).*

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◇ *Comet C/1995 O1 (Hale-Bopp)* *[text continued from page 80]* ⟹
w/ 7×50 B, dia. 15′-20′; the tail was divided in two parts near the coma, the length and p.a. referring to the long and quite narrow gas component; the W tail appeared somewhat curved and ended in a fainter glow towards W (mean p.a. ~ 280°); w/ 10.2-cm R (60×), coma was clearly shaped like a parabola; a broad jet was radiating towards W from the false nucleus [SKI]. Feb. 12.21: w/ 20.3-cm T (123×), the comet showed two tail components, the inner part of the W tail appearing slightly brighter than the inner portion of the E component; in the heart of comet, there was a bright false nucleus that looked like a short streak ~ 5″ long, oriented along p.a. ~ 60°-240°; a bright and wide fountain (1′-2′ long and spanning ~ 40° in p.a.) was radiating from this nucleus in mean p.a. ~ 230°; it curved towards the W tail; the N boundary of the fountain was considerably sharper than on the S side [GRA04]. Feb. 12.74: evening obs.; alt. 6°.5; comet easily visible to naked eye as a diffuse star, its visibility comparable to mag-3 stars overhead [GRA04]. Feb. 13.20: thin clouds in front of comet; w/ 7×50 B, DC = 7/, 3° tail [SKI]. Feb. 13.23: w/ 10×50 B, tail 6° long [HAS02]. Feb. 14.18: w/ 7×50 B, 2°.7 tail in p.a. 288° [SHA02]. Feb. 14.24: w/ 9×63 B, 1°.75 tail [ENT]. Feb. 14.83: w/ 8×56 B, coma dia. 9′, DC = 8, tail 5° long [OKA05]. Feb. 14.84: 4° dust tail in p.a. 285°, 3° long in p.a. 315° [SHI].

Feb. 15.13-15.15: w/ 10×50 B, two tail components were seen, one being 1°.5 long in p.a. 290°; the surface brightness of the inner portion of tail (at ~ 0°.5 from coma, before the splitting of the tails) was estimated as 17.7 mag/arcsec^2; w/ 25.4-cm L (108×), in the bright central cond., there were two cond. separated by ~ 3″; a bright and wide fountain radiated W from the central cond. and curved apparently towards the dust tail; some interference from clouds; temp. −20° C [GRA04]. Feb. 15.17: w/ 11-cm L (50×), strong nuclear cond. and very bright fountain w/ two or three jets starting SW of the false nucleus and curving counter-clockwise towards dust tail; several other nearly-straight jets in various directions [BAR06]. Feb. 15.17: w/ naked eye, 2° tail in p.a. 294° [SHA02]. Feb. 15.18: dust tail is wide and extends for 4°.5; its trailing edge points toward p.a. 277° [TAN02]. Feb. 15.24: w/ naked eye, 3° tail in p.a. 294° [SHA02]. Feb. 15.25: w/ 25.6-cm *f*/5 L (169×), stellar nucleus w/ a new shell of bright material at 15″ from p.a. 200° to 240°; several (2-4) condensations are seen on the jets, every 15″-20″ (p.a. 35°, 75°-90°, 150°, 165°, and 200°-240°), which seem to appear every 8-9 days [BIV]. Feb. 15.74: evening obs.; alt. 8°; w/ 7×50 B, DC = 7/, 3° tail [SKI]. Feb. 15.77: evening obs. in moonlight; alt. 5° [GRA04]. Feb. 16.18-16.19: w/ 10×50 B, two tails were seen, one being 2°.5 long in p.a. 280°; the W dust component was broader and more diffuse than the gas tail and was quite bright for ~ 2°; it apparently curved slightly towards S; the gas tail was clearly seen for 6°, but the rest of it was difficult due to the Milky Way background in Cyg (width 0°.5-1°); the surface brightness of the merged tail at ~ 0°.5 from central cond. was estimated as 17.6 mag/arcsec^2; the tails separated at ~ 0°.8 from the central cond.; temp −22° C [GRA04]. Feb. 16.19: w/ 7×50 B, DC = 7/, tail 8° long in p.a. 319°; two tail components were seen; the W dust tail had a somewhat higher surface brightness and was easier to detect to the naked eye than the longer ion tail; several streamers were seen; the ion tail was clearly seen for 5°-6°, the rest of it was faint; air temp at observing site was −20° C [SKI]. Feb. 16.19: second 'dust' tail 7° in p.a. 315° [ZNO]. Feb. 16.19: 4°.2 ion tail in p.a. 315°; 1°.2 dust tail in p.a. 300° [VAN06]. Feb. 16.21, 19.20, Mar. 2.19, 28.82, 30.82, Apr. 1.82, and 6.84: tab. tails are apparently gas tail; respective dust tail lengths and position

◇ *Comet C/1995 O1 (Hale-Bopp) [text continued from page 81]* ⟹
angles were ~ 3° in 280°, 2° in 295°, 10° in 320°, 8° in 0°, 14° in 0°, 12° in 345°, and 16° in 355° [GLI]. Feb. 16.83: w/ 8×56 B, coma dia. 17′, DC = 9, tail 1° long [OKA05]. Feb. 17.18-Apr. 17.80: "naked-eye brightness estimation done using a doublet achromat of focal length 36 cm (and in some cases, another doublet w/ a focal length of 30 cm); on Mar. 9.75 and Apr. 8.77, I employed the VSS and Morris methods w/ the help of these same lenses for defocusing images; for C/1996 B2 last year, I used a doublet w/ focal length 18 cm" [MIL02]. Feb. 17.24: to the naked eye, also dust tail ~ 4°.5 long near p.a. 290°; comparison basically w/ α Cyg + γ Cyg; α Aql and α Cep also used, but too far from the comet's alt. (~ 20°); in 9×34 B, parabolic tail over 4° spanning p.a. 290°-310°; W side of tail much brighter; parabolic envelope; a strongly-curved fountain p.a. ~ 260° is seen bending back into the tail; dark spine clearly offset towards the E part of the tail; in 25.3-cm L f/5.6 (58×), strongly-curved fountain initially spanning p.a. ~ 170°-210° close to the starlike nucleus, then bending back towards the tail, along p.a. ~ 290°; parabolic 'hollow' inside the tail, touching the nucleus; two hoods are seen, one involving the curved fountain, the other one (fainter) involves the former, but begins towards the NE, then strongly bends counter-clockwise through the sunward part of the coma, to follow the W part of the tail; thin cirrostratus likely to have interfered; m_1 = 1.7 w/ 1.4×35 monocular; w/ a divergent lens used, an in-focus estimate yields m_1 = 1.7 [PER01]. Feb. 18.16: dust tail 1°.4 long in p.a. 305° [KOZ]. Feb. 18.17: second tail 3°.5 in p.a. 295° [HOR02]. Feb. 18.18: second 'dust' tail 2° in p.a. 295° [PLS]. Feb. 18.195: wide-field 5-min exp. taken w/ 3.5/65-mm lens, CCD, and narrow-band H_2O^+ filter, centered at 620 nm (FWHM = 10 nm) shows ion tail at least 7° long in p.a. ~ 315° [MIK]. Feb. 18.20: 3°.3 ion tail; 1°.3 dust tail in p.a. 315° [VAN06]. Feb. 18.85: tail spans p.a. 260°-310° [MIY01]. Feb. 19.13: w/ 8-cm R (28×), second fan tail ~ 2° long spanning p.a. 250°-300°; w/ 8-cm R (40×), fan spans p.a. 300°-270°; star-like nucleus brighter than mag 5 [MAN01]. Feb. 19.14: narrow tail is 7°.5 long in p.a. 325°, second fan-like tail 2°.0 long spans p.a. 315°-300° [FIL05]. Feb. 19.16: bluish ion tail is 6° long in p.a. 313°, yellowish fan-like dust tail 1°.8 long spans p.a. 272°-302°, dust tail is brighter than ion tail; w/ 12×80 B, 30′ coma, tail 6° long in p.a. 313° [BAR06]. Feb. 19.84: w/ 10×50 B, coma dia. 9′, DC = 9, tail 3° long [OKA05]. Feb. 19.85: tail spans p.a. 260°-300° [MIY01]. Feb. 19.85: w/ 7×35 B, coma dia. 25′, DC = 7, tail 6° long [WAS].

Feb. 20.20: in 7×50 B, DC = 8; besides 6° gas tail in p.a. 320°, broad (slightly curved) dust tail spanning p.a. 320°-283° (longest 2°.4 in p.a. 296°); moon 4° over NW horizon [BOU]. Feb. 20.23: w/ 7×50 B, 2° tail in p.a. 302° [SHA02]. Feb. 20.24: w/ 9×63 B, m_1 = 1.7 (MM = S), 30′ coma, DC = D7, 2°.5 tail [LAN03]. Feb. 20.4 and 24.4: w/ 25-cm f/4 L at low power, bright jets toward SE are in very yellowish coma, whereas the coma on the NE side of the nucleus shows a faint but deep blue color; the SE jets are easily visible in 12×50 B; for all subsequent naked-eye m_1 estimates of this comet utilizing comparison stars where m_v differed from V by $\geq$ 0.1 mag, corrections were made on page 74 of this issue (last paragraph) [GRE]. Feb. 20.75: evening obs.; alt. 9°.5; w/ 10×50 B, two tails seen (one being 1°.5 long in p.a. 320°); the W dust tail was easier to detect than the gas component [GRA04]. Feb. 20.76: evening obs.; alt. 8°; listed tail lengths refer to the dust tail; w/ 7×50 B, DC = 7/, tail 3° long; w/ naked eye, the comet was first located w/ solar alt. −6°.3 [SKI]. Feb. 20.83: dust tail 2°.7 long in p.a. 275° and 1°.8 long in p.a. 320° [SHI]. Feb. 20.84: w/ 10×50 B, coma dia. 9′, DC = 8, tail 2° long [OKA05]. *(text continued on next page)*

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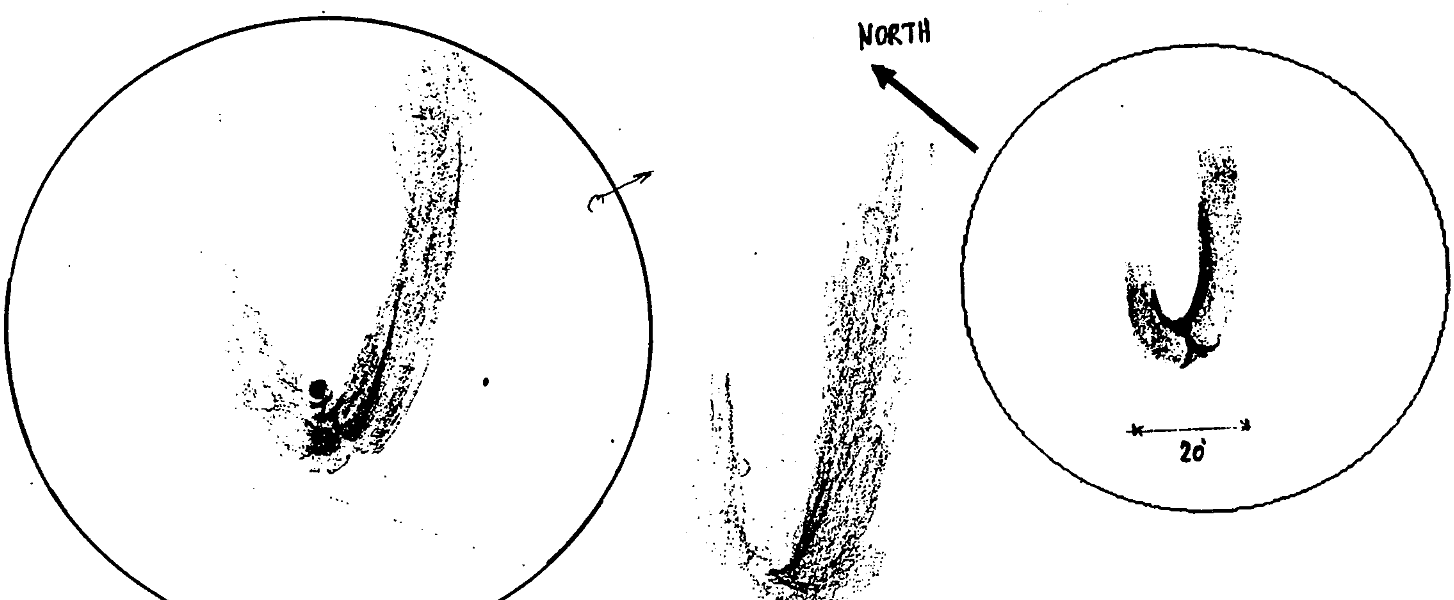
Below: drawings of comet C/1995 O1, oriented so that west is toward the upper right and north toward the upper left. At left is a drawing by Richard Didick on 1997 Feb. 23, as seen through his 25-cm f/4.5 L (127×). At center is a sketch by Daniel W. E. Green on Feb. 24.43 with his 25.4-cm f/4 L (44×), in which two bright jets were seen, and the right side of the coma in this view was very yellowish (toward which the dust tail ran), while the left side of the coma was very bluish (toward which the ion tail ran). At right is a drawing by Sandro Baroni (Milan, Italy), made using 20×80 B on Feb. 23.20; the line indicates 20′.



Above: Drawings of comet C/1995 O1 by Margareta Westlund as seen with 7×35 B on 1997 Mar. 3.81 (left) and 10.12 (right).

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◇ *Comet C/1995 O1 (Hale-Bopp) [text continued from page 82]* ⟹
Feb. 21.20 and 22.18: photometry w/ 90-mm-f.l. *f*/4 lens + *V* filter + ST-6 CCD; one YF standard star inside the comet field used for photometry [MIK]. Feb. 21.20: ion tail at least ~ 5° long in p.a. ~ 320°; diffuse dust tail ~ 3° long in p.a. ~ 250°-320° [MIK]. Feb. 21.20: w/ naked eye, the listed tail refer to the dust tail; gas tail glimpsed for a couple of deg; despite a nearly full moon, parts of the Milky Way were visible in Cyg; w/ 7×50 B, coma dia. ~ 15′, DC = 7/, and the gas tail was visible for over 5°, but the surface brightness of the dust tail was higher near the head of the comet; the p.a. of the dust tail was ~ 300° [SKI]. Feb. 21.83: w/ 8×56 B, coma dia. 8′, DC = 9, tail 3° long [OKA05]. Feb. 22.21: w/ 7×50 B, 2° tail in p.a. 327° [SHA02]. Feb. 23.69: obs. in the evening sky; w/ naked eye, coma dia. ~ 30′, DC = 5 [KUS]. Feb. 23.75: evening obs.; alt. 12°; comet was only observable for a couple of min, due to rapidly drifting clouds (first detected w/ the naked eye under better skies w/ solar alt. −6°.0) [SKI]. Feb. 24.51: central cond. of mag 7.1 and dia. almost 5″; although the tail, as tab., extended to the CCD frame edge, its major fan-shaped form was readily followed for at least 3° using binoc.; prominent, diffuse jets imaged at p.a. 23° and 67° through Kron-Cousins filters at wavelengths 650 (*R*), 550 (*Y*), and 440 nm (*B*), where they maintained approx. equal relative intensities in all three bands [ROQ]. Feb. 24.84: brightest part of dust tail 4° long in p.a. 285° [SHI].

Feb. 25.21: w/ naked eye, 2°.5 tail in p.a. 293° [SHA02]. Feb. 25.83: dust tail in p.a. 270°-305°; brightest part in p.a. 295° (6° long) [SHI]. Feb. 26.14-26.15: w/ naked eye, the comet was a prominent object w/ a nearly-stellar head and a clearly visible dust tail; w/ 10×50 B, two tails were seen (one being 3°.5 long in p.a. 290°); the E ion tail was the longer one, but until 2° from the head, the dust tail was clearly brighter than the gas tail; a distinct jet, ~ 1° long, was seen in the middle of the dust tail; w/ 20.3-cm T (123×), there was a nearly-stellar pseudo-nucleus, not more than 3″ in size, in the head of comet; a bright, wide fountain was radiating from this nucleus in p.a. 175°-245° (the fountain curved strongly towards the jet in the dust tail); a lot of detail seen in and near the fountain, incl. several small dark knots and rifts; the head showed a distinct golden yellow hue, w/ nearby star HR 8084 (spectral type F7) considerably bluer; first morning obs. since Feb. 16 after an extended period w/ poor weather [GRA04]. Feb. 26.17: w/ 8×50 B, 28′ coma, DC = 7, 2°.3 tail [DIE02]. Feb. 26.19: w/ 7×50 B, two tails were seen; the E gas tail was visible for 5° until it disappeared behind a cloud layer; surface brightness of dust tail was higher than that of the gas tail, this tail was also visible to the naked eye; interference from clouds [SKI]. Feb. 26.26: w/ 8×30 B, 14′ coma, DC = 8, 2° tail [ENT]. Feb. 26.78: evening obs.; alt. 10°.5; heavy cloud (even still, the dust tail was clearly seen for 2°) [GRA04]. Feb. 27.15-27.19: w/ naked eye, the comet showed a bright and nearly-stellar head and an easily visible tail; w/ 10×50 B, two tails were seen (one being 3° long in p.a. 239°); the W dust tail curved towards S and was considerably brighter than the gas tail until 2° from the head; the mean surface brightness of the dust tail estimated as 16.4 mag/arcsec^2 at 0°.5, and 16.9 mag/arcsec^2 at 1°.0 from the nucleus; ion tail clearly visible to 7° from the head (width ~ 0°.8); in the dust tail, there was a jet ~ 0°.8 long; w/ 20.3-cm T (123×), the pseudo-nucleus was small, but nonstellar; it looked like a bar that was ~ 4″ long and

◇ *Comet C/1995 O1 (Hale-Bopp) [text continued from page 83]* ⟹
directed along p.a. 5°-185°; from this nucleus, there was a bright fountain, ~ 1′ long and spanning p.a. 155°-225° (in this fountain, there were two dark rifts located ~ 15″ and ~ 30″ from the nucleus; the surface brightness of the fountain was 14.3 mag/arcsec^2); the head of the comet was yellow and bluer than the K5-star HR 8005; in moonlight, Milky Way faintly visible [GRA04]. Feb. 27.16: second tail 5° in p.a. 285° [HOR02]. Feb. 27.19: second tail 2°.2 in p.a. 290° [PLS]. Feb. 28.05: w/ 11-cm L (32×), m_2 ~ 5.3 [IVA03]. Feb. 28.16: w/ 11×80 B, coma dia. 15′ and 3°.5 tail in p.a. 310° [STO]. Feb. 28.16: w/ 9×63 B, ion tail displayed at at least two bright streamers; bright dust tail 3° long centered at p.a. 290° and spanning ~ 30°; tail > 5° long in p.a. 307°; DC = S8; extremely bright central cond.; obs. under severe moonlight [KAM01]. Feb. 28.19: ion tail at least ~ 5° long in p.a. ~ 325°; dust tail at least 3° long in p.a. ~ 260°-305° [MIK]. Feb. 28.19: in 7×50 B, DC = 8; besides 6°.5 gas tail in p.a. 322°, slightly-curved dust tail (longest 3°.3 in p.a. 303°); very strong nuclear cond. of slightly yellowish color; comet impressive despite moonlight [BOU]. Feb. 28.20: w/ 8×30 B, 2° tail [ENT]. Feb. 28.73: w/ 80x12 (B), ion tail 12° long and dust tail 4° long; shadow between two tails [BAR06].

1997 Mar. 1, 3, 9 and 10: three shells near the cometary nucleus were observed w/ 0.7-m L; on Mar. 3.14, distances of shells from nucleus were: 2nd shell, 7″; 3rd shell, 9″ (diameters of shells were 22″ and 25″) [CHU]. Mar. 1.17: dust tail 4° in p.a. 305° [KYS]. Mar. 1.18: dust tail 2° in p.a. 305° [KYS]. Mar. 1.19: in 7×50 B, DC = 8; besides 6°.6 gas tail in p.a. 324°, broad slightly-curved dust tail spans p.a. 283°-307° (longest 4°.0 in p.a. 299°); w/ 15×80 B and 0.16-m L (at 29×, 102×), broad fountain-like structure visible in p.a. ~ 220°, curving back (anti-clockwise) into the main tail and forming bright streamer some 1°.5 long near the N side of the tail in p.a. 305°; very strong central cond., yellowish in color [BOU]. Mar. 1.19: w/ 7×50 B, 26′ coma, DC = 7, 4° tail [DIE02]. Mar. 1.22: w/ 9×63 B, 3° tail [ENT]. Mar. 1.22-1.23: to the naked eye, besides the 9° gas tail near p.a. 320°, there is also a broad, slightly curved clockwise 7° dust tail spanning p.a. ~ 280°-305°; strong disk-like central cond.; in 9×34 B, conspicuous fountain, initially to the SW, then strongly bending anti-clockwise into the dust tail; a prominent streamer flowing from the nucleus along p.a. ~ 280° can be traced for at least 2° into the dust tail; there is a dark area very close to the nucleus, and between the N edge of the fountain and this streamer; gas tail is less well defined and fainter than the dust tail; dark spine separating the two tails clearly offset towards the gas tail (i.e., to the NE of two tails' axes); in 25.3-cm *f*/5.6 L (58×), even at such low power, the inner-coma structure is extremely complex and intricate; non-stellar nucleus, just above the resolution limit; huge fountain spanning p.a. ~ 160°-220° near-nucleus, now presenting sharp inner detail; four plumes, two on each side of the giant fountain, plus a bright cloud of material in a short circular arc (separated from the fountain, and towards p.a. ~ 100°, some 30″-60″ from the nucleus), all combine to give the impression of two concentric layers, estimated at ~ 30″ intervals; the dark 'hollow' tailwards of the pseudo-nucleus is much less pronounced and rather narrow-shaped now; the coma is strikingly asymmetric in brightness; the thick large stream of material in the continuation of the fountain makes the whole 'trailing' side of the coma look markedly brighter than the 'leading' edge, the transition being quite dramatic through p.a. ~ 120° from the nucleus; this gives the coma an almost-dichotomous phase aspect; the gas tail looks less defined; obs. made through a veil of cirrostratus, thought to have not affected m_1 significantly (i.e., estimates made at times when the veil was looking homogeneous, both at the comp. stars and at the comet); w/ 1.4×35 monocular, m_1 = +0.2 [PER01]. Mar. 2.07: w/ 11-cm L (32×), m_2 = 5.3 [IVA03]. Mar. 2.09: w/ 7×50 B, dust tail 7° long in p.a. 310° [VEL03]. Mar. 2.14: second tail 5° in p.a. 285° [HOR02]. Mar. 2.16: w/ naked eye, dust tail 8° long in p.a. 310°; m_2 = 1.8 [SAR02]. Mar. 2.16: dust tail 9° long in p.a. 310° [SZE02]. Mar. 2.17: ion tail at least ~ 5° long in p.a. ~ 323°; dust tail at least 3° in p.a. ~ 260-305° [MIK]. Mar. 2.17: curved dust tail 2°.8 long [MEY]. Mar. 2.19: 4°.8 ion tail in p.a. 325°; 2°.6 dust tail in p.a. 290° [VAN06]. Mar. 2.45: w/ naked eye, 4° gas tail at p.a. 326°, and broad 3° dust tail spanning p.a. 285°-310°; in 7×50 B, the gas tail was traced to ~ 5°.5 and it curved slightly counter-clockwise to ~ p.a. 330°; there was a dark lane w/ a spine-like tip separating the two tails; the central cond. was an elongated disk w/ axis pointing in p.a. ~ 285°, and w/ a bright streamer extending from the nucleus ~ 1° into the dust tail at p.a. ~ 305°; the gas tail and NE side of the coma had a definite bluish tint, giving way to a yellow color on the other side of the coma and into the dust tail [ADA03]. Mar. 2.67: "w/ 4-inch R, hoods are fabulous, like luminous arcs or interference patterns just like George Bond's drawings of comet Donati in 1858; jets form a 30° wedge, w/in which are three parabolic hoods that appear to be illuminated as w/ a flashlight beam *only w/in this 30° wedge*!; outside of this wedge, the hoods are much fainter" [OME]. Mar. 3.10: dust tail 2°.5 long in p.a. 305° [KOZ]. Mar. 3.11: w/ naked eye, 5° tail in p.a. 310° [SHA02]. Mar. 3.17: also dust tail 4°.7 long in p.a. 300° [BOU]. Mar. 3.23: w/ 8×30 B, 2°.5 tail [ENT]. Mar. 3.6: "nuclear cond. of C/1995 O1 was still easily visible well after sunrise at Apache Point Observatory, as viewed w/ the 60-cm Sloan Digital Sky Survey 'Monitor Telescope' and a 55-mm eyepiece; three concentric shell fragments and a huge jet, which had been visible around the nucleus in dawn twilight, were astounding!" [John W. Briggs, Apache Point Observatory, Sunspot, NM]. Mar. 4.06: w/ 11-cm L (50×), two bright and one faint shells, w/ best visibility towards fountain in the SW quadrant from the false nucleus; bright narrow jet 3′ long sunward; w/ naked-eye, ion tail 15° long was blue in color and dust tail 6° long in p.a. 270-298 was yellow; coma had bluish color [BAR06]. Mar. 4.08: w/ 7×50 B, dust tail 5° long in p.a. 300° [VEL03]. Mar. 4.18: also slightly-curved dust tail 5°.0 long in p.a. 304° [BOU]. Mar. 4.23: to the naked eye, 12°-long, broad, slightly-curved dust tail spanning p.a. ~ 290°-310°; also 11° gas tail near p.a. 325°; comet looks more diffuse; in 9×34 B, nearly-parabolic edges less well defined; gas tail near p.a. 310° much fainter than dust tail that spans p.a. 280°-300°; nearly-stellar nucleus; strongly-curved fountain, initially towards p.a. ~ 240°, seems to be feeding the trailing edge of a bright streamer inside the dust tail along p.a. ~ 295°; this streamer now looks much broader than in previous obs., the leading edge leaving the nucleus tailwards, almost w/o bending; dark spine offset towards the gas tail; overall, the comet resembles a 'hockey stick' surrounded by a fainter parabolic envelope; in 25.3-cm *f*/5.6 L (58×), dust tail much brighter than gas tail; dark area tailwards of the nucleus not so conspicuous, more contrasty near the inner edge of the dust tail; three hoods spanning p.a. ~ 135°-260° inside huge fountain, spaced by roughly 0′.5 difference, surround the nucleus; a bright jet (like a narrow 20° open fan) is centered near p.a. 200° inside a broad fountain, extending ~ 0′.2 from the nucleus; another weaker fountain-like structure leaves the nucleus towards

Above: Three sketches of the coma of comet C/1995 O1 by Daniel W. E. Green, showing the dust 'hoods' or 'haloes' emanating from the nuclear region. In each view, the yellowish dust tail (and coma) is above the nuclear region, and the bluish ion tail (and coma) is below. From left to right, the drawings were made at the telescope on 1997 Mar. 7.42 (25.4-cm f/4 L, 44× and 64×), Mar. 9.38 (81-cm f/4 L, 100×), and Mar. 13.98 (23-cm f/12 R, 86×).

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◇ *Comet C/1995 O1 (Hale-Bopp) [text continued from page 84]* ⟹

p.a. $\sim$ 120°, then strongly bends counter-clockwise through the sunward coma to join the trailing edge of the comet; as twilight advanced, the nucleus became separated from the bright jet, nevertheless remaining non-stellar just above the resolution limit, its dia. estimated as < 3″; w/ L, the brighter inner hood remained visible up until 15 min before sunrise [PER01]. Mar. 4.23: also 8° gas tail near p.a. 325° [VIT01]. Mar. 4.26: w/ 10×50 B, 1°.4 tail in p.a. 298° [TAY]. Mar. 4.80: brightest part of dust tail in p.a. 285° (5° long) [SHI]. Mar. 4.82: tail spans p.a. 295°-325° [MIY01].

Mar. 5.06: shells are wider than on day before [BAR06]. Mar. 5.14: dust tail 2°.5 long in p.a. 309° [KOZ]. Mar. 5.14 and 8.13: dust tail 4°.5 long [MEY]. Mar. 5.15: second tail 10° in p.a. 285° [HOR02]. Mar. 5.16: second tail 6° in p.a. 300° [PLS]. Mar. 5.17: also slightly curved dust tail 5°.1 long in p.a. 300° [BOU]. Mar. 5.25: w/ 10×50 B, 2°.5 tail in p.a. 295° [TAY]. Mar. 5.75: w/ 7×50 B, dust tail 6° long in p.a. 303° [VEL03]. Mar. 5.83: tail spans p.a. 295°-320° [MIY01]. Mar. 6.08: w/ 11-cm L (32×), m_2 = 4.8 [IVA03]. Mar. 6.13: gas tail 13° long in p.a. 332° and dust tail 4° long in p.a. 313° [CHE03]. Mar. 6.14: dust tail 6°.5 [KON06]. Mar. 6.14: dust tail 2°.5 long [CHV]. Mar. 6.15: w/ naked eye, 5° dust tail in p.a. 300°; curved slightly towards W [SAR02]. Mar. 6.15: second tail 12° in p.a. 290° [HOR02]. Mar. 6.15: w/ 7×50 B, dust tail 6° long in p.a. 301° [VEL03]. Mar. 6.23: w/ 10×50 B, 3°.5 tail [ENT]. Mar. 6.23: "w/ naked eye and 9×63 B, tails 14° (gas), 7° (dust); the tails had a comparable surface brightness at 3° from the nucleus; the area between the two tails seemed as dark as the sky background; m_1 estimated by taking off eyeglasses (this applies to all of my obs. of C/1995 O1 during Mar. 6-12" [Håkon Dahle = DAH, Observatorio del Roque de Los Muchachos, La Palma, Canary Is., Spain]. Mar. 6.46: a fan-shaped dust tail spanning p.a. 290°-309° started out straight for $\sim$ 4° and then gently curved to end near τ Cyg (total length $\sim$ 8° in p.a. 280°); the NW edge of the dust tail showed a bright spine of material extending for $\sim$ 4° in 7×50 B [ADA03]. Mar. 6.92: tail was broad and diffuse [HEE]. Mar. 7.14: dust tail 5° [KON06]. Mar. 7.18: w/ naked eye, curved dust tail 6° long, central cond. of mag $\sim$ 1.5; w/ 9×63 B, bright streamer on E border of dust tail; w/ 20-cm T (111×), false nucleus of mag $\sim$ 3.0, w/ curved jet and three bright envelopes (which were the origin of the bright streamer); sunward jet fan spanning $\sim$ 120°; in tailward direction, much darker area; false nucleus is not at the apex of the parabola, but positioned a bit to the NW [KAM01]. Mar. 7.18: besides gas tail, slightly curved dust tail in p.a. 288°–310° (longest 6°.3 in p.a. 300°); strong cond., yellowish in color [BOU]. Mar. 7.18: due to slight coma increase, the aperture size was enlarged accordingly [MIK]. Mar. 7.26: w/ naked eye and 9×63 B, tails 13° (gas), 5° (dust); gas tail lost in the Milky Way; m_1 uncertain due to clouds [DAH]. Mar. 7.44: comet's alt. same as that of comparison star (Capella) [CRE01]. Mar. 8.06: w/ 7×50 B, dust tail 5° long in p.a. 312° [VEL03]. Mar. 8.13: w/ 63-cm f/16 L (130×), 'waving stream' seen from the nucleus, w/ jet pointing towards p.a. 170°; three elongated concentric rings/brightenings in section w/ p.a. $\sim$ 170°-280° [CHE03]. Mar. 8.14: w/ naked eye, 10° dust tail in p.a. 310°; curved towards W [SAR02]. Mar. 8.15: dust tail 8° [KON06]. Mar. 8.15: second tail 10° long in p.a. 290° [HOR02]. Mar. 8.16: second tail 5° long in p.a. 305° [PLS]. Mar. 8.17: 12° ion tail in p.a. 330°; 4° dust tail in p.a. 310° [VAN06]. Mar. 8.17: dust tail 7° [FIA]. Mar. 8.17: second tail 10° in p.a. 300° [ZNO]. Mar. 8.26: w/ naked eye and 11×80 B, tails 14° (gas), 5° (dust); coma had distinctly yellow color; the N edge of the dust tail was much sharper and more well-defined than the S edge, which was very diffuse; several faint streamers seen in the gas tail [DAH]. Mar. 8.46: main (gas) tail showed possible extension to 15°.5; fan-shaped dust tail spanning p.a. 275°-310° had maximum confirmed length of 6° in p.a. 300°, but may have had faint extension to $\sim$ 10° in p.a. 275°; the dust tail showed more curvature than in my previous obs., and the tail spine was still visible, but was not as bright; light fog formed toward end of observing session [ADA03]. Mar. 8.53: "a pretty twin-tailed comet!"; very noticeable w/ naked eye; in 7×50 B, the S dust tail (yellow) is very broad (over 2° wide), over 7° long in p.a. 310°; narrow 10° plasma tail in p.a. 330° [SPR]. Mar. 8.82: brightest part of dust tail in p.a. 290° (5° long) [SHI]. Mar. 9.10: dust tail 6° long [MOR04]. Mar. 9.07: w/ 11-cm L (32×), m_2 = 4.3 [IVA03]. Mar. 9.10: w/ 4-cm R (8×), dust tail 7° long in p.a. 282°-295°; w/ naked-eye, ion tail 15° long in p.a. 333° [BAR06]. Mar. 9.14: 10° dust

◇ *Comet C/1995 O1 (Hale-Bopp) [text continued from page 85]* ⟹
tail in p.a. 315°, curved towards W [SAR02]. Mar. 9.15: second tail 10° long in p.a. 295° [HOR02]. Mar. 9.16: 13° ion tail in p.a. 330°; 5° dust tail in p.a. 310° [VAN06]. Mar. 9.17: also slightly-curved dust tail spans p.a. 296°–318° (longest 6°.5 in p.a. 305°); strong cond., yellowish in color; w/ 7×50 B, the head looks like an inverted 'J', w/ a broad fountain roughly centered in p.a. 210°, curving back anti-clockwise into the dust tail [BOU]. Mar. 9.24: to the naked eye, broad, slightly-curved dust tail spans p.a. 290°-310°, longest towards p.a. 310°; 7°-8° gas tail near p.a. 330°; the bright fountain and streamer are perceived; 0°.5 tail still seen 30 min before sunrise; still visible to naked eye 20 min before sunrise; in 9×34 B, very strong central cond.; a huge fountain continues as a broad bright streamer along the inner or leading edge of the dust tail (the inside boundary just tailwards of the nucleus being very sharply defined); inside this broad streamer, there is a brighter, narrow streamer that leaves the pseudo-nucleus towards p.a. 260°, then curving slightly tailwards; dust tail is better defined than gas tail; in 25.3-cm *f*/5.6 L (58×), wide open fountain initially spanning p.a. 180°-295°; four hoods inside this fountain, the first being linked to the nucleus by a 'V'-shaped wedge of bright material that leaves the nucleus towards p.a. 320°, then sharply turns back to touch the first hood near p.a. 295°; another weaker fountain-like structure leaves the nucleus towards p.a. 100°, then strongly curves counter-clockwise through the sunward part of the coma to join the outer edge of the great fountain; broad bright streamer flowing from the great fountain along the inner part of the dust tail, the inner or leading edge being sharply defined; the dark void tailwards of the nucleus is no longer prominent, there being a gradual brightness increase from the sharp inner edge of the dust tail to the outer, leading edge of the gas tail (the inner, trailing edge of the gas tail is ill-defined); as twilight advances, the nucleus remains stellar, while a knot of bright material is suspected very roughly 0'.5 to the NW; 15 min before sunrise, the first hood is still visible, whilst the nucleus itself could be followed until 4 min to sunrise, still w/ some diffuseness around; slight mist at the beginning of obs., conditions improving thereafter [PER01]. Mar. 9.26: w/ naked eye and 11×80 B, tails 14° (gas), 7° (dust); the dust tail is a wide fan beautifully curved towards the S, w/ a sharply-defined N edge and a very diffuse S edge; the gas tail was lost in the Milky Way, but there is a hint (stronger than yesterday) that the tail is emerging from the Milky Way into the N-galactic hemisphere, which would increase the quoted tail length by ~ 10° [DAH]. Mar. 9.31-9.44: comet viewed from its rising around 2:45 a.m. local time until in deep twilight around 5:30 a.m. local time (nearly 3 hr); forked tail (ion vs. dust) was really remarkable from a dark sky w/ 12×50 B; w/ 32-inch L (100×), remarkable structure in inner coma w/ 3 irregular hoods/shells and a faint outer fourth shell strongly suspected; as before, the SE side of the coma w/ the strong dust jets/shells is very yellowish, while the other side of the coma (where the ion tail commences) is very bluish; even from a very dark mountain site under crystal-clear winter skies, naked-eye ion tail is seen w/ difficulty to 10° (the outermost few deg extremely faint and tenuous), and the dust tail is seen to only ~ 5° or so [GRE, w/ B. Volz and M. Motta, Center Harbor, NH]. Mar. 9.78: w/ 4-cm R (8×), dust tail 8° long in p.a. 300°; w/ naked eye, ion tail 15° long in p.a. 326° [BAR06]. *(text continued on next page)*

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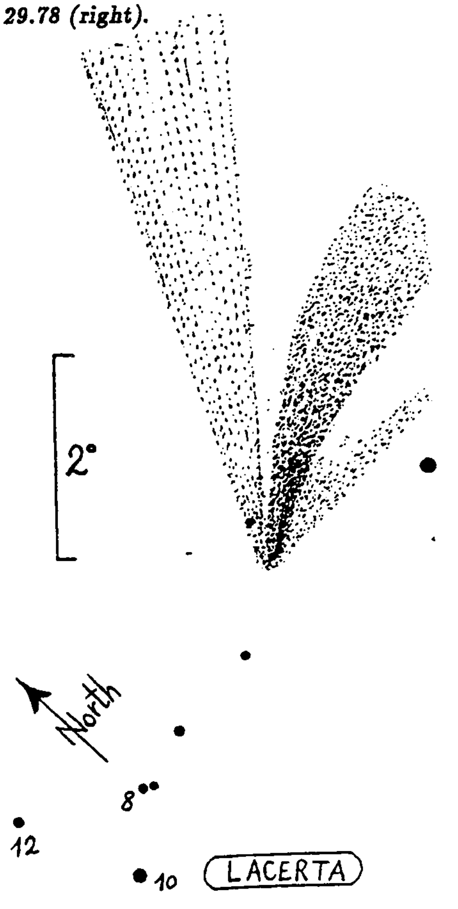
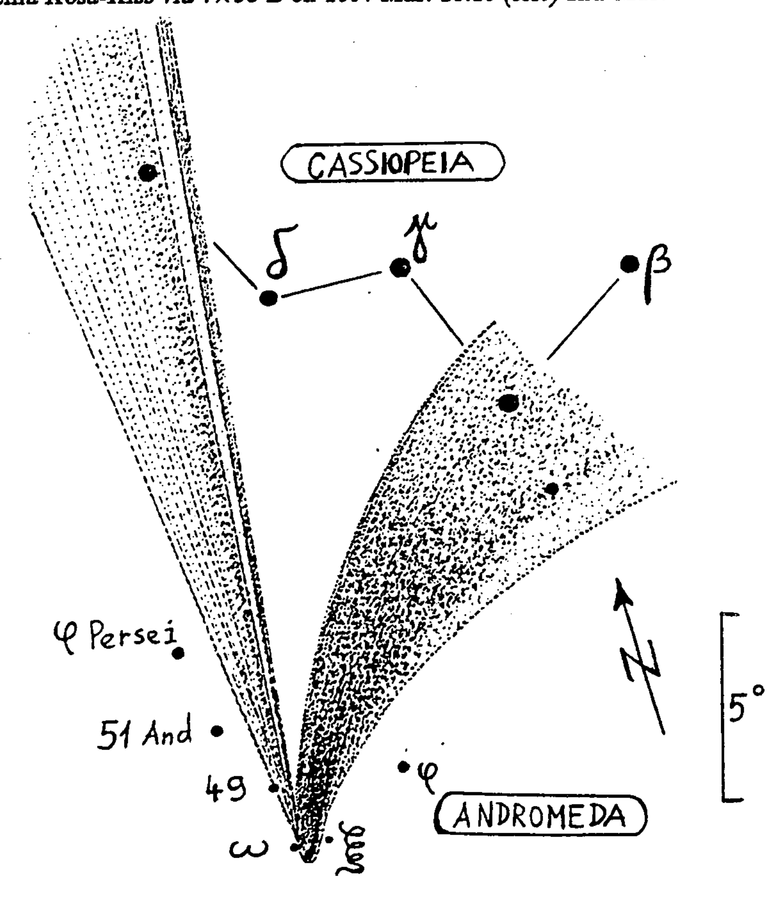
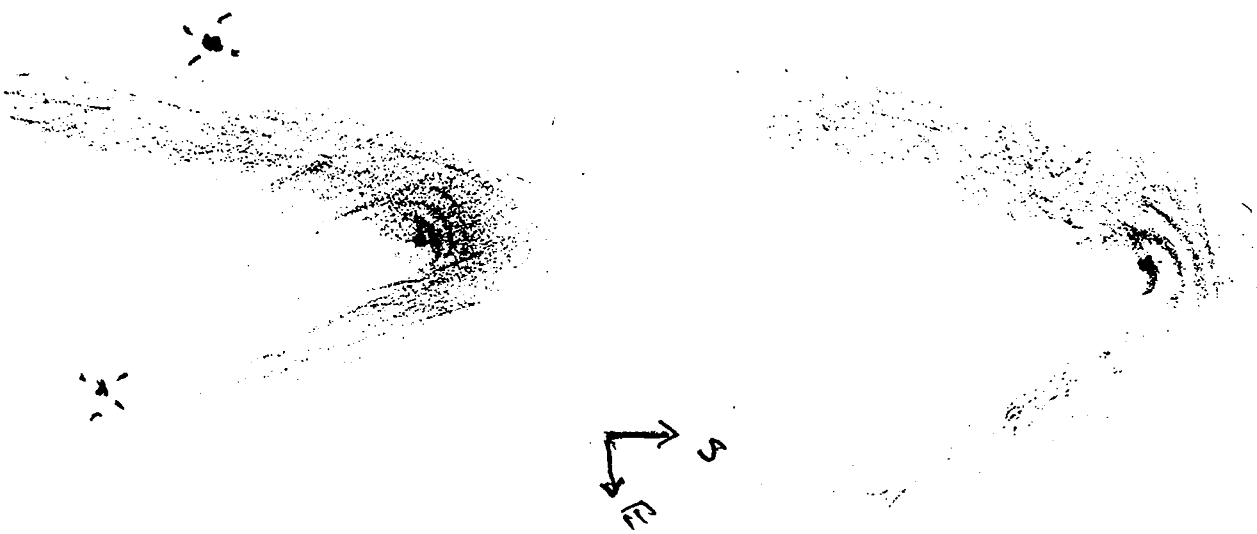
Below: drawings of comet C/1995 O1 by Atilla Kósa-Kiss via 7×50 B on 1997 Mar. 10.15 (left) and Mar. 29.78 (right).







Above: Two sketches of the coma of comet C/1995 O1 by Daniel W. E. Green, showing the changing dust 'hoods' or 'haloes' emanating from the nuclear region in 24 hours, as seen with the Harvard College Observatory 9-inch f/12 R (86×). The view at left was on 1997 Mar. 16.00 and that at the right was on Mar. 16.98. A new shell appears to be forming in the right picture.

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◇ *Comet C/1995 O1 (Hale-Bopp) [text continued from page 86]* ⟹

Mar. 10.06: w/ 7×50 B, dust tail 6° long in p.a. 314°.6 [VEL03]. Mar. 10.11: dust tail 3°.6 long in p.a. 340° [CHV]. Mar. 10.14: second tail 10° long in p.a. 295° [HOR02]. Mar. 10.14: dust tail 5° long [MEY]. Mar. 10.15: w/ naked eye, curved dust tail 6° long spanning p.a. 265°-310°; central cond. of mag ~ 1.0; w/ 9×63 B, coma dia. 15′, DC = S8/; bright streamer on E border of dust tail; w/ 20-cm T (111×), false nucleus of mag ~ 3.0; again visible is a curved (comma-shaped) jet and three bright envelopes; sunward jet fan spans ~ 120°; tailward is a much darker area; false nucleus not at the apex of the parabola, but positioned a bit to the NW [KAM01]. Mar. 10.16: 13° ion tail in p.a. 330°, 3°.5 dust tail in p.a. 305° [VAN06]. Mar. 10.17: also slightly-curved dust tail, longest 6°.5 in p.a. 306°; strong cond., yellowish in color [BOU]. Mar. 10.23: to the naked eye, gas tail ends a little S of α Cep; dust tail < 10° long, lost in Milky Way, spanning p.a. 290°-320°, the trailing edge being slightly curved clockwise; in 25.3-cm *f*/5.6 L (58×), overall appearance similar to previous night (however, the wedge of material linking the nucleus to the first hood looks slightly broader, centered at p.a. 280°); dark void tailwards of the nucleus slightly more prominent again [PER01]. Mar. 10.25: w/ naked eye, tails 24° (gas), 13° (dust); the gas tail is for the first time definitely seen to extend beyond the Milky Way; dust tail was lost in the Milky Way; both tails seem to have higher surface brightness than on previous mornings [DAH]. Mar. 10.74: w/ 7×50 B, dust tail 6° long in p.a. 320° [VEL03]. Mar. 10.76: dust tail 9° [KON06]. Mar. 10.77: second tail 7° in p.a. 295° [HOR02]. Mar. 10.82: brightest part of dust tail in p.a. 295° (7° long) [SHI]. Mar. 11.11: w/ 7×50 B, dust tail 6° long in p.a. 312° [VEL03]. Mar. 11.13: w/ 63-cm L (130×), two bright concentric rings; bright jet towards p.a. 260°; on Neopan 1600 film, 1- and 3-sec exp. w/ 63-cm L show four rings elongated w/in 3′ of the photometric nucleus; dust tail in the section p.a. 295°-308°; ion tail is suspected to length of 23° [CHE03]. Mar. 11.13: dust tail 6° long in p.a. 305° [KOZ]. Mar. 11.14: dust tail 6° long [MEY]. Mar. 11.15: second tail 10° in p.a. 295° [HOR02]. Mar. 11.16: 13° ion tail in p.a. 330°, 6° dust tail in p.a. 310° [VAN06]. Mar. 11.20: w/ 10×50 B, 4° tail [ENT]. Mar. 11.24: w/ naked eye and 9×63 B, tails 17° (gas), 9° (dust); m_1 uncertain due to clouds [DAH]. Mar. 11.51: twin tails very noticeable; in 7×50 B, coma very elongated and bright yellow in color; plasma tail seen w/ naked eye to stretch to 4° in p.a. 31°; dust tail to 8° in p.a. 32° [SPR]. Mar. 11.70: dust tail 6° long [MOR04]. Mar. 11.77: dust tail 4°.6 long [CHV]. Mar. 11.77: second tail 8° in p.a. 300° [HOR02]. Mar. 11.77: second tail 10° in p.a. 300° [PLS]. Mar. 11.78: dust tail 9° [KON06]. Mar. 11.99: w/ 11-cm L (32×), m_2 = 4.2 [IVA03]. Mar. 12.12: dust tail 5°.6 long [CHV]. Mar. 12.14: dust tail 3°.5 long [MEY]. Mar. 12.14: second tail 10° in p.a. 300° [HOR02]. Mar. 12.15: second tail 7° in p.a. 300° [PLS]. Mar. 12.15: second tail 9° in p.a. 295° [ZNO]. Mar. 12.16: w/ naked eye, curved dust tail 6° long spanning p.a. 280°-315°; central cond. of mag 0.7; w/ 20-cm T (111×), spectacular sight — false nucleus again showed the comma-shaped jet, starting in NW and creating the innermost envelope; this and a second envelope today were broader and more diffuse than on the preceding days; a ring-like feature (at first glance resembling one of the impact sites of comet D/1993 F2 = 1993e only a few hours after impact) surrounded the false nucleus, which was positioned a bit to the SE of the center of this feature; a closer inspection showed the feature to be most probably the result of a rotating jet; on the sunward side, it was identical w/ the innermost envelope, while on the tailward side, it started at the SE end of the envelope and then looped around the false nucleus w/ a radius of ~ 1′; the NE segment was weakest, while to the N and NW, it brightened again and got broader and more diffuse; w/ 9×63 B, coma dia. 15′, DC = S8/ [KAM01]. Mar. 12.20: w/ 10×50 B, 4° tail [ENT]. Mar. 12.23: to the naked eye, also 12° dust fan spans p.a. 290°-320°; in 25.3-cm *f*/5.6 L (58×), broad

◇ *Comet C/1995 O1 (Hale-Bopp) [text continued from page 87]* ⟹
fountain seems to be weakening, spanning p.a. 185°-295°; nucleus looks like a 0'.2 beam aligned towards p.a. 205°; broad wedge of material leaves the nucleus towards p.a. 270°, then abruptly turns 90° to S to 'start' the first hood, some 0'.5 from nucleus; the hood looks broken near the edge of the fountain at p.a. 180°, then reappears as a parabolic arc going through the sunward coma until p.a. 70°, where there is another abrupt turn, the hood going through tailwards of the nucleus to touch the beginning of the second hood at p.a. 295° (i.e., the hoods appear as a spiral made of ogival arcs!); this second hood also breaks at p.a. 185°, reappearing weakly as a short arc to p.a. 160°-180°; a new hood seems to be forming W of the p.a. 205° 'nucleus beam'; third hood spanning p.a. ~ 185°-295°; fourth hood much fainter, spanning p.a. 245°-285° [PER01]. Mar. 12.51: "both tails wider, longer, and more distinct; S side of comet more yellow; impressive sight!" [SPR]. Mar. 12.77: dust tail 9° [KON06]. Mar. 12.77: second tail 8° in p.a. 300° [HOR02]. Mar. 12.77: second tail 10° in p.a. 300° [PLS]. Mar. 13.10: dust tail 6° long [MOR04]. Mar. 13.10: w/ 11-cm L (32×), distinct starlike nucleus dia. 1'.5; coma observed as a small spherical triangle containing three or four bright arcs [MOS03]. Mar. 13.14: second tail 8° in p.a. 300° [HOR02]. Mar. 13.23: to the naked eye, 28° gas tail leaving the nucleus towards p.a. 335°, very slightly curving counter-clockwise after ~ 9°, ending close to β Cep; 9° dust fan spans p.a. 295°-315°; comp. stars Vega and Deneb; in 25.3-cm f/5.6 L (240×), stellar nucleus; 0'.2 jet towards p.a. 200°; fountain spanning p.a. 190°-290°; first hood 0'.5 from nucleus, spanning SSE-WNW, linked to the fountain by a broad bridge spanning p.a. 220°-270°; third hood spans p.a. 200°-270°, some 1'.1 from nucleus; at 58×, nucleus as a beam towards p.a. 190°-200°; weakening fountain now spans p.a. 170°-285°; void tailwards of the nucleus more prominent again, appearing as a narrow parabolic dark area; first hood spans the full fountain fan, fading at the p.a. 170° edge, then reappearing as a short arc to the SE; second hood also spans the full fountain fan, fading at the p.a. 170° edge, to reappear immediately as a parabolic arc that could be traced clockwise until p.a. 60°; third hood much weaker, as a short arc to the W; fourth hood only glimpsed towards p.a. 270°-290°; overall, the coma continues strongly dichotomized, the trailing part being prominently brighter; broad bright streamer inside dust tail as in recent obs. [PER01]. Mar. 13.39: "it *really* makes a HUGE difference seeing this comet in a dark sky, just as w/ C/1996 B2!!; naked-eye ion tail curves beautifully past the Milky Way — no doubt about it, more than 20° long; we both felt that the ion tail was both much longer and of much higher surface brightness this morning than four mornings earlier from the same site (both under clear conditions, near 0° F); dust tail curves about 8° in right fork (ion tail forming the left fork) — stunning via naked eye, in 12×50 B, and in 32-inch f/4 L; comet still visible at this latitude (+44°) for 1.5 hr prior to the commencement of astronomical twilight; words can hardly describe the beauty of this comet this morning" [GRE, w/ M. Motta, near Center Harbor, NH]. Mar. 13.99: w/ 11-cm L (32×), m_2 = 4.1 [IVA03]. Mar. 14.16: the end of the ion tail is superimposed on the Milky Way, clearly seen up to 18°; "I suspect a possible further extension up to 20°, but as it is superimposed on a bright star cloud, I cannot be sure it is real" [MIL02]. Mar. 14.50: both tails are growing larger; in the 7×50 B, the twin tails both extend to over 10° [SPR].
(text continued on next page)

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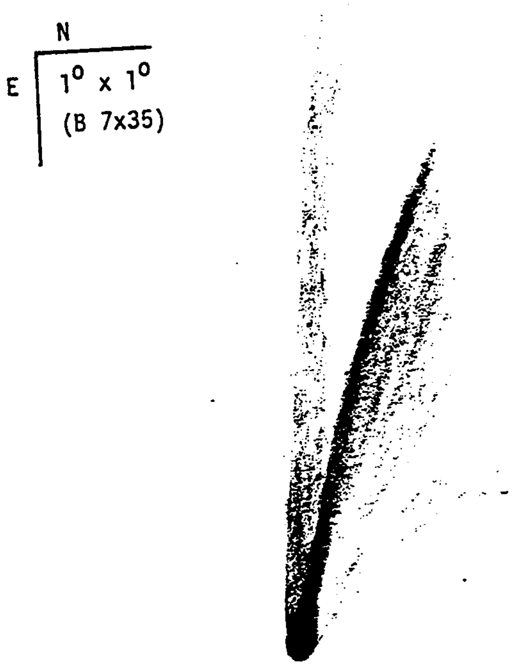
Below: drawings of comet C/1995 O1 by Margareta Westlund. At left, broad view of tails with 7×35 B on 1997 Mar. 18.10. At right, view of coma with 20-cm f/10 T (125×) on Mar. 22.82, in moonlight.



