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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 January 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.] Make checks or money orders payable in U.S. funds (and drawn on a U.S. bank) to *International Comet Quarterly* and send to Daniel Green; Smithsonian Astrophysical Observatory; 60 Garden St.; Cambridge, MA 02138, U.S.A. [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 *ICQ* Editor at the above address.

Cometary observations also 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* (CFAPS2::GREEN), *BITNET* (GREEN@CFA), or Internet (GREEN@CFA.HARVARD.EDU), or via floppy disks that can be read on an IBM PC], and should contact the Editor for further information.

Among the Observation Coordinators (OCs) listed below, those with postal addresses have e-mail contacts with the *ICQ* Editor (or regularly send data to the Editor on IBM PC-compatible floppy disks); 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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— From the Editor —

This issue contains the *Proceedings* of the first International Workshop on Cometary Astronomy, held in Selvino, Italy, this past February. I am especially indebted to *ICQ* Associate Editor Charles Morris for spending untold hours in refereeing and editing of the manuscripts, several of which required extensive modification to improve the English.

Numerous individuals have remarked in recent months and years that the *ICQ* would greatly benefit readers by including more articles, as we did in the early- to mid-1980s. Beginning with this issue, we will do just that, working towards at least two or three articles per issue henceforth. We thus encourage readers to contribute articles concerning the science, observation, or history of comets. All articles in the *ICQ* are refereed prior to publication by 2-3 individuals (some associated with the *ICQ* staff, some not), and unfortunately we have had to decline perhaps 10 to 20 percent of papers submitted in past years. We have streamlined our refereeing process, and authors will be promptly notified of the status of their contributed papers.

Finally, I must note the passage of a resolution (printed in its entirety on the next page) that was passed at the General Assembly of the International Astronomical Union (IAU) in August. Unfortunately, a specific resolution on actual comet names is still to be formulated, and there is much disagreement concerning uniqueness, team names, *etc.* The effects of this resolution will become apparent in these pages in the January 1995 *ICQ*, at which time we will issue recommendations to contributors of photometric data. For now, all observations of comets discovered through the end of 1994 should be contributed in the present (old) format. — *D. W. E. Green*

New Comet-Nomenclature Policy

The following was published on *Minor Planet Circulars* 23803–4:

The following resolution concerning designations and names of comets was adopted by the International Astronomical Union at its General Assembly in The Hague on Aug. 24:

1. Commission 20 of the IAU, considering that:
   (a) there is essentially a 1:1 correspondence between the provisional (year/letter) and definitive (year/Roman numeral) designation systems for comets;
   (b) the procedure for interpolating old discoveries of comets into the existing designation systems is unsatisfactory, particularly when orbit determinations are not available;
   (c) the application of a new designation at each return of a periodic comet to perihelion is an unnecessary complication, particularly when the comet's recovery can be described as "routine", or for the rapidly increasing number of periodic comets that are followed all around their orbits; and
   (d) there can be confusion whether a newly-discovered object is a comet or a minor planet,

   proposes to replace the present designation systems for comets with a system that closely resembles, but is not identical to, the designation system for minor planets.

2. Specifically, it is resolved that the year/letter and year/Roman numeral systems be replaced by one in which each cometary discovery is given a designation consisting of the year of observation, the upper-case code letter identifying the halfmonth of observation during that year according to the procedure used for minor planets, and a consecutive numeral to indicate the order of discovery announcement during that halfmonth. Each new designation shall be supplied by the IAU Central Bureau for Astronomical Telegrams when the discovery is announced in one of its *Circulars*. For example, the third comet reported as discovered during the second half of February 1995 would be designated 1995 D3.

3. The nature of an object can further be indicated by an initial prefix. In particular, such prefixes should be applied in cases where comets have possibly been misdesignated as minor planets, or vice versa. If necessary, the prefix *A*/ would precede a comet designation that actually refers to a minor planet (or asteroid). For comets the acceptable prefixes are *P*/ for a periodic comet (defined to have a revolution period of less than 200 years or confirmed observations at more than one perihelion passage) and *C*/ for a comet that is *not* periodic (in this sense), with the addition of *X*/ for a comet for which a meaningful orbit can not be computed and *D*/ for a periodic comet that no longer exists or is deemed to have disappeared.

4. If a comet is observed to return (or have its periodicity established by observation through aphelion or from identifications), the *P*/ (or *D*/) shall be preceded by an official sequential number (e.g., 1P/1682 Q1 = Halley), the list to be maintained by the Minor Planet Center and published in the *Minor Planet Circulars*. Subsequent recoveries shall be acknowledged with further designations only when the predictions are particularly uncertain.

5. The practice of providing future predictions for the returns to perihelion of all periodic comets for which there is a reasonable chance of future observations will continue. While this currently means, for example, the publication of predictions for the comets for the year n in the batch of *Minor Planet Circulars* for May of the year $n-3$, the elements being for the 40-day date closest to perihelion passage, it is to be expected that this process will be supplemented—and perhaps eventually supplanted—by one that provides the orbital elements for these comets routinely at epochs 200 days apart, as in the case of minor planets.

6. In the case of a comet that has separated into discrete components, those components should be distinguished by appending -*A*, -*B*, etc., to the designation (or to the *P*/ or *D*/ periodic comet number).

7. Noting that some redundancy of nomenclature is desirable, it is proposed to retain in general terms the tradition of naming comets for their discoverers. In this framework, a committee has been formed to establish more precise procedures to ensure fairness and simplicity.

8. It is proposed that comet names be announced in the *IAU Circulars* only following consultation between the Central Bureau for Astronomical Telegrams and the Commission 20 Small Bodies Names Committee.

9. Whereas the new designation system for comets implies the possibility of confusion (if incorrect spacing is used) with that for new planetary satellites, it is proposed to indicate satellites with the prefix *S*/.

10. It is proposed that the new designation system for comets be introduced at the beginning of the year 1995. In the interests of avoiding confusion and maintaining continuity, Roman numeral designations will be published in the *Minor Planet Circulars* for pre-1995 comet discoveries/recoveries passing perihelion in 1993 and 1994, and new-style designations will be supplied for pre-1995 comets, together with lists of correlations with both the year/letter and the year/Roman numeral systems.

The Commission 20 Small Bodies Names Committee replaces the Minor Planet Names Committee (viz. *MPC* 19055) and has as its members K. Aksnes, A. Carusi, Y. Kozai, B. G. Marsden, H. Rickman, L. D. Schmadel, V. A. Shor, R. M. West and D. K. Yeomans.

IWCA Proceedings

— Introduction —

Most of the papers sent to the *ICQ* for this special *Proceedings* issue are included herein. Nine of the talks presented at the first International Workshop on Cometary Astronomy (IWCA), which was held in Selvino last February, are represented here. A couple of additional papers that were not ready at press time may appear in the January *ICQ*. This meeting was a reflecting point for me as Editor of the *ICQ* and as chief architect of the *ICQ* archive of photometric data. It has been 15 years since the first volume of the *ICQ* was published and for me a full two decades of publishing this journal.

The *ICQ* project began for me in 1973, with the apparition of the "infamous" comet Kohoutek 1973 XII (1973f). While disappointed that the comet was not brighter than it was, I followed it for several weeks into 1974 with my new 8-inch *f*/6 Newtonian reflector made by Cave Optical. Then came comet Bradfield 1974b (1974 III), and I soon happily found that comets are visible in binoculars quite regularly. I became "hooked" on comet observing, and I incorporated this interest into my local astronomy club newsletter, which (quite by chance) was called *The Comet* — by publishing information on currently-observable comets and also observational data (mostly visual photometry).

I began making contact via postal mail with others who also had a keen interest in comets — of which there were four who had a major influence: Dennis Milon, John E. Bortle, and Charles S. Morris (all of whom were connected with the A.L.P.O. Comets Section in those days), and Brian G. Marsden (editor of the *IAU Circulars*). The encouragement of these four comet enthusiasts fueled my own growing interest, and in the summer of 1978 (after my second year at college), I found myself working under Dr. Marsden at the Harvard-Smithsonian Center for Astrophysics in Cambridge, Massachusetts. By now, *The Comet* had become *The Comet Quarterly* and had moved from a club newsletter into more of a publication devoted to comets.

Charles Morris was living in the Boston area, and we began observing together and "talking comets" regularly. Partway through that summer of 1978, Charles and I began talking about the need for a central (international) archive for comet data, and about the possibility of converting *The Comet Quarterly* into the associated publication. I had already been trying to publish tables of photometric data on comets, but the data were coming from only a dozen or so observers. When Dr. Marsden threw his full support behind the conversion, the *International Comet Quarterly* was born, and we planned to publish the first issue in January 1979.

After some experimenting with data format over the first couple of years, Charles and I settled on the current format. Punched computer cards dictated that each observation would be 80 characters in length, and that format has remained reasonable. The International Workshop on Cometary Astronomy (IWCA) in Selvino, Italy, this past February — the Proceedings of which are published in this issue of the *ICQ* — was held in part to mark the 15th anniversary of the *ICQ* as a most successful publication and archiving project for the study of comets. Now, some 2500 printed pages (including > 2000 regular pages and nearly 500 pages of *Comet Handbooks*) after we started, we have accomplished a lot by uniting observers worldwide through a single publication and archive.

The *ICQ* issues from January 1991 to January 1994 contained 19,941 tabulated observations; at this rate, we will reach the 100,000 mark for observations in the *ICQ* archive around the year 2000. As of February 1994, there were 25,304 observations of more than 100 short-period comets in the archive; also, nearly 200 long-period comets were then represented in the archive, broken down thus: 1932-1959, 2368 observations; 1960-1969, 3045; 1970-1974, 1960; 1975-1979, 4007; 1980-1984, 4099; 1985-1989, 9496; 1990-date, 9589.

(continued on next page)

I have compiled a file of photometric parameters on short-period comets, which is regularly updated; this file is used in the production of the annual *ICQ Comet Handbook*. It can readily be seen that short-period comets in general rise much more rapidly in brightness upon nearing perihelion than do long-period comets (though some "short-period" comets with orbital periods > 20 years act more like the long-period comets).

The field of comet photometry is changing, in that CCDs are rapidly becoming an important source of data for comets fainter than 12th magnitude. For all observers, the problem of methodology in determining a magnitude estimate is one that needs to be addressed more carefully, and we hope to do so in the pages of the *ICQ* during the coming year. I would be interested in receiving m_1, coma-diameter, and DC estimates (along with comparison-star, magnitude method, altitude, and full instrumentation details) of the following eight deep-sky objects from all interested observers of comets: NGC 2068 = M78; NGC 5024 = M53; NGC 3627 = M66; NGC 3640; NGC 4147; NGC 4374 = M84; NGC 4406 = M86; and NGC 3031 = M81. Observers should take numerous months to observe all eight objects, and they should strive to (1) make observations when the objects are as high in the sky as possible, and (2) use as few good, *ICQ*-accepted comparison-star references as possible [northern-hemisphere observers, for example, could use the North Polar Sequence for all objects, being careful to correct for extinction — noting any such corrections — if absolutely necessary]. The results will be reported as a part of a review of observational procedures.

The Proceedings in this issue give an idea of what was presented at the IWCA last February — though the discussions and interactions by participants, who came from around the world to talk with each other, were the most important feature of the meeting. The meeting was so successful that we immediately began discussing the next IWCA, which we are now planning for August 1999 in Cambridge, England — a few days after the total solar eclipse that will be visible from much of Europe. — Daniel W. E. Green

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The Visual Observation of Comets

John E. Bortle and Charles S. Morris

Abstract. In a seminar spanning several hours, a detailed account of the methodology of visual comet observation and associated resource material was presented. Problems that result from the method of observation, instrument size, magnification employed, sky conditions and background surface brightness, the comet's physical appearance, and inaccuracies in comparison star magnitudes were addressed. Suggestions for the reduction of observational scatter were also presented. The techniques reviewed are discussed in detail by Bortle (1981) and Morris (1980, 1981a, 1981b).

INSTRUMENTATION

The aspects of instrument type, aperture, and magnification were discussed at length. We stress the desirability of using a given instrument over as much of a comet's apparition as possible. It is noted that when the brightening or fading of the comet finally begins to force change of instrumentation, overlapping observations should always be made — just as is needed in the case of change in magnitude-determination method.

OBSERVING METHODOLOGY

TOTAL MAGNITUDE. There are four widely-recognized techniques for determining the total or integrated magnitude of a comet. These are the Sidgwick, Morris, Bobrovnikoff, and Beyer methods. Each has its advantages and drawbacks.

While the Sidgwick method is, by far, the most widely employed of the methods, it becomes less accurate when the coma's degree of condensation increases beyond a moderate value. Contrary-wise, the Bobrovnikoff and Beyer methods are poorly suited to very diffuse objects, but become increasingly applicable as the coma becomes highly condensed. The Morris method, which solves both of these problems, is considered by most observers to be more difficult to use. (The second author believes that the difficulty of using this method is overstated and that its advantages outweigh these concerns.) The Morris method becomes the Sidgwick method for very diffuse comets and provides a transition to the Bobrovnikoff method as the comets become more strongly condensed.

It is stressed that any change from one method to another during a comet's apparition must be accompanied by a transition period, when overlapping observations are made to ascertain if there are any personal corrections between the methods.

COMA DIAMETERS. Magnitude determinations without concurrent coma-diameter measurements are highly undesirable — and in some cases reduce the value of the brightness observation almost to nil. Without knowledge of the coma's apparent size, it is difficult to assess the observation's accuracy, instrumental effects, or influence of the sky-background brightness.

Several methods are available for determining approximate coma diameters. The simplest, yet one of considerable accuracy, is estimating the coma's diameter relative to the separation of paired field stars. The eye is an amazingly good judge of relative dimensions and, unlike other procedures, requires no attenuation or obscuration of the coma for results to be obtained. After the observations of the comet have been completed, the observer can retire indoors and carefully measure the separation of the paired field stars from a large-scale star atlas and subsequently determine the coma's diameter.

Of fairly wide use is the "drift" method which employs an eyepiece with a fixed transit-wire or bar. The comet's passage behind the transit-wire is timed in seconds with a stopwatch. Calculations are then performed to obtain the coma's size in arc minutes. While accurate for brighter comets, the vague outer boundaries of faint or very-diffuse objects will generally result in under-estimates of the coma's size, particularly if the transit-wire must be illuminated.

Filar micrometers are not widely used by current observers but do have a long history in the measurement of accurate dimensions of astronomical bodies. They do, however, suffer from the same problems as the transit-wire eyepiece. The area in which they do excel is in measures taken under difficult conditions like twilight or even during the daytime.

DEGREE OF CONDENSATION. Rating the coma's "degree of condensation" (DC) is highly subjective, but comet observers of long experience typically will derive identical DC values on a given night and, at worst, differ by no more than one unit on the DC scale. There is a need (as was made obvious by discussion during the seminar) for a set of quality drawings illustrating the various intensities of the DC scale. Alternatively, it might be possible to establish a list of galaxies or globular clusters that, with a given aperture, exhibit the differing degrees of DC. This would allow fledgling observers some basis of comparison.

There is significant disagreement on how to estimate DC when there is a stellar nucleus/condensation or a distinct, disklike condensation present. In one method, the existence of a stellar nucleus/condensation resulted in DC = 9, regardless of how diffuse the coma is. At the Workshop, it was decided that this was not an appropriate technique to use. However, there is still debate as to what should be done when there is a stellar nucleus/condensation or a distinct, disklike condensation in the coma. One point-of-view is that the nucleus or condensation should be ignored. The other is that the entire coma, including the nucleus or condensation, should be included in the estimate. The *ICQ* staff is investigating this issue and will issue recommendations in the near future.

TAILS. Significant observations of cometary tails are better suited to photographic or CCD applications than to visual means. However, a brief discussion on the relationship between the three Bredichen classes of tail, plus so-called anti-tails, and other coma activity was given.

MAGNITUDE REFERENCE SOURCES

Perhaps the most difficult aspect of comet observing is locating reliable visual magnitudes for comparison stars. Although stellar astronomy has advanced orders of magnitude in recent years, visual observers continue to lack a definitive catalogue of accurate visual magnitudes with a limiting magnitude greater than +7.0 and covering the entire sky. An early summary of available comparison-star magnitudes is given by Green and Morris (1982) and by Morris and Green (1982).

Much has been made of photoelectric photometry (PEP) magnitudes and, more recently, CCD magnitudes of stars. Each of these was supposed to provide both high precision and accuracy (with respect to what the visual observer sees). While very precise, it has become apparent that PEP and CCD V magnitudes fail to duplicate what the eye sees. Differences of a half-magnitude are possible. Observers should always use caution. A PEP or CCD magnitude does not guarantee an accurate visual magnitude.

The recent issuance of the ***Guide Star Catalogue*** (GSC) looked at first as if it might prove effective in answering this need. However, careful spot checking indicates that — while it does contain millions of stellar magnitudes extending to a very faint limit — the general accuracy is certainly no better than ±0.5 magnitude, at best. Put into perspective, the GSC is no more accurate than the much-maligned, though far-less-extensive, ***SAO Star Catalog*** of thirty years ago.

The authors believe that the most dependable and accessible sources of faint visual magnitudes for use in comet work continue to be: (1) North Polar Sequence charts (AAVSO), (2) AAVSO variable star charts, (3) ***AAVSO Star Atlas***, (4) Revised Harvard Photometry (RHP), (5) USNO Catalogue. Each of these sources has some minor drawbacks, but items 1, 2, and 4 have been utilized in some cases for up to a century in the observations of comets with good results. Unfortunately, neither the USNO Catalogue nor the RHP are now widely available, although a small fraction of the RHP stars are given in the ***SAO Catalog*** (indicated by H or T). Despite this, it seems likely that these five magnitude sources will continue to be highly useful at least through the end of this century. Observers are urged to try to locate and use these comparison-star sources.

Whatever magnitude source is used, it is the responsibility of the observer to choose the most consistent comparison-star sequence available. This can be accomplished by cross-checking stars of similar brightness in the sequence. Often a suspect star can be identified in this manner and the comet-magnitude estimate can be significantly improved. When possible, observers should cross-check sequences when changing to a new sequence, to determine whether the new sequence has the same zero point as the old sequence.

It is anticipated that the *ICQ* staff will update the review of comparison-star sources in the near future.

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CCD Photometry of Faint Comets

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Abstract. This paper presents our work on the CCD photometry of faint comets, obtained during the past two years. Regular observations started in September 1992 at the Črni Vrh Observatory, using the 20-cm f/2 Baker-Schmidt camera equipped with the ST-6 CCD detector and standard V filter. The image processing and data reduction are performed via the Observatory PC-AT computer with the PCVISTA package; this enables a wide variety of routines, including dark-subtraction and flat-fielding as well as complete photometric reduction. These procedures and also observational techniques are reviewed in detail. Our present configuration of telescope and CCD detector enables photometry of comets down to 15th magnitude.

1. INTRODUCTION

Until very recently, the visual magnitude estimates of faint comets have been rather tricky, reserved mainly to dedicated observers with large telescopes. According to our experiences, 14th-magnitude comets are barely visible via a 36-cm telescope, even in good conditions. In addition, there is often lack of good reference fields close to the comet — resulting in estimates that are rather uncertain. Thus, the quality of estimates greatly depends on the observer's experience and on physical observing conditions. However, the recent availability of commercial CCDs has changed the situation in the field. Thanks to their high sensitivity, accurate photometry can now be performed with fairly small telescopes.

