INTERNATIONAL COMET QUARTERLY

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The International Comet Quarterly (*ICQ*) is a journal devoted to news and observation of comets, published by the Smithsonian Astrophysical Observatory in Cambridge, Massachusetts. Regular issues are published 4 times per year (January, April, July, and October), with an annual *Comet Handbook* of ephemerides published normally in the first half of the year as a special fifth issue. An index to each volume normally is published in every other October issue (even-numbered years); the *ICQ* is also indexed in *Astronomy and Astrophysics Abstracts* and in *Science Abstracts Section A*.

The regular (invoiced) subscription rate is US$31.00 per year for surface-mail delivery (price includes the annual *Comet Handbook*; the price without the *Handbook* is US$23.00 per year). Subscribers who do not wish to be billed may subscribe at the special rate of US$23.00 per year for surface-mail delivery (rate is $15.00 without *Handbook*). Add $15.00/year to each of these rates for airmail delivery outside of the United States or for first-class delivery within the U.S. [The last set of digits (after the hyphen) on the top line of the mailing address label gives the Whole Number that signifies the last *ICQ* issue which will be sent under the current subscription status. An asterisk after these numbers indicates credit for the next annual Comet Handbook. The first five digits represent the subscriber's account number.] Make checks or money orders payable in U.S. funds (and drawn on a U.S. bank) to *International Comet Quarterly* and send to Mail Stop 18; Smithsonian Astrophysical Observatory; 60 Garden St.; Cambridge, MA 02138, U.S.A.

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Group subscription rates available upon request. Back issues are $6.00 each — *except* for "current" *Comet Handbooks*, which are available for $15.00 ($8.00 to subscribers if ordered with their *ICQ* subscription; see above). Up-to-date information concerning comet discoveries, orbital elements, and ephemerides can be obtained by subscribing to the *IAU Circulars* and/or the *Minor Planet Circulars* (via postal mail and also available via computer access); for further information, contact the above e-mail address (or the *ICQ* at the above postal address).

Cometary observations should be sent to the Editor in Cambridge; all data intended for publication in the *ICQ* that is not sent via computer electronic mail should be sent on standard *ICQ* observation report forms, which can be obtained upon request from the Editor. Those who can send observational data (or manuscripts) in machine-readable form are encouraged to do so [especially through e-mail via the computer networks *SPAN* (6700::DAN) or Internet (ICQ@CFA.HARVARD.EDU), or via floppy disks that can be read on an IBM PC], and should contact the Editor for further information. The *ICQ* has extensive information for comet observers on the World Wide Web, including the Keys to Abbreviations used in data tabulation (see URL http://cfa-www.harvard.edu/icq/icq.html). In early 1997, the *ICQ* published a 225-page *Guide to Observing Comets*; this edition is now out of print, but a revised edition is under preparation.

Most of the Observation Coordinators (OCs) listed below have e-mail contacts with the *ICQ* Editor; observers in the general area of such OCs who lack access to e-mail networks may send data to the OC for relay to the *ICQ* in electronic form.

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This issue is No. 117 of the publication originally called *The Comet* (founded March 1973) and is Vol. 23, No. 1, of the *ICQ*. *[ISSN 0736-6922]*

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2001 COMET HANDBOOK

The *2001 Comet Handbook* was mailed to all *ICQ* subscribers and complimentary recipients in the first three weeks of January 2001. Note that Syuichi Nakano's *Nakano Notes* (abbreviated 'NK') are now available on the World Wide Web at `http://www.oaa.gr.jp/~oaacs/nk.htm`.

George E. D. Alcock (1912 August 28-2000 December 15)

For most amateur astronomers, one comet or nova would be ample compensation for the years of lonely labour on chilly nights. The astronomer-schoolteacher George Alcock, who visually discovered five comets and five novae in the cloudy skies of England, once remarked that in 65 years' serious observing he had made 'only' ten discoveries. His total of ten finds nevertheless constitutes the all-time record for discoveries of comets and novae from the British Isles.

Alcock acknowledged his good fortune in possessing exceptionally keen eyesight and an excellent memory. The dogged perseverance he exhibited throughout his astronomical career, however, was a virtue of character rather than an innate gift. Inspired by the partial solar eclipse of 1921 April 8, he began studying the heavens at the age of eight; and ten years later, while a student teacher, he joined the Meteor Section of the British Astronomical Association (BAA). After many hair-raising experiences (including three courts-martial) in North Africa and Italy during World War II, he returned to England to find radar fast replacing human meteor-observers. It was time to contemplate other areas of astronomy to which an amateur might usefully turn his attention.

On 1953 January 1, he embarked on a five-year search for a comet. He was not, however, optimistic: "It was almost 60 years since a comet had been discovered in England." And in autumn 1955, he extended his search to cover novae. Already familiar with the positions of about 1,000 stars down to magnitude 6, he now set himself the task of memorising the positions of 20,000+ stars of magnitudes 7 and 8. In December 1957, after acquiring 25×105-mm binoculars and having greatly increased his familiarity with the constellations, he notified the BAA Comet Section of his intention to extend the comet search for another five years.

His 'near misses' were legion. The most painful was undoubtedly the bright Nova Cygni 1975 ("I'd missed a sitting duck . . ."); though the pain was eased when American pre-discovery photographs proved the nova to have been too faint to be seen through binoculars at the time he was observing the relevant area of Cygnus. Comets that eluded him included C/1955 O1 (Honda), lurking behind a neighbour's chimney; C/1956 R1 (Arend-Roland), just below barely visible galaxies; C/1963 R1 (Pereyra), resembling a distant car headlight; and C/1966 T1 (Rudnicki), which he was unable to relocate. As a keen meteorologist, Alcock did his best to predict optimum viewing times; but the weather was a constant enemy. In 1967 he advised fellow readers of *The Astronomer*: "No English comet-hunter can afford to be lethargic, no matter how trying the conditions!"

Of his successes, the best known to *ICQ* readers will be the five comets named Alcock: tailless, 10th-magnitude C/1959 Q1 (old-style designation 1959e) in Corona Borealis on August 25, and just five days later bright but short-lived C/1959 Q2 (1959f) in Cancer; 8th-magnitude C/1963 F1 (1963b) in Cygnus on March 19, which flared to naked-eye visibility in May; 10th-magnitude C/1965 S2 (1965h) in Hercules on September 26; and in Draco on May 3, the close-approach C/1983 H1 (1983d) — named IRAS-Araki-Alcock — which he was pleased to note was giving the professionals "some headaches but also some really new results".

The sole carer of his disabled wife, Alcock could only rarely attend the monthly BAA meetings in London. A quiet, modest man, he nevertheless remained fully aware of the value of his contributions to the science of astronomy. As a conscientious observer and meticulous recorder, he was understandably upset when his results were queried (usually by fellow Britons unfamiliar with the extent of his visual capacity) and greatly appreciative of the fact that vindication came most often from America. In January 1974, one of his sketches of comet C/1973 E1 (Kohoutek; O.S. 1973f) showed a detail unreported by other observers: a large, faint, uniform gas cloud on the sunward side of the coma. On this occasion it was *Sky & Telescope* that came to the rescue, with a photograph that confirmed the accuracy of his observation.

Mary Alcock died seven months after her husband made his final discovery, Nova Herculis 1991. Five years later, at the age of 84, he was still energetically engaged in studying weather patterns, birds, insects, botany, art, music, and church buildings, as well as the night sky. Yet in his own estimation, his most important achievement lay in the years he spent teaching. He was a much loved teacher with the gift of inspiring a passion for knowledge, as one former student recalled: "He just wanted us to be as excited by it all as he was. We were lucky enough to have our own private expert on art, architecture, geography, natural history, meteorology and astronomy." He had a profound influence on the lives of two generations of schoolchildren. And virtually all of them remember his dictum, "Live every moment of life, don't waste a minute."

Though memory and eyesight began to fail him in 1997, he was able to remain in Antares — the fenland house and garden from which he made all ten of his discoveries — almost to the end. His final public appearance was on 1999 August 15 at New Hall, Cambridge, where fellow astronomers at the second International Workshop on Cometary Astronomy gave him a standing ovation. A memorial service for George Alcock was to have been held on February 17 in the magnificent setting of Peterborough Cathedral, in whose lofty 12th-century nave he heard his first organ recital 80 years ago.

— *Kay Williams (Leighton Buzzard, England)*

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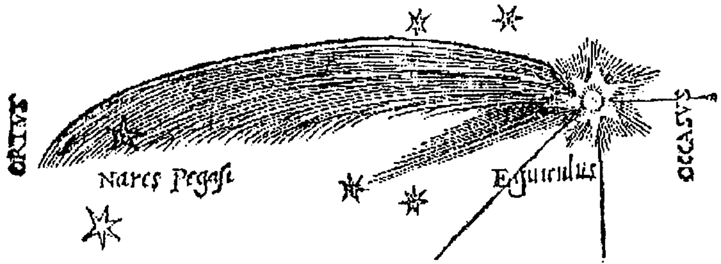
CORRIGENDUM

• In the October 2000 issue (*ICQ* 116), p. 148, and "Table of Contents" on cover (p. 103), *the title* INDEX TO THE INTERNATIONAL COMET QUARTERLY: Volume 17-22 *should read* INDEX TO THE INTERNATIONAL COMET QUARTERLY: Volume 18-22



Cambridge, England
1999 August 14-16

Second International Workshop on Cometary Astronomy

IWCA II: Introduction to Procedings Papers

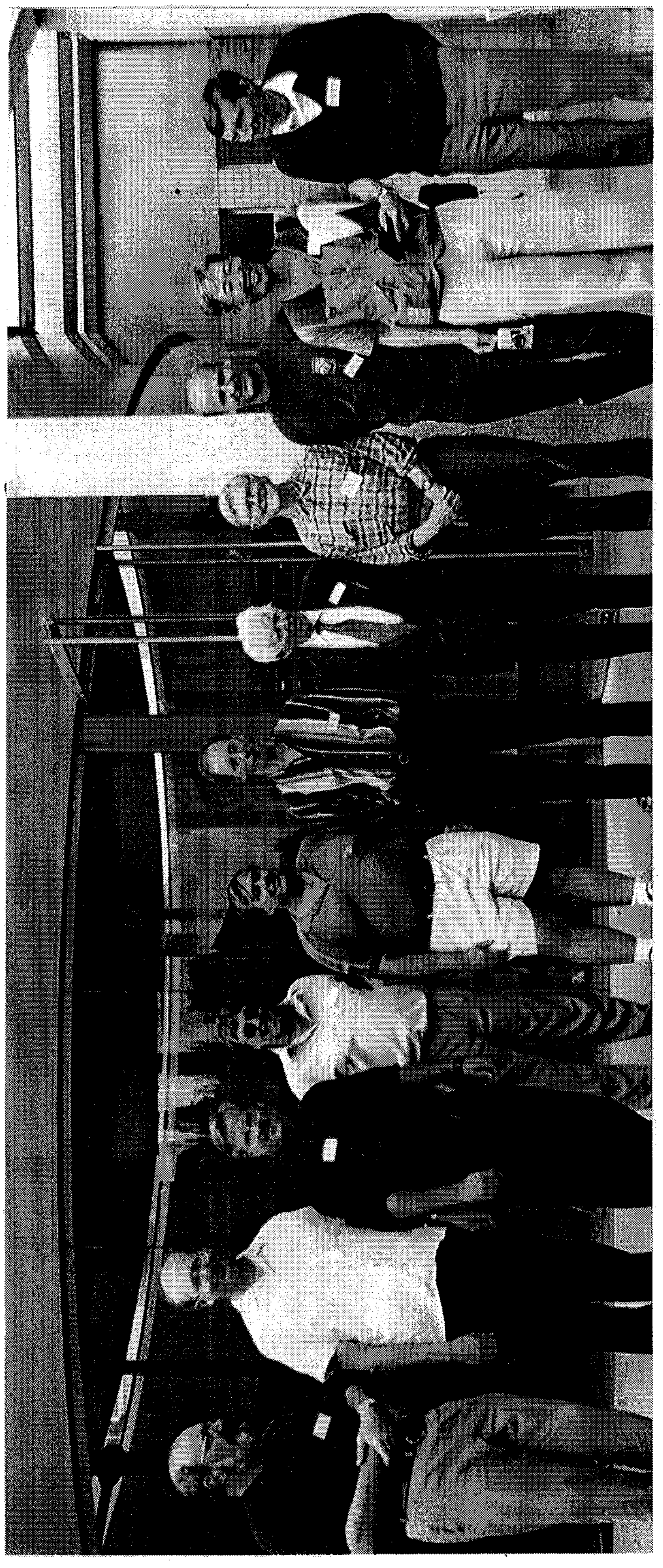
The second International Workshop on Cometary Astronomy (IWCA II) was held at New Hall at the University of Cambridge (U.K.) the weekend following the total solar eclipse of 1999 August 11. As I noted in the July 1999 *ICQ* (p. 79), a well-written, in-depth review of the meeting itself was written by co-organizer Jonathan Shanklin (printed in *The Comet's Tale* and still available at his website at URL `http://www.ast.cam.ac.uk/~jds/iwcarep.html`). Given Shanklin's splendid job, it seemed redundant for me to try and duplicate his efforts.

Indeed, I instead have put my efforts into editing (with the great help especially of the *ICQ* Associate Editors, Charles Morris and Carl Hergenrother, and also with referee help from the *ICQ* Editorial Advisory Board) the papers included in this issue. As was noted at the IWCA II itself, contributions of papers for publication in this procedings issue are (as is normal for all *ICQ* articles) refereed, sometimes by as many as three or four referees and editors. The aim is to keep a high standard for published material, even for amateur astronomers, such that readers can be confident of information that they find in the *ICQ* (though mistakes in any scientific publication do sometimes creep in). The process for refereeing and editing the IWCA II contributed papers has been a very lengthy one, partly because numerous of the papers were written by authors whose first language is not English (and thus have required much work to refine the English, in close collaboration with the authors). Several papers are still being revised by the authors, and the decision was made to split the proceedings papers into two or more issues of the *ICQ*, with this issue containing the first three contributions. It his hoped that three or four more IWCA II papers will be ready for publication in either the April or July 2001 issue of this journal.

It is with sadness that I note the passing of George Alcock, but we were especially glad that he was able to attend the Sunday meeting of the IWCA II, with great thanks to the efforts of his brother, John Alcock, and his biographer, Kay Williams, for arranging for his transportation to Cambridge. I am also grateful to Mrs. Williams for quickly responding to my request for an obituary article, and her fine synopsis of Alcock's life appears on page 3 of this issue; I again call readers' attention to her wonderfully written biography of George Alcock, *Under an English Heaven* (reviewed in *ICQ* **19**, 156).

George Alcock appears in the photograph of eleven comet discoverers (on page 5 of this issue) that was taken outside of New Hall in Cambridge during a break in at the Workshop. Additional participants at the meeting (as contributed by Jonathan Shanklin, the local organizer, with some additions by the undersigned) include, in alphabetical order: George Alcock, John Alcock, Doug amd Barbara Biesecker, Nicolas Biver, Tom Boles, Owen Brazell, Bernd Brinkman, Guiseppe Canonaco, Kazimieras Černis, Marie-Jose Danhiez, Frances Darroch, Kenelm England, Richard and Nicky Fleet, Stephane Garro, Dan Green, Alan Hale, Werner Hasubick, Sebastian Hoenig, Guy Hurst, Michael Jäger, Nick James, Andreas Kammerer, Xavier Leprette, Bill Liller, Angel Lopez, Don and Laura Machholz, Joe Marcus, Brian, Nancy, and Cindi Marsden, Salvador Sanchez- Martinez, Jean-Claude Merlin, Maik Meyer, Herman Mikuž, Carmelita Miranda, Martin Mobberley, Philippe Morel, Charles Morris, Neil Morrison, Bob Neville, Simona Nikolova, Janine Paccioni, Andrew Pearce, Helene Reyss, Bianca Rembrandt, Juan Rodriguez, David and Margaret Seargent, Jon Shanklin, Patrick, Meg, and Kyle Stonehouse, Gyula Szabo, Kesao Takamizawa, Keith Tritton, Cliff Turk, Miguel-Antoni Villalonga, Frans, Rene and Maarten Van Loo, Rene Verseau, Bill Ward, Kay Williams. — *D. W. E. Green*

Photographs taken at the second International Workshop on Cometary Astronomy by Carmelita Miranda. Top: photograph showing eleven comet discoverers present at the meeting on Sunday, August 15, 1999 (from left to right, shown are David Seargent, Australia; Don Machholz, U.S.A.; Patrick Stonehouse, U.S.A.; Keith Tritton, U.K.; Alan Hale, U.S.A.; Doug Biesecker of SOHO fame, U.S.A.; George Alcock, U.K.; William Liller, Chile; Michael Jäger, Austria; Kesao Takamizawa, Japan; and Kazimeras Černis, Lithuania. Bottom: photograph of IWCA II participants taken by Miranda on Saturday, August 14, in front of New Hall at the University of Cambridge.



CCD Photometry of Comet C/1995 O1

Herman Mikuž[1,2] *and Bojan Dintinjana*[2]

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[2]Department of Physics, University of Ljubljana, Slovenia

Abstract. This contribution is based on our program of CCD photometry of faint comets, performed mainly with 20-cm and 36-cm telescopes, V filters, and two CCDs. The recent apparition of comet C/1995 O1 (Hale-Bopp) proved to be an excellent opportunity to test our observing method, instrumentation, and software on a very bright comet. We found that our V observations of faint comets tend to be systematically fainter by 0.5-1 magnitude, in spite of the fact that CCDs record systematically more coma than does the human eye. We explain this with the fact that the human-eye and V-filter passbands are not the same and have thus different responses to C_2*, which is the main emission from the coma. Additional problems may appear with bright comets that have prominent inner tails composed mainly of dust. In the case of comet C/1995 O1, we show that by carefully choosing the aperture radius, the resulting total (*m_1*) V magnitudes are in good agreement with* m_1 *values of experienced visual observers.*

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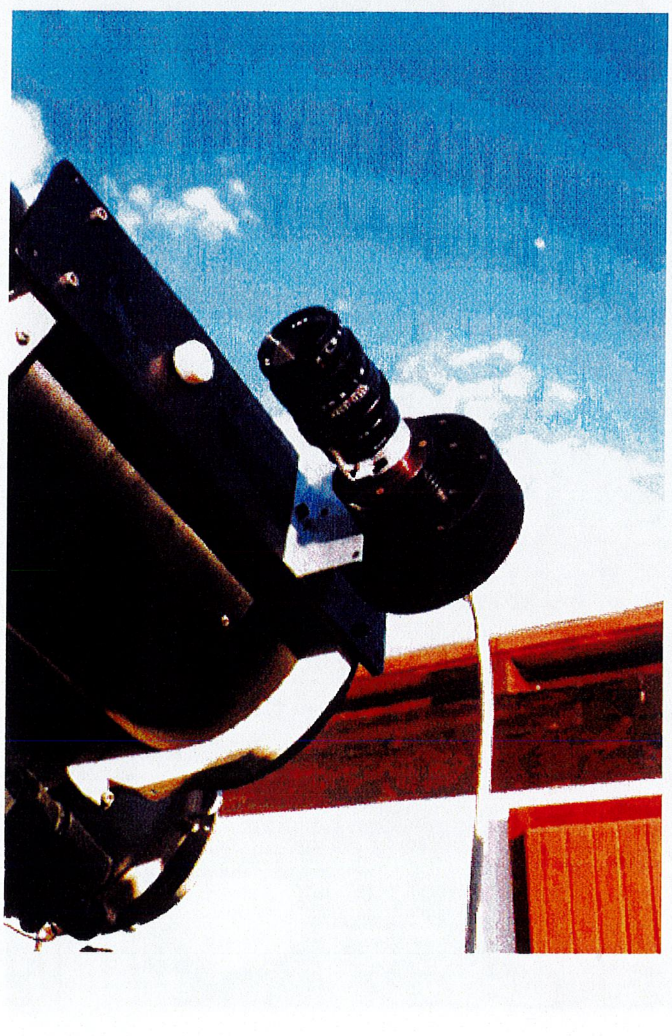
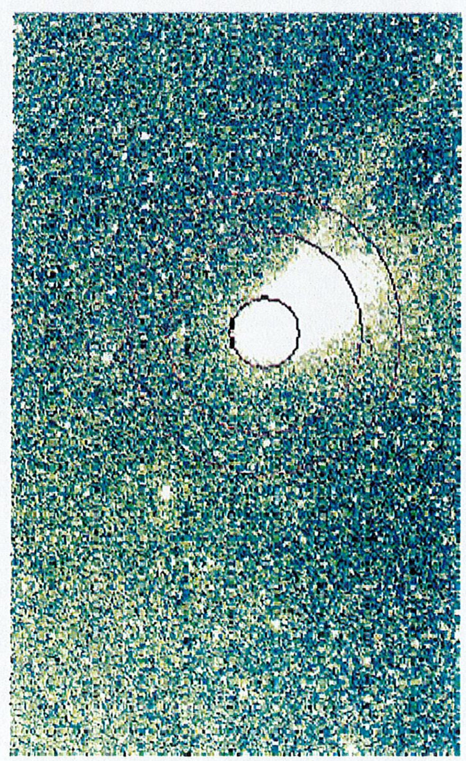
Figure 1 (left): Photograph showing the 90-mm lens with V filter and ST-6 CCD camera (mounted on the side of a larger telescope used for guiding) that was used for the comet photometry described in the paper. Figure 4 (right): The positioning of the three aperture annuli upon the Feb. 22 V image of comet C/1995 O1 (see text). [Note: Figures 2 and 3 are printed in black-and-white on pages 8 and 9.]