Above: Two sketches of the coma of comet C/1995 O1 by Daniel W. E. Green, showing the changing dust 'hoods' or 'haloes' emanating from the nuclear region, as seen with a 25.4-cm f/4 L (39× and 85×). The view at left was on 1997 Mar. 16.4 and that at the right was on Mar. 18.4. The right side of the coma (from whence issues the ion tail) was very bluish, while the left side of the coma (from whence issues the main part of the dust tail) was very yellowish in color. Numerous splintered streamers and rays where easily visible in the ion tail within a degree of the nucleus.

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◇ *Comet C/1995 O1 (Hale-Bopp) [text continued from page 88]* ⟹

Mar. 15.45: dust tail 8° long in p.a. ~ 310°, spanning p.a. 290°-315° [ADA03]. Mar. 15.49: comet lower but very impressive; twin tails seem to have 'merged' somewhat, as they now are more 'blended' together (wider); tail length over 10° in p.a. 32° [SPR]. Mar. 16.10: w/ naked eye, tails 14° (ion) and 8° (dust); the gas tail was nearly straight; in 7×50 B, gas tail 14° — easily seen for 10°; w/ 10.2-cm *f*/15 R (60×), the nucleus appeared round; two bright arcs (hoods) spanning ~ 120° were seen in the fountain that originated from the nucleus, the innermost hood being brightest [SKI]. Mar. 16.12: w/ naked eye, tails 13° in p.a. 340° (ion), 7° in p.a. 318° (dust); the dust tail was very bright until ~ 3° from central cond., and it showed a strong curvature towards S; the intensity of the gas tail was comparable to the Cyg Milky Way until 6°-7° from the head; in 10×50 B, tails 13° (ion), 7°.5 (dust) [GRA04]. Mar. 16.18: in 20.3-cm *f*/10 T (123×), a bright fountain was seen near the false nucleus, spanning p.a. ~ 170°-270°; 3-4 bright arcs (hoods) were seen in this fountain; these hoods were separated by dark lanes; observed in nautical twilight [GRA04]. Mar. 16.24: to the naked eye, slightly-curved 16° dust fan spans p.a. 290°-330°; also 14° gas tail near p.a. 350°; in 25.3-cm *f*/5.6 L (240×), stellar nucleus; broad bridge of material leaving the nucleus towards W, then abruptly turning clockwise to start the first hood, which spans p.a. 190°-270°; 2nd hood spans p.a. ~ 200°-270°; third hood spans p.a. 230°-270°; the distance between two first hoods is larger than the distance between second and third hoods; at 58×, 'nuclear beam' towards p.a. ~ 320°; broad, weak fountain spans p.a. 190°-270°; four hoods starting to convey the impression of layers; first hood linked to the 'nuclear beam' by a broad bridge of material due-W of the nucleus; strongly dichotomized coma, the trailing part being much brighter [PER01]. Mar. 16.75: w/ 7×50 B, dust tail 4° long in p.a. 320° [VEL03]. Mar. 16.83: w/ naked eye, tails 13° in p.a. 340° (ion), 7°.5 in p.a. 322° (dust) [GRA04]. Mar. 16.97: only the dust tail was seen; moonlight [SKI]. Mar. 16.99: in 20.3-cm *f*/10 T (123×), from the pseudo-nucleus there was a wide, bright fountain spanning p.a. ~ 160°-270°; three arcs (hoods) were visible in the fountain (the two innermost were bright and easily seen); the intensity of the inner part of the dust tail was considerably higher than the nearby planetary nebula NGC 7662 [GRA04]. Mar. 17.13: dust tail 6° long in p.a. 354° [KOZ]. Mar. 17.17: w/ naked eye, 8° tail in p.a. 320° [SHA02]. Mar. 17.23: w/ 7×50 B, dust tail 6° long in p.a. 325° [VEL03]. Mar. 17.24: to the naked eye, ~ 10° gas tail near p.a. ~ 345°; also ~ 10° dust fan spanning

◇ *Comet C/1995 O1 (Hale-Bopp) [text continued from page 89]* ⟹
p.a. 290°-310°; in 25.3-cm *f*/5.6 L (58×), stellar nucleus; broad bridge of material towards W links the nucleus to the first hood; the spiral structure of the four hoods like ogival arcs; first three hoods can be traced from W through S, to E; second hood also continues faintly from W to N, while the third hood has an ill-defined extension from W to NW; the fourth hood only spans WSW-W; there are clear breaks/dimmings in the hoods, both at p.a. 160° and 270°; narrow parabolic dark void tailwards of the nucleus, clearly offset towards the leading edge of the tail system — the contrast at the dust-tail leading edge being stronger than at the gas-tail trailing edge; strongly dichotomized coma, as in recent obs.; the 'terminator' along p.a. ~ 160° is slightly concave towards the leading part of the coma [PER01]. Mar. 17.38: the ion tail seems again fainter in surface brightness and not as obvious through Milky Way as during last obs. at this dark-sky site; can the ion tail be oscillating in brightness as did the ion tail of C/1996 B2?; crisp, clear (and cold! — 0° F) conditions near Center Harbor, NH [GRE]. Mar. 17.79: second tail 7° in p.a. 305° [ZNO]. Mar. 17.82: w/ naked eye, tails 7° (gas), 5° (dust); dust tail bright for 3°; moonlight and thin clouds; in 7×50 B, tails 8° (gas), 6° (dust) [SKI]. Mar. 17.84: w/ 7×50 B, DC = 8, tails 10° in p.a. 330° (gas), 5° in p.a. 310° (dust); both tails appeared curved; weak aurora borealis near comet [HEE]. Mar. 18.01: w/ naked eye, only the dust tail was seen; moonlight [GRA04]. Mar. 18.09: dust tail 7° long [MOR04]. Mar. 18.15: second tail 9° in p.a. 315° [HOR02]. Mar. 18.15: ion tail 4° in p.a. 325° [DVO]. Mar. 18.24: to the naked eye, dust tail spanning p.a. 300°-330° and 9° gas tail near p.a. 345°; in 25.3-cm *f*/5.6 L (240×), nearly-stellar nucleus; broad spiral arm initially leaves the nucleus towards p.a. ~ 280°, then strongly bends clockwise ~ 0'.3-0'.4 from the nucleus to form the first hood; near the opposite side of where this spiral arm leaves the nucleus, there is another weaker and smaller spiral arm leaving the nucleus towards p.a. ~ 110°, then strongly bending clockwise some 0'.2 from the nucleus, but it couldn't be traced much farther after the bend; the second hood spans p.a. ~ 180°-270°, some 0'.5 from nucleus; at 58×, hint of new hood or spiral arm very close and to the E side of the nucleus; the bridge or spiral arm linking the nucleus to the first hood, on the W side, is much weaker now, as if the detachment of the first hood was near completion; three hoods seen, all spanning p.a. ~ 110°-280°, there being a conspicuous weakening near p.a. 190°; overall, the hoods do not convey so strongly the impression of ogival arcs as previously, but rather the shape of wide parabolic arcs; narrow parabolic dark void tailwards of the nucleus [PER01]. Mar. 19.05: w/ naked eye, dust tail 6°; in 10×50 B, tails 9° in p.a. 347° (ion), 7° in p.a. 328° (dust) [GRA04]. Mar. 19.09: dust tail 8° long [MOR04]. Mar. 19.13: w/ 7×50 B, dust tail 5° long in p.a. 332° [VEL03]. Mar. 19.16: w/ naked eye, tails 7° (gas), 6° (dust); dust tail curved strongly towards W; observed in morning twilight; in 7×50 B, tails 10° (gas), 7° (dust) [SKI]. Mar. 19.84: w/ naked eye, tail 12° in p.a. 346° (ion), 7° (dust); the gas tail was quite easily seen for 7°; the comet was first detected when the solar alt. was −4°.1; in 7×50 B, tails 12° (gas) and 8° (dust) long [SKI]. *(text continued on next page)*

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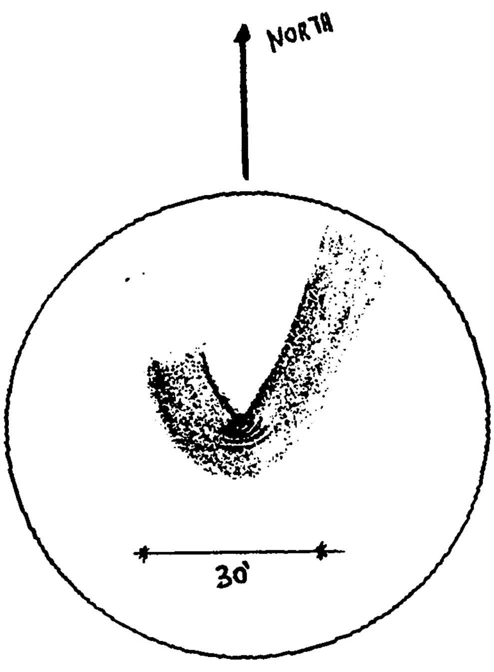
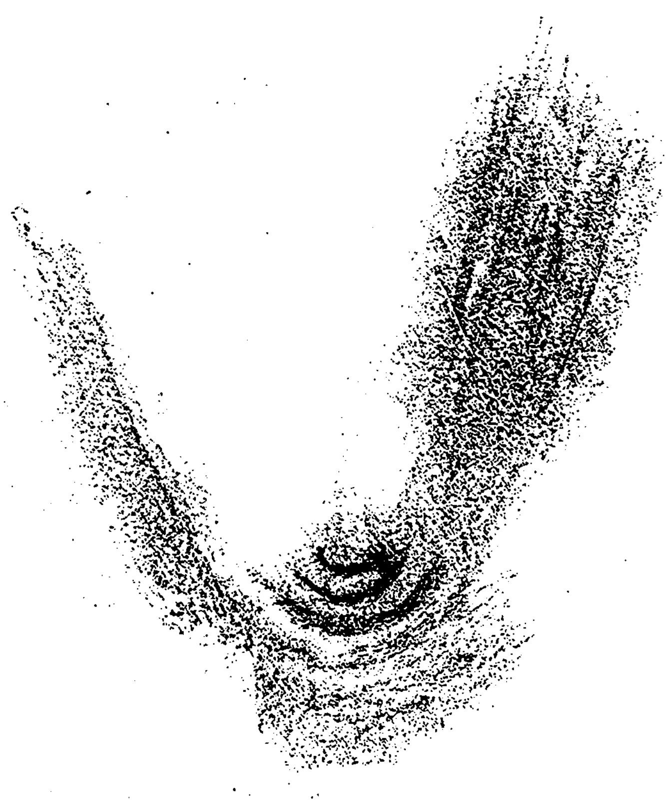
Below: drawings of comet C/1995 O1. At left, sketch by Sandro Baroni as viewed through 20×80 B on 1997 Mar. 20.78; the line is 30' in length. At right, sketch by Daniel W. E. Green as viewed through the Harvard College Observatory 9-inch f/9 Clark R on Mar. 24.98.





◇ *Comet C/1995 O1 (Hale-Bopp) [text continued from page 90]* ⟹

Mar. 20.04: w/11-cm L (32×), m_2 = 3.7 [IVA03]. Mar. 20.17-20.18: w/ naked eye, only dust tail seen; in 20.3-cm f/10 T (123×), extending from the nucleus was a bright fountain spanning p.a. ~ 160°-270°; four hoods were visible in the fountain near the nucleus, three of them easily seen; observed in strong morning twilight [GRA04]. Mar. 20.45: plasma tail very faint but traced for length of 10° in p.a. 350°; the dust tail, of length 9° in p.a. 320°, was much brighter and more broad, spanning p.a. 305°-323°; both tails were lost in the Milky Way; m_1 estimates w/ 1×50 monocular continue to be significantly fainter than naked-eye estimates [ADA03]. Mar. 20.77: tab. tail refers to the type-I tail; 1°.7 type-II tail in p.a. 305°; twilight [FOG]. Mar. 21.06: w/ naked eye, only the dust tail was seen for 5° (being bright despite the moonlight) [SKI]. Mar. 21.12: in 10×50 B, tails 12° in p.a. 352° (ion) and 6°.0 in p.a. 335° (dust); despite the moonlight (3 days from full moon) the gas tail was clearly seen [GRA04]. Mar. 21.80: in 10×50 B, tail 6° in p.a. 354° (ion), 6° in p.a. 336° (dust); moonlight [GRA04]. Mar. 22.14: slightly curving dust tail spans p.a. 318°-340° (longest 11° in p.a. 328°); strong cond., clearly yellowish in color [BOU]. Mar. 22.20: very strong moonlight; in 7×50 B, the S dust tail is a little more intense, stretching over 12° in length [SPR]. Mar. 22.81: central cond. of mag 0.3 [KAM01]. Mar. 22.82: moon and clouds interfered, ion tail not visible [ZNO]. Mar. 22.88: w/ naked eye, tails 7° (dust), 3°.5 (gas); gas tail was faint; comet first detected at w/ sun at alt. −3°.7; in 7×50 B, tails 8° (dust), 7° (gas); gas tail clearly seen for 5° [SKI]. Mar. 22.91: w/ 10.2-cm f/15 R (60×), three arcs (hoods) were seen (the innermost was bright and resembled a spiral outward from the nucleus; the next one was fainter but clearly visible, while the outermost was faint and best seen w/ averted vision); the distance between the arcs were clearly larger than nearly a week ago [SKI]. Mar. 23.00: w/ 10×50 B, tails 5° in p.a. 355° (ion) and 5° in p.a. 342° (dust); strong moonlight [GRA04]. Mar. 23.15: ion tail 6° [KYS]. Mar. 23.16: ion tail 6° [KYS]. Mar. 23.74: w/ 7×50 B, dust tail ~ 4° long in p.a. 343° [VEL03]. Mar. 23.77: dust tail 7° in p.a. 320° [ZNO]. Mar. 24.18: moon partially eclipsed [SPR]. Mar. 24.86: only the dust tail was seen w/ the naked eye; full moon and hazy sky; in 10×50 B, tails 5° in p.a. 7° (ion) and 6° in p.a. 345° (dust) [GRA04]. Mar. 24.86: only the dust tail was seen (easily seen for 4°); full moon and thin clouds [SKI].

Mar. 25.07: in 20.3-cm f/10 T (123×), a diffuse, fan-shaped fountain was seen on the preceding side on the pseudo-nucleus, spanning p.a. ~ 200°-320°; four hoods were seen in this fountain [GRA04]. Mar. 25.12: dust tail > 6° long in p.a. 343°-350° [BAR06]. Mar. 25.80: dust tail > 4° long in p.a. 334°-344° [BAR06]. Mar. 25.84: only dust tail seen clearly, due to full moon; the tail was curved; w/ 15.2-cm f/8 L (80×), 30′ coma, DC = 8, three arcs seen SW of nucleus at p.a. 170°-280° [THO03]. Mar. 26.77: w/ 7×50 B, dust tail 7° long in p.a. 352° [VEL03]. Mar. 26.84: w/ 15.2-cm f/8 L (80×), 30′ coma, DC = 8, three arcs seen SW of nucleus at p.a. 170°-280° (they were a bit wider than yesterday and seem to expand over a period of 1-2 hr) [THO03]. Mar. 26.85: w/ the naked eye and 7×50 B, tails 16° in p.a. 1° (gas) and 11° in p.a. ~ 335° (dust); the width of the gas tail increased outwards [SKI]. Mar. 26.85: excellent conditions (zodiacal light is glaringly obvious); comparison basically w/ α Aur, β Ori, and Sirius; the comet rivals Mars, but this wasn't used because of color; to the naked eye, strongly-curved-clockwise dust fan spanning p.a. 340°-350°; 10° gas tail near p.a. 5°; dust tail much brighter than gas tail [PER01]. Mar. 26.86-26.87: w/ naked eye, tails 15° in p.a. 7° (ion) and 14° in p.a. 336° (dust); very impressive sight, observed before moonrise; w/ 10×50 B, tails 15° (ion) and 11° (dust); the dust tail was very bright for 3°-4°; the gas tail was much weaker, its intensity comparable to the Cyg-Cas Milky Way; there was a possible bend in the gas tail at ~ 4° from the head [GRA04]. Mar. 26.93: in 10.2-cm f/15 R (60×), two arcs were seen near the nucleus, the innermost arc clearly seen despite a turbulent atmosphere; the width of the area between the arcs was comparable to the width of the arcs [SKI]. Mar. 27.06: ion tail 14° long, dust tail 11° long [CRE01]. Mar. 27.14: slightly-curved dust tail spans p.a. 328°-346° (longest 9°.5 in p.a. 337°); head clearly yellowish in color [BOU]. Mar. 27.16: w/ 20-cm T (101×-185×), the greenish-tinged coma shows a complex structure of 3 hoods; one hood comes from the comet's SW side and curves around some 110°+ from the false nucleus towards the solar vector; two other fainter hoods are very visible; the false nucleus and intense hood make the comet look like a giant comma [SPR]. Mar. 27.76: dust tail 11° long in p.a. 335° [BAR06]. Mar. 27.76: w/ 7×50 B, dust tail 9° long in p.a. 346° [VEL03]. Mar. 27.83-Apr. 18.80: ion tail > 7° long, dust tail > 6° long [MIK]. Mar. 27.85: to the naked eye, 10° dust fan strongly curved clockwise; also 10° ion tail; in 25.3-cm f/5.6 L (240× and 58×), bright 'nuclear beam' ~ 1′.5 towards p.a. 290°; possibly what was once the great fountain is now seen in the background of the hoods as a broad ~ 1′ fan spanning p.a. 160°-270°; new thin hood is seen, no more than 0′.1 from the nucleus, spanning p.a. ~ 130°-250°; the gap between this new hood and the nucleus is also very thin, the two structures being linked at the WSW end; the second hood has still some ill-defined, weak bridge linking it to the nucleus at the W end; this second hood spans p.a. 120°-305°, some 0′.5 from the nucleus; third hood ~ 1′ from nucleus spans p.a. 120°-305°; fourth hood better defined towards SW-WNW; along p.a. 320°, a sharp contrast is seen — the W coma being much brighter than the N coma, tailwards of the nucleus; dark void no longer seen; all hoods are roughly parabolic-shaped now [PER01]. Mar. 27.89: "w/ naked eye, ion tail 15°, dust tail 11°; w/ 7×50 B, several streamers were seen in the gas tail; the width of this tail at ~ 10° from the head was ~ 2°; the dust tail was broad and bright for ~ 7°; by now, I can imagine how Comet Donati looked like in 1858!" [SKI]. Mar. 27.90: "w/ naked eye, tails 15° in p.a. 5° (ion) and 13° in p.a. 341° (dust); the dust tail was clearly more prominent than 1-2 weeks ago; in 10×50 B, tails 13° (ion) and 10° (dust); the comet was clearly visible w/ reversed 10×50 B, and I est. total mag ~ −1.9 (ref: Mars)" [GRA04]. Mar. 28.05: ion tail 15° long, dust tail 12° long [CRE01]. Mar. 28.07: w/ 20.3-cm f/10 T (123×), comparison star ϕ And (spec. type B7) was clearly bluer than the nucleus, while ξ And (spec. type K0) was redder; there was a ~ 120°-wide sector (spanning p.a. ~ 160°-280°) of bright material originating from the false nucleus; in this sector there were at least three hoods separated by dark arcs [GRA04]. Mar. 28.77: ion tail 12° [KYS]. Mar. 28.80: ion tail 12° in p.a. 5° [HOR02]. Mar. 28.81: dust tail 18° [KON06]. Mar. 28.81: ion tail 20° in p.a. 5° [PLS]. Mar. 28.81: dust tail 16° in p.a. 335° [ZNO]. Mar. 28.84: also slightly-curving dust tail, longest 12° in p.a. 336° [BOU]. Mar. 28.85, 30.84, and 31.85: w/ naked eye, 14° tail in p.a. 343°, 14°, and 13° [SHA02]. Mar. 28.854: w/ naked eye, 8°.8 tail in p.a. 10° [HAS02]. Mar. 28.89: w/ naked eye, ion tail 15° in p.a. 6°, dust tail 13° in p.a. 343°;

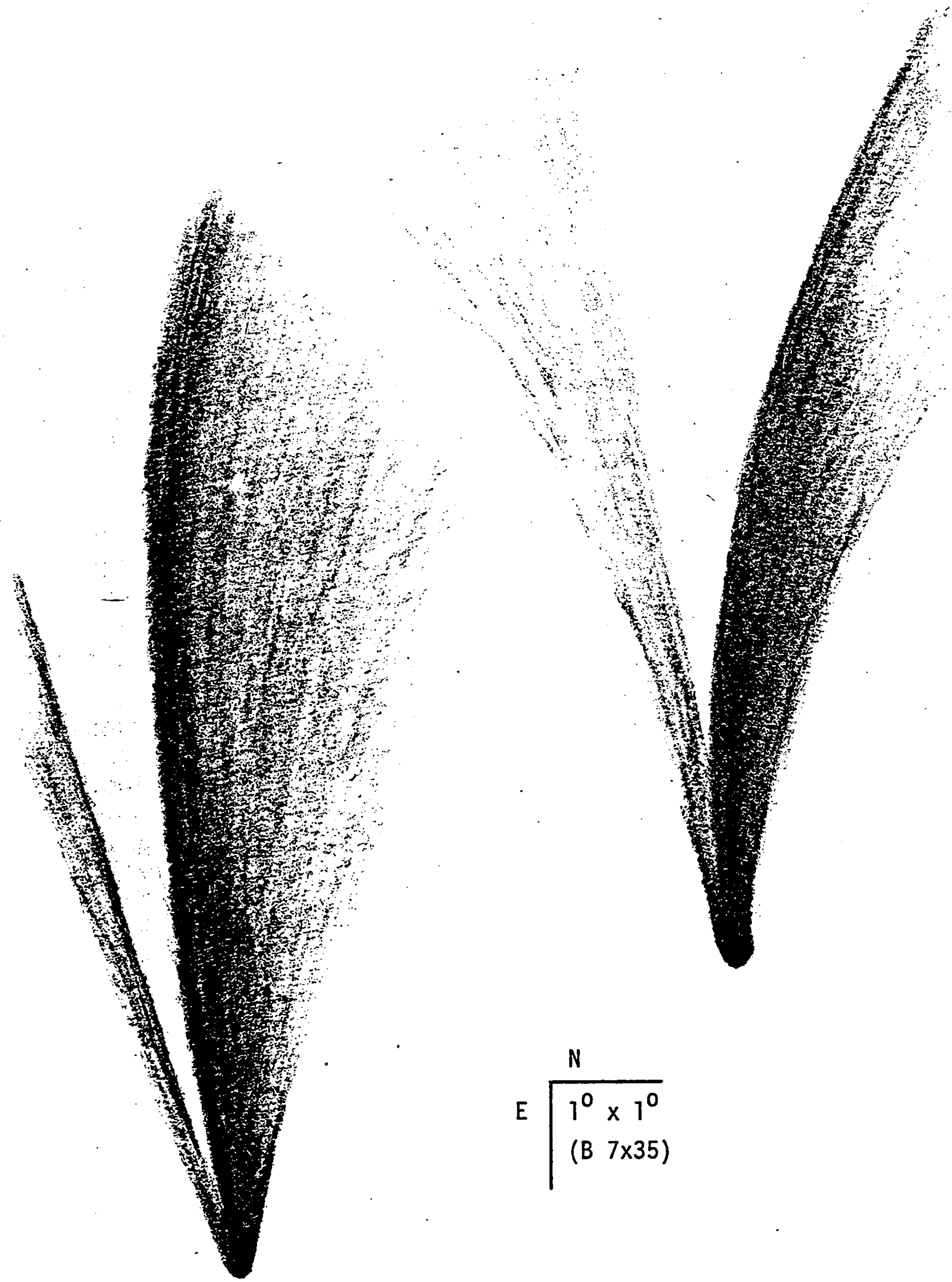
Below: drawings of comet C/1995 O1 by Margareta Westlund (Uppsala, Sweden), as seen through 7×35 B. At left is the view in moonlight on 1997 Mar. 27.91; at right is the view on Mar. 29.96.

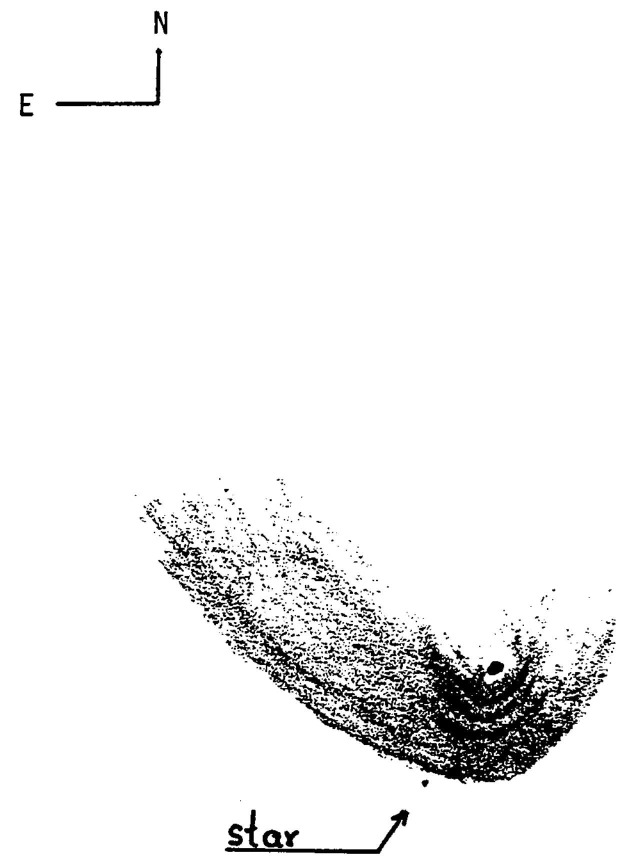
◇ *Comet C/1995 O1 (Hale-Bopp) [text continued from page 91]* ⟹

favorable conditions; w/ 10×50 B, both tails visible for 13°, at p.a. 6° (ion) and 350° (dust); gas tail was clearly split in two components, separated by 0°.5-1°; a streamer was seen in the dust tail [GRA04 = Bjørn H. Granslo]. Mar. 28.94: w/ naked eye, ion tail 15°, dust tail 11°; favorable conditions, but aurora below the comet; w/ 7×50 B, several streamers were seen in the gas tail [SKI]. Mar. 28.98: w/ 20.3-cm *f*/10 T (123×), four hoods were visible on the SW side of the nucleus (p.a. 170°-310°), these hoods were separated by dark arcs [GRA04]. Mar. 29.76: w/ 7×50 B, DC = D8, 13° tail in p.a. 7° [VEL03]. Mar. 29.79: w/ naked eye, 10° long curved dust tail in p.a. 340° [SAR02]. Mar. 29.85: tab. tail is ion; also dust tail ~ 10° long [PAL02]. Mar. 29.85: dust tail 16° in p.a. 335° [ZNO]. Mar. 29.88: ion tail 12° in p.a. 5° [HOR02]. Mar. 29.96: w/ naked eye, both the dust and gas tails were seen for 10°; conditions not ideal due to thin clouds [SKI]. Mar. 30.13: gas tail not visible w/ naked eye; the sky was covered by thin clouds, in morning twilight; w/ 10×50 B, gas tail 8° in p.a. 8°, dust tail 7° in p.a. 351°; comet not seen w/ reversed 10×50 B [GRA04]. Mar. 30.15: w/ 20.3-cm *f*/10 T (123×), a bright fountain was seen on the preceding side of the false nucleus, spanning p.a. 180°-310°; at least three hoods were seen in this fountain [GRA04]. Mar. 30.77: dust tail 16° in p.a. 330° [ZNO]. Mar. 30.78 and Apr. 1.78: w/ 20×60 B, large envelope as diffuse outer coma, ~ 20′ in dia. [CHE03]. Mar. 30.78: dust tail 15° [KYS]. Mar. 30.79: ion tail 6° [DVO]. Mar. 30.80: w/ 7×50 B, dust tail 11° long in p.a. 333° [VEL03]. Mar. 30.80: photometry w/ 90-mm-f.l. *f*/2.8 lens + *V* filter + CCD; the exposure time is listed as 1 sec, although the exp. are recently only 0.3-0.5 sec long [MIK]. Mar. 30.83: "also slightly curving dust tail, longest 13°.5 in p.a. 337°; in 15.6-cm L (102×), strong cond., yellowish in color; in sunward direction, sort of knot attached to small jet (new hood forming?); three concentric hoods visible, brightest in sunward direction, the inner two rather sharply defined, and the outer one very diffuse (some 1′-1′.5 in dia.)" [BOU]. Mar. 30.85: dust tail 18° [KON06]. Mar. 30.86: w/ naked eye, both the dust and ion tail were seen for 13°, directed toward p.a. 348° and 14°, respectively; observing affected by thin clouds; w/ 10×50 B, 11° dust tail in p.a. 355°, 10° ion tail in p.a. 14°; "for all of my obs. in Mar., the m_2 values refer to the nearly-stellar central cond. (dia. < 2′); the comet was clearly visible w/ reversed 10×50 B, at total mag −1.7, using Mars as a comparison object" [GRA04]. Mar. 30.97: dust tail 13° in p.a. 330° [HOR02]. Mar. 30.97: dust tail 15° in p.a. 335° [PLS]. Mar. 31.00: w/ naked eye, tails 15° (gas) and 12° (dust); w/ 7×50 B, two streamers easily seen on each side of the gas tail; a bright streamer was seen for ~ 2° w/in dust tail (another streamer was curved and formed the E edge of this tail); in reversed 7×50 B, the comet was as bright as Mars; w/ 10.2-cm *f*/15 R (84×), three hoods were seen on the SW side of the false nucleus — the innermost started near the nucleus and formed an outward spiral (the next one was fainter and formed a bright arc spanning 120° in p.a., while the outermost was faint but more sharply defined on its inner side) [SKI]. Mar. 31.07: plasma tail 7° long in p.a. 9°; an ~ 7° dust tail was also seen [ADA03]. Mar. 31.79: dust tail 12° in p.a. 330° [HOR02]. Mar. 31.795: w/ naked eye, 15°.4 tail in p.a. 13° [HAS02]. Mar. 31.80: dust tail [KYS]. Mar. 31.81: w/ 10.2-cm *f*/15 R (84×), three bright arcs were seen (the innermost was brighter and closer to the nucleus than on the preceding evening; the next one was nearly as bright, while the outermost was fainter, but still easily seen); the separation between arcs 2 and 3 were slightly less than between the two innermost arcs [SKI]. Mar. 31.83: w/ naked eye, curved dust tail 10° long (initially directed to p.a. 350°); ion tail fainter than on Mar. 12, but decidedly broader; central cond. of mag 0.5; w/ 9×63 B, very complex coma, which can roughly be divided into 3 regions — a region directed towards the ion tail, a considerably brighter region from which the dust tail emanates (which again is dominated by the dust streamer on the leading edge), and a diffuse-looking region immediately to the E of the trailing edge of the dust tail; w/ 20-cm T (80×), the false nucleus still showed the comma-shaped jet, starting in NW and creating the innermost of three envelopes [KAM01]. Mar. 31.84: "also slightly curving dust tail, longest 12° in p.a. 340°; strong cond. w/ clear yellow color; w/ 25.4-cm L (88×, 115×), new hood forming at end of small sunward jet; w/in 2′ of nucleus, three more concentric hoods visible, brightest in sunward direction, the outer one being very diffuse; at moments of good seeing, several more very diffuse hoods suspected, but this may have been an illusion" [BOU]. Mar. 31.86: w/ naked eye, tails 14° in p.a. 16° (ion) and 16° in p.a. 358° (dust); w/ 10×50 B, tails 12° in p.a. 16° (ion) and 13° in p.a. 3° (dust); two streamers visible in the ion tail, forming its W and E boundaries; a diffuse streamer was seen in the dust tail; the comet was easily seen and appeared brighter than Mars in reversed 10×50 B (the estimated mag was −1.9, which apparently includes parts of the dust tail) [GRA04]. Mar. 31.86: w/ naked eye, both the dust and gas tails were visible for 14°; w/ 7×50 B, same tail lengths as w/ the naked eye; the width of the dust tail reached nearly 2°.5; the gas tail was 2° wide at ~ 7° from the central cond.; in the dust tail, there was a bright streamer that originated from the nuclear region; the E edge of the dust tail was sharply defined, and much more diffuse on its other side; several streamers and structures were seen in the gas tail; the W edge of the gas tail was straight and more sharply defined than its E side [SKI].

1997 Apr. 1.05: ion and dust tails 15° and 10° long [CRE01]. Apr. 1.14: plasma tail faint, but also traced to 8° (extension to ~ 10° was suspected) in p.a. 9°; main dust tail spanned p.a. 338°-355° [ADA03]. Apr. 1.17: w/ 7×50 B, there is a distinctly-curved yellow tail stretching for over 14° in p.a. 34°; plasma tail much fainter; hints of 'veiled structure' in the main dust tail, w/ a bright narrow middle section curving outwards from the coma [SPR]. Apr. 1.79: dust tail 15° [KYS]. Apr. 1.80: dust tail 10° in p.a. 330° [HOR02]. Apr. 1.80 and 2.78: w/ naked eye, 12° curved dust tail in p.a. 345° and 350° [SAR02]. Apr. 1.81: ion tail 15° [KON06]. Apr. 1.82: dust tail 12° in p.a. 335° [ZNO]. Apr. 1.833: w/ naked eye, 15°.7 tail in p.a. 17° [HAS02]. Apr. 1.84: also slightly curving dust tail, longest 15° in p.a. 340°; nearly-stellar cond., yellowish in color [BOU]. Apr. 1.84: w/ naked eye, curved dust tail 12° long (initially directed to p.a. 355°); ion tail fainter and broader than yesterday; central cond. of mag 0.7; w/ 9×63 B, very complex coma of dia. 15′ and DC = S8/ (overall appearance as yesterday); highly structured ion tail w/ several streamers; w/ 20-cm T (80×), the innermost envelope showed a spiral-like appearance, one streamer emanating from the leading edge of the coma to the NE [KAM01]. Apr. 1.87: w/ naked eye, gas tail 14° in p.a. 14°; the outer portion of the gas tail was slightly easier to detect than on the previous evening; w/ reversed 7×50 B, total mag −1.3 (comparison w/ Mars); the comet was easily seen in 7×50 B when first detected w/ solar alt. −2°.7 [SKI]. Apr. 1.88: w/ naked eye, tails each 14° long in p.a. 18°

Below: drawings of comet C/1995 O1 by Margareta Westlund (Uppsala, Sweden), as seen through 7×35 B. At left is the view on 1997 Apr. 1.09; at right is the view on Apr. 4.89.





***Above:** Two sketches of the coma of comet C/1995 O1 in 1997 April. At left, drawing by Daniel W. E. Green on Apr. 11.06 UT at the Harvard College Observatory's 9-inch f/12 Clark R (261×, and lower magnifications). At right, drawing by Margareta Westlund with a 20-cm f/10 T (125×) on Apr. 20.82, in moonlight.*

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◇ *Comet C/1995 O1 (Hale-Bopp) [text continued from page 93]* ⟹

(ion) and 0° (dust); in 10×50 B, tails 14° in p.a. 22° (ion) and 13° in p.a. 6° (dust); several streamers were seen both in the ion and dust tails [GRA04]. Apr. 2.0-2.1: from a dark-sky site, this comet looks to the naked eye very similar to Bond's drawings of comet C/1858 L1 (Donati), w/ the curved dust tail and the ion tail streaming off to form a the 'upper branch' of the 'V'-shaped comet; the ion tail has considerable width ~ 5°-10° from the comet's head; at our latitude (+44°), the comet was observed for some 4 hr (and for more than 3 hr in a dark sky after the end of twilight); again, one must get to a really dark sky (away from any artificial sky glow) to appreciate the true splendor of this comet [GRE, w/ Andy Chaikin, observing near West Rumney, NH, at the edge of the White Mountains National Forest]. Apr. 2.06: ion and dust tails 18° and 11° long [CRE01]. Apr. 2.08: in 20.3-cm $f/10$ T (123×), the false nucleus was small, but not quite stellar (its size was not more than 3″-4″, as compared w/ the nearby double star γ And); there was a region of enhanched brightness SW of the nucleus (p.a. ~ 160°-300°), in which three, possibly four, hoods were seen; the comet's head was much more evenly illumated than in Feb. [GRA04]. Apr. 2.18: w/ 20-cm T (101×), the yellow-green-tinged coma shows a complex structure of 3 hoods; one hood comes from the comet's SW side and curves around some 100°+ from the false-nucleus towards the solar vector; two other fainter hoods are very visible; the false nucleus and intense inner hood make the comet look like a giant comma or 'S'-shaped spiral nebula [SPR]. Apr. 2.78: w/ 15-cm $f/15$ R (65×), bright inner coma of dia. 12′, outer coma of dia. 18′; nucleus offset w/ respect to geometric center of the outer coma; curved dust tail in p.a. 330°-350°, gas tail has sharp wavy structure w/in 7° of nucleus [CHE03]. Apr. 2.79: dust tail 14° in p.a. 340° [ZNO]. Apr. 2.80: dust tail 12° in p.a. 345° [HOR02]. Apr. 2.80: dust tail 13° in p.a. 350° [PLS]. Apr. 2.83: ion tail 5° [LIB]. Apr. 2.85: tab. tail is ion; also dust tail ~ 6° long [PAL02]. Apr. 3.78 and 4.78: w/ naked eye, 14° and 20° curved dust tail in p.a. 350° [SAR02]. Apr. 3.79: ion tail 9° [KON06]. Apr. 3.83: ion tail 4° [LIB].

Apr. 3.85: also slightly curving dust tail (longest 15° in p.a. 350°); strong, nearly-stellar cond., yellow in color [BOU]. Apr. 3.86: w/ naked eye, 9° tail in p.a. 22° [SHA02]. Apr. 4.18: w/ 7×50 B, the tail is a complex fabric of material (brighter up the middle section, but w/ a 'hook' or twist part way, giving the comet a 'tadpole' effect); the faint plasma tail extends for 8° whilst the dust tail can be traced well over 17° [SPR]. Apr. 4.83: w/ naked eye, 12°.0 tail in p.a. 348° and 12°.5 tail in p.a. 28° [HAS02]. Apr. 4.85: tab. tail is ion; also dust tail ~ 9° long [PAL02]. Apr. 4.86: to the naked eye, excellent conditions (the zodiacal light is strikingly conspicuous); dust fan at least 12° long, centered near p.a. 0°; ion tail at least 8° long, near p.a. 35°; in 9×34 B, two parabolic streamers flowing from the nucleus, symmetric to the ion-tail axis; broad dust fan curving clockwise, significantly sharper at the leading edge, the trailing edge being ill-defined; in 25.3-cm *f*/5.6 L (240×), non-stellar nucleus; first hood appears as a spiral arm, leaving the nucleus as a narrow fountain towards p.a. 270°, then strongly curving clockwise ~ 21″ from the nucleus, going through the sunward coma until p.a. 155°; the second hood also originates from the same narrow westward fountain, then strongly curving clockwise some 36″ from the nucleus; it was possible to trace the second hood through the sunward coma until p.a. 155°; hint of a weak new hood being formed as a narrow 9″ spiral arm touching the nucleus nearly S, but directed along ESE; at 58×, new hood is clearly seen, as well as four more hoods, the first two spanning p.a. 155°-270°; third hood spans p.a. 170°-270°; fourth hood as a short arc towards the SW — not concentric w/ the three inner hoods (i.e., more linear, not-so-strongly curving clockwise); parabolic coma w/ axis near p.a. 30°-35°; dust tail is seen w/ the trailing edge along NNW [PER01]. Apr. 4.87: dust tail 18° in p.a. 345° [ZNO].

Apr. 5.19: w/ 7×50 B, the faint plasma tail extends for 10° whilst the dust tail can be traced for 15° [SPR]. Apr. 5.79: w/ 5-cm R (20×), m_2 = 2.6 [BAR06]. Apr. 6.79: tab. tail refers to type-I tail; type-II tail in p.a. 25° [FOG]. Apr. 6.84: w/ naked eye, curved dust tail 14° long (initially directed toward p.a. 5°); weak, broad ion tail; central cond. of mag 0.8; w/ 9×63 B, very complex coma of dia. 25′ and DC = S8/; highly structured ion tail, dominated by several streamers, the brightest one at the leading edge; w/ 20-cm T (80×), false nucleus nearly at the apex of the paraboloid coma; three envelopes, more diffuse than six days ago; bright streamer easily visible as a conspicuous streak emanating from the brighter parts of the coma [KAM01]. Apr. 6.84: ion tail 5° [LIB]. Apr. 6.84: also slightly curving dust tail, longest 19° in p.a. 348°; strong, nearly-stellar cond., yellowish in color [BOU]. *(text continued on next page)*

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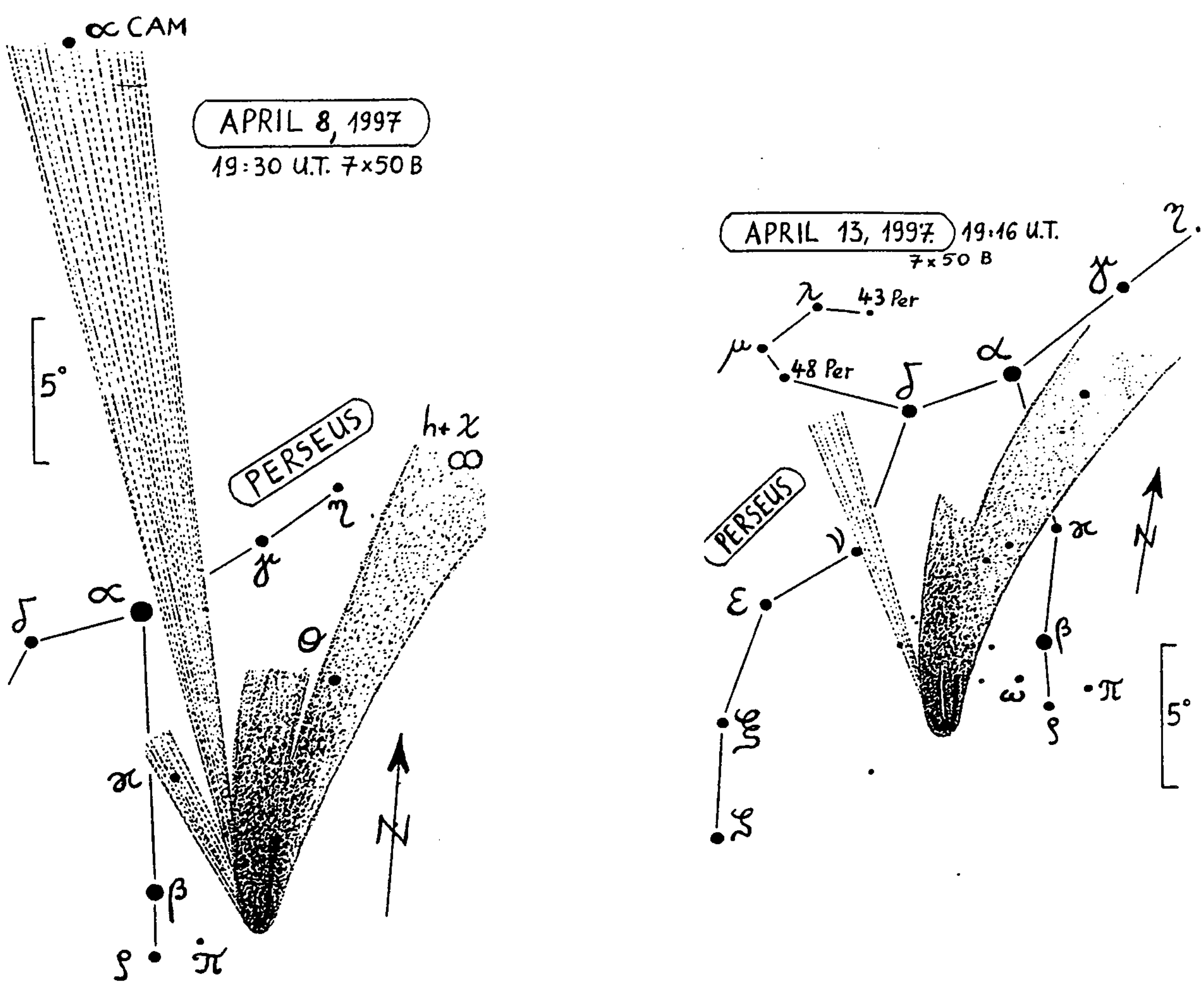
Below: drawings of comet C/1995 O1 by Attila Kósa-Kiss via 7×50 B, showing how the ion tail shortened and faded rapidly in April. At left, 1997 Apr. 8.81; at right, Apr. 13.80 UT.



◇ *Comet C/1995 O1 (Hale-Bopp) [text continued from page 96]* ⟹
Apr. 6.87: w/ naked eye, 14°.1 tail in p.a. 335° and 12°.1 tail in p.a. 25°; w/ 10×50 B, coma dia. 20′, DC = 8 [HAS02]. Apr. 7.79: dust tail [DVO]. Apr. 7.81: 15° dust tail in p.a. 350° [HOR02 and HYN]. Apr. 7.81: 6° ion tail [LIB]. Apr. 7.82: w/ naked eye, 10°.8 tail in p.a. 26°; w/ 10×50 B, coma dia. 9′.3, DC = 8 [HAS02]. Apr. 7.82: 21° dust tail in p.a. 345° [ZNO]. Apr. 7.82: 16° ion tail [KON06]. Apr. 7.84: w/ naked eye, curved dust tail 14° long (initially directed toward p.a. 5°); weak, broad ion tail, which could not be traced beyond the line α-γ Per, although the limiting mag at the comet's position was 5.3 and the zodiacal light well visible; central cond. of mag 0.6; w/ 9×63 B, 22′ coma, DC = S8/, highly-structured ion tail, streamers not as dominating as the night before; the part of the ion tail very near the coma looked like a DE (of the leading part) [KAM01]. Apr. 7.84: w/ naked eye, 6° tail in p.a. 28° [SHA02]. Apr. 7.85: also slightly curving dust tail, longest 20° in p.a. 349° [BOU]. Apr. 7.88: 16° dust tail in p.a. 350° [HOR02]. Apr. 8.06: ion and dust tails 8° and 12° long [CRE01]. Apr. 8.77: w/ naked eye, dust tail 13° long in p.a. 335°; w/ 5-cm R (20×), m_2 = 2.3 [BAR06]. Apr. 8.80: 6° ion tail [LIB]. Apr. 8.80: 13° dust tail in p.a. 355° [HOR02]. Apr. 8.83: 16° ion tail [KON06]. Apr. 8.85: 17° dust tail in p.a. 350° [ZNO]. Apr. 8.86: w/ naked eye, 13°.6 tail in p.a. 349° and 11°.1 tail in p.a. 30° [HAS02]. Apr. 8.90: tab. tail is ion; also dust tail ~ 12° long [PAL02]. Apr. 9.81: 7°.5 dust tail in p.a. 0° [HYN]. Apr. 9.89: w/ naked eye, 5° tail in p.a. 32° [SHA02].

Apr. 10.85: w/ naked eye, 5° tail in p.a. 29° [SHA02]. Apr. 11.79: 16° ion tail in p.a. 50° [ZNO]. Apr. 11.82: 12° ion tail [KON06]. Apr. 11.85: w/ 9×63 B, ion tail at p.a. 40°; interfering moonlight [KAM01]. Apr. 11.85: also 5° ion tail near p.a. 40°; moonlight [PER01]. Apr. 11.88: w/ naked eye, 10°.8 tail in p.a. 353° and 10°.7 tail in p.a. 30° [HAS02]. Apr. 12.19: moonlight starting to 'wash out' tail; Algol (near minimum) 2°.5 away [SPR]. Apr. 12.84: 10° ion tail [KON06]. Apr. 13.79: 12° ion tail in p.a. 50° [ZNO]. Apr. 13.80: 4° ion tail [LIB]. Apr. 13.84: w/ naked eye, curved dust tail traced to 10°; central cond. of mag 0.8; interfering moonlight [KAM01]. Apr. 14.85: moonlight; to the naked eye, dust tail could be as long as 12°, there being a sharp clockwise bend in the leading edge some 2°-3° from the head; in 9×34 B, hint of 'lobes' in the dust tail, as in recent two weeks; both the sharp leading edge and the diffuse trailing edge are slightly curved clockwise; in 25.3-cm *f*/5.6 L (240×), stellar nucleus w/ weak narrow jet towards W; newly-formed hood appears as a 'cumulonimbus anvil' fan spanning p.a. 130°-250°, the outer edge leaving the nucleus towards W, then strongly curving clockwise, reaching an average distance of 6″ from the nucleus; the second hood leaves the nucleus towards the W, then strongly bends clockwise through the sunward coma, w/ the outer edge ~ 19″ from the nucleus; third hood not clearly linked to the nucleus, but emerges at some distance Wwards, then strongly bending clockwise until S (the outer edge reaching ~ 31″ from the nucleus); at 58×, both edges of the tail curve slightly clockwise; the new 'anvil-shaped' hood gives the impression of having a faint extension going clockwise tailwards of the nucleus; the hood's edge towards W is involved in diffuseness; second hood spans p.a. 135°-260°; third hood spans p.a. 155°-260°; a fourth, weaker hood spans p.a. 185°-250°; parabolic-shaped, weakly-pronounced dark void tailwards of the nucleus; the leading part of the coma is now clearly brighter than the trailing part [PER01].