2. OBSERVATIONS

2.1. *Instrumentation.*

When observing weak comets with fast cameras, it is necessary to have sky conditions as good as possible. Our observations are performed at the Črni Vrh Observatory, a remote site located in the woodland region of Western Slovenia, at an altitude of 800 m; it has about 120 clear nights/year and unpolluted skies in all directions. The Observatory holds two short-focus cameras, mounted together on a Byers equatorial mounting. The 20-cm $f/2$ Baker-Schmidt camera is used for photometry of comets. It is equipped with the ST-6 CCD detector, covering a field of about one square-degree. At the same time, the 19-cm $f/4$ flat-field Schmidt-Cassegrain serves for accurate positioning. Both cameras have a special bar cage structure, made of a low-expansion Invar alloy that holds the mirrors at a permanent distance. This prevents shifting of the focal planes due to ambient temperature changes and enables us to begin observations without losing time for focusing.

CCDs have responses that vary with spectral wavelength; they are predominantly sensitive to longer wavelengths, reaching a peak at red spectral bands. Meanwhile, comparison stars have different surface temperatures and thus differ in color index. In order to measure comparison stars and the comet in the standard Johnson V band, we are using a V filter for coated CCDs as proposed by Bessel (1990). Using standard equatorial sequences (Menzies *et al.* 1991), we obtained the V color-transformation coefficient $\epsilon = 0.069$ (Henden and Kaitchuck 1990). We may therefore conclude that our combination of filter and CCD is very close to the standard Johnson V passband.

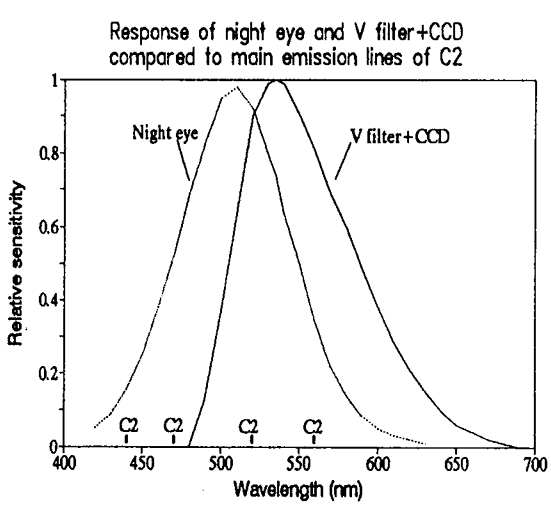
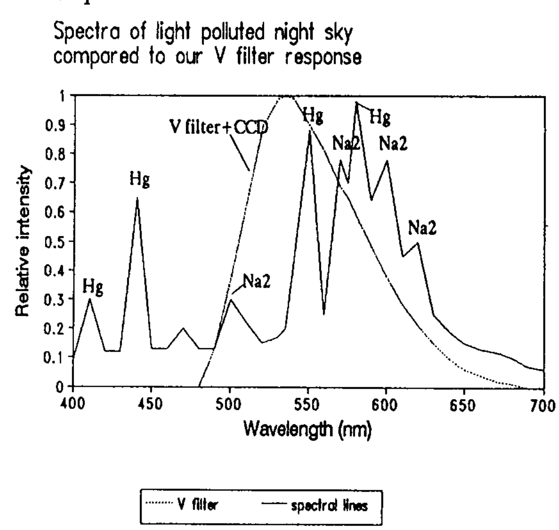


Figure 1. ⇐

Figure 2. ⇒



The molecular carbon and cyanogen emitted by the head are the first spectra to become visible as the comet approaches the sun (Brandt and Chapman 1992; A'Hearn and Festou 1990). The light of fainter comets mainly originates from the emission of diatomic carbon (C_2). There are several lines of C_2 dominating over the visual wavelengths, forming the so-called Swan bands (Liller 1992). The 515-nm line is often dominant; together with those at 560 nm, the Swan-band lines are well inside the passband of our filter (Figure 1).

Two additional reasons favor the use of a V-band filter. Due to its sharp cut-off at 480 nm (Figure 2), it considerably reduces the contribution of sky background at blue wavelengths. This enables photometry to be performed even in moonlight conditions. Also, the filter drop at 650 nm noticeably reduces the emission from artificial sources, mainly due to mercury and sodium streetlights (Wallis and Provin 1988; Liller 1992).

Altogether, the V-band filter absorbs the undesirable emission from sky background, transmitting mainly the light of cometary coma. This results in noticeable improvement of signal-to-noise (S/N) ratio of the cometary image.

2.2. Observational method.

Our observational procedure is similar to the technique used in differential photometry of variable stars (Henden and Kaitchuck 1990). It consists of successive imaging of the comparison star and the comet. Several sequences are usually obtained. During each observational run, dark and flat-field frames are taken. The dark frame is exposed for the same time as the object frame, but with the camera shutter closed. The flat-field frame is taken on an illuminated observatory wall.

In order to avoid the influence of atmospheric extinction, we always choose comparison stars as close to the comet as possible. Furthermore, we avoid observations at more than two air masses, which correspond to elevations less than 30° above the horizon. Fortunately, faint comets are generally far from the sun, which enables observations to be performed when they are at large solar elongations and well-placed in the night sky. In rare occasions, when data are urgently needed, observations at lower elevations are performed and the extinction corrections applied.

We mainly use comparison stars from the ***Bright Star Catalogue*** (Hoffleit 1982), as it contains precise V-band photometry for stars down to 7th magnitude. The secondary source for comparisons is ***The AAVSO Variable Star Atlas*** (Scovil 1980). In general, we avoid using comparisons from the AAVSO, because they are less accurate.

Our objective is to record as much cometary coma as possible. Since the $f/2$ camera is fast, we found that a 5-min exposure is long enough to record comets down to 15th magnitude with sufficient S/N ratio. The integration time for the comparison star depends on its brightness and is thus determined individually. Because comparison stars are relatively bright, exposures are short, ranging from a few seconds to one minute. Obviously it is necessary to be careful and avoid the saturation of the stellar image. During the final reduction, the comparison-star instrumental magnitude is corrected to the same integration time as the comet and the magnitudes are then compared. *(text cont. on next page)*

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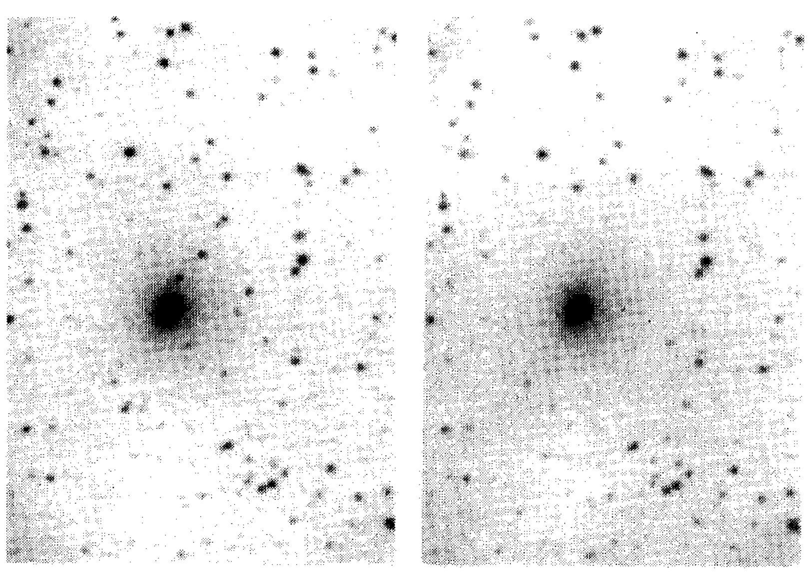

Figure 3. A 300-s CCD image of P/Kushida (1994a) taken on 1994 Jan. 23 with the 20-cm f/2 Baker-Schmidt camera and V filter. Note several stars inside the comet coma (left image) and pure coma with stars removed (on the right), using the PCVISTA CLIP procedure. The stars inside the coma added 0.15 mag to the comet's total V value.

3. IMAGE PROCESSING AND DATA REDUCTION

3.1. Image processing.

Due to the ST-6 CCD's high "dark current", it is necessary to subtract the dark frame immediately after the exposure, using the original software supplied with the camera. In that way, a relatively clear frame is obtained and the presence of comet checked. Since the ST-6 CCD camera software uses its own file format that is not widely supported by other packages, we convert files to FITS, which is the working format for the PCVISTA package (Wells *et al.* 1981; Richmond and Treffers 1989).

Next we have to perform flat-field correction on all frames; obviously, this must be done because fast systems have significant vignetting over the frame. The final step is to remove the stellar images that may appear inside the comet's coma. This is a common problem, particularly in dense Milky Way regions, and may significantly affect the measurements.

3.2. Data reduction.

The data analysis is performed by using the aperture photometry program. First, the positions of comet and comparison-star centroids are found manually and stored in a file. The next step is to inspect both images and carefully determine the radius of star/comet aperture in pixels. 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.

In this way we obtain instrumental magnitudes of the comet (m_c) and comparison star (m_*). Since the integration times of the comparison and the comet images are not the same, we must first calculate the magnitude difference (D) between frames by using standard Pogson equation:

$$D = -2.5 \log (E_c/E_*)$$

where E_c and E_* are the integration times of the comet and comparison, respectively. The difference (δm) between the comparison (m_*) and the comet instrumental magnitude (m_c) is then calculated by

$$\delta m = m_c - m_* - D$$

where m_* is the instrumental magnitude given by the aperture-photometry program. The standard V magnitude of the comet, V_c, may now be calculated from

$$V_c = V_* + \delta m$$

where V_* is the standard V magnitude of a comparison star obtained from the catalogue.

When the air mass of the comet (X_c) and that of the comparison star (X_*) differ by more than ~0.3, further correction for the atmospheric extinction is deemed necessary. The equations for this are:

$$\delta m' = \delta m - k'(X_c - X_*)$$
$$V_c = V_* + \delta m'$$

4. RESULTS

A summary of our observations is given in Table 1. During the given period of 18 months, we observed 16 comets and obtained a total of 102 observations. The faintest V magnitude detected was 16.0 for P/Giclas (1992ℓ). More than half of these comets were faint, having magnitudes between 12 and 15 at their brightest. Several outbursts of P/Schwassmann-Wachmann 1 were recorded and a light curve of P/Väisälä 1 was obtained (see Figures 4-5), for example.

(text cont. on next page)

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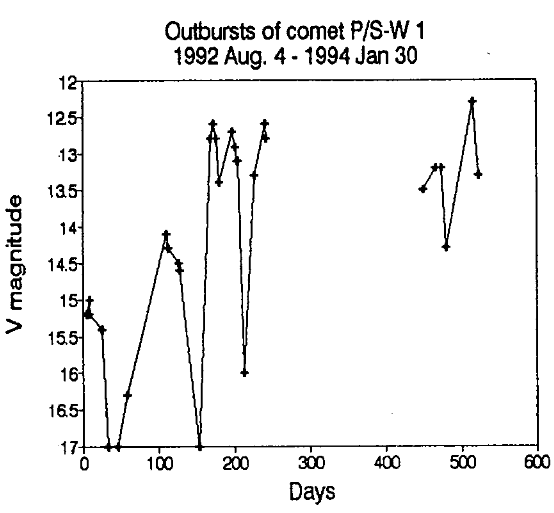


Figure 4. ⇐

Figure 5. ⇒

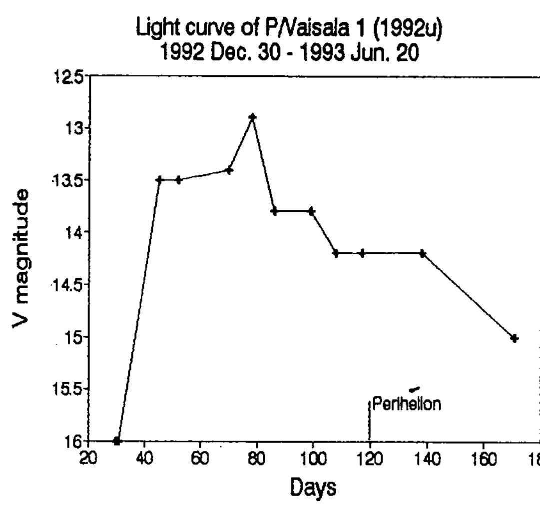


TABLE 1.
LIST OF COMETS FOR WHICH CCD PHOTOMETRY WAS PERFORMED
September 1992 - January 1994

Desig.	Comet	No. obs.	Detection range (V)
1992p	P/Brewington	2	13.2 - 14.4
1992t	P/Swift-Tuttle	4	
1992a1	Ohshita	7	11.9 - 15.5
1992l	P/Giclas	2	14.3 - 16.0
1993a	Mueller	15	9.8 - 14.0
1992u	P/Vaisala 1	12	12.9 - 15.0
1992x	P/Schaumasse	7	9.1 - 14.3
	P/Schwassmann-Wachmann 1	31	12.3 - 15.4
1993e	P/Shoemaker-Levy 9	4	13.2 - 14.2
1992c	P/Howell	1	14.9
1993p	Mueller	4	12.1 - 14.4
	P/Encke	2	13.2 - 14.6
1993o	P/West-Kohoutek-Ikemura	4	13.2 - 14.9
	P/Schwassmann-Wachmann 2	3	11.5 - 12.9
1993m	P/Hartley 3	2	14.5 - 15.0
1994a	P/Kushida	2	10.1 - 11.9
Total comets = 16		Total obs. = 102	

4.1. Estimation of errors in our measurements.

4.1.1. Errors induced by photon statistics

We calculated the S/N ratio and corresponding errors in magnitudes for three comets having V magnitudes between 10 and 15. All frames were exposed for 300 seconds. Following Buil (1991), we compared the comet signal (N_c) with the contribution of all noise sources using the formula

$$(S/N)_c = N_c(N_c + N_{\rm sky} + N_{\rm dark} + 3N^2_{\rm read})^{-1/2}$$

where N are signals given in electrons (for our ST-6 CCD we assumed that 1 ADU corresponds to 10 e^-). In our case, we considered comet, sky, dark-frame, and readout noise. The readout noise is induced in every reading of the CCD chip and was multiplied by 3, because it is present on the comet frame as well as on dark and flat-field frames. The uncertainties estimated from photon statistics are given in Table 2.

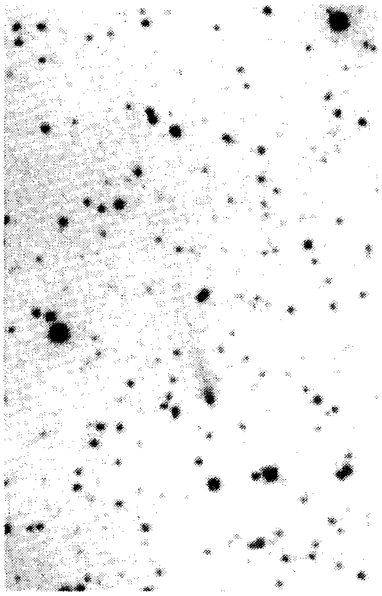
TABLE 2.

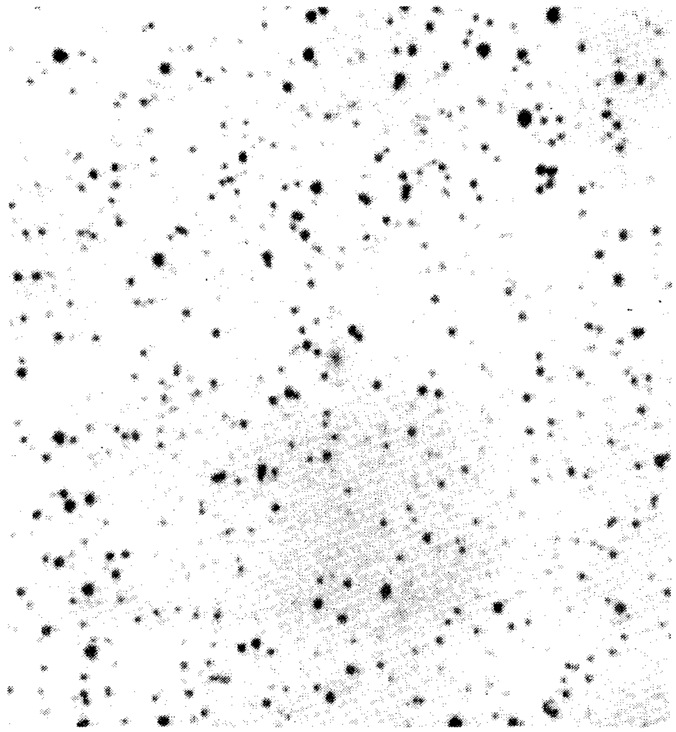
Comet	V	N(e-)	(S/N)c	Error (mag)
P/Kushida (1994a)	10.1	424030	211	0.005
P/S-W 1	12.3	76000	79	0.014
P/W-K-I (1993o)	14.9	7410	18	0.058

4.1.2. Errors induced by other sources

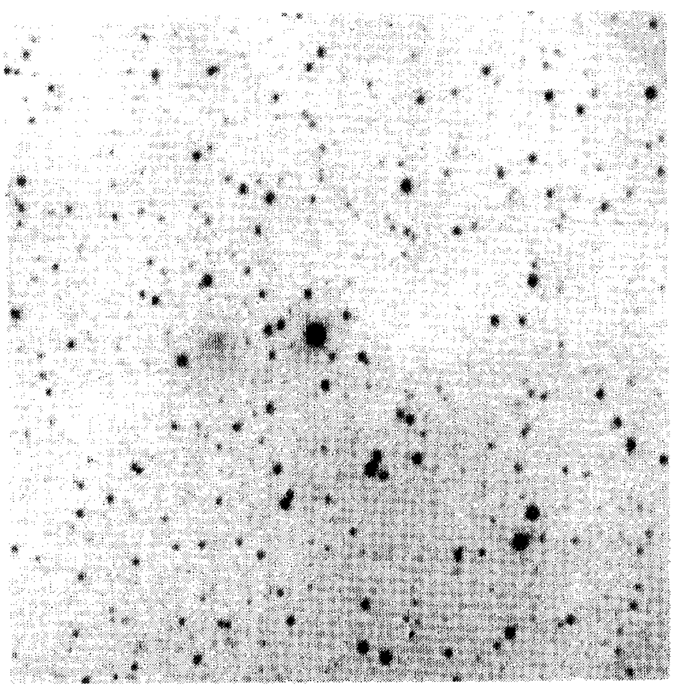
Some errors are introduced by the noise of the comparison star, but given the fact that the star is a brighter and more compact source than the comet, this cannot be a dominant source of error.

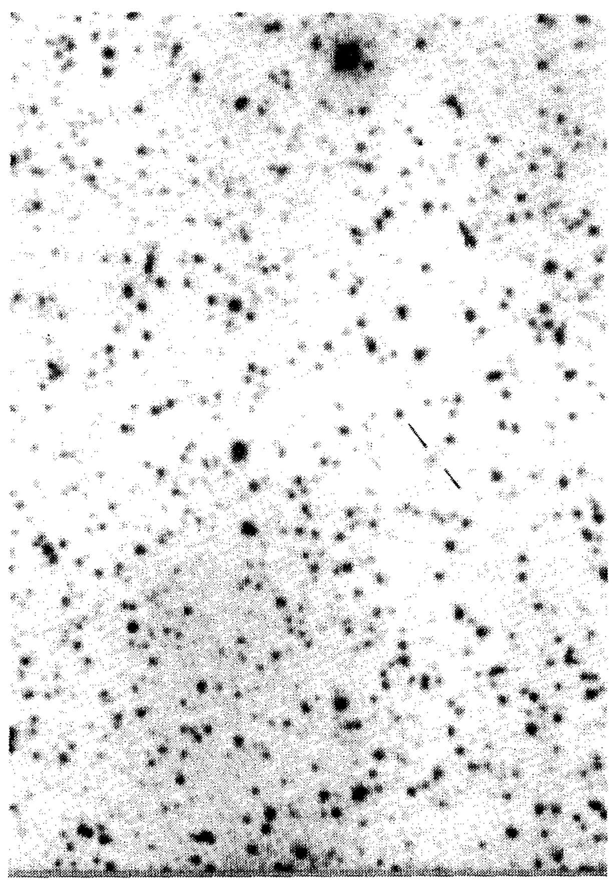
Finally, the measurements may be influenced by a poor determination of coma radius before running the aperture photometry program — for instance, when the specified radius of aperture is smaller than the actual radius of the coma. We may avoid this problem through careful reduction.