1. INTRODUCTION

With bright comets such as C/1996 B2 (Hyakutake) or C/1995 O1 (Hale-Bopp), the comae reached large angular sizes, so that the comet's nuclear condensation and the surrounding coma could be distinguished even with the naked eye. Total visual magnitude estimates m_1 when comets are very bright are usually made with the unaided eye. Useful results are obtained only by experienced observers, using special observing methods. Visual m_1 estimates of bright comets also require bright comparison stars that are often far away from the comet in the sky and located at different altitudes above the horizon. This may require good transparency over the large areas of night sky, and the resulting m_1 values should be corrected for atmospheric extinction. The quality of estimates therefore depends on the observer's experience and the physical morphology of the comet, as well as sky conditions. Bright comets are often located close to the horizon, where sky conditions (haze, clouds) hamper precise observations. We considered the use of a wide-field CCD imaging systems to be more appropriate than visual observing for this type of situation. Such an array may easily cover a field of several degrees, so that the comet and comparison stars always appear within the same frame (as CCD photometry can employ comparison stars that are much fainter than the comet, due to the inherent linearity of the CCD chip).

2. OBSERVATIONS

2.1. Instrumentation.

All observations were performed at the Crni Vrh Observatory in Slovenia, located some distance southwest of Ljubljana. The 1996 observations were collected with a 20-cm $f/2$ Baker-Schmidt camera and an ST-6 CCD, covering a field that extends $72' \times 54'$. After it passed conjunction in late December 1996, C/1995 O1 became visible again in the early January morning sky. By mid-January, the comet had brightened to third magnitude, and its coma diameter had grown to $\approx 1°$. At that time, we switched our observations to a new combination of short-focus lenses and CCDs. Three combinations employed a Wright CCD (578×385 pixels; pixel size $22\mu m \times 22\mu m$; thinned): a Zeiss Sonar 180-mm $f/2.8$ lens that yielded a useful field-of-view (FOV) of dimensions $3^{\circ}\!.8 \times 2^{\circ}\!.5$; a 250-mm $f/3.5$ lens that yielded a useful FOV of $2^{\circ}\!.8 \times 1^{\circ}\!.9$; and a 90-mm $f//2.8$ lens that yielded a useful FOV of dimensions $7^{\circ}\!.5 \times 5^{\circ}\!.0$. The pixel sizes for these three combinations are $25''\!.2$, $18''\!.2$, and $50''\!.4$, respectively. A fourth combination used an ST-6 CCD (375×244 pixels; pixel size $23\mu m \times 27\mu m$) and a 90-mm $f//2.8$ lens that yielded a useful FOV of dimensions $5^{\circ}\!.5 \times 4^{\circ}\!.1$ (with a pixel size of $52''\!.7 \times 61''\!.9$). These lenses are commercial lenses of very good optical quality, designed for use with 6×6-cm or 35-mm camera bodies and were used previously by us for photographic observations of comets.

In order to measure comparison stars and the comet in the standard Johnson V band, we used a V photometric filter as proposed by Bessel (1990, 1995). This filter is composed of two Schott glasses (2-mm GG495 + 3-mm BG39) and was assembled in a local optical workshop. By using standard calibration procedures (Henden and Kaitchuk 1990), we found that our V filter and CCD combinations are very close to the standard Johnson V passband.

2.2. Observational method.

Our observational methods were similar to the technique that we described previously for faint-comet photometry (Mikuž and Dintinjana 1994). Because of the low resolution of our imaging systems (typically $\approx 30''$-$60''$/pixel), the comparison-star images were undersampled. This usually results in some inconsistency in instrumental magnitudes, which we overcome by taking several consecutive images of comparison stars. With bright comets, the images became saturated even on very short exposures. The exposure times depend on the sensitivity of the CCD and were in the range 1-20 seconds for the ST-6 detector and < 5 sec with the Wright detector. The integration times for the comparison stars were considerably longer. Obviously it is necessary to be careful and avoid the saturation of both stellar and cometary images. Another way to avoid saturation is by slightly defocusing the lens. However, the lens should remain defocused by the same amount until the whole photometric sequence is completed. Usually, a sufficient amount of defocusing is achieved by turning the lens ring for ≈ 1 mm in either direction, so that the image is spread over more pixels. We used this method for the March 10 photometric sequence obtained with our 90-mm lens. We never took exposures shorter than one second for two reasons. The star signal became spoiled due to atmospheric scintillation noise. Also, CCDs with mechanical shutters do not have well-defined short exposures due to delays in shutter operation. During the final reduction, the comparison-star instrumental magnitude was corrected to the same integration time as the comet, and the magnitudes were then compared.

Because of a large FOV, at least two comparison stars were easily found within the frame. In case they were more than 2° away from comet, atmospheric-extinction corrections were applied (Green 1992). We used comparison stars from the *Bright Star Catalogue* (Hoffleit 1982), as it contains precise V-band photometry for stars down to 7th magnitude.

3. IMAGE PROCESSING AND DATA REDUCTION

The image-processing and data-reduction procedures (including software packages) were basically the same as described in our paper about faint-comet photometry (Mikuž and Dintinjana 1994). Since the comet was close to Milky-Way regions, stellar images frequently appeared inside the comet's coma. On such occasions, all stars of mag 12 and brighter were removed with PCVISTA software. Since the comet was rather low over the horizon throughout the apparition, the sky-brightness gradient differed significantly over the frame. This gradient was removed via the SKYSUB program, which calculates the linear sky-brightness gradient and reduces it to a mean sky value. In this way, we obtain images with uniform sky background.

The instrumental magnitudes of C/1995 O1 were obtained with FitsPro computer software (Dintinjana 1996) written for MS Windows. This software includes a user-friendly routine for CCD aperture photometry and was adapted to meet some specific requirements encountered during the CCD photometry of comets. Before the FitsPro program is run, we need to carefully determine the radius of the star/comet aperture in pixels, as well as the inner/outer radius of the surrounding sky background. The program counts the units inside the specified aperture, subtracts the sky counts — leaving only the star/comet counts — and converts them into instrumental magnitudes.

3.1. The influence of aperture size on total V magnitude.

The question of including the tail in the estimation of total V magnitude has come up with the recent appearances of bright comets. The definition that was adopted for m_1 (or total V) is the total integrated magnitude of the comet's

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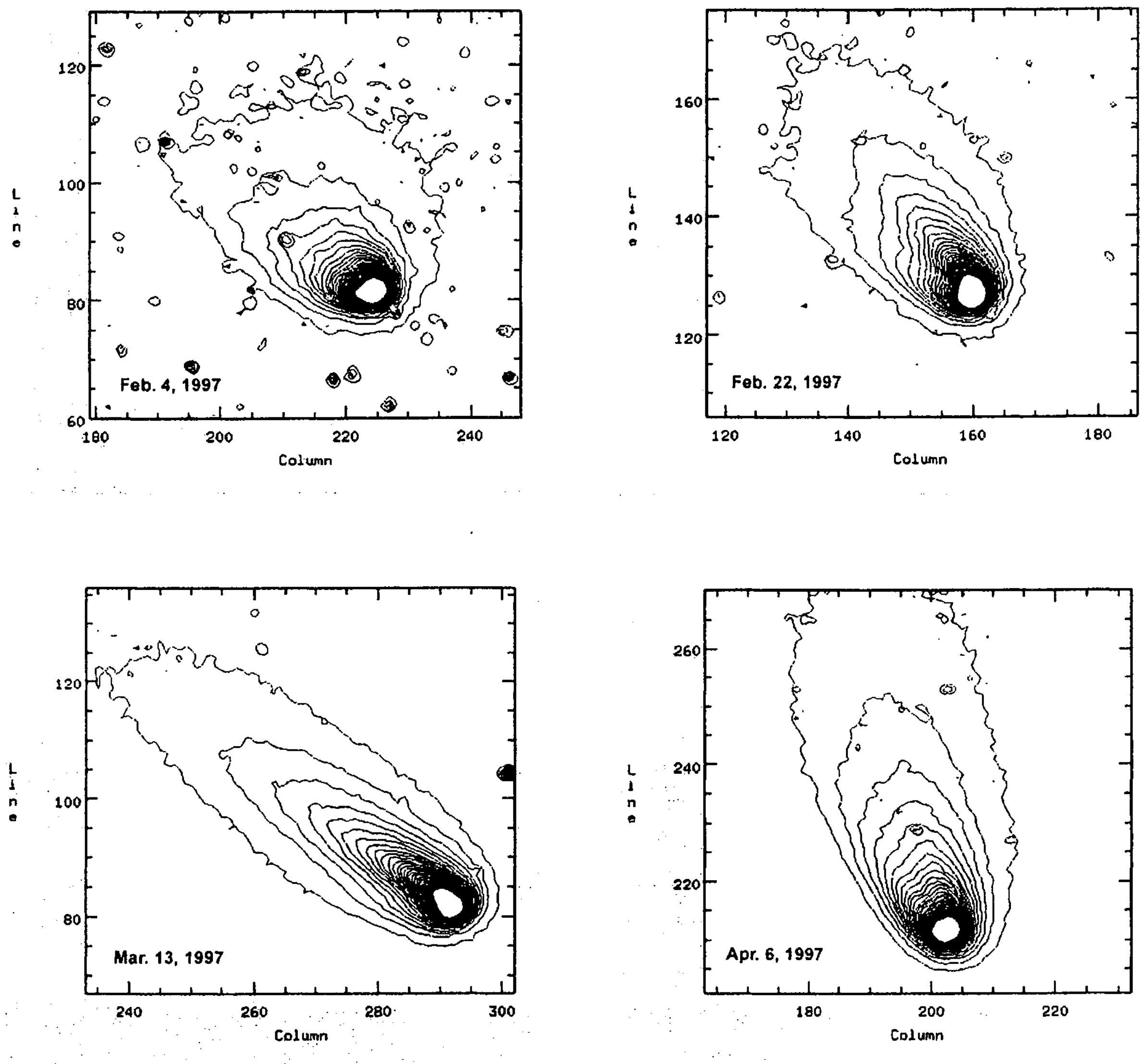

Figure 2. The coma and inner-tail development in comet C/1995 O1 during the period February-April 1997. Contoured maps were obtained with the IRAF software package, using four CCD images obtained during February-March 1997. All images are 3-sec exposures with a 90-mm f/4 lens and a V filter. Each isophote represents a 50-unit increase in coma brightness. The image scale is ~ 1 arcmin/pixel (corresponding to a field size of ~ 70′ × 70′). Morphological changes in the coma and tail development are well visible. While only the coma and broad dust tail are present on the Feb. 4 image, the prominent dust tail already dominates on the Feb. 22 image. Two bright jets of dust and gas are present on the April 6 image. It is also remarkable that coma dimensions did not change much during the analyzed period.

[text continued from page 8]
coma, not including the tail. Our observations show that the definition works fine with faint to moderately bright comets that develop only coma and gas tails, while the dust component remains less conspiciuous. For these comets, any increase of aperture size beyond the coma diameter does not influence noticeably the V magnitude, except for a small amount of background noise. However, with bright comets that have bright inner dust tails, as with C/1996 B2 and C/1995 O1, this may be difficult to do: it may be difficult to determine where the coma ends and the tail begins, especially with naked-eye observations (Green 1997a). These problems are well represented in our morphological analysis of the coma and tail development of comet C/1995 O1 during the period February-April 1997 (see Figure 2).

Figure 3 shows how much coma and dust tail are included within the various aperture sizes. The innermost circle on each image represents the aperture diameter that we selected for performing the CCD V photometry shown in Table 1. The outer two circles determine the sky region around the coma where the *FitsPro* software measured the sky-background value. The program then counts the units inside the innermost circle, subtracts the sky counts found between the outer two circles (leaving only the star/comet counts), and converts them into instrumental magnitudes.

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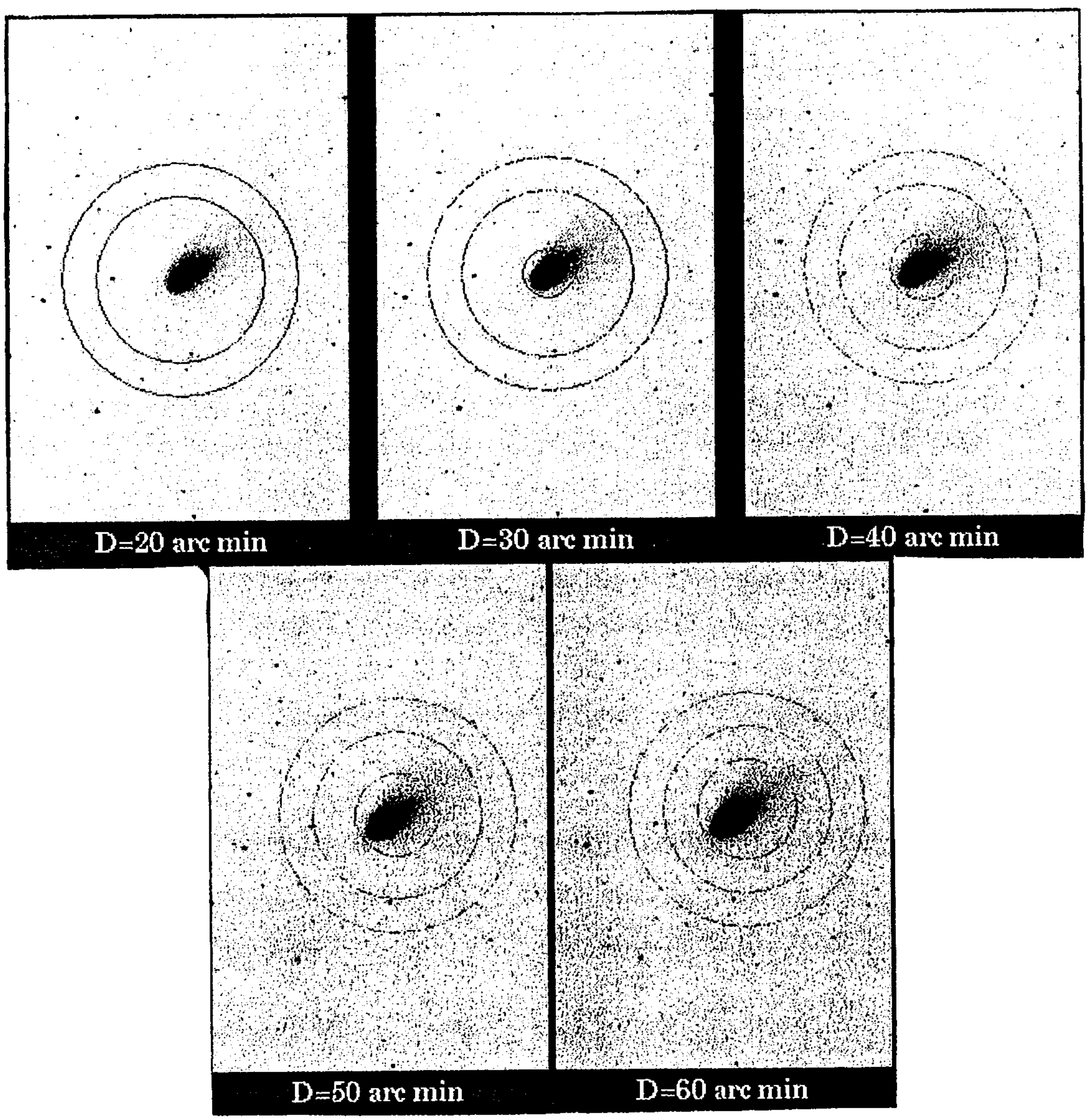

Figure 3. 1997 Feb. 22 sample image of comet C/1995 O1, superimposed by various aperture sizes. Standard V filter with a 90-mm-focal-length f/2.8 lens and ST-6 CCD; exposure time 10 seconds. Aperture diameters 20′-60′; inner sky diameter 100′; outer sky diameter 140′.

[text continued from page 9]

In order to investigate the influence of the bright inner dust tail in our total V measurements, we analyzed several images of comet C/1995 O1 taken on 1997 Feb. 4, 21, 22, and 23. Table 1 clearly shows that total V magnitude results are influenced by the aperture diameter that we used. This is not a surprise, since (as one may see on the images) a conspicuous dust tail was already present and a considerable amount of its brightest part has been included inside the specified apertures. The table above also shows that, over the range of $\approx 20'$-$60'$ in aperture diameter, D, every increase of $\approx 10'$ in D results in a 0.1- to 0.2-magnitude increase in total V magnitude. Going farther away (beyond 40′), the magnitude increase is smaller, and it became negligible at diameters beyond 60′. Thus, in case of comets with bright dust tails, the total V magnitude depends considerably on the selection of the aperture radius.

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Table 1. *Results of CCD photometry on 1997 Feb. 4, 21, 22, and 23, using five different apertures (D), given in minutes of arc.*

Total V magnitude

D	2/4	2/21	2/22	2/23
20'	2.4	1.2	1.15	1.0
30'	2.2	1.0	1.0	0.8
40'	2.1	0.9	0.9	0.7
50'	2.0	0.8	0.8	0.6
60'	1.9	0.75	0.75	0.5

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3.2. The determination of aperture diameter.

In order to properly determine the size of the comet's coma, we studied its dimensions on a Feb. 22 sample image by using two independent methods: (a) using a histogramic equalization technique, and (b) analyzing the coma intensity profile.

In order to include the comet's coma to the full extent, we carefully determined the aperture radii visually by using a histogramic display that is incorporated in the `FitsPro` computer software, enabling us to detect the smallest changes near the sky background. The aperture diameter was adjusted to match the coma diameter as much as possible, and the aperture annulus was placed so that it coincided with the outer coma radius on the sunward side of the coma. An example is given in Figure 4 (see page 6).

Aperture radii were adopted according to changes in the coma size, having been around 20′ through most of 1996, growing to 30′-45′ in 1997. The inner and outer sky radii were placed as far away from the comet as possible, to avoid the sky values being contaminated by the coma or tail.

Furthermore, using `IRAF` software, we obtained the coma-intensity profile for the Feb. 22 image (Figure 5). The profile cross-section was placed over the comet's nuclear condensation in the direction perpendicular to the sun-comet radius vector. It peaks at 18,000 units and (at $R \approx 20$ pixels) rather sharply vanishes in the sky noise. The coma diameter derived from the profile was thus ≈ 40 pixels (corresponding to 38′), which is in good agreement with the values we obtained with histogramic analysis. If we further increase the aperture diameter (beyond 40 pixels), we obtain only some small amount of additional coma flux and considerable amount of sky noise.