Apr. 15.85: 9° ion tail [KON06]. Apr. 15.85: w/ naked eye, 6° tail in p.a. 45° [SHA02]. Apr. 17.83: naked-eye estimate made w/ different pairs of comparison stars than 10×50 B estimate [GLI]. Apr. 17.85 and 21.85: w/ naked eye, central cond. of mag 1.1 and 1.2; strong moonlight [KAM01]. Apr. 19.89-29.89: comparison stars α Aur, β Ori, α Tau [DES01]. Apr. 20.82: estimates employed Capella and Procyon as comparison stars [GLI]. Apr. 20.85: only comp. star used (α Lyr) had the same zenith distance as the comet [GLI]. Apr. 24.19: w/ 7×50 B, the comet shows a very broad and distinctly-curved dust tail some 8°+ in length [SPR]. Apr. 24.81: ion tail > 5° long, dust tail > 6° long [MIK]. Apr. 27.21: w/ 7×50 B, the plasma tail is much more evident than in recent days; the dust tail shows a distinct filamentary structure to it [SPR]. Apr. 28.87: comparison stars α Aur, α CMi, β Gem, and α Vir [PER01]. Apr. 29.78: w/ naked eye, 10° dust tail and 16° ion tail; m_2 = 1.3 [MIL02]. Apr. 30.78: 12° ion tail, 8° dust tail [MIL02].

◇ *Comet C/1996 B2 (Hyakutake)* ⟹ 1996 Apr. 5.46: w/ 20.0 *f*/9 C (45×), 5′.8, DC = 8; ion tail 2°.5 long in p.a. 60° [NAG04]. Apr. 12.45: another tail in p.a. 50° [NAG04]. Apr. 13.47: another tail in p.a. 70° (> 1° long); w/ 20.0-cm *f*/9 C (60×), 6′.3 coma, DC = 7/ [NAG04]. Apr. 22.44: w/ 10×70 B, DC = 7, tail 13°.5 long in p.a. 40° [NAG04].

◇ *Comet C/1996 N1 (Brewington)* ⟹ 1996 Sept. 5.88 and 6.88: w/ 20.0-cm *f*/6 L (38×), m_1 = 8.7 and 9.5 (MM = S; Ref = *PPM Star Catalogue*, Röser and Bastian 1991, unacceptable for visual magnitude work); coma dia. 6′ and 4′; DC = 4 and 3 (respectively) [GIL01]. Oct. 2.88: w/ 20.0-cm *f*/6 L (38×), $m_1 \simeq$ 10.2 (see his data above for Sept. 5 and 6); coma dia. 6′, DC = 2 [GIL01].

◇ *Comet C/1996 Q1 (Tabur)* ⟹ 1996 Oct. 16.81: another faint narrow tail, 1°.1 long in p.a. 290° [NAG04]. Oct. 23.83: other faint tails in p.a. 303° (1°.25 long), 5° (60′), and 350° (33′) [NAG04].

◇ *Comet C/1997 D1 (Mueller)* ⟹ 1997 Mar. 4.94: starlike central cond. suspected [MEY]. Mar. 5.20: central cond. of dia. 2″ and mag 15.0; tail, as tab., although somewhat faint and irregular in shape, nevertheless was readily apparent [ROQ]. Mar. 9.27: central cond. of dia. 5″ and mag 15.4; inner coma region generally symmetrical [ROQ]. Mar. 9.84: photometry w/ 36-cm *f*/6.7 T + *V* filter + CCD [MIK]. Mar. 9.85: comet similar in appearance to nearby NGC 3824, but slightly smaller and rounder [BOU]. Mar. 13.15: central cond. of mag 14.6 and dia. 3″; coma was asymmetrical, as expected, in the direction of the tail; tail's structure and visibility appeared consistent on exposure-calibrated images made in *V*, *R*, and unfiltered [ROQ]. Mar. 18.16: central cond. of mag 15.7 and dia. ~ 4″ [ROQ]. Mar. 20.20: central cond. of dia. 4″ and mag 15.0 [ROQ]. Mar. 27.14: central cond. of dia. 2″ and mag 13.7; tail showed two distinct components — a tapering inner "core" extending 40″ at p.a. 108°, which was immersed in a fainter, diffuse component extending almost 100″ at p.a. 104° [ROQ]. Mar. 30.13: central cond. of dia. ~ 2″ and mag 14.6; tail showed no sub-structure w/in its main, diffuse body such as was evident three days previously [ROQ]. Apr. 13.15: central cond. of dia. 3″ and mag 15.1; image processing showed no sub-structure w/in the coma or tail [ROQ].

TABULATED DATA

The headings for the tabulated data are as follows: "DATE (UT)" = Date and time to hundredths of a day in Universal Time; "N" = notes [* = correction to observation published in earlier issue of the *ICQ*; an exclamation mark (!) in this same location indicates that the observer has corrected his estimate in some manner for atmospheric extinction (prior to September 1992, this was the standard symbol for noting extinction correction, but following publication of the extinction paper — July 1992 *ICQ* — this symbol is only to be used to denote corrections made using procedures different from that outlined by Green 1992, *ICQ* **14**, 55-59, and in Appendix E of the *ICQ Guide to Observing Comets* — and then only for situations where the observed comet is at altitude > 10°); '&' = comet observed at altitude 20° or less with no atmospheric extinction correction applied; '$' = comet observed at altitude 10° or lower, observations corrected by the observer using procedure of Green (*ibid.*); for a correction applied by the observer using Tables Ia, Ib, or Ic of Green (*ibid.*), the letters 'a', 'w', or 's', respectively, should be used].

"MM" = the method employed for estimating the total (visual) magnitude; see article on page 186 of the Oct. 1996 issue [B = VBM method, M = Morris method, S = VSS or In-Out method, I = in-focus, C = unfiltered CCD, c = same as 'C', but for 'nuclear' magnitudes, V = electronic observations — usually CCD — with Johnson *V* filter, *etc.*]. "MAG." = total (visual) magnitude estimate; a colon indicates that the observation is only approximate, due to bad weather conditions, *etc.*; a left bracket ([) indicates that the comet was not seen, with an estimated limiting magnitude given (if the comet IS seen, and it is simply estimated to be fainter than a certain magnitude, a "greater-than" sign (>) must be used, not a bracket). "RF" = reference for total magnitude estimates (see pages 98-100 of the October 1992 issue, and Appendix C of the *ICQ Guide to Observing Comets*, for all of the 1- and 2-letter codes). "AP." = aperture in centimeters of the instrument used for the observations, usually given to tenths. "T" = type of instrument used for the observation (R = refractor, L = Newtonian reflector, B = binoculars, C = Cassegrain reflector, A = camera, T = Schmidt-Cassegrain reflector, S = Schmidt-Newtonian reflector, E = naked eye, *etc.*). "F/" and "PWR" are the focal ratio and power or magnification, respectively, of the instrument used for the observation — given to nearest whole integer (round even); note that for CCD observations, in place of magnification is given the exposure time in seconds (see page 11 of the January 1997 issue).

"COMA" = estimated coma diameter in minutes of arc; an ampersand (&) indicates an approximate estimate; an exclamation mark (!) precedes a coma diameter when the comet was not seen (*i.e.*, was too faint) and where a limiting magnitude estimate is provided based on an "assumed" coma diameter (a default size of 1′ or 30″ is recommended; cf. *ICQ* **9**, 100); a plus mark (+) precedes a coma diameter when a diaphragm was used electronically, thereby specifying the diaphragm size (i.e., the coma is almost always larger than such a specified diaphragm size). "DC" = degree of condensation on a scale where 9 = stellar and 0 = diffuse (preceded by lower- and upper-case letters S and D to indicate the presence of stellar and disklike central condensations; cf. July 1995 issue, p. 90); a slash (/) indicates a value midway between the given number and the next-higher integer. "TAIL" = estimated tail length in degrees, to 0.01 degree if appropriate; again, an ampersand indicates a rough estimate. Lower-case letters between the tail length and the p.a. indicate that the tail was measured in arcmin ("m") or arcsec ("s"), *in which cases the decimal point is shifted one column to the right.* "PA" = estimated measured position angle of the tail to nearest whole integer in degrees (north = 0°, east = 90°). "OBS" = the observer who made the observation (given as a 3-letter, 2-digit code).

A complete list of the Keys to abbrevations used in the *ICQ* is available from the Editor for $4.00 postpaid (available free of charge via e-mail); these Keys are also now available in the new *Guide to Observing Comets* and via the *ICQ*'s World Wide Web site. *Please note that data in archival form, and thus the data to be sent in machine-readable form, use a format that is different from that of the Tabulated data in the printed pages of the ICQ;* see pages 59-61 of the July 1992 issue, p. 10 of the January 1995 issue, and p. 100 of the April 1996 issue for further information [note correction on page 140 of the October 1993 issue]. Further guidelines concerning reporting of data may be found on pages 59-60 of the April 1993 issue, and in the *ICQ Guide to Observing Comets.*

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Key to observers with observations published in this issue, *with 2-digit numbers between Observer Code and Observer's Name indicating source [07 = Comet Section, British Astronomical Assn.; 16 = Japanese observers (c/o Akimasa Nakamura, Kuma, Japan); 23 = Czech group (c/o P. Pravec and V. Znojil); 32 = Hungarian group (c/o K. Sarneczky); 37 = Ukrainian Comet Section (c/o A. R. Baransky and K. I. Churyumov); 42 = Belarus observers, c/o V. S. Nevski, Vitebsk; 43 = Slovenian observers, c/o Herman Mikuz, Ljubljana; etc.]. Those with asterisks (*) preceding the 5-character code are new additions to the Observer Key:*

ADA03		Brian Adams, IA, U.S.A.
AND03	17	Krasimir Andreev, Bulgaria
ANZ		Fabio Anzellini, Italy
*APE	07	Cornel Apetroaei, Romania
BAK01	32	Gaspar Bakos, Budapest, Hungary
BAN	18	Jaroslaw Bandurowski, Poland
BAR		Sandro Baroni, Italy
BAR06	37	Alexandr R. Baransky, Ukraine
BEA	07	Sally Beaumont, Cumbria, England
BIV		Nicolas Biver, France
BOJ01	34	Eva Bojurova, Bulgaria
*BON01	37	Anton Bondarenko, Ukraine
BOR04	37	Sergiy A. Borysenko, Ukraine
BOR05	34	Galin Borisov, Bulgaria
BOU		Reinder J. Bouma, Netherlands
BRL	12	Pal Brlas, Budapest, Hungary
*BRO06		Xavier Bros, Barcelona, Spain
BRU	42	Ivan S. Brukhanov, Belarus
BUS04	32	Sandor Busa, Hungary
CAN04		P. Candy, Viterbo, Italy
*CHA02	34	Neofit Chanev, Bulgaria
CHE03	33	Kazimieras T. Cernis, Lithuania
CHO01	18	Franciszek Chodorowski, Poland
*CHR	18	Antoni Chrapek, Pikulice, Poland

CHU		Klim Churyumov, Kiev, Ukraine
*CHV	37	V. V. Chvak, Ukraine
CNO	18	Ryszard Cnota, Poland
COO02		Tim P. Cooper, South Africa
CRE01		Phillip J. Creed, OH, U.S.A.
CSU	32	Matyas Csukas, Salonta, Romania
DAH	24	Haakon Dahle, Norway
DAM	36	Matteo Damiani, Italy
DER	18	Oskar Deren, Poland
DES01		Jose G. de Souza Aguiar, Brazil
DIE02		Alfons Diepvens, Belgium
DIN01	07	E. L. Dinham, Plymouth, England
*DOB	32	Szabolcs Dobra, Hungary
DOH	07	Paul B. Doherty, England
*DRA02	18	Michal Drahus, Krakow, Poland
DVO	23	Denisa Dvorakova, Czech Repub.
ELT		Maurizio Eltri, Italy
ENT	07	L. Entwisle, England
FAJ	18	Tomasz Fajfer, Torun, Poland
*FIA	23	Karolina Fialova, Czech Republic
FIL04	18	Marcin Filipek, Poland
FIL05	37	Alexander V. Filatov, Ukraine
*FIL06	34	Peter Filkov, Bulgaria
FOG		Sergio Foglia, Italy
*FRE01	45	Jose Rodriguez Freitas, Uruguay
FUK01	16	Hiromi Fukushina, Japan
*FUK02	16	Hideo Fukushima, Japan
*GEN	34	Maria Genkova, Bulgaria
*GEN01	34	Ivajlo Genov, Bulgaria
GER01	37	O. N. Geraschenko, Ukraine
GIL01	11	G. Gilein, Netherlands
GLI		Gunnar Glitscher, Germany
GOL	19	Vladimir A. Golubev, Belarus
*GOL02	07	Steven Goldsmith, Kent, U.K.
*GON05		Juan_Jose Gonzalez, Spain
GRA04	24	Bjoern Haakon Granslo, Norway
GRA07	34	Ivan Gradinarov, Bulgaria
GRE		Daniel W. E. Green, U.S.A.
GRO04	18	Jaroslaw Grolik, Poland
GUB		Herbert Gubo, Germany
HAL04	23	Karel Halir, Czech Republic
*HAN04	34	Hristo Handjijski, Bulgaria
HAR09	37	Sergiy V. Harchuk, Ukraine
HAS02		Werner Hasubick, Germany
HAS08	16	Yuji Hashimoto, Hiroshima, Japan
HAV		Roberto Haver, Italy
HEE	24	Lars Trygve Heen, Norway
HEN	07	Michael J. Hendrie, England
HOM	37	Vasyl M. Homyak, Ukraine
HOR	12	Tibor Horvath, Hungary
HOR02	23	Kamil Hornoch, Czechoslovakia
*HYN	23	Petr Hynek, Czech Republic
*ILI	34	Georgi Iliev, Bulgaria
ISH03	37	Andriy S. Ishchenko, Ukraine
IVA03	37	Vladimir Ivanov, Russia
JAR01	18	Marcin Jarski, Poland
*JOR01	34	Ivajlo Jordanov, Bulgaria
KAM01		Andreas Kammerer, Germany
KAT01	16	Taichi Kato, Kyoto, Japan
KES01		Sandor Keszthelyi, Hungary
KID01	18	Krzysztof Kida, Elblag, Poland
KIN	16	Kazuo Kinoshita, Japan
KIS02	32	Laszlo Kiss, Szeged, Hungary
KOB01	16	Juro Kobayashi, Kumamoto, Japan
*KOJ01	34	Michail Kojchev, Bulgaria
KON06	23	Jiri Konecny, Czech Republic
KOS		Attila Kosa-Kiss, Romania
KOZ	37	Vladimir A. Kozlov, Ukraine
KRY02		Washington Kryzanowski, Uruguay
KWI	18	Maciej Kwinta, Krakow, Poland
KYS	23	J. Kysely, Czech Republic
LAN02	32	Zsolt Lantos, Budapest, Hungary
LEH01	37	Kostayntyn S. Lehman, Ukraine
*LIB	23	Jan Libich, Czech Republic
LOU	35	Romualdo Lourencon, Brazil
LUK04	37	Igor Lukyanyk, Ukraine
MAI	37	Alexander S. Maidic, Ukraine
MAN01	37	Vladimir Man'ko, Ukraine
MAR02	13	Jose Carvajal Martinez, Spain
MAR12	18	Leszek Marcinek, Poland
MAR19	34	Alexander Marinov, Bulgaria
MAR20	38	Fernando Martin, Madrid, Spain
MAT06	18	Leslaw Materniak, Poland
MCK	07	Richard McKim, England
MEN03	07	Haldun I. Menali, Turkey
MEY	28	Maik Meyer, Germany
MIK		Herman Mikuz, Slovenia
MIL02		Giannantonio Milani, Italy
MIY01	16	Osamu Miyazaki, Japan
MOE		Michael Moeller, Germany
MOR04	37	Vladimir G. Mormyl, Ukraine
MOS03	37	Yurij A. Moskalenko, Ukraine
NAG02	16	Takashi Nagata, Akashi, Japan
NAG04	16	Kazuro Nagashima, Japan
NAG08	16	Yoshimi Nagai, Matsumoto, Japan
NAK01	16	Akimasa Nakamura, Kuma, Japan
*NAN02		Kouji Naniwada, Tokyo, Japan
NAU	37	Alexandr V. Naumov, Ukraine
NEV	42	Vitali S. Nevski, Belarus
OHM	16	Fumihiko Ohmori, Japan
OKA05	16	Takuma Oka, Tokyo, Japan
OKS	07	Gabriel Oksa, Slovak Republic
OLE	18	Arkadiusz Olech, Poland
OME		Stephen O'Meara, MA, U.S.A.
PAL02	43	Rok Palcic, Kamnik, Slovenia
PAR03	18	Mieczyslaw L. Paradowski, Poland
*PEN	34	Swetlana Peneva, Bulgaria
PER01		Alfredo J. S. Pereira, Portugal
PIO01	18	Marek Piotrowski, Poland
PLE01	18	Janusz Pleszka, Poland
PLS	23	Martin Plsek, Czech Republic
POD	23	M. Podzorny, Czech Republic
POP01	34	Kostadin Popanastasov, Bulgaria
POR05	40	Joao Porto, Azores Is., Portugal
RAD01	17	Veselka Radeva, Bulgaria
RED	37	Sergei Red'ko, Kiev, Ukraine
RES	18	Maciej Reszelski, Poland
ROD01	13	Diego Rodriguez, Spain
ROG02		John H. Rogers, England
ROM	42	Aleksandr M. Romancev, Belarus
ROQ		Paul Roques, AZ, U.S.A.
ROT01	23	Michal Rottenborn, Czech Repub.
*SAL01	42	Mihail Saltanov, Minsk, Belarus
SAN04	38	Juan M. San Juan, Madrid, Spain
SAN07	32	Gabor Santa, Hungary
SAR02	32	Krisztian Sarneczky, Hungary
*SCH14	34	Vladislav Schiderov, Bulgaria
SCI		Tomasz Sciezor, Poland
*SCU	07	Virgil V. Scurtu, Romania
SEA	14	David A. J. Seargent, Australia
SEA01	14	John Seach, Australia
SER	42	Ivan M. Sergey, Belarus
SHA02	07	Jonathan D. Shanklin, England
SHI	16	Hiroyuki Shioi, Yachiyo, Japan
SIW	18	Ryszard Siwiec, Poland
SIW01	18	Michal Siwak, Tuchow, Poland

SKI	24	Oddleiv Skilbrei, Norway
*SLI01	37	Bogdan V. Slipachok, Ukraine
SMI08	15	T. Smith, Keetmanshoop, Namibia
SOC	18	Krzysztof Socha, Poland
SPE01	18	Jerzy Speil, Poland
SPR		Christopher E. Spratt, Canada
*SRA	32	Marta Sragner, Pecs, Hungary
STO		Enrico Stomeo, Italy
SWI	18	Mariusz Swietnicki, Poland
SZA		Sandor Szabo, Sopron, Hungary
*SZA05	18	Konrad Szaruga, Telatyn, Poland
SZE02	32	Laszlo Szentasko, Hungary
*TAK06	16	Shin Takeda, Habikino, Japan
TAN02		Tony Tanti, Malta
TAY	07	Melvyn D. Taylor, England
THO03	24	Steinar Thorvaldsen, Norway
TOD	16	Hiroyuki Toda, Okayama, Japan
*TOL	07	Alin Tolea, Romania
*TOY	16	Takehiro Toyoshima, Japan
TRI		Josep M. Trigo Rodriguez, Spain
TSU02	16	Mitsunori Tsumura, Japan
TUB	12	Vince Tuboly, Hungary
*VAL01	34	Taschko Valchev, Bulgaria
VAN06		Gabriele Vanin, Italy
*VAS03	34	Valcho Vasilev, Bulgaria
VEL02	17	Valentin Velkov, Bulgaria
VEL03	37	Peter Velestschuk, Ukraine
VET01	23	Marie Vetrovcova, Czech Republic
VIT01	40	Catarina Vitorino, Portugal
*WAL02	07	Richard Walters, Switzerland
WAS	16	Shinsyo (Shinsho) Washi, Japan
WLO	18	Robert Wlodarczyk, Poland
YOS	16	Shigeru Yoshida, Japan
YOS02	16	Katsumi Yoshimoto, Japan
YOS04	16	Seiichi Yoshida, Ibaraki, Japan
ZAN		Mauro Vittorio Zanotta, Italy
*ZEK		Hans Zekl, Einhausen, Germany
*ZIF	23	Michal Zifcak, Czech Republic
ZNO	23	Vladimir Znojil, Czech Republic

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Comet C/1992 F1 (Tanaka-Machholz)

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1992 05 03.03		S	8.5	SC	6.0	R	10	30	3		0.04		MAN01
1992 05 10.03		S	7.3	SC	6.0	R	10	30	3				MAN01
1992 05 23.88		S	8.6	SC	6.0	R	10	30	3.5				MAN01

Comet C/1994 J2 (Takamizawa)

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1996 12 03.64		C	17.9	GA	60.0	Y	6	a240	0.35				NAK01
1997 01 11.58		C	17.4	GA	60.0	Y	6	a480	0.75				NAK01

Comet C/1995 O1 (Hale-Bopp)

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1995 07 28.94		S	10.3	NP	44.5	L	5	100	5	5			MAR02
1995 07 30.96		S	10.4	NP	44.5	L	5	100	4	4			MAR02
1995 07 30.96		S	10.5	NP	44.5	L	5	100	4	4			ROD01
1996 04 12.74		B	8.6	S	20.0	C	9	90	1.7	3			NAG04
1996 04 21.77		B	8.5:	S	20.0	C	9	60	2.5	3			NAG04
1996 04 27.76		B	8.3	S	20.0	C	9	60	2.1	4			NAG04
1996 06 16.76		B	7.1	S	3.5	B		7					NAG04
1996 06 17.90		S	6.6	S	20	L	8	83		6			CO002
1996 06 20.41		S	7.3	AA	21.0	L	6	48	3	3			KRY02
1996 06 21.09		S	7.0	AA	21.0	L	6	48	4	4			KRY02
1996 06 24.05		S	7.0	AA	21.0	L	6	48	4	2			KRY02
1996 07 05.80		S	6.5	S	20	L	8	83		5			CO002
1996 07 14.90		B	6.0	S	15	L	9	50	15	5			SMI08
1996 07 15.83		S	6.3	S	20	L	8	83		5			CO002
1996 07 19.96		S	6.3	S	10	B	4	25		9			HAL04
1996 07 19.97		S	6.7	TI	10	B	4	25	10				VET01
1996 07 20.01		B	6.0	S	15	L	9	50	16	5			SMI08
1996 07 20.89		S	6.7	TI	10	B	4	25	10	5			VET01
1996 07 20.91		S	6.3	S	10	B	4	25	6	7	0.13	40	HAL04
1996 07 21.87		S	6.3	S	10	B	4	25	6	6	0.13	10	HAL04
1996 07 22.88		S	6.2	S	10	B	4	25	6	6	0.13	10	HAL04
1996 07 22.89		S	6.1	TI	7.0	B	4	10	10	5/			VET01
1996 08 01.86		S	6.5	S	10	B	4	25	6	7			HAL04
1996 08 05.85		S	6.0	S	10	B	4	25	10	7	0.25	10	HAL04
1996 08 06.70		S	5.6	S	20	L	8	83	5.0	6			CO002
1996 08 08.86		S	6.8	S	10	B	4	25	12	6			HAL04
1996 08 08.87		M	5.6	S	15	L	9	80	18	6	1.0	130	SMI08

Comet C/1995 O1 (Hale-Bopp) [cont.]

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1996 08 10.05		S	6.2	AA	3.0	B		8					FRE01
1996 08 10.85		S	5.5	TI	10	B	4	25	15	7			VET01
1996 08 13.81		S	5.4	S	20	L	8	83		5			CO002
1996 08 13.87		B	5.5	S	15	L	9	80	18	6	1.2	130	SMI08
1996 08 15.86		S	6.8	S	10	B	4	25	12	6			HAL04
1996 08 17.83		S	6.5	S	10	B	4	25	15				HAL04
1996 08 18.87		S	6.3	S	10	B	4	25	15				HAL04
1996 08 19.85		S	6.2	S	10	B	4	25	19				HAL04
1996 08 20.58					20.0	C	9	45	5.9	8	45 m	115	NAG04
1996 08 20.58		B	5.9	AA	7.0	B		10					NAG04
1996 08 20.88		S	6.2	S	10	B	4	25	20				HAL04
1996 08 21.08		S	6.5	AA	21.0	L	6	48	4	4			KRY02
1996 08 24.08		S	6.2	AA	3.0	B		8					FRE01
1996 08 29.81		S	6.6	TI	10	B	4	25	5.0	5			ROT01
1996 08 30.81		S	6.4	TI	10	B	4	25	5.0				ROT01
1996 08 31.82		S	5.0	S	5.0	B		10		6			CO002
1996 09 01.78		S	5.7	AA	5.0	B		12		5			TAN02
1996 09 03.80		S	5.3	S	15	L	9	80	11	7	2.0	125	SMI08
1996 09 04.78		M	6.1	AA	7.0	B		20	8	6			TAN02
1996 09 04.80		S	5.9	AA	5.0	B		12	11	5/			TAN02
1996 09 05.80		S	5.2	S	5.0	B		10		6			CO002
1996 09 06.05		S	6.4	AA	3.0	B		8					FRE01
1996 09 06.78		S	5.7	AA	5.0	B		12	13	5			TAN02
1996 09 06.96		S	6.3	AA	3.0	B		8					FRE01
1996 09 07.09		S	6.0	AA	21.0	L	6	48		5			KRY02
1996 09 07.79		M	5.9	AA	5.0	B		12	15	5/			TAN02
1996 09 08.83		S	5.1	AA	0.0	E		1	12				HAV
1996 09 09.09		S	5.8	AA	21.0	L	6	48		7			KRY02
1996 09 13.80		S	5.3	S	15	L	9	80	10	7	2.0	130	SMI08
1996 09 14.77		M	6.0	AA	5.0	B		12		5/			TAN02
1996 09 14.77		S	5.5	S	5.0	B		10		4			CO002
1996 09 14.83	—	S	5.1	AA	0.0	E		1					HAV
1996 09 16.83		S	5.7	SC	15	R	13	40	2.5	7			HEN
1996 09 17.80		S	5.6	SC	15	R	13	40	2.5	7			HEN
1996 09 17.87		S	5.6	S	5.0	B		10	12				ENT
1996 09 19.80		S	5.3	TI	10	B	4	25	12	4			VET01
1996 09 19.81		S	6.1	TI	10	B	4	25	7.0	5			ROT01
1996 09 29.75		S	5.6	S	5.0	B		10		4			CO002
1996 09 30.77		M	5.6	AA	5.0	B		12		6/			TAN02
1996 09 30.77		S	5.6	S	10	B	4	25	15	4	0.40	70	HAL04
1996 09 30.79		S	5.3	TI	10	B	4	25	10		0.25		VET01
1996 09 30.80		S	5.7	TI	10	B	4	25	7.0				ROT01
1996 10 02.80		S	5.0:	SC	15	R	13	80	2	6			HEN
1996 10 03.77		S	5.2	TI	10	B	4	25	10	5	0.33		VET01
1996 10 03.77		S	5.7	TI	10	B	4	25	9.0				ROT01
1996 10 05.76		M	5.7	AA	5.0	B		12		5			TAN02
1996 10 05.95		S	6.0	AA	3.0	B		8					FRE01
1996 10 06.77		M	5.6	AA	5.0	B		12		5/			TAN02
1996 10 06.97		S	5.9	AA	3.0	B		8					FRE01
1996 10 07.75		S	5.2	AA	11	L	7	32		4			IVA03
1996 10 08.67		S	5.2	AA	11	L	7	32		4			IVA03
1996 10 08.77		M	5.5	AA	5.0	B		12	22	5/			TAN02
1996 10 09.66		S	5.1	AA	11.0	B		20		5			IVA03
1996 10 10.67		S	5.2	AA	11	L	7	32		5			IVA03
1996 10 10.69		S	5.0	AA	3.0	R	5	6	8	5			IVA03
1996 10 11.66		S	5.1	AA	11	L	7	32		5			IVA03
1996 10 11.69		S	5.1	AA	3.0	R	5	6	8	5/			IVA03
1996 10 11.69		S	5.1	AA	3.0	R	5	6	8	5/			IVA03
1996 10 11.74		S	5.7	TI	10	B	4	25	9.0	5			ROT01
1996 10 11.75		S	5.2	TI	10	B	4	25	12	6	0.37		VET01
1996 10 12.69		S	5.1	AA	11	L	7	32		5/			IVA03
1996 10 13.66		S	5.0	AA	11	L	7	32		6			IVA03
1996 10 14.74		S	5.7	TI	10	B	4	25	12	5			ROT01
1996 10 14.80		S	5.2	TI	10	B	4	25	12	5/	0.45		VET01
1996 10 15.75		S	4.9	S	5.0	B		10		5			CO002

Comet C/1995 O1 (Hale-Bopp) [cont.]

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1996 10 15.75		S	5.3:	SC	15	R	13	40	2	6	0.50	50	HEN
1996 10 15.80		S	4.7:	SC	5.0	B		10	20	6			MCK
1996 10 15.80		S	5.8	S	5.0	B		10					ENT
1996 10 16.45		B	6.2	AA	7.0	B		10					NAG04
1996 10 16.75		M	5.4	AA	5.0	B		12	17	5/			TAN02
1996 10 17.66		S	4.9	AA	11	L	7	32		6			IVA03
1996 10 19.74		S	5.4	TI	10	B	4	25	10	5			ROT01
1996 10 21.38		S	4.7	AA	5.0	B		10	9	2			SEA01
1996 10 23.76		S	6.9	S	10	B	4	25	7	5	0.40	85	HAL04
1996 10 25.40		S	5.2	AA	5.0	B		10	7	4	10 m		SEA01
1996 10 26.39		S	5.1	AA	5.0	B		10	5	3			SEA01
1996 10 27.71		S	4.8	S	5.0	B		10		5			COO02
1996 11 01.75		S	4.7	AA	0.0	E		1	12				HAV
1996 11 02.72		S	4.6	S	5.0	B		10		4			COO02
1996 11 04.41		S	5.8	AA	7.0	B		10					NAG04
1996 11 07.73		M	5.0	AA	5.0	B		12	19	6			TAN02
1996 11 09.41		S	4.7	AA	5.0	B		10	6	S6	1.4	80	SEA01
1996 11 11.63		S	4.6	AA	3.0	R	5	6	8	6			IVA03
1996 11 11.63		S	4.6	AA	11	L	7	32		6			IVA03
1996 11 13.76		S	5.0:	SC	15	R	13	100	2	6			HEN
1996 11 14.63		S	4.5	AA	11	L	7	32		6			IVA03
1996 11 14.64		S	4.5	AA	3.0	R	5	6	8	6			IVA03
1996 11 15.63		S	4.5	AA	11	L	7	32		4			IVA03
1996 11 21.69		S	4.9	TI	10	B	4	25	20	7	0.42	280	ROT01
1996 11 22.63		S	4.4	AA	3.0	R	5	6	6	5	0.5		IVA03
1996 11 22.63		S	4.4	AA	11	L	7	32		4			IVA03
1996 11 22.69	a	M	4.4	S	5.0	B		10	15	6/	1	70	HOR02
1996 11 22.70	a	M	3.9	S	0.0	E		1	20	4			HOR02
1996 11 24.72	!	S	4.5	AA	5.0	B		10	7.5	6			HAV
1996 11 30.64		S	4.5	AA	11	L	7	32	7	6	0.47		IVA03
1996 11 30.72		B	4.6	AA	0.0	E		1					VAN06
1996 11 30.72		M	4.9	AA	5.0	B		10	8	5	0.3	80	VAN06
1996 12 01.63		S	4.4	AA	3.0	R	5	6	11	6	0.5		IVA03
1996 12 01.63		S	4.5	AA	11	L	7	32	7	6	0.47		IVA03
1996 12 01.70		S	4.5	Y	10.0	C	10	40	10	5	0.5	75	HOR
1996 12 01.72		M	4.8	AA	5.0	B		10	8	5	0.5	67	VAN06
1996 12 01.72	!	S	4.1	AA	5.0	B		10	9	6	0.4	60	HAV
1996 12 01.73		S	4.0	Y	7.2	R	7	20	15	4	0.5	24	TUB
1996 12 02.72		B	4.6	AA	0.0	E		1					VAN06
1996 12 02.72		M	4.8	AA	5.0	B		10	6	6	0.4	60	VAN06
1996 12 03.37		B	5.2	AA	7.0	B		10					NAG04
1996 12 03.40					20.0	C	9	45	5.3	7	1.8	42	NAG04
1996 12 04.63		S	4.4	AA	3.0	R	5	6	12	6	0.5		IVA03
1996 12 04.69		S	4.3	S	10	B	4	25	5	6	0.67	55	HAL04
1996 12 04.70		S	4.7	TI	10	B	4	25	15	7	0.42	280	ROT01
1996 12 04.71		S	4.5	Y	10.0	C	10	40	10	5	0.5	70	HOR
1996 12 04.73		M	4.7	AA	5.0	B		10	6	7	0.5	65	VAN06
1996 12 04.75		S	5.5:	AA	6.0	B		13	2.5	6	0.50	40	HEN
1996 12 04.76		M	4.4	AA	5.0	B		12	21	6	2.4	58	TAN02
1996 12 05.63		S	4.2	AA	3.0	R	5	6	12	6	0.5		IVA03
1996 12 05.72		S	5.0:	AA	15	R	13	100		7			HEN
1996 12 05.73		S	4.0	AA	5.0	B		8	20	6	0.67	30	BEA
1996 12 07.64		S	4.2	AA	3.0	R	5	6	12	6	0.5		IVA03
1996 12 07.72	!	S	4.2	AA	8.0	B		20	11	7	1.5	50	HAV
1996 12 08.37		B	4.5:	AA	7.0	B		10			>1		NAG04
1996 12 12.62		S	4.1	AA	3.0	R	5	6	12	6	0.6		IVA03
1996 12 13.73		S	4.7	AA	6.0	B		13	3	6	>0.5	50	HEN
1996 12 14.37		B	4.2	AA	7.0	B		10					NAG04
1996 12 14.62		S	4.1	AA	3.0	R	5	6	14	6	0.9		IVA03
1996 12 16.66		B	4.2	AA	5.0	R	5	7	8	6			KOZ
1996 12 16.69		S	4.7	AA	3.0	B		8	12	S5	5	58	CSU
1996 12 20.60		S	3.9	AA	3.0	R	5	6	14	6	0.9		IVA03
1996 12 26.67		S	3.7	SC	8.0	B		12	14	S5/	0.8	13	ISH03
1996 12 27.66		B	4.6:	AA	5.0	B		7		5			HOM
1996 12 28.66		S	3.6	SC	8.0	B		12	14	S5/	0.8	10	ISH03

Comet C/1995 O1 (Hale-Bopp) [cont.]

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1996 12 28.67		B	4.7:	AA	5.0	B		7	6	4			HOM
1996 12 28.69	a	O	4.4:	Y	5.0	B		7	10	7			KYS
1996 12 28.70	a	S	3.6	AA	5.0	B		10	11	6	0.8		MEY
1996 12 30.68	a	O	4.0:	Y	5.0	B		7	10				KYS
1997 01 06.69	a	M	3.2	S	8.0	B		10	11	5	1.0		HOR02
1997 01 07.14		B	3.5	HD	5.0	B		7	8	6	0.4		MOR04
1997 01 07.26		S	3.7	AA	5.0	B		8	40	6	1.20	30	BEA
1997 01 08.14		B	3.5	HD	5.0	B		7	8	6	0.4		MOR04
1997 01 08.21		M	3.5	Y	5.0	B		10	15	s7	0.5	0	SAN07
1997 01 09.88		S	3.5:	AA	7.0	B		10	5	6			TAK06
1997 01 10.87		S	3.5:	AA	17.0	L	5	45	5	6			TAK06
1997 01 12.14		B	3.4	HD	5.0	B		7	10	7	0.4	10	MOR04
1997 01 12.21					5.0	B		10	6	7	0.5	65	VAN06
1997 01 12.21		M	3.0	AA	3.6	B		4					VAN06
1997 01 12.88		S	3.3	AA	17.0	L	5	36	12	7	25 m	30	TAK06
1997 01 13.14		B	3.4	HD	5.0	B		7	10	7	0.5	10	MOR04
1997 01 13.21		B	2.7	AA	0.0	E		1					ELT
1997 01 14.21					8.0	B		11	7	4	1.5	325	STO
1997 01 14.21		B	2.7	AA	0.0	E		1					STO
1997 01 14.21	w	B	2.7	AA	0.0	E		1					VAN06
1997 01 14.22					8.0	B		20	5	8	0.3	360	VAN06
1997 01 14.23		S	2.7	S	10	B	4	25	6	7	0.67	40	HAL04
1997 01 14.25	a	S	2.9	SC	5.0	B		7	11	7	0.8	350	OKS
1997 01 14.28		S	3.1	AA	5.0	B		8	40	6	1	30	BEA
1997 01 16.20	a	M	2.8	AA	5.0	B		12		5/	2.0	332	TAN02
1997 01 16.21	a	M	2.9	S	5.0	B		7	25	5	2.0		POD
1997 01 16.23		S	2.3	S	10	B	4	25	10	7	0.43	20	HAL04
1997 01 16.28		S	3.5	AA	0.0	E		1	40	7			DIE02
1997 01 16.87		S	3.1	AA	17.0	L	5	36	7	6	15 m	30	TAK06
1997 01 17.14		B	3.3	HD	5.0	B		7	10	7	0.5	350	MOR04
1997 01 17.20	a	M	2.8	AA	5.0	B		12	20	5/	2.0	336	TAN02
1997 01 17.21	w	B	2.5	AA	0.0	E		1					VAN06
1997 01 17.22					8.0	B		20	5	8	0.4	345	VAN06
1997 01 18.20	a	B	2.8	AA	0.6	E		1					MEY
1997 01 18.20	a	M	2.9	AA	5.0	B		10	11	D5/	1.6		MEY
1997 01 18.84		I	3.0	S	0.0	E		1					TOY
1997 01 19.20	a	M	3.0	AA	5.0	B		12		5/	1.5	343	TAN02
1997 01 19.28		S	3.1	AA	5.0	B		8	40	6	1	350	BEA
1997 01 19.88		S	3.3	AA	5.0	B		7	10				TOD
1997 01 20.20	a	M	2.8	AA	5.0	B		12	17	6			TAN02
1997 01 20.86		B	3.0	HS	3.5	B		7		6			OHM
1997 01 20.86		S	3.1	AA	17.0	L	5	36	8	6	20 m	10	TAK06
1997 01 21.20	a	M	2.8	AA	5.0	B		12	15	6			TAN02
1997 01 21.25		S	2.7	YF	3.0	B		8	18	7	2.5	345	ENT
1997 01 21.25		S	3.0	AA	5.0	B		8	40	7	1	350	BEA
1997 01 21.25	a	S	2.6	SC	5.0	B		7	10	7/	1.0	340	OKS
1997 01 22.22	a	M	2.5	S	0.0	E		1	30	7	0.5	325	PLS
1997 01 22.26	!	M	2.8	S	5.0	B		12	6	S7/	1		GON05
1997 01 22.27		S	3.0:	SC	3.0	B		8	15	7	1.08	10	DIN01
1997 01 22.84		I	3.3	S	7.0	B		10					TOY
1997 01 23.15	!	B	3.4	SC	5.0	B	6	7	12	4	0.4	2	FIL05
1997 01 23.15	!	S	3.4	SC	5.0	B	6	7	12	4	0.4	2	FIL05
1997 01 23.16		B	2.9	AA	5.0	B		7	9	3	0.3		HOM
1997 01 23.16	!	B	3.5	SC	7.0	R	6	60	15	4	0.5	357	FIL05
1997 01 23.19		B	3.7	AA	5.0	B		7	13	S7	1.5	330	VEL03
1997 01 23.19		G	3.5	AA	0.0	E		1		4			VEL03
1997 01 24.25		S	2.6	SC	6.3	B		9	8	8	0.42	350	DIN01
1997 01 24.84		S	3.3	S	3.5	B		7					TOY
1997 01 24.87		B	3.0	HS	3.5	B		7		7			OHM
1997 01 25.16		B	2.8	AA	2.0	B		2	12	8			KOZ
1997 01 25.16		B	2.9	AA	5.0	R	5	7	10	7			KOZ
1997 01 25.17		B	3.0	AA	10.0	B	4	12	9	7	1.2	336	KOZ
1997 01 25.19		B	3.3	AA	5.0	B		7	13	D7	1.5	321	VEL03
1997 01 25.19		G	3.3	AA	0.0	E		1					VEL03
1997 01 25.19		S	2.7	AA	5.0	B		10		S8	1		SCU

Comet C/1995 O1 (Hale-Bopp) [cont.]

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1997 01 25.30		B	3.2	SC	0.7	E		1	15	5	0.5		ROG02
1997 01 26.14		B	3.2	HD	5.0	B		7	10	7	0.5	335	MOR04
1997 01 26.17		S	2.8	SC	8.0	B		12	15	S6	0.6	340	ISH03
1997 01 26.18		M	2.5	Y	5.0	B		10	10	S8	2	310	SAN07
1997 01 26.18		S	2.9	SC	0.0	E		1	10	S6	0.6	340	ISH03
1997 01 26.19		B	3.3	AA	5.0	B		7	13	S7	1.0	331	VEL03
1997 01 26.19		G	3.3	AA	0.0	E		1					VEL03
1997 01 26.19		M	2.5	Y	6.0	B		20	25	s4	2		LAN02
1997 01 26.19		S	2.5	Y	0.0	E		1	25	s4	2		LAN02
1997 01 26.19		S	3.0	AA	5.0	B		7	14	S9	8	320	KOS
1997 01 26.19	a	M	3.1	Y	5.0	B		7	12	7	>3	335	KYS
1997 01 26.21	a	M	2.4	S	0.0	E		1	25	7/	3.5	330	PLS
1997 01 26.21	a	M	2.4	S	3	R		2	25	7/			HOR02
1997 01 26.21	a	O	2.6	SP	0.0	E		1	25	5/	1.8		ZNO
1997 01 26.22	a	M	2.3	TI	5.0	B		7	20	6	1.0		DVO
1997 01 26.23	a	M	2.6	Y	10	B		25	15	5/	0.7		HYN
1997 01 26.25		S	3.0:	AA	6.0	B		13	3		>0.5		HEN
1997 01 26.26		S	3.0	YF	5.0	B		10	14	7	2.0		ENT
1997 01 26.26		S	3.2	AA	7.0	B		16	8	3	0.13	357	TAY
1997 01 26.30		B	3.3	SC	0.7	E		1	15	5			ROG02
1997 01 26.85		S	3.2	S	3.6	B		12					TOY
1997 01 26.87		B	2.9	HS	3.5	B		7		7			OHM
1997 01 26.89		S	2.9	AA	5.0	B		7					TAK06
1997 01 27.14		B	3.1	HD	5.0	B		7	10	7	0.5	335	MOR04
1997 01 27.16		B	2.5	AA	5.0	B		7	9	6	0.5		HOM
1997 01 27.17		S	2.7	AA	5.0	B		10		S8	1		SCU
1997 01 27.17		S	4.0	AA	0.7	E		1	12	S3	2	294	CSU
1997 01 27.18		S	3.0	AA	6.3	R	13	52	14	S9	10	320	KOS
1997 01 27.19		B	3.3	AA	5.0	B		7	13	S7	1.5	330	VEL03
1997 01 27.19		G	3.2	AA	0.0	E		1	14	S5			VEL03
1997 01 27.19		S	2.0	S	10	B	4	25	8	7	0.67	340	HAL04
1997 01 27.20	—	M	2.5	Y	5.0	B		10	7	S8	1	320	SAN07
1997 01 27.20		S	2.4	TI	10	B	4	25	22	7	0.60	330	ROT01
1997 01 27.84		S	3.3	S	3.6	B		12					TOY
1997 01 28.16		B	1.8:	AA	3.0	B		7		7	0.3		CHV
1997 01 28.18		B	2.9	SC	5.0	B		10					VEL02
1997 01 28.18		M	2.5	SC	11.0	B		20	22	4	1.5		BAR06
1997 01 28.19		S	2.7	AA	5.0	B		10		S8	1		SCU
1997 01 28.20	a	M	2.7	AA	5.0	B		12	20	6			TAN02
1997 01 28.23		S	2.7	YF	3.0	B		8	12	7	2.5	355	ENT
1997 01 28.26		S	2.6	AA	5.0	B		8	45	7	1.30	320	BEA
1997 01 29.14		B	3.0	HD	5.0	B		7	13	7	0.5	336	MOR04
1997 01 29.15		B	2.9	SC	5.0	B		10		7			RAD01
1997 01 29.16		B	2.9	SC	5.0	B		10		5			BOR05
1997 01 29.16		B	3.2	SC	5.0	B		10		8			BOJ01
1997 01 29.17		B	1.2:	AA	5.0	B		7	14	7	0.7		HOM
1997 01 29.17		S	2.4	SC	0.0	E		1	30	3	2		BAR06
1997 01 29.18					4	R	7	20	7	8	0.28	310	TOL
1997 01 29.18		M	2.8	Y	0.0	E		1	5	7			KES01
1997 01 29.18		S	2.8	Y	0.0	E		1	5	7			KES01
1997 01 29.19		B	2.5	SC	5.0	B		10		7			GRA07
1997 01 29.19		S	2.9	SC	5.0	B		7	10	7	0.67	320	TOL
1997 01 29.20		S	2.5	Y	0.0	E		1	25	s4	2	350	LAN02
1997 01 29.20	a	M	2.8	AA	5.0	B		12		6/			TAN02
1997 01 29.87		S	2.5	AA	5.0	B		7	12	6	50 m	310	TAK06
1997 01 30.13	&	S	2.8	S	5.0	R	8	20	24	D6	1.6	330	BOR04
1997 01 30.17		S	2.5	SC	8.0	B		12	18	S6	1.0	330	ISH03
1997 01 30.18		B	2.6	AA	2.0	B		2	14	7			KOZ
1997 01 30.18		B	2.8	AA	5.0	R	5	7	12	7			KOZ
1997 01 30.18		M	2.8	Y	5.0	B		10	8	S8	1	330	SAN07
1997 01 30.18		S	2.8	Y	5.0	B		10	25	S8	1	330	SAN07
1997 01 30.20	a	M	2.5	AA	5.0	B		12		7/	2.5	327	TAN02
1997 01 30.21	w	B	2.5	AA	0.0	E		1					VAN06
1997 01 30.22					8.0	B		20	5	6	0.4	3	VAN06
1997 01 30.85		S	3.3	S	3.5	B		7					TOY

Comet C/1995 O1 (Hale-Bopp) [cont.]

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1997 01 31.15		B	1.8	SC	8.0	B		8		8			RAD01
1997 01 31.17		B	1.5	SC	8.0	B		8		6			BOR05
1997 01 31.17		B	1.9	SC	8.0	B		8					BOJ01
1997 01 31.18		B	2.6	SC	5.0	B		10					VEL02
1997 01 31.19		B	1.7	SC	8.0	B		8		6			GRA07
1997 01 31.85		I	2.9	S	7.0	B		10					TOY
1997 01 31.87		S	2.5	AA	5.0	B		7	9	6	1	310	TAK06
1997 02 01.14		B	3.0	HD	5.0	B		7	13	7	0.5	320	MOR04
1997 02 01.15		M	2.7	AA	3.0	R	4	7	10	5	0.5		MAI
1997 02 01.16		B	2.7	AA	2.0	B		2	14	8			KOZ
1997 02 01.16		B	2.8	AA	5.0	R	5	7	12	8			KOZ
1997 02 01.17		B	1.8	AA	3.0	B		7		7	0.5	337	CHV
1997 02 01.17		B	2.8	AA	10.0	B	4	12	10	8	1.3	327	KOZ
1997 02 01.17		G	2.8	AA	0.0	E		1		8			KOZ
1997 02 01.18		S	2.4	Y	0.0	E		1	7	7	0.3	300	KES01
1997 02 01.18		S	2.7	AA	5.0	B		10		S8	0.8		SCU
1997 02 01.19		B	3.0	AA	5.0	B		7	18	S7	1	325	VEL03
1997 02 01.19		G	3.0	AA	0.0	E		1	20	S5			VEL03
1997 02 01.19		S	2.4	AA	5.0	B		10	9	8	3	320	MOE
1997 02 01.20	a	M	2.2	TI	5.0	B		7	20	6/	2.5		DVO
1997 02 01.20	a	M	2.3	S	3	R		1	30	7/	2.5	330	HOR02
1997 02 01.21	a	M	2.1	S	3	R		1	25	7	2.5	330	PLS
1997 02 01.23		M	2.2	YG	0.7	E		1	12	7	2.5	321	GRA04
1997 02 01.23		N	4.9	YG	5.0	B		10	12	7/	4.5	321	GRA04
1997 02 01.24		B	2.7	SC	0.0	E		1	15	8			BIV
1997 02 01.24		S	2.2	YG	0.7	E		1			1		SKI
1997 02 01.24	a	M	2.2	Y	10	B		25		6	1.2	320	HYN
1997 02 01.85					12.5	B		20	10	8	1	330	TOY
1997 02 01.85		I	2.6	YG	0.0	E		1	<20	8			YOS04
1997 02 01.85		S	2.5	S	3.5	B		7					TOY
1997 02 01.85		S	2.5	YG	2.4	B		10	18	7	0.6	330	YOS04
1997 02 02.14		B	1.7	AA	3.0	B		7		7	0.7	338	CHV
1997 02 02.17		B	1.3	SC	5.0	B		10					BOR05
1997 02 02.17		B	1.9	SC	8.0	B		8					BOJ01
1997 02 02.17		B	2.2	SC	5.0	B		10					VEL02
1997 02 02.17		S	2.5	SC	4	R	7	20	12.5	8	0.58	300	TOL
1997 02 02.17	!	B	2.0	Y	0.0	E		1	&15	S8	7	330	SAR02
1997 02 02.18		B	1.3	SC	8.0	B		8		7			GRA07
1997 02 02.18		B	2.9	AA	5.0	B		7	14	S8	1.5	317	VEL03
1997 02 02.18		G	2.9	AA	0.0	E		1	18	S6	1		VEL03
1997 02 02.18		S	2.5	AA	5.0	B		10		S8	1		SCU
1997 02 02.18		S	2.5	AA	6.3	R	13	52	14	S9	13	345	KOS
1997 02 02.19					5.0	B		7	6	7	0.60	300	TOL
1997 02 02.19		B	2.2	AA	0.0	E		1	&15	7	1.5	325	CHE03
1997 02 02.19		S	2.3	AA	5.0	B		10	11	8	2.5	325	MOE
1997 02 02.19	a	M	2.1	S	3	R		1	25	7	2	335	PLS
1997 02 02.19	a	M	2.2	AA	5.0	B		12	22	8/	3	322	TAN02
1997 02 02.19	a	M	2.3	AA	0.6	E		1		8	0.6		MEY
1997 02 02.19	a	M	2.5	AA	5.0	B		10	13	S8	2.7		MEY
1997 02 02.20		B	1.8	S	0.0	E		1	20	7	1.75	315	HAL04
1997 02 02.20		S	2.1	TI	10	B	4	25	20	7	0.67	330	ROT01
1997 02 02.20		S	3.0	AA	0.7	E		1	17	S3/	7	313	CSU
1997 02 02.20	a	M	2.2	S	3	R		1	30	7/	2.5	330	HOR02
1997 02 02.20	a	O	2.3	TI	0.0	E		1	30	7	2.8		KON06
1997 02 02.21					8.0	B		20	4	8	1.1	315	VAN06
1997 02 02.21		S	2.1	YG	0.7	E		1	&15	7	1.5		SKI
1997 02 02.21	w	B	2.3	AA	0.0	E		1					VAN06
1997 02 02.22		M	2.1	YG	0.7	E		1	12	7			GRA04
1997 02 02.23					5.0	B		10	5.3	6	1.0	320	HAS02
1997 02 02.23		N	4.7	YG	5.0	B		10	14	7/	4.0	325	GRA04
1997 02 02.23		S	2.2	AA	0.7	E		1					BOU
1997 02 02.25		K	2.5	SC	3.0	B		8			&6	312	WAL02
1997 02 02.25		M	2.8:	SC	5.0	B		10		7/	&0.5		GLI
1997 02 02.49	w	M	2.2	YF	0.0	E		1		9	&1.5	312	ADA03
1997 02 02.49	w	M	2.3	YF	5.0	B		7	&15	S8	&3.0	312	ADA03

Comet C/1995 O1 (Hale-Bopp) [cont.]