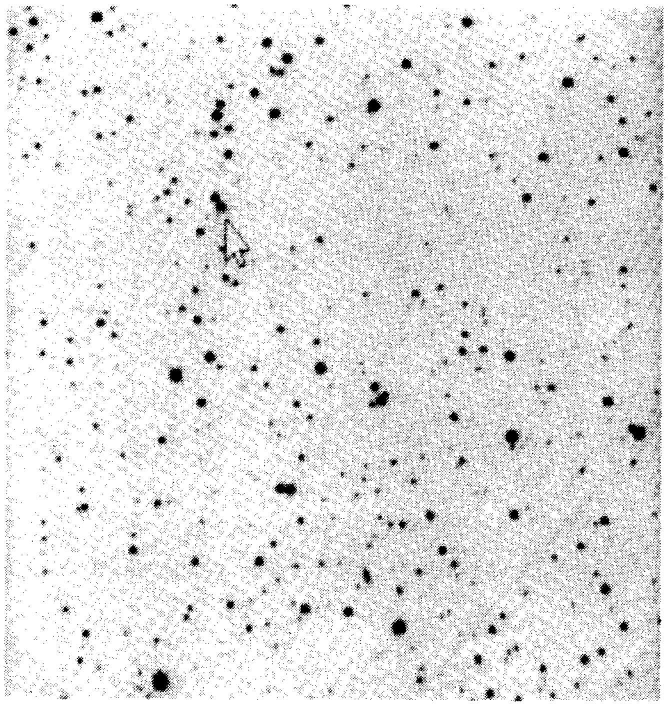




Figures 6-9 (beginning upper left and proceeding clockwise): All images obtained with the 20-cm f/ Baker-Schmidt camera (+ ST-6 CCD + standard V filter); 5-min exposures. Fig. 6 — P/Schwassmann-Wachmann 2 on 1993 Dec. 12.147 UT. Fig. 7 — P/Schwassmann-Wachmann 1 on 1993 Nov. 16.976. Fig. 8 — P/West-Kohoutek-Ikemura (1993o) on 1994 Jan. 29.777. Fig. 9 — P/Encke on 1993 Dec. 3.821.







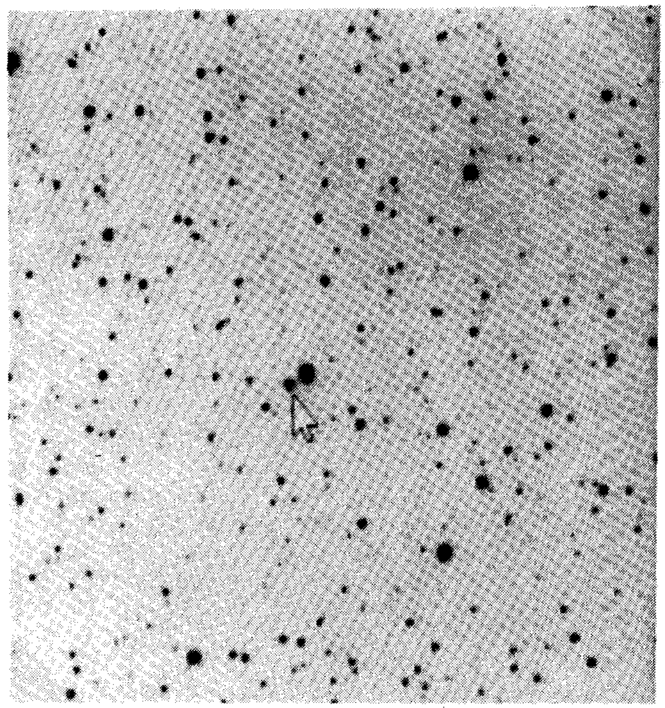


Figure 10 (left): Comet Mueller (1993a) on 1993 Jan. 6.226 UT. Figure 11 (right): P/Väisälä 1 (1992u) on 1993 Feb. 13.899. Both images taken as described for Figures 6-9 (see page 135).

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5. CONCLUSIONS

Our recent work on CCD photometry of comets enables us to perform routine V-magnitude measurements of comets down to 15th magnitude with precision exceeding those obtained by any visual method. This is even more impressive when we consider that they were collected with only a 20-cm-aperture camera.

We conclude that, when using our present equipment, we are able to measure a 15th-magnitude comet with the accuracy of ~0.1 magnitude. Better results are achieved for brighter comets. The introduction of this new technique made it possible for us to start a regular observing program.

Another important advantage of using CCD detectors is that a large number of quality observations may be collected on a single night without too much fatigue.

6. ACKNOWLEDGEMENTS

The authors wish to thank D. W. E. Green of the *ICQ* for his encouragement in starting our observing program. Thanks are also due to the "Javornik Astronomical Society" in Ljubljana, which provided us with the ST-6 CCD detector.

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8. APPENDIX

Further remarks about the computer programs that we currently use for CCD photometry of comets.

ST6OPS is supplied with the ST-6 CCD camera by the Santa Barbara Instrument Group and is used for the image acquisition and dark subtraction. The program also enables conversion to FITS file format (Wells *et al.* 1981). We use 16-bit conversion. In order to transport frames to PCVISTA, the generated files must be divided by 2 and added the constant of 16384.

PCVISTA is an image processing and analysis package, developed at the University of California (Richmond and Treffers 1989).

We used the following procedures:

MN — computes mean of the image.

DIV — divides object image with flat image to perform flat-field correction.

CLIP — replaces all pixels in a specified box; it is used to remove stars inside the comet coma by replacing star counts with the nearby sky value.

CURSOR — displays data values at cursor position on the image.

PHOT — performs aperture photometry with specified aperture radii.

The following programs were written by the authors and are available upon request.

XST6 reads the data from the FITS image header and calculates the air mass, X, of the object.

SKYSUB calculates the linear best-fit sky value and subtracts it from the frame; it is used when the comet is near the horizon and the sky gradient differs significantly over the frame.

FITSVIEW is an image display program for *MS Windows 3.1*; it incorporates various display options and works with FITS-format files.

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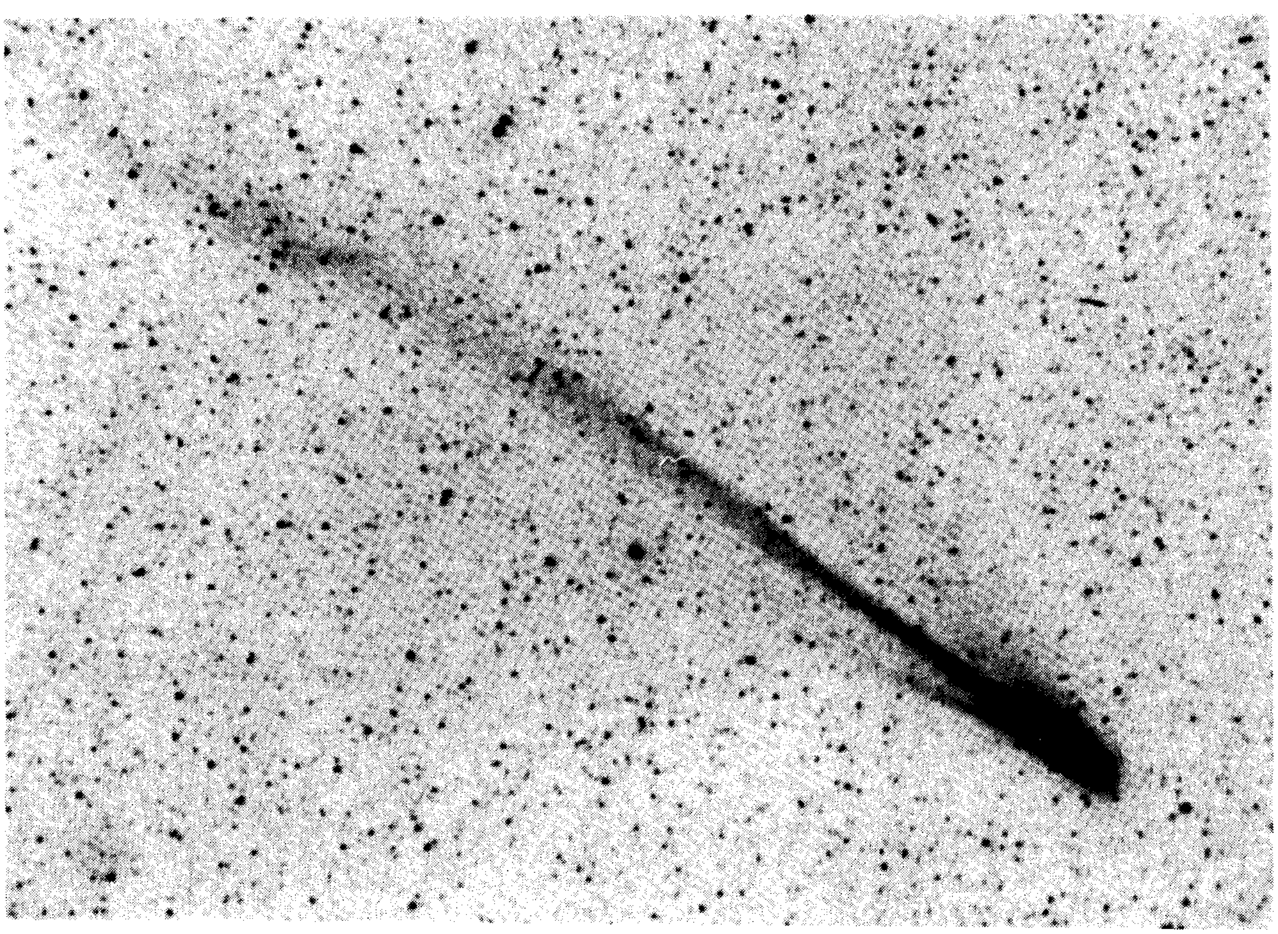

Figure 12. Ten-minute exposure of P/Swift-Tuttle (1992t) beginning at 1992 Dec. 15.709 UT; taken by H. Mikuž with 250-mm f/4 lens and 574×384 CCD + narrow-band H_2O^+ filter centered at 620 nm (FWHM = 10 nm) — used to record the comet tail in the light of singly-ionized water ions.

CCD Images of P/Swift-Tuttle 1992 XXVIII

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Abstract. During the week before the International Workshop on Cometary Astronomy in Selvino, Alex Scholten and I visited the amateur observatory of Danny Cardoen at Puimichel (France), when we were shown CCD images of P/Swift-Tuttle taken by himself and Daniel Zambenedetti in 1992. After processing the images, many interesting near-nucleus structures became visible. Some images resemble the drawings made by A. Winnecke (1864) at the previous appearance of P/Swift-Tuttle in 1862. Because of the short time available for processing images, only preliminary results are given here.

1. Introduction.

In the 19th century and at the beginning of the 20th century, many structures were observed near the nuclei of bright comets. Most of these observations were made visually by very experienced observers using large apertures and high magnification. Quantitative analysis of drawings are, except in very rare situations, impossible.

At the beginning of the 20th century, high-quality images were obtained of heads of comets using large reflectors. To obtain a useful photograph, one needs a short exposure time, precise guiding on the comet, high resolution, good seeing, and a very transparent, dark sky. Because of the relatively slow photographic emulsions at the beginning of this century, the exposure times varied between 1 and 30 minutes. However, photographs made with short exposure times show near-nucleus features better, whereas photographs using longer exposure times shows the outer envelopes.

For near-nucleus studies, a CCD-camera can be a useful instrument because of the very short exposure times that can be used — assuming that high spatial resolutions can be obtained. *(text cont. on next page)*

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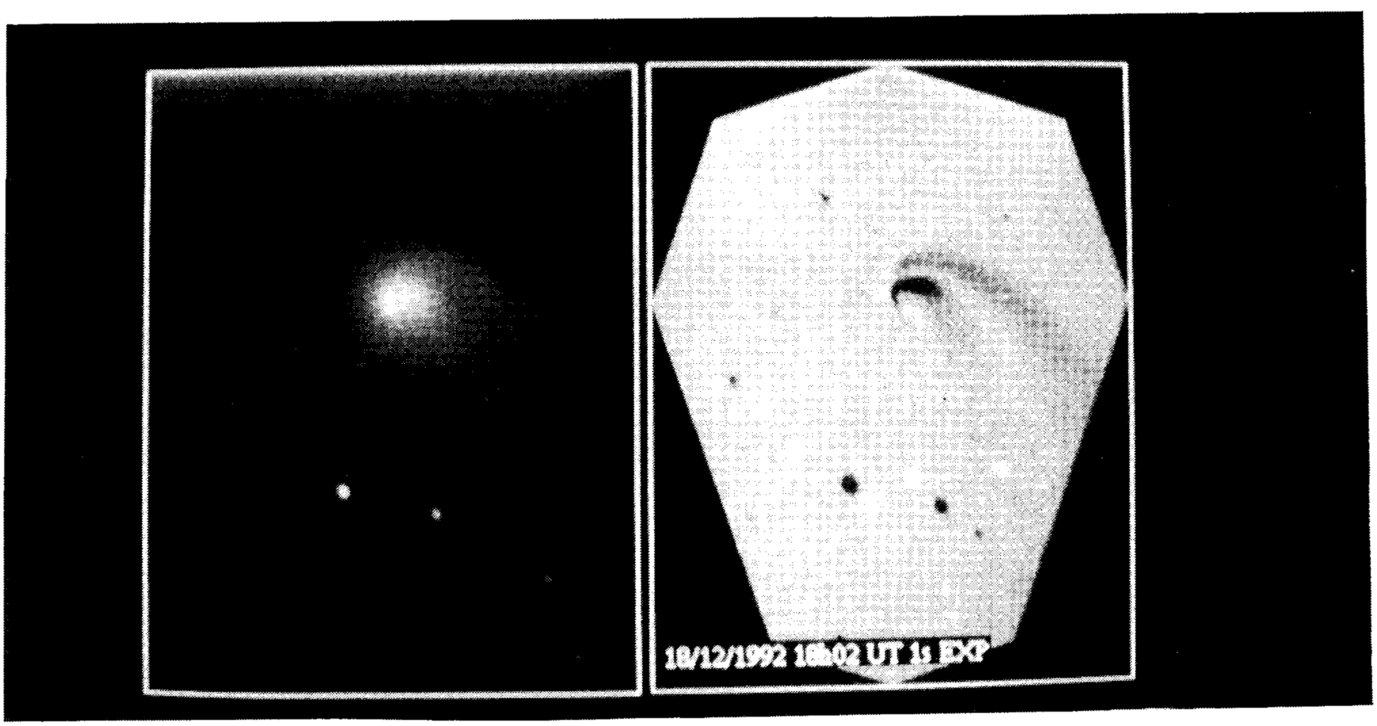

Figure 1. CCD image taken on 1992 Dec. 18.751 UT. Original CCD image at left; image-processed picture at right.

2. CCD Images of P/Swift-Tuttle

On six nights in the period 1992 Nov. 29-Dec. 20, about 30 CCD images of P/Swift-Tuttle were obtained by Danny Cardoen and Daniel Zambenedetti with the 104-cm $f/3.54$ reflector at Puimichel, France. The exposure times varied from 1 to 120 seconds. The observations on November 29, December 1, 5, and 6 were obtained when there were no(!) aluminum layers on the mirrors (thus, exposure times of 30-120 seconds were then necessary). On December 18 and 20, the exposure times were only one and two seconds, due to the the freshly-coated mirrors. The reflector has an effective aperture of 1040 mm and a focal length of 3672 mm. The secondary mirror gives an obstruction of 220 mm. The Thompson TH7863 CCD camera has an array of 288×384 useful pixels, each with a size of 23 μm. The field measured $\sim 8'.2 \times 6'.2$, with a plate scale of $\sim 64''$/mm.

3. Image Processing

Together with Daniel Zambenedetti, we selected the best single picture from each night for a preliminary analysis. All images were processed using the Microcomputer Image Processing System Version 2.0, applying the algorithm published by Larson and Sekanina (1984). We did not made any corrections, such as removing artifacts or substraction of a dark field image of the CCD camera.

To make the details of pictures visible, the most successful method is to use the radial/rotational shift-difference algorithm. The center point of rotation was chosen to be as close as possible the center of light. When the radial/rotational shift differences are applied the structures in the coma become visible; the steep, positive-gradient changes produce dark areas, a negative-gradient produces light areas, and near-zero gradients (the sky-background) result in grey. We used only three kinds of shifts: 60°, 40°, and finally we choose an (arbitrary) rotational shift of 20° for all images — because this gives, visually, the best results in analyzing the details of the original images.

4. The First Results

Comparing the original, unprocessed CCD images of comet P/Swift-Tuttle with the processed images, the structures near the nucleus are now distinctly visible. At first sight, some details resemble the same structures observed by A. Winnecke (1864) in 1862. For instance, compare the CCD image obtained on 1992 December 18 (Figure 1) with the drawing by Winnecke of 1862 September 3 (Figure 2). Also, the CCD image on December 20 closely resembles the drawings made by Winnecke on September 1 and 4 (Figures 3-5).

The CCD images of comet P/Swift-Tuttle will have to be processed more extensively before scientifically sound conclusions can be drawn.

Acknowledgements

I am grateful to Paolo Sirtou for using his Personal Computer to show the CCD images at this Workshop, and to Rob van de Weg for advising on this paper.