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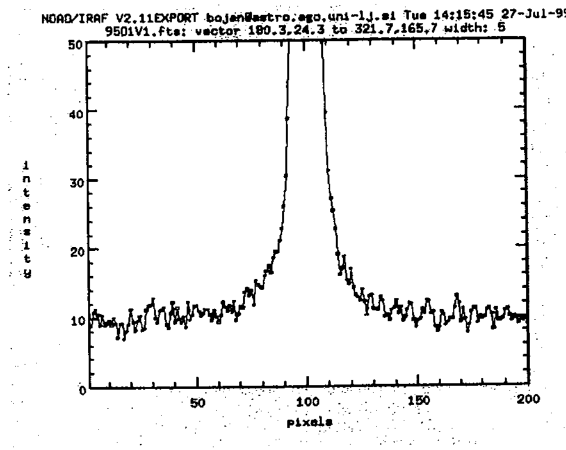

Figure 5. Intensity profile of the coma of comet C/1995 O1, obtained from the Feb. 22 V-filter image.

[text continued from page 10]

4. RESULTS OF CCD *V* PHOTOMETRY OF COMET C/1995 O1

Altogether, 63 CCD *V* measurements were collected, covering the period March 1996-April 1997. Of the total of 63 observations, 35 were obtained during January-April, when the comet reached its maximum brightness. In order to compare our CCD *V* results, we plotted them together with selected visual m_1 estimates from the *International Comet Quartely (ICQ)* archive (Green 2001a). A total of 1026 total visual magnitude estimates, covering the same time span as our CCD data, were used in the analysis. The visual data were carefully selected by Green, whereby observer experience and good arcs of observation were strongly considered, leaving only observations with good consistency and internal errors not exceeding 0.5 magnitude. In addition, we included the CCD data from two other observers that provided either filtered or unfiltered CCD data to the *ICQ* archive. The list of *ICQ* observers whose visual and CCD data were used is given in Table 2.

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Table 2. *ICQ observers, providing visual m1 and CCD data.*

CCD observers	
MIK	Herman Mikuž, Slovenia (V filter)
ROQ	Paul Roques, AZ, U.S.A (V filter)
NAK01	Akimasa Nakamura, Japan (unfiltered)
Visual observers	
ADA03	Brian Adams, MN, U.S.A.
BOR	John E. Bortle, NY, U.S.A.
BOU	Reinder J. Bouma, The Netherlands
DES01	Jose Guilherme de Souza Aguiar, Brazil
GLI	Gunnar Glitscher, Germany
GRA04	Bjoern Haakon Granslo, Norway
GRE	Daniel W. E. Green, U.S.A.
HAV	Roberto Haver, Italy
KRO02	Gary W. Kronk, IL, U.S.A.
LUE	Hartwig Luethen, Germany
MOR	Charles S. Morris, U.S.A.
SKI	Oddleiv Skilbrei, Norway
SPR	Christopher E. Spratt, BC, Canada

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As seen from Figure 6 (see page 13), the visual observations are very consistent and almost always within half a magnitude for all 13 observers (Green 2001c). In general, our CCD *V* results follow well the *ICQ* visual data throughout the observing period. However, a systematic deviation of ≈ 0.3 mag toward the fainter magnitudes is clearly present in 1996 CCD data, particularly during the comet's standstill brightness period. The 1997 data almost perfectly follow the *ICQ* visual data, with some slight variations near the comet's brightness maximum. Most probably the variations originate from changes in cometary activity around the time of perihelion passage, when the dust and gas release was at maximum.

To check the CCD data alone, we plotted the CCD *V* and unfiltered data together in order to compare the internal consistency, as well as their 'conformance' to visual data. Besides the 63 CCD *V* measurements included in Figure 6, we added also 23 CCD *V* measurements from Paul Roques (*ICQ* observer code ROQ) and 11 unfiltered measurements from Akimasa Nakamura (NAK01). The results are shown on Figure 7 (see page 13). Again, the CCD magnitudes follow well the visual light curve, with some departures present (mainly in Roques' data). The unfiltered data have a surprisingly good fit to the mean curve, though any final conclusions are difficult to state due to the scarcity of data for the 1997 period. It seems reasonable to point out that our CCD *V* data show the least scattering and a good conformance to the visual data; we believe that choosing the proper comparison stars and the use of a consistent observing method played a key role in this.

Furthermore, we performed a coma/aperture-diameter analysis for the same period. We plotted the *ICQ* visual coma diameters and CCD *V* apertures by Mikuž (MIK) against the Modified Julian Date (MJD),[1] and the results are presented in Figure 8. It should be noticed that, with our CCD and *V* filter, we detected systematically more coma than did visual observers. Consequently, we used systematically larger aperture diameters. There is a good agreement between the top third of the visual coma diameters and our CCD *V* coma diameters until the end of 1996 (MJD 50430). A significant increase in CCD *V* aperture diameters is present after MJD 50460, which corresponds to the period January-April when

[1]This corresponds to the Julian Date minus 2400000.5. For example, the dates (abscissa) in Figures 6-9 for comet C/1995 O1 span MJD 50100-50600, corresponding to 1996 Jan. 18-1997 June 1.

the comet was most active; surprisingly, this does not reflect in the CCD V light curve, as one might expect, and it seems to be somewhat in conflict with conclusions found in section 3.1 (above). We suggest that the abrupt increase in CCD V aperture diameters after MJD 50460 is probably due to the fact that we switched to short-focus lenses after this date. According to our experience, CCD images obtained with wide-field lenses tend to include more coma in photometric measurement. However, as shown in Table 1, the outer coma and tail add only 0.1-0.2 magnitude to the comet's total magnitude. Variations of this order are too small to be visible in the final light curve (Figure 6).

The somewhat arbitrary nature of deciding what coma diameter to include while performing the photometric analysis is also shown on Figure 9 (see page 13), where we plotted the aperture diameters used by observers who contributed CCD data.[2] Considerable scattering in aperture diameters is present also among the CCD observers. In particular, the deviation toward the systematically smaller diameters is present in Roques' data. There is no significant difference between the filtered (MIK) and the unfiltered (NAK01) CCD values. Again, these variations do not reflect to a similar extent in CCD light curve (Figure 7). Very good example in confirming this are observations by Nakamura and Roques around MJD 50500 (1997 Feb. 19 and 24) with aperture diameters differing by 20 arc min and reduced CCD magnitudes being almost the same (Figure 7). We may therefore conclude once again that outer coma contributes little to the total comet magnitude.

5. THE PROBLEM OF SYSTEMATICALLY FAINTER CCD MAGNITUDES

Since the start of our program of CCD V photometry of comets in 1992, we noticed that our results on faint-to-moderately bright comets are systematically fainter by 0.5-1 magnitude when compared to visual m_1 estimates. On the other hand, in the case of a very bright comet like C/1995 O1, our CCD V measurements almost perfectly match the visual data (Figure 6). In order to find a reasonable explanation, we further analyzed the visual m_1/CCD light curve of another moderately bright comet and compared it to the CCD light curve of C/1995 O1 (Figure 6). We found comet 103P/Hartley to be a good example, since it was well covered by visual and CCD observers throughout the 1997-1998 apparition. It reached perihelion on 1997 Dec. 22 at $q = 1.03$ AU and passed the earth at $\Delta \simeq 0.8$ AU in early January 1998 (at $m_1 \approx 8$). According to our observations, 103P never showed any dust-tail activity throughout the apparition. The combined light curve of 103P/Hartley (composed of 251 *ICQ* visual, 32 CCD V, 22 unfiltered CCD, and 2 CCD R magnitudes; Green 2001b) is shown in Figure 10 (see page 14). The list of contributing observers is given in Table 3.

Measurements from Roques (*ICQ* code ROQ) were obtained with the Kron-Cousins V filter (Murnaghan Instruments 1999) with a peak transmittance slightly shifted with respect to the Bessell set that we used. According to the manufacturer's data, this filter closely matches the Johnson V passband. However, no calibration of Roques' V filter and CCD to a standard photometric system was actually done (Roques 2001).

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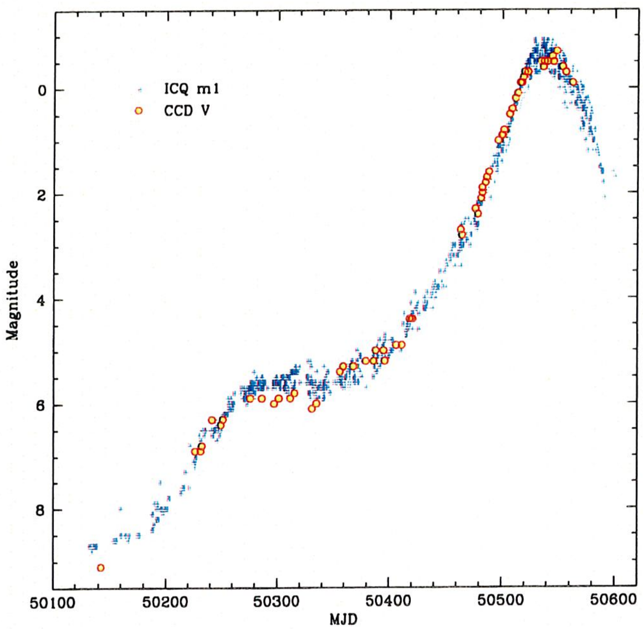
Table 3. *ICQ observers, contributing visual m_1 and CCD data for periodic comet 103P/Hartley.*

	Visual observers
BAR06	Alexandr R. Baransky, Okhnovka, Ukraine
BIV	Nicolas Biver, France
BOR	John E. Bortle, NY, U.S.A.
BOU	Reinder J. Bouma, The Netherlands
GRA04	Bjoern Haakon Granslo, Norway
HAL	Alan Hale, U.S.A.
HAV	Roberto Haver, Italy
KAM01	Andreas Kammerer, Ettlingen, Germany
MAR02	Jose Carvajal Martinez, Spain
MAT08	Michael Mattiazzo, Wallaroo, S. Australia
MOR03	Warren C. Morrison, Canada
OKS	Gabriel Oksa, Trnava, Slovak Republic
PEA	Andrew R. Pearce, Australia
PER01	Alfredo Jose Serra Pereira, Portugal
SAN04	Juan Manuel San Juan, Madrid, Spain
SAR02	Krisztián Sárneczky, Budapest, Hungary
SEA	David A. J. Seargent, Australia
SHA02	Jonathan D. Shanklin, Cambridge, England
SPR	Christopher E. Spratt, BC, Canada
YOS02	Katsumi Yoshimoto, Hirao, Yamaguchi, Japan

(Table 3 continued on page 14)

[2] Observers ROQ and NAK01 reported actual coma diameters to the *ICQ*. However, they both confirmed that they measured the magnitudes of the comet within the coma diameter that was report (and tabulated) with the same published observations (Nakamura 2001; Roques 2001). This means that the reported actual coma diameters are equal to the aperture diameters that they set in performing their photometry. We therefore considered them as 'aperure-size diameters' in this analysis.



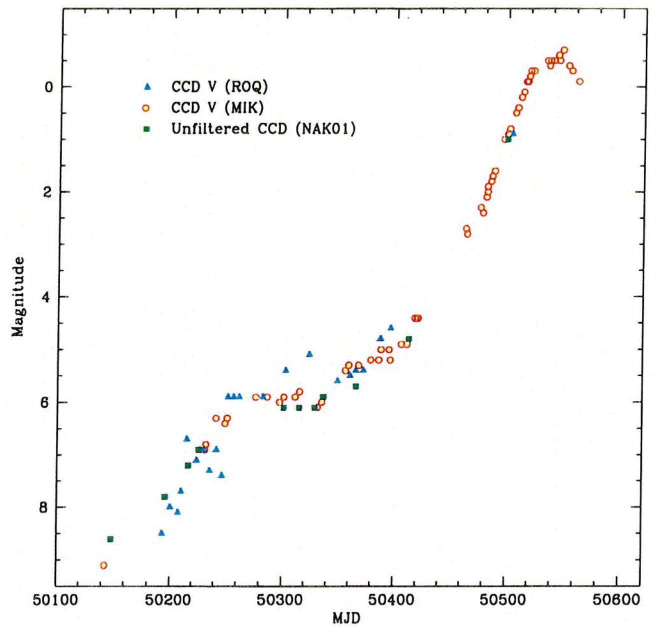


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Figure 6 (above, left). Total CCD V magnitudes of C/1995 O1, superimposed over the ICQ visual m_1 estimates. The range MJD 50100-50600 (abscissa) corresponds to the calendar-date range 1996 Jan. 18-1997 June 1 (see also footnote 2). Figure 7 (above, right). The comparison of CCD V and unfiltered CCD magnitudes of comet C/1995 O1 (see also caption to Figure 6). Figure 8 (below, left). Comparison of all of the ICQ-archive coma diameters vs. the CCD V "aperture diameters" of C/1995 O1 that were used in our m_1 photometry (see also caption to Figure 6). Figure 9 (below, right). Comparison of CCD V "aperture diameters" and unfiltered CCD coma diameters reported by other observers for comet C/1995 O1 (and used in the photometry depicted in Figure 7).

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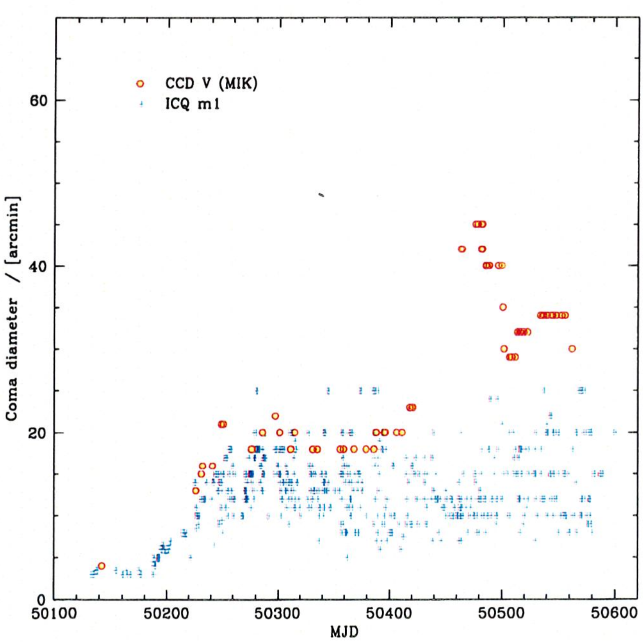

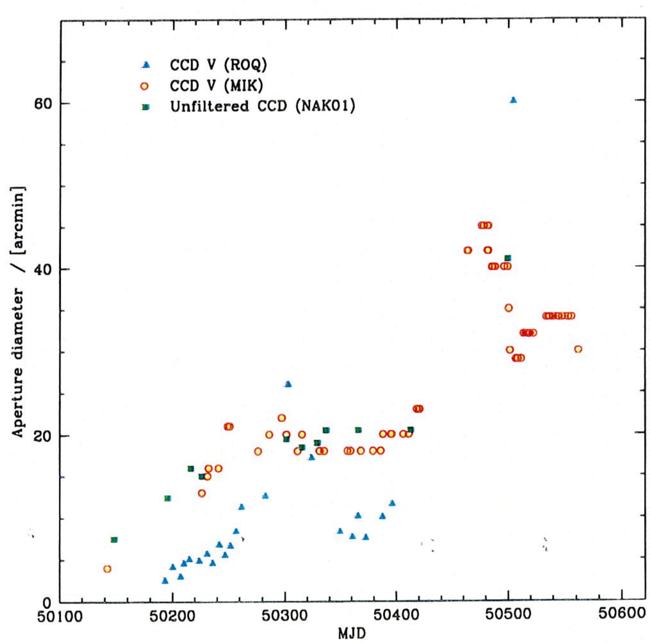

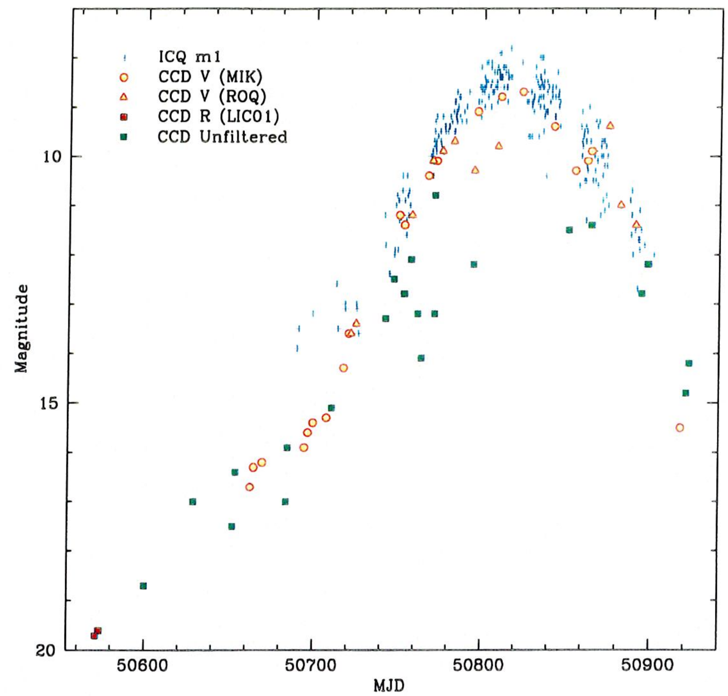

Figure 10. The light curve of comet 103P/Hartley. Visual m_1, CCD V, CCD R, and unfiltered CCD magnitudes are plotted by date. The date range MJD 50600-50900 corresponds to the calendar-date range 1997 June 1-1998 Mar. 28.

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[Table 3 continued from page 12]

	CCD observers	filtering data
MIK	Herman Mikuz, Slovenia	V filter
ROQ	Paul Roques, AZ, U.S.A	V filter
GAL03	Adrian Galad, Modra-Piesok, Slovak Republic	unfiltered
JOH04	Tom Johnston, CO, U.S.A.	unfiltered
LIC01	Javier Andrs Licandro, Uruguay	R filter
NAK01	Akimasa Nakamura, Japan	unfiltered
PRA02	Alexander Pravda, Modra-Piesok, Slovak Republic	unfiltered
SUZ02	Masayuki Suzuki, Utsunomiya, Japan	unfiltered

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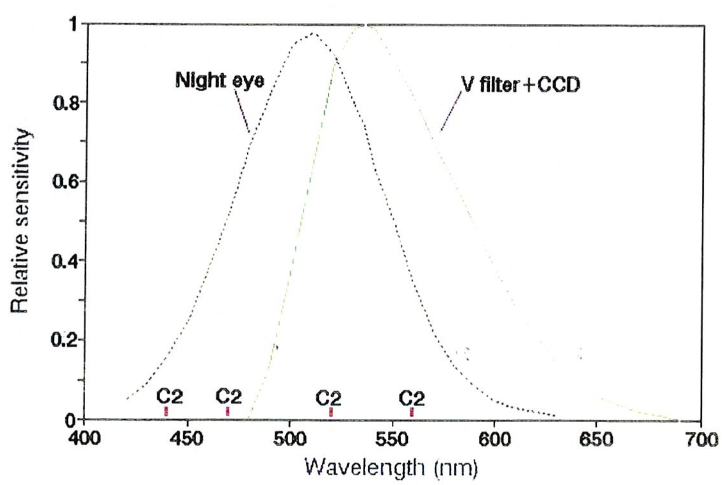

Figure 11. Spectral response of the dark-adapted eye compared to that of a V filter + CCD, as a function of wavelength (with the prominent C_2 emission lines shown for reference).

[text continued from pages 13 and 14]

There is little or only poor-quality visual data until the end of October 1997 (MJD 50750), when the comet's total magnitude was fainter than 12th magnitude. CCD *V* data are quite consistent (except for a few measurements by Roques) and follow well the visual light curve, but they show systematically fainter values by 0.2-0.5 mag around the brightness maximum. Unfiltered CCD data is either quite scattered (prior to MJD 50720 = late September 1997) or well outside of the visual/CCD *V* light curve. Anyway, it should be noticed that all CCD data tend to merge more closely at fainter magnitudes. Figure 10 clearly demonstrates the importance of using filters in performing CCD photometry of comets.