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1997 02 02.55		M	2.2	SC	0.0	E		1			5		OME
1997 02 03.13		G	2.6	AA	0.0	E		1					GER01
1997 02 03.14		S	2.0	SC	0.0	E		1	30	3	2		BAR06
1997 02 03.15		B	2.4	AA	5.0	B		7	& 7	7	0.7		HOM
1997 02 03.15		B	2.7:	SC	3.5	R	5	30	4	7	0.13	322	APE
1997 02 03.16		B	1.5	AA	3.0	B		7		7	0.7	339	CHV
1997 02 03.16		B	2.1	SC	6.0	L	10	25	20	S6	1.3	315	ISH03
1997 02 03.16		M	2.5	Y	11.0	L	8	36		S6			HOR
1997 02 03.16		S	2.5	Y	0.0	E		1	7	S8	5	330	SAN07
1997 02 03.17		B	1.9	SC	0.0	E		1	30	3	2		BAR06
1997 02 03.17		B	2.0:	SC	0.0	E		1	&30	D4	&2	320	MAN01
1997 02 03.17	w	I	2.0	SC	0.0	E		1			0.6		FIL05
1997 02 03.17	w	S	2.3:	SC	5.0	B	6	7	& 7	4	0.9		FIL05
1997 02 03.18		B	2.6	AA	5.0	B		7	14	S8	4	320	VEL03
1997 02 03.18		G	2.5	AA	0.0	E		1		S6	3	320	VEL03
1997 02 03.18		S	3.0	AA	0.7	E		1	17	S3/	11	309	CSU
1997 02 03.18	a	M	2.1	AA	5.0	B		12	18	8	2.3	321	TAN02
1997 02 03.19	!	V	2.0	YF	6.4	A	3 a	5	&50	7	&2.5	320	MIK
1997 02 03.19	a	O	2.2	TI	0.0	E		1	30	7	3		KON06
1997 02 03.20		B	2.3	S	0.0	E		1	17	7	1.20	310	HAL04
1997 02 03.20		K	2.5	SC	25	L	4	40			10	315	WAL02
1997 02 03.20		S	2.5:	AA	0.7	E		1	15	5	1.5		GIL01
1997 02 03.20	!	V	2.0	YF	2.3	A	4 a	30	&60	7	&3	320	MIK
1997 02 03.20	a	M	2.3	S	3	R		2	25	7/	3	330	HOR02
1997 02 03.21	a	O	1.9	SP	0.0	E		1	15	6/	2.0		ZNO
1997 02 03.22		S	1.9	TI	10	B	4	25	18	7	0.60	335	ROT01
1997 02 03.22	a	M	2.3	TI	5.0	B		7	20	6	2		DVO
1997 02 03.23		S	2.0	YG	0.7	E		1			1.5		SKI
1997 02 03.23	!	S	2.3	AA	5.0	B		7	5	8	2	319	SHA02
1997 02 03.24		S	2.3	SC	6.3	B		9	10	8	1.25	315	DIN01
1997 02 03.24	!	S	2.5	AA	0.7	E		1	4	8			SHA02
1997 02 03.24	a	S	2.0	SC	0.6	E		1	15	7	5.5	330	OKS
1997 02 03.25		G	2.6	SC	6.0	B		13		7	>1.5	320	HEN
1997 02 03.27		S	2.5	AA	7.0	B		16	9	D3	1.2	330	TAY
1997 02 03.28		B	2.1	S	5.0	B		7	40	6			TRI
1997 02 03.30		B	2.4	SC	0.7	E		1	24	5	&1.5		ROG02
1997 02 03.46	a	G	2.2:	SC	0.0	E		1	10	8/			CRE01
1997 02 03.84					15.0	B		25	>60	5	>2.5	325	FUK02
1997 02 03.84		B	2.3	YG	0.0	E		1					KAT01
1997 02 03.84		B	2.5	YG	3.5	B		7	14	7	1.5	300	OHM
1997 02 03.84		G	2.3	S	0.0	E		1					FUK02
1997 02 03.85		B	2.3	YG	0.0	E		1	<20	S5	1	310	YOS04
1997 02 03.85		I	2.6	S	0.0	E		1					TOY
1997 02 03.85		S	2.1	YG	2.4	B		10	12	7	1.6	310	YOS04
1997 02 03.86		S	2.1	YG	0.0	E		1	15	7/	1.5	300	NAG08
1997 02 04.13	&	B	2.6	S	5.0	R	8	20	24	D6	1.6	325	BOR04
1997 02 04.14		B	2.9	HD	5.0	B		7	15	7	1	305	MOR04
1997 02 04.14		S	1.8	SC	0.0	E		1	40	3	3		BAR06
1997 02 04.16		B	1.5	AA	3.0	B		7		7	1	340	CHV
1997 02 04.16		S	2.3	AA	5.0	B		10		S8	2		SCU
1997 02 04.17		B	1.9	SC	0.0	E		1	30	D4	&2	320	MAN01
1997 02 04.17		S	3.0	AA	0.7	E		1	17	S3/	11	301	CSU
1997 02 04.17	w	I	2.0	SC	0.0	E		1			1.0		FIL05
1997 02 04.17	w	S	2.2:	SC	5.0	B	6	7	10	4	1.3		FIL05
1997 02 04.18		B	2.1	AA	0.0	E		1	&13	7	1.0	325	CHE03
1997 02 04.18		B	2.6	AA	5.0	B		7	12	S8	3	317	VEL03
1997 02 04.18		G	2.5	AA	0.0	E		1		S5			VEL03
1997 02 04.18		S	2.0	AA	5.0	B		7	14	S9	15	320	KOS
1997 02 04.18	!	V	1.9	YF	6.4	A	3 a	2	&50	7	&2.5	320	MIK
1997 02 04.18	w	B	1.5	SC	0.0	E		1		8	1		BOR05
1997 02 04.21	!	V	1.9	YF	2.3	A	4 a	20	&60	7	&3	320	MIK
1997 02 04.22					8.0	B		20	6	7	1	305	VAN06
1997 02 04.22	w	B	2.1	AA	0.0	E		1					VAN06
1997 02 04.23		S	1.9	YG	0.7	E		1		8	1.5		SKI
1997 02 04.25		M	2.2	S	5.0	B		12	12	S8	2.5		GON05

Comet C/1995 O1 (Hale-Bopp) [cont.]

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1997 02 04.29		B	1.8	S	0.0	E		1		8			TRI
1997 02 04.29		B	2.0	S	5.0	B		7	50	6	3	340	TRI
1997 02 04.31		M	2.2:	SC	5.0	B		10	&45	6/	&1.0	315	POR05
1997 02 04.65		M	2.0	SC	0.0	E		1			5		OME
1997 02 04.72	!	M	2.1:	YG	5.0	B		10	10	7			GRA04
1997 02 04.72	!	N	4.4	YG	5.0	B		10					GRA04
1997 02 04.83		I	2.4	S	0.0	E		1					TOY
1997 02 04.84		B	2.5	YG	0.0	E		1	<15	S5			YOS04
1997 02 04.84		S	2.4	YG	2.4	B		10	12	7	0.8	320	YOS04
1997 02 04.85		B	2.5	AA	4.2	B		7		7			HAS08
1997 02 04.85		S	2.1	YG	0.0	E		1	&12	7/			NAG08
1997 02 04.86		G	2.2	AA	0.0	E		1					YOS02
1997 02 04.86		M	2.3	AA	3.5	B		7	15	7	1.6	310	YOS02
1997 02 04.86		S	2.2	AA	0.0	E		1		8			HAS08
1997 02 04.86		S	2.3	AA	7.0	B		10		7			FUK01
1997 02 04.86	a	B	2.3	YG	0.0	E		1					NAK01
1997 02 05.10	&	B	2.7	S	5.0	R	8	30	24	D5/	1.5	325	BOR04
1997 02 05.11		M	2.3	AA	3.0	R	4	7	12	5	0.5		MAI
1997 02 05.12		B	2.8	HD	5.0	B		7	15	7	1	305	MOR04
1997 02 05.14		G	2.4	AA	0.0	E		1					GER01
1997 02 05.15		S	2.3	AA	5.0	B		10		S8			SCU
1997 02 05.15	w	B	2.3	SC	5.0	B		10		8			VEL02
1997 02 05.17	w	B	1.5	SC	5.0	B		10		8	1.5		BOR05
1997 02 05.17	w	B	1.7	SC	0.0	E		1		8			GRA07
1997 02 05.17	w	B	2.2	SC	0.0	E		1		6			BOJ01
1997 02 05.18	w	B	2.0	SC	5.0	B		10		7			MAR19
1997 02 05.19	a	M	1.9	AA	5.0	B		12	19	8	2.5	318	TAN02
1997 02 05.22		S	1.8	YG	0.7	E		1		8	1.5		SKI
1997 02 05.23		M	2.0	YG	0.7	E		1	12	7			GRA04
1997 02 05.24					5.0	B		10	10	7/	3.0	320	GRA04
1997 02 05.25		S	2.2	SC	6.3	B		9	9	8	1.25	315	DIN01
1997 02 05.25	!	S	1.9	AA	5.0	B		7	12	8	1.3	314	SHA02
1997 02 05.25	!	S	2.1	AA	0.7	E		1	12	7	1.3	315	SHA02
1997 02 05.26		G	2.5	SC	0.7	E		1	10	7	>1.5	320	HEN
1997 02 05.27		B	1.7	S	0.0	E		1	30	8	1	310	TRI
1997 02 05.28		B	1.9	S	5.0	B		7	50	6	3	310	TRI
1997 02 05.87		S	2.2	AA	5.0	B		7	10	6	1	310	TAK06
1997 02 06.19	a	M	2.1	AA	5.0	B		12	16	9	3	311	TAN02
1997 02 06.20		B	2.1	S	0.0	E		1	20	7	1.30	300	HAL04
1997 02 06.22		M	2.0	YG	0.7	E		1	12	7			GRA04
1997 02 06.22		N	4.4	YG	5.0	B		10	10	7/	4.0	324	GRA04
1997 02 06.22		S	1.8	YG	0.7	E		1			2		SKI
1997 02 06.22		S	2.0	TI	10	B	4	25	20	6			ROT01
1997 02 06.22	s	M	1.7	SC	0.0	E		1	& 8	7/	&2.0	325	GLI
1997 02 06.24		B	2.5	SC	0.0	E		1	15	7			BIV
1997 02 06.25		B	1.8	S	0.0	E		1	30	8	1	300	TRI
1997 02 06.25		B	2.0	S	5.0	B		7	40	6	2	300	TRI
1997 02 06.25		M	2.1	S	5.0	B		12	10	S8/	3		GON05
1997 02 06.31		M	1.9	SC	5.0	B		10	&35	7	&1.2	320	POR05
1997 02 06.83		B	2.2	S	2.5	B		8			0.8	320	TOY
1997 02 06.85		B	2.2	YG	0.0	E		1	<30	S5	1	310	YOS04
1997 02 06.85		S	1.9	AA	0.0	E		1	20	7	2	310	NAG08
1997 02 06.85		S	2.1	YG	2.4	B		10	14	7	0.6	300	YOS04
1997 02 07.12		B	2.7	HD	3.5	B		7	15	S7/	2	315	HAR09
1997 02 07.12		B	2.7	HD	5.0	B		7	18	S7/	3	320	MOR04
1997 02 07.12		M	2.2	AA	3.0	R	4	7	12	5	0.5		MAI
1997 02 07.16	!	B	1.5	Y	0.0	E		1	&20	S8	20	315	SAR02
1997 02 07.18		S	2.0	Y	0.0	E		1	14	8	0.9	290	KES01
1997 02 07.19		M	2.0	S	3	R		1	35	7	3	335	PLS
1997 02 07.19		S	1.6	TI	0.8	E		1	20	7/	0.5		VET01
1997 02 07.20					6.3	B		9	15	S8	3.5	327	KAM01
1997 02 07.20	a	M	1.9	S	3	R		1	25	7/	2	330	HOR02
1997 02 07.20	w	G	1.7	AA	0.6	E		1					KAM01
1997 02 07.21	!	V	1.8	YF	6.4	A	3 a	2	&40	7	&3	320	MIK
1997 02 07.21	a	M	1.9	TI	5.0	B		7	20	6/	3		DVO

Comet C/1995 O1 (Hale-Bopp) [cont.]

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1997 02 07.22					5.0	B		7	15	7/	6	319	SKI
1997 02 07.22		S	1.7	YG	0.7	E		1		8	2.5		SKI
1997 02 07.22		S	2.0	TI	10	B	4	25	20	6	1.00		ROT01
1997 02 07.22	w	M	1.9	SC	0.0	E		1	&10	7/	&4	325	GLI
1997 02 07.23		B	1.7	S	0.0	E		1	30	8	1	315	TRI
1997 02 07.23		B	1.8	S	5.0	B		7	40	6	2.5	315	TRI
1997 02 07.25		B	1.8	S	5.0	B		7	50	6	4	350	ROD01
1997 02 07.25		B	2.4	SC	0.0	E		1	20	7			BIV
1997 02 07.26	s	B	1.9	S	5.0	B		7	40	8	1.5	290	MAR20
1997 02 07.41	a	B	1.6	AA	0.0	E		1		8/	&1		GRE
1997 02 07.73	!	M	1.8:	YG	5.0	B		10	10	7/	0.6		GRA04
1997 02 07.75	!	S	2.6	AA	7.0	B		16	7	3			TAY
1997 02 08.12		B	2.6	HD	3.5	B		7	15	S7/	3	315	HAR09
1997 02 08.15	w	B	2.0	SC	0.0	E		1		8			RAD01
1997 02 08.16		S	1.7	SC	0.0	E		1	40	3	3		BAR06
1997 02 08.16		S	1.7	SC	8.0	B		12	25	S6	2.1	318	ISH03
1997 02 08.17		B	1.7	S	0.0	E		1	12	7	0.70	300	HAL04
1997 02 08.17		S	1.5	SC	0.0	E		1	40	3	3		CHU
1997 02 08.17		S	2.0	AA	5.0	B		10	9	8	4.5	330	MOE
1997 02 08.17	w	B	1.9	SC	5.0	B		10		8			RAD01
1997 02 08.18	!	S	1.5	AA	0.8	E		1	15	7	4	318	SHA02
1997 02 08.19	!	V	1.7	YF	6.4	A	3 a	2	&40	7	&3	320	MIK
1997 02 08.19	a	M	1.9	Y	0.0	E		1	15	7			KYS
1997 02 08.19	a	O	1.7	S	0.0	E		1	30	5	5		POD
1997 02 08.20		S	1.5:	AA	0.0	E		1					ANZ
1997 02 08.20		S	1.6	AA	5.0	B		10			6		ANZ
1997 02 08.20	a	M	1.8	Y	5.0	B		7	15	8	8	320	KYS
1997 02 08.21		B	1.7	SC	8.0	B		11		D6			BRO06
1997 02 08.21		S	1.6	YG	0.7	E		1		8	2		SKI
1997 02 08.21	w	M	1.6	Y	0.0	E		1	20	D7	4	300	CAN04
1997 02 08.22		B	1.8	S	5.0	B		7	40	6	2.5	315	TRI
1997 02 08.22	—	M	1.8	YG	0.7	E		1	10	8			GRA04
1997 02 08.22		N	4.3	YG	5.0	B		10	10	7/	4.5	321	GRA04
1997 02 08.22	a	B	1.6	AA	0.7	E		1					BOU
1997 02 08.23					3.2	B		8	4.4	4	4.8	330	HAS02
1997 02 08.23		B	1.6	S	0.0	E		1	30	8	1	315	TRI
1997 02 08.27		M	1.9:	SC	5.0	B		10	&45	6/	&2.3	320	POR05
1997 02 08.74	!	M	1.9:	YG	5.0	B		10	10	7	0.8	323	GRA04
1997 02 08.81		S	1.9:	AA	0.0	E		1	&20	7/	1	310	NAG08
1997 02 08.83		I	1.8	S	0.0	E		1					TOY
1997 02 08.85		S	1.7	S	15.0	R	5	25	15	6	1.4		NAG02
1997 02 08.86		I	2.3	YG	0.0	E		1		8			YOS04
1997 02 08.86		S	2.0	YG	2.4	B		10	25	7			YOS04
1997 02 08.87		M	1.9	YG	3.0	B		8	20	6	0.8	300	KAT01
1997 02 08.87		M	2.1	AA	3.5	B		7	&15	7	1.2	320	YOS02
1997 02 08.88		S	2.0:	AA	5.0	B		7	12	7	1		TAK06
1997 02 09.12		B	1.7	SC	0.0	E		1	30	S6	5	320	MAN01
1997 02 09.12		B	2.5	HD	5.0	B		7	19	S7/	4	315	MOR04
1997 02 09.12		B	2.6	HD	3.5	B		7	16	S7/	4	320	HAR09
1997 02 09.13		M	2.0	AA	3.0	R	4	7	11	5	0.6		MAI
1997 02 09.15		B	1.4	AA	3.0	B		7		7	0.8	338	CHV
1997 02 09.15		S	1.5	SC	0.0	E		1	42	3			LUK04
1997 02 09.15	w	B	1.9	SC	0.0	E		1		8	1.5		AND03
1997 02 09.16					8.0	B		12	40	S6	4.5	324	BAR06
1997 02 09.16		S	1.6	SC	0.0	E		1	42	3	3.5	320	BAR06
1997 02 09.16	w	B	1.3	SC	0.0	E		1		8			RAD01
1997 02 09.16	w	B	1.6	SC	0.0	E		1		7			BOJ01
1997 02 09.17	w	B	1.3	AA	0.0	E		1	&25	6	5	317	CHE03
1997 02 09.17	w	B	1.5	SC	5.0	B		10		8			GRA07
1997 02 09.17	w	B	1.5	SC	5.0	B		10		8			RAD01
1997 02 09.18		S	1.5	AA	8.0	B		20			6.5		ANZ
1997 02 09.18		S	1.7:	AA	0.0	E		1					ANZ
1997 02 09.18	w	B	1.4	SC	5.0	B		10		8	4.5		BOR05
1997 02 09.19	a	M	1.6	AA	5.0	B		12	24	8/	5	316	TAN02
1997 02 09.21					8.0	B		20	5	7	3	310	VAN06

Comet C/1995 O1 (Hale-Bopp) [cont.]

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1997 02 09.21	w	B	1.7	AA	0.0	E		1					VAN06
1997 02 09.21	w	M	1.5	Y	0.0	E		1	20	D7	7	325	CAN04
1997 02 09.22		B	1.4	S	6.0	B		10	8	7	0.75	315	SAN04
1997 02 09.22		B	1.7	S	5.0	B		7	40	6	1.5	320	TRI
1997 02 09.23					3.2	B		8	6.6	3	5.8	340	HAS02
1997 02 09.23		B	1.6	S	0.0	E		1	30	8	1	300	TRI
1997 02 09.25		B	2.3	SC	0.0	E		1	20	7			BIV
1997 02 09.25		M	1.9	S	5.0	B		12	10	S8/	4		GON05
1997 02 09.25	s	B	1.7	S	5.0	B		7	40	8	2	300	MAR20
1997 02 09.26	a	I	2.1	AT	0.0	E		1			&7	320	VIT01
1997 02 09.27	a	I	1.8	AT	0.0	E		1			&4.5	320	PER01
1997 02 09.46	a	I	1.5	SC	0.0	E		1	10	9	3	320	CRE01
1997 02 09.74	!	S	1.7:	YG	0.7	E		1		8/			SKI
1997 02 09.84		B	1.6	AA	0.0	E		1					OKA05
1997 02 09.84		I	2.2:	AA	0.0	E		1					TSU02
1997 02 09.84		S	1.5	S	15.0	R	5	25	15	6/	1.5		NAG02
1997 02 09.85		I	1.8	AA	0.0	E		1					WAS
1997 02 09.85		M	2.1	AA	3.5	B		7	15	7	2.0		WAS
1997 02 09.85		S	2.3	AA	5.0	B		7	10	7	1.2	300	TAK06
1997 02 09.86		B	2.2	YG	3.5	B		7	11	8	2.0	310	OHM
1997 02 09.86		I	2.2	YG	0.0	E		1		8			OHM
1997 02 09.86		M	2.2	AA	5.0	B		7	20				TOD
1997 02 09.86		S	2.1	AA	0.0	E		1					TAK06
1997 02 09.97		B	3.2:	AA	5.0	B		7		7			HOM
1997 02 10.11		B	2.4	HD	3.5	B		7	16	S7/	4	315	HAR09
1997 02 10.11		M	1.9	AA	3.0	R	4	7	13	5	0.7		MAI
1997 02 10.12		B	2.3	HD	5.0	B		7	19	S7/	4	315	MOR04
1997 02 10.14	w	B	1.8	SC	5.0	B		10	30	8	4		AND03
1997 02 10.15	w	B	1.9	SC	0.0	E		1		8	1.5		AND03
1997 02 10.16		S	1.6	SC	5.0	B		7	7	9	1.50	315	TOL
1997 02 10.16	w	B	1.5	SC	5.0	B		10		8	4		GRA07
1997 02 10.16	w	B	1.8	SC	0.0	E		1		8			RAD01
1997 02 10.17	w	B	1.4	SC	0.0	E		1		8			BOJ01
1997 02 10.17	w	B	1.5	SC	5.0	B		10		8			BOR05
1997 02 10.18		B	2.0	S	0.0	E		1	10	6	0.70	305	HAL04
1997 02 10.18	a	M	1.4	AA	5.0	B		12	23	8	6	321	TAN02
1997 02 10.19	!	V	1.6	YF	6.4	A	3 a	1	&40	7	&3	320	MIK
1997 02 10.20					8.0	B		20	3	7	3.3	315	VAN06
1997 02 10.21	w	M	1.4	Y	0.0	E		1	25	D7	7.5	325	CAN04
1997 02 10.23					5.0	B		10	13.2	3	4.0	330	HAS02
1997 02 10.24		B	1.5	S	0.0	E		1	30	8	0.5	300	TRI
1997 02 10.24		B	1.6	S	5.0	B		7	35	6	1	315	TRI
1997 02 10.24		S	1.6	YG	0.7	E		1		8/			SKI
1997 02 10.25		S	2.0	SC	6.3	B		9	6	7	1.92	315	DIN01
1997 02 10.25	s	B	1.7	S	5.0	B		7	40	8	2	290	MAR20
1997 02 10.26	a	I	1.9	AT	0.0	E		1			&4.5	302	VIT01
1997 02 10.27	a	B	1.9	AT	0.0	E		1		7/	&6.5	290	PER01
1997 02 10.27	a	I	1.6	AT	0.0	E		1		7/	&6.5	290	PER01
1997 02 10.27	a	S	1.6	AT	0.0	E		1		7/	&6.5	290	PER01
1997 02 10.76	!	S	1.4:	AA	5.0	B		7	6	6			SHA02
1997 02 10.84		S	1.3	S	15.0	R	5	25	15	6/	1.5		NAG02
1997 02 10.86		M	1.6	YG	3.0	B		8	20	7	0.6	300	KAT01
1997 02 11.15		B	1.4	AA	3.0	B		7		6	1.5	339	CHV
1997 02 11.15		B	1.6	AA	3.0	B		8		6	1.5		SLI01
1997 02 11.15		B	1.6	AA	3.0	B		8		6	2.5		SLI01
1997 02 11.15	w	B	1.6	SC	0.0	E		1		8	1.5		VEL02
1997 02 11.15	w	B	1.7	SC	5.0	B		10		8	4.5		AND03
1997 02 11.16		S	1.5	SC	4	R	7	20	6	9	1.6	320	TOL
1997 02 11.16		S	1.6	AA	6.3	R	13	52	14	S9	19	320	KOS
1997 02 11.16	w	B	1.3	SC	0.0	E		1		8	2		BOR05
1997 02 11.16	w	B	1.6	SC	5.0	B		10		8			RAD01
1997 02 11.17	w	B	1.4	SC	0.0	E		1		8			RAD01
1997 02 11.17	w	B	1.5	SC	0.0	E		1		8			BOJ01
1997 02 11.18	a	M	1.3	AA	5.0	B		12	23	7/			TAN02
1997 02 11.19					15.0	R	8	30	22	7	1.2	330	DIE02

Comet C/1995 O1 (Hale-Bopp) [cont.]

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1997 02 11.19		S	1.9	AA	0.0	E		1					DIE02
1997 02 11.21		M	1.5:	YG	0.7	E		1	&12				GRA04
1997 02 11.21	a	S	1.5	AA	0.7	E		1					BOU
1997 02 11.22			1.4:	AA	0.6	E		1	15	5	2.0	320	GIL01
1997 02 11.22		B	1.7	SC	0.7	E		1	22	5	&5		ROG02
1997 02 11.22		S	1.3	SC	5.0	B		10	25	8	3.5	312	MCK
1997 02 11.22	w	M	1.7	SC	0.0	E		1	&10	7/	&4	315	GLI
1997 02 11.23	!	S	1.9	AA	5.0	B		7	5	8	2	310	SHA02
1997 02 11.23	!	S	2.0	AA	0.7	E		1	10	8	2	310	SHA02
1997 02 11.23	!	S	2.3	AA	8.0	B		20	4.9	8	2	310	SHA02
1997 02 11.24		B	1.7	S	5.0	B		7	35	6			TRI
1997 02 11.24		S	1.7	SC	6.3	B		9	8	7	3.5	320	DIN01
1997 02 11.24	a	S	1.5	SC	0.6	E		1	20	8	>8	320	OKS
1997 02 11.74	!	M	1.6	YG	5.0	B		10	11	7/	1.2		GRA04
1997 02 11.74	!	S	1.5	YG	0.7	E		1		8			SKI
1997 02 11.81		I	1.8	S	0.0	E		1					TOY
1997 02 11.82	!	S	1.3	SC	0.0	E		1	20	S8	9	320	SHI
1997 02 11.82	!	S	1.6	SC	3.0	B		10	13	D7	6	320	SHI
1997 02 11.84		B	2.0	YG	3.5	B		7	15	8	3.2	300	OHM
1997 02 11.84		I	1.8	YG	0.0	E		1	<20	S4	1.5	310	YOS04
1997 02 11.84		S	1.6	YG	2.4	B		10	15	7	2.0	320	YOS04
1997 02 11.85		S	1.8	AA	0.0	E		1	20	7	1	310	NAG08
1997 02 11.86		G	1.5	AA	0.0	E		1			2		YOS02
1997 02 11.86		M	1.7	AA	3.5	B		7	15	7	1.8	320	YOS02
1997 02 12.06		S	2.2	AA	11.0	L	7	32	17	6	1.5		IVA03
1997 02 12.12		B	2.4:	AA	5.0	B		7	5	6	3		HOM
1997 02 12.13		B	1.8	SC	7.0	B		40			2.0		PEN
1997 02 12.14		B	1.5	AA	3.0	B		7		6	1	340	CHV
1997 02 12.14		B	1.8	SC	7.0	B		40			2.0		CHA02
1997 02 12.14		S	1.3	SC	0.0	E		1		5			LUK04
1997 02 12.14	w	B	1.3	SC	0.0	E		1		8			VEL02
1997 02 12.15					8.0	B		12	34	S6	6	324	BAR06
1997 02 12.15		B	2.1	AA	5.0	B		7	10	S8	4	315	VEL03
1997 02 12.15		G	1.9	AA	0.0	E		1	14	S6			VEL03
1997 02 12.15		S	1.4	SC	0.0	E		1	40	3/			BAR06
1997 02 12.15	w	I	1.2	SC	0.0	E		1		4	3	325	FIL05
1997 02 12.16	w	B	1.3	SC	0.0	E		1		8			BOJ01
1997 02 12.16	w	B	1.5	SC	5.0	B		10		8			RAD01
1997 02 12.17	w	B	1.3	SC	0.0	E		1		8	2		BOR05
1997 02 12.17	w	B	1.4	SC	0.0	E		1		8			RAD01
1997 02 12.18	a	M	1.3	AA	5.0	B		12	16	8	7	315	TAN02
1997 02 12.20					5.0	B		7	&18	7/	7.5	320	SKI
1997 02 12.20		S	1.3	YG	0.7	E		1		8	3		SKI
1997 02 12.21		M	1.5	YG	0.7	E		1	12	8	2		GRA04
1997 02 12.21		N	4.0	YG	5.0	B		10	11	7/	6.5	322	GRA04
1997 02 12.24		B	1.5	S	0.0	E		1	30	8	1	300	TRI
1997 02 12.24		B	1.6	S	5.0	B		7	35	6	1	335	TRI
1997 02 12.25	s	B	1.8	S	5.0	B		7	40	8	2	300	MAR20
1997 02 12.65	a	M	1.6	SC	0.0	E		1			15		OME
1997 02 12.74	!	M	1.7	YG	5.0	B		10	10	7/	1.0	305	GRA04
1997 02 12.83					5.0	B		7	15	8	3.0	320	NAG08
1997 02 12.83		I	1.6	S	0.0	E		1					TOY
1997 02 12.83		S	1.6	AA	0.0	E		1	20	7/	1.5	310	NAG08
1997 02 12.84		B	1.5	YG	0.0	E		1	<20	S4	1	310	YOS04
1997 02 12.84		S	1.4	YG	2.4	B		10	15	s6	1.2	310	YOS04
1997 02 12.86		M	2.0	AA	5.0	B		7	20				TOD
1997 02 12.86		S	1.2	S	15.0	R	5	25	18	7	2.0		NAG02
1997 02 12.87		S	2.2	AA	5.0	B		7					TAK06
1997 02 13.16	w	B	1.5	SC	0.0	E		1		8			RAD01
1997 02 13.20		S	1.4	YG	0.7	E		1		8			SKI
1997 02 13.20	w	M	1.3	Y	0.0	E		1	30	D7	15	325	CAN04
1997 02 13.22			1.5:	AA	0.6	E		1	15	5	1.5	315	GIL01
1997 02 13.24		B	1.5	S	5.0	B		7	35	6	0.5	330	TRI
1997 02 13.41	w	B	1.3	AA	0.0	E		1		8	&4		GRE
1997 02 13.46	a	M	1.5	SC	5.0	B		7	8	9	4.5	315	CRE01

Comet C/1995 O1 (Hale-Bopp) [cont.]

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1997 02 13.65	a	M	1.3	SC	0.0	E		1			15		OME
1997 02 13.81		I	1.6	S	0.0	E		1					TOY
1997 02 13.82		B	1.5	YG	0.0	E		1	<20	S4	2	310	YOS04
1997 02 13.82		S	1.6	YG	2.4	B		10	18	7	1.5	310	YOS04
1997 02 13.83		M	1.1	YG	3.0	B		8	20	7	1.5	310	KAT01
1997 02 13.83		S	1.2	S	15.0	R	5	25	18	6/	2.0		NAG02
1997 02 13.83		S	1.6	AA	0.0	E		1	20	7/	2	310	NAG08
1997 02 13.84		B	1.8	YG	3.5	B		7		8	4	340	OHM
1997 02 13.84		I	1.4	AA	0.0	E		1					TSU02
1997 02 13.84		I	1.9	YG	0.0	E		1		8			OHM
1997 02 13.85		B	1.4	AA	0.0	E		1			2		YOS02
1997 02 13.85		B	1.8	AA	0.0	E		1					TOD
1997 02 13.85		M	2.0	AA	5.0	B		7	15				TOD
1997 02 13.86					5.0	B		7	12	7	1	310	TAK06
1997 02 13.86		S	2.0	AA	0.0	E		1					TAK06
1997 02 14.18					15.0	R	8	30	23	7	1.35	320	DIE02
1997 02 14.18		S	1.7	AA	0.0	E		1					DIE02
1997 02 14.18	!	G	1.1	AA	0.8	E		1	12	8	11	323	SHA02
1997 02 14.18	!	M	1.1	AA	5.0	B		7	9	8	6	323	SHA02
1997 02 14.18	a	M	1.4	AA	5.0	B		12	20	8			TAN02
1997 02 14.19	a	S	1.4	SC	0.6	E		1	15	8	3	315	OKS
1997 02 14.20	w	M	1.3	Y	0.0	E		1	30	D7	15	325	CAN04
1997 02 14.22			1.6:	AA	0.6	E		1	15	5	0.5	315	GIL01
1997 02 14.24		B	1.5	SC	0.7	E		1		5	&1		ROG02
1997 02 14.24		S	1.8	YF	6.3	B		9	18	8	3		ENT
1997 02 14.25		S	1.2	AA	7.0	B		16	12	D3	1.1	316	TAY
1997 02 14.83					5.0	B		7	15	7/	7.0	320	NAG08
1997 02 14.83		B	1.1	S	0.0	E		1	&20	5	&6	325	FUK02
1997 02 14.83		B	1.8	AA	0.0	E		1					OKA05
1997 02 14.83		S	1.4	AA	0.0	E		1	20	7/	3	320	NAG08
1997 02 14.84	!	S	1.2	SC	0.0	E		1	20	S7	9	315	SHI
1997 02 15.15		M	1.4	YG	0.7	E		1	12	8			GRA04
1997 02 15.15	—	N	3.5	YG	5.0	B		10	12	7/	6.5	317	GRA04
1997 02 15.15	w	B	1.3	SC	8.0	B		8		8			GRA07
1997 02 15.15	w	B	1.3	SC	8.0	B		8		8			RAD01
1997 02 15.16		S	1.5	SC	4	R	7	20	5	9	0.40	330	TOL
1997 02 15.17		S	1.1	SC	0.0	E		1	25	4	4	319	BAR06
1997 02 15.17		S	1.1	SC	0.0	E		1	30	S6	6	319	ISH03
1997 02 15.17	!	G	0.9	AA	0.8	E		1	12	8	5	329	SHA02
1997 02 15.17	w	B	1.3	SC	5.0	B		10		8			BOR05
1997 02 15.18	a	M	1.3	AA	5.0	B		12	22	8	10	320	TAN02
1997 02 15.20		B	1.9	SC	0.0	E		1	30	8			BIV
1997 02 15.23		B	1.4	S	0.0	E		1	35	8	1.5	315	TRI
1997 02 15.23		B	1.5	S	5.0	B		7	35	6	1.5	315	TRI
1997 02 15.23		S	1.4	AA	5.0	B		8	45	8	2	315	BEA
1997 02 15.23		S	1.4	AA	12.5	R	5	20	45	8	2	315	BEA
1997 02 15.23	s	B	1.2	S	0.0	E		1		8	1	300	MAR20
1997 02 15.23	s	B	1.5	S	5.0	B		7	35	8	3	295	MAR20
1997 02 15.23	s	B	1.6	SC	0.0	E		1	10	8		310	GLI
1997 02 15.24		B	1.3	SC	0.7	E		1		5	4		ROG02
1997 02 15.24		G	1.5	AA	0.8	E		1	12	8	9	329	SHA02
1997 02 15.25		S	1.2	AA	7.0	B		16	15	D3	1.3	313	TAY
1997 02 15.25	a	I	1.4	AT	0.0	E		1		7/	&5	310	PER01
1997 02 15.25	a	I	1.5	AT	0.0	E		1					VIT01
1997 02 15.74	!	S	1.5	YG	0.7	E		1		8			SKI
1997 02 15.77	!	M	1.6:	YG	5.0	B		10	10	7/	1.0		GRA04
1997 02 16.13		M	1.7	AA	3.0	R	4	7	14	6	2		MAI
1997 02 16.14					8.0	R	10	28	12	S7	0.8	305	GER01
1997 02 16.14		G	1.8:	AA	0.0	E		1					GER01
1997 02 16.15	w	B	1.1	SC	0.0	E		1		8			GRA07
1997 02 16.15	w	B	1.3	SC	8.0	B		8		8			RAD01
1997 02 16.16	w	B	1.2	SC	0.0	E		1		8	6.5		BOR05
1997 02 16.17	w	B	1.2	AA	0.0	E		1	25	6/	5	322	CHE03
1997 02 16.18		N	3.4	YG	5.0	B		10	12	7/	10	321	GRA04
1997 02 16.19					8.0	B		20	4	7	4.2	315	VAN06

Comet C/1995 O1 (Hale-Bopp) [cont.]

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1997 02 16.19		M	1.3	YG	0.7	E		1	&12	8	5		GRA04
1997 02 16.19		S	1.1	YG	0.7	E		1		8	3.5		SKI
1997 02 16.19	a	O	1.1	SP	0.0	E		1	45	7	12	340	ZNO
1997 02 16.19	w	B	1.4	AA	0.0	E		1					VAN06
1997 02 16.21	s	B	1.5	SC	0.0	E		1	12	8	>8	310	GLI
1997 02 16.21	w	B	1.0	S	0.0	E		1		8	3	290	SAN04
1997 02 16.22	w	B	1.2	S	0.0	E		1		8/	5	315	MAR02
1997 02 16.23		B	1.3	S	0.0	E		1	35	8	1.5	315	TRI
1997 02 16.23		B	1.8	SC	0.0	E		1	20	8			BIV
1997 02 16.23	s	B	1.1	S	0.0	E		1		8	1	300	MAR20
1997 02 16.23	s	B	1.5	S	5.0	B		7	35	8	3	290	MAR20
1997 02 16.23	w	M	1.4	S	3.0	B		6	20	7	5	320	MAR02
1997 02 16.24		B	1.4	S	5.0	B		7	35	6	1.5	315	TRI
1997 02 16.42	w	B	1.3	AA	0.0	E		1		8			GRE
1997 02 16.65	a	M	1.4	SC	0.0	E		1			12		OME
1997 02 16.81		I	1.2	S	0.0	E		1					TOY
1997 02 16.82		S	1.3	AA	0.0	E		1	&20	7/	2	320	NAG08
1997 02 16.83		B	1.7	AA	0.0	E		1					OKA05
1997 02 17.08		S	1.3	AA	11.0	L	7	32	20	6	1.8		IVA03
1997 02 17.14	!	G	2.7:	AA	0.7	E		1	6	7			SHA02
1997 02 17.14	!	M	3.2:	AA	8.0	B		10	6	7	0.33	317	SHA02
1997 02 17.16					5.0	B		7	16	S7	6	315	VEL03
1997 02 17.16		G	1.3	AA	0.0	E		1	20	S5	3	318	VEL03
1997 02 17.16		S	1.3	AA	8.0	B		20	20		8.5	320	ANZ
1997 02 17.17		B	1.4	S	0.0	E		1	18	6	1.20	310	HAL04
1997 02 17.17		S	1.1	AA	0.0	E		1					ANZ
1997 02 17.17	w	B	1.2	AA	0.0	E		1	25	6	6	322	CHE03
1997 02 17.17	w	M	1.2	Y	0.0	E		1	30	D7	&15	310	CAN04
1997 02 17.18		M	1.5	Y	6.3	R	13	33		S6	9	310	HOR
1997 02 17.18		S	0.8	AA	6.3	R	13	52	14	S9	23.3	295	KOS
1997 02 17.18	a	B	1.3	AT	0.0	E		1					MIL02
1997 02 17.18	a	M	1.0	S	5	R		1	35	7/			HOR02
1997 02 17.21	a	O	1.1	SP	0.0	E		1	35	7			ZNO
1997 02 17.23		B	1.4	S	5.0	B		7	30	6	1	310	TRI
1997 02 17.24		M	1.2	S	5.0	B		7	12	S8/	6		GON05
1997 02 17.24	a	B	1.7	AT	3.5	R		1					PER01
1997 02 17.24	a	I	1.5	AT	0.0	E		1		8	&9	310	PER01
1997 02 17.24	s	B	1.5	S	5.0	B		7	<40	8	2	285	MAR20
1997 02 17.47		G	1.1:	SC	0.0	E		1	11	7	1.0	315	CRE01
1997 02 17.65	a	M	1.5	SC	0.0	E		1			10		OME
1997 02 17.83		S	1.1	S	15.0	R	5	25	20	7	2.8		NAG02
1997 02 17.85		B	1.3	YG	3.5	B		7	20	8	6	320	OHM
1997 02 18.11		B	1.5	HD	5.0	B		7	20	S7/	6	318	MOR04
1997 02 18.11		B	1.9	HD	3.5	B		7	17	S7/	5	310	HAR09
1997 02 18.12		S	0.7	SC	0.0	E		1	35	S6	7	320	ISH03
1997 02 18.14		S	0.9	SC	8.0	B		12	30	S6	6	320	ISH03
1997 02 18.16		B	1.5	AA	2.0	B		2	13	7			KOZ
1997 02 18.16		S	1.2	Y	0.0	E		1	11	S7/	7	313	SAN07
1997 02 18.16	w	M	1.1	AA	0.0	E		1	30	6	7	322	CHE03
1997 02 18.17		S	0.6	AA	6.3	R	13	52	14	S9	25	295	KOS
1997 02 18.17	!	G	1.2	AA	0.7	E		1	5	7			SHA02
1997 02 18.17	!	M	1.4	AA	5.0	B		7	4	8	1.5	303	SHA02
1997 02 18.17	a	M	0.8	S	5	R		1	40	7/	6	325	HOR02
1997 02 18.18		B	1.1	Y	0.0	E		1	20	S8	5	300	SAR02
1997 02 18.18		B	1.4	S	0.0	E		1	12	7	0.75	305	HAL04
1997 02 18.18		S	1.2	Y	0.0	E		1	10	8	1.5	290	KES01
1997 02 18.18	a	M	1.1	S	5	R		1	30	7/	4	325	PLS
1997 02 18.18	a	O	1.6	SP	0.0	E		1	25	6	4		POD
1997 02 18.19	!	V	1.0	YF	6.4	A	3 a	1	&40	8			MIK
1997 02 18.20	a	M	0.8	TI	5	R		1	25	7	4		DVO
1997 02 18.20	a	O	1.1	SP	0.0	E		1	35	7	11		ZNO
1997 02 18.20	w	B	1.4	AA	0.0	E		1					VAN06
1997 02 18.22		S	1.4	SC	6.3	B		9	2	7	3	320	DIN01
1997 02 18.24		B	1.3	S	5.0	B		7	30	6	1	320	TRI
1997 02 18.76		B	1.8	AA	7.0	B		16	8	D6			TAY

Comet C/1995 O1 (Hale-Bopp) [cont.]

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1997 02 18.76		S	0.6	AA	7.0	B		16	8	D6			TAY
1997 02 18.77	!	M	1.4	AA	5.0	B		7	7	7	0.33	350	SHA02
1997 02 18.85		B	0.9	AA	0.0	E		1			5		YOS02
1997 02 18.85		B	1.4:	AA	0.0	E		1	&20	6	&3	310	MIY01
1997 02 18.85		B	1.6:	AA	5.0	B		7	20	D7	7	310	MIY01
1997 02 18.85		I	1.3	AA	0.0	E		1					TSU02
1997 02 18.85		M	1.1	AA	3.5	B		7	20	8	7	325	YOS02
1997 02 18.86		B	1.3	AA	0.0	E		1					TOD
1997 02 18.86		I	1.5	S	0.0	E		1					TOY
1997 02 18.86		M	1.0	Y	0.0	E		1	25	7	9	320	KOB01
1997 02 19.10		G	1.3	Y	0.0	E		1		S8			MOS03
1997 02 19.11		B	1.7	HD	3.5	B		7	17	S7/	6	320	HAR09
1997 02 19.12					8.0	R	10	28	10	S6	>1.3	326	GER01
1997 02 19.12		B	1.5	HD	5.0	B		7	20	S7/	7	318	MOR04
1997 02 19.12		G	1.7:	AA	0.0	E		1					GER01
1997 02 19.12	w	I	0.9	SC	0.0	E		1		4	5		FIL05
1997 02 19.13		B	1.3:	SC	0.0	E		1	&25	S6	&3	320	MAN01
1997 02 19.13	w	B	1.1	SC	0.0	E		1		8	3.5		VEL02
1997 02 19.14		S	0.8	SC	0.0	E		1	40	4	4	313	BAR06
1997 02 19.15		S	0.8	SC	0.0	E		1	40	5	4		LUK04
1997 02 19.15	w	B	1.2	SC	0.0	E		1		8			BOJ01
1997 02 19.16	w	B	1.2	SC	0.0	E		1		8			RAD01
1997 02 19.16	w	B	1.2	SC	0.0	E		1		8	6.5		BOR05
1997 02 19.18	w	B	1.0:	AA	0.0	E		1	22	6	4	323	CHE03
1997 02 19.20	w	B	1.4	SC	0.0	E		1	12	8	>8	325	GLI
1997 02 19.21		S	1.3	AA	0.0	E		1	16	7	3	300	BAR
1997 02 19.21	w	B	1.2	S	0.0	E		1	25	7/	4	310	MAR02
1997 02 19.22			1.3:	AA	0.6	E		1	12	7	2.0	315	GIL01
1997 02 19.22	w	B	1.3	S	3.0	B		6	30	7	6	320	MAR02
1997 02 19.23		B	1.1	S	0.0	E		1	30	8	2	310	TRI
1997 02 19.23		B	1.2	S	5.0	B		7	25	7	4	320	TRI
1997 02 19.24		M	1.1	S	5.0	B		7	12	S8/	8		GON05
1997 02 19.24	s	B	1.1	S	0.0	E		1		8	1	290	MAR20
1997 02 19.24	s	B	1.4	S	5.0	B		7	30	8	3	270	MAR20
1997 02 19.82		I	1.2	S	0.0	E		1					TOY
1997 02 19.83		B	1.1	YG	0.0	E		1	&20	S5	3	310	YOS04
1997 02 19.83		S	1.0	S	15.0	R	5	25	22	7	3.0		NAG02
1997 02 19.83		S	1.1	AA	0.0	E		1	&20	7/	3	320	NAG08
1997 02 19.84		B	1.4	AA	0.0	E		1					OKA05
1997 02 19.84		I	1.1	AA	0.0	E		1			3		WAS
1997 02 19.84		S	1.3	YG	2.4	B		10	15	S6	3	320	YOS04
1997 02 19.85		B	1.4:	AA	0.0	E		1	&20	6	5	300	MIY01
1997 02 19.85		B	1.6:	AA	8.0	B		11	20	D7	7	300	MIY01
1997 02 19.85		I	0.8	AA	0.0	E		1					TSU02
1997 02 19.86		B	1.2	YG	0.0	E		1					NAK01
1997 02 19.86		C	1.0	YF	2.5	A	2		41		7.5	319	NAK01
1997 02 19.86		M	0.9	YG	3.0	B		8	20	7	1.5	310	KAT01
1997 02 19.87		B	1.3	AA	0.0	E		1					TOD
1997 02 20.09		G	1.0	AA	0.0	E		1	18	9	0.8	320	SER
1997 02 20.11		M	1.5	AA	3.0	R	4	7	14	6	2.5		MAI
1997 02 20.12		B	1.4	HD	5.0	B		7	20	S8	7	320	MOR04
1997 02 20.13	w	I	0.8	SC	0.0	E		1		5			FIL05
1997 02 20.14		S	0.7	SC	0.0	E		1	50	4			BAR06
1997 02 20.14	w	S	0.6	SC	0.0	E		1	50	4			BAR06
1997 02 20.15		S	1.1	Y	0.0	E		1	9	S8	3	315	SAN07
1997 02 20.17					5.0	B		8	25	7	1.5	313	DIE02
1997 02 20.17		S	1.5	AA	0.0	E		1					DIE02
1997 02 20.20			1.2	AA	0.6	E		1	12	8	2.5	315	GIL01
1997 02 20.20	a	B	1.0	AA	0.7	E		1					BOU
1997 02 20.21		S	1.2	AA	5.0	B		10	30	6	4	290	FOG
1997 02 20.22		B	1.4	S	0.0	E		1	8	7	0.75	300	HAL04
1997 02 20.23		B	1.0	S	0.0	E		1	30	8	3	310	TRI
1997 02 20.23		B	1.2	S	5.0	B		7	25	7	6	320	TRI
1997 02 20.23		G	1.1	AA	0.7	E		1	18	8	2	304	SHA02
1997 02 20.23		I	1.0	AA	0.8	E		1					HAS02

Comet C/1995 O1 (Hale-Bopp) [cont.]

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1997 02 20.23		M	1.1	AA	5.0	B		7	7	8	3.5	322	SHA02
1997 02 20.23	w	B	1.2	SC	0.0	E		1		8			GLI
1997 02 20.25		B	1.3	SC	0.7	E		1		5	3.5		ROG02
1997 02 20.40	Gw	B	1.1	AA	0.0	E		1		8	&2		GRE
1997 02 20.45		G	1.0	SC	0.0	E		1	11	8	2.0	315	CRE01
1997 02 20.45		M	1.1	SC	5.0	B		10	9	9	5	315	CRE01
1997 02 20.75	!	M	1.2:	YG	0.7	E		1	12	8			GRA04
1997 02 20.75	!	N	3.2	YG	5.0	B		10		8	2	290	GRA04
1997 02 20.76	!	S	0.9:	YG	0.7	E		1		8/	1.5		SKI
1997 02 20.81		I	1.5	S	0.0	E		1					TOY
1997 02 20.83	!	S	1.1	SC	0.0	E		1	17	S8	7	320	SHI
1997 02 20.84		B	1.5	AA	0.0	E		1					OKA05
1997 02 20.84		I	1.5	YG	0.0	E		1		8	1	300	YOS04
1997 02 20.84		S	1.5	YG	2.4	B		10	&15	s7	1	310	YOS04
1997 02 21.12		B	1.4	HD	5.0	B		7	18	S8	6	320	MOR04
1997 02 21.14		B	1.9:	AA	5.0	B		7	5	6	2		HOM
1997 02 21.14		M	1.5	AA	3.0	R	4	7	14	6	3		MAI
1997 02 21.16		B	0.5	Y	5.0	B		10	20	S6	8	325	BUS04
1997 02 21.17		M	1.3	Y	6.0	B		20					TUB
1997 02 21.17		S	1.0	Y	0.0	E		1	10	S8	4	320	SAN07
1997 02 21.17	a	B	1.2	AT	0.0	E		1					MIL02
1997 02 21.18		B	1.5	AA	0.0	E		1	20		4.5	308	STO
1997 02 21.20		S	1.0	SC	0.7	E		1	30	7/			MCK
1997 02 21.20		S	1.0	YG	0.7	E		1		8	2.5		SKI
1997 02 21.20	!	V	0.9	YF	2.3	A	4 a	5	&40	8	&5	320	MIK
1997 02 21.23		B	0.9	S	0.0	E		1	30	8	0.5	330	TRI
1997 02 21.23		B	1.0	S	5.0	B		7	25	7	3	320	TRI
1997 02 21.67		M	1.3	SC	0.0	E		1					OME
1997 02 21.73		I	1.2	AA	0.7	E		1					MOE
1997 02 21.81		I	1.3	S	0.0	E		1					TOY
1997 02 21.83		B	1.3	AA	0.0	E		1					OKA05
1997 02 21.84		B	1.2	YG	0.0	E		1	&20	S5	1.5	310	YOS04
1997 02 21.84		S	0.8	S	15.0	R	5	25	20	7	3.0		NAG02
1997 02 21.84		S	1.3	YG	2.4	B		10	&18	s7	2	320	YOS04
1997 02 22.11		M	1.5	AA	3.0	R	4	7	14	6	3		MAI
1997 02 22.18	!	V	0.9	YF	2.3	A	4 a	10	&35	8			MIK
1997 02 22.20		S	1.1	SC	0.7	E		1					MCK
1997 02 22.21		M	1.4:	AA	5.0	B		7	7	8	2	307	SHA02
1997 02 22.21		S	1.2:	AA	0.7	E		1	10	8	1	300	SHA02
1997 02 22.65		M	1.1	SC	0.0	E		1					OME
1997 02 22.82		B	1.0	YG	0.0	E		1		8	1	305	YOS04
1997 02 22.82		S	1.1	YG	2.4	B		10	15	s7	1.5	315	YOS04
1997 02 22.85		B	1.0	YG	0.0	E		1					NAK01
1997 02 22.85		I	1.1	S	0.0	E		1					TOY
1997 02 23.14		M	1.2	Y	6.0	B		20	40	4	5		TUB
1997 02 23.15		M	0.9	Y	0.0	E		1	11	S6/	2	300	SAN07
1997 02 23.16					5.0	B		10	11.5	8	2.0	300	HAS02
1997 02 23.16					5.0	B		10	11.5	8	4.0	315	HAS02
1997 02 23.16	s	B	1.2	AA	0.6	E		1		S8	0.6		MEY
1997 02 23.16	s	M	1.4	AA	5.0	B		10	9.5	S7	1.8		MEY
1997 02 23.17		B	1.2	S	0.0	E		1	12	7	0.67	320	HAL04
1997 02 23.17		S	0.4	AA	6.3	R	13	52	14	S9		297	KOS
1997 02 23.17		S	1.3	AA	0.7	E		1	17	S2	15.5	304	CSU
1997 02 23.18		I	0.9	AA	0.8	E		1					HAS02
1997 02 23.18		M	1.2:	S	3	R		1	30	7/	2	320	PLS
1997 02 23.19	!	V	0.8	YF	2.3	A	4 a	5	&30	8			MIK
1997 02 23.19	a	M	0.7	TI	5	R		1	30	7	5		DVO
1997 02 23.19	a	O	0.8	SP	0.0	E		1	40	7/	13		ZNO
1997 02 23.41	Gw	B	0.9	AA	0.0	E		1		8	&2.5		GRE
1997 02 23.69	w	B	0.8:	SC	0.0	E		1	&30	3			BAR06
1997 02 23.75	!	S	0.9	YG	0.7	E		1		8/	1		SKI
1997 02 23.81		I	1.2	S	0.0	E		1					TOY
1997 02 23.85		B	1.1	AA	0.0	E		1					TOD
1997 02 23.85		B	1.3:	AA	0.0	E		1	&20	6	&2	290	MIY01
1997 02 23.85		B	1.4:	AA	5.0	B		7	20	D7	3	290	MIY01

Comet C/1995 O1 (Hale-Bopp) [cont.]