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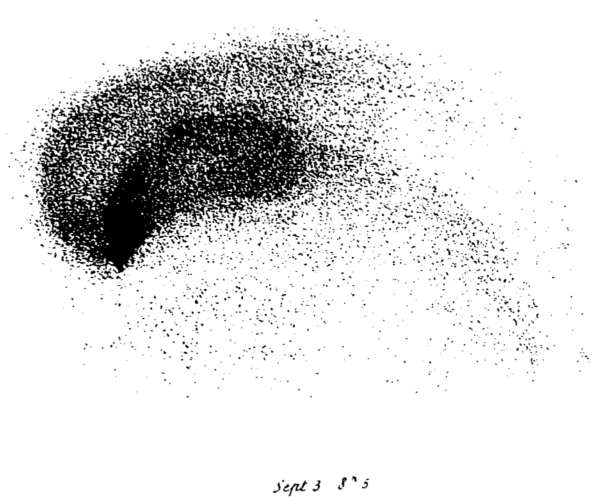
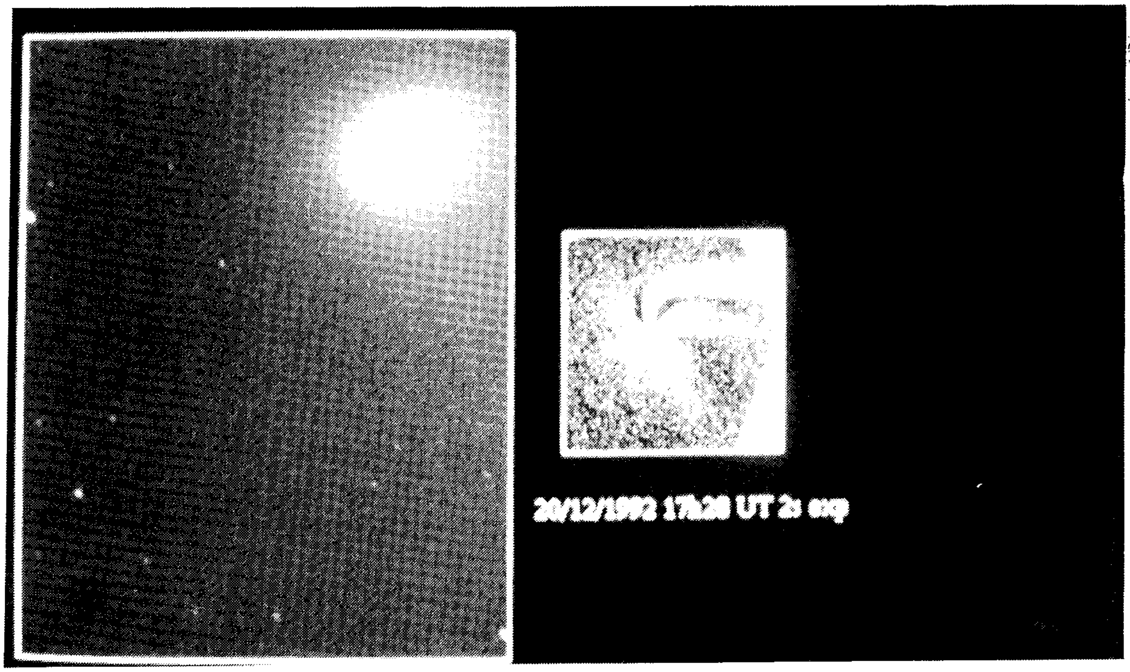
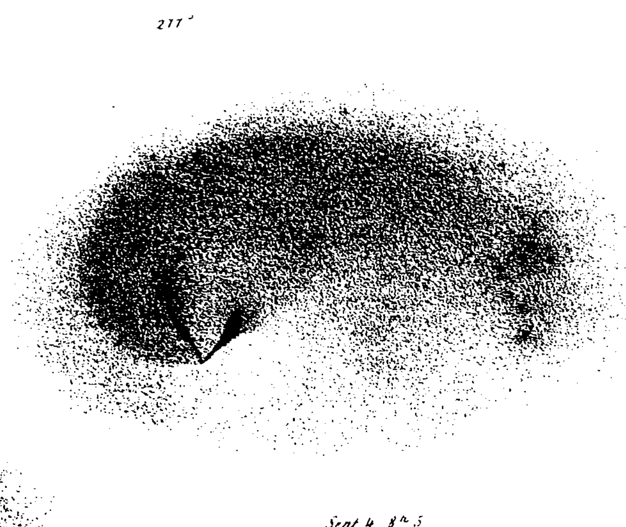
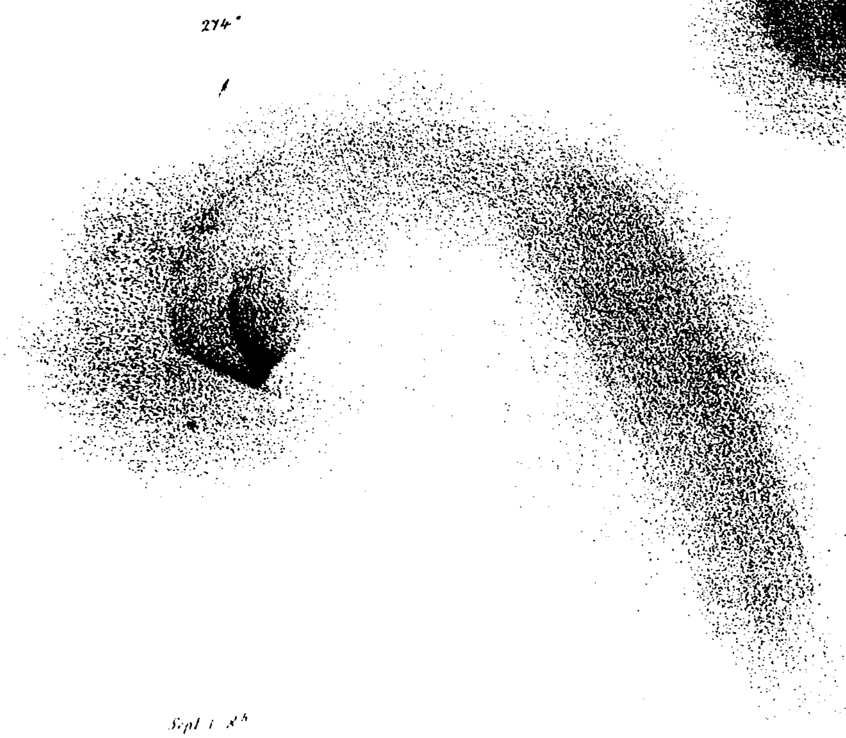


Figure 2. Drawing made by A. Winnecke on 1862 Sept. 3.77; 38-cm Merz and Mahler refractor.



Figures 3-5. counterclockwise from top: (3) CCD image taken on 1992 Dec. 20.728; original CCD image at left and image-processed picture at right. (4) Drawing by Winnecke on 1862 Sept. 4.77. (5) Drawing by Winnecke on 1862 Sept. 1.75.





Observing and Depicting Near-Nucleus Structure in Comets

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Abstract. The observational history and classification of specific coma features is discussed. Techniques for their observation are offered, and various methods for artistically representing these structures are presented.

On the night of 1682 September 8, the illustrious Polish astronomer Johannes Hevelius made a most singular observation of Periodic Comet Halley, then a striking 1st-magnitude object. Hevelius' drawing from that date is highly stylized but unequivocally shows a conspicuous, curving jet of bright material issuing from the region of the comet's nucleus. One can clearly see that this feature initially rises sunward from the nucleus and then is swept back into the tail. This is the first recorded depiction of an emission jet or jet sector within the cometary coma.

Although Hevelius could perceive P/Halley's jet sector with his rudimentary telescope, such structures are normally very difficult, ephemeral features of the inner coma — even with telescopes of moderate aperture. In the three centuries since Hevelius made his epochal observation, upwards of 1,000 comet apparitions have taken place. Of this immense total, probably less than 25 of these wonderous objects have unquestionably displayed similar or more intricate phenomena (*i.e.*, similar features being simultaneously reported by independent observers over the course of several days).

Perhaps not surprisingly, the greatest number of sightings of distinct internal detail occurred during what many consider the "Golden Age" of visual astronomy — the latter half of the 19th century. This period, however, also coincides with one of the most prolific intervals of cometary activity on record, with no less than 7 spectacularly bright comets appearing in the relatively short span of 30 years (1853 to 1882).

During the first seven decades of the present century only comets 1907 IV, 1910 II, and 1930 VI are generally acknowledged to have shown clear evidence of near-nucleus structure visually. One must recall, of course, that in this period, photographic observation had almost totally supplanted visual work, reducing the potential for such specialized observations being made. The field of detailed visual observations of comets remained largely dormant until the last three decades of the 20th century, when it re-emerged as the province of mainly non-professional astronomers. Over the course of this final interval, three objects (1970 II, 1986 III, and 1992t) have displayed near-nucleus structure distinctly enough to be reported by numerous visual observers, while also being recorded by photographic and electronic means.

CLASSIFICATION OF FEATURES

The structural features to be discussed in the following may be classified into four general types, to which the author has assigned letter designations for the purpose of simplified identification. Progressing from the largest to the smallest in physical dimensions, they are:

Class H features. The largest of the coma structures, these are often referred to as "hoods" or "envelopes". Evident only in large, bright comets, they appear as fairly-well-defined brightness layers within the coma. Their outline may be either parabolic or semi-circular, with a perimeter that is usually traceable only on the sunward side of the coma. Occasionally they appear as separate, luminous arcs within the coma that can be seen to expand with the passage of time. Class H features should not be confused with a central condensation within the coma, which is circular in outline and rarely as sharply-defined. In some comets, hoods or envelopes appear to be associated with jet structure (discussed below) in some manner. Class H features were well represented in comets 1858 VI, 1874 III, and 1970 II.

Class R features. These are long but very-narrow, near-linear, and often filamentary rays that always extend in the anti-solar direction. They typically appear to originate near the anti-solar side of the nucleus and are bluish in color. These rays rarely can be traced right up to the false nucleus (the nearly star-like object at the heart of the coma) but rather become visible a short distance from it. In truth, these rays are the beginnings or root of the type-I plasma (ion) tail. Examples are too numerous to cite individually.

Class F features. Commonly referred to as fountain structure, these are continuum features appearing as a column or well-defined fan of bright material issuing from the sunward side of the false nucleus. Boundaries are often softer than those of true jets (described below) but they are closely-related features. The central axis of a fountain is often tilted with respect to the solar direction. Occasionally class-F features are intense enough for the ejected material to be traced far out into the coma and noted to be swept back toward the anti-solar direction. This gives the feature an overall comma-shape and, if large and broad, will cause the coma to appear strikingly dichotomized, one-half being distinctly brighter than the other. This is the type of structure perceived in P/Halley by Hevelius and by many later observers in this same comet, as well as in P/Swift-Tuttle.

Class J features. True jets are narrow streamers of bright material, often multiple, that are initially directed more-or-less sunward from the false nucleus, then may curve back toward the anti-solar direction. Continuum features, their bases appear to originate directly at the false nucleus itself. In height they rarely have been reported to exceed 60″, with widths only a small fraction of this figure. Jets were prominently visible in comets 1861 II, 1862 III, and 1970 II.

TECHNIQUES FOR OBSERVATION

As already indicated, comets displaying internal structure that is detectable with modest instruments have historically been exceedingly rare. The situation may be put in its proper prospective when one considers the following. During the latter half of the 19th century, when there were literally scores of active visual observers who were the match of the better of any living today, only a mere handful of bright comets were ever reported to show striking internal structure. Likewise, the author of this paper has made extensive observations of 180 comets since 1957 but of these, only three objects (1970 II, 1986 III, and 1992t) visually displayed distinct internal structure of class H, F, or J. In consideration of this, observers should be very careful in distinguishing in their records and in reporting observations as to what is definitely visible and what is simply suspected. Suspected detail is very often simply subjective.

As a general rule, true jet structure is most often detected in very bright comets when not far from perihelion passage or in those of lesser brightness passing unusually close to Earth. Even in the former case, such detail seems not to be detectable if the comet lies more than 0.75 AU from Earth. Further, comets with perihelia significantly greater than 1 AU are poor candidates for showing significant jet structure.

Brilliant comets, those of magnitude +1 or brighter, present a rather unique observing problem. Here the inner coma's surface brightness may be so great that the glare can literally hide delicate features from the eye, particularly when the comet is viewed with instruments of large aperture. Viewing such a comet through the veil of twilight helps to reduce this glare in ever-varying stages. On more than one occasion, the author has noted that certain delicate internal features were only detectable during a brief period in the twilight. This same technique will usually clarify the reality of any suspected subsidary nuclei. True secondary nuclei become sharper and more star-like in twilight, while emission features progressively grow more diffuse and fade away as the twilight glow increases.

Jets and fountain-structure visibility responds best to moderate magnification. An eyepiece providing $\sim 6\times$ to $8\times$ per centimeter-of-aperture seems to render them most evident. This may be a result of reducing the surface brightness of the coma.

Class H features (hoods/envelopes) are always very difficult to detect visually but are present more often than jet structure, at least in their layered form (as opposed to the luminous arcs). These strata of luminous material are best perceived visually using very low magnification ($2\times$ per centimeter-of-aperture), in conjunction with large aperture and a very dark sky background. Class H features are generally missed for want of contrast, so the entire coma must be viewed — surrounded by dark sky — before one has much hope of spying the hoods.

Photographically, these features are much more obvious, and the layered form is present in nearly every very bright comet, particularly those with small perihelia. They reach their ultimate development in the Kreutz sungrazing comets, where one or more of these envelopes may encompass the entire comet (being then referred to as a "sheath")!

Features of class R (anti-solar rays) are much more common than any other internal-coma structures and, given a large enough aperture instrument, are likely visible any time that a strong ion tail is present. A few persons, most notably G. E. D. Alcock of England, have vision that is particularly blue-sensitive. These individuals can sometimes see extraordinarily-delicate class-R detail — not only in the coma, but extending far out into the comet's tail. For the rest of us, the visibility of class-R rays can be enhanced by employing appropriate narrow-transmission filters, like the Lumicon Swan-band comet filter. Since this same filter usually suppresses the visibility of class-J features, it may be used to differentiate between the two. Relatively low magnification ($3\times$ to $5\times$ per centimeter-of-aperture) can be employed to advantage in the detection of class-R rays.

DEPICTING COMETARY DETAIL

While a detailed written description of one's comet observations is of considerable value in portraying the nature of the perceived internal details, nothing can convey a comet's appearance as well as some form of illustration. Few astronomers, professional or non-professional, are also artists — but this should not deter one from attempting to depict what he or she has seen at the eyepiece.

There are a number of methods or media that prove very effective in illustrating comets. These range from the simplicity of pencil sketches to techniques used by artists and commercial illustrators. In the following, four methods are discussed in order of increasing difficulty. Any "journeyman" observer should be capable of mastering at least one (if not several), and many readers of this paper will undoubtedly be familiar with some of the techniques already. It is noted, however, that with the possible exception of the first to be mentioned, none are really suitable to actual preparation at the eyepiece. A rough pencil sketch and detailed notes are more applicable here, from which a better representation can be prepared later indoors.

PSEUDO-ISOPHOTO DRAWINGS. The simplest form used for illustrating comets is a pseudo-isophoto sketch. True isophoto images, often appearing as colorful illustrations in astronomical texts, cannot be produced by simple visual means, but their essence may be captured in a picture that represents areas of essentially equal brightness within the coma.

The observer uses a pencil and paper, drawing a series of outlines like the layers in an onion, each depicting an increasingly brighter region within the coma. Steep gradations in brightness are represented by closely-spaced lines, slight differences by widely-separated ones. The result, although highly simplistic, will be capable of conveying the comet's general appearance.

NEGATIVE SHADING DRAWINGS. This drawing technique is probably the most widely employed among observers today to depict comets. As the name implies, these are illustrations that show the bright areas of the comet by increasingly deeper shades of grey. The overall appearance is similar to a photographic negative.

While there are several ways of producing these drawings, the easiest is by employing pencil graphite as the basic shading medium. A very light tracing of the comet's form may first be drawn on the paper, outlining the areas of increasing brightness just as in the pseudo-isophoto method. On a separate surface a dense rubbing of soft graphite is laid down. Tissue, or even a finger, is rubbed into the graphite and then transferred to the drawing in a light circular motion. This will provide a faintly-dark basic background, representing the outer coma. Further applications of graphite, applied with greater pressure, will increase the darkness of the image to most any degree necessary.

Small, particularly intense, or even somewhat-delicate features may be added to the drawing by use of an "artist's stump/stub" — a small, pencil-like cylinder of stiff paper that is pointed on one end. These are inexpensively available at art-supply stores. The pointed tip, which can be broadened as desired by scrubbing on a rough surface, is rubbed in the graphite until darkened and then used to apply graphite to the illustration in the required pattern. The observer can fashion the tips of a selection of artist's stumps to a variety of widths to allow depiction of very narrow, delicate features to broad, ill-defined structures.

Very intense features, such as a strong false nucleus, are best applied as a dark spot directly on the drawing using a pencil. It may then be rubbed with an artist's stump to soften/blend it into the surrounding coma. A sharpened eraser may be used to highlight areas in the drawing, as in depicting the so-called "shadow of the nucleus", when present. Patience in the application of the various shadings and diffuse details will lead to a very credible rendering of the object.

STIPPLE DRAWINGS. Stipple drawing is an old technique and has been used in illustrating comets for at least 150 years. Although taking considerably longer to create a drawing than the foregoing methods, this technique allows the observer to execute a very high degree of control over the final appearance of the illustration. Stipple drawing is a form of the negative shading technique, but when the final product is viewed from an appropriate distance, it serves much better to convey the subtle brightness differences and diffuse features often evident in comets. No great artistic skill is required to employ this method, but patience is a virtue, since it may take as long as one or two hours to complete a single illustration.

Once again, the observer starts out with a light pencil sketch of the comet on his paper and then proceeds to apply tiny ink dots to the paper in rapid succession. The density or numerical cross section of dots per unit area controls the darkness of a particular area. All manner of subtle features can be depicted by very slightly increasing the number of dots in a given area. A particular advantage of the stipple technique is the ability to keep going back and adjusting the number of dots to increase or decrease the relative intensity/visibility of a feature. When the work is to the observer's satisfaction the faint pencil outlines are erased, leaving only the pure dot image.

While special stippling pens are available, the author finds that many modern fine-point ink pen/markers are quite acceptable for the job. The pen must be of the hard-tipped variety so that it will lay down consistent, distinct, black dots each time it strikes the paper. Once learned, the stipple technique can be applied to many areas of observing, such as in illustrating nebulae, sunspots, and even planetary detail!

ARTIST'S MEDIA. Only a few professional artists have ever attempted paintings in which a comet was the principle subject. Of these, the large ($\sim 40 \times 60$ cm) rendering of comet 1881 III by L. Trouvelot is arguably the finest ever done. Viewed from a distance, it is the Great Comet seen above a landscape that includes a small observatory dimly lit, as a supposed observer scrutinizes the comet. However, when the viewer examines the comet's image close-up, it reveals that Trouvelot has depicted the comet's head showing the internal jet structure surrounding the nucleus as if seen through a telescope!

Any observer who has artistic talent should really attempt a comet "painting" at some point in their career. Oils and water colors are not particularly suited to the nebulous appearance of comets. Pastels, however, might be a very good choice for representing a natural appearance (rather than a negative image) and in illustrating the wonderously-subtle shadings usually present in the coma and particularly the tail. Likewise, the modern airbrush, often used by commercial artists and illustrators, is eminently suited to the task. The latter device can produce an almost-infinite variety of shadings and subtle effects and would, in the author's opinion, be the ultimate means for realistically depicting any large, bright comet.

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— MEPCO '95 —

Daniel Fischer (Im Kottsiefen 10, 53639 Königswinter, Germany) writes to inform us of the Second Meeting of European (and International) Planetary and Cometary Observers (MEPCO), to be held in Violau, Bavaria (Germany), during 1995 March 24-27. The guest of honor and keynote speaker will be geologist Eugene Shoemaker, who will also guide a field trip to the Nördlinger Ries crater.

The meeting will host papers and posters on observational work and results in different countries, as well as discussions and workshops to foster Europe-wide contacts and collaboration. There will be emphasis on results of the collision of comet 1993e with Jupiter.

The meeting fee, which will include the *Proceedings*, is DM 270. Contact Wolfgang Meyer for further information at Martinstr. 1, D-12167 Berlin, Germany. (Copies of the *Proceedings* of MEPCO '92 can still be ordered from Fischer at his above address for DEM 10. plus postage; his e-mail address is p515dfi@mpifr-bonn.mpg.de.)

A Simple Approach to the Prediction of Visual Tail Length

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1. Introduction

The possibility of simulating the tail development of a comet can add significantly not only to the realism of astronomy programs but also to more reliable predictions about newly-discovered comets. Furthermore, it would be of interest to derive comet parameters for ancient comets from the reported tail lengths. The author presents a simple method for the prediction of the visual tail length.

2. Basic Suggestions

The reason for this investigation was the problem of how to simulate the apparent size of the tail of a comet. One feature of astronomy computer programs is the ability to construct a visibility diagram of any solar-system object. In the case of a comet, it would be nice to know not only the elevation and azimuth for a given location, date, and time, but also the apparent tail length and orientation relative to the horizon (see *Fig. 1*).