6. CONCLUSIONS

Following the analyses of visual and CCD data of comets C/1995 O1 (Hale-Bopp) and 103P/Hartley, described in sections 4 and 5, some conclusions regarding the visual/CCD light-curve behavior may be drawn:

1. The effects of not including enough coma on CCD images, either due to small FOV or because of bad determination of sky-brightness values due to background-sky contamination where a large coma is involved, have been frequently discussed as a possible reason for getting systematically fainter CCD magnitudes of comets (Green 1997b). Using wide-field imaging systems and proper calibration procedures, we obtained sky values uncontaminated by the comet's coma and tail. By comparing the visual and CCD light curves and coma/aperture diameters for C/1995 O1, represented in Figures 6-9 above, we concluded that integrating the coma to larger radii has a very small effect on the total comet magnitude.

2. In case of faint-to-moderately bright comets, we consider that the light of the comet is mainly composed of the solar continuum and Swan-band emissions. Systematically fainter CCD *V* magnitudes that we obtained are more likely due to different spectral responses of the dark-adapted human eye and a *V*-filtered CCD. Figure 11 compares the responses of the dark-adapted human eye and a *V* filter + CCD to Swan-band (C_2) emissions. While the dark-adapted-eye response curve is almost centered on the Swan bands, the *V* filter transmits only part of this emission. This may explain the systematically fainter CCD results for faint comets (Green 1997b). On the other hand, the *V*-band filter is well positioned also for recording emission from dust in the coma and inner tail. This is the case for bright comets like C/1995 O1 (Hale-Bopp), where the inner dust tail corresponds to a significant part of the light flux, and part of it was unavoidably included in our photometric analysis. In the case of C/1995 O1, the deficiency in recording the C_2 emission was probably compensated with better detection at longer wavelengths (reflection by dust particles), either in the outer coma or inner tail. This may be a reasonable explanation for the nice agreement between our CCD *V* and the visual data.

3. Unfiltered CCD measurements depend much on the color index of the comparison stars. Since the front-illuminated CCD quantum efficiency (QE) peaks in the *R* spectral band, comparison stars with a larger $B-V$ color index are better detected (i.e., they produce more signal). This results in systematically brighter measurements, and the reduced CCD magnitudes of comets are then systematically fainter. This may explain fainter values, sometimes obtained with unfiltered CCDs (Figure 10). Therefore, we recommend the use of comparison stars with $B-V \simeq +0.7$, which is the color index of the sun.

4. Looking into the CCD data of 103P/Hartley (Figure 10), we consider that — far from the sun — the solar continuum may be the prevailing radiation from the comet. This may explain better agreement between unfiltered and *V*-filtered CCD data prior to late Sept. 1997 (MJD 50715) and after early March 1998 (MJD 50880). A possible explanation might be that radiation was about equally well detected by *V*-filtered (transmitting also a part of the *R* band) or unfiltered CCDs, having peak QE in the *R* band where the dust continuum emision is strongest.

Our observations of comet C/1995 O1 are an attempt to obtain a light curve of a bright comet with the implementation of a CCD detector and *V* filter. It is shown that, by properly choosing observational technique and data-reduction procedures, accurate measurements of total *V* magnitudes of a bright comet are possible with a precision exceeding those obtained by visual methods. The combination of CCD and short-focus lenses proved to be a good solution, since it secured a field-of-view large enough to include the comet's coma and suitable standard comparison stars on the same frame. This ensured a good consistency of our results, as well as very good agreement with m_1 values of experienced visual observers. However, due to the fact that the human eye and the *V*-filter passbands are not the same, we suggest that good agreement between visual and CCD *V* results may not occur for some other bright comets that are less abundant in dust.

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Estimating the Rotation Period of Comet C/1995 O1 (Hale-Bopp) From Drawings*

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Abstract. Comet C/1995 O1 (Hale-Bopp) has presented a wealth of highly contrasted structures in its inner coma during spring 1997. Using mainly a 25.6-cm telescope, recurring structures (such as arcs or curved jets) in the inner coma of comet C/1995 O1 were drawn on a weekly to daily basis from 1997 February 6 to May 18. After a careful scaling, measurement of the positions of these features, based on 93 drawings, has enabled an accurate determination of their recurrence period. A first look suggested a period between 7 and 10 days. But some specific observations did show that this was an aliasing effect: indeed, just a little more than two cycles took place every 24 hours. Taking this effect into account, the synodic "rotation period" of comet C/1995 O1 is derived from a three-parameter least-squares linear fit to the expanding shells. Observations spanning from 49 days before to 44 days after perihelion have been used to derive a mean period of 11.33 ± 0.04 hr. If this period did vary on a timescale larger than about ten days during these three months of observations, then the variation should have been within 0.1 hr of the given value.

1. INTRODUCTION

In addition to being a very popular comet because of its brightness and long-lasting appearance in our sky, comet C/1995 O1 (Hale-Bopp) was also a fascinating object to the amateur astronomer, even when observed with small equipment. The inner 1′ to 2′ of the coma showed unprecedented details with high contrast. These were more obvious than in any other of the tens of comets that I have observed since 1985. These shell structures remind us of the ones drawn during the 19th century by J. F. Julius Schmidt and G. P. Bond for comet C/1858 L1 (Donati; O.S. 1858 VI; cf. Rahe *et al.* 1969). I will show that, from sketches drawn at the eyepiece and a minimal use of mathematics, a fairly good estimate of what could be the "rotation period" of the nucleus of C/1995 O1 can be obtained. This work is only an analysis of the coma's appearance, and there is no claim for deducing anything accurate about the nucleus itself or the jet morphology, which can be fairly complex. The aim of this work is not to give the most accurate value but to show that even simple but careful observations can yield valuable results. This paper is mostly based on a previous French version published in *L'Astronomie* (Biver 1998).

2. OBSERVATIONS

Most observations were done with my 25.6-cm Newtonian telescope on a simple Dobsonian-like mount, from various places in the region around Paris (many in the highly light-polluted suburbs, but under generally relatively steady skies). Other telescopes, a 20.3-cm Newtonian, a "Celestron 8" (at Pico Veleta, Spain), and the 60-cm Cassegrain telescope of Meudon Observatory were used on a few other occasions. The magnifications used were all between 159× and 507×, yielding a sufficiently small field-of-view (17′ down to 5′) for an acceptable scaling of the drawings. Step 2 (below) will

* Poster paper presented at the IWCA II.

show that subsequent corrections were still necessary in some cases. Each drawing was rated on a scale of 1 to 5 according to its quality, reflecting the accuracy of the scaling and other problems that may have affected the observation.

3. DATA REDUCTION

I have converted the raw data (for each drawing) into useful numerical values in three steps:

1) The measurement of the positions of each arc with respect to the nucleus, along two different axes (Fig. 1), corrected for the varying earth-comet distance). The choice of the position angles (p.a.) of the two "jets", 170°-190° and 230°-250°, reflects the evolution of the structures between February and May. The shell system evolved in a more-or-less complex manner during this period, but it was always possible to isolate clearly each "arc" along those two directions. The use of two nearly perpendicular directions can help to smooth out some distortion in the drawings;

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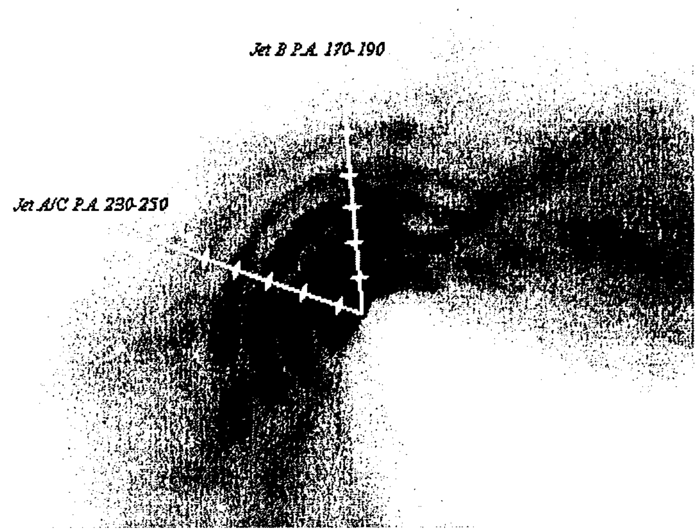

Figure 1. Drawing made at 1997 Apr. 19.830 UT from visual observations with a 25.6-cm reflector (169×), showing the measurement of arc positions. South is up and east is to the right in all drawings. The image size is 4'.5 by 3'.4 (on the sky).

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Table 1. *Mean radial spacing between consecutive arcs.*

Date	r_h [AU]	Mean distance [arcsec]	Mean distance [km]
05/02	1.32	10	14000
10/02	1.26	11	14500
15/02	1.20	12	15000
19/02	1.16	13	15500
23/02	1.13	14	16000
27/02	1.08	15	16500
3/03	1.05	16	16900
8/03	1.01	17	17200
13/03	0.97	18	17600
19/03	0.94	19	18200
26/03	0.92	20	19000
2/04	0.91	19	19000
9/04	0.92	18	18700
15/04	0.95	17	18600
20/04	0.97	16	18500
26/04	1.02	15	18400
2/05	1.07	14	18300
9/05	1.13	13	18000

[text continued from page 17]

2) "Scaling correction": The drawings were primarily scaled (step 1 above) according to star positions of Guide Star Catalog (GSC) stars plotted on the drawing or rough notes of the (known) field-of-view at the eyepiece. However, the GSC was generally not dense enough down to magnitude 13-14 to provide a sufficient number of reference stars for the scaling. A subset of the best-quality drawings (plus three photographs taken with the 60-cm Cassegrain reflector on Feb. 27.2, Mar. 18.2 and Apr. 13.8 UT — although their weight is weak in the total) has been selected as a reference. From these, a mean spacing between each consecutive arc has been deduced as a function of time (Table 1). The other drawing measurements were then corrected by a factor between 0.7 and 1.3 (rounded to the nearest 0.05). This factor was determined from the ratio of the expected spacing of the shells (Table 1) and the measured value. This *a priori* correction only reduces the uncertainty in the derived "rotation period" and was below 5 percent in half of the cases and above 15 percent for only 1/7th of the observations. In some cases, this was necessary, as the drawings were clearly not very well scaled.

3) Once this was done, a second numerical data set was extracted from the 93 observations. Measurements were interpolated or extrapolated (for half of the data) to standard times: 5^h30^m UT for morning observations (22 days or data points) or 20^h30^m UT for evening ones (37 days). To extrapolate, I assumed that the structures were expanding by 1 arc per period — about 11.5 hr, as could already be derived from the previous set (see next section and Table 2, line 1). The standard times were chosen close enough to the times of observation so that corrections were all $< 4''$ on the sky.

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Table 2. *Various measurements of the true "rotation period" [in hours].*

Dates (1997)	Number of points	Number of drawings	Period Jet A/C	Period Jet B	Mean Δ t	Mean Rotation Period
1 point per day at 5:30 UT (Figure 4a)						
6.2–16.2 February	5	6	11.32 ± 0.02	11.34 ± 0.03	-49.3 d	11.32 ± 0.03
19.2–30.2 February	7	16	11.26 ± 0.01	11.26 ± 0.02	-35.2 d	11.26 ± 0.02
2.2–12.2 March	7	14	11.30 ± 0.01	11.29 ± 0.01	-23.5 d	11.30 ± 0.02
12.2–22.2 March	5	7	11.27 ± 0.02	11.36 ± 0.01	-14.5 d	11.32 ± 0.04
Long series:						
2.2–22.2 March	11	19	11.27 ± 0.01	11.30 ± 0.01	-19.7 d	11.28 ± 0.02
1 point per day at 20:30 UT (Figure 4b)						
7.8–17.9 March	4	6	11.27 ± 0.02	11.33 ± 0.01	-17.8 d	11.30 ± 0.03
17.8–25.9 March	7	10	11.29 ± 0.01	11.24 ± 0.02	-11.0 d	11.27 ± 0.03
27.8–36.9 March	7	9	11.34 ± 0.01	11.32 ± 0.02	+0.6 d	11.33 ± 0.02
7.8–15.9 April	4	7	11.24 ± 0.02	11.37 ± 0.01	+10.7 d	11.32 ± 0.07
17.8–24.9 April	8	15	11.56 ± 0.01	11.48 ± 0.01	+20.2 d	11.52 ± 0.04
24.8–37.9 April	5	7	11.32 ± 0.02	11.28 ± 0.02	+30.5 d	11.30 ± 0.03
7.8–18.8 May	5	7	11.41 ± 0.03	11.49 ± 0.03	+43.7 d	11.45 ± 0.05
Long series:						
-16.2–37.9 April	32	49	11.37 ± 0.01	11.33 ± 0.01	+6.2 d	11.35 ± 0.02
1 point per observation: direct measurement (Figure 3)						
7.2–11.2 March	10	10	11.56 ± 0.55	11.46 ± 0.56	-22.93 d	11.51 ± 0.56

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All measurements also assume that there are no significant projection effects to take into account. This would be the case when the brightness maxima correspond to the intersection of a shell with the plane of the sky, rather than to a three-dimensional linear structure.

4. True rotation period: From 9.5 days to 11.3 hours

At the beginning of February, when the structures just became clear but the weather and availability of the comet only enabled a few observations, I thought that I was seeing events recurring on a weekly basis (7-10 days). This is also visible in the series of observations between April 12 and 24 (Figure 5). But later observations proved it to be an aliasing effect due to a sampling period close to 24 hr (every morning or evening, within short observing windows) and that the actual period was a little below 12 hr:

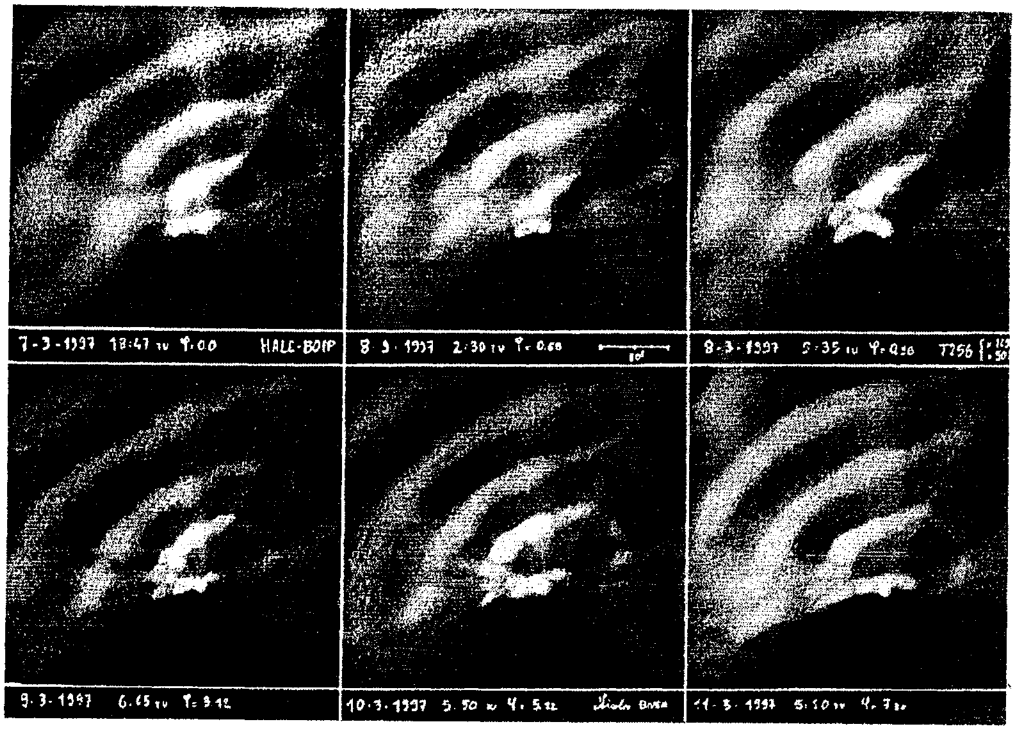

Figure 2. Series of drawings (1997 Mar. 7.8-11.2) extracted from the direct measurement of the rotation period (cf. Figure 3). Each drawing is 90″ by 90″ in size (on the sky). The rotation phase, φ (origin as indicated in Figure 1), is 0.00, 0.68, 0.96, 3.12, 5.22, and 7.30 respectively, from left to right and top to bottom..

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[text continued from page 18]

• A more frequent sampling during the night of 1997 March 7-8 (Figure 2) showed the true period being close to 12 hr.

• Two "outbursts" noticed on March 12.2 and April 22.8 (Figure 5) showed the arcs to be nearly circular (instead of extending from p.a. 100°-160°), which seemed to expand by two arcs the next night.

• An expansion rate of 2 arcs in 24 hr implies a dust velocity around 0.4 km/s (or more if there are projection effects). This is compatible with, and on the same order of magnitude as, the gas expansion velocity (around 1.0 km/s at that time; cf. Biver *et al.* 1999), and close to the value of Burns and Dries (1998).

Then the true period ($P_t \approx 12$ hr) can be related to the apparent period ($P_a \approx 9$ days) and the sampling period ($P_1 = 24$ hr = 1 day):

$$P_1 = P_t(n + P_1/P_a),$$

which implies that $P_t = (n + 1/P_a)^{-1}$ (in days), where n is the number (estimated to be 2) of integer periods P_t in P_1.

5. Least-squares fit to the data: Computation of the period

Figure 3 plots the positions $Y_j(t_i)$ (vertical scale) of each arc j for each date t_i (horizontal scale). Assuming a constant expansion velocity, v, we fit the segments of lines (the slope is v) for each arc j, assuming equal spacing between two consecutive ones: vP in space (vertical scale) or P in time (horizontal scale). Hence, the fitted lines follow the equation

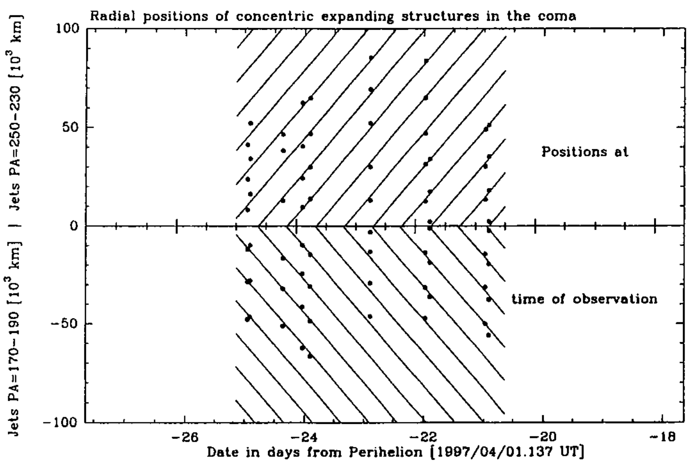
$$Y_j(t) = v[t - t_0 - (j-1)P],$$

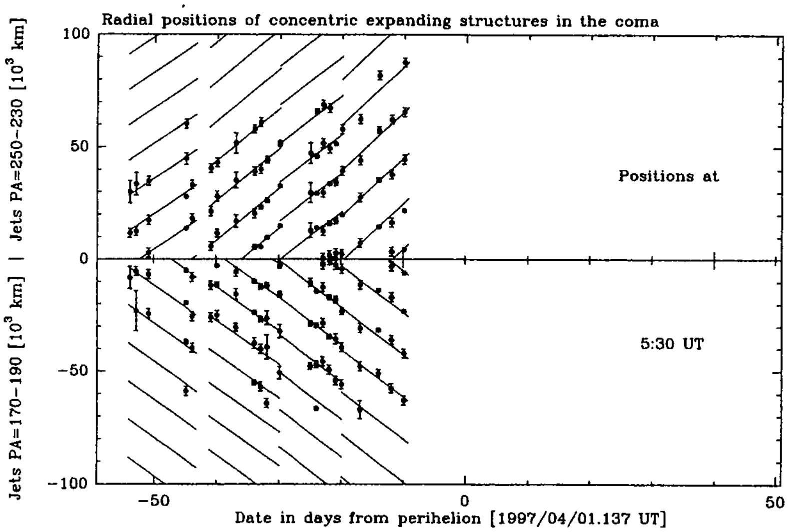
the three parameters being v, t_0 (a reference date), and P (the searched periodicity). The first result is $P \approx 11.5 \pm 0.6$ hr (Table 2, line 1) and is used for the data-reduction Step 3 (see above). Its accuracy is sufficient not to add any significant uncertainty or bias to the reduction and forthcoming analysis.