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1997 02 23.85		M	0.9	YG	3.0	B		8	20	7	2.0	300	KAT01
1997 02 23.86		S	0.5	S	15.0	R	5	25	25	7/	3.5		NAG02
1997 02 24.13		B	1.2	HD	5.0	B		7	18	S8			MOR04
1997 02 24.14		B	0.5	SC	0.0	E		1	35	4	5	338	BAR06
1997 02 24.14		S	0.3	SC	0.0	E		1	35	4			LUK04
1997 02 24.14		S	0.5	SC	0.0	E		1	35	S6	5	340	ISH03
1997 02 24.16		S	1.3	AA	0.7	E		1	17	S2	15.5	311	CSU
1997 02 24.17		S	0.4	AA	6.3	R	13	52	14	S9			KOS
1997 02 24.20		S	1.2	Y	0.0	E		1	10	8			SRA
1997 02 24.23		B	0.7	S	0.0	E		1	20	8			TRI
1997 02 24.23		B	0.8	S	5.0	B		7	25	7	2	320	TRI
1997 02 24.25		S	1.3	SC	3.0	B		8	3.5	7	3		DIN01
1997 02 24.42	w	B	0.8	AA	0.0	E		1		8	&1.5		GRE
1997 02 24.69	w	S	0.8:	SC	8.0	B		12	&15	7			BAR06
1997 02 24.82		B	1.1	YG	0.0	E		1		8			YOS04
1997 02 24.82		I	1.1	S	0.0	E		1					TOY
1997 02 24.82		S	1.1	YG	2.4	B		10	12	s7	0.6	305	YOS04
1997 02 24.83		I	0.9	AA	0.0	E		1	&15	8	1	330	NAG08
1997 02 24.83		I	1.1	AA	0.0	E		1					YOS
1997 02 24.84		B	1.1	AA	0.0	E		1					TOD
1997 02 24.84		S	0.7	SC	0.0	E		1	18	D8	7	325	SHI
1997 02 25.06		S	0.9	AA	11.0	L	7	32	20	6	2		IVA03
1997 02 25.08		M	1.4	AA	3.0	R	4	7	15	6	3		MAI
1997 02 25.11					8.0	R	10	28	10	S6	>1.2	310	GER01
1997 02 25.11		G	1.5:	AA	0.0	E		1					GER01
1997 02 25.13		I	0.4	SC	0.0	E		1	28	S6	6.5	338	ISH03
1997 02 25.14		B	0.5	SC	0.0	E		1	35	4/			BAR06
1997 02 25.14	w	B	0.9	SC	5.0	B		10		8			BOR05
1997 02 25.14	w	G	0.2	SC	0.0	E		1		6			LUK04
1997 02 25.14	w	G	0.3	SC	0.0	E		1	35	4/			BAR06
1997 02 25.15	w	B	1.1	SC	0.0	E		1		8			RAD01
1997 02 25.17		M	1.0	Y	0.0	E		1	20	7	4		BRL
1997 02 25.21	—	G	0.7	AA	0.7	E		1	10	8	3	321	SHA02
1997 02 25.23		B	0.5	SC	0.7	E		1		5	&6		ROG02
1997 02 25.23		B	-0.4	SC	6.3	R		53		7	4		POP01
1997 02 25.24		S	1.0	SC	6.3	B		9	3.5	7	3	320	DIN01
1997 02 25.43	Gw	B	0.7	AA	0.0	E		1		8	&2.5		GRE
1997 02 25.44		G	0.8	SC	0.0	E		1	10	8	2.0	310	CRE01
1997 02 25.78		B	2.0	AA	7.0	B		16	10	7	1.5	330	TAY
1997 02 25.81		I	1.0	S	0.0	E		1			1	310	TOY
1997 02 25.81		I	1.0	S	0.0	E		1			1	310	TOY
1997 02 25.83		B	1.2	AA	0.0	E		1		8	1		OKA05
1997 02 25.83		S	0.7	SC	0.0	E		1	20	D8	8	320	SHI
1997 02 25.84		B	0.8	YG	0.0	E		1	15	S4	1	310	YOS04
1997 02 25.84		S	0.9	YG	2.4	B		10	15	s7	1.5	310	YOS04
1997 02 26.13	w	B	0.9	SC	0.0	E		1		8			RAD01
1997 02 26.14		M	0.8	YG	0.7	E		1		8/	3		GRA04
1997 02 26.14		N	2.8	YG	5.0	B		10	10	8	7.0	319	GRA04
1997 02 26.14	w	B	0.9	SC	0.0	E		1		8			BOR05
1997 02 26.15		N	5.6:	YG	20.3	T	10	123					GRA04
1997 02 26.15	w	B	0.9	SC	0.0	E		1		8	3.5		BOJ01
1997 02 26.15	w	B	1.0	SC	0.0	E		1		8			JOR01
1997 02 26.17		S	1.1	AA	0.0	E		1					DIE02
1997 02 26.19		S	0.8	YG	0.7	E		1		8	3		SKI
1997 02 26.21		S	1.1:	AA	0.6	E		1	12	8	2.5	315	GIL01
1997 02 26.23		B	-0.7	SC	6.3	R		53		7	4.5		POP01
1997 02 26.23		S	0.7	SC	0.7	E		1					MCK
1997 02 26.78	!	G	1.1	AA	0.7	E		1	12	8	1	296	SHA02
1997 02 26.78	!	M	0.9:	YG	5.0	B		10	12	7/	2		GRA04
1997 02 26.82		S	0.4	S	15.0	R	5	25	22	7	4		NAG02
1997 02 26.84		I	1.1	AA	0.0	E		1					YOS
1997 02 27.07		S	0.6	AA	11.0	L	7	32	15	5/	2.2		IVA03
1997 02 27.13		B	1.2	SC	7.0	B		40			5		CHA02
1997 02 27.15		M	0.7	YG	0.7	E		1		8/	3		GRA04
1997 02 27.15		N	2.8	YG	5.0	B		10	10	7/	10	321	GRA04

Comet C/1995 O1 (Hale-Bopp) [cont.]

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1997 02 27.15		S	0.9	AA	5.0	B		10	12	7	4	330	MOE
1997 02 27.16	a	M	0.5	S	5	R		1	25	8	10	315	HOR02
1997 02 27.18		M	0.6	Y	10	B		25	25	7	2.5	345	HYN
1997 02 27.18		S	0.7	AA	0.0	E		1	20	8	5.5	297	BAR
1997 02 27.19		N	5.8	YG	20.3	T	10	123					GRA04
1997 02 27.19	a	M	0.3	TI	5	R		1	25	7/	4		DVO
1997 02 27.19	a	M	0.4	S	3	R		1	40	7/	8	310	PLS
1997 02 27.20	a	O	0.6	SP	0.0	E		1	25	8			ZNO
1997 02 27.21	a	B	0.6	AA	0.7	E		1		8			BOU
1997 02 27.23		B	-0.8	SC	6.3	R		53		7	4.5		POP01
1997 02 27.24		S	1.0	YF	3.0	B		8	12	8	7		ENT
1997 02 27.24		S	1.1	AA	5.0	B		8	20	8	1	315	BEA
1997 02 27.75		I	1.0	AA	0.7	E		1	10	8	3	320	MOE
1997 02 28.05		S	0.6	AA	11.0	L	7	32	14	5/	2.2		IVA03
1997 02 28.12		B	1.2	AA	5.0	B		7	10	S8	10	314	VEL03
1997 02 28.14		S	0.6	AA	6.0	B		20		8			SCU
1997 02 28.15	w	M	0.7	Y	0.0	E		1	35	D8	8	315	CAN04
1997 02 28.16		B	0.5	Y	0.0	E		1	15	S8	10	310	SAR02
1997 02 28.16		B	1.0	AA	0.0	E		1					STO
1997 02 28.16		M	0.6	Y	0.0	E		1	15	s8	5	315	SAN07
1997 02 28.16	a	G	0.8	AA	0.6	E		1		8			KAM01
1997 02 28.17					5.0	B		7	24	7	4	307	DIE02
1997 02 28.17		M	0.6	Y	10	B		25	25	7	3		HYN
1997 02 28.17		S	0.8	AA	0.7	E		1	17	S2	15	300	CSU
1997 02 28.17		S	1.4	AA	0.0	E		1					DIE02
1997 02 28.17	a	B	0.5	AT	0.0	E		1					MIL02
1997 02 28.18		S	1.1	Y	0.0	E		1	8	7	2	305	SRA
1997 02 28.18	a	B	0.5	AA	0.7	E		1					BOU
1997 02 28.19		I	0.6	AA	0.8	E		1					HAS02
1997 02 28.19		S	0.6	AA	0.0	E		1	25	8/	6	300	ZAN
1997 02 28.19	!	V	0.5	YF	2.3	A	4 a	3	+29	8	&5	325	MIK
1997 02 28.19	a	M	0.5	S	5	R		1	25	8	4	285	HOR02
1997 02 28.20		S	1.0	YF	3.0	B		8		8	6		ENT
1997 02 28.20	a	O	0.6	S	0.0	E		1	25		2		LIB
1997 02 28.20	a	O	0.6	SP	0.0	E		1	25	7/	>8		ZNO
1997 02 28.70	w	S	0.5	SC	0.0	E		1	45	4/			BAR06
1997 02 28.73		B	0.5	SC	8.0	B		12	40	6	12		BAR06
1997 02 28.74	a	M	0.8:	Y	5.0	B		7	10	8	>2		KYS
1997 02 28.83		I	0.8	S	0.0	E		1			0.5	300	TOY
1997 02 29.09					5.0	B		7	11	S8	7.5	321	VEL03
1997 02 29.13		I	0.0	SC	0.0	E		1	28	S6	9.5	330	ISH03
1997 03 01.07		B	1.0	SC	7.0	B		40			5		CHA02
1997 03 01.08		G	0.6	Y	0.0	E		1		S8			MOS03
1997 03 01.11	!	G	0.0	AA	0.7	E		1	12	8	1	304	SHA02
1997 03 01.13		S	0.8	AA	6.0	B		20		8			SCU
1997 03 01.13	w	B	0.6	SC	0.0	E		1		8			BOR05
1997 03 01.15		S	0.8	AA	0.7	E		1	17	S2			CSU
1997 03 01.16		B	1.5	SC	3.5	R	5	30	4.5	8	0.25	30	APE
1997 03 01.16		S	0.0	AA	6.3	R	13	52	12	S9		337	KOS
1997 03 01.16	w	M	0.5	Y	0.0	E		1	25	D8	8	315	CAN04
1997 03 01.17	a	M	0.7	Y	5.0	B		7	15	9	10	335	KYS
1997 03 01.17	a	O	0.6	SP	0.0	E		1	30	6	5		POD
1997 03 01.17	w	B	0.7	SC	0.0	E		1		8			VEL02
1997 03 01.18		B	0.5	S	0.0	E		1	12	7	1.75	300	HAL04
1997 03 01.18	a	O	0.1	Y	0.0	E		1	10	8	10	335	KYS
1997 03 01.19		S	1.0	AA	0.0	E		1					DIE02
1997 03 01.19	a	B	0.5	AA	0.7	E		1					BOU
1997 03 01.20		B	0.3	SC	0.7	E		1		5	6		ROG02
1997 03 01.21		S	0.8	SC	0.7	E		1	20	8	5		MCK
1997 03 01.22		S	0.7	YF	6.3	B		9	12	8	5	330	ENT
1997 03 01.22	s	G	0.4	AT	0.0	E		1					PER01
1997 03 01.22	s	I	0.4	AT	0.0	E		1		D8	&9	320	PER01
1997 03 01.22	s	I	0.5	AT	0.0	E		1			&7	325	VIT01
1997 03 01.23	s	B	0.2	AT	3.5	R		1					PER01
1997 03 01.23	s	G	0.5	AT	0.0	E		1					VIT01

Comet C/1995 O1 (Hale-Bopp) [cont.]

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1997 03 01.72		B	0.3	SC	0.0	E		1	35	4/	14		BAR06
1997 03 01.72	w	G	0.1	SC	0.0	E		1	35	4/	14		BAR06
1997 03 01.81		B	0.9	AA	0.0	E		1		9	4		OKA05
1997 03 01.82		B	0.6	YG	0.0	E		1	20	S4	3	300	YOS04
1997 03 01.82		S	0.7	YG	2.4	B		10	15	s7	3	290	YOS04
1997 03 01.83		S	0.3	S	15.0	R	5	25	22	7	5		NAG02
1997 03 01.84		M	0.0	AA	0.0	E		1			3.0	330	TSU02
1997 03 02.07		B	1.0	SC	7.0	B		40			5		CHA02
1997 03 02.07		S	0.4	AA	11.0	L	7	32	17	6	4.5		IVA03
1997 03 02.09		G	0.7	AA	0.0	E		1	21	S7	4	310	VEL03
1997 03 02.13	w	B	0.6	SC	0.0	E		1		8			VEL02
1997 03 02.14	a	M	0.3	S	5	R		1	35	7	5	315	HOR02
1997 03 02.15		S	0.8	AA	0.7	E		1	17	S2	15	297	CSU
1997 03 02.15	w	B	0.5	SC	0.0	E		1		8			BOR05
1997 03 02.16		B	0.3	Y	0.0	E		1	20	S7	17	320	SAR02
1997 03 02.16		B	0.4	Y	0.0	E		1	25	S7	13	325	SZE02
1997 03 02.16		S	-0.1	AA	6.3	R	13	52	12	S9		340	KOS
1997 03 02.16	a	O	0.5	SP	0.0	E		1	30	7	12		ZNO
1997 03 02.16	w	B	0.7	SC	0.0	E		1		8			RAD01
1997 03 02.17	!	V	0.4	YF	2.3	A	4 a	3	+29	8	&5	323	MIK
1997 03 02.17	a	M	0.2	TI	5	R		1	25	7	2.5		DVO
1997 03 02.17	s	M	0.6	AA	5.0	B		10	15	S8			MEY
1997 03 02.17	s	S	0.3	AA	0.6	E		1		S8	7		MEY
1997 03 02.18	a	M	0.5	S	0.0	E		1	30	8	5		KON06
1997 03 02.19					5.0	B		7	26	7	5	320	DIE02
1997 03 02.19		S	0.6	AA	0.0	E		1					DIE02
1997 03 02.19	s	M	0.2	SC	0.0	E		1	20	7/	10	290	GLI
1997 03 02.19	w	B	0.5	AA	0.0	E		1		8	4.8	325	VAN06
1997 03 02.20		I	0.6	AA	0.8	E		1					HAS02
1997 03 02.20	a	O	0.6	S	0.0	E		1	25		2		LIB
1997 03 02.22		M	0.4	S	5.0	B		7	12	S8/	6		GON05
1997 03 02.23		S	0.8	SC	3.0	B		8		7	6		DIN01
1997 03 02.45	w	B	0.2	YF	0.0	E		1	&15	8/	4	326	ADA03
1997 03 02.45	w	M	0.2	YF	5.0	R		1					ADA03
1997 03 02.67	w	M	0.5:	SC	0.0	E		1					OME
1997 03 02.78		S	1.1	SC	0.7	E		1		9			MCK
1997 03 02.80		S	0.3	AA	5.0	B		10	14	7	6	320	MOE
1997 03 02.80	!	B	0.4	YF	0.5	E		1		8			ENT
1997 03 03.08		I	0.4	AA	0.8	E		1	12	8	9	330	MOE
1997 03 03.10		B	0.5	AA	2.0	B		2	10	7			KOZ
1997 03 03.10		B	0.9	SC	7.0	B		40			6		CHA02
1997 03 03.10		S	0.3	AA	6.0	B		20		8			SCU
1997 03 03.10	w	B	0.5	SC	0.0	E		1		8			SCH14
1997 03 03.10	w	B	0.6	SC	0.0	E		1		8			JOR01
1997 03 03.11					8.0	R	10	28	11	S6	>1.3	312	GER01
1997 03 03.11		B	1.1	HD	5.0	B		7	20	S8	7	330	MOR04
1997 03 03.11		G	0.7:	AA	0.0	E		1					GER01
1997 03 03.11	!	G	0.1	AA	0.8	E		1	10	8	10	325	SHA02
1997 03 03.12		B	0.7	AA	5.0	R	5	7	10	7			KOZ
1997 03 03.12		G	0.2	SC	0.0	E		1	35	5	16		BAR06
1997 03 03.13		I	0.0	SC	0.0	E		1	30	S6	10	325	ISH03
1997 03 03.14	w	B	0.4:	AA	0.0	E		1	30	6/	8	315	CHE03
1997 03 03.15	a	S	0.5	AA	0.7	E		1	25	8	2.5	300	MEN03
1997 03 03.15	w	B	0.5	SC	0.0	E		1		8			RAD01
1997 03 03.16		S	-0.3	AA	6.3	R	13	52	12	S9		315	KOS
1997 03 03.16	w	B	0.4	SC	0.0	E		1		8			VEL02
1997 03 03.17	a	B	0.3	AA	0.7	E		1		8	9.5	324	BOU
1997 03 03.19		S	0.3	AA	5.0	B		8	40	8	4	320	BEA
1997 03 03.20		B	0.0:	SC	0.7	E		1		5	6		ROG02
1997 03 03.23	!	B	0.4	YF	0.5	E		1	8	8	6		ENT
1997 03 03.78		I	0.6	AA	0.8	E		1	11	8	3.5	330	MOE
1997 03 03.80		S	0.4	AA	0.0	E		1	&15	7/	3	330	NAG08
1997 03 03.81		S	0.3	AA	5.0	B		8	40	8	4	320	BEA
1997 03 03.85	$	M	0.1	YG	0.0	E		1	20	7	10	335	KOB01
1997 03 04.06		B	0.0	SC	0.0	E		1	45	5	15	323	BAR06

Comet C/1995 O1 (Hale-Bopp) [cont.]

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1997 03 04.06	w	G	-0.1	SC	0.0	E		1	45	5	15	323	BAR06
1997 03 04.08		B	0.6	AA	5.0	B		7	12	D8	6	323	VEL03
1997 03 04.08		B	0.8	SC	7.0	B		40			6		CHA02
1997 03 04.08		G	0.6	AA	0.0	E		1	17	S7	5	323	VEL03
1997 03 04.11	a	S	0.6	AA	0.7	E		1	25	8	1.5	300	MEN03
1997 03 04.12		B	1.0	HD	5.0	B		7	20	S8	7	330	MOR04
1997 03 04.14		M	0.6	AA	3.0	R	4	7	17	6	4		MAI
1997 03 04.15		S	-0.3	AA	6.3	R	13	52	12	S9		317	KOS
1997 03 04.18	a	B	0.3	AA	0.7	E		1		8	10	325	BOU
1997 03 04.21		S	0.1	AA	5.0	B		8	40	8	4	320	BEA
1997 03 04.22	!	B	0.4	YF	0.5	E		1		8	6	325	ENT
1997 03 04.23	a	B	0.5	AT	3.5	R		1					PER01
1997 03 04.23	a	G	0.4	AT	0.0	E		1					PER01
1997 03 04.23	a	G	0.6	AT	0.0	E		1					VIT01
1997 03 04.23	a	I	0.3	AT	0.0	E		1		6	12	300	PER01
1997 03 04.23	a	I	0.6	AT	0.0	E		1			15	295	VIT01
1997 03 04.24	a	B	0.6	AT	3.5	R		1					VIT01
1997 03 04.26		S	0.7	AA	5.0	B		10	35	D7	2.5	312	TAY
1997 03 04.67	w	M	0.4	SC	0.0	E		1			&5.5		OME
1997 03 04.68		B	1.0	HD	5.0	B		7	18	S8	4		MOR04
1997 03 04.74	a	O	0.5	S	0.0	E		1	30		2.5		LIB
1997 03 04.74	w	B	-0.1	AA	0.0	E		1		7	9	318	CHE03
1997 03 04.78		S	0.2	AA	5.0	B		10	14	7	10	330	MOE
1997 03 04.80	!	S	0.5	SC	0.0	E		1	21	D8	7	320	SHI
1997 03 04.82		B	0.6	AA	0.0	E		1	&15	7	10	320	MIY01
1997 03 04.82		B	0.6:	AA	5.0	B		7	10	S7	10	320	MIY01
1997 03 04.82		I	0.6	S	0.0	E		1			0.5	310	TOY
1997 03 04.82		S	0.3	AA	0.0	E		1	&15	7/	7	300	NAG08
1997 03 04.85	a	B	0.2	YG	0.0	E		1			4	300	NAK01
1997 03 04.85	a	B	0.3	AA	0.0	E		1					YOS02
1997 03 05.00		S	0.3	AA	11.0	L	7	32	16	6	5		IVA03
1997 03 05.06		I	0.2	AA	0.8	E		1	15	8	13	330	MOE
1997 03 05.06	w	S	-0.2	SC	0.0	E		1	50	5	14		BAR06
1997 03 05.10		G	0.6	AA	0.0	E		1	21	9	6	350	SER
1997 03 05.10		S	0.5	AA	6	R	10	16	18	6	3.5	295	ROM
1997 03 05.13		S	0.1	SC	0.6	E		1	15	8	7	310	OKS
1997 03 05.13	w	B	0.0	AA	0.0	E		1		6/			CHE03
1997 03 05.14		B	0.6	AA	2.0	B		2	9	8			KOZ
1997 03 05.14	a	M	0.0	AA	0.6	E		1		S8	14		MEY
1997 03 05.14	a	M	0.3	AA	5.0	B		10	13	S8			MEY
1997 03 05.15		S	-0.4	AA	6.3	R	13	52	12	S9		330	KOS
1997 03 05.15	a	M	0.0	S	5	R		1	40	7/	25	320	HOR02
1997 03 05.17	a	B	0.2	AA	0.7	E		1		8	9	324	BOU
1997 03 05.18		M	0.3	Y	10	B		25	20	6	1.5		HYN
1997 03 05.19					5.0	B		7	28	7	5	315	DIE02
1997 03 05.19		S	0.4	AA	0.0	E		1					DIE02
1997 03 05.19	!	V	0.2	YF	2.3	A	4 a	3	+29	8	>6	323	MIK
1997 03 05.25		S	0.2	AA	5.0	B		10	25	D7	5.5	320	TAY
1997 03 05.68		B	0.7	HD	5.0	B		7	15	S8	5		MOR04
1997 03 05.72		S	-0.1	SC	0.0	E		1	50	5	14		BAR06
1997 03 05.73	a	O	0.1	SP	0.0	E		1	35	6/	>8		ZNO
1997 03 05.74	w	B	-0.2	AA	0.0	E		1		6/	13	332	CHE03
1997 03 05.75					5.0	B		7	12	S7	10	322	VEL03
1997 03 05.81		S	0.0	AA	5.0	B		8	45	8	5	320	BEA
1997 03 05.82		I	0.6	S	0.0	E		1			0.5	310	TOY
1997 03 05.82	w	M	-0.1	YG	0.0	E		1			15	320	KIN
1997 03 05.83		B	0.6	AA	0.0	E		1	&10	7	25	315	MIY01
1997 03 05.83		B	0.6:	AA	5.0	B		7	10	S7	10	315	MIY01
1997 03 05.83	w	B	0.5	YG	0.0	E		1	&20	8	1.5	310	YOS04
1997 03 05.83	w	S	0.5	YG	2.4	B		10	15	S6	1.5	310	YOS04
1997 03 06.08		B	0.6	SC	7.0	B		40			8		CHA02
1997 03 06.08		G	0.2	AA	0.0	E		1		S7	12	323	VEL03
1997 03 06.08		S	0.3	AA	11.0	L	7	32	20	6	6		IVA03
1997 03 06.09		B	0.6	SC	7.0	B		40			7		PEN
1997 03 06.09		B	0.6	SC	7.0	B		40			9		GEN

Comet C/1995 O1 (Hale-Bopp) [cont.]

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1997 03 06.10		B	0.6	SC	7.0	B		40			8		GEN01
1997 03 06.10		I	-0.3	SC	0.0	E		1	32	S6	10	325	ISH03
1997 03 06.10	w	B	-0.2	AA	0.0	E		1	45	5	14		BAR06
1997 03 06.13		G	0.5	AA	0.0	E		1	20	8	6	319	GOL
1997 03 06.13		S	0.3	AA	6	R	10	16	19	6	6	305	ROM
1997 03 06.13		S	-1.0:	AA	6.0	B		20		8			SCU
1997 03 06.13	!	G	0.2	AA	0.7	E		1	14	8	3	306	SHA02
1997 03 06.13	w	B	-0.1	AA	0.0	E		1		6/	4	313	CHE03
1997 03 06.14		B	0.5	AA	3.0	B		7		6	6	339	CHV
1997 03 06.14		M	0.5	AA	3.0	R	4	7	18	6	5		MAI
1997 03 06.14	a	M	0.2	S	0.0	E		1	25	8	8		KON06
1997 03 06.15		B	0.2	Y	0.0	E		1	20	S7	20	330	SAR02
1997 03 06.15		B	0.6:	AA	5.0	B		7	10	D7	14	323	VEL03
1997 03 06.15		G	0.3	AA	0.0	E		1					VEL03
1997 03 06.15		S	-0.5	AA	6.3	R	13	52	14	S9		325	KOS
1997 03 06.15	a	M	-0.1	S	5	R		1	40	7/	25	330	HOR02
1997 03 06.15	w	B	0.9	SC	0.0	E		1		9			VEL02
1997 03 06.17		S	0.7	AA	0.7	E		1	17	S2			CSU
1997 03 06.18	a	M	-0.1	TI	5	R		1	25	8	5		DVO
1997 03 06.19	a	O	0.2	SP	0.0	E		1	30	7	>5	320	ZNO
1997 03 06.21		B	-0.2	SC	0.7	E		1		5	10		ROG02
1997 03 06.21		S	-0.1	AA	5.0	B		8	50	8	10	330	BEA
1997 03 06.23		B	-0.2:	YG	0.7	E		1		8	14		DAH
1997 03 06.23		B	-1.2	SC	6.3	R		53		7	9.5		POP01
1997 03 06.23	!	B	0.3	YF	0.5	E		1	16	8	8		ENT
1997 03 06.46	w	B	-0.1	YF	0.0	E		1	&15	S9	18	328	ADA03
1997 03 06.75	w	B	-0.2	AA	0.0	E		1	45	5	14		BAR06
1997 03 06.78		S	0.1	AA	5.0	B		10	13	8	9	330	MOE
1997 03 06.79			0.3	AA	0.6	E		1	20	9	3.0	325	GIL01
1997 03 06.81		I	0.5	S	0.0	E		1			1.5	310	TOY
1997 03 06.81		S	0.3	SC	0.7	E		1	15	9	3		MCK
1997 03 06.83	w	B	0.3	YG	0.0	E		1	&20	8	2	310	YOS04
1997 03 06.83	w	S	0.2	YG	2.4	B		10	15	S6	2	310	YOS04
1997 03 06.92					5.0	B		7	7	9	3.0	305	HEE
1997 03 06.92		S	0.5	YG	0.7	E		1					HEE
1997 03 07.01		B	0.6	SC	7.0	B		40			7		CHA02
1997 03 07.07		S	0.3	AA	11.0	L	7	32	20	6	6		IVA03
1997 03 07.11		B	0.6	SC	7.0	B		40			4		HAN04
1997 03 07.12		B	0.6	SC	7.0	B		40			7		GEN01
1997 03 07.13	a	S	0.4	AA	0.7	E		1	25	8	3.5	305	MEN03
1997 03 07.18	!	V	0.1	YF	2.3	A	4 a	5	+32	8	>6	325	MIK
1997 03 07.18	a	B	0.1	AA	0.7	E		1		8	12	325	BOU
1997 03 07.18	a	G	0.2	AA	0.6	E		1		S8/	8	325	KAM01
1997 03 07.19	s	M	0.0	SC	0.0	E		1	12	8			GLI
1997 03 07.22	w	G	-0.2	YF	0.0	E		1	&12	S9	11	70	ZEK
1997 03 07.26		B	0.0:	YG	0.7	E		1		8	13		DAH
1997 03 07.39	Gw	B	0.0	AA	0.0	E		1		8/	&5		GRE
1997 03 07.44	&	G	-0.1	SC	0.0	E		1	15	8	13	305	CRE01
1997 03 07.74	a	O	-0.1	SP	0.0	E		1	35	6/	14	325	ZNO
1997 03 07.74	w	B	-0.1	AA	0.0	E		1		6/	12	324	CHE03
1997 03 07.76	a	M	0.1	Y	0.0	E		1	20	7	3	330	HYN
1997 03 07.76	a	M	0.1	Y	10	B		25	20	7	4	330	HYN
1997 03 07.76	a	O	-0.3	Y	0.0	E		1	10	9	4		KYS
1997 03 07.77	a	O	0.4	S	0.0	E		1	30		3		LIB
1997 03 07.77	s	M	0.0:	SC	0.0	E		1					GLI
1997 03 07.78		S	0.0	AA	5.0	B		10	13	8	7	330	MOE
1997 03 07.81	a	M	0.3	S	0.0	E		1	25	8	8		KON06
1997 03 07.82	!	S	0.0	AA	0.0	E		1	&15	7/	10	330	NAG08
1997 03 07.84	a	B	-0.2	AA	0.0	E		1			12	330	YOS02
1997 03 07.99	w	B	-0.2	Y	0.0	E		1		8			GRE
1997 03 08.03		G	-0.5	AA	0.0	E		1	25	9	5	280	SER
1997 03 08.06		B	0.6	AA	5.0	B		7	11	D8	13	324	VEL03
1997 03 08.08		G	-0.1	AA	0.0	E		1	17	S8	13	324	VEL03
1997 03 08.09		G	-0.5	AA	0.0	E		1		8	5	322	GOL
1997 03 08.10		B	-0.3	AA	0.0	E		1	50	5	15		BAR06

Comet C/1995 O1 (Hale-Bopp) [cont.]

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1997 03 08.12		M	0.4	AA	3.0	R	4	7	18	6	5		MAI
1997 03 08.13	!	S	-0.7:	AA	0.0	E		1			10		ANZ
1997 03 08.13	a	M	-0.1	AA	0.6	E		1		S8	11		MEY
1997 03 08.13	w	B	-0.2	AA	0.0	E		1	22	6	6	308	CHE03
1997 03 08.14		B	-0.2	Y	0.0	E		1	15	S7/	25	330	SAR02
1997 03 08.14		S	-0.8	AA	6.3	R	13	52	14	S9		312	KOS
1997 03 08.15	a	M	0.1	S	0.0	E		1	20	8	10		KON06
1997 03 08.16		B	0.4	AA	0.0	E		1					STO
1997 03 08.16	a	M	0.3	S	0.0	E		1	30	9	7		ZIF
1997 03 08.16	a	M	-0.1	TI	5	R		1	25	8	15		DVO
1997 03 08.16	w	M	-0.2	Y	0.0	E		1	30	D8	15	340	CAN04
1997 03 08.17	a	M	0.3	S	0.0	E		1	25	8	11		FIA
1997 03 08.17	a	O	0.0	SP	0.0	E		1	30	7	16	335	ZNO
1997 03 08.17	w	B	0.1	AA	0.0	E		1		8	12	330	VAN06
1997 03 08.18	w	M	0.3	SC	0.0	E		1	12	7/	9		GLI
1997 03 08.19		S	-0.4	AA	5.0	B		8	40	8	10	330	BEA
1997 03 08.20		S	0.8	SC	6.3	B		9	4	7	6		DIN01
1997 03 08.21		M	0.1	Y	10	B		25	25	7	2	320	HYN
1997 03 08.22		M	-0.2	S	5.0	B		7	15	S8/	9		GON05
1997 03 08.25		B	0.5	SC	8.0	B		11		D6			BRO06
1997 03 08.26		B	-0.1	YG	0.7	E		1		8	14		DAH
1997 03 08.45	w	M	0.0	YF	5.0	R		1					ADA03
1997 03 08.46	w	B	-0.1	YF	0.0	E		1	&18	S9	12	323	ADA03
1997 03 08.53	w	S	0.0	AA	5.0	B		7	8	8/	7	325	SPR
1997 03 08.70		B	0.2	HD	5.0	B		7	15	S8	4	330	MOR04
1997 03 08.78		S	-0.4	AA	5.0	B		8	40	8	10	330	BEA
1997 03 08.79	w	M	-0.2	Y	0.0	E		1	30	D8	3.5	320	CAN04
1997 03 08.80		B	-0.3	AA	0.0	E		1	50	5	15		BAR06
1997 03 08.81		I	0.0	S	0.0	E		1			8	330	TOY
1997 03 08.82					2.4	B		10	15	S6	4	305	YOS04
1997 03 08.82		B	0.0	AA	4.0	R		8	25	S7	9		BAR06
1997 03 08.82	!	S	0.0	SC	0.0	E		1	27	D7	9	325	SHI
1997 03 08.82	w	B	0.1	YG	0.0	E		1	&20	8	4	305	YOS04
1997 03 09.01		B	1.1	HD	5.0	B		7	20	S8	10	330	MOR04
1997 03 09.07		S	0.2	AA	11.0	L	7	32	25	6	7		IVA03
1997 03 09.10		B	0.0	HD	5.0	B		7	15	S7	10	331	LEH01
1997 03 09.10		M	0.0	AA	4.0	R		8	25	S7	9	333	BAR06
1997 03 09.12		B	-0.2	AA	0.0	E		1	45	6	14		BAR06
1997 03 09.12	w	B	-0.3	AA	0.0	E		1	45	6	14		BAR06
1997 03 09.13	w	M	-0.3	AA	0.0	E		1	30	6	12	324	CHE03
1997 03 09.14		B	-0.3	Y	0.0	E		1	12	S8	20	340	SAR02
1997 03 09.14	!	S	-0.4:	AA	0.0	E		1			13		ANZ
1997 03 09.16	w	B	0.0	AA	0.0	E		1		8	13	330	VAN06
1997 03 09.17	a	B	-0.1	AA	0.7	E		1		8	13	328	BOU
1997 03 09.17	a	M	-0.2	TI	5	R		1	25	8	6		DVO
1997 03 09.17	w	B	-0.2	S	0.0	E		1		9	12	335	MAR02
1997 03 09.18	!	V	-0.1	YF	2.3	A	4 a	3	+32	8	>6	325	MIK
1997 03 09.18	w	B	0.1	S	3.0	B		6		9	8.5	335	MAR02
1997 03 09.18	w	B	-0.1	S	0.0	E		1		9	9	330	SAN04
1997 03 09.21					5.0	B		7	20	7	4.5	320	DIE02
1997 03 09.21		S	0.1	AA	0.0	E		1					DIE02
1997 03 09.22		M	-0.4	S	5.0	B		7	15	S8/	13		GON05
1997 03 09.22	s	I	0.4	AT	0.0	E		1			10	310	VIT01
1997 03 09.23	s	G	0.6	AT	0.0	E		1					PER01
1997 03 09.23	s	G	0.6	AT	0.0	E		1					VIT01
1997 03 09.23	s	I	0.3	AT	0.0	E		1			18	310	PER01
1997 03 09.26	!	B	-0.2	YG	0.7	E		1		9	14		DAH
1997 03 09.38	w	B	-0.3	Y	0.0	E		1		8/	10		GRE
1997 03 09.40	&	G	-0.2	SC	0.0	E		1	15	8	10	305	CRE01
1997 03 09.74	w	B	-0.3	AA	0.0	E		1	25	6	6	312	CHE03
1997 03 09.75		B	0.6	AA	5.0	B		7	10	D8	12	327	VEL03
1997 03 09.75	a	B	-0.3	AA	0.0	E		1			5		MIL02
1997 03 09.75	a	M	-0.4	AA	0.0	E		1			5		MIL02
1997 03 09.76	a	O	-0.3:	Y	0.0	E		1	10	8	>3		KYS
1997 03 09.77		I	-0.5	SC	0.0	E		1	30	S7	13	330	ISH03

Comet C/1995 O1 (Hale-Bopp) [cont.]

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1997 03 09.77	w	B	-0.3	AA	0.0	E		1	45	6	14		BAR06
1997 03 09.78		S	-0.3	SC	8.0	B		12	30	S7	10	330	ISH03
1997 03 09.78	w	B	0.0	AA	4.0	R		8	25	S7	9	326	BAR06
1997 03 09.80		S	0.0	AA	5.0	B		7	13	8	8	330	MOE
1997 03 09.80	w	M	-0.2	Y	0.0	E		1	30	D8	3.5	320	CAN04
1997 03 09.81		I	0.2	S	0.0	E		1			2	330	TOY
1997 03 09.82	!	S	-0.1	AA	0.0	E		1	&15	7/	11	330	NAG08
1997 03 09.83					2.4	B		10	18	S6	4	305	YOS04
1997 03 09.83	w	B	-0.1	YG	0.0	E		1	&20	8	5	305	YOS04
1997 03 10.06		B	0.0	AA	5.0	B		7	13	D8	15	327	VEL03
1997 03 10.06		G	-0.1	AA	0.0	E		1			15	327	VEL03
1997 03 10.06		S	0.2	AA	11.0	L	7	32	25	6/	7		IVA03
1997 03 10.10		B	-0.1	HD	5.0	B		7	15	S7	10	333	LEH01
1997 03 10.11		B	0.3	AA	3.0	B		7		6	6.6	346	CHV
1997 03 10.12		B	0.5	AA	3.0	B		8	25	8/	4	322	SAL01
1997 03 10.13	w	B	-0.3	AA	0.0	E		1		6/	14	328	CHE03
1997 03 10.14		S	-1.0	AA	6.3	R	13	52	14	S9		340	KOS
1997 03 10.14	a	M	-0.2	AA	0.6	E		1		S8	12		MEY
1997 03 10.14	a	M	-0.4	S	5	R		1	35	7/	13	330	HOR02
1997 03 10.15	w	G	-0.4	AA	0.6	E		1		S8/	14	332	KAM01
1997 03 10.16	a	O	-0.1	SP	0.0	E		1	30	7	9	335	ZNO
1997 03 10.16	w	B	-0.4	AA	0.0	E		1	15	8	13	330	VAN06
1997 03 10.17	a	B	-0.1	AA	0.7	E		1		8	12	331	BOU
1997 03 10.17	a	B	-0.2	AT	0.0	E		1			6		MIL02
1997 03 10.17	w	G	-0.5	YF	0.0	E		1	&12	S9	11	70	ZEK
1997 03 10.18	!	V	-0.1	YF	2.3	A	4 a	3	+32	8	>6	325	MIK
1997 03 10.22	a	I	0.5	AT	0.0	E		1			12	310	VIT01
1997 03 10.23	a	G	0.7	AT	0.0	E		1					VIT01
1997 03 10.23	a	I	0.1	AT	0.0	E		1	>30	7	25	330	PER01
1997 03 10.24	a	G	0.4	AT	0.0	E		1					PER01
1997 03 10.25	!	B	-0.3	YG	0.7	E		1		9	24		DAH
1997 03 10.40	a	G	-0.4:	SC	0.0	E		1	18	8	>5	300	CRE01
1997 03 10.70		B	0.2	HD	3.5	B		7	18	S7/	9	332	HAR09
1997 03 10.71		G	-1.0:	Y	0.0	E		1		8			MOS03
1997 03 10.74					5.0	B		7	17	D8	&8	329	VEL03
1997 03 10.74	w	M	-0.5	AA	0.0	E		1		6/	8	301	CHE03
1997 03 10.75		B	0.4	AA	3.0	B		7		7	6.5	342	CHV
1997 03 10.76	!	S	-0.4:	AA	0.0	E		1					ANZ
1997 03 10.76	a	M	0.0	S	0.0	E		1	20	8	14		KON06
1997 03 10.77	a	M	-0.3	S	5	R		1	30	7/	8	330	HOR02
1997 03 10.77	a	O	0.3	S	0.0	E		1	35		3		LIB
1997 03 10.78		S	-0.2	AA	5.0	B		10	15	8	11	335	MOE
1997 03 10.79		S	-0.2	SC	0.7	E		1	15		>4		MCK
1997 03 10.79	!	G	0.9	AA	0.7	E		1	9	8	0.5	305	SHA02
1997 03 10.80		S	1.2	AA	7.0	B		16	10	6	1.2	340	TAY
1997 03 10.81					2.4	B		10	15	S6	3	310	YOS04
1997 03 10.81		I	0.6	S	0.0	E		1			1	310	TOY
1997 03 10.81	a	B	0.2	YG	0.0	E		1	&15	8	3	310	YOS04
1997 03 10.82	!	S	-0.3	SC	0.0	E		1	32	D7	9	330	SHI
1997 03 11.00		S	0.2	AA	11.0	L	7	32	25	6/	7		IVA03
1997 03 11.07		B	-0.2	HD	5.0	B		7	15	S8	7	335	MOR04
1997 03 11.08		S	0.2	AA	6	R	10	16	19	7	6	305	ROM
1997 03 11.10		B	-0.2	HD	5.0	B		7	15	S7	10	334	LEH01
1997 03 11.11		B	0.4	AA	3.0	B		8	23	9	4	322	SAL01
1997 03 11.11		B	0.4	AA	5.0	B		7		D8	15	330	VEL03
1997 03 11.11		S	-0.8	AA	6.0	B		20		8			SCU
1997 03 11.12		M	0.3	AA	3.0	R	4	7	18	6	5		MAI
1997 03 11.12	w	B	0.0	AA	4.0	R		8	30	S7	10		BAR06
1997 03 11.12	w	B	-0.3	AA	0.0	E		1	45	5	16		BAR06
1997 03 11.13		B	0.0	AA	2.0	B		2	9	8	10.5	336	KOZ
1997 03 11.13	w	B	-0.5	AA	0.0	E		1	24	6/	18	333	CHE03
1997 03 11.14		S	-1.1	AA	6.3	R	13	52	14	S9		352	KOS
1997 03 11.14	!	B	-0.3	Y	0.0	E		1	13	S7/	3	305	SAR02
1997 03 11.14	a	G	-0.2	AA	0.8	E		1			6.6	325	HAS02
1997 03 11.14	a	I	-0.4	AA	0.8	E		1			13.8	335	HAS02

Comet C/1995 O1 (Hale-Bopp) [cont.]

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1997 03 11.14	a	M	-0.1	AA	0.6	E		1		S8	13		MEY
1997 03 11.15	a	M	-0.4	S	5	R		1	35	7/	13	330	HOR02
1997 03 11.16		M	-0.2	Y	10	B		25	35		3.5		HYN
1997 03 11.16		S	0.3	AA	0.7	E		1	17	S2	13	346	CSU
1997 03 11.16	w	B	-0.6	AA	0.0	E		1	15	8	13	330	VAN06
1997 03 11.17	!	V	-0.1	YF	2.3	A	4 a	3	+32	8	>6		MIK
1997 03 11.17	a	O	-0.3	SP	0.0	E		1	25	8	12	335	ZNO
1997 03 11.20	!	B	0.2	YF	0.5	E		1	18	8	7	325	ENT
1997 03 11.21		B	1.0	AA	4.0	B		8	15	6	2.2	330	TAY
1997 03 11.21		B	-0.5	SC	0.7	E		1		5	6		ROG02
1997 03 11.24		B	-0.3:	YG	0.7	E		1		8	17		DAH
1997 03 11.42	a	G	-0.4	SC	0.0	E		1	12	9	15	320	CRE01
1997 03 11.51	w	S	0.1	AA	5.0	B		7	9	8/	8	325	SPR
1997 03 11.70		B	0.0	HD	3.5	B		7	15	S7/	6	333	HAR09
1997 03 11.72		I	-0.6	SC	0.0	E		1	30	S7	15	335	ISH03
1997 03 11.74	a	M	-0.3	Y	0.0	E		1			3		HYN
1997 03 11.74	w	B	-0.4	AA	0.0	E		1		6/			CHE03
1997 03 11.76		B	0.2	AA	0.0	E		1					STO
1997 03 11.76	a	O	-0.3	SP	0.0	E		1	25	8	16	335	ZNO
1997 03 11.77		B	0.4	AA	3.0	B		7		6	8		CHV
1997 03 11.77	a	M	-0.3	S	5	R		1	30	7/	13	340	HOR02
1997 03 11.77	a	M	-0.3	S	5	R		1	40	7/	15	335	PLS
1997 03 11.77	a	O	0.2	S	0.0	E		1	40		4		LIB
1997 03 11.78	a	M	0.0	S	0.0	E		1	20	8	14		KON06
1997 03 11.78	w	B	-0.2	AA	0.0	E		1	50	5	16		BAR06
1997 03 11.79		S	0.0	SC	0.7	E		1	20	9	>5		MCK
1997 03 11.79	w	M	0.0	AA	4.0	R		8	30	S7	10		BAR06
1997 03 11.80	!	G	0.3	AA	0.7	E		1	4	8	4	308	SHA02
1997 03 11.81	!	S	-0.2	AA	0.0	E		1	&15	7/	5	300	NAG08
1997 03 11.81	w	M	-0.3	Y	0.0	E		1	25	D8	4	320	CAN04
1997 03 11.85	a	B	-0.3	YG	0.0	E		1			3	325	NAK01
1997 03 11.99	—	S	0.2	AA	11.0	L	7	32	25	6/	7		IVA03
1997 03 12.07		B	-0.3	HD	5.0	B		7	18	S8	5	336	MOR04
1997 03 12.08		S	0.2	AA	6	R	10	16	20	6	7	315	ROM
1997 03 12.10		B	-0.3	HD	5.0	B		7	15	S7	10	335	LEH01
1997 03 12.10		B	-0.3	HD	5.0	B		7	20	S8	10	335	MOR04
1997 03 12.10	w	B	-0.3	AA	0.0	E		1	50	5	16		BAR06
1997 03 12.10	w	M	-0.1	AA	4.0	R		8	35	S7	10		BAR06
1997 03 12.11		M	0.3	AA	3.0	R	4	7	20	6	5		MAI
1997 03 12.12		B	0.5	AA	3.0	B		7		6	9.5		CHV
1997 03 12.12		S	-0.5	AA	6.0	B		20		8			SCU
1997 03 12.13	w	B	-0.9	SC	0.0	E		1		8			RAD01
1997 03 12.14		S	-0.1	SC	0.6	E		1	12	8/	10	300	OKS
1997 03 12.14	a	M	-0.1	AA	0.6	E		1		S8	8		MEY
1997 03 12.14	a	M	-0.4	S	5	R		1	40	7/	17	340	HOR02
1997 03 12.15	a	G	-0.2	AA	0.8	E		1			5.9	330	HAS02
1997 03 12.15	a	I	-0.4	AA	0.8	E		1			12.5	350	HAS02
1997 03 12.15	a	M	-0.3	S	5	R		1	35	7/	10	335	PLS
1997 03 12.15	a	O	-0.3	SP	0.0	E		1	30	8	17	335	ZNO
1997 03 12.16	a	B	-0.4	AA	0.0	E		1		8	&5		MIL02
1997 03 12.16	s	G	-0.5	AA	0.6	E		1		S8/	11	326	KAM01
1997 03 12.17	!	V	-0.2	YF	2.3	A	4 a	3	+32	8	>6		MIK
1997 03 12.20	!	B	-0.1	YF	0.5	E		1	18	8	7	322	ENT
1997 03 12.22		M	-0.6	S	5.0	B		7	15	S8/	13		GON05
1997 03 12.23	a	B	0.4	AT	3.5	R		1					PER01
1997 03 12.23	a	B	0.4	AT	3.5	R		1					VIT01
1997 03 12.23	a	G	0.3	AT	0.0	E		1					PER01
1997 03 12.23	a	G	0.6	AT	0.0	E		1					VIT01
1997 03 12.23	a	I	0.3	AT	0.0	E		1			18	310	VIT01
1997 03 12.23	a	I	-0.1	AT	0.0	E		1			16	330	PER01
1997 03 12.41	w	B	-0.2	Y	0.0	E		1		8/	&5		GRE
1997 03 12.51	s	S	0.0	AA	0.0	E		1	10	9	8	320	SPR
1997 03 12.70		B	-0.3	HD	5.0	B		7	19	S8	10	340	MOR04
1997 03 12.75	a	O	-0.3	SP	0.0	E		1	22	8/	15	335	ZNO
1997 03 12.75	w	B	-0.7	SC	0.0	E		1		9			VAL01

Comet C/1995 O1 (Hale-Bopp) [cont.]