Whereas the calculation of the tail orientation represents no problem, one has to find a method of calculating the dimensions of the apparent tail length. Because the calculation of both quantities represents only a minor feature of a program, it was decided to search for a correlation between the tail length and the heliocentric magnitude of the comet. This approach was supported by an investigation of Festou (1986), in which he found a correlation between the gas-production rate, Q, and the heliocentric magnitude $m_{\rm hel}$ which works pretty well (alas, not for P/Halley):

$$\log Q(\mathrm{OH}) = -0.4 m_{\rm hel} + 32.04$$

3. The Analysis

To derive a convincing correlation between the mentioned quantities, I analyzed about 10,000 observations of comets after 1955 (including $\sim$ 2,500 tail-length estimates), using mainly the *ICQ* archive, but also reports appearing in the British magazine *The Astronomer* and observations of the German Comet Section.

The analysis included the following steps per comet:

- In the first step, all biased brightness estimates (situated distinctly above or below the main body of estimates) were eliminated. With the remaining estimates, the photometric parameters were derived.
- In the second step, all tail estimates were plotted, and those selected for further analysis were situated at the upper limit of the main body of estimates (*Fig. 2a*); no differentiation between gas and dust tail was applied. To avoid a predominance of some widely-observed comets, it was decided to do the selection at roughly 5-day intervals.

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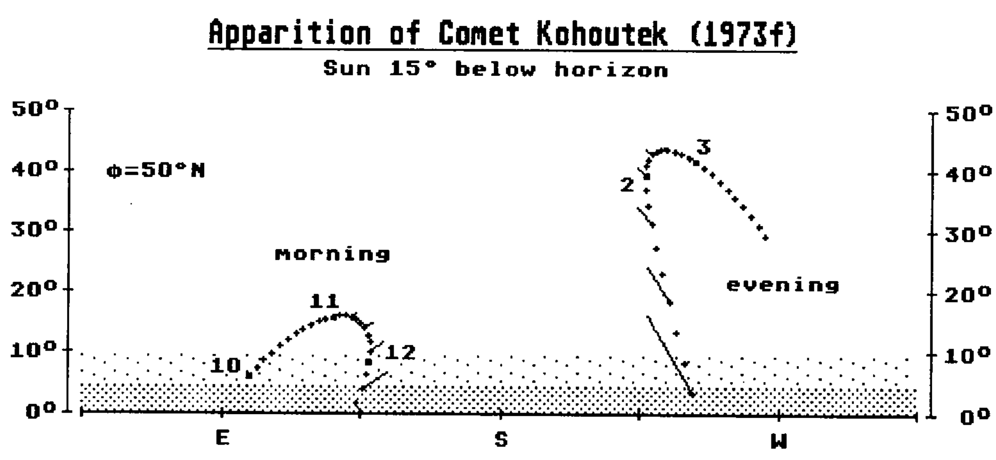

Figure 1. Visibility diagram for comet Kohoutek 1973f; the depicted tail is enlarged 2×.

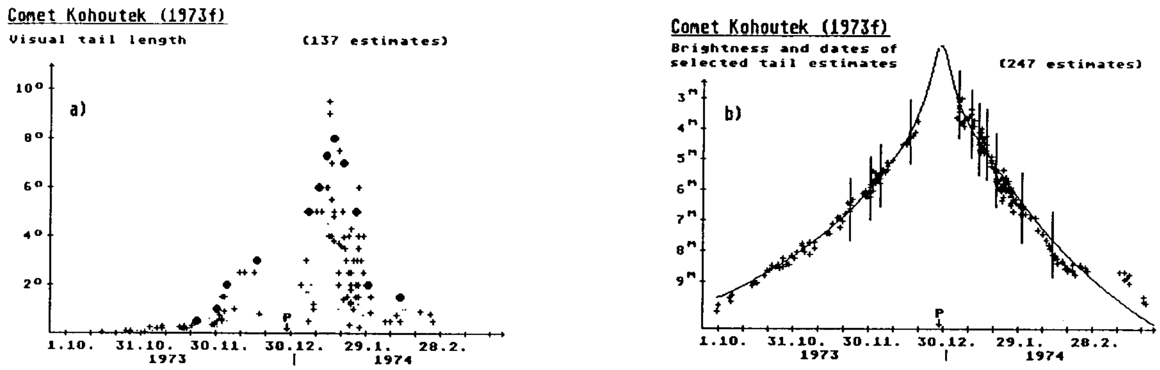

Figure 2. The selection procedure. Fig. 2a (left): selected tail length estimates (full circles); Fig. 2b (right): extracting the coma brightness belonging to the tail-length estimate.

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- From the apparent tail length in degrees, the absolute tail length, L (in million 10^6 km), was derived by assuming that the tail always pointed in the anti-solar direction.
- For every selected tail-length estimate, the corresponding heliocentric magnitude was found by plotting all brightness estimates (together with the derived light curve) and marking the times of the selected tail estimates. In this way, it is possible to account for short-term brightness variations (*Fig. 2b*).
- In the last step, the absolute tail length *versus* the heliocentric magnitude was plotted.

Altogether, 210 estimates of 36 comets were chosen for the final analysis. Comet Halley was not chosen, because Festou's formula did not work for it and its dust tail definitely did not point in the anti-solar direction. To evaluate this database, *Figure 3* shows some histograms.

Figure 3a demonstrates that no comet is over-represented. In this way, it is assured that the resulting formula will represent the average tail development of all examined comets.

Figure 3b demonstrates that the tail-length estimates, which are situated at the upper limit of the main body of estimates, come mostly from experienced observers. To recognize the faintest parts of a tail requires not only great experience, but also the optimum combination of sky conditions and equipment — circumstances best fulfilled by experienced observers.

The third histogram (*Fig. 3c*) shows the interval of sun-comet distances (r) covered by this analysis. It is important to note that there are only 7 observations at $r < 0.4$ AU, including 2 observations (both of comet Ikeya-Seki 1965f) at $r < 0.3$ AU.

Finally, *Figure 3d* comes as no surprise, because the analysis concentrated on fairly bright comets.

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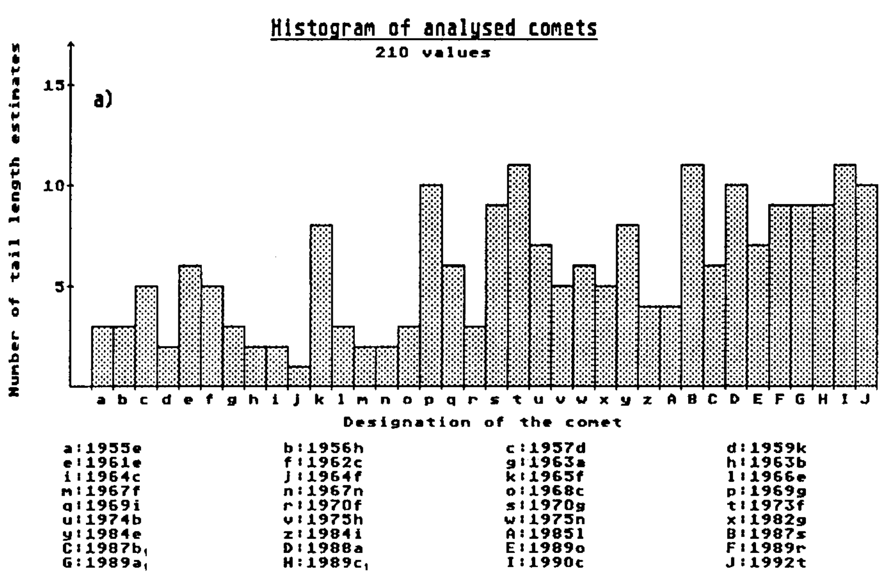


Figure 3a. Histogram of the database for the final analysis; see text.

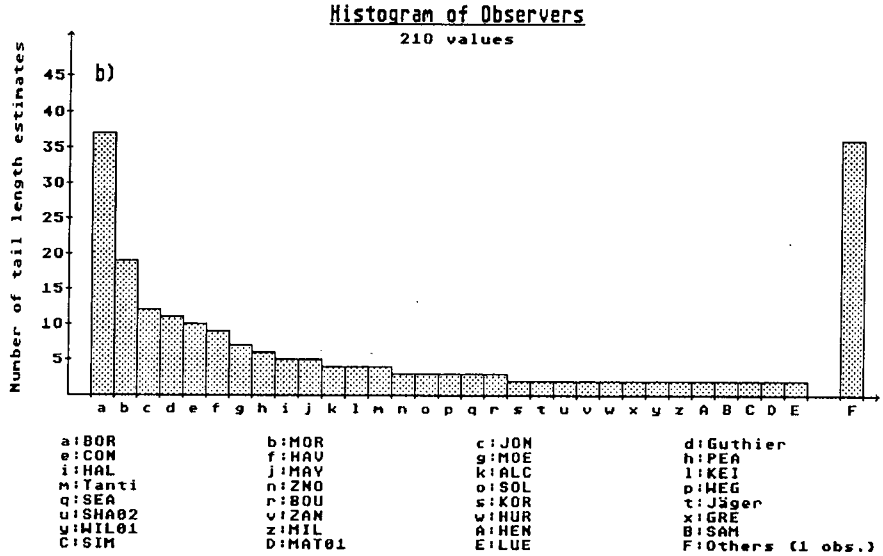
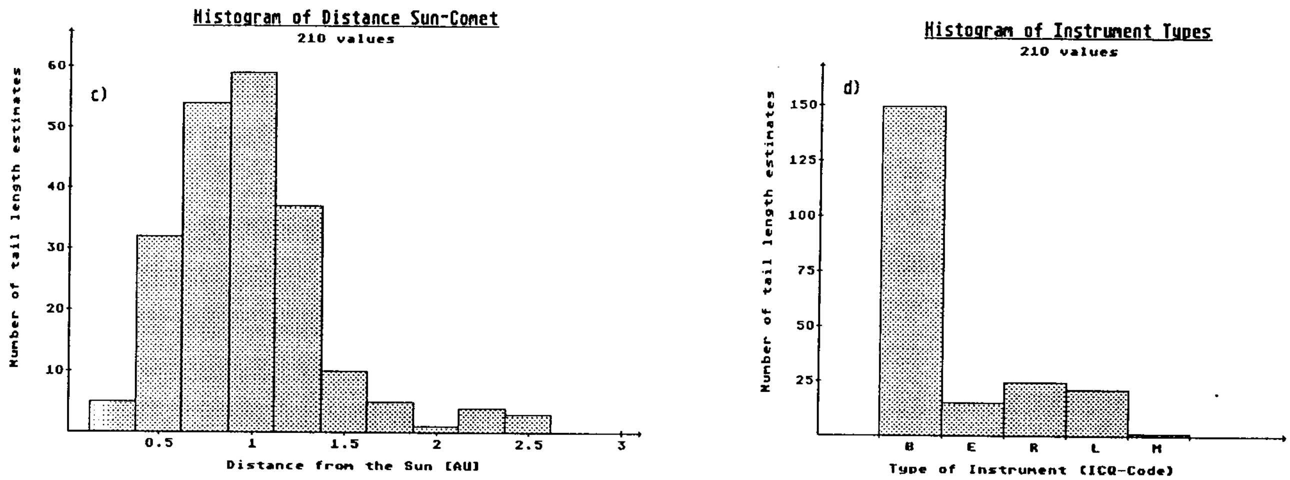


Figure 3. Histograms of the database for the final analysis. (b, above; c, below left; d, below right)



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The above assumption, that all tails point in the anti-solar direction, means that every deviation from this direction (or curvature of a tail) is ignored in this analysis. Whereas it can be shown that — in the case of a curved tail — the resulting errors will normally be < 5 percent, they are highly dependent on the phase angle and the deviation angle in the case of a tail deviating from the anti-solar direction. I have no data about which comets showed definite deviations or about the value the deviation angle can attain. But, assuming a deviation angle of 10°, the resulting errors will be small in comparison with the scatter of the tail-length estimates for phase angles between $\sim$ 40° and 140°. A corresponding investigation of both databases (recent and ancient comets) showed that only a small fraction of the selected estimates were taken at phase angles beyond these limits, and that both do not exhibit any correlation between the phase angle and the heliocentric magnitude. Thus, it is also difficult to estimate the errors introduced by assuming an anti-solar direction of the tail on a specific estimate, but this simplification should not have much influence on the resulting formula.

4. Results

Figure 4a shows the 210 selected tail-length estimates plotted *versus* the heliocentric magnitude. A closer inspection of the diagram shows some biased values, which are situated significantly below or above the main body of values. It turned out that every one of these values is due to special conditions. For example, the value at ($m_{\rm hel} = 8.9$, $\log L = +0.95$) represents the short-term dust outburst of comet Austin 1989c_1 at the end of May 1990. The other values above the main body of estimates belong to comet Ikeya-Seki 1965f, which exhibited an extraordinarily large tail (probably a result of the split nucleus) and to comet Humason 1961e. The biased values of the latter comet are caused by the fact that, at the time, it was very near a phase angle of 0°, at which a slight variation in the observed tail length causes a great variation in the absolute tail length. The values that are too small can all be explained by the fact that these observations were made under unfavorable observing conditions (*i.e.*, comet at a very low altitude).

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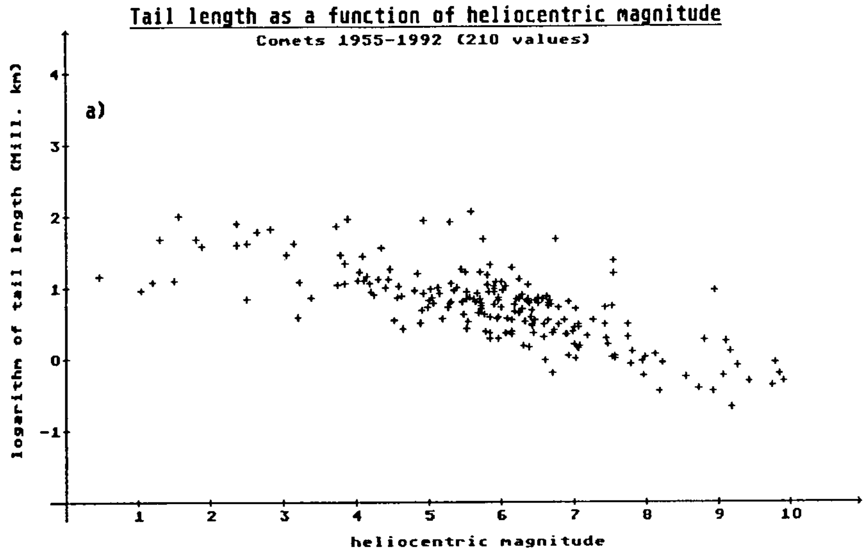

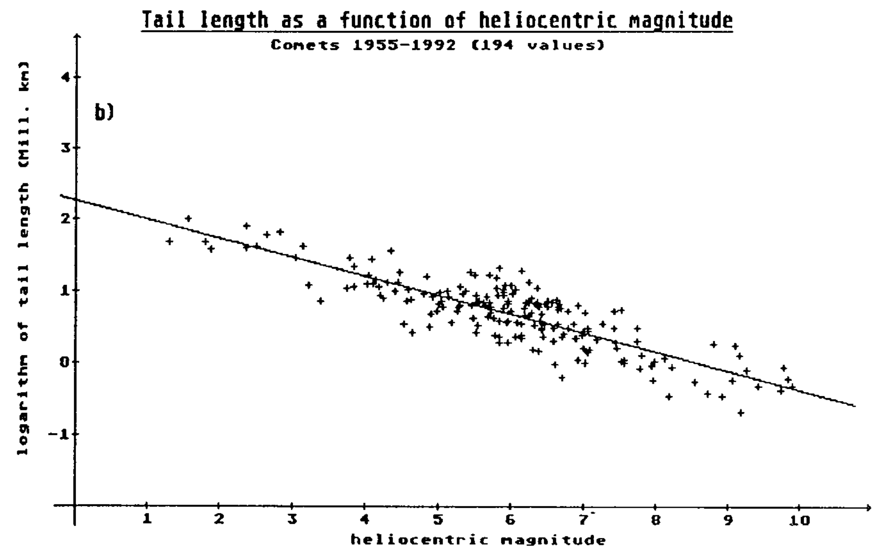

Figure 4. Visual tail length as a function of the heliocentric magnitude. (a, upper right) all 210 values; (b, lower right) excluding the biased values.

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All biased values that could be explained as being unrepresentative were ignored for the following calculation. In *Figure 4b*, one can see the resulting diagram, which shows a really good correlation. The correlation coefficients were calculated by using the method of least squares. The formula, which is representative only for $r > 0.4$ AU, describes the average development of the visual tail length of a comet:

$$\log L\ [10^6 \text{ km}] = -0.26(\pm 0.01) * m_{\text{hel}} + 2.25(\pm 0.07).$$

Although this formula was derived from estimates of fairly bright comets, it works equally well on weaker comets that display a gas tail only.

At small r, the formula yields too great a tail length, as can be verified by observations from space of recent sungrazing comets. Only in rare cases can a tail of a comet that is at $r < 0.4$ AU be seen under a fairly dark sky to allow a reliable estimate of its apparent dimensions. But the few such cases (together with observations from space) nevertheless demonstrate the need to stop the exponential increase of the tail length resulting from the formula above. This can be done, for example, by fitting a parabolic formula for small r to the formula above.

5. Ancient Comets

Finally, I analysed 85 brightness and tail-length reports of 36 comets between 1449 and 1947 that were published by Mucke (1976). For this part of the analysis, it has to be taken into account that the reported brightness values are often nothing more than a guess.

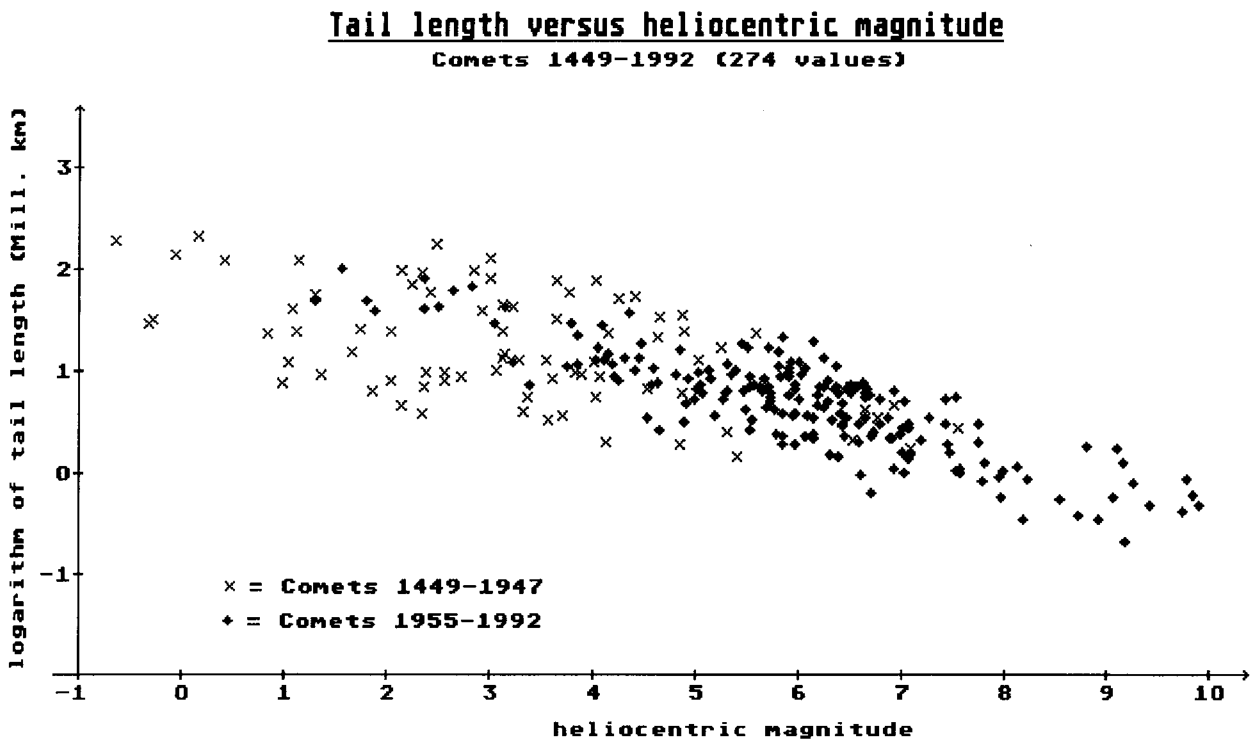

Figure 5. Visual tail length versus *heliocentric magnitude for the analyzed recent and ancient comets.*

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Nevertheless, I decided to make a test. Again, observations made under unfavorable conditions (indicated by the visibility diagram of the specific comet) were ignored. The result can be seen in *Figure 5.* Whereas there is a remarkably good correlation between recent and ancient comets at fainter heliocentric magnitudes, the deviation at bright heliocentric magnitudes is significant; it can neither be explained with unfavorable observing conditions nor with a greater number of observations at $r < 0.4$ AU.