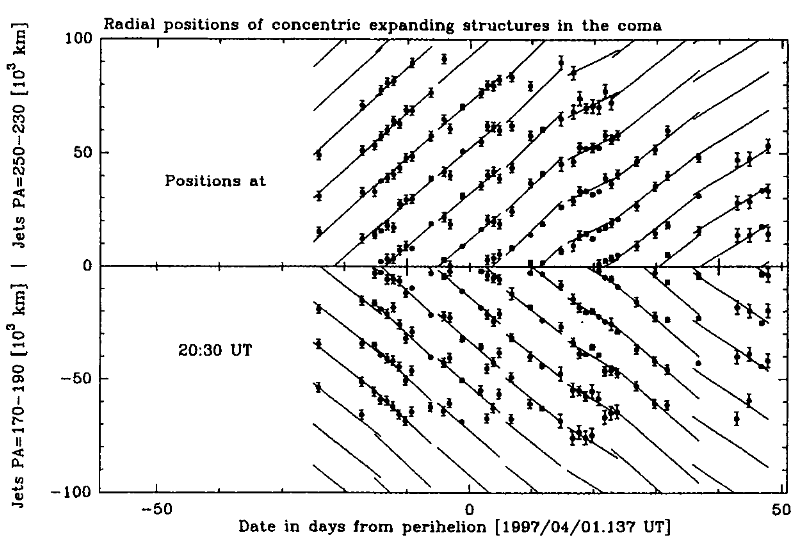
In Figures 4a and 4b, we do the same for each selected period of time, simply identifying the arc j with the arc $2p+j$ at a time $24p$ hours later. Therefore, the period found is the apparent period, P_a. This can be done only after Step 3 of the data reduction (see Section 3, above).

[text continued on page 22]

Figure 3 (top figure). Linear fit to the measured position of arcs, versus time. The corresponding derived rotation periods are given in the first line of Table 2. Figures 4a and 4b (middle and bottom figures, respectively): As in Figure 3, but the plotted positions skip two arcs per day (points are every 24 hr) and are connected by broken lines corresponding to each of the data subsets of Table 2 (lines 2-5 for Figure 4a and lines 7-13 for Figure 4b).







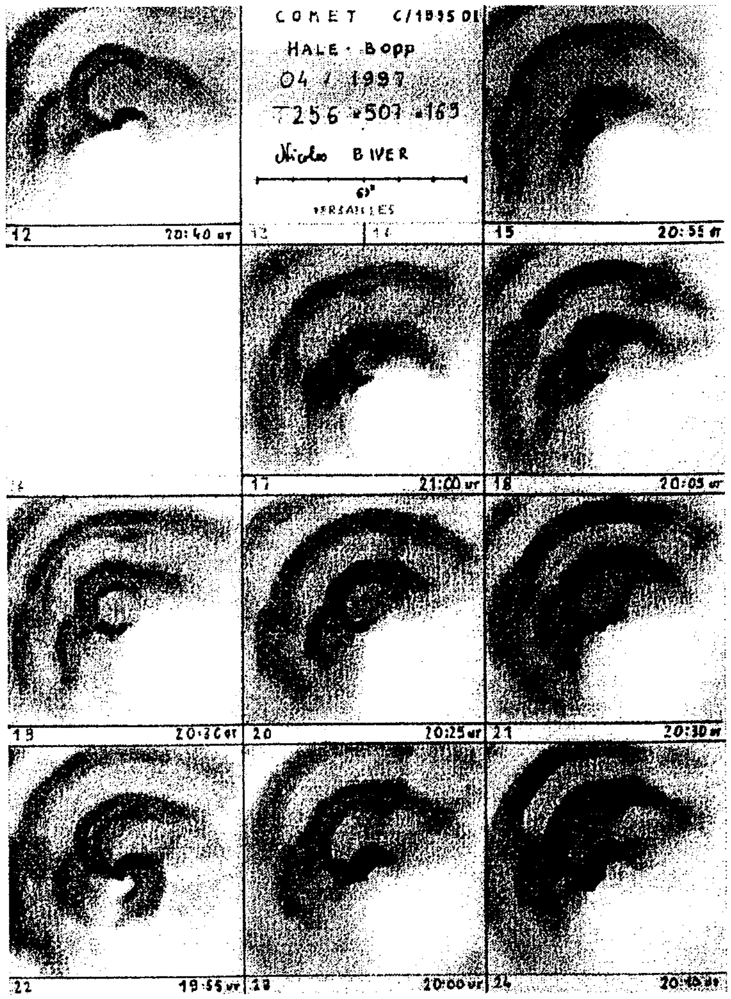


Figure 5. Series of daily observations showing an apparent period around 10 days, corresponding to a true rotation period close to 11.4 hr. The scales are 70″ by 70″, and orientation has south up and east to the right.

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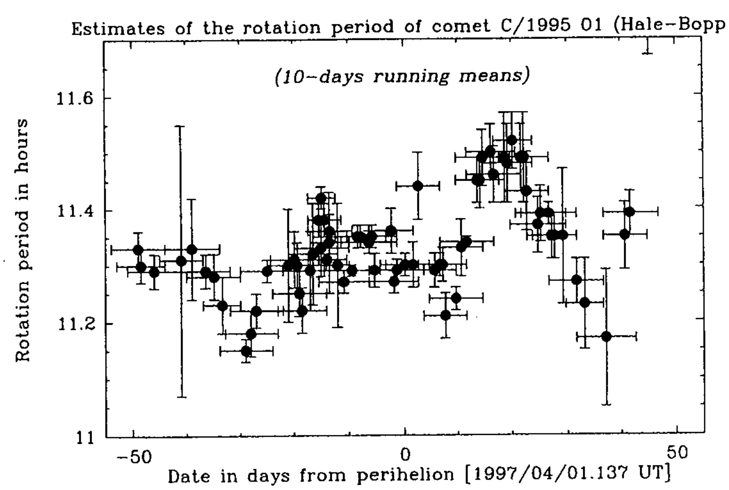
Figure 6. Whole set of data used for computing 70 estimates of the rotation periods versus time, using windows of 10 days of observations. Hence, values closer than 10 days apart are not completely independant, contrary to values in Table 2.



[text continued from page 19]

The least-squares fit to the data yields P_t with an uncertainty (formal uncertainty on the fitted parameters), $\sigma(P_t)$, in the first case, and P_a with an uncertainty, $\sigma(P_a)$, in the case of Figures 4a and 4b. From P_a, we can deduce $P_t = (n + 1/P_a)^{-1}$ (days) and $\sigma(P_t)/P_t = (P_t/P_a)\sigma(P_a)/P_a$, which implies a much better accuracy on P_t, given that $P_t/P_a = 0.05$ ($\approx$ 0.5 days/9 days).

Table 2 gives the results of all of the independent measurements and averages that correspond to the time intervals selected in Figures 3 and 4. Note that the jets labelled 'A' and 'B' in Figure 1 are referred to in Table 2. In addition, two long series of the most regular set of observations (one from the morning — Table 2, line 6; and one from the evening — Table 2, line 14) have been included. They yield similar results and marginally show a shorter period (11.28 hr) in early March than in mid-March to early May (11.35 hr). The mean of the 22 independent estimates is 11.33 ± 0.04 hr, where ±0.04 hr is the 95-percent-confidence interval of the Student law. Figure 6 plots all the values (means of the two p.a. of measurements) that can be obtained using a moving window of 10 days between Feb. 6 and May 18. However, contrary to the results in Table 2, the consecutive values are not all independent.

6. CONCLUSIONS

This analysis gives a fairly good estimate of the synodic "rotation" period of $11^h 20^m \pm 2^m$ for comet C/1995 O1. Given the evolution of the earth-comet geometry in the absolute reference frame, this "rotation" period could not differ from the "true" sidereal period by more than 2 min, and it did not change significantly over 3 months. Other estimates (using similar or different methods) have yielded very similar results (11.33 hr on average): 11.31 ± 0.01 hr (Farnham *et al.* 1998, 1999); 11.35 ± 0.04 hr (Jorda *et al.* 1999); 11.34 ± 0.02 hr (Licandro *et al.* 1998). Some astronomers have used much more accurate modeling, taking into account Monte-Carlo modeling of the dust particle trajectories in three dimensions, with possible variable velocity (due to the influence of radiation pressure). But this shows that it may not have been necessary to use expensive equipment and modeling, and that most amateurs (with the advantage of being more flexible in their observations plans) could have estimated the rotation period of comet C/1995 O1 and reached a similar result with good accuracy.

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Φ Φ Φ

The Comets Section of the SAF

Philippe Morel

Founded in 1887 by Camille Flammarion, the Société Astronomique de France (SAF) is an association without lucrative ends, recognized for public utility in 1897 and accepted as a national association of youth and popular education. Over time, the SAF pulled together most French astronomers and many foreigners. If it underwent competition with the professional societies, the SAF preserves nevertheless the privilege of counting among its members a fair number of professional astronomers, and it enjoy a renown all over the world. The SAF solidifies the relations between amateurs and professionals in the process of learning about and understanding astronomy, and in showing astronomy to the public.

Working in specialized SAF sections, amateurs and professional meet regularly to develop research programs and to organize programs of observation with conviviality between enthusiasts. The ten sections include those devoted to the sun, comets, double stars, planets, instruments, photography, sundials, history of astronomy, space exploration, and radioastronomy. Once per year, the sections meet for a whole day at the Observatory of Meudon to discuss their programs and results.

L'Astronomie, founded in 1887 by Flammarion, is published ten times per year. ***Observations et Travaux***, published four times per year, offers more technical articles, emanating the work of the commissions or advanced amateurs astronomers. ***Les Ephémérides*** is a publication prepared by the SAF and sent annually to subscribers. ***Le Ciel de l'Année***, also prepared by the SAF, gives a summary by month of astronomical events with simple maps for a larger public. The complete presentation of SAF is available on the WEB to the address `http://www.iap.fr/saf`.

The SAF Comets Section was created in the 1970s by Charles Bertaud. Annie Chantal Levasseur Regourd followed Bertaud as president in the 1980s and assured the preparation of observations of Halley's comet with multiple activities such as two trips to Réunion Island in 1986. At the end of 1989, Serge Thébault began presiding over the Comets Section. The section organized a camp for observation of comet C/1989 X1 (Austin) in Provence in 1990 and a second camp for C/1995 O1 (Hale-Bopp) in Normandy in April 1997. At the end of 1998, Philippe Morel followed as section president.

The Comets Section counts in its file of members about 120 people distributed in France and other countries. Currently about fifteen advanced observers send their drawings, photographs, and regular abstracts of observations to the Section. The Comets Section receives 100 to 150 such abstracts of observations per year during times of little bright-comet activity and close to 400 reports in periods of greater activity. Observers communicate with the Section increasingly via the Internet.

The SAF Comets Section wishes to develop relations between its members and the *ICQ* by helping observers to transcribe summaries and proposing a centralization of these. The section is achieving the important work of old-observation storage. It encourages comet observations by alerting observers of new objects. Two members of the Commission were recently rewarded for their efforts: Michel Meunier, co-discoverer of comet C/1997 J2 (Meunier-Dupouy); and Alain Maury, involved in the discovery of comet C/1998 X1 (ODAS).

Φ Φ Φ

Review of Recent Literature: Research Concerning Comets*

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Comet Dynamics

A German and Swedish team led by Claes-Ingvar Lagerkvist (Uppsala Astronomical Observatory, Sweden) has identified comets P/1997 T3 (Lagerkvist-Carsenty) and P/1998 U3 (Jäger) to have experienced deep, close encounters with Saturn. Numerical integrations of their dynamical histories have shed light on a 1954 encounter to within 0.011 AU of Saturn by P/1997 T3 and a 1991 encounter to within 0.018 AU by P/1998 U3. Prior to these encounters, both comets resided in orbits with perihelia near Saturn's distance. P/1998 U3's initial orbit had a very low eccentricity of 0.08 and was placed just interior to Saturn. Of the 171 short-period comets in this study, only the above-mentioned comets were drastically influenced by Saturn.

Comet Splitting

Over 200 small sungrazing comets have been detected by the European Space Agency's Solar and Heliospheric Observatory (SOHO) since 1996. Zdenek Sekanina (Jet Propulsion Laboratory, California Institute of Technology) has noticed that the number of SOHO comets arriving at perihelion in pairs is too high for a random sample. At least 15 pairs of comets with perihelion times separated by < 0.5 days have been identified. The author theorizes that these pairs are related pieces that underwent a series of splitting episodes. Unlike most tidally split comets, the SOHO objects split not only around the time of perilhelion but well afterwards, as well.

* This is the second installment of a regular *ICQ* column begun in the July 2000 issue of the *ICQ*.

Comet Ions

A group of University of Texas researchers led by Anita Cochran used the McDonald Observatory 2.7-m Harlan J. Smith telescope to obtain visible-light spectra of comets 122P/de Vico and C/1995 O1 (Hale-Bopp). The ratio N_2^+/CO^+ has been used in an attempt to determine the temperature at which primordial cometary ices formed and, hence, at what heliocentric distance the nucleus formed. Though the data on these two comets contained evidence of CO^+, no N_2^+ was detected. This result suggests that N_2, the parent molecule of N_2^+, is depleted relative to CO, the parent of CO^+. What caused this depletion is unknown. Possible explanations include a different region of formation relative to most long-period comets or post-formation heating.

A study of the abundances of carbon (C) isotopes in comets has been conducted by a team led by Susan Wyckoff (Arizona State University). The $^{12}C/^{13}C$ ratio was found by studying the three molecular species C_2, HCN, and CN in comets C/1989 Q1 (Okazaki-Levy-Rudenko), C/1989 X1 (Austin), and C/1990 K1 (Levy). The $^{12}C/^{13}C$ ratios are similar to those found in other comets and are consistent with measured ratios throughout the solar system. Hence, comets must have formed at the same time as the rest of the planetary system. The comets do not share the same ratios as the interstellar medium at the Galactic center. If significant, it indicates that the galaxy is not as homogeneous as previously thought.

Observations of C/1999 H1 (Lee) in the near-infrared with the Keck telescope on Mauna Kea in Hawaii have been analyzed by Michael Mumma (NASA Goddard Space Flight Center, Maryland) and collaborators. The spectra reveals that, relative to other comets, the CO/CH_3OH ratio in C/1999 H1 is much lower, suggesting that its original endowment of CO was also less than normal. New OH multiplets were detected at wavelengths around 3.05 μm, which may be provide a temperature-insensitive method for measuring water production.

Comets and NEOs

The origin of the near-Earth-object (NEO) population has always been in question. The rough similarity between high-eccentricity, high-inclination NEO orbits and short-period-comet orbits led many early studies to declare that the NEO population contained a significant number of extinct or dormant comet nuclei. The past decade has seen a shift towards explaining the NEOs as objects pumped out of the main asteroid belt by resonances with Jupiter. Brett Gladman (Observatoire de la Côte d'Azur, France) and colleagues have reanalyzed this problem. Their results find no dynamical reason to require that a significant portion of the NEO population must derive from comets. However, the existence of comets such as 2P/Encke and 107P/Wilson-Harrington show that at least some comets have evolved onto NEO orbits.

Most comets are discovered as a byproduct of NEO surveys. In recent years, the most productive has been the Lincoln Near-Earth Asteroid Program (LINEAR) based in Massachusetts and New Mexico. Grant Stokes (Massachusetts Institute of Technology, Lincoln Laboratory) and the LINEAR team have recently published a review of their operations. LINEAR employs up to two 1.0-m telescopes, equipped with CCD arrays of 2560 $\times$ 1960 pixels. The CCD arrays read out on the order of several milliseconds. The ultra-fast readout and short exposures (3-11 seconds) allow 10000-20000 square degrees of sky to be surveyed per lunation. Through September 1999, the survey had discovered 257 NEOs and 32 comets, including the recent disintegrating comet C/1999 S4 (LINEAR).[1]

Comet Dust

Material in the orbits of comets has been often observed as meteor showers from the earth. During the 1998 Leonid storm, astronomers led by R. Nakamura (Kobe University, Japan) successfully observed the Leonid meteor stream outside the earth's atmosphere. Observations from Mauna Kea with a wide-angle lens attached to a CCD camera detected the presence of the meteoric stream. The radius of the trail was estimated at 0.01 AU and its brightness was $\approx$ 2-3 percent of zodiacal light.

Infrared observations of comet 2P/Encke with the European Space Agency's Infrared Space Observatory (ISO) have helped William Reach (Infrared Processing and Analysis Center, California Institute of Technology) and collegues model the formation and age of the comet's dust trail. Observations from 1997 of 2P/Encke's coma and trail are best modelled if the dust coma was produced during the 1997 apparition, while the dust trail is the result of activity over the previous 10 orbits. The estimated total mass lost during the 1997 return suggests that 2P/Encke's dust-to-gas mass ratio is 10-30, much higher than earlier estimates. This greater mass ratio suggests that 2P/Encke may shed its entire mass within 3000-10000 years.

Comet Bombardment

During the early years of our solar system, the earth underwent a period of heavy bombardment from minor planets. The formation of the moon, the creation of the oceans, and even the origins of life have been linked to this early era. Two recently published studies examine the source of the earth's water. A French group led by Nicolas Dauphas (Centre de Recherches Petrographiques et Geochimiques) has used the deuterium-to-protium (D/H) ratio, thus utilizing two different types of water molecules containing different hydrogen isotopes, to determine that only 0-10 percent of the earth's water was derived from comets. In order to match the D/H ratio of the deep mantle, which may be a remnant of the early oceans, the majority of the water must have originated within the early earth with up to 50% possibly being delivered via asteroids. The total mass of asteroids and comets impacting the earth since its accretion is estimated at 4×10^{20} to 2×10^{22} kg.

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[1] Sixty comets carried the named 'LINEAR' as of early March 2001. — Ed.

Similar results were obtained by Andrea Morbidelli (Observatoire de la Côte d'Azur) and colleagues. Their modeling of the D/H ratio suggests that most of the earth's water was transported from the outer main asteroid belt by large planetary embryos and accreted by the earth at its final stages of formation. Though comets may have added to the earth's water inventory, their contribution was at most 10%.

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Φ Φ Φ

FROM THE EDITOR

The re-discovery of comet D/1984 W1 (Shoemaker 2) by LINEAR on 2000 September 27 (cf. *IAUCs* 7498, 7499), resulting in the new designation and name 146P/2000 S2 (Shoemaker-LINEAR), presents a problem, in that there were previously four short-period comets with the name Shoemaker: what should be done with "Shoemaker 3" and "Shoemaker 4"? Of course, it makes no sense to "move them up a number" to "Shoemaker 2" and "Shoemaker 3", as this would create mass confusion. And it makes little sense to have "Shoemaker 3" and "Shoemaker 4" without a "Shoemaker 2". In light of what was shown by Brian G. Marsden at the 1997 IAU General Assembly in Kyoto (namely, in response to a suggestion by a non-cometary-astronomer that *all* comets should have numerals after the names, whereby Marsden showed that there was no logical way to add such numerals to old comets), it appears highly appropriate that — especially with the good functionality of the new comet designation scheme (introduced in 1995) — all numerals after short-period-comet names should be dropped.

For numbered short-period comets, it is totally redundant to keep numeral suffixes. We had considered dropping the numbered comet's suffixed numerals only, but then there would be another illogical break in the numerals by retaining only the unnumbered short-period comets. So it really makes sense to drop all of the numerals at once, as we have done. After all, the unnumbered short-period comets have only been seen once, and most of these are quite faint comets that are not referred to very much beyond their astrometry and orbits in the *MPCs* and their photometry in the *ICQ*; once they are observed at a second apparition, they are given their permanent number. We will make more of an effort in these pages to give both the new-style and old-style designations for unnumbered comets discovered prior to 1995, to help readers.

Why not just keep the numerals? There is a very good reason for changing at this time, and that is the loss of "Shoemaker 2" from the system, leaving an awkward gap. Crossing into the new millennium was an added incentive. But the best reasons are as follows: (1) historical trends for using numerals as comet-name suffixes have been highly inconsistent over the years and decades, and comet numeral suffixes have not remained the same over time; (2) the concept of suffixed numerals is highly illogical; (3) the suffixed numerals are redundant, given the new designation system; and

(4) the system with suffixed numerals is unnecessarily complex. The elimination of suffixed numerals is a move toward a simpler system that is easier to use. Furthermore, the argument that the use of numerals can help avoid mistakes also fails in practice because mistakes will be made occasionally by most people who use comet designations a lot (as with those who report observations of comets, as well as Observation Coordinators and people writing about various comets); in fact, adding more and more numerals (even with the short-period comets alone) will fail to help identify individual comets easily simply because such programs as LINEAR will get the lion's share of comet discoveries.