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1997 03 12.75	w	B	-0.8	SC	0.0	E		1		9			RAD01
1997 03 12.77	a	M	0.0	S	0.0	E		1	20	8	14		KON06
1997 03 12.77	a	M	-0.5	S	3	R		1	40	7/	8	335	PLS
1997 03 12.77	a	M	-0.5	S	5	R		1	30	7/	10	340	HOR02
1997 03 12.77	a	M	-0.5	Y	10	B		25	30	6	4	325	HYN
1997 03 12.77	a	O	0.1	S	0.0	E		1	35		4		LIB
1997 03 12.77	w	B	-0.2	AA	0.0	E		1	50	5	16		BAR06
1997 03 12.78	w	M	0.0	AA	4.0	R		8	35	S7	9		BAR06
1997 03 12.79		S	-0.5	SC	0.7	E		1	30	6	3		MCK
1997 03 12.80	!	G	0.3	AA	0.7	E		1	6	8	3.5	320	SHA02
1997 03 12.80	a	O	-0.2:	Y	0.0	E		1	15	9	>2		KYS
1997 03 12.83	w	B	-0.5:	AA	0.0	E		1		6/			CHE03
1997 03 12.99	w	B	-0.5	Y	0.0	E		1		8			GRE
1997 03 13.05		S	0.1	AA	11.0	L	7	32	30	6/	9		IVA03
1997 03 13.07		B	0.5	SC	7.0	B		40			5		CHA02
1997 03 13.08		B	1.6:	AA	5.0	B		7	9	6	3.3		HOM
1997 03 13.10		B	-0.3	HD	5.0	B		7	17	S7	10	340	LEH01
1997 03 13.10		B	-0.3	HD	5.0	B		7	19	S8	10	340	MOR04
1997 03 13.10		G	-1.5:	Y	0.0	E		1		8			MOS03
1997 03 13.11		M	0.3	AA	3.0	R	4	7	20	6	5		MAI
1997 03 13.13		B	0.4	SC	7.0	B		40			6		HAN04
1997 03 13.13		B	0.5	SC	7.0	B		40			6		GEN01
1997 03 13.14	a	M	-0.4	S	5	R		1	40	7/	17	340	HOR02
1997 03 13.15	!	S	-0.4	AA	0.0	E		1			13		ANZ
1997 03 13.15	w	M	-0.4	Y	0.0	E		1	30	D8	18	325	CAN04
1997 03 13.17	!	V	-0.3	YF	2.3	A	4 a	3	+32	8	>6		MIK
1997 03 13.20		B	-0.5	SC	0.7	E		1		5	7.5		ROG02
1997 03 13.23		B	-1.5	SC	6.3	R		53		7	10.5		POP01
1997 03 13.23	a	B	0.3	AT	3.5	R		1					PER01
1997 03 13.23	a	B	0.4	AT	3.5	R		1					VIT01
1997 03 13.23	a	G	0.2	AT	0.0	E		1					PER01
1997 03 13.23	a	G	0.4	AT	0.0	E		1					VIT01
1997 03 13.23	a	I	0.1	AT	0.0	E		1			24	335	VIT01
1997 03 13.23	a	I	-0.2	AT	0.0	E		1			28	335	PER01
1997 03 13.39	fw	B	-0.4	Y	0.0	E		1		8	&20		GRE
1997 03 13.66	a	M	-0.3	SC	0.0	E		1			20		OME
1997 03 13.70		B	-0.3	HD	5.0	B		7	15	S8	6	345	MOR04
1997 03 13.72	a	S	0.2	AA	0.7	E		1	20	8	3	320	MEN03
1997 03 13.75	w	B	-0.7	SC	0.0	E		1		9			RAD01
1997 03 13.82		S	-0.3	AA	5.0	B		10	15	8	7	345	MOE
1997 03 13.82		S	-0.5	SC	0.7	E		1	30	6	5		MCK
1997 03 13.99		S	0.1	AA	11.0	L	7	32	30	6/	9		IVA03
1997 03 13.99	fs	B	-0.5:	Y	0.0	E		1					GRE
1997 03 14.09		B	0.5	SC	7.0	B		40			5		HAN04
1997 03 14.10		B	-0.4	HD	5.0	B		7	15	S7	11	339	LEH01
1997 03 14.12		B	0.5	SC	7.0	B		40			6		GEN01
1997 03 14.16	a	B	-0.5	AA	0.0	E		1		8	18		MIL02
1997 03 14.22		S	0.6	SC	6.3	B		9	6	7	4		DIN01
1997 03 14.50	s	S	-0.0	AA	0.0	E		1	11	9	10	325	SPR
1997 03 14.70		B	-0.2	HD	3.5	B		7	15	S7/	6	338	HAR09
1997 03 14.70		B	-0.3	HD	5.0	B		7	15	S8			MOR04
1997 03 14.80	w	M	-0.4	Y	0.0	E		1	30	D8	4	325	CAN04
1997 03 15.10		B	-0.4	HD	5.0	B		7	16	S7	11	340	LEH01
1997 03 15.45	w	B	-0.5	YF	0.0	E		1		S8/	15	338	ADA03
1997 03 15.45	w	M	-0.3	YF	5.0	R		1					ADA03
1997 03 15.49	s	S	-0.3	AA	0.0	E		1	12	9/	10	325	SPR
1997 03 15.70		B	-0.3	HD	3.5	B		7	15	S7/	5	340	HAR09
1997 03 15.79	!	G	0.6	AA	0.7	E		1	10	8	2		SHA02
1997 03 15.85	!	B	-0.1	AA	4.0	B		8	25	6	4	354	TAY
1997 03 15.88		S	-0.4	AA	5.0	B		10	16	8	12	350	MOE
1997 03 15.95	w	B	-0.7	AA	0.0	E		1		6/	8	330	CHE03
1997 03 15.99	fw	B	-0.5	Y	0.0	E		1		8	&2		GRE
1997 03 16.06		S	0.0	AA	11.0	L	7	32	30	6/	10		IVA03
1997 03 16.10	!	B	-0.6	YG	0.7	E		1		8/	14		SKI
1997 03 16.12	!	B	-0.2	YG	0.7	E		1		8/	13	340	GRA04

Comet C/1995 O1 (Hale-Bopp) [cont.]

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1997 03 16.12	!	N	1.8	YG	5.0	B		10	17	8	13		GRA04
1997 03 16.16	!	S	0.0	AA	0.7	E		1	25	8	3	320	MEN03
1997 03 16.17	!	S	-0.5	AA	0.0	E		1					ANZ
1997 03 16.17	!	V	-0.3	YF	2.3	A	4 a	3	+32	8	>6		MIK
1997 03 16.22	a	B	0.1	AT	3.5	R		1					VIT01
1997 03 16.22	a	G	0.3	AT	0.0	E		1					PER01
1997 03 16.22	a	G	0.3	AT	0.0	E		1					VIT01
1997 03 16.23	a	B	0.3	AT	3.5	R		1					PER01
1997 03 16.23	a	I	-0.4	AT	0.0	E		1			12	310	VIT01
1997 03 16.23	ra	I	-0.4	AT	3.4	B		9					PER01
1997 03 16.23	a	I	-0.6	AT	0.0	E		1			16	310	PER01
1997 03 16.38	w	B	-0.6	Y	0.0	E		1		8	15		GRE
1997 03 16.75					5.0	B		7	14	D7	&7	339	VEL03
1997 03 16.80	w	M	-0.5	Y	0.0	E		1	30	D8	6	320	CAN04
1997 03 16.83	!	B	-0.2	YG	0.7	E		1		8/	13	340	GRA04
1997 03 16.88	!	B	0.4	AA	7.0	B		16	10	D6	5	334	TAY
1997 03 16.97	!	B	-0.7:	YG	0.7	E		1		8/	5		SKI
1997 03 16.99	!	N	1.7	YG	5.0	B		10	15	7/			GRA04
1997 03 16.99	!	N	4.8	YG	20.3	T	10	123					GRA04
1997 03 16.99	w	B	-0.4	Y	0.0	E		1		8			GRE
1997 03 17.03	a	G	-0.6:	SC	0.0	E		1	15	9	4	330	CRE01
1997 03 17.08		B	0.8:	AA	5.0	B		7	9	6	6.7		HOM
1997 03 17.08	w	B	-0.5	AA	0.0	E		1	60	5	16		BAR06
1997 03 17.09	w	M	-0.2	AA	4.0	R		8	35	S7	10		BAR06
1997 03 17.10	w	M	-0.8	AA	0.0	E		1	25	7	14	350	CHE03
1997 03 17.13		B	-0.3	AA	2.0	B		2	12	8	9	354	KOZ
1997 03 17.13		G	-0.2	AA	0.0	E		1	19	D8	14	342	VEL03
1997 03 17.15	!	G	0.5	LN	0.7	E		1	10	8	2	314	SHA02
1997 03 17.15	a	B	-0.4	AA	0.7	E		1		8			BOU
1997 03 17.17	!	G	0.3	LN	0.8	E		1	12	8	10	341	SHA02
1997 03 17.20		B	-0.9	SC	0.7	E		1		5	7		ROG02
1997 03 17.22	a	B	0.4	AT	3.5	R		1					VIT01
1997 03 17.22	a	G	0.2	AT	0.0	E		1					PER01
1997 03 17.22	a	G	0.3	AT	0.0	E		1					VIT01
1997 03 17.22	a	I	-0.5	AT	0.0	E		1					VIT01
1997 03 17.22	a	I	-0.5	AT	0.0	E		1			10	300	PER01
1997 03 17.23		B	-0.2	AA	5.0	B		7	12	D8	15	342	VEL03
1997 03 17.23	a	B	0.3	AT	3.5	R		1					PER01
1997 03 17.23	ra	I	-0.5	AT	3.4	B		9					PER01
1997 03 17.38	fw	B	-0.6	Y	0.0	E		1		8/	&15		GRE
1997 03 17.70		B	-0.4	HD	3.5	B		7	15	S7/	5	340	HAR09
1997 03 17.70	w	B	-0.9	SC	0.0	E		1		9			RAD01
1997 03 17.74					5.0	B		7	12	D8	&6	346	VEL03
1997 03 17.74		G	0.0	HD	0.0	E		1	20	8	6		BRU
1997 03 17.75		B	-0.5	HD	5.0	B		7	19	S8	5	340	MOR04
1997 03 17.79	a	M	-0.7	S	5	R		1	30	7/	8	320	HOR02
1997 03 17.79	a	O	-0.1	S	0.0	E		1	40		5		LIB
1997 03 17.79	a	O	-0.5	SP	0.0	E		1	40	8	11	345	ZNO
1997 03 17.80	w	B	-0.7	AA	0.0	E		1	60	5	16		BAR06
1997 03 17.80	w	M	-0.6	Y	0.0	E		1	30	D8	6.5	320	CAN04
1997 03 17.81	!	S	-0.4	AA	0.0	E		1	&15	7/	12	350	NAG08
1997 03 17.81	w	M	-0.3	AA	5.0	B		7	35	S7	10		BAR06
1997 03 17.82		S	-0.5	AA	5.0	B		10	16	8	11	350	MOE
1997 03 17.82	!	B	-0.6	YG	0.7	E		1		8	7		SKI
1997 03 17.83		M	-0.6	AA	0.0	E		1	&20	8	&4	320	PAL02
1997 03 17.84	!	S	-0.5	YG	0.7	E		1					HEE
1997 03 18.01	!	B	-0.3	YG	0.7	E		1		8/	6	330	GRA04
1997 03 18.09		B	-0.5	HD	5.0	B		7	16	S8	11	340	MOR04
1997 03 18.10		S	0.0	AA	6	R	10	16	21	8	7	310	ROM
1997 03 18.13		S	-1.5	AA	6.3	R	13	52	15	S9		353	KOS
1997 03 18.14	w	M	-0.7	Y	0.0	E		1	25	D8	20	320	CAN04
1997 03 18.15	a	M	-0.6	S	5	R		1	30	7/	15	345	HOR02
1997 03 18.15	a	M	-0.6	TI	5	R		1	35	8	8	295	DVO
1997 03 18.20		S	0.0	SC	3.0	B		8		7	10	45	DIN01
1997 03 18.21		M	-0.7	S	5.0	B		7	20	S8/	15		GON05

Comet C/1995 O1 (Hale-Bopp) [cont.]

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1997 03 18.22	a	B	-0.2	AT	3.5	R		1					PER01
1997 03 18.22	a	G	0.2	AT	0.0	E		1					PER01
1997 03 18.22	a	I	-0.6	AT	0.0	E		1			11	315	PER01
1997 03 18.22	ra	I	-0.6	AT	3.4	B		9					PER01
1997 03 18.38	a	B	-0.6	Y	0.0	E		1		8/	&5		GRE
1997 03 18.72	!	B	-0.5	AA	0.7	E		1	20	8	2.5	325	MEN03
1997 03 18.74		B	0.6:	AA	3.0	B		7		6			CHV
1997 03 18.75		B	0.3	SC	3.5	R	5	30	5.5	8/	2.67	319	APE
1997 03 18.76	a	O	-0.5:	Y	5.0	B		7	15	8	>3		KYS
1997 03 18.84	a	B	-0.7	AA	0.0	E		1	20	7	9	345	CHE03
1997 03 19.05	!	B	-0.4	YG	0.7	E		1		8	6		GRA04
1997 03 19.05	!	N	1.6	YG	5.0	B		10	&15	7/	9	347	GRA04
1997 03 19.08		B	-0.6	HD	5.0	B		7	16	S8	12	352	MOR04
1997 03 19.10		S	-0.1	AA	6	R	10	16	21	8	7	310	ROM
1997 03 19.13		G	-0.5	AA	0.0	E		1			15	344	VEL03
1997 03 19.16	!	B	-0.5	YG	0.7	E		1		8/	7		SKI
1997 03 19.19		S	-1.0	AA	5.0	B		8	40	8	10	335	BEA
1997 03 19.80	!	G	0.2	SC	0.7	E		1	12	8	2	323	SHA02
1997 03 19.80	!	G	0.6	SC	5.0	B		7	12	8	2.2	323	SHA02
1997 03 19.80	w	M	-0.8	Y	0.0	E		1	30	D8	7	325	CAN04
1997 03 19.81	a	B	-0.8	AA	0.0	E		1	22	7	6	308	CHE03
1997 03 19.84	!	B	-0.3	AA	4.0	B		8	12	D6	3.2	315	TAY
1997 03 19.84	!	B	-0.7	YG	0.7	E		1		8/	12	346	SKI
1997 03 19.91		S	-1.0	AA	5.0	B		8	40	8	5	335	BEA
1997 03 19.99	fs	B	-0.5:	Y	0.0	E		1		8	&2.5		GRE
1997 03 20.04		S	-0.2	AA	11.0	L	7	32	30	6/	7		IVA03
1997 03 20.17	!	B	-0.3	YG	0.7	E		1		8/	4		GRA04
1997 03 20.17	!	N	1.7	YG	5.0	B		10		8	12		GRA04
1997 03 20.18	!	N	5.0	YG	20.3	T	10	123					GRA04
1997 03 20.45	w	B	-0.9	AE	0.0	E		1		S9	10	350	ADA03
1997 03 20.45	w	M	-0.6	AE	5.0	R		1					ADA03
1997 03 20.77		S	-0.2	AA	5.0	B		10	50	7	1.1	325	FOG
1997 03 20.78	a	O	-0.7	SP	0.0	E		1	35	8/	8	315	ZNO
1997 03 20.80	w	B	-0.6	AA	0.0	E		1	70	5			BAR06
1997 03 20.81	w	M	-0.3	AA	4.0	R		8	40	S7	8		BAR06
1997 03 20.90		I	-0.6	AA	0.8	E		1	15	8	7	340	MOE
1997 03 20.90		S	-1.1	AA	5.0	B		8	40	8	10	335	BEA
1997 03 21.04	s	G	-0.8	SC	0.0	E		1	20	9	5	330	CRE01
1997 03 21.06	!	B	-0.9	YG	0.7	E		1		8/	5		SKI
1997 03 21.10	a	I	-0.5	AA	0.8	E		1					HAS02
1997 03 21.10	w	M	-0.3	AA	4.0	R		8	40	S7	8		BAR06
1997 03 21.11	!	B	-0.3	YG	0.7	E		1		8	6		GRA04
1997 03 21.12	!	N	1.6	YG	5.0	B		10	15	8	12	352	GRA04
1997 03 21.12	w	B	-0.6	AA	0.0	E		1	70	5			BAR06
1997 03 21.21		M	-0.8	S	5.0	B		7	20	S8/	12		GON05
1997 03 21.38	w	B	-0.8	Y	0.0	E		1		8	&5		GRE
1997 03 21.75	!	M	-0.6	Y	0.0	E		1	13	S7	4	340	SAR02
1997 03 21.75	w	B	-0.5	AA	0.0	E		1	60	5			BAR06
1997 03 21.76	a	B	-0.7	AA	0.0	E		1			5		MIL02
1997 03 21.76	a	M	-0.7:	AA	0.0	E		1		6/			CHE03
1997 03 21.78		G	-0.1	AA	0.0	E		1	25	9	4	330	SER
1997 03 21.80		G	0.3:	SC	0.7	E		1	10	8	&2		SHA02
1997 03 21.80		S	-0.6	AA	5.0	B		10	16	8	8	340	MOE
1997 03 21.80	!	B	-0.4	YG	0.7	E		1		8/	6		GRA04
1997 03 21.80	!	N	1.6	YG	5.0	B		10	15	7/	6	336	GRA04
1997 03 21.80	a	M	-0.7	SC	0.0	E		1	15	8	4	315	GLI
1997 03 21.80	w	M	-0.3	AA	4.0	R		8	40	S7	9		BAR06
1997 03 21.80	w	M	-1.0	Y	0.0	E		1	25	D8	8	330	CAN04
1997 03 21.82		S	-1.2	AE	5.0	B		8	40	8	5	340	BEA
1997 03 21.84					5.0	B		7	15	7	5.5	332	DIE02
1997 03 21.84		S	-0.3	AA	0.0	E		1					DIE02
1997 03 21.84	a	B	-0.6	AA	0.7	E		1		8			BOU
1997 03 22.10	w	M	-0.2:	AA	4.0	R		8	40	S7	10		BAR06
1997 03 22.12	w	B	-0.5:	AA	0.0	E		1	60	5			BAR06
1997 03 22.14	a	B	-0.7	AA	0.7	E		1		8	11	328	BOU

Comet C/1995 O1 (Hale-Bopp) [cont.]

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1997 03 22.16	s	M	-0.5	SC	0.0	E		1	15	8	15	320	GLI
1997 03 22.20	a	S	-0.7	AA	0.0	E		1	7	9	14	325	SPR
1997 03 22.21		M	-0.6	S	5.0	B		7	20	S8/	7		GON05
1997 03 22.76	a	G	-0.2	AA	0.0	E		1	20	9			NEV
1997 03 22.79		I	-0.9	SC	0.0	E		1	35	S7	>10	15	ISH03
1997 03 22.79		S	-0.5	AA	5.0	B		10	18	8	8	340	MOE
1997 03 22.79	s	M	-0.7	SC	0.0	E		1	12	8	7	330	GLI
1997 03 22.81	a	G	-0.4	AA	0.6	E		1		S8/	&6	326	KAM01
1997 03 22.81	w	M	-1.1	Y	0.0	E		1	25	D8	7	325	CAN04
1997 03 22.82	a	O	-0.7	SP	0.0	E		1	30	8/	6	320	ZNO
1997 03 22.83	a	M	-0.9:	AA	0.0	E		1	22	6/			CHE03
1997 03 22.88	!	B	-0.6	YG	0.7	E		1		8/	7		SKI
1997 03 22.89	!	B	0.3	AA	4.0	B		8	18	D6	3	351	TAY
1997 03 23.00	!	M	-0.7	YG	0.7	E		1		8/	5		GRA04
1997 03 23.00	!	N	1.5	YG	5.0	B		10	15		5	355	GRA04
1997 03 23.08	w	M	-0.1:	AA	4.0	R		8	40	S7	10		BAR06
1997 03 23.11	w	B	-0.4:	AA	0.0	E		1	50	5			BAR06
1997 03 23.15	a	O	-0.2:	Y	5.0	B		7	15	9	8		KYS
1997 03 23.16	a	O	-0.6	Y	0.0	E		1	15	9	8		KYS
1997 03 23.38	w	B	-0.8	Y	0.0	E		1		8	&5		GRE
1997 03 23.73	w	B	-0.4	SC	0.0	E		1		8			RAD01
1997 03 23.74					5.0	B		7	13	D8	&6	351	VEL03
1997 03 23.74		G	-0.7	AA	0.0	E		1	18	D8			VEL03
1997 03 23.76	a	O	-0.4	S	0.0	E		1	40		8		LIB
1997 03 23.77	a	O	-0.7	SP	0.0	E		1	25	8	11	2	ZNO
1997 03 23.78	w	B	-0.5:	AA	0.0	E		1	50	5			BAR06
1997 03 23.79	a	M	-0.8	S	5	R		1	30	7/	5	340	PLS
1997 03 23.80	w	M	-0.2:	AA	4.0	R		8	40	S7	9		BAR06
1997 03 23.83	a	M	-0.6	TI	5	R		1	30	7	3	295	DVO
1997 03 24.02	w	B	-0.6	Y	0.0	E		1		8	&2.5		GRE
1997 03 24.04	w	G	-0.8	SC	0.0	E		1	20	9	6	340	CRE01
1997 03 24.07	w	M	-0.2:	AA	4.0	R		8	30	S7	9		BAR06
1997 03 24.18	a	S	-0.5	AA	0.0	E		1	10	9	9	320	SPR
1997 03 24.38	a	B	-0.6	Y	0.0	E		1		8	&4		GRE
1997 03 24.78		S	0.3	AA	0.7	E		1	17	S2/	32	342	CSU
1997 03 24.80		I	-1.0	SC	0.0	E		1	35	S7	>10	17	ISH03
1997 03 24.84	!	B	0.2	AA	4.0	B		8	24	D6	3.2	12	TAY
1997 03 24.86	!	B	-0.3:	YG	0.7	E		1		8	5.5		SKI
1997 03 24.86	!	M	-0.6	YG	0.7	E		1		8/	6		GRA04
1997 03 24.86	!	N	1.7	YG	5.0	B		10	20	8	6	345	GRA04
1997 03 24.97	!	G	-0.3	SC	0.7	E		1	10	8	2.6	349	SHA02
1997 03 25.00	fw	B	-0.6	Y	0.0	E		1		8	&4		GRE
1997 03 25.07		N	4.9	YG	20.3	T	10	80					GRA04
1997 03 25.12	a	B	-0.5:	AA	0.0	E		1	40	6			BAR06
1997 03 25.12	a	M	-0.4:	AA	4.0	R		8	20	S7			BAR06
1997 03 25.74	w	B	-0.5	SC	0.0	E		1		9			VEL02
1997 03 25.75	a	G	-0.2	AA	0.0	E		1	23	9	8	357	NEV
1997 03 25.75	w	B	-0.6	SC	0.0	E		1		9			RAD01
1997 03 25.77	a	B	-1.0:	AA	0.0	E		1			4		MIL02
1997 03 25.79	a	B	-0.6	AA	0.0	E		1	40	5			BAR06
1997 03 25.79	a	M	-1.2	AA	0.0	E		1		7	15	0	CHE03
1997 03 25.80		M	-0.8	AA	0.0	E		1	&20	8	&5	320	PAL02
1997 03 25.80	a	M	-0.4:	AA	4.0	R		8	23	S8			BAR06
1997 03 25.84		M	-1.1	S	5.0	B		7	20	S8/	10		GON05
1997 03 25.84		S	-0.5:	S	0.7	E		1			6	348	THO03
1997 03 26.12	a	B	-0.5:	AA	0.0	E		1	35	6			BAR06
1997 03 26.12	a	M	-0.3:	AA	4.0	R		8	22	S7			BAR06
1997 03 26.12	w	M	-1.0	Y	0.0	E		1	25	D8	6	330	CAN04
1997 03 26.75	a	G	0.0	AA	0.0	E		1	23	9	8	358	NEV
1997 03 26.75	w	B	-0.6	SC	0.0	E		1		8			RAD01
1997 03 26.76	a	B	-0.6	AA	0.0	E		1	40	6			BAR06
1997 03 26.76	a	M	-0.5	AA	4.0	R		8	20	S7			BAR06
1997 03 26.77					5.0	B		7	18	D8	10	4	VEL03
1997 03 26.77		G	-0.9	AA	0.0	E		1					VEL03
1997 03 26.77		S	0.0	AA	0.7	E		1	17	S2/			CSU

Comet C/1995 O1 (Hale-Bopp) [cont.]

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1997 03 26.79	a	S	-0.7	SC	0.6	E		1	20	8/	>10	345	OKS
1997 03 26.81	a	M	-1.2	AA	0.0	E		1	20	7	8	343	CHE03
1997 03 26.83		B	-0.8	S	0.0	E		1	15	9	10	5	MAR02
1997 03 26.84		S	-0.5:	S	0.7	E		1			6	345	THO03
1997 03 26.84	!	B	-0.4	AA	4.0	B		8	21	7	3.5	345	TAY
1997 03 26.84	w	G	-0.9	AT	0.0	E		1					PER01
1997 03 26.84	w	I	0.0	AT	0.0	E		1			10	10	VIT01
1997 03 26.85		M	-1.1	S	5.0	B		7	20	S8/	14		GON05
1997 03 26.85		S	-1.4	AE	5.0	B		8	40	8	11	350	BEA
1997 03 26.85	!	B	-0.7	YG	0.7	E		1		8	16	1	SKI
1997 03 26.85	w	B	-0.4	AT	3.5	R		1					VIT01
1997 03 26.85	w	B	-0.5	AT	3.5	R		1					PER01
1997 03 26.85	w	G	-1.1	AT	0.0	E		1					VIT01
1997 03 26.85	rw	I	-1.0	AT	3.4	B		9					PER01
1997 03 26.85	w	I	-1.3	AT	0.0	E		1			10	5	PER01
1997 03 26.85	w	M	-1.1	Y	0.0	E		1	25	D8	9	330	CAN04
1997 03 26.86	!	M	-0.6	YG	0.7	E		1		8/	15	7	GRA04
1997 03 26.87	!	N	1.5	YG	5.0	B		10	27	8	15		GRA04
1997 03 26.91	!	G	-0.2	SC	0.7	E		1	10	7	5.5	347	SHA02
1997 03 27.06	a	G	-0.8	SC	0.0	E		1	20	9	14	0	CRE01
1997 03 27.14	a	B	-0.8	AA	0.7	E		1		8	9.5	337	BOU
1997 03 27.16	a	S	-0.8	AA	0.0	E		1	18	9	14	330	SPR
1997 03 27.26	w	M	-0.7	SC	0.0	E		1			20		OME
1997 03 27.74		B	-0.7	SC	6.3	R		34			3		HAN04
1997 03 27.74		B	-1.0	AA	8.0	B		12	15	9	2.5	340	MEN03
1997 03 27.75		B	-0.7	SC	6.3	R		34			4		FIL06
1997 03 27.75		B	-0.7	SC	6.3	R		34			4		GEN
1997 03 27.76		G	-0.8	AA	0.0	E		1	15	D8	11	2	VEL03
1997 03 27.76	a	B	-0.6	AA	0.0	E		1	40	6	15	5	BAR06
1997 03 27.76	a	M	-0.5	AA	4.0	R		8	20	S7			BAR06
1997 03 27.81		M	-1.0	AA	0.0	E		1	&20	8	10	320	PAL02
1997 03 27.81		S	-0.6	AA	5.0	B		10	22	8	14	10	MOE
1997 03 27.82	w	M	-1.2	Y	0.0	E		1	25	D8	11	335	CAN04
1997 03 27.83		B	-1.8	SC	6.3	R		53		7	12.5		POP01
1997 03 27.83	!	V	-0.5	YF	3.2	A	3 a	1	+34	8	>7		MIK
1997 03 27.85		B	-1.0	S	0.0	E		1	20	9	16	5	MAR02
1997 03 27.85		M	-1.1	S	5.0	B		7	20	S8/	16		GON05
1997 03 27.85	a	B	-0.6	AT	3.5	R		1					VIT01
1997 03 27.85	a	B	-0.7	AT	3.5	R		1					PER01
1997 03 27.85	a	G	-1.2	AT	0.0	E		1					PER01
1997 03 27.85	a	G	-1.2	AT	0.0	E		1					VIT01
1997 03 27.85	ra	I	-0.8	AT	3.4	B		9					PER01
1997 03 27.85	a	I	-1.0	AT	0.0	E		1			10		VIT01
1997 03 27.85	a	I	-1.5	AT	0.0	E		1			10		PER01
1997 03 27.86		B	-0.7	SC	6.3	R		34			4		KOJ01
1997 03 27.89	!	B	-0.9	YG	0.7	E		1		8	15		SKI
1997 03 27.89	a	O	-0.3	S	0.0	E		1	40		3		LIB
1997 03 27.90	!	M	-0.8	YG	0.7	E		1		8/	15	5	GRA04
1997 03 27.90	!	N	1.5	YG	5.0	B		10	26	8	13		GRA04
1997 03 27.97	!	B	0.2	AA	5.0	B		10	12	7	2.2	355	TAY
1997 03 28.02	fw	B	-0.8	Y	0.0	E		1		8	&13		GRE
1997 03 28.05	a	G	-0.8	SC	0.0	E		1	20	9	15	5	CRE01
1997 03 28.07	!	N	4.5	YG	20.3	T	10	123					GRA04
1997 03 28.12	!	G	-0.1	SC	0.7	E		1	10	8	6	339	SHA02
1997 03 28.74		B	-0.7	SC	6.3	R		34			9		CHA02
1997 03 28.74		B	-0.7	SC	6.3	R		34			9		KOJ01
1997 03 28.76		B	-1.0	AA	8.0	B		12	15	9	2.5	330	MEN03
1997 03 28.76		B	-1.9	SC	6.3	R		53		7	12		POP01
1997 03 28.76		S	-0.8	SC	0.6	E		1	12	9	10	350	OKS
1997 03 28.77	a	M	-0.7	Y	0.0	E		1	20	9	15		KYS
1997 03 28.80	a	M	-1.1	S	5	R		1	50	8	16	325	HOR02
1997 03 28.81	a	M	-0.6	S	0.0	E		1	25	9	24		KON06
1997 03 28.81	a	M	-1.0	S	5	R		1	45	7/	16	340	PLS
1997 03 28.81	a	O	-0.9	SP	0.0	E		1	25	8	21	12	ZNO
1997 03 28.82		S	-0.6	AA	5.0	B		10	23	8	15	10	MOE

Comet C/1995 O1 (Hale-Bopp) [cont.]

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1997 03 28.82	!	B	-0.3	AA	4.0	B		8	18	7	3	358	TAY
1997 03 28.82	w	M	-0.9	SC	0.0	E		1	12	8	12	340	GLI
1997 03 28.84	a	B	-0.8	AA	0.7	E		1		8	15	10	BOU
1997 03 28.85					5.0	B		7	12	7	10	355	DIE02
1997 03 28.85		S	-0.7	AA	0.0	E		1					DIE02
1997 03 28.85	!	G	-0.4	AE	0.8	E		1	10	8	15	12	SHA02
1997 03 28.85	a	G	-1.3	AA	0.8	E		1			8.0	330	HAS02
1997 03 28.85	a	I	-1.4	AT	0.0	E		1			&8		VIT01
1997 03 28.88		B	-0.9	S	0.0	E		1	12	9	15	5	MAR02
1997 03 28.88		S	-1.1	AE	5.0	B		8	50	8	12	350	BEA
1997 03 28.89		B	-1.3	S	0.0	E		1		9	20	3	SAN04
1997 03 28.89	!	M	-0.8	YG	0.7	E		1		8/	15	6	GRA04
1997 03 28.89	!	N	1.6	YG	5.0	B		10	25	8	13	350	GRA04
1997 03 28.89	a	O	-0.5	S	0.0	E		1	40		7		LIB
1997 03 28.94	!	B	-0.6	YG	0.7	E		1		8	15		SKI
1997 03 28.98	!	N	4.5	YG	20.3	T	10	123					GRA04
1997 03 29.76		G	-0.9	AA	0.0	E		1			11	7	VEL03
1997 03 29.76		S	0.0	AA	0.7	E		1	17	S2/			CSU
1997 03 29.77		B	-0.5	AA	5.0	B		10	50	8	2.8		FOG
1997 03 29.77		S	-1.8	AA	6.3	R	13	52	25	S9		15	KOS
1997 03 29.78	a	B	-0.4	AA	0.0	E		1			16		MIL02
1997 03 29.79	!	B	-0.9	Y	0.0	E		1	12	S8	13	10	SAR02
1997 03 29.81		G	0.0:	SC	0.7	E		1	&10	8	1	360	SHA02
1997 03 29.82		S	-0.6	AA	5.0	B		10	24	8	17	15	MOE
1997 03 29.82	a	M	-0.9	Y	0.0	E		1	20	9	>15		KYS
1997 03 29.83		B	-1.0	S	0.0	E		1	10	9	19	10	MAR02
1997 03 29.83	!	V	-0.4	YF	3.2	A	3 a	1	+34	8	>7		MIK
1997 03 29.83	w	M	-1.2	Y	0.0	E		1	25	D8	15	330	CAN04
1997 03 29.85		M	-0.9	AA	0.0	E		1	&25	8	15	330	PAL02
1997 03 29.85		M	-1.1	S	5.0	B		7	20	S8/	19		GON05
1997 03 29.85		S	-1.0	AE	5.0	B		8	40	8	8	355	BEA
1997 03 29.85	a	B	-0.7	AT	3.5	R		1					PER01
1997 03 29.85	a	B	-0.8	AT	3.5	R		1					VIT01
1997 03 29.85	a	G	-1.0	AT	0.0	E		1					PER01
1997 03 29.85	a	G	-1.1	AT	0.0	E		1					VIT01
1997 03 29.85	ra	I	-1.0	AT	3.4	B		9					PER01
1997 03 29.85	a	I	-1.1	AT	0.0	E		1					PER01
1997 03 29.85	a	I	-1.1	AT	0.0	E		1					VIT01
1997 03 29.85	ra	I	-1.3:	AT	3.4	B		9					VIT01
1997 03 29.85	a	O	-0.9	SP	0.0	E		1	25	8/	18	9	ZNO
1997 03 29.86	!	B	-0.6	AA	4.0	B		8	19	7	4.2	360	TAY
1997 03 29.88	a	M	-1.1	S	5	R		1	45	8	12	330	HOR02
1997 03 29.89	a	B	-0.9	Y	10	B		25	40	7	6	345	HYN
1997 03 29.96	!	B	-0.5	YG	0.7	E		1			10		SKI
1997 03 30.13	!	M	-0.7	YG	0.7	E		1		8	9	351	GRA04
1997 03 30.13	!	N	1.7	YG	5.0	B		10	20	7/	8	8	GRA04
1997 03 30.15	!	N	4.7	YG	20.3	T	10	123					GRA04
1997 03 30.75	a	B	-0.8	AA	0.0	E		1	40	6	15		BAR06
1997 03 30.75	a	G	-0.9	AA	0.0	E		1	40	6	15		BAR06
1997 03 30.76		G	-0.9	AA	0.0	E		1					VEL03
1997 03 30.76	a	G	0.0	AA	0.0	E		1	26	9	11	5	NEV
1997 03 30.77	a	M	-1.2	AA	0.0	E		1	&30	7	17	14	CHE03
1997 03 30.77	a	O	-0.8	SP	0.0	E		1	20	7	20	8	ZNO
1997 03 30.78		S	-1.8	AA	6.3	R	13	52	25	S9		15	KOS
1997 03 30.78	a	B	-0.4	AA	0.0	E		1			12		MIL02
1997 03 30.78	a	M	-0.8	Y	0.0	E		1	20	9	17		KYS
1997 03 30.79		B	-0.8	AA	0.0	E		1					STO
1997 03 30.79		S	-0.6	AA	5.0	B		10	50	8	3.0	10	FOG
1997 03 30.79		S	-0.7	SC	0.6	E		1	15	8/	9	350	OKS
1997 03 30.79	a	M	-1.1	S	5	R		1	45	7/	19	7	HOR02
1997 03 30.79	a	M	-1.1	S	5	R		1	45	7/	20	5	PLS
1997 03 30.79	a	M	-1.2	TI	5	R		1	40	7/	12		DVO
1997 03 30.80	!	V	-0.5	YF	3.2	A	3 a	1	+34	8	>7		MIK
1997 03 30.81	a	O	-0.6	S	0.0	E		1	35		8		LIB
1997 03 30.82	s	M	-0.9	SC	0.0	E		1	12	8	14	335	GLI

Comet C/1995 O1 (Hale-Bopp) [cont.]

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1997 03 30.83	a	B	-0.8	AA	0.7	E		1		8	21	12	BOU
1997 03 30.83	w	M	-1.2	Y	0.0	E		1	25	D8	11	330	CAN04
1997 03 30.84	!	G	-0.3	AE	0.8	E		1	9	8	14.5	360	SHA02
1997 03 30.85		M	-1.1	S	5.0	B		7	20	S8/	18		GON05
1997 03 30.85	!	B	-0.2	AA	4.0	B		8	21	8	4	15	TAY
1997 03 30.85	a	M	-0.6	S	0.0	E		1	20	9	24		KON06
1997 03 30.86	!	M	-0.6	YG	0.7	E		1		8	13	348	GRA04
1997 03 30.86	!	N	1.8	YG	5.0	B		10	25	7/	11	355	GRA04
1997 03 30.87					5.0	B		7	12	7	8	355	DIE02
1997 03 30.87		S	-0.7	AA	0.0	E		1					DIE02
1997 03 30.87	a	I	-0.9	AA	0.8	E		1	25	8	11	330	MOE
1997 03 31.00	!	B	-0.8	YG	0.7	E		1			15		SKI
1997 03 31.01	fs	B	-0.5	Y	0.0	E		1		8	&7		GRE
1997 03 31.07	w	B	-0.6	AE	0.0	E		1		S9	7	9	ADA03
1997 03 31.78		S	-2.0	AA	6.3	R	13	52	26	S9		20	KOS
1997 03 31.79	a	M	-1.1	S	5	R		1	45	8	14	10	HOR02
1997 03 31.80	a	G	-1.2	AA	0.8	E		1			12.9	332	HAS02
1997 03 31.80	a	O	-0.6:	Y	0.0	E		1	20	9	>3		KYS
1997 03 31.83	a	B	-0.9	Y	10	B		25	40	7	10	350	HYN
1997 03 31.83	a	G	-0.5	AA	0.6	E		1		S8/	15	10	KAM01
1997 03 31.83	a	O	-0.5	S	0.0	E		1	35		8		LIB
1997 03 31.83	a	O	-0.7	SP	0.0	E		1	18	8	14		ZNO
1997 03 31.84					5.0	B		7	12	7	8	355	DIE02
1997 03 31.84		S	-0.7	AA	0.0	E		1					DIE02
1997 03 31.84	!	B	-0.1	AA	4.0	B		8	12	8	4.2	15	TAY
1997 03 31.84	a	B	-0.9	AA	0.7	E		1		8	14	14	BOU
1997 03 31.84	a	S	-0.9	AA	5.0	B		10	23	8	17	20	MOE
1997 03 31.85		B	-1.0	S	0.0	E		1	20	9	14	15	MAR02
1997 03 31.85		M	-1.1	S	5.0	B		7	20	S8/	16		GON05
1997 03 31.85		S	-1.0	AE	5.0	B		8	40	8	8	360	BEA
1997 03 31.85	!	G	-0.7	AE	0.8	E		1	12	8	16	350	SHA02
1997 03 31.85	a	G	-0.9	AT	0.0	E		1					PER01
1997 03 31.85	a	G	-1.0	AT	0.0	E		1					VIT01
1997 03 31.85	ra	I	-0.8	AT	3.4	B		9					PER01
1997 03 31.85	a	I	-1.1	AT	0.0	E		1			15	20	PER01
1997 03 31.85	a	I	-1.2	AT	0.0	E		1					VIT01
1997 03 31.86	!	B	-0.6	YG	0.7	E		1		8	14		SKI
1997 03 31.86	!	M	-0.9	YG	0.7	E		1	&20	8	16	358	GRA04
1997 03 31.86	!	N	1.6	YG	5.0	B		10	22	7/	13	3	GRA04
1997 03 31.86	a	B	-0.3	AT	3.5	R		1					VIT01
1997 03 31.86	a	B	-0.4	AT	3.5	R		1					PER01
1997 03 31.87	a	B	-0.8	AA	0.0	E		1	45	6	15		BAR06
1997 03 31.95	!	B	0.6	SC	5.0	B		7	18	8			SHA02
1997 04 01.05	w	G	-0.6	SC	0.0	E		1	21	9	15	10	CRE01
1997 04 01.10	a	B	-0.8	AA	0.0	E		1	40	6	16		BAR06
1997 04 01.14	w	B	-0.7	AE	0.0	E		1		S9	8	350	ADA03
1997 04 01.17	a	S	-0.5	AA	0.0	E		1	21	9	12	340	SPR
1997 04 01.76	a	G	0.3	AA	0.0	E		1	24	9	12	9	NEV
1997 04 01.77	a	G	-1.0	AA	0.0	E		1	38	6	16		BAR06
1997 04 01.78	a	B	-0.3	AA	0.0	E		1			6		MIL02
1997 04 01.78	a	M	-1.3	AA	0.0	E		1	&30	7	15	345	CHE03
1997 04 01.78	a	M	-1.3	TI	5	R		1	30	7/	4		DVO
1997 04 01.79	a	M	-0.6	Y	0.0	E		1	20	9	17		KYS
1997 04 01.80	!	M	-1.0	Y	0.0	E		1	12	S8	25	15	SAR02
1997 04 01.80	a	M	-1.1	S	5	R		1	40	8	5	10	HOR02
1997 04 01.80	a	O	-0.7	SP	0.0	E		1	18	8	16	10	ZNO
1997 04 01.81	a	M	-0.8	S	0.0	E		1	25	8/	23		KON06
1997 04 01.82	s	M	-0.9	SC	0.0	E		1	10	8	15	20	GLI
1997 04 01.83	a	G	-1.1	AA	0.8	E		1			12.0	341	HAS02
1997 04 01.83	a	O	-0.4	S	0.0	E		1	35		7		LIB
1997 04 01.84	a	B	-0.9	AA	0.7	E		1		8	22	15	BOU
1997 04 01.84	a	G	-0.3	AA	0.6	E		1		S8/	13	15	KAM01
1997 04 01.85		M	-1.1	S	5.0	B		7	20	S8/	20		GON05
1997 04 01.85	a	S	-0.8	AA	5.0	B		10	20	8	8	320	MOE
1997 04 01.87					5.0	B		7	11	7	8	358	DIE02

Comet C/1995 O1 (Hale-Bopp) [cont.]

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1997 04 01.87		S	-0.6	AA	0.0	E		1					DIE02
1997 04 01.87	!	B	-0.5	YG	0.7	E		1		8	14	14	SKI
1997 04 01.88	!	B	-0.6	YG	0.7	E		1		8	14	18	GRA04
1997 04 01.88	!	N	1.7	YG	5.0	B		10	23	7/	14	22	GRA04
1997 04 02.04	a	B	-0.7:	AA	0.0	E		1	35	6	16		BAR06
1997 04 02.04	fw	B	-0.7	Y	0.0	E		1		8	&20		GRE
1997 04 02.06	w	G	-0.6	SC	0.0	E		1	15	9	18	10	CRE01
1997 04 02.08	!	N	4.3	YG	20.3	T	10	123					GRA04
1997 04 02.18	a	S	-0.3	AA	0.0	E		1	20	9	10	340	SPR
1997 04 02.78	!	M	-0.9	Y	0.0	E		1	12	S8	24	20	SAR02
1997 04 02.78	a	B	-0.4	AA	0.0	E		1			4		MIL02
1997 04 02.78	a	B	-0.9	AA	0.0	E		1	40	6	15		BAR06
1997 04 02.78	a	G	0.2	AA	0.0	E		1	21	9	14	15	NEV
1997 04 02.78	a	M	-0.9	AA	0.0	E		1	18	7	14	18	CHE03
1997 04 02.79	!	V	-0.5	YF	3.2	A	3 a	1	+34	8	>7		MIK
1997 04 02.79	a	O	-0.7	SP	0.0	E		1	18	7/	16	12	ZNO
1997 04 02.80	a	B	-1.0	Y	10	B		25	30	7	8	360	HYN
1997 04 02.80	a	M	-0.8	AA	4.0	R		8	25	S8			BAR06
1997 04 02.80	a	M	-0.9	S	5	R		1	40	7/	10	25	HOR02
1997 04 02.80	a	M	-1.1	S	5	R		1	50	7/	10	20	PLS
1997 04 02.80	a	M	-1.2	TI	5	R		1	30	8	3		DVO
1997 04 02.83	a	O	-0.7	S	0.0	E		1	35		9		LIB
1997 04 02.84					5.0	B		7	11	7	8	0	DIE02
1997 04 02.84		S	-0.6	AA	0.0	E		1					DIE02
1997 04 02.85		M	-0.6	AA	0.0	E		1	&25	8	&8		PAL02
1997 04 02.85		M	-0.9	S	5.0	B		7	20	S8/	18		GON05
1997 04 02.96	a	M	-0.9	AA	0.0	E		1		7	12	333	CHE03
1997 04 03.05	fw	B	-0.7	Y	0.0	E		1		8/	&15		GRE
1997 04 03.78	!	M	-1.2	Y	0.0	E		1	14	S8	30	15	SAR02
1997 04 03.78	a	B	-0.4	AA	0.0	E		1			5		MIL02
1997 04 03.79	a	B	-0.8	AA	0.0	E		1	55	6	16		BAR06
1997 04 03.79	a	G	-0.9	AA	0.0	E		1	50	6	16		BAR06
1997 04 03.79	a	M	-0.6	S	0.0	E		1	20	8/	20		KON06
1997 04 03.80	a	M	-1.0	S	5	R		1	30	7/	12	345	HOR02
1997 04 03.83	a	O	-0.5	S	0.0	E		1	35		7		LIB
1997 04 03.83	w	M	-1.1	Y	0.0	E		1	25	D8	12	330	CAN04
1997 04 03.85					5.0	B		7	11	7	8	358	DIE02
1997 04 03.85		S	-0.6	AA	0.0	E		1					DIE02
1997 04 03.85	a	B	-0.7	AA	0.7	E		1		8	16	20	BOU
1997 04 03.86		M	-0.8	S	5.0	B		7	20	S8/	20		GON05
1997 04 03.86	!	G	-0.5	AE	0.7	E		1	12	8	12	8	SHA02
1997 04 03.88	a	S	-0.8	AA	5.0	B		10	22	8	12	30	MOE
1997 04 03.90		S	-1.1	AE	5.0	B		8	40	8	12	15	BEA
1997 04 04.18	a	S	-0.8	AA	0.0	E		1	22	9	14	340	SPR
1997 04 04.78	!	M	-1.1	Y	0.0	E		1	14	S8	35	15	SAR02
1997 04 04.81	a	B	-0.9	AA	0.0	E		1	48	6	16		BAR06
1997 04 04.81	a	M	-0.9	AA	4.0	R		8	20	D7/	15		BAR06
1997 04 04.82	a	S	-0.5	AA	5.0	B		10	20	8	12	25	MOE
1997 04 04.85	!	M	-0.8	AA	0.0	E		1	&25	8	&15		PAL02
1997 04 04.85	a	B	-0.4	AT	3.5	R		1					PER01
1997 04 04.85	a	B	-0.6	AT	3.5	R		1					VIT01
1997 04 04.85	a	G	-0.8	AT	0.0	E		1					VIT01
1997 04 04.85	a	I	-1.5	AT	0.0	E		1					VIT01
1997 04 04.86	a	G	-0.9	AT	0.0	E		1					PER01
1997 04 04.86	a	I	-1.1	AT	0.0	E		1			12	0	PER01
1997 04 04.86	ra	I	-1.1	AT	3.4	B		9					PER01
1997 04 04.87	a	O	-0.8	SP	0.0	E		1	35	6/	20	11	ZNO
1997 04 04.88		B	-0.9	S	0.0	E		1	25	9	13	340	MAR02
1997 04 05.05	a	M	-0.9	AA	0.0	E		1	18	7	15	18	CHE03
1997 04 05.07	fw	B	-0.7	Y	0.0	E		1		8	&15		GRE
1997 04 05.19	a	S	-0.7	AA	0.0	E		1	22	9	12	345	SPR
1997 04 05.78	a	G	0.5	AA	0.0	E		1	20	9			NEV
1997 04 05.79	a	B	-0.8	AA	0.0	E		1	55	6	14		BAR06
1997 04 05.79	a	M	-0.7	AA	4.0	R		8	21	D7/	15		BAR06
1997 04 05.81		B	-0.2	SC	6.3	R		34			18		CHA02

Comet C/1995 O1 (Hale-Bopp) [cont.]

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1997 04 05.82		B	-0.2	SC	6.3	R		34			11		HAN04
1997 04 05.82		B	-1.2	SC	3.5	R	5	30	6	8	3.10	352	APE
1997 04 05.83		B	-0.7	S	0.0	E		1	20	9	14	340	MAR02
1997 04 05.86		M	-0.8	S	5.0	B		7	20	S8/	14		GON05
1997 04 06.78	a	B	-0.4	AA	0.0	E		1			8		MIL02
1997 04 06.79		S	-0.7	AA	5.0	B		10	50	8	4.0	32	FOG
1997 04 06.82	!	V	-0.6	YF	3.2	A	3 a	1	+34	8	>7		MIK
1997 04 06.84	a	B	-0.5	AA	0.7	E		1		8	19	29	BOU
1997 04 06.84	a	G	-0.2	AA	0.6	E		1		S8/	11	23	KAM01
1997 04 06.84	a	O	-0.6	S	0.0	E		1	35		10		LIB
1997 04 06.84	a	S	-0.6	AA	5.0	B		10	20	8	14	330	MOE
1997 04 06.84	w	M	-0.2	SC	0.0	E		1	10	8	10	25	GLI
1997 04 06.85					5.0	B		7	10	7	7	345	DIE02
1997 04 06.85		S	-0.6	AA	0.0	E		1					DIE02
1997 04 06.86		M	-0.7	S	5.0	B		7	20	S8/	11		GON05
1997 04 07.20	a	S	-0.3	AA	0.0	E		1	20	9	10	340	SPR
1997 04 07.77		B	0.5	SC	6.3	R		34			13		GEN
1997 04 07.78	!	S	-0.8	AA	0.0	E		1					ANZ
1997 04 07.78	a	G	0.4	AA	0.0	E		1	21	9	10	29	NEV
1997 04 07.78	a	O	-0.8	SP	0.0	E		1	40	7	17	15	ZNO
1997 04 07.79	a	M	-1.0	TI	5	R		1	35	8	9		DVO
1997 04 07.80	a	B	-0.7:	AA	0.0	E		1	45	6			BAR06
1997 04 07.80	a	M	-0.7:	AA	4.0	R		8	18	8			BAR06
1997 04 07.81		B	0.5	SC	6.3	R		34			11		CHA02
1997 04 07.81	!	V	-0.5	YF	3.2	A	3 a	1	+34	8	>7		MIK
1997 04 07.81	a	B	-1.1	Y	10	B		25	30	7	15	20	HYN
1997 04 07.81	a	M	-1.0	S	5	R		1	40	7/	10	35	HOR02
1997 04 07.81	a	O	-0.8	S	0.0	E		1	35		11		LIB
1997 04 07.82	a	G	-0.8	AA	0.8	E		1			15.3	340	HAS02
1997 04 07.82	a	M	-0.6	S	0.0	E		1	20	8/	21		KON06
1997 04 07.84		B	-0.4	AE	0.8	E		1	15	8	16	13	SHA02
1997 04 07.84	a	S	-0.6	AA	5.0	B		10	21	8	15	330	MOE
1997 04 07.84	w	G	-0.4	AA	0.6	E		1		S8/	11	27	KAM01
1997 04 07.85	a	B	-0.3	AT	3.5	R		1					VIT01
1997 04 07.85	a	B	-0.4	AT	3.5	R		1					PER01
1997 04 07.85	a	B	-0.5	AA	0.7	E		1		8	16	30	BOU
1997 04 07.85	a	G	-0.7	AT	0.0	E		1					VIT01
1997 04 07.85	a	G	-0.8	AT	0.0	E		1					PER01
1997 04 07.85	a	I	-0.5	AT	0.0	E		1					VIT01
1997 04 07.85	a	I	-0.6	AT	0.0	E		1					PER01
1997 04 08.03	fa	B	-0.5	Y	0.0	E		1		8/	&7		GRE
1997 04 08.06	w	G	-0.5	SC	0.0	E		1	18	9	12	0	CRE01
1997 04 08.75		B	0.7	SC	6.3	R		34			11		GEN01
1997 04 08.76		B	0.7	SC	6.3	R		34			13		CHA02
1997 04 08.76	a	M	-0.6	AA	4.0	R		8	25	S7	>13		BAR06
1997 04 08.76	a	S	-0.7	AA	0.0	E		1	45	S7	>12		BAR06
1997 04 08.77	a	I	-0.8	AA	0.0	E		1	37	S8	>12		BAR06
1997 04 08.77	a	S	-0.6	AT	0.0	E		1			4		MIL02
1997 04 08.78	a	B	-0.5	AT	0.0	E		1			4		MIL02
1997 04 08.78	a	G	0.4	AA	0.0	E		1	24	9	12	351	NEV
1997 04 08.80	a	M	-1.0	S	5	R		1	40	7/	5	35	HOR02
1997 04 08.80	a	O	-0.8	S	0.0	E		1	35		12		LIB
1997 04 08.83	a	M	-0.6	S	0.0	E		1	25	8	23		KON06
1997 04 08.85	a	O	-0.6	SP	0.0	E		1	35	7	12	20	ZNO
1997 04 08.90	!	M	-0.9	AA	0.0	E		1	&20	8	&8		PAL02
1997 04 09.06	fa	B	-0.5	Y	0.0	E		1		8	&4		GRE
1997 04 09.20	a	S	-0.5	AA	0.0	E		1	20	9	10	345	SPR
1997 04 09.21		S	-1.0	AE	5.0	B		8	30	8	5	25	BEA
1997 04 09.75		B	1.1	SC	6.3	R		34			10		GEN
1997 04 09.76		B	1.1	SC	6.3	R		34					VAS03
1997 04 09.77	a	B	-0.3	AT	0.0	E		1			8		MIL02
1997 04 09.78	a	I	-0.8	AA	0.0	E		1	38	S7/	>13		BAR06
1997 04 09.79	a	G	0.5	AA	0.0	E		1	23	9	16	349	NEV
1997 04 09.79	a	M	-0.7	AA	4.0	R		8	18	S7	>13		BAR06
1997 04 09.81	!	S	-0.6	AA	0.0	E		1					ANZ

Comet C/1995 O1 (Hale-Bopp) [cont.]