The result can be interpreted in several ways. Personally, I prefer interpretations (3) and (4): (1) The analyzed number of 85 observations is too small to establish a convincing deviation. (2) The comets in the second half of this century exhibited exceptionally-large tails (very active sun). (3) The ancient observers did not recognize the faintest parts of a tail, (meansing that modern observers would report a larger apparent tail). (4) The magnitude of the very bright comets is over-estimated.

6. Conclusion

The analysis demonstrated that there exists a correlation between the heliocentric magnitude and the visual tail length. By applying the derived formula, one always has to take into account that it only works for $r > 0.4$ AU and that it only yields the average tail development of a comet. On the other hand, a greater deviation of a comet from the average development might point to some unusual processes.

Further analysis should refine the formula, and one should perhaps search for additional comet parameters responsible for the tail development.

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— CORRIGENDUM —

• In the October 1990 issue, page 114, "Comet Levy 1990c", line 13, *for* June 27.20: 7-min exp. with 0.2-m f//2 *read* June 27.019: 7-min exp. with 20-cm f/2

The BAA Comet Section

Jonathan Shanklin

The British Astronomical Association (BAA) comet section was founded just over 100 years ago, and its first Director was W. F. Denning. His original aims for the section were to secure observations of comets, to discover new comets and nebulae, to record telescopic meteors, *etc.* He further amplified this when he called on observers ". . . to note physical details and changes of aspect, to make drawings, to ascertain positions and watch for special phenomena such as . . . abnormal fluctuations of brightness in the nuclei of comets". The Director instructed that "the book of reference will be the New General Catalogue...". A few months later, three members had joined the section, but no results or observations had been communicated to the Director. By the following year, no members were working with him, and he was contemplating resigning the position — though in March 1892 he had discovered a new comet. He resigned in September 1893, citing ill-health as the reason, though he later directed the Meteor Section, and died in 1931. The new Director, W. E. Plummer, made a number of changes to the program, which reinvigorated the section. His program of work was as follows: observations of position, sweeping for new comets, orbit and ephemeris computation, photographic and spectroscopic observation, and telescopic drawings. The section's first *Memoir* was on comet Halley's apparition in 1910, and this was followed at irregular intervals by others on a variety of cometary subjects until the most recent, detailing the 1986 apparition of comet Halley (1991). The first P/Halley *Memoir* had only 20 or so approximate magnitude estimates, and no light curve was presented — though pre- and post-perihelion magnitude formulae were given.

Several of the Directors comment in their annual reports that many observations had been received, but surprisingly few reports were published using them. A. C. D. Crommelin published a series between 1898 and 1908 and one in 1921, and Gerald Merton published a series for 1946 to 1949. The first light curve is presented in the report for 1947. No observations prior to 1948 seem to be extant and they are thought to have been lost during the war, though the "Memoranda for Observers" (1928) suggests that, in any case, magnitude estimates were not often made.

There are, however, many observations in the section archives — dating back to the early 1950s — that have never been published. Observations for the years 1948-1954 have been analyzed by Hendrie and Morris (1982) and published in the *ICQ*. BAA observations between 1979 and 1990 have sometimes been published in the *ICQ*, though there are gaps. Since 1990, when I became Director of the BAA comet section, BAA observations have been sent directly to *ICQ* by electronic mail (e-mail) and all observations that are published in *The Astronomer* are also sent to *ICQ*. BAA observations of comet Kohler 1977 XIV were analyzed by Hendrie and Keitch (1981), Levy 1990 XX and Shoemaker-Levy 1991a_1 by Shanklin (1994), and P/Swift-Tuttle 1992t by Mobberley (1994); reports on comets Austin 1989c_1 and P/Schaumasse 1992x are in preparation. There are, however, still several thousand observations remaining in the files for the years 1955 to 1978. My work with the British Antarctic Survey involves regular trips to the Antarctic, and I have been using the time spent travelling there and back by ship to enter some of these observations into *ICQ* format. The observation forms in the archive are grouped by comet, but the sequence of comets is not in chronological order, and I have often preferred to enter comets with fewer observations first! At this stage, no formal analysis of the observations has been carried out, though the intention is to publish magnitude parameters and brief descriptions in the *Journal of the British Astronomical Association (JBAA)*.

All the archive observations are recorded on a standard form, with one observation per form. This form had entries for the name of the comet, date, place of observation, position of the comet, observing conditions, magnitude estimate (and comparison stars), description (coma diameter; degree of condensation, or DC; nucleus; tail, length and p.a.) and remarks, instrument and magnification, and observer. There was also an opportunity to draw a field sketch on the reverse of the form. The BAA comet observing practices of the time are given in the book *Observational Astronomy for Amateurs* by J. B. Sidgwick (1955, 1961, 1971) and also in the BAA pamphlet "Nature, Aims and Methods" (1944, 1948, 1969, 1993).

The BAA observers of the 1950s and early 1960s were generally more interested in obtaining an accurate or semi-accurate position than in making an accurate magnitude estimate or quantified description of the comet. For this reason, many of the magnitude estimates can only be regarded as educated guesses, despite clear instructions on procedures that should be followed (BAA 1948). In general observers used the Sidgwick technique, as recommended by Steavenson (1942), though this is rarely stated explicitly. The source of stellar magnitudes is not often given, but the Henry Draper catalogue was recommended prior to the introduction of the *Atlas Coeli* and *SAO Catalog.* Fields of variable stars observed by the BAA Variable Star Section and the North Polar Sequence were also used. In the 1960s, observers were asked to be more systematic and include field sketches showing comparison stars; sometimes it has proved possible to identify these comparisons and re-reduce the observation. Assignment of a numeric value for the DC does not appear until the mid-1970s, but I have attempted to assign a value based on a verbal description when possible. The focal length of the telescope is rarely quoted.

In view of these problems, I developed an abbreviated format for typing the observations, in order to speed up the data entry. The abbreviated data file is processed, using a Pascal program that reads auxiliary data files containing *ICQ*-formatted comet designations, to give the final *ICQ* format. Observations where the magnitude needs re-determining are flagged and later evaluated using a planetarium program such as "The Sky". There are still many observations remaining to be reduced, and this will require several more trips to the Antarctic!

Today, there are some 50 section members, and about ten make regular contributions. The observing program is very similar to that of 100 years ago, though it now concentrates more on visual observations and some members also have an interest in historical research . Total visual magnitude determinations generally follow the procedures of the IHW/*ICQ*, though additional details of observing conditions are required. All comet section observations are published in the *ICQ* and many are also published in *The Astronomer* magazine. Members are not restricted to the U.K., and observations have been received from most continents, including Antarctica. Prospects for visual observation in the U.K. — particularly of the fainter comets — are not encouraging, with the wide-spread increase in light pollution. This light pollution generally makes sky conditions in the U.K. unsuitable for successful comet hunting, though there have been a few successes, such as Roy Panther's discovery of 1980u and George Alcock's discovery of IRAS-Araki-Alcock 1983d.

The BAA has a tradition of computing comet orbits, and some orbits are still published in the annual *BAA Handbook*. However, personal computers (PC) have taken much of the labor out of orbital computation and predictions for future returns of all periodic comets are now published in the *ICQ Handbook*. Some PC software packages enable orbits to be calculated from observations, though orbits for new comets are normally soon available on e-mail.

Communication between section members is important and much use is made of e-mail for submitting observations and distributing information on new discoveries. The e-mail circulars service run by Guy Hurst, Editor of *The Astronomer*, gives early warning of new discoveries and many members subscribe to it. There is also a section newsletter, published about twice per year. A number of electronic bulletin boards (including several in the UK) and Usenet carry comet information and can also be used to ask questions; in particular sci.astro on Usenet is increasingly being used as a forum for exchanging information.

Some members carry out astrometric observations, and have even constructed their own plate measuring machines. Photography will continue to be important for tail observations, but developments in CCD imaging are playing an increasingly larger part in cometary work and now give reliable total magnitude measurements and objective views of the inner coma. It is also possible to carry out astrometry, using a CCD and the appropriate software, instead of a photographic plate. A suitable lens attached to a CCD should allow good-resolution images of tail structure to be obtained. This is particularly important as tail disconnection events give information on the solar wind that is of use to professional astronomers, and the section is participating in the International Comet Watch in support of the Ulysses spacecraft.

Historical research is rather a sideline for most comet section members, however many British libraries contain much interesting historic material and some of this occasionally relates to comets. A paper by Wright (1992) describes two possible comets seen in 1165, though it seems more likely that these were tornadoes. The libraries of the Cambridge University and Royal Greenwich Observatories in particular, have much material that could be used to obtain magnitude estimates for comets, and some observations of comet 1861 II have been extracted for Joe Marcus. A recent paper by Orchiston in the *JBAA* described the birth of cometary astronomy in New Zealand (1993).

I foresee that CCDs will revolutionize comet observing, but that there will still be a place for the visual observer — particularly in the U.K., where gaps between the clouds can be very short. Despite the increase in light pollution, the number of observers submitting reports on comets seems to be increasing and the section is well-placed to continue the work of the past one hundred years. Further details of the history of the section can be found in the two *BAA Memoirs* describing the first 100 years of the Association.

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Table 1. Directors of the BAA comet section

1891 - 1893	W. F. Denning
1893 - 1897	W. E. Plummer
1897 - 1939	A. C. D. Crommelin
1939 - 1945	M. Davidson
1945 - 1958	G. Merton
1958 - 1968	M. P. Candy
1968 - 1977	S. W. Milbourn
1977 - 1987	M. J. Hendrie
1987 - 1990	G. S. Keitch
1990 -	J. D. Shanklin

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James Lancashire, 21 Warkworth Street, CAMBRIDGE CB1 1EG, England.
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For further information on British Astronomical Association publications contact: The Assistant Secretary, British Astronomical Association, Burlington House, Piccadilly, London W1V 9AG. Publications include:

- *Journal of the British Astronomical Association*: published bi-monthly, includes notes and news on comets and analyses of observations.
- *BAA Circulars*: irregular publication; give news of comet, nova, etc., discoveries, and ephemerides of observable comets.
- *Memoirs of the British Astronomical Association*: published infrequently, contain more lengthy analyses of observations, etc., made by the various sections of the BAA.
- *The Astronomer* is a monthly magazine listing observations and news items. It includes observations by comet section members, information from *IAUCs* and some analysis of observations. Subscription is currently 28 pounds (or 50 pounds including e-mail); the secretary is: Peter Meadows, 250 Linnet Drive, Chelmsford CM2 8AJ, England (phone: 44+245 268162).

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DUTCH COMET SECTION

The Dutch Comet Section (DCS) was founded in 1976 in connection with the appearance of comet West. Currently, the DCS has about 70 members. The members make both visual and photographic observations. Some members experiment with CCDs.

In recent years, about a dozen observers make magnitude estimates, particularly on brighter comets like P/Swift-Tuttle. Fainter comets are regularly observed by only 3 or 4 observers. Most observers are limited by light pollution and weather conditions. Despite these limitations, more than 100 comets have been observed since 1976 and more than 3000 magnitude estimates have been made. The best observed comets are: P/Halley (424 estimates, 24 observers), P/Giacobini-Zinner (149/13), P/Swift-Tuttle (122/10), Bradfield 1987s (106/9), and Levy 1990c (104/9). The coordinator sends the observations to the *ICQ* and makes preliminary analyses.

Four times a year, the DCS publishes *Kometen Nieuwsbrief.* This publication includes ephemerides, charts and AAVSO sequences for observable comets, tabulations of the observations, analyses, and news about comets. As a special service, the DCS operates the TWS (telephonic warning system) to inform observers about new discoveries.

An observational committee of the DCS carries out analyses of magnitude estimates, instrumental corrections, coma diameter, DC, *etc.* A special effort has been made on tail predictions and analyses with respect to the physical water production of comets.

More information about the Dutch Comet Section can be obtained from Alex Scholten, Horsterdijk 6a, NL 6961 KP Eerbeek, The Netherlands (telephone 08338 52716). — *E. P. Bus and A. Scholten*

The German Comet Section (VdS-Fachgruppe Kometen)

The German Comet Section (VdS-Fachgruppe Kometen) was reconstituted in 1984 by Jürgen Linder and Andreas Kammerer. Today it consists of about 75 members — amateur astronomers who have specialized in comets. The members represent every state of observing knowledge — from the beginner to the very experienced observer. Today our database contains several thousand visual estimates of the various comet parameters and a huge number of photographs (both collected primarily by the experienced observers).

The VdS-Fachgruppe Kometen publishes the bimonthly newsletter *Schweifstern*, which contains all aspects of comet observation — with the focus on the currently observable comets. To inform members quickly about newly discovered comets, an Early Warning Service by letter and by Mail Box was established.

The members of the German Comet Section estimate the visual appearance of a comet by applying the instructions of the International Halley Watch organizers. The same applies to photographic aspects. A small number of members are active in astrometry and in spectroscopy.

One important aspect is the analysis of the received observations — mainly visual and photographic. Reports are published either in *Sterne und Weltraum* or in *Kometen-Planetoiden-Meteore*. The VdS-Fachgruppe Kometen appreciates a cooperation with other Comet Sections and hopes that the I.W.C.A. 1994 will be the starting point of such a worldwide enterprise.

For more information contact me at the address given below.

— *Andreas Kammerer (Johann-Gregor-Breuer-Str. 28, 76275 Ettlingen, Germany)*

Φ Φ Φ

Hungarian Comet Observations

In Hungary, numerous comet observers are working as members of the Hungarian Astronomical Association (HAA), and our results are published in the association's monthly journal, *Meteor*. This paper has been published for 23 years, though it has belonged to the HAA only since 1990. Organized comet observations began around 1976, then directed by Vince Tuboly, but there was a lull in observing activity following the perihelion passage of P/Halley. *Meteor* had published comet observations occasionaly, but we have had a regular comet column now only since late 1980. The Comet Section of the HAA was founded in 1991.

In recent years, a few experienced amateurs have been observing comets regularly. Unfortunately, most of the hungarian amateurs are unable to get access to big reflectors because of their high purchase prices. Most of us live in cities with great light pollution, and we cannot allow ourselves to drive to dark places several times every week. The regular observers use three telescopes, including Laszlo Szentasko's 33-cm Dobsonian telescope (which is located 20 kilometers northeast of Budapest), and Zoltan Vician's 30-cm Newtonian telescope (which is located 60 km from Budapest). The third and the biggest amateur telescope in Hungary is a 44-cm Dobsonian that lies 150 km west of Budapest. The HAA organizes observing weekends monthly, when we usually also observe faint comets. This larger telescope is used by three or four amateurs regularly.

Hungarian comet observations between 1990 and 1994.

Year	Comets	Observers	Observations	Photos	Magnitude interval
1990	6	66	365	27	3.5-9.5
1991	6	8	30		8.5-10.8
1992	7	41	201	10	4.8-12.2
1993	7	18	108	8	8.5-14
1994	17	33	336	3 (+1 CCD)	6.8-14.1

The observers are supplied with information via the *Comet News*, which is available both in electronic and paper forms and is published about 12-20 times a year. Our observing results are published in *Meteor* across some 4-6 pages in every issue (including many comet drawings). The year 1994 has been very succesful; in January alone, 9 observers were made 68 observations of 7 comets. In Hungary, nobody deals with comet research because the weather and the observing conditions are usually poor and the observers have no possibility to travel far from the cities to the mountains. The highest point of Hungary lies at 1050 meters above sea level, so the observers are happy when they are only at elevations around 400-500 m. — *Krisztián Sárneczky (e-mail address: sky@mcse2.zpok.hu)*

TABULATION OF COMET OBSERVATIONS

Numerous observations of comets made prior to 1994 and also those contributed on paper have been withheld from this issue, due to time and space constraints; they will appear in the January 1995 issue. Likewise, some descriptive information dealing with tabulated observations in this issue is being postponed for publication in the January issue.

For P/Machholz 2, which has exhibited at least 5 different nuclei, the tabulated data are listed by component; the lettering system used is that adopted on *IAU Circular* 6081, dated 1994 September 21 [this official system is different from that used by some observers during the prior 3-4 weeks following discovery of the second component by Michael Jäger; that earlier, informal system had components B and D reversed from the final, official version]. Observers contributing data in *ICQ* format are requested to place the appropriate component capital letter in column 12.

Descriptive Information (to complement the Tabulated Data):

◇ *Comet Mueller 1993a* ⟹ 1993 Oct. 7.85: in 10×50 B, 5′ coma [KEI].

◇ *Comet Takamizawa-Levy 1994f* ⟹ 1994 July 1.93: "comet bigger (not brighter) w/ Lumicon Swan-band filter [MEY]. July 10: the first observation marks the comet's first sighting by me; it was then virtually centered over a 10th-mag star; the second observation revealed the cond. to the side of the star; the last observation revealed the comet to have cleared the star [KRO02]. July 10.25: faint stellar cond. [MOR]. July 29.85: straight tail [MIK]. July 31.17: low altitude and poor sky; observation had to be hurried due to fast-moving cirrus overcast [HAL].

◇ *Comet Takamizawa 1994i* ⟹ 1994 July 2.22: stellar cond. [MOR]. July 3.20: possible faint stellar cond. [MOR]. July 7.46: "sharp central cond. at 114×" [SEA]. July 9.21 and 10.20: "use of AAVSO chart for R Cor resulted in significantly brighter m_1 (by about a magnitude) than using the North Polar Sequence w/ extinction" [MOR].

◇ *Comet Nakamura-Nishimura-Machholz 1994m* ⟹ 1994 July 10.94: only slightly more condensed toward the center; very vague outer coma [KAM01]. July 11.42: "observation and estimate severely hampered by fast-moving clouds; the brightness estimate is somewhat of a guess" [HAL]. Aug. 6.94: "slight enhancement w/ Lumicon SB-Filter; comet involved w/ star of mag 9" [MEY]. Aug. 7.29: "the comet appears like a small, faint cloud in 10×50 B; in 41-cm L, the overall coma diameter is 5′; within the coma is a bright cond. that appears to diffuse suddenly into the rest of the coma, the brightness profile of which is relatively flat" [HAL]. Aug. 11.22: "the coma appears to be growing more diffuse; while there is still a distinct central brightening, the cond. seen during previous observations is no longer visible" [HAL]. Aug. 27.20: "the comet appears as a large, diffuse cloud in 10×50 B" [HAL]. Aug. 27.85: at 214×, 4′ tail in p.a. 190°; bright star nearby [SZE02]. Aug. 28.86: mag estimation uncertain because of the very large coma [SZE02]. Aug. 29.87: w/ 44.5-cm *f*/5 L (100×), coma dia. 3′, DC = 3 [HAS02]. Sept. 2.93: w/ 20.3-cm T (80×), fan-shaped tail spans p.a. 4°-75°; length is 0°.28 at p.a. 4°, 0°.36 at p.a. 58°, and 0°.23 at p.a. 75° [GAR02]. Sept. 3.14: obs. affected by an 11th-mag star < 1′ away [KRO02]. Sept. 3.19: in 25.6-cm L (45-156×), DC = 5 w/ a nearly stellar cond. [MOR]. Sept. 3.51: "somewhat brighter using Swan-band filter" [SEA]. Sept. 3.86: w/ 20.3-cm T (80×), fan-shaped tail spans p.a. 354°-48°; length is 0°.63 at p.a. 354°, 0°.28 at p.a. 7°, and 0°.29 at p.a. 48° [GAR02]. Sept. 6.91: w/ 44.5-cm *f*/4 L (146×), 8′ coma, DC = 6-7 [SAR02]. Sept. 9.27: "difficult object in 10×50 B; it could only be seen once its location was determined from observation with the 41-cm L; in the 41-cm L the comet appears as a bright cond., surrounded by a very large, faint, very diffuse coma, the brightness profile of which is almost entirely flat" [HAL]. Sept. 9.85: the coma extends faintly to a dia. of ~ 12′; 0°.54 dust tail in p.a. 10°, curved toward p.a. 344°; 0°.56, 0°.26, and 0°.27 ion tails in p.a. 37°, 78°, and 118° [GAR02]. Sept. 28.18: very vague and diffuse; the comet is not much more than a "presence" [HAL].