Only short-period comets (with periods < 200 yr) have had numerals appended to their names when more than one such comet had the same name; this was a trend that was inconsistently in place dating back to the nineteenth century. There has never been a policy advocating that long-period comets have numerals placed after their names. So the question was brought up a few years ago (by a non-comet-specialist, of course!) as to why we don't add numeral suffixes to *all* comet names! The answers to this are easy and trivial: (1) it would create a new system of names, with numerals that have never before appeared in print, causing great confusion; (2) there is no logical way to add numerals to all comet names, because the procedure in use has been to assign them chronologically, and chronological ordering would be lost without changing the numeral suffixes on existing comet names; and (3) it does nothing to help the situation regarding comet names. And the problem of comet names changing (particularly lost comets that are rediscovered after many years) again poses the problem of gaps in numeral sequencing. And comets such as those found by SOHO are announced often years after they were imaged, so that sequencing of numeral suffixes would be impossible to maintain in any logical fashion; indeed, for some reason the SOHO program maintains an internal numeral count of the SOHO comet discoveries that is quite different from the order in which they are given official year/letter/number designations and in which they are announced!

It is, of course, to understand fully the historical context in which comet designations and names have evolved, and few present-day astronomers appear to be knowledgeable about this. A large problem with the suffixed numerals to short-period-comet names was outlined well by Brian Marsden in the January 1995 issue of the *ICQ* (pp. 3-6). It is perhaps useful to mention here some of the cases that were noted in that article. The comet titled "1886 IV (Brooks 3)" by the leading nineteenth-century journal (and recognized designator of new comets), the *Astronomische Nachrichten*, is what has been called in recent decades "P/Brooks 1" (or now, D/1886 K1). The comet that has in recent decades been known as "P/Brooks 2" (or now, 16P) was not discovered until 1889; the comet assigned the appellation "Brooks 2" by the *A.N.* was discovered in May 1886, but that long-period comet is now simply known as C/1886 J1 (Brooks). In fact, the *A.N.* appears to have given such suffixed numerals for a given year (so that "Brooks 2" could appear on different comets in years where there were two or more comets discovered by Brooks). (Placing the name of the discoverer in parentheses after the comet's designation was, of course, a practice established by the *A.N.* in the mid-nineteenth century and carried for many decades in other publications including the early *IAU Circulars*. The *A.N.* began using years and Roman numerals as the chief way to identify comets beginning about 1849 and continuing for a century, through World War 2, with the discoverer's name given parenthetically, if at all; other mainstream astronomical journals followed suit. This practice of placing names parenthetically after the designation has been again embraced since 1995 in the *ICQ* and other professional publications.)

Suffixed numerals have, over the years, been given in numerous ways, as in "Brooks 2", "Brooks (2)", and "Brooks II". The IAU has published little on the matter of comets names over the decades, and indeed the *IAU Circulars* in their nearly eight decades of publication have also been inconsistent, where we find "Tempel II", "Tempel 2", and "Tempel's Second Periodic Comet", or "Periodic Comet Tempel (1866 I)" and "Comet Tempel-Tuttle (1866 I)". For some time after comets 29P and 31P were discovered, the *IAUCs* put "Schwassmann-Wachmann" in parentheses without suffixed numerals after the designations of both comets (and, later, Roman numerals were sometimes used instead of Arabic numerals for the suffixes of these two comets). The short-period Neujmin comets also followed a pattern on *IAUCs* similar to that of the Tempel and Schwassmann-Wachmann comets. So although patterns did develop later in the twentieth century, mainly due to Marsden, in which more consistency was employed in the use of Arabic numeral suffixes to short-period-comet names, the history certainly shows an inconsistency that highlights the lack of logic and the lack of simplicity in this concept.

Thus, effective at the end of the year 2000, numerals were dropped from the *ICQ* pages (including the *2001 Comet Handbook*) and webpages. While some readers may prefer to retain the numeral suffixes simply because they are familiar with them (and also because many authors and editors have referred to comets only by their names and not by their designations — an unwise procedure in any case!), there is no ambiguity by not using numeral suffixes, due to the use of the wonderful new system (in effect for fully six years now) of permanent numbers for multiple-apparition short-period comets and of year/letter/number designations for one-apparition comets. It is expected that *ICQ* readers in particular will have no problem with the elimination of the illogical, redundant, and unnecessarily complicated numeral suffixes. *ICQ* contributors almost universally employ the new designations for comets, as the archiving of data greatly benefits from the use of designations *alone*, and this archiving of both comet photometry and astrometry has for decades been done with designations only (i.e., without names). Indeed, it can be amazing to see the myriad different ways in which authors elsewhere insist on referring to comets, particularly the amusing abbreviations of comet names into a handful of characters in tables (e.g., 'HMP', when '45P' is every bit as quick).

Also, while editors of perhaps a majority of astronomical publications are inconsistent in their referring to comets by designation/name (sometimes referring to designations or names in awkward ways, with different such ways appearing in the same publication, depending upon the author), we have made great efforts to have great consistency in how the *ICQ* refers to comets. Such consistency is encouraged elsewhere, as well, because this helps to retain clarity and to avoid ambiguity. Editors have a particular responsibility to keep uniformity in designations of all things astronomical, as confusion can result when they allow individual authors each to maintain his or her own system. It is anticipated that *ICQ* readers will readily see that the permanent short-period-comet numbers and the provisional short-period-comet year-letter designations will be entirely sufficient to identify unambiguously each comet.

Short-period comets discovered since the end of 1994 have not had numeral suffixes added to names. While no such comets are probably in line for numbering for several years still (when they are detected at their second apparition), it makes little sense to add numerals at the time that they receive their permanent numbers! Though Galle would have greatly simplified matters a century ago (when he published his great catalogue of cometary orbits) if he had begun using the permanent-numbering scheme begun by Marsden in 1995, it is not too late to get the comet-naming system into a simpler, more logical state by eliminating the suffixed numerals now. It is hoped that readers will see the logic of doing this via the *ICQ*'s lead. Some will refuse to drop the numerals for quite some time, but others will surely see the light. We encourage others to follow suit.

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CORRIGENDA

- In the October 2000 issue (*ICQ* 116), p. 108, third paragraph, line 7, *for* $+90° \leq \delta \leq -23°$. *read* $+90° \geq \delta \geq -23°$.
- In the October 2000 issue (*ICQ* 116), p. 145, line 5, *for* Visual m_1 data are generally 1-2 magnitudes fainter than CCD magnitudes *read* Visual m_1 data are generally 1-2 magnitudes brighter than CCD magnitudes
- In the October 2000 issue (*ICQ* 116), p. 145, `Comet 97P/Metcalf-Brewington`, the observation on `2000 10 28.94` by observer `SEG` is to be deleted.
- In the October 2000 issue (*ICQ* 116), p. 148, last line, *for* Vol. 22, No. 3a *read* Vol. 22, No. 4a

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Tabulation of Comet Observations

Due to time constraints, observations contributed on paper and descriptive information to complement the observations tabulated below will be published in the April issue.

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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; `x` indicates that a secondary source (often amateur computer software) was used to get supposedly correct comparison-star magnitudes from an accepted catalogue].

"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; an updated list is also maintained at the *ICQ* World Wide Website). "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; a lower-case "a" indicates an exposure time under 1000 seconds, an upper-case "A" indicates an exposure time of 1000-1999 seconds (with the thousands digit replaced by the "A"), an upper-case "B" indicates an exposure time of 2000-2999 seconds (with the thousands digit replaced by the "B"), etc.].

"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^o, east = 90^o). "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 (with the exception of the Observer Codes) 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 [11 = Dutch Comet Section (via A. Scholten); 13 = Agrupacion Astronomica de Madrid (via J. Carvajal); 16 = Japanese observers (via Akimasa Nakamura, Kuma, Japan); 23 = Czech group (via P. Pravec and V. Znojil); 32 = Hungarian group (via K. Sarneczky); 35 = South American observers (via J. G. de Souza Aguiar, Brazil); 36 = Italian observers (via Antonio Milani); 37 = Ukrainian Comet Section (via A. R. Baransky); etc.]. Those with asterisks (*) preceding the 5-character code are new additions to the Observer Key:*

AKA	16	Ayahiko Akahori, Nagano, Japan
AMO01	35	Alexandre Amorim, Brazil
BAR06	37	Alexandr R. Baransky, Ukraine
BOU		Reinder J. Bouma, Netherlands
COM	11	Georg Comello, The Netherlands
*CRE02	36	Claudio Cremaschi, Italy
DES01		Jose G. de Souza Aguiar, Brazil
END	16	Tsunenobu Endo, Nagano, Japan
EZA	16	Yuusuke Ezaki, Osaka, Japan
FUK02	16	Hideo Fukushima, Tokyo, Japan
HAS02		Werner Hasubick, Germany
HAS08	16	Yuji Hashimoto, Hiroshima, Japan
*HOD01	35	Felipe Hodar, Campinas, Brazil
*HOD02	35	Juan M. Hodar, Campinas, Brazil
HOR02	23	Kamil Hornoch, Czech Republic
JON		Albert F. Jones, New Zealand
KAD02	16	KenIchi Kadota, Saitama, Japan
KAM01		Andreas Kammerer, Germany
KOR01	19	Valeriy L. Korneev, Russia
MAT08		Michael Mattiazzo, S. Australia
*MIC	36	Marco Micheli, Pompiano, Italy
MIL02		Giannantonio Milani, Italy
MOR09		Philippe Morel, France
NAG08	16	Yoshimi Nagai, Yamanashi, Japan
NAK01	16	Akimasa Nakamura, Ehime, Japan
ORI	16	Takaaki Oribe, Tottori, Japan
RAE		Stuart T. Rae, New Zealand
ROD01	13	Diego Rodriguez, Spain
ROQ		Paul Roques, AZ, U.S.A.
SAR02	32	Krisztián Sárneczky, Hungary
*SAR03	35	Leandro Sarmiento, Argentina
SEA	14	David A. J. Seargent, Australia
SEG	38	Carlos Segarra, Valencia, Spain
SOU01	35	Willian Carlos de Souza, Brazil
SUZ02	16	Masayuki Suzuki, Japan
SZA		Sándor Szabó, Sopron, Hungary
TAK05	16	Kesao Takamizawa, Nagano, Japan
TIC		Milos Tichy, Czech Republic
TOT03	32	Zoltán Tóth, Hungary
TSU02	16	Mitsunori Tsumura, Japan
YOS02	16	Katsumi Yoshimoto, Japan
YOS04	16	Seiichi Yoshida, Ibaraki, Japan

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Comet C/1997 BA6 (Spacewatch)

```
DATE (UT)        N MM MAG.  RF  AP.  T F/  PWR   COMA   DC   TAIL   PA   OBS.
2000 12 09.37      C 14.9   TJ  18.0 L  6 a 90    0.35                   KAD02
```

Comet C/1999 H3 (LINEAR)

```
DATE (UT)        N MM MAG.  RF  AP.  T F/  PWR   COMA   DC   TAIL   PA   OBS.
2000 11 25.81      C 16.9   TJ  18.0 L  6 a180    0.25                   KAD02
```

Comet C/1999 H3 (LINEAR) [cont.]

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
2000 11 28.80		C	16.8	TJ	18.0	L	6	a120	0.25				KAD02
2000 12 05.85		C	16.3	GA	60.0	Y	6	a120	0.7				NAK01

Comet C/1999 K5 (LINEAR)

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
2000 11 21.65		S	13.8	HS	20	L	7	160	0.8	4			MAT08
2000 11 27.45		S	13.4	GA	25.4	L		114					SEA
2000 11 28.52		S	13.4	GA	25.4	L		114					SEA

Comet C/1999 K8 (LINEAR)

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
2000 10 18.71		C	14.7	TJ	18.0	L	6	a 60	0.6				KAD02
2000 10 22.09	d	k	14.6:	FD	35	L	5	a420	0.6				HOR02
2000 11 01.76		S	14.0	HS	44.0	L	5	156	0.5	3			HAS02
2000 11 03.90		S	13.8	HS	31.0	J	6	143	0.8	3/			BOU
2000 11 04.63		C	15.4	TJ	18.0	L	6	a 90	0.5				KAD02
2000 11 18.53		C	15.4	TJ	18.0	L	6	a120	0.5				KAD02
2000 11 18.57		C	14.8	GA	60.0	Y	6	a120	1.2				NAK01
2000 12 01.55	a	C	15.2	GA	60.0	Y	6	a120	1.1				NAK01
2000 12 23.72		S	[14.5	HS	44.0	L	5	156					HAS02
2000 12 29.43		C	15.8	GA	60.0	Y	6	a120	0.85				NAK01

Comet C/1999 N4 (LINEAR)

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
2000 06 22.92		C	17.0	HV	41.0	L	5	a480	0.5				MIL02

Comet C/1999 S4 (LINEAR)

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
2000 07 10.06		S	7.9	TI	20.0	T	10		3.5	4	0.22	285	CRE02
2000 07 10.07		S	7.7	TI	20.0	T	10		3.5	4	0.25	285	MIC
2000 07 30.30		S	7.7	TT	5.0	B		10	8	3			RAE
2000 08 01.84		S	[8.5	HS	27	T	6	43					TOT03

Comet C/1999 T1 (McNaught-Hartley)

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
2000 11 01.30		S	8.8:	TT	14.3	L	6	78	1	3			AM001
2000 11 03.72		M	8.6	AA	10.0	B		25	3	6			SEA
2000 11 17.74		M	8.6	TJ	10	B		25	3.0	5/			MAT08
2000 11 18.84		C	9.3	TJ	18.0	L	6	a 30	1.2				KAD02
2000 11 19.25		S	8.6	TT	14.3	L	6	78	1	4			AM001
2000 11 19.63		M	8.5	TT	15	L	5	27	3.7	5			RAE
2000 11 20.28		S	8.6	TT	14.3	L	6	78	1.5	5			AM001
2000 11 22.26		S	8.5	TT	14.3	L	6	78	1.5	5/			AM001
2000 11 23.29		S	8.4	TT	14.3	L	6	78	1.5	5			AM001
2000 11 23.85		C	9.2	TJ	18.0	L	6	a 30	1.2		1.3m	239	KAD02
2000 11 26.72		M	8.5	TJ	10	B		25	3.0	6			MAT08
2000 11 27.27		B	8.4	TJ	14.3	L	6	35	1.5	6			AM001
2000 11 27.28		B	8.3	TJ	5.0	B		20	2	4			AM001
2000 11 27.29		B	8.3	TJ	5.0	B		7	2	4			AM001
2000 11 28.83		S	7.9	TJ	25.4	T	6	62	4.0	6			YOS04
2000 11 28.84		C	8.9	TJ	18.0	L	6	a 20	1.6		3.0m	230	KAD02
2000 11 28.84	x$	S	8.1	TJ	32.0	L	5	58	3.5	5			NAG08
2000 12 01.70		B	8.1	AA	10.0	B		25			20 m	265	SEA
2000 12 01.83	x$	S	7.4	TJ	32.0	L	5	58	3.2	6			NAG08
2000 12 01.84	x$	S	8.0	TJ	15.0	B		25	3.0	4/			HAS08
2000 12 03.24		S	8.7	NP	25	L	5	60	3	3			SEG
2000 12 03.74		M	8.1	TJ	10	B		25	3.0	6/	0.08	250	MAT08
2000 12 03.83		C	8.8	TJ	18.0	L	6	a 30	2.1		5.5m	218	KAD02
2000 12 03.85	xw	S	7.8	TT	10.0	B		20	3	6			YOS02
2000 12 05.83		S	7.8	TJ	25.4	T	6	32	7.5	7			YOS04

Comet C/1999 T1 (McNaught-Hartley) [cont.]

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
2000 12 05.84	x$	S	7.7	TJ	8.0	B		11	4	7			NAG08
2000 12 06.85	x$	S	8.0	TJ	15.0	B		25	3.0	5/			HAS08
2000 12 07.29		S	8.3:	TT	14.3	L	6	35	2	5			AMO01
2000 12 08.75		M	8.2	TJ	10	B		25	3.0	6/			MAT08
2000 12 08.83		C	8.6	TJ	18.0	L	6	a 30	2.6		12 m	215	KAD02
2000 12 08.83	xw	S	7.6	TJ	10.0	B		20	4	7			NAG08
2000 12 08.85	x$	S	7.8	TJ	15.0	B		25	2.8	6			HAS08
2000 12 08.86	xw	M	7.9	TT	10.0	B		20	4	5			YOS02
2000 12 09.29		S	8.7	TT	14.3	L	6	35	3	5			AMO01
2000 12 11.28		S	8.7:	TT	14.3	L	6	78					AMO01
2000 12 16.83		S	7.7	TJ	25.4	T	6	32	4.1	5/			YOS04
2000 12 17.71		M	7.5	AA	10.0	B		25					SEA
2000 12 18.14		S	8.4	AA	11	V	3	17	3.9	4			KOR01
2000 12 18.17		S	8.3	AA	6.0	B		15	4	4			KOR01
2000 12 19.74		M	8.0	TJ	10	B		25	2.0	6			MAT08
2000 12 20.17		S	8.0	AA	6.0	B		15	5	4/			KOR01
2000 12 20.18		S	8.0	AA	11	V	3	17	6	5	0.1		KOR01
2000 12 21.84	xw	S	7.7	TJ	8.0	B		11	4	6			NAG08
2000 12 22.25		M	7.7	TJ	15.6	L	5	29	3.6	6			BOU
2000 12 22.84	xw	S	7.7	TJ	8.0	B		11	5	7			NAG08
2000 12 23.25		M	7.7	TJ	15.6	L	5	36	3.4	6			BOU
2000 12 23.83		S	7.9	TJ	25.4	T	6	32	4.8	s7	9 m		YOS04
2000 12 23.85	xw	S	7.8	TJ	32.0	L	5	58	3.5	6			NAG08
2000 12 24.18		S	8.2	TT	10.0	B		25	4.6	4	0.17	275	HAS02
2000 12 25.85	xw	S	7.7	TJ	32.0	L	5	58	3.7	6			NAG08
2000 12 26.24		M	7.6	TJ	15.6	L	5	29	4.4	6			BOU
2000 12 26.27		B	8.5	TT	14.3	L	6	45	4	5			AMO01
2000 12 26.72		B	7.8	AA	10.0	B		25	2	6	8 m	270	SEA
2000 12 26.83	xw	M	7.9	TT	10.0	B		20	5	6	8 m	270	YOS02
2000 12 26.85	xw	S	7.8	TJ	32.0	L	5	58	3.8	6			NAG08
2000 12 27.83		S	8.1	TJ	25.4	T	6	32	6.0	7			YOS04
2000 12 27.84	x	P	6.9	TT	10.0	R	4	a425	3.5	5	3.0m	269	TAK05
2000 12 27.86		M	8.1	TT	12.5	L	6	31	4.0	2			TSU02
2000 12 28.85	xw	S	7.8	TJ	8.0	B		11	5	7			NAG08
2000 12 31.19	!	C	8.5	TI	30	T	6	a180	> 5	D6	>15 m	286	ROD01
2000 12 31.23	!	C	8.5	HI	40	D	2	a 60	> 5.7	D6	>25 m	286	ROD01
2000 12 31.85	xw	S	7.8	TJ	10.0	B		20	5	6/			NAG08
2001 01 01.17		S	7.9	HS	6.0	B		20	6	6	0.3	300	SAR02

Comet C/1999 T2 (LINEAR)