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1997 04 09.81	a	B	-1.2	Y	10	B		25	25	7	8	25	HYN
1997 04 09.83		B	1.1	SC	6.3	R		34			11		CHA02
1997 04 09.83	a	S	-0.4	AA	5.0	B		10	18	8	14	330	MOE
1997 04 09.89	!	B	0.3	SC	0.8	E		1	15	8	25	22	SHA02
1997 04 09.91	w	M	-0.4	SC	0.0	E		1	12	8	>8	0	GLI
1997 04 09.92		S	-1.0	AE	5.0	B		8	40	8	10	25	BEA
1997 04 10.06	fw	B	-0.7	Y	0.0	E		1		8	&15		GRE
1997 04 10.46	a	S	-1.0:	YG	0.0	E		1	&15	8/	15	350	NAN02
1997 04 10.75		B	1.1	SC	6.3	R		34			5		GEN
1997 04 10.76		B	1.1	SC	6.3	R		34			5		ILI
1997 04 10.76		B	1.1	SC	6.3	R		34			6		VAS03
1997 04 10.76		B	1.1	SC	6.3	R		34			11		CHA02
1997 04 10.83	!	V	-0.7	YF	3.2	A	3 a	1	+34	8	>7		MIK
1997 04 10.85		B	-0.3	AE	0.8	E		1	20	8	20	15	SHA02
1997 04 10.86		M	-0.7	S	5.0	B		7	15	S9	15		GON05
1997 04 10.88		S	-1.0	AE	5.0	B		8	40	8	12	30	BEA
1997 04 10.89	a	S	-0.5	AA	5.0	B		10	17	8	11	35	MOE
1997 04 11.05	fa	B	-0.6	Y	0.0	E		1		8	&7		GRE
1997 04 11.21	a	S	-0.3	AA	0.0	E		1	20	9	10	345	SPR
1997 04 11.57		B	1.1	SC	6.3	R		34			8		CHA02
1997 04 11.75		B	1.1	SC	6.3	R		34			7		GEN
1997 04 11.76		B	1.1	SC	6.3	R		34			5		ILI
1997 04 11.76		B	1.1	SC	6.3	R		34			6		GEN01
1997 04 11.79		B	1.1	SC	6.3	R		34			8		HAN04
1997 04 11.79	a	O	-0.5	SP	0.0	E		1	40	6/	32	3	ZNO
1997 04 11.82	a	M	-0.3	S	0.0	E		1	25	8	19		KON06
1997 04 11.84	a	B	-0.7	Y	10	B		25	20	7	8	20	HYN
1997 04 11.84	s	M	0.0	SC	0.0	E		1	8	8/	10	10	GLI
1997 04 11.85	a	B	-0.3	AT	3.5	R		1					PER01
1997 04 11.85	a	B	-0.7	AT	3.5	R		1					VIT01
1997 04 11.85	a	G	-0.2	AA	0.6	E		1		S8/			KAM01
1997 04 11.85	a	G	-0.7	AT	0.0	E		1					PER01
1997 04 11.85	a	G	-0.7	AT	0.0	E		1					VIT01
1997 04 11.85	a	I	-0.8	AT	0.0	E		1			14	30	PER01
1997 04 11.85	a	I	-0.9	AT	0.0	E		1					VIT01
1997 04 11.85	a	S	-0.4	AA	5.0	B		10	16	8	10	35	MOE
1997 04 11.86	!	B	-0.4	AE	0.7	E		1	20	8	17	29	SHA02
1997 04 11.88		S	-0.8	AE	5.0	B		8	30	8	6	30	BEA
1997 04 12.03	fs	B	-0.4:	Y	0.0	E		1		8	&5		GRE
1997 04 12.19	a	S	-0.2	AA	0.0	E		1	20	9	6	345	SPR
1997 04 12.42	s	S	-0.7	YG	0.0	E		1	&15	8/	2	0	NAN02
1997 04 12.78	a	B	-0.5	AT	0.0	E		1			8		MIL02
1997 04 12.78	a	I	-0.8	AA	0.0	E		1	38	S7	>14		BAR06
1997 04 12.84	a	M	-0.3	S	0.0	E		1	25	8	19		KON06
1997 04 12.84	a	S	-0.2	AA	5.0	B		10	16	8	11	335	MOE
1997 04 13.77	a	B	-0.6:	AT	0.0	E		1			4		MIL02
1997 04 13.78	a	I	-0.8	AA	0.0	E		1	38	S7	>14		BAR06
1997 04 13.79	a	M	-0.8	AA	4.0	R		8	20	S7	>13		BAR06
1997 04 13.79	a	O	-0.3	SP	0.0	E		1	40	7	21	0	ZNO
1997 04 13.80	a	O	-0.6	S	0.0	E		1	30		8		LIB
1997 04 13.83	s	M	-0.2	SC	0.0	E		1	10	8	11	15	GLI
1997 04 13.84	a	G	-0.2	AA	0.6	E		1		S8/			KAM01
1997 04 13.85		B	0.6	SC	0.7	E		1	15	7	4	28	SHA02
1997 04 14.79	a	B	-0.6	AT	0.0	E		1			2		MIL02
1997 04 14.83	a	S	-0.1	AA	5.0	B		10	16	8	8	340	MOE
1997 04 14.85	!	B	-0.7	AE	0.8	E		1	20	8	10	18	SHA02
1997 04 14.85	a	B	-0.4	AT	3.5	R		1					VIT01
1997 04 14.85	a	B	-0.6	AT	3.5	R		1					PER01
1997 04 14.85	a	G	-0.5	AT	0.0	E		1					VIT01
1997 04 14.85	a	G	-0.6	AT	0.0	E		1					PER01
1997 04 14.85	a	I	-0.6	AT	0.0	E		1			>8	30	PER01
1997 04 14.85	a	I	-0.7	AT	0.0	E		1					VIT01
1997 04 14.88		M	-0.3	S	5.0	B		7	15	S9	13		GON05
1997 04 15.04	fa	B	-0.5	Y	0.0	E		1		8	&6		GRE
1997 04 15.06	a	G	-0.3	SC	0.0	E		1	15	9	4	20	CRE01

Comet C/1995 O1 (Hale-Bopp) [cont.]

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1997 04 15.82	!	V	-0.4	YF	3.2	A	3 a	1	+34	8	>7		MIK
1997 04 15.84	a	M	0.3	SC	0.0	E		1	10	8			GLI
1997 04 15.84	a	M	-0.6:	AA	4.0	R		8	18	S7			BAR06
1997 04 15.84	a	S	-0.2	AA	5.0	B		10	15	8	8	340	MOE
1997 04 15.85	!	B	-0.4	AE	0.8	E		1	15	8	14	9	SHA02
1997 04 15.85	a	M	-0.2	S	0.0	E		1	25	8	14		KON06
1997 04 16.04	fa	B	-0.6	Y	0.0	E		1		8	&4		GRE
1997 04 16.43	s	M	0.2	YG	5.6	B		8	&12	8/	2	5	NAN02
1997 04 16.78	a	B	-0.6	AA	0.0	E		1	35	S7			BAR06
1997 04 16.78	a	M	-0.5	AA	4.0	R		8	19	S7			BAR06
1997 04 16.83	a	G	-0.6	AA	0.8	E		1					HAS02
1997 04 16.84	a	S	-0.2	AA	5.0	B		10	15	8	13	350	MOE
1997 04 16.85	a	B	-0.5	AT	3.5	R		1					PER01
1997 04 16.85	a	G	-0.4	AT	0.0	E		1					PER01
1997 04 16.85	a	I	-0.1	AT	0.0	E		1			>7.5	28	PER01
1997 04 16.85	a	M	0.1:	SC	0.0	E		1	10	7/			GLI
1997 04 16.87	a	B	0.0	AT	3.4	B		9	&10	7/			PER01
1997 04 17.02	fs	B	-0.5	Y	0.0	E		1		8	&4		GRE
1997 04 17.45	s	S	0.2	YG	5.6	B		8	&12	8/	2	10	NAN02
1997 04 17.80	a	B	-0.2	AT	0.0	E		1			>3		MIL02
1997 04 17.83	w	M	0.4	SC	0.0	E		1	10	8	5	30	GLI
1997 04 17.85	a	G	0.0	AA	0.6	E		1		S8			KAM01
1997 04 17.85	a	S	-0.1	AA	5.0	B		10	15	8	11	350	MOE
1997 04 17.86	a	G	-0.1	AT	0.0	E		1					PER01
1997 04 17.87	a	B	0.4	AT	3.4	B		9	&14	7/			PER01
1997 04 17.87	a	B	-0.3	AT	3.5	R		1					PER01
1997 04 17.87	a	I	-0.3	AT	0.0	E		1			>7	25	PER01
1997 04 17.87	w	B	0.5	SC	5.0	B		10					GLI
1997 04 17.91	!	B	0.2	AA	0.8	E		1	23	8	13	27	SHA02
1997 04 18.80	!	V	-0.3	YF	3.2	A	3 a	1	+34	8	>7		MIK
1997 04 18.84	s	M	-0.1	SC	0.0	E		1	10	8	5	30	GLI
1997 04 18.85	a	S	-0.1	AA	5.0	B		10	13	8	10	350	MOE
1997 04 19.06	a	G	-0.1	SC	0.0	E		1	15	9	8	30	CRE01
1997 04 19.79	a	B	-0.4	AA	0.0	E		1	36	S6			BAR06
1997 04 19.79	a	M	-0.3	AA	4.0	R		8	21	S7			BAR06
1997 04 19.85	a	M	-0.5	AA	0.0	E		1	10	7	5	26	CHE03
1997 04 19.86	a	S	-0.1	AA	5.0	B		10	13	8	8	350	MOE
1997 04 19.89		S	-0.3	AA	8.0	B		11	25	7	>4	40	DES01
1997 04 20.05	a	G	-0.1	SC	0.7	E		1	12	9	6	35	CRE01
1997 04 20.82	a	G	-0.3	AA	0.0	E		1	32	6			BAR06
1997 04 20.82	w	B	0.1	SC	0.0	E		1	8	8/	&8	35	GLI
1997 04 20.83	a	B	-0.3	Y	10	B		25	35	8	3	45	HYN
1997 04 20.85		B	0.0	SC	0.0	E		1					GLI
1997 04 20.85	a	B	0.0	AT	3.5	R		1					PER01
1997 04 20.85	a	G	0.0	AT	0.0	E		1					PER01
1997 04 20.85	a	I	0.1	AT	0.0	E		1			>7.5	40	PER01
1997 04 20.85	a	S	0.0	AA	5.0	B		10	13	8	8	0	MOE
1997 04 20.86	a	G	0.1	AT	0.0	E		1					VIT01
1997 04 20.87	!	B	1.0	AA	0.7	E		1	18	8	7	33	SHA02
1997 04 20.87	a	B	0.2	AT	3.4	B		9	& 6	7/			PER01
1997 04 20.87	a	B	0.9	AT	3.4	B		9	&10				VIT01
1997 04 20.87	a	I	0.3	AT	0.0	E		1					VIT01
1997 04 21.78	a	B	-0.3	AA	0.0	E		1	32	6			BAR06
1997 04 21.78	a	M	-0.2	AA	4.0	R		8	20	S7			BAR06
1997 04 21.82	w	B	0.1	SC	0.0	E		1	8	9	>8	35	GLI
1997 04 21.85	a	G	0.1	AA	0.6	E		1		S7/			KAM01
1997 04 21.90		S	-0.1	AA	8.0	B		11	25	8	>4	40	DES01
1997 04 22.86	a	S	-0.1	AA	5.0	B		10	12	8	7	10	MOE
1997 04 22.87	!	B	0.7	SC	0.7	E		1	15	7	2	42	SHA02
1997 04 23.02	fs	B	-0.3	Y	0.0	E		1		7/	&2		GRE
1997 04 23.44	a	S	0.3	YG	0.0	E		1	&10	8/	2		NAN02
1997 04 23.78	a	B	-0.2	AA	0.0	E		1	30	6			BAR06
1997 04 23.78	a	M	-0.0	AA	4.0	R		8	20	S7			BAR06
1997 04 23.81	a	B	-0.2	Y	10	B		25	18	8	2	45	HYN
1997 04 23.81	a	B	-0.4	AA	0.0	E		1	12	7	4	28	CHE03

Comet C/1995 O1 (Hale-Bopp) [cont.]

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1997 04 23.83	a	B	0.1	SC	0.0	E		1	10	8/	>5	35	GLI
1997 04 23.83	a	O	-0.1	S	0.0	E		1	25		5		LIB
1997 04 23.85	!	B	1.0	SC	0.7	E		1	20	7	3.5	41	SHA02
1997 04 23.86		M	-0.2	S	5.0	B		7	10	S9	4		GON05
1997 04 24.19	a	S	-0.1	AA	0.0	E		1	18	9	7	340	SPR
1997 04 24.78	a	B	-0.2	AA	0.0	E		1	35	6			BAR06
1997 04 24.81	!	V	-0.1	YF	3.2	A	3 a	1	+30	8	>5		MIK
1997 04 24.81	a	O	0.1	S	0.0	E		1	25		5		LIB
1997 04 25.44	a	S	0.3	YG	0.0	E		1	&10	8/	3		NAN02
1997 04 25.83	$	B	0.0	AA	0.0	E		1	12	7	7	40	CHE03
1997 04 25.86	a	B	0.5	AT	3.5	R		1					VIT01
1997 04 25.86	a	G	0.2	AT	0.0	E		1					PER01
1997 04 25.86	a	G	0.5	AT	0.0	E		1					VIT01
1997 04 25.86	a	I	0.3	AT	0.0	E		1					VIT01
1997 04 25.86	a	M	1.1	AT	3.4	B		9	&11	7/			PER01
1997 04 25.87	a	B	0.5:	AT	3.4	B		9					VIT01
1997 04 25.87	a	I	0.2	AA	0.8	E		1	10	8	7	30	MOE
1997 04 25.87	a	I	-0.2	AT	0.0	E		1			13	40	PER01
1997 04 26.46	s	S	0.1	YG	0.0	E		1	&10	8/	10	25	NAN02
1997 04 26.78	a	B	-0.1	AA	0.0	E		1	35	6			BAR06
1997 04 26.87	a	S	0.1	AA	5.0	B		10	14	8	11	35	MOE
1997 04 26.89			0.2	AA	0.0	E		1	20	6/	>4	40	DES01
1997 04 26.91			0.0	AA	0.0	E		1	20	9	5	40	LOU
1997 04 27.04	fa	B	-0.3	Y	0.0	E		1		7/	&3.5		GRE
1997 04 27.21	a	S	-0.0	AA	0.0	E		1	14	9	5	345	SPR
1997 04 27.78	a	B	-0.1	AA	0.0	E		1	35	6			BAR06
1997 04 27.79	a	B	0.0	SC	0.0	E		1		9			RAD01
1997 04 27.84	$	B	0.3	AA	0.0	E		1	10	7	5	40	CHE03
1997 04 27.85	a	B	0.1	SC	0.0	E		1	8	9	>6		GLI
1997 04 27.90			0.2	AA	0.0	E		1	20	7	>4	40	DES01
1997 04 27.91			0.0	AA	0.0	E		1	20	9	>5	40	LOU
1997 04 28.79	a	B	0.0	SC	0.0	E		1		9			RAD01
1997 04 28.79	a	B	0.2:	AA	0.0	E		1	30	6			BAR06
1997 04 28.86	a	G	0.4	AT	0.0	E		1					PER01
1997 04 28.86	a	I	0.3	AT	0.0	E		1			12		VIT01
1997 04 28.87	a	I	0.2	AT	0.0	E		1			12	40	PER01
1997 04 28.88	a	G	0.4	AT	0.0	E		1					VIT01
1997 04 28.91			0.1	AA	0.0	E		1	25	7/	>4	40	DES01
1997 04 29.85		B	0.1	S	0.0	E		1		7/	14	9	MAR02
1997 04 29.87	a	G	0.2	AT	0.0	E		1					PER01
1997 04 29.87	a	G	0.2	AT	0.0	E		1					VIT01
1997 04 29.87	a	M	0.6	AT	3.4	B		9	&11	7			PER01
1997 04 29.88	a	B	0.8	AT	3.4	B		9					VIT01
1997 04 29.88	a	I	0.1	AT	0.0	E		1			12	50	PER01
1997 04 29.88	a	I	-0.2	AT	0.0	E		1					VIT01
1997 04 29.88	a	M	0.8	AT	3.4	B		9					VIT01
1997 04 29.89			0.3	AA	0.0	E		1	25	7/	>4	40	DES01
1997 04 30.04	fa	B	-0.1	Y	0.0	E		1		7	&3.5		GRE
1997 04 30.87		M	0.1	S	5.0	B		7	10	S9	15		GON05

Comet C/1995 Q1 (Bradfield)

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1995 10 06.83		B	8.9	S	20.0	C	9	60		3			NAG04
1995 11 03.81		B	8.9	S	20.0	C	9	60	2.3	1			NAG04

Comet C/1995 Y1 (Hyakutake)

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1996 02 22.84		B	8.5	S	20.0	C	9	60	1.9	3			NAG04
1996 02 28.85		B	9.0	S	25	H	3	45	1.5	3			NAG04

Comet C/1996 B1 (Szczepanski)

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1996 02 28.79		B	8.5	S	25	H	3	45	3.5	2			NAG04
1996 03 13.65		B	9.1	AA	16	H	3	28	4.6	1			NAG04

Comet C/1996 B2 (Hyakutake)

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1996 02 22.81		B	8.1	S	20.0	C	9	60	3.5	7			NAG04
1996 02 28.83		B	7.3	S	25	H	3	45	4.7	7	20 m	275	NAG04
1996 02 29.11		S	6.3	AA	8.0	B		12		5			BON01
1996 03 04.83		B	6.2	AA	10.0	R	4	20	3.0	7			NAG04
1996 03 13.67		B	4.6	AA	10.0	R	4	20	11.3	7	1.1	280	NAG04
1996 03 20.15		M	2.3	AA	0.8	E		1					GUB
1996 03 23.63		B	-0.1	AA	0.7	E		1	58	7	16.5	225	NAG04
1996 03 23.94		M	0.2	AA	0.8	E		1			28	220	GUB
1996 03 25.87		M	0.0	AA	0.8	E		1					GUB
1996 03 25.94		G	-0.5:	SP	0.7	E		1	45	8	4		HEN
1996 03 26.04		M	-0.2	AA	0.8	E		1	70	1	50	205	GUB
1996 03 26.80					7.0	B		10	27	8	15	170	NAG04
1996 03 26.80		S	0.0	Y	0.7	E		1					NAG04
1996 03 27.82					7.0	B		10	22	8	6	60	NAG04
1996 03 27.82		B	0.8	Y	3.5	R		7					NAG04
1996 03 27.83		G	-0.5:	SP	0.7	E		1		8	4		HEN
1996 03 28.14		M	0.4	AA	0.8	E		1			27	290	GUB
1996 03 29.08		G	-0.3:	SP	0.7	E		1	30	7			HEN
1996 03 29.81		G	0.0:	SP	0.7	E		1		6	5		HEN
1996 03 30.83		G	0.5	SP	0.7	E		1		8			HEN
1996 03 30.84		M	2.0	AA	0.8	E		1					GUB
1996 04 01.88		G	1.9	SP	0.7	E		1		6	4		HEN
1996 04 02.87		G	1.9	SP	0.7	E		1		8			HEN
1996 04 03.96		G	2.5	SP	0.7	E		1		7	5		HEN
1996 04 04.83		G	2.1	SP	0.7	E		1		7			HEN
1996 04 05.46		B	2.1	Y	7.0	B		10			4.5	55	NAG04
1996 04 05.88		G	2.3	SP	0.7	E		1		7	7		HEN
1996 04 12.45		B	3.0	Y	7.0	B		10		8	6	45	NAG04
1996 04 13.47		B	3.0	Y	7.0	B		10			5.5	40	NAG04
1996 04 13.87		S	3.5:	SP	3.5	B		9		8	2		HEN
1996 04 17.88		G	2.3	SP	0.7	E		1		7	7		HEN
1996 04 23.87		G	2.0:	SP	3.5	B		9		6	4		HEN
1996 06 18.15		S	5.7	S	11	L	8	72		7	0.3		CO002
1996 07 16.16		S	7.6	S	11	L	8	72		5			CO002
1996 07 17.14		M	7.5	S	15	L	9	80	4.9	5			SMI08
1996 07 19.14		S	8.0	S	15	L	9	80	4.7	5			SMI08
1996 08 06.20		S	[10 :	S	20	L	8	83					CO002
1996 08 13.20		S	[10 :	S	20	L	8	83					CO002

Comet C/1996 N1 (Brewington)

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1996 07 16.76		S	9.0	S	15	L	9	50	4.8	2			SMI08
1996 08 13.74		S	8.1	S	15	L	9	80	4.0	3			SMI08
1996 08 18.91		B	7.2	YF	5.0	B		15	8	D3			FAJ
1996 08 19.90		B	7.4	YF	5.0	B		15	7	D4			FAJ
1996 08 20.91		B	7.8	YF	5.0	B		15	6	D4			FAJ
1996 08 21.91		B	8.0	YF	5.0	B		15	9	D2			FAJ
1996 08 24.90		B	8.2	YF	5.0	B		15	4	D0/			FAJ

Comet C/1996 P2 (Russell-Watson)

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1997 02 09.44	a	C	16.7	GA	60.0	Y	6		0.65			305	NAK01

Comet C/1996 Q1 (Tabur)

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1996 09 04.08		S	8.7:	AC	5.0	B		10	& 4	3			RES

Comet C/1996 Q1 (Tabur) [cont].

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1996 09 05.08		S	8.6	AC	5.0	B		10	3.1	1			RES
1996 09 09.05		S	7.7	AA	8.0	B		15	11	4			HAV
1996 09 09.08		S	8.2	S	5.0	B		10	8.6	0/			RES
1996 09 12.08		B	7.0:	S	10	M	10	56	3	2			MAR12
1996 09 12.12	&	S	8.2	S	11	L	7	32	& 3.5	d3			CHO01
1996 09 14.09		S	7.9	S	15	L	9	80	6	4			SMI08
1996 09 14.12	$	S	7.7	S	6.6	B		20	6	s4			PLE01
1996 09 14.97		S	7.4	S	20	L	8	83		4			CO002
1996 09 15.05		B	7.5:	S	8.0	B		20	6.6	s4			SPE01
1996 09 15.08		S	6.9	AA	8.0	B		15	10	5	0.4	275	HAV
1996 09 15.11		S	7.3:	S	5.0	B		10	& 7	0/			RES
1996 09 15.72		S	8.2	S	20.0	C	9	45	3.75	3			NAG04
1996 09 15.94		B	7.0	S	15.0	L	6	30	9.5	s2/			PIO01
1996 09 16.04		S	6.6	S	5.0	B		10	5.8	1			RES
1996 09 16.08		S	6.3	S	0.0	E		1	& 7	0/			RES
1996 09 17.09		S	7.5	S	20	L	8	83	4	3			CO002
1996 09 17.12	$	B	7.4	S	6.6	B		20	6	s4			PLE01
1996 09 18.06		S	6.7	S	5.0	B		10	& 4	0/			RES
1996 09 18.10	&	S	8.0	S	11	L	7	32	& 3.5	d3			CHO01
1996 09 19.09		I	7.5:	S	5	R	6	20	& 6	2			WLO
1996 09 19.10	!	B	7.0	S	5.0	B		7	7	s4/			PLE01
1996 09 19.98		B	7.5:	S	7.0	B		25	& 2	s1			SOC
1996 09 21.03		B	7.7:	S	6.6	B		20	& 7	4			FIL04
1996 09 21.07		M	6.9	S	8	R	7	35	8	5			KWI
1996 09 21.09		B	7.2	S	5	R	6	20	& 8	2			WLO
1996 09 22.04		S	6.6	S	5.0	B		10	8.1	0/			RES
1996 09 22.05		B	7.0	S	5.0	B		10	4	2			MAR12
1996 09 22.06		B	7.0	S	6.4	R	6	20	& 8	d4			CNO
1996 09 22.08		S	7.0	S	5.0	B		10	& 9	1			OLE
1996 09 23.00		B	6.5	S	6.4	R	6	20	& 8	d4			CNO
1996 09 23.02		S	6.5	S	7.0	B		25	&13	2/			OLE
1996 09 23.04	—	S	6.5	S	5.0	B		10	11	1/			RES
1996 09 23.11	!	B	6.1	S	5.0	B		7	7	s4/			PLE01
1996 09 24.00		S	6.4	S	5.0	B		10	&10	3			OLE
1996 09 27.08		S	6.2	S	5.0	B		10	6	1			RES
1996 09 27.11		B	6.0	S	5.0	B		15	15	S3	0.2	210	FAJ
1996 09 27.13		B	6.8	S	8.0	B		20	8.3	s5			SPE01
1996 09 29.08		S	5.7	S	5.0	B		10	& 7	2			RES
1996 09 29.09		I	6.0:	S	4.0	B		12	&10	3/			WLO
1996 09 30.13	a	B	5.5	S	5.0	B		7	10	s5			PLE01
1996 10 01.06		B	5.5	S	5.0	B		10	7	3			MAR12
1996 10 01.07		M	5.7	S	8	R	7	35	8	5			KWI
1996 10 01.10		I	6.0:	S	4.0	B		12	&10	3/			WLO
1996 10 01.94		B	6.7:	S	6.5	R	6	28	& 3	1			SWI
1996 10 02.09		B	5.4	S	5.0	B		10	11	3			SIW01
1996 10 02.10		I	5.5:	S	4.0	B		12	&10	4			WLO
1996 10 02.13		B	5.5	S	5.0	B		10	8	3			MAR12
1996 10 02.17		I	7.5:	S	4.0	B		12	& 5	6			WLO
1996 10 02.94		B	4.9	S	5.0	B		15	25	S2	0.4	80	FAJ
1996 10 03.94		S	5.9	S	5.0	B		10	&13	6/			OLE
1996 10 03.96		B	6.1	S	5.0	B		7	& 9	5			BAN
1996 10 04.05		B	5.9	S	5.0	B		7	&10	d4			CNO
1996 10 04.06	&	S	5.5	S	11	L	7	32					CHO01
1996 10 04.10		B	6.2	S	8.0	B		20	11	S5			SPE01
1996 10 04.11		B	5.5	S	5.0	B		10	9	3			MAR12
1996 10 04.12		B	5.2	S	4.0	B		12	&12	5			WLO
1996 10 04.13	&	M	6.0	S	5.0	B		10	25	2/			GRO04
1996 10 04.86		M	5.4	S	5.0	B		7	10	d4			PAR03
1996 10 04.93		S	5.9	S	5.0	B		10	&22	5/			OLE
1996 10 04.95	!	B	6.3	S	6.8	R	12	40	15	d4			CHR
1996 10 04.98		B	6.0	S	5.0	B		7	& 9	5			BAN
1996 10 05.05		B	5.8	S	5.0	B		10	9	4			MAR12
1996 10 05.10		B	5.1	S	4.0	B		12	&15	5			WLO
1996 10 05.13		S	6.2	YF	5.0	B		10	12				ENT
1996 10 05.15		B	5.8	S	5.0	B		7	&10	d4			CNO

Comet C/1996 Q1 (Tabur) [cont].

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1996 10 06.75		S	5.3:	S	5.0	B		10	& 8	5			RES
1996 10 06.92		S	5.0	S	5.0	B		10	&10	3/			RES
1996 10 07.89		B	6.5:	S	5.0	B		15	18	S1/	0.3	190	FAJ
1996 10 07.91	&	B	5.3	S	5.0	B		10	12	3/			SIW01
1996 10 08.11		B	5.9	S	5.0	B		10	10	9			MAR12
1996 10 08.12		I	5.2:	S	4.0	B		12	&12	4/			WLO
1996 10 08.20		M	5.2	S	8	R	7	35	11	5	0.6	290	KWI
1996 10 08.96		B	6.6	S	7.0	B		25	& 3	s2			SOC
1996 10 08.99		S	5.6	AA	0.0	E		1					IVA03
1996 10 09.08		B	6.4:	S	5.0	B		7	&10	d5			CNO
1996 10 09.13		B	6.4	S	5.0	B		10	8	4			MAR12
1996 10 10.00		S	5.5	AA	0.0	E		1					IVA03
1996 10 10.13	&	M	5.8	S	5.0	B		10	30	3			GRO04
1996 10 10.15		S	5.7	YF	5.0	B		10	9				ENT
1996 10 10.75		B	5.6	S	5.0	B		15	20	S2	1.4	115	FAJ
1996 10 10.75		S	4.7	S	0.0	E		1	&15	7			RES
1996 10 10.76		B	6.1	S	6.0	B		20	12	2			KID01
1996 10 10.76		S	4.9	S	5.0	B		10	&15	4/	0.50	310	RES
1996 10 10.82	a	B	5.3	S	10.0	B		25	15	S5/	0.7	305	PLE01
1996 10 10.94	&	S	7.0	S	11	L	7	32	& 5	d			CHO01
1996 10 10.98		S	5.9:	S	5.0	B		10	&13	4			OLE
1996 10 11.13		B	6.4:	S	5.0	B		10	& 6	3/			MAR12
1996 10 11.74		B	6.5	S	5.0	B		10	9	2			DER
1996 10 11.75		B	5.6	S	6.0	B		20	5	6			SZA05
1996 10 11.75		S	4.9	S	5.0	B		10	&15	1	0.33	310	RES
1996 10 11.78	&	O	5.8:	NP	5	R	6	20	3	s2/	&0.07		JAR01
1996 10 11.83	&	B	5.3	S	5.0	B		10	12	3/			SIW01
1996 10 11.92		B	6.5	S	6.6	B		20	8	4	&0.37	325	FIL04
1996 10 11.92	!	B	6.6	S	6.8	R	12	40	14	d3			CHR
1996 10 11.94		S	6.1:	S	5.0	B		10	&14				OLE
1996 10 12.00	&	S	6.9	S	11	L	7	32					CHO01
1996 10 12.10		B	6.7	S	5.0	B		10	& 6	4			MAT06
1996 10 12.10		S	6.3:	AA	8.0	R	10	40	6.3	4			GER01
1996 10 12.13		B	5.3	S	4.0	B		12	&12	5			WLO
1996 10 12.13		B	5.8	S	6.0	B		20	&10	6	0.25	320	SCI
1996 10 12.13		B	6.4	S	5.0	B		10	7	4			MAR12
1996 10 12.73		B	5.7	S	6.0	B		20	5	6			SZA05
1996 10 12.73		M	5.9	S	5.0	B		7	10	d4			PAR03
1996 10 12.75		B	6.5	S	5.0	B		7	7.2	S4			SPE01
1996 10 12.76		B	6.6	S	5.0	B		10	12	2			DER
1996 10 12.77		B	6.5	S	8.0	B		20	11.7	S4			SPE01
1996 10 12.77		S	5.2	S	5.0	B		10	&15	1/			RES
1996 10 12.79	&	O	6.3	NP	9	L	10	70	1.5	s2	&0.05		JAR01
1996 10 12.96		M	5.7	S	8	R	7	35	11	5	0.8	320	KWI
1996 10 13.00		B	6.7	S	5.0	B		7	& 7	3			BAN
1996 10 13.09		S	6.3:	AA	8.0	R	10	40	6.8	5/			GER01
1996 10 13.10		B	6.7	S	5.0	B		10	& 6	4			MAT06
1996 10 13.12		B	6.5	S	5.0	B		10	6	4			MAR12
1996 10 13.13		I	5.4:	S	4.0	B		12	&12	4/			WLO
1996 10 13.21		M	5.9	S	8	R	7	35	12	6	0.8	316	KWI
1996 10 13.70		B	6.4:	AA	8.0	R	10	40	6.5	5/			GER01
1996 10 13.73		B	6.5	S	5.0	B		10	4	3			SWI
1996 10 13.73		M	6.0	S	5.0	B		7	10	d4			PAR03
1996 10 13.75		B	6.4	S	5.0	B		7	7.7	S4			SPE01
1996 10 13.75		S	5.7	S	5.0	B		10	& 5	3	0.40	310	RES
1996 10 13.75		S	6.3	AA	6.0	B		20	&10	d3			SIW
1996 10 13.76	&	O	6.6	NP	5	R	6	20	2.5	s2/	&0.07		JAR01
1996 10 13.78		B	6.4	AA	5.0	B		10	&10				SIW
1996 10 13.89	&	S	7.5	S	11	L	7	32	& 5	d0			CHO01
1996 10 13.98		B	5.9	S	5.0	B		10	8	4			SIW01
1996 10 14.00		S	5.4	AA	0.0	E		1					IVA03
1996 10 14.09		B	6.4:	AA	8.0	R	10	40	6.3	4/			GER01
1996 10 14.11		B	5.9:	S	6.0	B		20	& 6	6	0.83	330	SCI
1996 10 14.13		B	5.5	S	4.0	B		12	&10	5			WLO
1996 10 14.13		B	6.3	S	5.0	B		10	5	3/			MAR12

Comet C/1996 Q1 (Tabur) [cont].

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1996 10 14.20		B	6.5	S	5.0	B		10	& 6	4			MAT06
1996 10 14.72		B	6.1	S	15.0	L	6	30	10.4	s2/			PIO01
1996 10 14.72		S	5.9	S	6.0	B		20	15	s3			DRA02
1996 10 14.73	&	M	5.6	S	5.0	B		10	30	3			GRO04
1996 10 14.75		B	5.6:	S	5.0	B		15	10	S2/	0.2	100	FAJ
1996 10 14.75		B	5.8	S	6.0	B		20	5	6			SZA05
1996 10 14.75		S	5.4	S	5.0	B		10	& 8	2/			RES
1996 10 14.75	&	O	6.6	NP	5	R	6	20	2.5	s3/			JAR01
1996 10 14.76	&	B	5.5	S	5.0	B		10	9				SIW01
1996 10 14.79		S	6.3	AA	6.0	B		20	&10				SIW
1996 10 14.82	!	B	6.5	S	6.8	R	12	40	12	D4			CHR
1996 10 14.84	a	B	5.7	S	5.0	B		7	15	S6	1.0	320	PLE01
1996 10 15.11		B	6.1	S	5.0	B		10	16	3			DER
1996 10 15.13		B	5.9	S	6.0	B		20	&10	6	0.50	350	SCI
1996 10 15.13		B	6.1	S	5.0	B		10	6	5			MAR12
1996 10 15.14		B	5.6	S	4.0	B		12	& 9	6			WLO
1996 10 15.20		B	6.4	S	5.0	B		10	& 7	5			MAT06
1996 10 15.73		B	6.2	S	15.0	L	6	30	13	s0			PIO01
1996 10 15.74		B	6.2	S	5.0	B		10	5	3			SWI
1996 10 15.74	&	O	6.6	NP	5	R	6	20	3	s3			JAR01
1996 10 15.75		B	5.8	S	6.0	B		20	6	6/			SZA05
1996 10 15.75		B	6.7	S	7.0	B		25	& 3	S2			SOC
1996 10 15.77		B	6.1	S	6.0	B		20	7	2			KID01
1996 10 15.79		S	5.7	YF	5.0	B		10	9				ENT
1996 10 15.80		S	5.7:	SC	5.0	B		10	16	3/			MCK
1996 10 15.82	!	B	6.6	S	6.8	R	12	40	12	D4			CHR
1996 10 15.84	a	B	5.8	S	5.0	B		7	15	S6	1.2	324	PLE01
1996 10 15.85	&	S	6.3	S	11	L	7	32	&10	d3			CHO01
1996 10 16.00		B	6.3	S	5.0	B		10	10				SIW01
1996 10 16.09		B	6.3:	AA	8.0	R	10	40	7.0	5			GER01
1996 10 16.11		B	6.2:	S	6.0	B		20	& 5	5			SCI
1996 10 16.13	—	B	6.2	S	5.0	B		10	6	s5/			MAR12
1996 10 16.15		I	5.8:	S	4.0	B		12	& 8	6/			WLO
1996 10 16.18		S	6.0	YF	5.0	B		10	10				ENT
1996 10 16.73	&	O	6.6	NP	5	R	6	20	2.5	s2/			JAR01
1996 10 16.75		B	6.0:	S	5.0	B		15	13	S1	0.1		FAJ
1996 10 16.75		S	5.7	S	5.0	B		10	&10	2			RES
1996 10 16.81					20.0	C	9	45	5.0	3	1.3	323	NAG04
1996 10 16.81		B	6.1	AA	7.0	B		10					NAG04
1996 10 16.82		S	5.7	YF	5.0	B		10	10				ENT
1996 10 16.83	&	M	6.1	S	8	R	7	35	12	6	1.1	315	KWI
1996 10 16.84		B	6.1	S	7.0	B		25	& 5	d5			SOC
1996 10 16.84	a	B	5.8	S	5.0	B		7	14	S6	1.0	331	PLE01
1996 10 17.78		P	5.5	SP	15	R	5		4	7	0.08	345	HEN
1996 10 17.83	a	B	5.9	S	5.0	B		7	12	S6	0.9	335	PLE01
1996 10 17.87	&	B	6.6	S	5.0	B		10	8				SIW01
1996 10 17.90	!	B	6.9	S	6.8	R	12	40	10	d3			CHR
1996 10 18.01		B	6.1	S	7.0	B		25	& 6	D5			SOC
1996 10 18.05		B	6.1	S	5.0	B		10	9		&0.50		SIW01
1996 10 18.12		B	7.0	S	5.0	B		10	5	s4			MAR12
1996 10 18.12		B	7.2	S	6.0	B		20	& 5	5			SCI
1996 10 18.15		I	6.0:	S	4.0	B		12	& 8	7			WLO
1996 10 18.85	a	B	6.5	S	5.0	B		7	11	S5/	0.8	339	PLE01
1996 10 19.76		S	5.9	S	5.0	B		10	10	2			RES
1996 10 20.71	&	B	8.0:	S	10	M	10	56	3	0			MAR12
1996 10 20.76		B	[7.0	S	8.0	B		20	! 3				SPE01
1996 10 20.78	!	B	7.3	S	6.8	R	12	40	10	d3			CHR
1996 10 20.80	a	B	7.2	S	6.6	B		20	10	S5			PLE01
1996 10 20.84		S	6.5:	S	5.0	B		10	& 6	2/			RES
1996 10 23.74	a	B	8.0	S	10.0	B		25	8	s4			PLE01
1996 10 23.83		S	8.1	S	20.0	C	9	45	2.9	1	1.2	0	NAG04
1996 10 25.72		B	8.3	S	15.0	L	6	30	6.1	s0/			PIO01
1996 10 25.72	$	S	8.5:	S	35	M	10	90	& 6	s3			PLE01
1996 10 29.81	&	S	8.6	S	8	R	7	35	9	5			KWI
1996 10 30.81		S	7.6:	S	5.0	B		10	& 6	1			RES

Comet C/1996 Q1 (Tabur) [cont].

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1996 11 01.78		S	8.0:	S	5.0	B		10	& 5	1			RES
1996 11 03.72		S	8.5	AA	7.2	R	7	20	10	2	0.1	316	TUB
1996 11 04.74		B	9.8:	S	15.0	L	6	30	5.5	s1			PIO01
1996 11 04.74		S	8.7	S	5.0	B		10	5	2			RES
1996 11 04.74		S	8.8	S	8	R	7	35	8	5			KWI
1996 11 04.75		S	9.0	AA	30	L	3	20	5	8			TUB
1996 11 04.76		B	7.8	S	5.0	B		15	8	D0/			FAJ
1996 11 06.77	$	S	9.1:	S	35	M	10	90	& 5	s2/			PLE01
1996 11 08.72		B	9.8:	S	15.0	L	6	30	3.9	s1			PIO01
1996 11 08.73		S	8.8	S	5.0	B		10	3	2			RES
1996 11 08.74		B	[8.0	S	8.0	B		20	! 3.5				SPE01
1996 11 09.71		S	10.7	AA	27	L		100	2.5	0			SZA
1996 11 12.74		S	8.6	S	5.0	B		10	6	1			RES

Comet C/1997 A1 (NEAT)

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1997 01 13.70		C	17.2	GA	60.0	Y	6	a240	0.5		0.9m	165	NAK01
1997 01 18.79		C	17.2	GA	60.0	Y	6	a240	0.6		0.7m	154	NAK01
1997 01 31.65		C	16.9	GA	60.0	Y	6	a240	0.75		1.1m	151	NAK01
1997 02 09.61		C	17.0	GA	60.0	Y	6	a240	0.7		1.1m	142	NAK01
1997 02 27.59		C	17.7	GA	60.0	Y	6	a120	0.4		1.5m	136	NAK01
1997 03 07.48		C	17.8	GA	60.0	Y	6	a240	0.4		0.8m	130	NAK01

Comet C/1997 BA6 (Spacewatch)

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1997 02 13.70		C	19.3	GA	60.0	Y	6	a240		9			NAK01
1997 03 04.61		C	19.5	GA	60.0	Y	6	a240		9			NAK01

Comet C/1997 D1 (Mueller)

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1997 02 20.56		C	15.1:	GA	60.0	Y	6	a120	0.65				NAK01
1997 02 22.77		C	14.7	GA	60.0	Y	6	a120	0.95		1.6m	134	NAK01
1997 03 01.76		C	14.4	GA	60.0	Y	6	a120	1.3		1.9m	131	NAK01
1997 03 01.80		S	14.0	HS	35	L	5	237	0.7	2			HOR02
1997 03 04.94		S	13.3	AC	25.4	L	5	104	0.5	4/			MEY
1997 03 05.20		J	12.9	SC	25.4	T	4		0.43	d5	49.4s	130	ROQ
1997 03 05.80		S	13.8	HS	35	L	5	158	1.1	2			HOR02
1997 03 06.11		S	13.7	HS	30	R	18	170	0.4	4			SHA02
1997 03 07.78		M	13.9	HS	35	L	5	158	0.9	3			HOR02
1997 03 07.81		S	14.0	HS	35	L	5	158	1.0	3/			PLS
1997 03 07.98		S	13.4	AC	25.4	L	5	104	0.8	4			MEY
1997 03 08.13		S	13.7	HS	44.5	L	5	230	0.8	5			SAR02
1997 03 08.13		S	14.0	HS	44.5	L	5	230	1	2/			SZE02
1997 03 08.81		S	14.3	HS	44.0	L	5	100	1.1	3			HAS02
1997 03 08.95		S	13.9	NP	44.5	L	5	100	0.75	1			MAR02
1997 03 09.15		S	14.2	HS	44.5	L	5	146	0.8	5			SAR02
1997 03 09.15		S	14.6	HS	44.5	L	5	146	1	3			BAK01
1997 03 09.27		J	13.1	SC	25.4	T	4		0.54	s5	54.7s	117	ROQ
1997 03 09.84	!	V	14.5	GA	36.0	T	7	a300	+ 0.7	8	& 4 m	110	MIK
1997 03 09.85		S	13.2	GA	25.4	J	6	115	1.2	3/			BOU
1997 03 10.81		M	13.9	HS	35	L	5	158	1.1	3			HOR02
1997 03 10.98		S	13.3	AC	25.4	L	5	104	0.7	3/			MEY
1997 03 11.66		C	14.5	GA	60.0	Y	6	a120	1.0		2.8m	124	NAK01
1997 03 11.81		M	13.8	HS	35	L	5	158	1.1	3			HOR02
1997 03 12.83		M	13.6	HS	35	L	5	104	1.3	2/			HOR02
1997 03 12.84		S	14.0	HS	35	L	5	104	0.9	2			PLS
1997 03 13.00		S	13.1	HS	30	R	18	170	1.0	2			SHA02
1997 03 13.15	!	J	12.6	SC	25.4	T	4		0.41	s5/	91.9s	114	ROQ
1997 03 18.16		J	12.1	SC	25.4	T	4		0.49	s5/	42.3s	116	ROQ
1997 03 20.20		J	12.9	SC	25.4	T	4		0.45	s5/	75.0s	104	ROQ
1997 03 27.14		J	11.8	SC	25.4	T	4		0.41	S6	98.7s	104	ROQ
1997 03 28.91		S	13.6	NP	44.5	L	5	167	1	0			MAR02

Comet C/1997 D1 (Mueller) [cont.]

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1997 03 30.13		J	12.8	SC	25.4	T	4		0.31	s5/	78.5s	92	ROQ
1997 03 30.89		S	13.6:	NP	20	T	10	135	0.6	4			SHA02
1997 03 31.91		S	13.9:	VB	20	T	10	135	0.4	4			SHA02
1997 04 01.86		S	13.3	GA	25.4	J	6	143	1.0	1/			BOU
1997 04 02.83		M	13.6	HS	35	L	5	158	1	2			HOR02
1997 04 02.93		S	13.8:	HS	44.5	L	5	230	0.8	2			SAR02
1997 04 03.91		S	13.9:	HS	30	R	18	170	0.5	3			SHA02
1997 04 07.89		S	13.6:	VB	33	L	5	75	0.7	3			SHA02
1997 04 07.90		S	13.3	AC	25.4	J	6	143	1.0	1/			BOU
1997 04 09.92		S	[13.9	VB	20	T	10	135					SHA02
1997 04 10.91		S	13.6:	VB	33	L	5	100	1.1	3			SHA02
1997 04 13.15		J	13.1	SC	25.4	T	4		< 1	s6	65.2s	96	ROQ

Comet 4P/Faye

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1991 10 19.80		S	10.5:	SC	6.0	R	10	30	& 1				MAN01
1991 11 09.80		S	10.0	SC	6.0	R	10	30	& 1		3m	90	MAN01

Comet 6P/d'Arrest

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1995 07 29.04		S	12.1	NP	44.5	L	5	100	4	4			MAR02
1995 07 30.07		S	11.5	NP	44.5	L	5	100	3	3			ROD01
1995 07 30.07		S	11.9	NP	44.5	L	5	100	4	3			MAR02
1995 09 18.66		B	9.8	S	20.3	T	10	48	2.7	1			NAG04

Comet 22P/Kopff

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1996 07 05.81		S	8.2	S	20	L	8	83		3			COO02
1996 07 14.89		S	8.7	S	15	L	9	50	4.0	3			SMI08
1996 07 15.84		S	8.6	S	20	L	8	83	2.0	3			COO02
1996 07 20.04		S	8.8	S	15	L	9	50	3.9	3			SMI08
1996 07 24.98		S	8.1	AA	8.0	B		11	6	4			DES01
1996 07 31.98		S	8.1	AA	8.0	B		11	6	3/			DES01
1996 08 01.99		S	8.2	AA	8.0	B		11	5	3			DES01
1996 08 02.98		S	8.2	AA	8.0	B		11	5	3			DES01
1996 08 03.98		S	8.3	AA	8.0	B		11	6	3/			DES01
1996 08 04.99		S	8.3	AA	8.0	B		11	6	3/			DES01
1996 08 05.99		S	8.5	AA	8.0	B		11	5	3			DES01
1996 08 06.79		S	8.9	S	20	L	8	83	0.7	3			COO02
1996 08 06.98		S	9.0	S	15	L	9	50	3.2	2			SMI08
1996 08 06.99		S	8.5	AA	8.0	B		11	5	3/			DES01
1996 08 07.98		S	8.6	AA	8.0	B		11	5	3/			DES01
1996 08 13.71		S	9.5	S	20	L	8	83		2			COO02
1996 08 13.98		S	9.6	S	15	L	9	80	3.0	1			SMI08
1996 08 31.76		S	[10 :	AA	20	L	8	83					COO02
1996 09 05.81		S	10.2	AA	20	L	8	83		1			COO02
1996 09 05.91		S	10.2	AA	15	L	9	80	1.0	0			SMI08
1996 09 15.78		S	10.5	AA	20	L	8	83		1			COO02
1997 01 12.42	a	C	14.3	GA	60.0	Y	6		2.2				NAK01
1997 02 09.41		C	15.8:	GA	60.0	Y	6		1.3				NAK01

Comet 29P/Schwassmann-Wachmann 1

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1996 12 22.20		S	[13.0	AC	25.4	L	5	104	! 0.5				MEY
1997 02 02.19		S	11.6	TI	35	L	5	92	2.1	1/			HOR02
1997 02 02.20		S	11.7	HS	35	L	5	92	1.8	2			PLS
1997 02 03.19		S	12.0:	TI	35	L	5	104	1.6	1/			HOR02
1997 02 08.15		S	14.1:	VB	30	R	18	170	0.3	5			SHA02
1997 02 14.15		S	13.7	VB	30	R	18	170	0.7	s2			SHA02
1997 02 16.18		S	14.1	NP	44.5	L	5	100	1.5	0/			MAR02
1997 03 01.02		S	13.7	VB	30	R	18	210	0.6	2			SHA02

Comet 29P/Schwassmann-Wachmann 1 [cont.]