◇ *Comet Machholz 1994r* ⟹ 1994 Oct. 12.11: "revised photometry, using data from the YF catalogue instead of AAVSO (which appears to be in error by 0.6 mag); I have used SAO 26946 (m_V = 6.5) from AA Chart 20; however, more-reliable YF gives V = 5.91 for the same star (HR 3408)" [MIK].

◇ *Periodic comet Borrelly (1994l)* ⟹ 1994 Aug. 5.46: observation slightly affected by nearby 11th-mag star [HAL]. Aug. 5.78: jet-like fan-shaped coma in p.a. 110° [NAK01]. Aug. 15.79: jet-like fan-shaped coma in p.a. 112° [NAK01]. Sept. 3.44 - Oct. 10.47: "using the AAVSO S Ori sequence resulted in m_1 estimates 0.3 mag brighter than via use of the North Polar Sequence" [MOR]. Sept. 3.44: "nearly-stellar cond." [MOR]. Sept. 4.45: "comet was involved with several faint stars" [MOR]. Sept. 8.78: jet-like fan-shaped coma in p.a. 98° [NAK01]. Sept. 10.08: hint of a 2′ tail toward p.a. 340° [GAR02]. Sept. 10.09: "Lumicon SB-Filter doesn't enhance the comet" [MEY]. Sept. 11.47: stellar cond. at 156× [MOR]. Oct. 7.47 - 9.48: anti-tail was sharper on the NE side and more diffuse (almost a fan) on the SW side [MOR]. Oct. 9.42: "bright cond., near trailing edge of faint fan-shaped coma; there appears to be a tail-like structure emanating from the cond. and extending through the coma" [HAL]. Oct. 12.44: coma elongated [MOR].

◇ *Periodic comet Brooks 2 (1994j)* ⟹ 1994 Aug. 7.42: "an extremely faint candidate was suspected, which — in light of the successful observation made a week later — may possibly have been the comet" [HAL]. Aug. 14.46: "on all observations the comet was an extremely faint object near the visual threshold; it appeared slightly more condensed tonight than during later observations" [HAL].

◇ *P/Encke* ⟹ 1994 July 10.458: also sunward dust trail extending 1′.69 in p.a. 60°.4 [SCO01].

◇ *Periodic Comet Harrington (1994g)* ⟹ 1994 Sept. 10.04: coma elongated along p.a. 290°/110° (all observations from Merlette, France, in the Hautes-Alpes) [GAR02]. Oct. 9.36: the comet is brighter, more condensed and, in general, more obvious than during previous observations; brief unsuccessful searches were conducted for components B and C (*IAUC* 6089) [HAL].

◇ *Periodic Comet Machholz 2 (1994o)* ⟹ 1994 Aug. 15.92: "coma dia. 4'.5 w/ faint halo of dia. 6'.0; extension in inner coma (w/in 30″ of nuclear cond.) in p.a. 300° — probably the brightest parts of developing plasma tail" [PRA01]. Aug. 15.97: 1-min exp. shows prominent, slightly-curved jet of gas extending ~ 3′ from the comet nucleus in p.a. 350°; equal exposures taken on Aug. 15.994 and 16.016 show no trace of jet activity [MIK]. Aug. 15.98: ill-defined coma; w/ Lumicon SB-Filter enhanced and more condensed [MEY]. Aug. 16.90: coma dia. 4'.2; "coma significantly fainter than 1 day ago (by ~ 1.0 mag through 1'.3 aperture); this, together w/ rather diffuse appearance on both days, may suggest that a possible brightness outburst occured several days before the observations (perhaps allowing the visual discovery)" [PRA01]. Aug. 19.09 and 19.10: photographic negatives taken by Michael Jäger show pre-discovery images of component D, which is much smaller and fainter (mag 13.5) than on the photos upon which discovered the object; coma dia. 0'.5, condensed [reported by H. Lüthen, Hamburg]. Aug. 23.07: coma dia. 6'.0; "the 'total' magnitudes measured in 2'.0 and 1'.3 apertures indicate that the comet is ~ 2-3 mag brighter than on Aug. 15.92 and 16.90; narrow plasma tail is very bright and prominent within 1'.4 of nuclear cond. (its outer part is slightly curved and of inhomogeneous brightness, and is 1'.0 long at p.a. 297°, 3'.6 at 298°, 5'.5 at 294°, and 8'.0 at 292°; the tail has its lowest surface brightness around 4'.6 from the nuclear cond., where it is virtually invisible; measured on composite images of 120 sec total integration time; images were obtained by Marek Wolf and Lenka Šarounová at Ondřejov [PRA01].

Sept. 2.42: "component A is bright and obvious in the 20-cm L; component D is vague, faint and diffuse, and is not easy to see" [HAL]. Sept. 2.43: faint, but definite narrow tail [KRO02]. Sept. 2.46: CCD image w/ 25-cm *f*/4 T (+ Wratten No. 15 yellow filter) shows a central cond. of dia. 40″ and mag 9.08; there is a secondary tail (less-well-defined) 3′ long in p.a. 340° [ROQ]. Sept. 3.14: w/ 20.3-cm T (80×), tail is quite visible toward p.a. 302° (length 0°.75) [GAR02]. Sept. 3.5 and 4.5: "in hindsight, it is believed that components B and E were seen on these dates, but not recognized for what they were; this would put their brightness near mag 12.0" [MOR]. Sept. 4.14: Celestron 8 at 80× shows a 0°.68 tail in p.a. 304° [GAR02]. Sept. 5: unfiltered CCD image w/ 30-cm *f*/5.2 T shows a bright jet emanating 0'.5 from component A in p.a. 305°, and also a diffuse 0'.3 fan spanning p.a. 140°-215° [H. Raab and E. Meyer, Linz, Austria]. Sept. 5: there is a faint, diffuse glow 40′ long connecting the fragments, extending in p.a. 24° from component A; main tail 40′ long in p.a. 300° [Jäger, via Lüthen]. Sept. 5.12: almost starlike coma; faint tail [MIK]. Sept. 6.11: no tail was visible; coma more diffuse than on Sept. 5.12; 20×80 B shows faint tail ~ 0°.4 long in p.a. ~ 290° [MIK]. Sept. 6.43: films taken with the 18-inch Schmidt telescope at Palomar show what appears to be some tail activity that is not present on films taken on Sept. 4.5 [K. Lawrence]. Sept. 7: main tail 60′ long in p.a. 300° [Jäger, via Lüthen]. Sept. 7.08: "secondary tail 6′ long in p.a. 280° from component A; very faint tail or 'cloud' in p.a. 60° (component B?)" [SAR02]. Sept. 8: main tail 50′ long in p.a. 298° [Jäger, via Lüthen]. Sept. 9.47: "in 41-cm L, the tail on component A (0° in p.a. 300°) is faint, straight, and essentially featureless; at 72×, component A had DC = 5; components B and D are faint and vague, and appear similar to each other; components C and E were searched for but not seen; component C would have been located near some faint stars, which might have made observation difficult" [HAL]. Sept. 11.51: "estimate of component C may have been affected by a nearby star" [MOR]. Sept. 13.80: two CCD images w/ an 8.0-cm R show a faint 'bridge' of dust that extends from component E to A [NAK01].

Sept. 16.46: "the tail on component A is no longer seen; instead, a bright, extensive fan extending in the general direction of component D is visible; component D appears somewhat brighter and more condensed than it was on Oct. 9; the other components were searched for but not seen; component B was likely involved within the fan around component A" [HAL]. Sept. 23.11-23.13: w/ 65-cm *f*/3.6 reflector + CCD, component A has coma dia. 7'.0; magnitudes measured in 2'.0 and 1'.3 apertures w/ a *V* filter (60-sec image); component B was located 143″ from A in p.a. 22° and had coma dia. 2'.5 and "little (but clearly visible) central cond."; "component C was invisible (probably hidden by the coma of component D)"; component D has brightened since Sept. 10.13 by ~ 3 mag and developed a large coma and tail (its appearance is rather similar to that of component A), and it has coma dia. 7′; the morphologies of components A and D are now very similar, w/ the only clearly-visible differences between them being that D has stronger central cond. (it's evident also from larger differences in m_2 than in m_1), and that D has a narrow, slightly-curved tail, while the tail of A is somewhat broader (more developed); component E is located at 130″ in p.a. 23° from D, and it is diffuse w/ little cond. and coma dia. 1'.5 [PRA01]. Sept. 24.5-Oct. 9.5: components B and E are involved with the coma of components A and D, respectively, and are only visible at high magnification; rather than being distinct objects, they are better described as secondary brightenings extending from (or within) the coma of the brighter component [MOR]. Sept. 25.83: "central cond. of component A is becoming weaker, whereas that of D was strong" [KOB01].

Oct. 2.49: "components A and D appear fairly similar to each other in brightness and appearance; A is slightly brighter and more condensed than D" [HAL]. Oct. 5.14: CCD images obtained w/ 65-cm *f*/3.6 reflector show that "the activity of D is much lower now than when near *T*; very interesting is the swarm (trail) of material present along the orbit around component D; all magnitudes measured on 60-sec clear-filter images and are consistent to 0.2 mag; component A is fainter by ~ 2 mag (while central cond. is stronger) than on Sept. 23.11; component B is located 88″ in p.a. 6° from A and has little central cond. and coma dia. 1'.8; component C is marginally visible 10″ in p.a. 185° from D — and is almost hidden by the coma of D; component D has two nuclear condensations of similar brightness 7″ apart in p.a. 112°; component E is located at ~ 80″ in p.a. ~ 9° from D; there is a swarm (trail) of material — along a line (p.a. 10°-190°)

(cont. on next page)

near component D — that spans from $2'.0$ (S end) in p.a. 190° to $5'$ in p.a. 10° (N end) w/ respect to D (measured on composite image of 240-sec total integration time, though the trail is visible also on individual 60-sec images); the double character of component D is indicated also by images taken on Sept. 2.1 and 4.1, when the cond. of D was prolonged to about the same extent and in similar direction; this prolongation is less prominent, but still present, on images taken on Aug. 30.1" [PRA01]. Oct. 9.48: "both components A and D are noticeably fainter than on Oct. 2; while D is quite faint and vague, A appears somewhat condensed; a very faint and small starlike cond. was noticed with higher magnification; the other components were looked for but not seen; the expected position of component B was very close to A, and although a faint 'presence' was suspected, it could not be confirmed; there was some overall interference from zodiacal light" [HAL].

◇ *P/Reinmuth 2 (1993g)* ⟹ 1994 Sept. 6.98: strong nuclear cond.; measurements done on 120-sec clear-filter images [PRA01].

◇ *Periodic Comet Shoemaker-Levy 9 (1993e)* ⟹ 1994 May 27.88: observation confirmed also by Damiani Matteo; a CCD image obtained with the 40-cm reflector at the "S. Zani" Observatory in Lumezzane, Brescia, Italy, clearly shows three ditinct nuclei in the coma [FOG]. July 6.26: "the comet was assumed to be a long, narrow streak; the positions specifically observed were those calculated for nuclei $Q_1 = 7a$ and $G = 15$" [HAL].

◇ *Periodic Comet Tempel 1 (1993c)* ⟹ 1994 May 1.24: stellar cond. and coma elongated toward SW [MOR]. May 2.83: 11-cm $f/7$ L (40×) shows $2'$ coma, DC = 4 [BAR06]. May 14.23: coma elongated ($2'.6 \times 5'.2$) [MOR]. June 29: the comet was $2'$ from a 7.0-mag star [KRO02]. July 6.21: observation somewhat hampered by nearby 8th-mag star [HAL]. July 31.17: poor sky; observation had to be hurried due to fast-moving cirrus overcast; observation also somewhat affected by skyglow [HAL]. Aug. 27 and Sept. 3: comet very low in the sky, but no magnitude correction applied [GAR02].

◇ *Periodic Comet Wild 3 (1994b)* ⟹ 1994 July 10.203: faint tail [SCO01].

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Key to observers with observations published in this issue, *with 2-digit numbers between Observer Code and Observer's Name indicating source [07 = Comet Section, British Astronomical Assn.; 11 = Dutch Comet Section; 16 = Japanese observers (c/o Akimasa Nakamura, Kima, Japan); 23 = Czech group (c/o P. Pravec); 32 = Hungarian group (c/o K. Sarneczky); etc.]. Those with asterisks (*) preceding the 5-character code are new additions to the Observer Key:*

*APF	23	Ladislav Apfelthaler, Czech Republic
AUG		Todd Augustyniak, IL, U.S.A.
BAK01	32	Gaspar Bakos, Budapest, Hungary
BAR06	26	Alexandr R. Baransky, Okhnovka, Ukraine
BEA	07	Sally Beaumont, England
BRO04	27	Eric Broens, Belgium
CAM03	14	Paul Camilleri, Australia
CAN03	27	Giuseppe Canonaco, Belgium
CHE03		Kazimieras T. Cernis, Lithuania
CSU	32	Matyas Csukas, Salonta, Romania
DEM	23	Eduard Demencik, Slovak Republic
DIE02	27	Alfons Diepvens, Belgium
DVO	23	Denisa Dvorakova, Czech Republic
FAB	23	Peter Fabian, Prievidza, Slovak Republic
FOG		Sergio Foglia, Italy
GAR02		Stephane Garro, France
GRE		Daniel W. E. Green, U.S.A.
GRZ		Piotr Grzywacz, Lodz, Poland
HAL		Alan Hale, U.S.A.
HAS02		Werner Hasubick, West Germany
HAS07	16	Akie Hashimoto, Japan
HOR02	23	Kamil Hornoch, Czechoslovakia
ITO02	16	Kazuyuki Ito, Japan
KAM01		Andreas Kammerer, West Germany
KAN04	16	Shigemi Kanbara, Japan
KEI		Graham Keitch, England
KOB01	16	Juro Kobayashi, Japan
KON03	16	Eitoshi Konno, Japan
KOS	32	Attila Kosa-Kiss, Salonta, Romania
KRO02		Gary W. Kronk, IL, U.S.A.
KUB	23	Pavel Kubicek, Czech Republic
KYS	23	J. Kysely, Czech Republic
LAN02	32	Zsolt Lantos, Budapest, Hungary
LAN03	07	James A. Lancashire, Cambridge, England
MEY		Maik Meyer, Germany
MIK		Herman Mikuz, Slovenia
MIL02		Giannantonio Milani, Italy
MIT	16	Shigeo Mitsuma, Japan
MOE		Michael Moeller, West Germany
MOR		Charles S. Morris, U.S.A.
NAG02	16	Takashi Nagata, Hyogo, Japan
NAG04	16	Kazuro Nagashima, Japan
NAK01	16	Akimasa Nakamura, Japan
OHM	16	Fumihiko Ohmori, Japan
*OTO	16	Seikou Otomo, Miyagi, Japan
PRA01	23	Petr Pravec, Czech Republic
ROQ		Paul Roques, AZ, U.S.A.
SAR02	32	Krisztian Sarneczky, Budapest, Hungary
SCO01		James V. Scotti, AZ, U.S.A.
SEA	14	David A. J. Seargent, Australia
SHA02	07	Jonathan D. Shanklin, England
SPR		Christopher E. Spratt, BC, Canada
SZE02	32	Laszlo Szentasko, Budapest, Hungary
TOM	16	Akira Tominaga, Japan
TSU02	16	Mitsunori Tsumura, Japan
VAN04	27	Tony VanMunster, Belgium
VIC	32	Zoltan Vician, Hehalom, Hungary
ZNO	23	Vladimir Znojil, Czech Republic

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Comet Mueller 1992 XX

DATE (UT)	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1994 04 13.76	C	18.8	GA	60.0	Y	6		0.25		0.04	324	NAK01
1994 04 30.61	C	19.0:	GA	60.0	Y	6		0.2				NAK01
1994 05 18.70	C	19.2	GA	60.0	Y	6		0.25		0.02	325	NAK01
1994 07 11.58	C	19.4	GA	60.0	Y	6		0.25			324	NAK01

Comet Shoemaker 1992y

DATE (UT)	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1994 07 06.25	C	20.9	FA	91.4	L	5		0.12				SCO01