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
2000 08 02.87		S	[13.0	HS	27	T	6	167					TOT03
2000 10 15.43		C	14.2	HS	20.0	T	10	a120	0.4				EZA
2000 10 15.75		S	13.3	HS	35	L	5	158	1.0	2/			HOR02
2000 10 15.77	d	k	13.7	FD	35	L	5	a600	0.6		1.6m	54	HOR02
2000 10 17.77		S	13.0	GA	25.4	J	6	115	1.1	3			BOU
2000 10 21.77	d	k	13.5	FD	35	L	5	a360	0.8				HOR02
2000 10 22.74	d	k	13.7	FD	35	L	5	a600	0.8				HOR02
2000 10 28.74		S	12.9	HS	27	T	6	167	0.8	2			TOT03
2000 10 29.73		S	13.0	HS	35	L	5	158	1.1	2/			HOR02
2000 11 01.72		S	12.9	HS	35	L	5	158	1.2	3			HOR02
2000 11 01.74	d	k	13.6	FD	35	L	5	a600	0.7		2.5m	47	HOR02
2000 11 01.77		S	13.4	HS	44.0	L	5	156	1.0	4			HAS02
2000 11 01.83		S	13.0	AC	31.0	J	6	109	0.9	3			BOU
2000 11 05.37		C	14.3	TJ	18.0	L	6	a 60	0.55				KAD02
2000 12 24.18		S	13.5	HS	44.0	L	5	156	0.5	4			HAS02

Comet C/1999 T3 (LINEAR)

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
2000 11 29.57	a	C	17.5	GA	60.0	Y	6	a240	0.4		1.1m	12	NAK01
2000 12 29.57		C	17.6	TJ	60.0	Y	6	a240	0.3		1.0m	21	NAK01

Comet C/1999 U4 (Catalina-Skiff)

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
2000 10 11.79		C	16.4	TJ	18.0	L	6	a120	0.3				KAD02
2000 10 18.58		C	16.2	GA	40.0	L	6	a120	0.3				AKA
2000 10 18.73		C	16.4	TJ	18.0	L	6	a 90	0.25				KAD02
2000 10 21.84	d	k	15.7	FD	35	L	5	a600	0.3				HOR02
2000 10 22.90	d	k	15.7	FD	35	L	5	a660	0.35				HOR02
2000 10 30.56		C	15.0	HS	20.0	T	10	a120	0.4				EZA
2000 11 01.76		S	13.9:	HS	44.0	L	5	156	0.2	4			HAS02
2000 11 01.85	d	k	15.6	FD	35	L	5	a600	0.3				HOR02
2000 11 01.88		S	14.2	GA	31.0	J	6	143	0.6	3			BOU
2000 11 03.92		S	14.1	GA	31.0	J	6	143	0.6	4/			BOU
2000 11 04.67		C	16.4	TJ	18.0	L	6	a120	0.3				KAD02
2000 11 18.62		C	16.2	TJ	18.0	L	6	a120	0.35				KAD02
2000 11 18.64		C	15.8	GA	60.0	Y	6	a120	0.5			145	NAK01
2000 11 27.98	d	k	15.7	FD	35	L	5	a600	0.5				HOR02
2000 11 29.82	d	k	15.7	FD	35	L	5	a360	0.45				HOR02
2000 11 30.77		S	14.8:	HS	44.0	L	5	226	0.2	4			HAS02
2000 12 03.98		S	13.9	GA	31.0	J	6	143	0.7	4			BOU
2000 12 21.91		S	13.9	AC	31.0	J	6	177	& 0.5	5			BOU
2000 12 22.93		S	14.0	GA	31.0	J	6	143	0.6	4			BOU
2000 12 23.73		S	14.7	HS	44.0	L	5	156	0.3	4			HAS02
2000 12 29.49		C	15.9	GA	60.0	Y	6	a120	0.55				NAK01

Comet C/1999 Y1 (LINEAR)

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
2000 10 02.90		S	13.2	AA	30.5	T	10	150	& 1.0	3/			COM
2000 10 03.88		S	12.7	GA	25.4	J	6	115	1.2	4			BOU
2000 10 04.18		S	12.9	AA	30.5	T	10	117	& 1	3/			COM
2000 10 05.97		S	12.7	AC	25.4	J	6	100	1.2	3/			BOU
2000 10 11.45		C	13.1	GA	40.0	L	6	a 60	0.6				AKA
2000 10 11.73		C	13.3	TJ	18.0	L	6	a 60	0.6		0.8m	39	KAD02
2000 10 17.79		S	12.6	AC	25.4	J	6	88	1.2	5			BOU
2000 10 17.79		S	12.8	AA	30.5	T	10	150	& 1.5	3			COM
2000 10 18.70		C	12.9	TJ	18.0	L	6	a 40	0.75		1.0m	38	KAD02
2000 10 20.85		M	12.3	HS	35	L	5	158	1.6	3			HOR02
2000 10 20.90		S	12.3	HS	27	T	6	83	0.8	4			TOT03
2000 10 20.90	d	k	12.9	FD	35	L	5	a360	0.8				HOR02
2000 10 21.75		S	13.0	HS	44.5	T	4	146	1.0	D6			SAR02
2000 10 21.80	d	k	12.6	FD	35	L	5	a660	1.2		1.9m	23	HOR02
2000 10 22.82	d	k	12.6	FD	35	L	5	a600	1.0		1.9m	20	HOR02
2000 10 22.84		M	12.6	TT	35	L	5	158	1.4	3			HOR02
2000 10 23.76		C	13.2	TJ	18.0	L	6	a 40	0.65		0.8m	35	KAD02
2000 10 23.77		S	12.1	HS	27	T	6	83	1.2	4			TOT03
2000 10 23.89		S	12.5	HS	27	T	6	83	0.6	3			TOT03
2000 10 24.54	a	H	12.2	LA	50.0	C	12	a360	1.15	6	1.9m	32	FUK02
2000 10 26.63	x	S	12.4	HS	32.0	L	5	91	1.1	5			NAG08
2000 10 27.51		C	12.9	HS	20.0	T	10	a 60	0.6				EZA
2000 10 27.51		M	12.5	HS	35.0	C	14	208	0.5				TSU02
2000 10 27.69		C	13.1	TJ	18.0	L	6	a 60	0.75		1.0m	30	KAD02
2000 10 27.86		M	12.6	TT	35	L	5	158	1.4	4			HOR02
2000 10 29.74		M	12.1	TT	35	L	5	158	1.6	3			HOR02
2000 10 29.86		S	11.9	HS	11	L	7	70	2.0	2			BAR06
2000 10 30.49	x	S	12.4	HS	32.0	L	5	91	1.0	5			NAG08
2000 10 30.88		S	13.1	AA	30.5	T	10	117	& 1.5	3			COM
2000 10 30.97		S	12.5	GA	25.4	J	6	88	1.4	4/			BOU
2000 10 31.86		S	13.0	AA	30.5	T	10	117		3/			COM
2000 11 01.76		S	13.2	HS	44.0	L	5	156	0.3	4			HAS02
2000 11 01.77	d	k	12.6	FD	35	L	5	a600	1.0		0.7m	14	HOR02
2000 11 01.79		M	12.3	TT	35	L	5	158	1.6	3			HOR02
2000 11 01.91		M	12.5	GA	31.0	J	6	89	1.4	5			BOU
2000 11 02.87		S	12.8	AA	30.5	T	10	117	1.5	4			COM
2000 11 02.94		S	12.6	GA	25.4	J	6	88	1.2	5			BOU
2000 11 03.52		C	12.8	GA	60.0	Y	6	a120	1.4		3.8m	29	NAK01
2000 11 03.96		M	12.6	GA	31.0	J	6	89	1.4	5			BOU
2000 11 04.66		C	13.0	TJ	18.0	L	6	a 40	0.75		1.1m	27	KAD02

Comet C/1999 Y1 (LINEAR) [cont.]

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
2000 11 05.50		C	12.5	HS	20.0	T	10	a 60	0.6				EZA
2000 11 05.56		S	11.7	HS	25.4	T	6	116	2.2	3			YOS04
2000 11 09.39		C	11.9	GA	40.0	L	6	a 60	0.7				AKA
2000 11 16.84		S	12.3	HS	30.5	L	10	115	0.7	3			KAM01
2000 11 17.87		S	12.7	GA	25.4	J	6	115	1.2	4			BOU
2000 11 18.52		C	12.8	GA	60.0	Y	6	a120	1.6		5.1m	34	NAK01
2000 11 18.52		C	13.1	TJ	18.0	L	6	a 60	0.85		2.6m	32	KAD02
2000 11 18.74		S	12.5	HS	44.0	L	5	156	0.8	4			HAS02
2000 11 20.81		S	13.4	NP	25	L	5	96	4	2			SEG
2000 11 23.42		C	13.0	GA	40.0	L	6	a 60	1.0		3.5m	32	AKA
2000 11 23.58		S	11.6	HS	25.4	T	6	116	2.2	3/			YOS04
2000 11 24.51		M	12.6	HS	35.0	C	14	120	0.7	4			TSU02
2000 11 24.92		S	12.4	GA	25.4	J	6	88	1.3	4/			BOU
2000 11 24.96		S	12.9	AC	30.5	T	10	117	1.5	3/			COM
2000 11 26.81		S	13.0	AC	30.5	T	10	117	1.5	3			COM
2000 11 27.95	d	k	12.7	FD	35	L	5	a480	1.1		5.0m	24	HOR02
2000 11 28.49	x	S	12.8	HS	25.4	L	4	113	1.0	4			YOS02
2000 11 29.89	d	k	13.0	FD	35	L	5	a420	1.0		3.9m	21	HOR02
2000 11 30.78		S	13.0	HS	44.0	L	5	63	0.9	4			HAS02
2000 11 30.80		S	12.6	AC	25.4	J	6	88	1.2	4			BOU
2000 11 30.89		S	12.6	HS	30.5	L	10	115	0.8	4			KAM01
2000 12 01.51		C	13.0	GA	60.0	Y	6	a120	1.5		4.6m	33	NAK01
2000 12 03.95		S	12.6	AC	31.0	J	6	89	1.4	4			BOU
2000 12 06.41		C	13.2	TJ	18.0	L	6	a 60	0.8		1.2m	33	KAD02
2000 12 07.45		C	13.1	GA	40.0	L	6	a120	0.8		4.0m	32	AKA
2000 12 09.83		C	13.3	HS	14.3	D	4	a 60	0.7	3	3.9m	39	MOR09
2000 12 12.48	x	C	13.1	TJ	20.3	T	10	a 60	1.3				SUZ02
2000 12 14.73		S	12.7	AC	25.4	J	6	88	1.4	3/			BOU
2000 12 14.84		C	13.1	HS	14.3	D	4	a 60	0.7	7	3.9m	46	MOR09
2000 12 15.39	w	H	12.7	LA	50.0	C	12	C600	1.16	7	4.2m	24	FUK02
2000 12 15.43	w	V	13.4	LA	50.0	C	12	a360	1.16	7	4.2m	24	FUK02
2000 12 15.85		C	12.7	HS	14.3	D	4	a 60	0.7	6	3.2m	52	MOR09
2000 12 16.40		S	11.7	HS	25.4	T	6	116	1.8	3/			YOS04
2000 12 17.82		C	13.4	HS	14.3	D	4	a 60	0.5	6			MOR09
2000 12 17.85		S	12.5	GA	25.4	J	6	58	1.3	4			BOU
2000 12 20.83		S	13.3	AC	30.5	T	10	117	1.5	2			COM
2000 12 21.82		S	13.2	AC	30.5	T	10	117	1.2	1/			COM
2000 12 21.84		C	13.7	HS	14.3	D	4	a 60	0.6	6			MOR09
2000 12 21.86	a	S	12.7	AC	31.0	J	6	89	1.1	3			BOU
2000 12 22.84		C	13.3	HS	14.3	D	4	a 60	0.7	6	0.9m	25	MOR09
2000 12 22.87		S	13.2	AC	30.5	T	10	117					COM
2000 12 22.88		S	12.7	AC	31.0	J	6	89	1.0	3			BOU
2000 12 23.80		C	13.5	HS	14.3	D	4	a 60	0.7	6			MOR09
2000 12 27.41		C	13.4	GA	60.0	Y	6	a120	1.5		3.3m	30	NAK01
2000 12 27.42		M	13.1	HS	35.0	C	14	208					TSU02
2000 12 30.80		C	13.3	HS	14.3	D	4	a 60	0.5	6	1.2m	58	MOR09

Comet C/2000 A1 (Montani)

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
2000 11 28.81		C	18.6	GA	60.0	Y	6	a240	0.25			250	NAK01
2000 12 29.71		C	18.6	GA	60.0	Y	6	a240	0.3			235	NAK01

Comet C/2000 K2 (LINEAR)

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
2000 10 19.41		C	15.2	GA	40.0	L	6	a 60	0.25				AKA
2000 10 22.79	d	k	14.3	FD	35	L	5	a540	0.45				HOR02
2000 11 05.41		C	15.4	TJ	18.0	L	6	a120	0.25				KAD02
2000 11 18.78		S	14.3	HS	44.0	L	5	156	0.2	4			HAS02
2000 11 22.41	a	C	14.3	GA	60.0	Y	6	a120	0.75			50	NAK01
2000 12 06.40		C	14.7	TJ	18.0	L	6	a 60	0.45				KAD02
2000 12 22.41	x	C	14.3	TJ	60.0	Y	6	a 60	0.95				NAK01

Comet C/2000 O1 (Koehn)

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
2000 11 22.46		C	18.9	GA	60.0	Y	6	a240	0.3		0.7m	65	NAK01

Comet C/2000 S3

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
2000 11 03.56		C	18.6	GA	60.0	Y	6	a240	0.25				NAK01
2000 11 18.53		C	18.7	GA	60.0	Y	6	a240	0.3				NAK01
2000 12 22.48		C	19.7:	GA	60.0	Y	6	a240	0.2				NAK01
2000 12 27.47	a	C	20.2:	GA	60.0	Y	6	a240	0.2				NAK01

Comet C/2000 SV_74 (LINEAR)

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
2000 10 21.68		C	16.4	TJ	18.0	L	6	a120	0.2				KAD02
2000 11 03.62		C	16.7	GA	60.0	Y	6	a120		9		155	NAK01
2000 11 04.64		C	16.3	TJ	18.0	L	6	a120	0.2				KAD02
2000 11 18.54		C	16.6	TJ	18.0	L	6	a120	0.2				KAD02
2000 11 18.62		C	16.5	GA	60.0	Y	6	a120	0.4			130	NAK01
2000 11 27.93	d	k	15.8	FD	35	L	5	a480	0.3				HOR02
2000 11 29.53		C	16.5	GA	60.0	Y	6	a120	0.5	8		130	NAK01
2000 12 09.39		C	16.7	TJ	18.0	L	6	a 90	0.25				KAD02
2000 12 22.50		C	16.4	GA	60.0	Y	6	a120	0.5	8			NAK01

Comet C/2000 U5 (LINEAR)

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
2000 11 03.67		C	16.1	GA	60.0	Y	6	a120	0.5		0.5m	200	NAK01
2000 11 03.75		C	16.0	TJ	18.0	L	6	a 90	0.3				KAD02
2000 11 04.71		C	16.2	TJ	18.0	L	6	a 90	0.3				KAD02
2000 11 18.59		C	16.3	TJ	18.0	L	6	a120	0.35				KAD02
2000 11 18.66		C	15.6	GA	60.0	Y	6	a120	0.85		0.9m	152	NAK01
2000 11 20.23		J	14.7	SC	25.4	T	5	a100	0.53	s4	0.6m	172	ROQ
2000 11 23.58		C	15.6	GA	60.0	Y	6	a120	0.75		0.8m	153	NAK01
2000 11 23.66		C	16.1	TJ	18.0	L	6	a120	0.35				KAD02
2000 12 22.57		C	16.1	GA	60.0	Y	6	a120	0.6		0.8m	142	NAK01
2000 12 23.73		S	[14.5	HS	44.0	L	5	156					HAS02
2000 12 29.59		C	16.3	GA	60.0	Y	6	a120	0.65		0.9m	138	NAK01

Comet C/2000 W1 (Utsunomiya-Jones)

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
2000 11 25.63	x	S	8.0	TT	4.5	R	6	13	4	2			JON
2000 11 26.39	x	S	8.2	TT	7.8	R	8	30	3.5	2			JON
2000 11 26.45	x	S	7.5	TT	4.5	R	6	13	5	2			JON
2000 11 26.61	x	S	7.5	TT	4.5	R	6	13	5	2			JON
2000 11 26.63		S	7.4	TJ	10	B		25	5.0	3/			MAT08
2000 11 26.71		S	7.3	TJ	5.0	B		7	5.0	3			MAT08
2000 11 27.44		S	7.5:	AA	10.0	B		25					SEA
2000 11 27.50		S	7.1	TJ	5.0	B		7	5.0	3			MAT08
2000 11 27.92	x	S	7.5:	TJ	8.0	B		11	3	4			DES01
2000 11 28.42	x	S	7.0	TT	4.5	R	6	13	6	2			JON
2000 11 28.45	s	M	7.2	AA	10.0	B		25	5	4	15 m	60	SEA
2000 11 28.52		S	7.0	TJ	5.0	B		7	5.0	4			MAT08
2000 11 29.40	x	S	7.1	TT	4.5	R	6	13	6	2			JON
2000 11 29.52		S	6.8	TJ	5.0	B		7	5.0	4/			MAT08
2000 11 30.54		S	6.7	TJ	5.0	B		7	4.5	4/			MAT08
2000 12 01.36		M	6.8	TT	5	R	6	5	10	7	20 m	110	RAE
2000 12 01.48		M	7.3	AA	10.0	B		25					SEA
2000 12 02.94		S	6.8	TJ	5.0	B		7	10	5			HOD02
2000 12 02.94		S	6.8	TJ	5.0	B		7	12	4/			HOD01
2000 12 02.94		S	6.8	TJ	8.0	B		11	10	5			SOU01
2000 12 02.94	x	S	6.8	TJ	8.0	B		11	12	5			DES01
2000 12 02.95		S	6.8	TJ	20.0	L	8	65	12	5			SOU01
2000 12 03.50		S	6.8	TJ	5.0	B		7	3.0	4/			MAT08
2000 12 03.94	x	S	6.9	TJ	8.0	B		11	10	5/			DES01

Comet C/2000 W1 (Utsunomiya-Jones) [cont.]