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1997 03 06.13		S	[13.4	HS	30	R	18	170					SHA02
1997 03 07.96		S	[13.5	HS	44.5	L	5	230	1				SAR02
1997 03 08.96		S	[13.5	HS	44.5	L	5	230	1				SAR02
1997 03 10.93		S	13.5	HS	35	L	5	237	0.8	1			HOR02
1997 03 12.92		S	13.6	HS	35	L	5	237	0.8	1			HOR02
1997 03 13.02		S	13.6	VB	30	R	18	290	0.5	2			SHA02
1997 03 28.93		S	14.2	NP	44.5	L	5	100	< 1	0/			MAR02
1997 03 28.93		S	[12.9	HS	20	T	10	135					SHA02
1997 03 31.92		S	[13.8:	VB	20	T	10	135					SHA02
1997 04 01.92		S	[13.5	HS	44.5	L	5	230	1				SAR02
1997 04 02.93		S	[13.5	HS	44.5	L	5	230	1				SAR02
1997 04 07.91		S	[13.4	VB	33	L	5	75					SHA02
1997 04 09.94		S	[13.5	VB	20	T	10	135					SHA02

Comet 46P/Wirtanen

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1997 02 01.75		S	11.8	AC	25.4	L	5	104	1.5	3			MEY
1997 02 02.72		S	11.5	TI	35	L	5	104	1.6	3			PLS
1997 02 02.73		M	11.4	TI	35	L	5	104	1.8	2/			HOR02
1997 02 03.71		S	[10.8	AC	11.0	L	7	50	! 1.5				BAR06
1997 02 06.74	!	S	11.0	HS	44.5	L	5	230	1.8	2			BAK01
1997 02 06.74	!	S	11.4	HS	44.5	L	5	230	1.8	4			SAR02
1997 02 06.75		M	10.9	TI	35	L	5	104	2.4	2/			HOR02
1997 02 07.77		S	10.5:	HS	30	R	18	170	0.7	2			SHA02
1997 02 07.77	a	S	11.3	AC	25.4	L	5	65	2	3			MEY
1997 02 09.42		C	12.1	GA	60.0	Y	6		3.0		2.4m	71	NAK01
1997 02 10.74		M	10.8:	TI	10	B		25	2.5	4			ZNO
1997 02 10.78	!	S	10.8	AC	30	R	18	100	1.8	3			SHA02
1997 02 14.75		M	10.2:	TI	35	L	5	92	3.6	2/			HOR02
1997 02 14.75		M	10.3:	TI	35	L	5	92	1.8	2/			PLS
1997 02 18.79		S	10.6	AC	20	R	14	90	1.2	2			SHA02
1997 02 22.75		S	10.4	TI	10	B		25	2.5	3			ZNO
1997 02 24.43	a	C	11.8	GA	60.0	Y	6		3.8		5.7m	72	NAK01
1997 02 24.71		B	9.7:	AC	11.0	L	7	50	6	1			ISH03
1997 02 24.72		B	10.0	AC	11.0	L	7	50	6	1			NAU
1997 02 24.73		S	9.9	AC	11	L	7	50	6	2/			BAR06
1997 02 25.73		S	9.8:	AC	11	L	7	50	6	2			BAR06
1997 02 27.75		M	9.4	TI	13	L	8	69	3.5	3			HOR02
1997 02 27.76		S	9.5	TI	13	L	8	69	3	2			PLS
1997 02 28.75		S	10.6	TI	10	B		25	3.0	2			ZNO
1997 02 28.76		M	9.4	TI	35	L	5	92	3.5	3			HOR02
1997 02 28.77		S	10.5	AC	11.0	L	7	50	6	3/			BAR06
1997 02 28.79		B	10.5	AC	11.0	L	7	50	4	2			ISH03
1997 03 01.42		S	10.5:	HS	25.4	T	6	60	1.3	4			YOS04
1997 03 01.44		S	10.2	A	41.0	L	6	80	3	3			KOB01
1997 03 01.75		S	10.2	TI	10	B		25	3.0	2/			ZNO
1997 03 01.76		M	9.3	TI	35	L	5	92	3	3			HOR02
1997 03 01.77		S	9.6	AC	25.4	L	5	65	2	3/			MEY
1997 03 04.77		M	9.6	TI	35	L	5	66	3.7	3			HOR02
1997 03 04.77		S	9.5	AC	25.4	L	5	65	1.5	3/			MEY
1997 03 04.77		S	10.0:	TI	35	L	5	66	2.2	1/			PLS
1997 03 05.75		B	10.2	AC	11.0	L	7	32	4	1			ISH03
1997 03 05.77		M	9.4	TI	35	L	5	66	3	3			HOR02
1997 03 06.77		S	10.3	AA	6.3	R	13	52	3	1			KOS
1997 03 06.78		S	9.9:	AC	15.2	L	5	42	3.5	2			MOE
1997 03 06.80		S	9.6	HS	25.4	J	6	58	2.2	2/			BOU
1997 03 07.42		C	10.9	GA	60.0	Y	6	a120	4.1				NAK01
1997 03 07.44		S	10.2:	HS	10.0	B		20	& 3				YOS02
1997 03 07.75		M	10.1	HS	44.5	L	5	72	5	5/	0.18	120	SZE02
1997 03 07.75		S	9.9	HS	44.5	L	5	72	4	5	0.1	150	BAK01
1997 03 07.75		S	10.0	HS	44.5	L	5	72	4	5	0.14	130	SAR02
1997 03 07.77		M	9.5	TI	20	L	5	48	3.5	2/			PLS
1997 03 07.77		S	9.4	TI	10	B		25	3.5	3			ZNO
1997 03 07.78		M	9.2	TI	20	L	5	48	3.5	3			HOR02

Comet 46P/Wirtanen [cont.]

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1997 03 07.78		S	9.5	AC	25.4	L	5	65	2	3			MEY
1997 03 08.79		S	9.8	HS	44.0	L	5	63	1.4	3			HAS02
1997 03 09.80		S	9.7	HI	25.4	J	6	58	2.8	1/			BOU
1997 03 09.83	a	S	9.6	VF	25.3	L	6	58	& 2.5	2			PER01
1997 03 09.83	a	S	10.3	VF	25.3	L	6	58	& 2.1	2/			VIT01
1997 03 10.75		S	10.0	AA	6.3	R	13	52	3	2			KOS
1997 03 10.78		M	9.1	TI	20	L	5	48	3.6	3			HOR02
1997 03 10.78		S	9.4	AC	25.4	L	5	65	2	4			MEY
1997 03 10.87		S	10.0	AC	11.0	L	7	56	6	3			BAR06
1997 03 11.78		S	9.5:	AC	25.4	L	5	65	2	3			MEY
1997 03 11.79		M	9.0	TI	20	L	5	48	3.3	2/			HOR02
1997 03 11.79		M	9.5	TI	20	L	5	48	4	2/			PLS
1997 03 11.83	!	S	10.1	AC	20	R	14	90	2.5	1			SHA02
1997 03 12.80		M	9.5	TI	20	L	5	48	3.5	2			PLS
1997 03 12.81		M	9.0	TI	20	L	5	48	3	2/			HOR02
1997 03 26.75		S	10.0:	AC	20.0	L	5	71	3.5	2			BAR06
1997 03 28.86		M	9.7	NP	44.5	L	5	100	2	5			MAR02
1997 03 28.89	!	S	9.5	NP	20	T	10	75	2.5	2			SHA02
1997 03 29.84		M	9.8	NP	21.0	L	6	60	3	4/			MAR02
1997 03 29.85	a	S	9.3	PA	25.3	L	6	58	& 2.4	3			PER01
1997 03 29.85	a	S	9.5	PA	25.3	L	6	58	& 2	3/			VIT01
1997 03 30.75		S	10.8:	AC	11.0	L	7	32	2	1			BAR06
1997 03 30.78		M	10.1	TI	10	B		25	3	3			ZNO
1997 03 30.86	!	S	10.5	VB	20	T	10	75	2.3	3			SHA02
1997 03 31.84	a	S	10.0	GA	25.4	J	6	72	2.6	2			BOU
1997 03 31.85		M	9.7	NP	21.0	L	6	60	2	4			MAR02
1997 03 31.85	!	S	9.9	VB	20	T	10	75	3.1	2			SHA02
1997 03 31.85	a	S	9.6	PA	25.3	L	6	58	& 1.8	3/			PER01
1997 03 31.85	a	S	9.9	PA	25.3	L	6	58	& 1.3	2/			VIT01
1997 03 31.87		S	10.3	AC	28.0	T	6	68	2.5	2			MOE
1997 04 01.79		S	10.6:	HS	25.4	L	6	104	1.5	2			SAR02
1997 04 01.83		S	9.7	HS	20.3	T	10	80	1.7	2			KAM01
1997 04 01.84	a	S	10.1	GA	25.4	J	6	72	2.6	2			BOU
1997 04 02.79		S	10.0	HS	44.5	L	5	82	1.9	5			SAR02
1997 04 02.80		M	10.2	TI	10	B		25	2.5	2/			ZNO
1997 04 02.82		M	10.4	TI	35	L	5	104	1.5	2			HOR02
1997 04 03.78		S	9.7	HS	44.5	L	5	82	2.2	5/			SAR02
1997 04 03.85	!	S	9.5	VB	33	L	5	45	3.4	2			SHA02
1997 04 04.75		S	[10.7:	AC	11.0	L	7	50	! 2				BAR06
1997 04 04.78		S	10.4	HS	44.5	L	5	82	2.0	4			SAR02
1997 04 04.78		S	10.9	HS	44.5	L	5	82	3	2			DOB
1997 04 04.85	a	S	9.3	PA	25.3	L	6	58	> 2	3			PER01
1997 04 04.85	a	S	9.5	PA	25.3	L	6	58	& 2.5	3/			VIT01
1997 04 05.85		M	9.6	NP	21.0	L	6	60	> 3	4			MAR02
1997 04 06.84		S	9.6	HS	20.3	T	10	80	1.7	2			KAM01
1997 04 07.79		M	9.8	TI	10	B		25	3	2			ZNO
1997 04 07.84		S	9.4	HS	20.3	T	10	80	2.1	1/			KAM01
1997 04 07.84		S	10.5	AC	15.2	L	5	42	2	3			MOE
1997 04 07.85		S	10.3	GA	25.4	J	6	72	2.5	2			BOU
1997 04 07.86		S	10.5	VB	33	L	5	45	3.1	2			SHA02
1997 04 09.83		S	10.3	AC	15.2	L	5	42	2	2			MOE
1997 04 09.87	!	S	10.7	VB	20	T	10	75	2.4	2			SHA02
1997 04 10.88	!	S	11.4	VB	33	L	5	75	4.0	2			SHA02
1997 04 11.20		S	10.1	AC	20.0	T	10	125	2.1	2/			SPR
1997 04 13.79		M	10.2	TI	10	B		25	2.5	2/			ZNO
1997 04 15.13	!	J	10.1	SC	25.4	T	4		1.70	s5/	?		ROQ
1997 04 15.86		S	10.6	HS	20	R	14	90	2.0	2			SHA02
1997 04 23.87		S	[10.5	VB	20	R	14	90					SHA02
1997 04 26.88		S	10.5	AC	15.2	L	5	42	2	2			MOE
1997 04 27.79		S	[11.3	VF	20.0	L	7	71	! 2				BAR06

Comet 81P/Wild 2

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1996 12 22.19		S	12.2	AC	25.4	L	5	104	1.3	4/			MEY

Comet 81P/Wild 2 [cont.]

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1997 01 06.87		S	11.3	AC	25.4	L	5	65	1.3	s5/			MEY
1997 01 12.84		S	11.2	AC	25.4	L	5	65	2.3	s5/			MEY
1997 01 16.15		S	10.7	AC	20.0	T	10	102	1.5	4			SPR
1997 01 18.12		M	10.8	AC	25.4	L	5	65	2.0	S5/			MEY
1997 01 25.72		M	10.6	TI	35	L	5	92	1.5	5			HOR02
1997 01 25.73		M	10.6	TI	35	L	5	92	1.7	4			PLS
1997 01 26.73		M	10.3	TI	35	L	5	92	2	5			HOR02
1997 01 26.73		M	10.6	TI	35	L	5	92	1.8	4/			PLS
1997 01 26.77		M	10.4	AC	25.4	L	5	65	1.5	S6			MEY
1997 01 27.78		S	9.7	AA	11.0	L	7	32	4.5	4			VEL03
1997 01 29.75		S	9.9	AC	11	L	7	50	5	3/			BAR06
1997 01 29.81		B	10.0	AC	11	L	7	32	4	2			RED
1997 01 29.81		B	10.0	AC	11	L	7	32	4.5	2/			ISH03
1997 01 30.92		S	10.4	AC	20.3	T	10	50					ANZ
1997 01 30.96		M	10.7	AC	25.4	J	6	58	1.8	5			BOU
1997 01 31.80		M	10.0	TI	35	L	5	92	2.4	5			HOR02
1997 01 31.81		M	10.0	TI	35	L	5	92	1.8	5			PLS
1997 02 01.08		M	10.3	AC	25.4	L	6	108	2.0	6			GRA04
1997 02 01.56		C	10.2	GA	60.0	Y	6		5.1		> 6.8m	280	NAK01
1997 02 01.74		M	10.0	TI	10	B		25	2.5	5			ZNO
1997 02 01.77		S	10.3	AC	15.2	L	5	76	3.5	2			MOE
1997 02 01.80		M	10.1	AC	25.4	L	5	65	2	S5			MEY
1997 02 01.83		M	9.8	TI	35	L	5	92	2.5	5			HOR02
1997 02 01.90		M	10.4	AC	25.4	J	6	58	2.0	5			BOU
1997 02 01.96		S	10.5	AA	37.0	C	12	79	2	4			ANZ
1997 02 01.96		S	10.5:	AA	37.0	C	12	79	& 2	4			ANZ
1997 02 01.99		B	9.9	AC	11	L	7	50	4.5	3/			BAR06
1997 02 01.99		S	10.0	AC	11	L	7	50	4.5	3/			BAR06
1997 02 02.00		M	10.1	AC	25.4	L	6	108	2.5	6			GRA04
1997 02 02.75		S	9.7	TI	11	L	8	32	3	4			KYS
1997 02 02.77		M	9.7	TI	35	L	5	66	2.6	5/			PLS
1997 02 02.77		M	9.7	TI	35	L	5	66	2.7	6			HOR02
1997 02 02.82		S	9.9	AC	11	L	7	50		2			LUK04
1997 02 02.82		S	9.9	AC	11	L	7	50	4.5	3			BAR06
1997 02 02.84		S	9.6	AA	11.0	L	7	32	3.8	4			VEL03
1997 02 02.84		S	10.5	VB	30	R	18	100	1.1	s4			SHA02
1997 02 03.03		M	10.2	AC	25.3	L	6	58	& 2.0	5			PER01
1997 02 03.03		S	9.9	AC	25.3	L	6	58	& 2.0	5			PER01
1997 02 03.08		S	10.1	AC	11	L	7	50	4	3			BAR06
1997 02 03.09		S	10.3	AC	20.3	T	10	50	2	4			ANZ
1997 02 03.09		S	10.3:	AC	20.3	T	10	50	& 2	4			ANZ
1997 02 03.49		S	9.7	GA	10.0	B		25					SEA
1997 02 03.75		M	10.3	AC	11	L	7	50	4	4			LUK04
1997 02 03.77		S	10.3	AC	11	L	7	50	4.5	3/			BAR06
1997 02 03.88		S	9.9	AA	15.0	R	8	30	2	5			DIE02
1997 02 03.97		M	10.3	AC	25.3	L	6	58	& 1.4	5/			VIT01
1997 02 03.97		M	10.3	AC	25.3	L	6	58	& 2.3	5			PER01
1997 02 04.14		S	10.3	AC	11	L	7	50	3	2			BAR06
1997 02 04.42		M	9.9	GA	10.0	B		25	7	6			SEA
1997 02 04.66		S	9.6	AA	10.5	R	7	23		3			HAS08
1997 02 04.78		S	10.4	AA	11.0	L	7	115	1	3			IVA03
1997 02 04.86		B	9.9	AC	11	L	7	50	4.5	3			ISH03
1997 02 04.86		B	10.0	AC	11	L	7	50	5	3			RED
1997 02 05.00		S	9.9	AC	11	L	7	50	4.5	3			BAR06
1997 02 05.16		S	9.9	AC	20.0	T	10	64	3.0	4/			SPR
1997 02 05.47		S	10 :	GA	10.0	B		25					SEA
1997 02 05.76		P	10.5:	AA	5.0	A	4		1				IVA03
1997 02 05.77		S	10.2	AC	15.2	L	5	42	3.5	3			MOE
1997 02 05.79		S	9.8	AA	15.0	R	8	30	2	6			DIE02
1997 02 05.83		S	10.4:	HS	30	R	18	100	4.2	s3			SHA02
1997 02 05.89		B	10.3	HS	25.6	L	5	42	3.5	7			BIV
1997 02 06.16		S	9.8	AA	20.0	T	10	64	2.5	4			SPR
1997 02 06.78		S	9.8	HS	25.4	L	6	104	2.5	5/			SAR02
1997 02 06.78		S	9.9	HS	25.4	L	6	104	3	6			BAK01
1997 02 06.80		M	9.2	TI	35	L	5	92	2.5	6			HOR02

Comet 81P/Wild 2 [cont.]

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1997 02 06.88		B	10.1	HS	25.6	L	5	42	3	6			BIV
1997 02 06.90		S	9.8	AA	15.0	R	8	30	2	6			DIE02
1997 02 06.92		S	9.8	AC	11	L	7	32	5	3			BAR06
1997 02 07.06		S	10.1	AC	20.3	T	10	50	& 2	4/			ANZ
1997 02 07.20		B	10.2	NP	17.3	L	6	42	3	5			TRI
1997 02 07.55		E	9.8	GA	10.0	B		25					SEA
1997 02 07.55		S	9.7	GA	10.0	B		25					SEA
1997 02 07.73		S	10.3	AA	11.0	L	7	115	1.3	3			IVA03
1997 02 07.77		M	10.1	AC	25.4	L	5	65	2	S5/			MEY
1997 02 07.83		B	9.9	AC	11	L	7	50	5	3			ISH03
1997 02 07.85		S	9.9	AC	11	L	7	50	4	3			BAR06
1997 02 07.86		S	10.0	AC	11	L	7	50	5	3			CHU
1997 02 07.93		M	10.3	AC	25.4	J	6	58	2.2	5/			BOU
1997 02 07.94		S	10.6	VB	33	L	5	100	1.7	4		103	SHA02
1997 02 07.97		S	10.0	AC	15.2	L	5	42	3.5	3			MOE
1997 02 07.98		S	10.7	VB	30	R	18	100	1.4	5			SHA02
1997 02 08.21		B	10.5	NP	17.3	L	6	42	2.5	5			TRI
1997 02 08.72		S	10.2	AC	11	L	7	50	3.8	3			BAR06
1997 02 08.78		S	11.9:	VB	30	R	18	170	0.7	2			SHA02
1997 02 08.81		S	10.2	AA	11.0	L	7	115	1.3	3			IVA03
1997 02 08.92		S	9.8	AC	8.0	B		12	6	2			BAR06
1997 02 08.92		S	10.0:	AC	11	L	7	50	6	3			MAN01
1997 02 08.93		S	9.9	AC	15.2	L	5	42	3.5	4			MOE
1997 02 08.95		B	9.7	NP	44.5	L	5	100	4	4/			SAN04
1997 02 08.95		M	10.1	NP	44.5	L	5	100	3	5			MAR02
1997 02 09.02		M	10.2	AC	25.3	L	6	58	& 2.4	4/			PER01
1997 02 09.02		M	10.3	AC	25.3	L	6	58	& 1.3	4/			VIT01
1997 02 09.02		S	10.2	AC	25.3	L	6	58					PER01
1997 02 09.02		S	10.2	AC	25.3	L	6	58					VIT01
1997 02 09.16		B	10.5	HS	25.6	L	5	42	3	5			BIV
1997 02 09.20		B	10.4	NP	17.3	L	6	42	2	5			TRI
1997 02 09.54	—	S	9.7	GA	10.0	B		25	6				SEA
1997 02 09.57		C	9.8	GA	8.0	R	6		8.3		15 m	288	NAK01
1997 02 09.73		M	9.3	AA	12.0	B		20	6	3			WAS
1997 02 09.95		M	10.0	AC	25.4	L	5	65	3	S5			MEY
1997 02 09.96		S	10.2	AC	25.3	L	6	58	& 2.3	4/			PER01
1997 02 09.96		S	10.5	AC	25.3	L	6	58	& 1.3	3/			VIT01
1997 02 10.75		M	9.7	TI	10	B		25	3.5	6			ZNO
1997 02 10.81		M	9.8	TI	20	L	5	48	2.2	4			PLS
1997 02 10.83		S	11.1	VB	30	R	18	100	0.9	s4	0.02	110	SHA02
1997 02 10.89		M	9.2	TI	13	L	8	69	3	3/			HOR02
1997 02 10.91	!	V	10.3	GA	36.0	T	7		& 7	8	&10 m	270	MIK
1997 02 10.93		M	10.2	AC	25.4	J	6	58	2.3	4/			BOU
1997 02 11.10		S	9.9	AA	15.0	R	8	30	2	3			DIE02
1997 02 11.83		S	10.0	AC	11	L	7	50	5	3			BAR06
1997 02 11.83		S	10.2	AC	11	L	7	50	5	2			LUK04
1997 02 11.88		M	9.6	TI	20	L	5	48	3	3/			PLS
1997 02 11.88		S	9.7	AC	8.0	B		12	8.5	2			BAR06
1997 02 11.88		S	9.9	AC	8.0	B		12	6	2			BAR06
1997 02 11.89		S	10.1	AA	11.0	L	7	115	1.5	3			IVA03
1997 02 12.69		S	8.8	HS	10.0	B		20	5	5			YOS02
1997 02 12.94		S	9.9	AC	11	L	7	50	5.8	3	0.05	71	BAR06
1997 02 12.94		S	10.0	AC	11	L	7	50	6	2/	0.05	69	LUK04
1997 02 13.73		M	10.0	HS	12.5	L	6	60	2.0	4			TSU02
1997 02 13.74		S	9.1	HS	25.4	T	6	60	2.5	5			YOS04
1997 02 13.79		S	11.1	VB	30	R	18	100	1.3	s4			SHA02
1997 02 14.06		S	9.7	AA	15.0	R	8	30	2	7			DIE02
1997 02 14.77		M	9.6	TI	35	L	5	92	3.0	4/			PLS
1997 02 14.77		M	9.7	TI	35	L	5	92	3.0	6			HOR02
1997 02 15.02		S	9.9	AC	25.4	L	6	61	2.0	5			GRA04
1997 02 15.17		S	10.9	NP	10	B		14	2.3	3			SHA02
1997 02 15.79		S	9.9	AC	25.4	L	6	108	2.2	5			GRA04
1997 02 15.79		S	11.0	VB	30	R	18	100	1.0	s3			SHA02
1997 02 15.84		S	10.1	AA	11.0	L	7	80	1.5	3			IVA03
1997 02 15.94		S	10.2	AC	25.3	L	6	58	& 2	3/			PER01

Comet 81P/Wild 2 [cont.]

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1997 02 15.94		S	10.3	AC	25.3	L	6	58	& 1.3	3			VIT01
1997 02 16.13		M	9.8	NP	44.5	L	5	100	2.5	4			SAN04
1997 02 16.14		M	9.9	NP	44.5	L	5	100	3	6/			MAR02
1997 02 16.79		S	9.6	AA	6.3	R	13	52	4	0/			KOS
1997 02 22.74		M	9.7	TI	10	B		25	3.0	5/			ZNO
1997 02 23.72		B	9.7	AC	11.0	L	7	50	6	3			ISH03
1997 02 23.77		S	9.3	AA	6.3	R	13	52	4	0/			KOS
1997 02 23.94		S	10.0:	AC	11	L	7	50	6	2			BAR06
1997 02 24.72		B	9.7	AC	11.0	L	7	50	6	3			ISH03
1997 02 24.73		K	9.5	AC	8.0	B		12		3			LUK04
1997 02 24.73		S	9.5	AC	8.0	B		12	9	3			BAR06
1997 02 24.73		S	9.6	AC	8.0	B		12	8	4			ISH03
1997 02 24.73		S	9.8	AC	11	L	7	50	7	3			BAR06
1997 02 24.76		S	9.2	AA	6.3	R	13	52	4	0/			KOS
1997 02 24.93		S	10.6	VB	30	R	18	100	1.4	3			SHA02
1997 02 25.73		S	9.5	AC	11	L	7	50	4	2/	0.1	110	BAR06
1997 02 25.83		S	10.3	VB	20	R	14	40	1.7	s3			SHA02
1997 02 26.83		M	9.8	TI	20	L	5	48	4	5			PLS
1997 02 26.90		S	10.0	AA	11.0	L	7	80	1.5	3			IVA03
1997 02 27.77		M	9.2	TI	8.0	B		10	5	4/			HOR02
1997 02 27.77		S	9.8	AC	15.2	L	5	42	3.5	2			MOE
1997 02 27.78		S	9.5	TI	8.0	B		10	6	3			PLS
1997 02 27.94		M	10.3	AC	25.3	L	6	58	& 2.3	4/			PER01
1997 02 27.94		M	10.5	AC	25.3	L	6	58	& 1.3	3/			VIT01
1997 02 27.94		S	9.9	AC	25.3	L	6	58	& 2.3	4/			PER01
1997 02 27.94		S	10.3	AC	25.3	L	6	58	& 1.3	3/			VIT01
1997 02 28.76		M	9.8	TI	10	B		25	3.0	4/			ZNO
1997 02 28.78		S	9.2	AC	8.0	B		12	10	3			ISH03
1997 02 28.79		S	9.1	AC	8.0	B		12	8	2			BAR06
1997 02 28.79		S	9.2	AC	11.0	L	7	50	6	3			BAR06
1997 02 28.81		B	9.3	AC	11.0	L	7	50	10	3	0.15	90	ISH03
1997 02 28.83		S	9.6	TI	11	L	8	32	3.5	2/			KYS
1997 02 28.99		S	10.6	VB	30	R	18	100	1.2	s3	0.02	20	SHA02
1997 03 01.10		S	10.3	VB	20	R	14	110	1.3	3			SHA02
1997 03 01.47		S	9.2	S	15.0	R	5	25	5	4/			NAG02
1997 03 01.49		S	9.3	AA	41.0	L	6	80	8	5			KOB01
1997 03 01.56		S	9.0	HS	25.4	T	6	60	4.2	5			YOS04
1997 03 01.76		M	9.7	TI	10	B		25	3.5	4			ZNO
1997 03 01.77		M	9.4	TI	35	L	5	92	3.6	5			HOR02
1997 03 01.77		S	9.3	AA	6.3	R	13	52	3	1			KOS
1997 03 01.83		M	9.6	AC	25.4	L	5	65	3	s5			MEY
1997 03 01.83		S	9.7	TI	8.0	B		10	4				POD
1997 03 01.86		S	10.8	AC	33.4	L	4	61	3	s4	0.2	90	SZE02
1997 03 01.93		S	10.3	AA	20	C		10	1.5	3			DAM
1997 03 02.76		S	9.5	AA	6.3	R	13	52	3	1			KOS
1997 03 02.78		M	9.4	TI	20	L	5	48	4.5	4/			PLS
1997 03 02.80		M	9.5	TI	20	L	5	48	3.6	5/			HOR02
1997 03 02.82		S	9.0	AC	8.0	B		12	9	2			BAR06
1997 03 02.82		S	9.2	AC	11.0	L	7	50	5.5	3			BAR06
1997 03 02.84		B	9.3	AC	11.0	L	7	50	7	3	0.1	90	ISH03
1997 03 02.84		S	9.2	AC	8.0	B		12	9	3	0.1	90	ISH03
1997 03 02.93		S	10.2	VB	30	R	18	100	1.3	4			SHA02
1997 03 03.02		S	10.1	VB	20	T	10	75	1.6	3			SHA02
1997 03 03.46		S	10.0	AA	10.0	B		25					SEA
1997 03 03.46		S	10.0	AA	10.0	B		25					SEA
1997 03 03.79		S	10.1	AC	15.2	L	5	42	2.5	3			MOE
1997 03 03.82		S	9.0	AC	8.0	B		12	9	3			BAR06
1997 03 03.82		S	9.2	AC	11.0	L	7	50	6.5	3			BAR06
1997 03 03.84		M	9.4	TI	35	L	5	92	3.2	5	0.07	115	HOR02
1997 03 03.88		S	9.9	AC	25.3	L	6	58	& 2.2	4			PER01
1997 03 03.88		S	10.3	AC	25.3	L	6	58	& 1.9	3/			VIT01
1997 03 04.04		M	9.2	S	8.0	B		10	4	5			GON05
1997 03 04.06		S	9.3	AC	11.0	L	7	50	6	2			BAR06
1997 03 04.77		S	9.8	AA	6.3	R	13	52	3	1			KOS
1997 03 04.78		M	9.3	TI	35	L	5	66	3.2	5	0.03	115	PLS

Comet 81P/Wild 2 [cont.]

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1997 03 04.78		M	9.5	TI	35	L	5	66	3.5	5/	0.07	115	HOR02
1997 03 04.79		S	9.8	AC	25.4	L	5	65	2.5	D4			MEY
1997 03 04.83		S	10.1	AC	28.0	T	6	59	3	2			MOE
1997 03 04.86		S	9.0	AC	8.0	B		12	8	2			BAR06
1997 03 04.88		S	13.7	HS	44.0	L	5	156	0.3	5			HAS02
1997 03 05.06		S	9.1	AC	11.0	L	7	50	7	3			BAR06
1997 03 05.49		S	10.1	HS	40.0	L		96	2.1	5			NAG08
1997 03 05.50		S	9.8	AA	10.0	B		25					SEA
1997 03 05.52		S	8.9	VG	10.0	B		20	7.5	5			NAG08
1997 03 05.75		B	8.9	AC	8.0	B		12	12	3/	0.15	90	ISH03
1997 03 05.79		S	9.4	AA	11.0	L	7	32	6	3			VEL03
1997 03 05.83		M	9.3	TI	8.0	B		10	5.5	3/			HOR02
1997 03 05.85		S	9.5	AA	15.0	R	8	30	1.5	2			DIE02
1997 03 06.09		S	10.6	VB	30	R	18	100	1.6	3			SHA02
1997 03 06.76		S	10.0	AA	6.3	R	13	52	3	1			KOS
1997 03 06.81		S	9.9	AC	15.2	L	5	42	2.5	3			MOE
1997 03 06.82		M	9.8	GA	25.4	J	6	58	2.2	4			BOU
1997 03 07.51		S	9.2	HS	10.0	B		20	4	5			YOS02
1997 03 07.76		M	9.6	TI	10	B		25	4.5	3/			ZNO
1997 03 07.80		M	9.4	TI	20	L	5	48	4.5	5	0.05	105	PLS
1997 03 07.80		M	9.5	TI	20	L	5	48	4	4/			HOR02
1997 03 07.80		S	9.9	AC	25.4	L	6	104	4	s5	0.3	90	BAK01
1997 03 07.80		S	10.4	AC	25.4	L	6	104	4	s4	0.25	80	SAR02
1997 03 07.80		S	10.4	AC	25.4	L	6	104	6	s5	0.6	80	SZE02
1997 03 07.84		S	9.7	AA	15.0	R	8	30	2	4			DIE02
1997 03 07.84		S	9.7	AC	25.4	L	5	65	3	s4			MEY
1997 03 07.91		M	10.1	NP	21.0	L	6	60	4	6			MAR02
1997 03 08.75		M	9.7	TI	10	B		25	4	3			ZNO
1997 03 08.79		S	10.2	AC	33.4	L	5	61	4				SZE02
1997 03 08.88		S	9.5	AC	10.0	B		25	3.1	3			HAS02
1997 03 08.98		S	9.7	AC	6.0	B		20	10	2			SAR02
1997 03 08.99		M	9.9	NP	44.5	L	5	100	3	5/			MAR02
1997 03 09.00		S	10.0	AC	25.3	L	6	58	& 1.6	4/			PER01
1997 03 09.00		S	10.5	AC	25.3	L	6	58	& 1.6	5			VIT01
1997 03 09.77		S	9.4	AA	11.0	L	7	32	4.1	4			VEL03
1997 03 09.80		S	9.2	AC	11.0	L	7	32	9	5			ISH03
1997 03 09.82		M	9.8	GA	25.4	J	6	72	2.5	4/			BOU
1997 03 09.83		S	9.5	AC	20.3	T	10	50	1.9	5			KAM01
1997 03 09.85		S	9.7	AA	15.0	R	8	30	2	4			DIE02
1997 03 09.86		S	9.8	AC	25.3	L	6	58	& 2.2	4			PER01
1997 03 09.86		S	10.4	AC	25.3	L	6	58	& 1.9	4/			VIT01
1997 03 09.87	a	S	10.3	NP	25.3	L	6	58	& 2.2	4			PER01
1997 03 09.87	a	S	10.5	NP	25.3	L	6	58	& 1.9	4/			VIT01
1997 03 10.06		S	9.0	AC	11.0	L	7	32	7	3			BAR06
1997 03 10.75		S	10.4	AA	6.3	R	13	52	2	1			KOS
1997 03 10.80		S	9.8	AC	15.2	L	5	42	3	3			MOE
1997 03 10.80		S	10.0	AC	33.4	L	5	61	6	s6	0.5	95	SZE02
1997 03 10.81		S	9.3	AA	11.0	L	7	32	4	3			VEL03
1997 03 10.82		S	9.6	AC	25.4	L	5	65	3	s5			MEY
1997 03 10.86		M	9.2	TI	20	L	5	48	3.7	4/			HOR02
1997 03 11.46		S	9.6	AA	10.0	B		25					SEA
1997 03 11.77		M	9.8	TI	10	B		25	3.5	3/			ZNO
1997 03 11.79		S	9.2	AA	11.0	L	7	32	4	4			VEL03
1997 03 11.79		S	9.6	AC	25.4	L	5	65	2.5	4/			MEY
1997 03 11.84		M	9.1	TI	20	L	5	48	4	4/			HOR02
1997 03 11.85		S	10.6	VB	20	R	14	90	2.0	3		190	SHA02
1997 03 11.92		S	9.9	AC	25.3	L	6	58	& 3.2	4			PER01
1997 03 11.92		S	10.2	AC	25.3	L	6	58	& 2.2	4			VIT01
1997 03 11.93	a	S	9.9	NP	25.3	L	6	58	& 3.2	4			PER01
1997 03 11.93	a	S	10.4	NP	25.3	L	6	58	& 2.2	4			VIT01
1997 03 12.42		S	9.4	AA	10.0	B		25					SEA
1997 03 12.76		M	9.6	TI	10	B		25	4	4			ZNO
1997 03 12.81		M	9.1	TI	20	L	5	48	3.5	4/			HOR02
1997 03 12.82		M	9.6	TI	20	L	5	48	3.7	4			PLS
1997 03 12.97		M	9.8	AC	25.3	L	6	58	& 3.2	3/			PER01

Comet 81P/Wild 2 [cont.]

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1997 03 12.97		S	9.7	AC	25.3	L	6	58	& 3.2	3/			PER01
1997 03 12.97		S	10.6	VB	30	R	18	100	1.6	s3			SHA02
1997 03 16.09		M	9.9	AC	25.3	L	6	58	& 3	3/			PER01
1997 03 16.09		S	9.8	AC	25.3	L	6	58	& 3	3/			PER01
1997 03 21.96		S	10.7	VB	30	R	18	170	0.8	3			SHA02
1997 03 22.81		S	9.9	AC	15.2	L	5	42	2.5	2			MOE
1997 03 26.81		S	9.5:	AC	20.0	L	5	70	5	2			BAR06
1997 03 26.94		S	10.2	VB	20	R	14	90	1.5	3			SHA02
1997 03 27.17		S	9.8	AA	20.0	T	10	64	2.2	3/			SPR
1997 03 27.85		S	9.4:	AC	5.0	B		20	5	2/			BAR06
1997 03 28.88		M	9.3	NP	44.5	L	5	100	2	5			SAN04
1997 03 28.88		M	9.9	NP	44.5	L	5	100	1.5	6			MAR02
1997 03 28.90		S	9.9	AA	15.0	R	8	30	2	6			DIE02
1997 03 28.91		S	9.8	VB	20	T	10	75	1.7	s4			SHA02
1997 03 29.84		S	9.8	AC	15.2	L	5	42	3	2			MOE
1997 03 29.85		M	9.7	NP	21.0	L	6	60	1	6	2.0m	70	MAR02
1997 03 29.85		S	10.5	AA	6.3	R	13	52	3	2			KOS
1997 03 29.87		S	9.7	AC	25.3	L	6	58	& 3	3			PER01
1997 03 29.87		S	10.1	AC	25.3	L	6	58	& 2	4			VIT01
1997 03 30.82		M	9.7	TI	10	B		25	2.5	5	0.08	110	ZNO
1997 03 30.84		M	9.3	TI	20	L	5	48	2.8	4/			HOR02
1997 03 30.84		S	9.3	AA	11.0	L	7	32	6	4			VEL03
1997 03 30.85		M	9.7	TI	20	L	5	48	3.5	4			PLS
1997 03 30.85		S	8.9	AA	11.0	L	7	32	6	4			BAR06
1997 03 30.86		S	9.0	AA	5.0	B		20	5	3			BAR06
1997 03 30.87		S	9.7	VB	20	T	10	75	2.0	4			SHA02
1997 03 30.89		S	9.7	GA	15.6	L	5	29	4.0	2/			BOU
1997 03 30.94		S	9.5	VB	10	B		14	2.8	3			SHA02
1997 03 30.94		S	11.3	HS	30	T	10	170	1	2			GOL02
1997 03 31.85		S	9.1	AA	5.0	B		20	5	3			BAR06
1997 03 31.86		M	9.9:	NP	21.0	L	6	60	3	5/	2.0m	80	MAR02
1997 03 31.86		S	9.8	GA	25.4	J	6	72	3.0	3/			BOU
1997 03 31.87		S	9.4	S	20.3	T	10	80	2.3	4/			KAM01
1997 03 31.88		S	9.6	AC	25.3	L	6	58	& 2.2	4			PER01
1997 03 31.88		S	9.9	AC	28.0	T	6	68	2.5	3			MOE
1997 03 31.88		S	10.0	AC	25.3	L	6	58	& 0.8	4			VIT01
1997 03 31.89		S	9.7	VB	20	T	10	75	2.7	s4			SHA02
1997 04 01.80		S	9.6	HD	44.5	L	5	146	2.5	s5	0.4	100	SAR02
1997 04 01.85		S	9.2	AA	11.0	L	7	32	6	4			BAR06
1997 04 01.86		S	9.1	AA	11.0	L	7	50	5.5	4			BAR06
1997 04 01.86		S	9.6	S	20.3	T	10	80	2.2	4/	0.02	100	KAM01
1997 04 01.87		S	8.9	AA	5.0	B		20	6	3			BAR06
1997 04 01.87		S	9.7	GA	25.4	J	6	58	3.3	3			BOU
1997 04 01.87		S	10.3	AA	15.0	R	8	30	1.5	6			DIE02
1997 04 02.81		M	9.6	TI	10	B		25	3	4	0.07	105	ZNO
1997 04 02.83		S	9.2:	AA	5.0	B		20	3	2			BAR06
1997 04 02.86		M	9.7	TI	35	L	5	66	3	3/	0.1	120	HOR02
1997 04 02.91		E	10.4	NP	30	L	5	60	3	4			NEV
1997 04 02.91		S	9.8	HD	44.5	L	5	82	5	5/	0.3	110	SAR02
1997 04 03.79		S	9.8	HD	6.0	B		20	4	2			SAR02
1997 04 03.79		S	9.9	HD	44.5	L	5	82	2	s6			SAR02
1997 04 03.80		S	10.0	HD	6.0	B		20	1	0			KIS02
1997 04 03.83		S	9.3	AA	11	L	7	32	5	3			BAR06
1997 04 03.86		S	9.5	VB	33	L	5	45	1.9	3			SHA02
1997 04 03.86		S	10.3	AA	15.0	R	8	30	1.5	6			DIE02
1997 04 04.83		S	9.3:	AA	5.0	B		20	3	2			BAR06
1997 04 04.88		S	9.6	AC	25.3	L	6	58	& 2.3	3/			PER01
1997 04 04.88		S	10.1	AC	25.3	L	6	58	& 1.3	4			VIT01
1997 04 05.86		M	9.9	NP	21.0	L	6	60	1.5	6			MAR02
1997 04 06.83		S	9.7	S	20.3	T	10	80	2.2	4/			KAM01
1997 04 07.80		M	9.7	TI	10	B		25	3	4/	0.07	100	ZNO
1997 04 07.85		S	9.7	S	20.3	T	10	80	2.1	4			KAM01
1997 04 07.86		S	10.0	AC	15.2	L	5	42	2.5	3			MOE
1997 04 07.88		E	10.4	NP	30	L	5	60	3	4/			NEV
1997 04 07.88		M	9.7	GA	25.4	J	6	58	3.0	3/			BOU

Comet 81P/Wild 2 [cont.]

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1997 04 07.88		S	9.7	VB	33	L	5	45	1.8	3			SHA02
1997 04 07.89		S	11.3	HS	30	T	10	170	1.5	2			GOL02
1997 04 09.84		S	10.0	AC	15.2	L	5	42	2.5	3			MOE
1997 04 09.89		E	10.4	NP	30	L	5	60	3	4/			NEV
1997 04 09.90		S	10.1	VB	20	T	10	75	1.4	s3			SHA02
1997 04 10.89		S	10.2	VB	33	L	5	75	2.9	3			SHA02
1997 04 11.21		S	9.9	AC	20.0	T	10	125	2.3	3/			SPR
1997 04 11.84		S	10.2	TI	10	B		25	2	2			HYN
1997 04 11.88		S	10.6	VB	30	R	18	100	1.8	3			SHA02
1997 04 13.80		M	9.7	TI	10	B		25	3	4/	0.07	105	ZNO
1997 04 23.89		S	[10.4	VB	20	R	14	90					SHA02
1997 04 24.83		S	9.3	VF	20	L	5	71	5.3	3			BAR06
1997 04 26.83		S	9.2	VF	20	L	5	71	8	2			BAR06
1997 04 26.85		S	10.2	AC	15.2	L	5	42	2	3			MOE
1997 04 27.22		S	10.3	AC	20.0	T	10	125	1.9	2/			SPR
1997 04 27.83		S	9.6:	VF	20	L	5	71	& 4	2/			BAR06
1997 04 28.83		S	9.6:	VF	20	L	5	71	5	2			BAR06
1997 04 29.90		S	10.2	AC	25.3	L	6	58	& 2	2/			PER01
1997 04 29.90		S	10.3	AC	25.3	L	6	58	& 2	3			VIT01

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DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1996 11 13.83		C	19.2	GA	60.0	Y	6	a240	0.25			295	NAK01
1997 01 18.88		C	17.0	GA	60.0	Y	6	a240	0.55		2.8m	292	NAK01
1997 02 04.84		C	16.7	GA	60.0	Y	6	a120	0.6		2.1m	291	NAK01
1997 03 01.74		C	16.3	GA	60.0	Y	6	a120	0.6		3.3m	288	NAK01
1997 03 11.71		C	16.1	GA	60.0	Y	6	a120	0.85		3.6m	287	NAK01

Comet 96P/Machholz 1

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1996 08 13.70		S	[11 :	AA	20	L	8	83					CO002
1996 08 31.74		S	[11 :	AA	20	L	8	83					CO002

Comet 100P/Hartley 1

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1997 01 18.85		C	19.1	GA	60.0	Y	6	a240	0.35		0.9m	297	NAK01
1997 01 19.87		C	19.1	GA	60.0	Y	6	a240	0.35		0.8m	293	NAK01
1997 02 04.85		C	18.4	GA	60.0	Y	6	a240	0.4		1.8m	289	NAK01
1997 03 05.71		C	16.9	GA	60.0	Y	6	a240	0.5		2.4m	285	NAK01
1997 03 11.77		C	16.9	GA	60.0	Y	6	a120	0.6			295	NAK01

Comet 109P/Swift-Tuttle

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1992 11 12.82		S	5.2	AE	5.0	B		10	4.5	6/			DOH
1992 11 13.78		S	4.9	AE	5.0	B		10	4	6/	0.5	32	DOH
1992 11 18.90		S	4.8	AE	5.0	B		10	4	6/	0.33	42	DOH
1992 11 20.72		S	5.1	AE	5.0	B		10	3.7	6/	0.33	42	DOH
1992 11 23.83		S	5.0	AE	5.0	B		10	3.5	6	0.5	45	DOH
1992 11 26.73		S	4.9	AE	5.0	B		10	3.5	6	0.42	54	DOH

Comet 118P/Shoemaker-Levy 4

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1996 12 28.78		S	12.9	AC	25.4	L	5	104	1.0	3			MEY
1997 01 06.84		S	12.4	AC	25.4	L	5	104	1.2	3/			MEY
1997 01 12.86		S	12.8	AC	25.4	L	5	104	1.1	2/			MEY
1997 01 25.74		S	13.0:	HS	35	L	5	237	1	2/			HOR02
1997 01 26.76		S	12.8	AC	25.4	L	5	104	0.8	3			MEY
1997 01 30.43		C	13.1	GA	60.0	Y	6	a120	2.5			70	NAK01
1997 02 01.78		S	12.9	AC	25.4	L	5	104	1.0	2/			MEY
1997 02 01.84		M	13.5	HS	35	L	5	158	0.8	3			HOR02

Comet 118P/Shoemaker-Levy 4 [cont.]

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1997 02 01.89		S	13.1	AC	25.4	J	6	115	0.9	1			BOU
1997 02 02.75		M	12.7:	HS	35	L	5	104	1.6	2/			PLS
1997 02 02.75		M	12.8	HS	35	L	5	104	1.5	3			HOR02
1997 02 02.86		S	13.3:	VB	30	R	18	170	0.7	3			SHA02
1997 02 03.46		S	12.8	GA	25.4	L	4	71					SEA
1997 02 05.86		B	13.0	HS	25.6	L	5	42	1.5	5			BIV
1997 02 06.79		M	12.7	HS	35	L	5	104	1.4	3			HOR02
1997 02 06.80		S	13.7:	HS	25.4	L	6	104	1	4			SAR02
1997 02 07.75		S	13.2	HS	44.5	L	5	230	0.7	3/			SAR02
1997 02 07.78		S	12.9	AC	25.4	L	5	104	1.2	2			MEY
1997 02 07.92	a	S	12.9	AC	25.4	J	6	88	1.4	1/			BOU
1997 02 07.93		S	13.5:	VB	33	L	5	100	1.3	2			SHA02
1997 02 07.97		S	14.2:	VB	30	R	18	170	0.7	1			SHA02
1997 02 08.79		S	13.4	HS	44.5	L	5	230	0.5	2			SAR02
1997 02 08.79		S	13.5	HS	44.5	L	5	230					BAK01
1997 02 08.89		S	12.5	NP	44.5	L	5	100	1	2			MAR02
1997 02 08.89		S	12.7	NP	44.5	L	5	100	2	1			SAN04
1997 02 09.51		C	13.3	GA	60.0	Y	6	a120	2.2				NAK01
1997 02 09.94		S	12.9	AC	25.4	L	5	104	1.1	2			MEY
1997 02 10.82		S	13.5:	VB	30	R	18	290	0.3	2			SHA02
1997 02 10.91	a	S	13.0	AC	25.4	J	6	88	1.4	1			BOU
1997 02 14.78		M	12.7	HS	35	L	5	237	0.7	2			HOR02
1997 02 14.79		S	12.6	HS	35	L	5	237	0.7	1/			PLS
1997 02 24.44		C	13.6	GA	60.0	Y	6	a120	1.75		2.8m	94	NAK01
1997 02 25.85		S	14.1	VB	30	R	18	290	0.7	3			SHA02
1997 02 28.77		M	13.0	HS	35	L	5	158	0.9	2			HOR02
1997 03 01.78		S	13.5	HS	35	L	5	237	0.5	3			HOR02
1997 03 01.83		S	13.1:	AC	25.4	L	5	104	1.1	1			MEY
1997 03 02.92		S	[13.5	VB	30	R	18	290					SHA02
1997 03 05.78		M	13.3	HS	35	L	5	237	0.8	2/			HOR02
1997 03 07.77		S	13.3	HS	35	L	5	237	0.8	1/			HOR02
1997 03 07.78		M	13.2	HS	35	L	5	237	0.6	3			PLS
1997 03 07.81		S	14.5	HS	44.5	L	5	230	1	2/			SAR02
1997 03 07.81		S	14.6	HS	44.5	L	5	230	1	5			BAK01
1997 03 07.81		S	14.6	HS	44.5	L	5	230	1	5	0.03	90	SZE02
1997 03 08.83		S	13.7	HS	44.0	L	5	156	0.3	3			HAS02
1997 03 10.79		S	13.2	HS	35	L	5	237	0.9	1/			HOR02
1997 03 10.81		S	13.3	AC	25.4	L	5	104	0.8	2			MEY
1997 03 11.79		S	13.3:	HS	35	L	5	158	0.8	1/			HOR02
1997 03 12.80		S	13.1	HS	35	L	5	158	1.2	1/			HOR02
1997 03 12.81		M	12.9	HS	35	L	5	158	0.8	3			PLS
1997 03 31.88		S	13.8:	VB	20	T	10	135	0.5	2			SHA02
1997 04 01.84		S	14.5:	HS	44.5	L	5	230	0.5	3			SAR02
1997 04 02.85		S	13.2:	HS	35	L	5	237	0.7	2			HOR02
1997 04 02.92		S	[13.5	HS	44.5	L	5	230	0.5				SAR02
1997 04 09.88		S	[13.8	VB	20	T	10	135					SHA02

Comet 121P/Shoemaker-Holt 2

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1997 01 31.66		C	14.9	GA	60.0	Y	6	a120	1.5		2.2m	254	NAK01
1997 02 02.90		S	14.3	HS	35	L	5	237	0.7	2/			HOR02
1997 02 07.04		S	13.7	HS	44.5	L	5	230	0.8	5			BAK01
1997 02 07.04		S	14.5:	HS	44.5	L	5	230	1	3			SAR02
1997 02 07.19		S	13.9:	HS	35	L	5	237	1	3			HOR02
1997 03 01.69		C	14.8	GA	60.0	Y	6	a120	1.3		1.7m	251	NAK01
1997 03 01.82		S	13.8:	HS	35	L	5	237	0.5	2			HOR02
1997 03 04.81		S	14.1	HS	35	L	5	237	0.7	2			HOR02
1997 03 04.85		S	9.5	AC	10.0	B		25	1.3	4			HAS02
1997 03 05.82		S	13.9	HS	35	L	5	158	0.7	2/			HOR02
1997 03 07.83		S	13.9	HS	35	L	5	237	0.9	2			HOR02
1997 03 07.84		S	13.9	HS	35	L	5	237	0.8	1/			PLS
1997 03 07.98		S	14.5	HS	44.5	L	5	230	0.5	6			SAR02
1997 03 07.98		S	14.7	HS	44.5	L	5	230	0.4	8			SZE02
1997 03 07.98		S	14.9	HS	44.5	L	5	230	0.5	s6			BAK01

Comet 121P/Shoemaker-Holt 2 [cont.]

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1997 03 08.83		S	14.1	HS	44.0	L	5	156	0.6	3			HAS02
1997 03 08.99		S	14.6	HS	44.5	L	5	230	0.7	3			SAR02
1997 03 08.99		S	14.6	HS	44.5	L	5	230	1	5/			BAK01
1997 03 10.84		S	14.6	HS	35	L	5	237	0.6	2/			HOR02
1997 03 11.65		C	15.0	GA	60.0	Y	6	a120	1.0		1.8m	240	NAK01
1997 03 11.83		S	14.0	HS	35	L	5	237	0.9	1/			HOR02
1997 03 12.93		S	14.4	HS	35	L	5	237	0.8	1			HOR02
1997 04 02.92		S	13.7	HS	44.5	L	5	230	1	3/			SAR02

Comet 122P/de Vico

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1995 10 03.78		B	5.8	AA	20.0	C	9	60	2.6	8	0.9	295	NAG04
1995 10 06.80		B	5.6	S	20.0	C	9	60		7	1.2	300	NAG04
1995 10 09.81		B	5.6	S	10.0	R	4	20	2.3	7	<1.0		NAG04
1995 10 25.18		S	6.0:	SC	6.0	R	10	30	6				MAN01
1995 11 04.84		B	7.9	S	15.0	B		25	3.9	3			NAG04

Comet 126P/IRAS

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1996 12 28.40		C	14.3	GA	60.0	Y	6	a120	1.2				NAK01
1997 01 12.43		C	14.2	GA	60.0	Y	6	a120	1.9		2.1m	77	NAK01
1997 01 30.42	a	C	15.0	GA	60.0	Y	6	a120	1.3		2.3m	69	NAK01
1997 02 09.43		C	15.0	GA	60.0	Y	6	a120	1.1			62	NAK01
1997 02 24.42	a	C	15.3	GA	60.0	Y	6	a120	1.0				NAK01
1997 03 08.80		S	[14.0	HS	44.0	L	5	222					HAS02

Comet P/1997 B1 (Kobayashi)

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1997 02 04.75		C	17.5	GA	60.0	Y	6	a240	0.3	8/	0.6m	290	NAK01
1997 02 09.69		C	17.4	GA	60.0	Y	6	a240	0.4	8	0.6m	295	NAK01
1997 02 27.62		C	17.6:	GA	60.0	Y	6	a240	0.4	8	1.0m	297	NAK01

Comet P/1997 C1 (Gehrels)

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1997 02 04.71		C	17.4	GA	60.0	Y	6	a240	0.55		1.3m	291	NAK01
1997 02 09.66		C	17.9	GA	60.0	Y	6	a240	0.6		1.5m	290	NAK01
1997 02 24.45		C	18.4	GA	60.0	Y	6	a240	0.45		1.2m	298	NAK01
1997 03 01.60		C	18.4	GA	60.0	Y	6	a240	0.45		1.1m	298	NAK01
1997 03 05.56		C	18.4	GA	60.0	Y	6	a240	0.4		1.9m	294	NAK01

◇ ◇ ◇

Below: two drawings of comet C/1996 B2 (Hyakutake) by Martin Lehký at Hradec Králové, Czech Republic, as seen through a 42-cm f/5 L (75×), on 1996 Mar. 25.94 (left) and Mar. 27.81 (right).