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
2000 12 03.96		B	6.9	TJ	5.0	B		20	8	4			AM001
2000 12 03.97		B	7.0	TJ	5.0	B		7	5	6			AM001
2000 12 04.41	x	S	7.0	TT	4.5	R	6	13	3.5	2			JON
2000 12 05.00		S	6.8	TJ	5.0	B		10	11	4/			SAR03
2000 12 05.39	x	S	7.1	TT	7.8	R	8	30	2.5	2			JON
2000 12 05.93	x	S	7.0	TJ	8.0	B		11	8	4/			DES01
2000 12 06.35		C	9.2:	TJ	18.0	L	6	a 30	1.5				KAD02
2000 12 06.93	x	S	7.0	TJ	8.0	B		11	5	4/			DES01
2000 12 06.97		B	6.5	TJ	5.0	B		7	9	6/			AM001
2000 12 06.97		B	6.5	TJ	5.0	B		20	6	5			AM001
2000 12 07.93	x	S	7.0	TJ	8.0	B		11	5	5			DES01
2000 12 07.98		B	7.0:	TJ	14.3	L	6	35	3	4/			AM001
2000 12 08.47		S	6.9	TJ	10	B		25	2.0	5/			MAT08
2000 12 08.94	x	S	7.1	TJ	8.0	B		11	5	5			DES01
2000 12 09.36		C	8.7	TJ	18.0	L	6	a 30	1.8				KAD02
2000 12 09.38	x	M	7.0	TT	16.0	L	4	49	3.0	4			TSU02
2000 12 09.48		S	7.0	TJ	10	B		25	2.0	5/			MAT08
2000 12 10.94	x	S	7.1	TJ	8.0	B		11	3	5			DES01
2000 12 12.36	x$	S	7.0	TJ	32.0	L	5	58	2.5	6			NAG08
2000 12 13.36		C	8.2	GA	40.0	L	6	a 30	2.2		> 4 m	87	AKA
2000 12 13.36	x$	S	6.6	TJ	32.0	L	5	58	2.7	6/			NAG08
2000 12 13.47		S	6.8	TJ	10	B		40	2.5	5/	0.17	90	MAT08
2000 12 15.34	w	H	8.9	LA	50.0	C	12	a 40	0.8	5	3.4m	89	FUK02
2000 12 15.36		C	7.0	GA	40.0	L	6	a 20	2.7		>10 m	86	AKA
2000 12 15.36	x$	S	6.4:	TJ	10.0	B		20	3	7/			NAG08
2000 12 15.37	$	S	6.3	HD	7.0	B		10	3	7/			END
2000 12 16.36	x$	S	6.0:	TJ	32.0	L	5	58	3	7			NAG08
2000 12 16.37		S	5.5	TJ	25.4	T	6	62	4.5	7			YOS04
2000 12 17.44		S	6.2	AA	10.0	B		25	& 1				SEA
2000 12 18.46		S	6.6	TJ	10	B		40	1.0	5/			MAT08
2000 12 24.36	x$	S	[5.0:	TJ	32.0	L	5	58	! 1.0				NAG08

Comet C/2000 WM1 (LINEAR)

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
2000 12 22.43		C	17.2	GA	40.0	L	6	a240	0.2				AKA
2000 12 22.52		C	18.1	GA	60.0	Y	6	a240	0.25				NAK01
2000 12 29.48		C	18.0	GA	60.0	Y	6	a120	0.25				NAK01

Comet C/2000 Y1 (Tubbiolo)

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
2000 12 22.59		C	19.4	GA	60.0	Y	6	a240	0.2			45	NAK01
2000 12 22.63	!	k	18.9	LA	103.0	C	4	a240	0.2		0.2m	55	ORI
2000 12 29.58		C	19.4	GA	60.0	Y	6	a240	0.25		0.3m	53	NAK01

Comet C/2000 Y2

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
2000 12 29.69		C	17.8	GA	60.0	Y	6	a240	0.35				NAK01
2000 12 29.74	!	k	17.5	LA	103.0	C	4	a240	0.25		0.5m	300	ORI

Comet 2P/Encke

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
2000 08 02.04		S	[11.0	HS	35	T	6	80					SZA
2000 08 10.05		S	11.0:	HS	35	T	6	80	1	1			SZA
2000 08 12.05		S	10.3	HS	27	T	6	83	1.0	2/			TOT03
2000 08 12.06		S	10.5	HS	35	T	6	80	1	3			SZA

Comet 9P/Tempel

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
2000 11 22.52	a	C	17.5	GA	60.0	Y	6	a240	0.6				NAK01
2000 12 27.44	a	C	19.0	GA	60.0	Y	6	a240	0.3				NAK01

Comet 10P/Tempel

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
2000 11 28.70		C	19.7	GA	60.0	Y	6	a240		9			NAK01
2000 12 06.75		C	19.6	GA	60.0	Y	6	a240		9			NAK01

Comet 14P/Wolf

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
2000 11 22.44		C	18.8	GA	60.0	Y	6	a240	0.25				NAK01
2000 12 22.43		C	19.2	GA	60.0	Y	6	a240	0.25				NAK01

Comet 17P/Holmes

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
2000 11 18.63		C	16.8	TJ	18.0	L	6	a120	0.25				KAD02
2000 11 22.62		C	16.5	GA	60.0	Y	6	a240	0.5		0.8m	228	NAK01
2000 12 22.53		C	17.2	GA	60.0	Y	6	a120	0.45		0.6m	221	NAK01

Comet 24P/Schaumasse

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
2000 11 22.57		C	18.7	GA	60.0	Y	6	a240	0.25				NAK01
2000 11 29.54		C	18.3	GA	60.0	Y	6	a240	0.4				NAK01
2000 12 22.51		C	18.0	GA	60.0	Y	6	a240	0.35				NAK01

Comet 33P/Daniel

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
2000 12 22.82	!	k	18.5	LA	103.0	C	4	a240	0.3				ORI

Comet 41P/Tuttle-Giacobini-Kresák

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
2000 11 17.82		C	16.1	TJ	18.0	L	6	a120	0.3				KAD02
2000 11 23.83		C	13.9	TJ	18.0	L	6	a 90	0.5				KAD02
2000 11 25.83		C	12.7	TJ	18.0	L	6	a 60	0.85				KAD02
2000 11 27.79	x	S	10.1	TT	25.4	L	4	46	2.3	5			YOS02
2000 11 28.81		S	11.0	TJ	25.4	T	6	116	2.3	5			YOS04
2000 11 28.82		C	11.5	TJ	18.0	L	6	a 90	1.4		2.1m	293	KAD02
2000 11 28.83	xw	S	10.5	TJ	32.0	L	5	58	1.8	6			NAG08
2000 11 28.84		M	11.3	HS	35.0	C	14	120					TSU02
2000 11 28.85		M	11.3	HS	35.0	C	14	120					TSU02
2000 11 28.86	a	C	11.3	GA	60.0	Y	6	a 60	3.3		5.1m	296	NAK01
2000 12 01.82	xw	S	10.4	TJ	32.0	L	5	58	1.9	5			NAG08
2000 12 01.83		C	12.7	TJ	18.0	L	6	a 60	0.8		1.7m	299	KAD02
2000 12 01.85	x$	S	10.7	TJ	15.0	B		25	1.8	3			HAS08
2000 12 03.23		S	12.6	NP	25	L	5	96	2	1			SEG
2000 12 03.75		S	[10.5	TJ	10	B		40					MAT08
2000 12 03.82		C	12.4	TJ	18.0	L	6	a 60	0.9		1.6m	294	KAD02
2000 12 03.82	x	S	11.0	HS	25.4	L	4	46	2.2	3/			YOS02
2000 12 05.82		S	11.1	HS	25.4	T	6	116	2.3	3			YOS04
2000 12 05.83	xw	S	10.6	TJ	32.0	L	5	58	2.1	3/			NAG08
2000 12 06.86	a	C	11.9	GA	60.0	Y	6	a 60	3.1		4.7m	296	NAK01
2000 12 07.85		M	11.7	HS	35.0	C	14	120	1.5	3			TSU02
2000 12 08.76		S	[11.0	TJ	10	B		40					MAT08
2000 12 08.82		C	12.6	TJ	18.0	L	6	a 60	0.85		0.8m	291	KAD02
2000 12 08.83		C	12.1	GA	40.0	L	6	a 60	2.2		4.5m	298	AKA
2000 12 08.84	x	S	11.6	HS	25.4	L	4	46	2.5	3			YOS02
2000 12 12.83		C	13.0	TJ	18.0	L	6	a 60	0.8		0.7m	288	KAD02
2000 12 15.83		C	8.7	TJ	18.0	L	6	a 60	3.1		16 m	286	KAD02
2000 12 16.81		S	7.9	TJ	25.4	T	6	62	4.8	5			YOS04
2000 12 16.82		C	9.2	TJ	18.0	L	6	a 60	2.8		5.0m	295	KAD02
2000 12 16.85	xw	S	8.1	TJ	32.0	L	5	58	3.8	5			NAG08
2000 12 17.73		M	7.9	AA	10.0	B		25	& 1				SEA
2000 12 19.75		S	8.6	TJ	10	B		40	3.5	3			MAT08
2000 12 19.85		M	8.4	TT	12.5	L	6	31					TSU02
2000 12 19.86		C	9.0	TJ	18.0	L	6	a 60	3.2		10 m	292	KAD02

Comet 41P/Tuttle-Giacobini-Kresák [cont.]

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
2000 12 20.15		S	7.9	AA	11	V	3	17	3.5	5			KOR01
2000 12 21.82		C	10.0:	TJ	18.0	L	6	a 60	2.2		8.1m	291	KAD02
2000 12 21.83	xw	S	8.9	TJ	32.0	L	5	58	2.0	5			NAG08
2000 12 22.24		M	7.9	TJ	15.6	L	5	29	4.5	4/			BOU
2000 12 22.82	xw	S	9.1	TJ	32.0	L	5	58	1.8	5/	5 m	290	NAG08
2000 12 22.85	x	P	9.2	TT	10.0	R	4	a370	2.6	3	9.0m	274	TAK05
2000 12 23.24		M	8.2	TJ	15.6	L	5	36	4.0	4/			BOU
2000 12 23.84		S	9.2	TJ	25.4	T	6	62	2.5	7			YOS04
2000 12 23.84	xw	S	9.1	TJ	32.0	L	5	58	2.5	5			NAG08
2000 12 23.85		C	10.3	TJ	18.0	L	6	a 60	2.6		26 m	290	KAD02
2000 12 24.18		S	9.4	TT	44.0	L	5	63	2.3	4	0.11	290	HAS02
2000 12 25.84	xw	S	9.1	TJ	32.0	L	5	58	3.3	5			NAG08
2000 12 26.24		S	8.6	TJ	15.6	L	5	29	4.2	3/			BOU
2000 12 26.29		B	9.8	TT	14.3	L	6	112	1	2			AMO01
2000 12 26.72		S	9.1	AA	10.0	B		25					SEA
2000 12 26.84		C	10.5	TJ	18.0	L	6	a 60	2.3		23 m	290	KAD02
2000 12 26.84	xw	S	9.4	TJ	32.0	L	5	58	3.0	4/			NAG08
2000 12 26.85	xw	M	8.8	TT	10.0	B		20	3	7	12 m	280	YOS02
2000 12 27.84		S	10.1	TJ	25.4	T	6	62	2.1	3/			YOS04
2000 12 28.81		C	10.9	TJ	18.0	L	6	a 60	2.2		21 m	289	KAD02
2000 12 28.85	xw	S	9.8	TJ	32.0	L	5	58	2.5	4			NAG08
2000 12 29.86		C	11.2	TJ	18.0	L	6	a 60	2.0		10 m	288	KAD02
2001 01 01.19		S	9.5	HS	6.0	B		20	8	2			SAR02
2001 01 01.84		C	11.7	TJ	18.0	L	6	a 60	1.3		6.0m	288	KAD02

Comet 47P/Ashbrook-Jackson

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
2000 11 01.75		S	13.7:	HS	44.0	L	5	156	0.6	3			HAS02
2000 11 05.39		C	13.8	TJ	18.0	L	6	a 90	0.45				KAD02
2000 11 18.73		S	13.7	HS	44.0	L	5	156	0.5	3			HAS02
2000 11 20.78		S	13.5	NP	25	L	5	133	3	1			SEG
2000 11 22.42	a	C	13.3	GA	60.0	Y	6	a120	1.4			60	NAK01
2000 12 09.38		C	14.0	TJ	18.0	L	6	a 90	0.5		0.8m	40	KAD02
2000 12 16.39		S	12.0:	HS	25.4	T	6	116	1.8	3			YOS04
2000 12 22.42	x	C	13.4	TJ	60.0	Y	6	a 60	1.6		1.4m	64	NAK01
2000 12 23.71		S	[14.0	HS	44.0	L	5	156					HAS02

Comet 65P/Gunn

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
2000 12 06.77		C	18.3	GA	60.0	Y	6	a240	0.25		1.1m	277	NAK01

Comet 70P/Kojima

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
2000 11 28.84		C	16.7	GA	60.0	Y	6	a120	0.5		1.3m	292	NAK01
2000 12 05.86		C	16.9	GA	60.0	Y	6	a120	0.45		1.0m	294	NAK01
2000 12 08.81		C	16.9	TJ	18.0	L	6	a120	0.25				KAD02

Comet 73P/Schwassmann-Wachmann

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
2000 11 04.84		C	13.2	TJ	18.0	L	6	a 60	0.5		0.8m	310	KAD02
2000 11 18.83		C	12.5	TJ	18.0	L	6	a100	0.75		12 m	299	KAD02
2000 11 23.83		S	10.4	HS	25.4	T	6	116	2.1	6			YOS04
2000 11 28.84		S	11.4	HS	25.4	T	6	116	2.6	4			YOS04
2000 12 01.84	x$	S	11.3	TJ	32.0	L	5	91	2.2	4			NAG08

Comet 73P/Schwassmann-Wachmann (component B)

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
2000 11 28.83		C	15.4	TJ	18.0	L	6	a 30	0.3				KAD02
2000 12 03.85		C	15.2	TJ	18.0	L	6	a 40	0.3				KAD02
2000 12 08.85		C	14.9	TJ	18.0	L	6	a 60	0.35				KAD02

Comet 73P/Schwassmann-Wachmann (component C)

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
2000 11 17.85		C	12.5	TJ	18.0	L	6	a120	0.7		3.4m	299	KAD02
2000 11 25.84		C	11.8	TJ	18.0	L	6	a 60	0.5		1.5m	298	KAD02
2000 11 28.84		C	11.5	TJ	18.0	L	6	a 60	0.75		14 m	297	KAD02
2000 12 03.86		C	11.4	TJ	18.0	L	6	a 60	0.8		13 m	296	KAD02
2000 12 03.87	x	S	10.9:	HS	25.4	L	4	46	0.9	3			YOS02
2000 12 05.84		S	10.3	TJ	25.4	T	6	116	2.2	4/			YOS04
2000 12 05.85	x$	S	11.5:	TJ	32.0	L	5	58	& 2	4			NAG08
2000 12 08.85		C	11.3	TJ	18.0	L	6	a 60	0.75		21 m	295	KAD02
2000 12 23.85		S	9.9	TJ	25.4	T	6	116	1.5	3/			YOS04

Comet 73P/Schwassmann-Wachmann (component E)

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
2000 11 28.84		C	13.4	TJ	18.0	L	6	a 60	0.6				KAD02
2000 12 01.86		C	13.8	TJ	18.0	L	6	a 60	0.4				KAD02
2000 12 03.84		C	14.0	TJ	18.0	L	6	a 60	0.45		0.6m	299	KAD02
2000 12 08.85		C	13.9	TJ	18.0	L	6	a 60	0.45		0.7m	298	KAD02

Comet 74P/Smirnova-Chernykh

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
2000 11 28.81		C	16.5	TJ	18.0	L	6	a120	0.3				KAD02
2000 11 28.85		C	16.7	GA	60.0	Y	6	a120	0.45		2.0m	292	NAK01
2000 12 24.17		S	[14.0	HS	44.0	L	5	156					HAS02

Comet 97P/Metcalf-Brewington

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
2000 11 03.50		C	18.0	GA	60.0	Y	6	a120	0.3				NAK01
2000 11 18.73		S	14.0	HS	44.0	L	5	226	0.5	4			HAS02
2000 11 22.54		C	17.8	GA	60.0	Y	6	a240	0.4				NAK01
2000 11 22.56		S	[13.5	HS	20	L	7	160					MAT08
2000 11 30.77		S	[14.5	HS	44.0	L	5	156					HAS02
2000 12 22.46		C	17.9	GA	60.0	Y	6	a240	0.5				NAK01

Comet 110P/Hartley

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
2000 10 21.88	d	k	16.2	FD	35	L	5	a600	0.35				HOR02
2000 10 22.93	d	k	16.7	FD	35	L	5	a660	0.25				HOR02
2000 11 01.89	d	k	16.6	FD	35	L	5	a660	0.25				HOR02
2000 11 03.65		C	16.1	TJ	18.0	L	6	a 90	0.25				KAD02
2000 11 03.66		C	16.2	GA	60.0	Y	6	a120	0.45		0.7m	251	NAK01
2000 11 04.70		C	15.9	TJ	18.0	L	6	a120	0.35				KAD02
2000 11 16.14		J	14.6	SC	25.4	T	5	a 60	0.36	s5	?		ROQ
2000 11 18.58		C	15.6	TJ	18.0	L	6	a120	0.35		0.3m	233	KAD02
2000 11 18.65		C	15.4	GA	60.0	Y	6	a120	0.55			230	NAK01
2000 11 18.75		S	14.8:	HS	44.0	L	5	286	0.3	4			HAS02
2000 11 28.02	d	k	14.7	FD	35	L	5	a600	0.5				HOR02
2000 11 29.58		C	14.8	GA	60.0	Y	6	a120	1.0		1.1m	226	NAK01
2000 11 29.85	d	k	14.6	FD	35	L	5	a600	0.45				HOR02
2000 12 03.97		S	14.0	GA	31.0	J	6	124	0.6	5			BOU
2000 12 15.97		C	15.5	HS	14.3	D	4	a 60	0.3	0	0.7m	119	MOR09
2000 12 18.07		J	13.6	SC	25.4	T	5	a100	0.59	s5/	?		ROQ
2000 12 22.56		C	14.7	GA	60.0	Y	6	a120	1.2		1.0m	104	NAK01
2000 12 22.91		S	13.9	GA	31.0	J	6	124	0.8	4			BOU
2000 12 23.73		S	14.2	HS	44.0	L	5	156	0.5	4			HAS02

Comet 113P/Spitaler

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
2000 11 03.53		C	18.0	GA	60.0	Y	6	a240	0.25				NAK01
2000 11 22.56		C	18.1	GA	60.0	Y	6	a240	0.35		0.6m	83	NAK01
2000 12 04.41		C	18.2	GA	40.0	L	6	a240	0.2		0.4m	80	AKA
2000 12 27.49		C	18.3	GA	60.0	Y	6	a240	0.35		0.4m	80	NAK01

Comet 137P/Shoemaker-Levy

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
2000 12 29.73	!	k	19.2	LA	103.0	C	4	a240	0.15				ORI

Comet 141P/Machholz (component A)

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1999 11 25.70		C	[15.0	HS	20.0	L	4	a330	! 0.5				MIL02

Comet 145P/Shoemaker-Levy

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
2000 11 03.69		C	17.0:	GA	60.0	Y	6	a120	0.4				NAK01
2000 11 18.70		C	16.0	GA	60.0	Y	6	a240	0.6				NAK01
2000 11 28.69		C	15.9	GA	60.0	Y	6	a120	0.65				NAK01
2000 12 08.76		C	16.1	TJ	18.0	L	6	a120	0.4				KAD02

Comet 146P/Shoemaker-LINEAR

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
2000 11 28.79		C	18.6	GA	60.0	Y	6	a240	0.35				NAK01
2000 12 05.81		C	18.9	GA	60.0	Y	6	a240	0.3		0.5m	264	NAK01
2000 12 29.66		C	18.9	GA	60.0	Y	6	a240	0.25		0.4m	248	NAK01

Comet 148P/Anderson-LINEAR

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
2000 12 22.47		C	18.4	GA	60.0	Y	6	a240	0.3		0.4m	66	NAK01

Comet P/1999 WJ7 (Korlević)

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
2000 11 28.84		C	17.1	GA	60.0	Y	6	a240	0.35		2.2m	291	NAK01
2000 12 05.83		C	17.1	GA	60.0	Y	6	a120	0.35		1.9m	293	NAK01
2000 12 08.79		C	16.9	TJ	18.0	L	6	a120	0.25				KAD02

Comet P/2000 R2 (LINEAR)

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
2000 11 22.49		C	20.0	GA	60.0	Y	6	a240	0.2				NAK01

Comet P/2000 S1 (Skiff)

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
2000 10 27.58		C	15.8	GA	40.0	L	6	a180	0.35				AKA
2000 11 03.51		C	16.5	GA	60.0	Y	6	a120	0.55				NAK01
2000 11 04.62		C	16.2	TJ	18.0	L	6	a 90	0.25				KAD02
2000 11 18.50		C	16.7	GA	60.0	Y	6	a120	0.6		0.5m	70	NAK01
2000 11 18.74		S	14.9	HS	44.0	L	5	226	0.3	4			HAS02
2000 11 22.55	a	C	16.9	GA	60.0	Y	6	a120	0.55		0.5m	64	NAK01
2000 11 30.77		S	[14.8	HS	44.0	L	5	156					HAS02
2000 12 22.44		C	18.1	GA	60.0	Y	6	a240	0.35		0.4m	69	NAK01

Comet P/2000 U6 (Tichý)

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
2000 10 23.96		C	18.4	UO	57.0	P	5	a 90					TIC
2000 10 28.95		C	18.3	UO	57.0	P	5	a 60					TIC
2000 10 29.98		C	18.4	UO	57.0	P	5	a 90					TIC
2000 11 03.64		C	18.4	GA	60.0	Y	6	a240	0.3				NAK01
2000 11 05.95		C	18.4	UO	57.0	P	5	a120					TIC
2000 11 18.63		C	18.3	GA	60.0	Y	6	a240	0.35				NAK01
2000 11 22.63		C	18.7	GA	60.0	Y	6	a240	0.25				NAK01
2000 11 28.49		C	18.6	GA	40.0	L	6	a240	0.15				AKA
2000 12 22.55		C	19.4	GA	60.0	Y	6	a240	0.25				NAK01