Comet Mueller 1993a

DATE (UT)	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1993 08 12.86	B	11.5	GA	34.0	L	4	45	3	1			CHE03
1993 09 21.80	S	10.2	HS	25	L	6	56	4	4			KON03
1993 10 06.85	S	9.2	AA	5.0	B		10	3.8				KEI
1993 10 06.85	S	9.4	AA	10.0	B		20	3.1	4	0.23	352	KEI
1993 10 07.81	S	9.3	AA	10.0	B		20	3.8	4			KEI
1993 10 07.81	S	9.5	AA	15.0	B		25	2.5	4/			KEI
1993 10 08.80	S	9.1	AC	10.0	B		20	5.0	4			KEI
1993 10 09.46	M	10.5	AA	12.0	B		20	4	4			MIT
1993 10 09.77	I	9.8	S	5.0	B		7	3				KYS
1993 10 09.79	S	9.1	AC	10.0	B		20	4.1	4			KEI
1993 10 09.91	S	9.0	AA	5.0	B		10	4.0				KEI
1993 10 11.81	S	9.2	AC	10.0	B		20	4.5	5			KEI
1993 10 14.81	S	8.9	AC	5.0	B		10	6.7				KEI
1993 10 14.81	S	8.9	AC	10.0	B		20	6.7	4/			KEI
1993 10 15.90	S	9.0	AC	10.0	B		20	6.2	5	0.10	87	KEI
1993 10 16.79	S	9.0	AC	10.0	B		20	7.8	4/	0.20	341	KEI
1993 10 16.95	S	8.9	AA	5.0	B		10	6.1	4			KEI
1993 10 17.90	S	9.0	AC	10.0	B		20	4.4	5	0.08	360	KEI
1993 10 18.79	S	9.0	AC	10.0	B		20	4.6	4			KEI
1993 10 20.92	S	8.9	AC	10.0	B		20	5.8	4/			KEI
1993 10 21.93	S	8.7	AC	3.2	B		6	11.4				KEI
1993 10 21.93	S	8.8	AC	5.0	B		10	7.6	4			KEI
1993 10 21.93	S	9.0	AC	10.0	B		20	5.7	5	0.20	27	KEI
1993 10 23.01	S	8.9	AC	5.0	B		10	7.4	4			KEI
1993 10 24.15	S	8.9	AC	10.0	B		20	6.6	5	0.15	35	KEI
1993 10 27.84	B	9.2	S	20.3	T	7	48	2.6	2			NAG04
1993 11 03.45	M	9.6	AA	12.0	B		20	2.5	6			MIT
1993 11 03.80	S	8.8	AA	10.0	B		20	6.6	5	0.15	35	KEI
1993 11 06.92	S	8.7	AA	10.0	B		20	5.0	5			KEI
1993 11 09.00	S	9.0	AA	10.0	B		20	4.5	4			KEI
1993 11 10.81	S	8.8	AA	10.0	B		20	6.6	5			KEI
1993 11 11.78	S	8.9	AA	10.0	B		20	5.0	5/	0.20	79	KEI
1993 11 11.91	S	8.7	AA	5.0	B		10	6.5				KEI
1993 11 14.45	M	9.3	AA	12.0	B		20	3.5	5			MIT
1993 11 14.99	S	8.9	AA	10.0	B		20	5.2	5/	0.17	47	KEI
1993 11 15.00	S	8.9	HS	5.0	B		10	5.0				KEI
1993 11 16.82	S	8.9	HS	10.0	B		20	4.6	5/		45	KEI
1993 11 17.85	S	8.8	AA	10.0	B		20	5.1	5/	0.17	41	KEI
1993 11 19.93	S	8.9	HS	10.0	B		20	4.5	5			KEI
1993 11 20.86	S	8.9	HS	10.0	B		20	5.0	5		45	KEI
1993 11 24.55	B	9.2	S	20.3	T	7	48	1.0	3			NAG04
1993 12 01.76	S	8.6	HS	10.0	B		20	5.3	4			KEI
1993 12 04.48	M	8.8	AA	12.0	B		20	4.5	4			MIT
1993 12 04.90	S	9.0	HS	10.0	B		20	3.5	5			KEI
1993 12 04.90	S	9.5	HS	15.0	B		25	2.4				KEI
1993 12 05.83	S	9.1	AC	10.0	B		20	4.2	5			KEI
1993 12 09.78	S	9.0	AC	10.0	B		20	3.8				KEI
1993 12 10.82	S	9.2	AC	10.0	B		20	3.9	3/			KEI
1993 12 11.48	P	8.7	S	14.3	A	3		2	6			KAN04
1993 12 15.46	S	9.8	AA	12.0	B		20	4	3			MIT
1993 12 15.47	P	8.7	S	14.3	A	3		2	6			KAN04
1993 12 15.77	S	9.2	AC	10.0	B		20	3.5	4			KEI
1993 12 16.76	S	9.2	AC	10.0	B		20	3.1	4			KEI
1993 12 16.81	S	9.1	AC	5.0	B		10	3.7				KEI
1993 12 30.77	S	9.2	HS	10.0	B		20	4.0	4			KEI
1994 01 02.88	S	9.2	AA	10.0	B		20	4.0	4			KEI
1994 01 03.78	S	9.4	AA	10.0	B		20	4.0	4	0.13	38	KEI
1994 01 04.77	S	9.4	AA	10.0	B		20	3.3	4	0.17	32	KEI
1994 01 06.77	S	9.3	AA	10.0	B		20	4.5	3			KEI
1994 01 06.78	S	9.2	AA	5.0	B		10	4.5				KEI
1994 01 07.79	S	9.4	AA	10.0	B		20	3.8	3			KEI
1994 01 10.84	S	9.4	HS	10.0	B		20	4.8	4			KEI
1994 01 11.80	S	9.3	HS	10.0	B		20	6.9	4			KEI
1994 01 13.82	S	9.4	HS	10.0	B		20	3.8	3			KEI

Comet Mueller 1993a [cont.]

DATE (UT)	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1994 01 14.77	S	9.4	HS	10.0	B		20	5.8	3			KEI
1994 02 01.79	S	9.3	AA	10.0	B		20	2.4	1			KEI
1994 02 01.79	S	9.5	AA	15.0	B		25	3.5	2			KEI
1994 02 04.79	S	9.4	AA	10.0	B		20	4.2	3			KEI
1994 02 04.79	S	9.5	AA	15.0	B		25	2.3				KEI
1994 02 05.79	S	9.5	AA	15.0	B		25	3.1	3			KEI
1994 02 06.80	S	9.6	AA	15.0	B		25	3				KEI
1994 07 03.72	a C	12.3	GA	60.0	Y	6		1.45				NAK01
1994 07 15.72	a C	12.0	GA	60.0	Y	6		2.3			320	NAK01

Comet Mueller 1993p

DATE (UT)	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1993 10 07.83	S	11.5:	AC	15.0	B		25	1.2				KEI
1993 10 08.85	S	11.5	AC	15.0	B		25	1.1	2			KEI
1993 10 09.81	S	11.6	AC	15.0	B		25	0.7	2			KEI
1993 10 11.82	S	11.3	AC	15.0	B		25	1.5	2			KEI
1993 10 14.84	S	11.1	AC	15.0	B		25	2.2	3	0.13	281	KEI
1993 10 15.92	S	11.2:	AC	15.0	B		25	1.9	4			KEI
1993 10 16.81	S	11.2	AC	15.0	B		25	1.8	4			KEI
1993 10 18.81	S	11.2	AC	15.0	B		25	1.3	4			KEI
1993 10 22.03	S	11.2	AC	15.0	B		25	1.6	3/			KEI
1993 10 23.04	S	11.2	AC	15.0	B		25	1.8	3			KEI
1993 11 06.95	S	11.0	AC	15.0	B		25	2.1				KEI
1993 11 09.03	S	10.9	AC	15.0	B		25	3.0	3			KEI
1993 11 10.81	S	11.1	AC	15.0	B		25	2.2	3/			KEI
1993 11 11.77	S	11.0	AC	15.0	B		25	2.2	3			KEI
1993 11 14.78	S	10.9	HS	10.0	B		20	2.4				KEI
1993 11 14.78	S	11.0	HS	15.0	B		25	2.1	2/			KEI
1993 11 16.79	S	10.8	HS	10.0	B		20	2.2				KEI
1993 11 16.79	S	10.9	HS	15.0	B		25	2.0	3			KEI
1993 11 17.83	S	10.8:	HS	10.0	B		20	2.5				KEI
1993 11 19.91	S	10.6	HS	15.0	B		25	1.7	3			KEI
1993 11 21.00	S	10.6	HS	15.0	B		25	2.5	3			KEI
1993 12 04.75	S	10.5	HS	10.0	B		20					KEI
1993 12 04.75	S	10.7	HS	15.0	B		25	2.0	3			KEI
1993 12 07.75	S	10.4	HS	29.8	L	5	62	2.4	2/			KEI
1993 12 09.79	S	10.1	HS	10.0	B		20	3.1	2/			KEI
1993 12 09.79	S	10.3	HS	15.0	B		25	2.5	2/			KEI
1993 12 10.83	S	10.4	HS	10.0	B		20	1.8				KEI
1993 12 11.50	P	9.0	S	14.3	A	3		2	3			KAN04
1993 12 11.81	S	10.5	HS	15.0	B		25	2.2	2			KEI
1993 12 15.49	P	9.0	S	14.3	A	3		2	3			KAN04
1993 12 15.84	S	11.0	HS	15.0	B		25	2.0	2			KEI
1993 12 16.77	S	10.6	HS	10.0	B		20	3.3	0/			KEI
1993 12 31.75	S	10.3	HS	10.0	B		20	3.8	3			KEI
1994 01 03.75	S	10.2	HS	10.0	B		20	2.5	2/			KEI
1994 01 04.75	S	10.1	HS	10.0	B		20	3.1	3			KEI
1994 01 06.76	S	9.9	HS	10.0	B		20	4.4	3			KEI
1994 01 07.76	S	9.9	HS	10.0	B		20	3.9	3			KEI
1994 01 13.77	S	9.9	HS	10.0	B		20	2.8	4			KEI
1994 01 14.77	S	9.9	HS	10.0	B		20	2.8	3			KEI
1994 01 14.77	S	10.0	HS	15.0	B		25	2.8	4	0.10	31	KEI
1994 07 02.20	S	12.7	NP	25.6	L	4	111	1.5	2			MOR

Comet McNaught-Russell 1993v

DATE (UT)	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1994 03 22.73	S	7.4	S	15.0	M	15	90	6.5	3			CHE03
1994 03 25.84	S	7.3	AA	5.0	B		10	3.5				KEI
1994 03 25.84	S	7.3	AA	10.0	B		20	3.5	5	0.17	33	KEI
1994 03 25.84	S	7.3	AA	15.0	B		25	3.5	6/	0.17	33	KEI
1994 03 30.75	B	7.5	S	25.0	C	5	48	6.5	3			CHE03
1994 03 31.78	B	7.6	S	25.0	C	5	48	5.5	5			CHE03
1994 04 01.86	S	6.6	AA	3.2	B		6	6.5	7			KEI

Comet McNaught-Russell 1993v [cont.]

DATE (UT)	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1994 04 01.86	S	6.7	AA	5.0	B		10	5.6	7/			KEI
1994 04 02.81	S	7.0	AA	11.4	L	8	45	7	5	0.5	210	FOG
1994 04 02.85	S	6.8	AA	5.0	B		10	6.5	7	0.40	4	KEI
1994 04 04.86	S	7.0	AA	5.0	B		10	6.8	6/	0.33	91	KEI
1994 04 07.86	S	7.0	AA	5.0	B		10	6.3	6			KEI
1994 04 09.88	S	6.8	HS	5.0	B		10	8.8	4/			KEI
1994 04 10.87	S	6.9	HS	5.0	B		10	6.6	4/			KEI
1994 04 11.90	S	7.0	AA	5.0	B		10	6.1	6			KEI
1994 04 12.94	S	7.0	AA	5.0	B		10	6.1	5/			KEI
1994 04 13.91	S	7.0	AA	5.0	B		10	7.5	6	0.5	71	KEI
1994 04 14.51	S	7.8	AC	16	L	6	40	5	2			TOM
1994 04 14.85	B	7.5	S	12.0	R	5	25	6	5			CHE03
1994 04 16.81	B	8.1	S	12.0	R	5	25	4	3			CHE03
1994 04 28.83	S	9.4	AC	6.3	R	13	28	& 3.5	3	0.17	155	CSU
1994 04 28.84	B	8.3	TI	5.0	B		7					APF
1994 04 30.92	S	7.6	AA	5.0	B		10	6.6	4	0.5	80	KEI
1994 05 01.19	M	8.3	AA	8.0	B		20	11.5	3/			MOR
1994 05 02.82	S	8.6	AA	11	L	7	32	4	3			BAR06
1994 05 02.87	B	9.8:	S	9	R	6	15					GRZ
1994 05 02.88	B	9.0	TI	5.0	B		7					APF
1994 05 03.87	S	10.4	AC	15	L	10	54	& 2.5	4	0.7	135	CSU
1994 05 03.89	B	8.3:	S	12.0	R	5	25	4	3			CHE03
1994 05 05.05	S	9.1	AA	11	L	7	32	4	2			BAR06
1994 05 05.84	S	9.3	AA	11	L	7	32	3				BAR06
1994 05 06.01	B	8.9	AA	12.0	R	5	25	3.5	3			CHE03
1994 05 06.56	S	9.2	AC	16	L	6	40	3	3			TOM
1994 05 07.93	S	8.1	AA	5.0	B		10	4.8	4			KEI
1994 05 08.00	B	9.0	AA	12.0	R	5	25	4	3			CHE03
1994 05 10.22	S	8.3	NP	5.0	B		10		2			MOR
1994 05 12.97	S	8.4	AA	5.0	B		10	3.8				KEI
1994 05 12.97	S	8.5	AA	10.0	B		20	3.8	4			KEI
1994 05 14.19	M	9.2	NP	8.0	B		20	7	2			MOR
1994 05 14.19	M	9.2	NP	25.6	L	4	45	7	3			MOR
1994 05 15.03	S	8.6	AA	5.0	B		10	4.5				KEI
1994 05 15.03	S	8.7	AA	10.0	B		20	4.5	3/			KEI
1994 06 01.92	S	11.2	HS	10.0	B		25	2				FAB
1994 06 30.16	S	12.2	HS	33.3	L	4	56	1.7	1			KRO02
1994 07 01.15	S	12 :	HS	33.3	L	4	56	1.5	0			KRO02
1994 07 01.28	S	[13.0	NP	25.6	L	4	111					MOR
1994 07 01.91	S	12.3:	HS	10.0	B		25	1.5	2			ZNO
1994 07 03.65	C	15.8	GA	60.0	Y	6		0.65				NAK01
1994 07 04.50	C	15.9	GA	60.0	Y	6		0.55			140	NAK01
1994 07 10.96	S	12.4	HS	20.3	T	10	93	0.4	3			HAS02
1994 07 13.56	C	16.1	GA	60.0	Y	6		0.65			146	NAK01
1994 07 29.92	! V	[15.5	YF	20.0	T	2						MIK
1994 08 03.49	C	17.4	GA	60.0	Y	6		0.35				NAK01
1994 08 26.54	C	17.9	GA	60.0	Y	6		0.3				NAK01
1994 09 08.48	C	18.3	GA	60.0	Y	6		0.3				NAK01

Comet Takamizawa-Levy 1994f

DATE (UT)	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1994 04 17.77	S	11.1	AC	16	L	6	40	2	3			TOM
1994 05 03.01	B	9.0	AA	15.6	L	10	54	4	1			KOS
1994 05 03.04	B	10.2:	S	9	R	6	45					GRZ
1994 05 03.93	S	9.2:	S	12.0	R	5	25	4.5	3			CHE03
1994 05 05.04	B	8.9	AA	15.6	L	10	54	5	1			KOS
1994 05 05.98	B	8.6	S	12.0	R	5	25	5	5			CHE03
1994 05 06.70	S	9.6	AC	16	L	6	40	5	2			TOM
1994 05 08.01	B	8.8	S	12.0	R	5	25	3.5	5			CHE03
1994 05 09.08	S	8.2	GA	40	Y	5	40	6	5			FOG
1994 05 12.91	B	8.6	S	12.0	R	5	25		5			CHE03
1994 05 13.01	S	8.1	AA	10.0	B		20	4.5	4			KEI
1994 05 13.04	B	8.7	AA	15.6	L	10	54	5	2			KOS

Comet Takamizawa-Levy 1994f [cont.]

DATE (UT)	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1994 05 14.35	M	8.8	NP	8.0	B		20	4.5	3			MOR
1994 05 14.35	M	8.8	NP	25.6	L	4	45	4.5	3			MOR
1994 05 14.95	B	8.2	S	12.0	R	5	25		5			CHE03
1994 05 15.03	S	8.0	AA	5.0	B		10	4.0				KEI
1994 05 15.03	S	8.0	AA	10.0	B		20	4.2	4/			KEI
1994 05 15.89	B	8.5	AA	15.6	L	10	54	7	2	0.4	278	KOS
1994 05 17.92	B	8.3	AA	15.6	L	10	54	7	2	0.5	274	KOS
1994 05 17.95	S	8.5	AA	12.5	R	5	20	5	6			BEA
1994 05 20.03	B	8.4	AA	15.6	L	10	54	6	4	0.3	266	KOS
1994 05 21.45	M	8.0	AA	8.0	B		20	12	6	0.33	230	MOR
1994 05 26.85	B	8.6	AA	15.6	L	10	54	6	4			KOS
1994 05 27.20	M	8.3	AA	8.0	B		20		3/			MOR
1994 05 27.99	S	8.6	GA	28	T	6	93	3	7			FOG
1994 05 31.88	B	8.3	AA	15.6	L	10	54	8	6			KOS
1994 06 01.87	B	8.3	AA	15.6	L	10	54	8	6			KOS
1994 06 02.61	B	8.6	AC	16	L	6	40	10	5	0.17	140	TOM
1994 06 03.86	B	8.7	AA	15.6	L	10	54	6	5			KOS
1994 06 03.93	S	9.2	S	10.0	B		25	5				FAB
1994 06 04.87	B	8.7	AA	15.6	L	10	54	6	5			KOS
1994 06 04.94	S	8.9	AA	10.0	B		20	5.1	6	0.25	156	KEI
1994 06 08.87	S	8.9	AC	6.0	B		20	&13	2	?0.15		CSU
1994 06 11.33	M	8.6	AA	12.5	T	10	48	5	3/			MOR
1994 06 12.28	M	8.7	AA	12.5	T	10	48	5	2/			MOR
1994 06 13.96	B	8.9	S	12.0	R	5	25	2.0	5			CHE03
1994 06 14.97	B	8.5:	S	12.0	R	5	25		3			CHE03
1994 06 14.97	B	8.8	AA	15.6	L	10	54	6	5			KOS
1994 06 17.98	B	9.2	AA	15.6	L	10	54	4	4			KOS
1994 06 19.88	S	9.5	S	11	L	8	54	2.5	3			KYS
1994 06 21.97	B	9.0:	S	12.0	R	5	25		3			CHE03
1994 06 26.18	M	8.7	NP	10.8	L	4	43					HAL
1994 06 27.90	S	9.9	S	11	L	8	32	2	3			KYS
1994 06 27.99	S	9.7	AA	20	R	14	40	4	2			LAN03
1994 06 28.03	S	9.8	AA	20	R	14	40	2.8	2			SHA02
1994 06 29.16	S	10.2	HS	33.3	L	4	56	3.3	5			KRO02
1994 06 29.92	S	9.6	GA	11	L	7	40	4	3			BAR06
1994 06 30.05	S	9.7	AA	20	R	14	40	3.5	2			SHA02
1994 06 30.14	S	10.2	HS	33.3	L	4	56	3.3	3			KRO02
1994 06 30.91	S	9.7	AA	13.0	L	6	36	2	2			MEY
1994 06 30.96	S	9.8	AA	33.3	L	5	55	3.1	2			SHA02
1994 07 01.16	S	10.2	HS	33.3	L	4	56	4.1	4			KRO02
1994 07 01.23	M	9.7	NP	25.6	L	4	45	4.5	4			MOR
1994 07 01.90	S	9.7	TI	11	L	8	32	2	4			KYS
1994 07 01.90	S	10.7	TI	10.0	B		25	3	2			ZNO
1994 07 01.92	M	9.8	TI	6.5	L	9	33	3	3			HOR02
1994 07 01.92	M	9.9	TI	6.5	L	9	33					DVO
1994 07 01.93	S	9.9	AC	13.0	L	6	36	2.5	3			MEY
1994 07 01.94	S	9.9	GA	11	L	7	40	4	2/			BAR06
1994 07 01.95		[9.0	S	25.0	C	5	48					CHE03
1994 07 01.95	S	10.5:	AC	15.2	L	5	42	2	2			MOE
1994 07 02.29	S	9.4	AA	10	R	5	27	2.0	2			SPR
1994 07 02.87	B	9.4	AA	15.6	L	10	54	5	4			KOS
1994 07 02.90	S	9.8	TI	11	L	8	32	2	3			KYS
1994 07 02.94	S	10.1	AC	13.0	L	6	36	3.5	2/			MEY
1994 07 02.95	S	9.8	GA	11	L	7	40	3	3			BAR06
1994 07 02.96	S	9.7	GA	11	L	7	40	3	3			BAR06
1994 07 03.17	Y	11.2	SC	25	T	4		& 0.8		?	100	ROQ
1994 07 03.24	M	9.8	NP	25.6	L	4	45	4.5	4			MOR
1994 07 03.29	S	9.7	AA	20	T	10	64	2.0	2/			SPR
1994 07 03.92	M	10.6	TI	6.5	L	9	33	2.5	2			HOR02
1994 07 03.93	M	10.5	TI	6.5	L	9	33		2			DVO
1994 07 03.93	S	9.7	GA	11	L	7	40	3	3/			BAR06
1994 07 04.93	S	9.5	GA	11	L	7	40	5	2			BAR06
1994 07 05.95	S	9.3	GA	11	L	7	32	5	2			BAR06
1994 07 05.97	S	9.9	VB	33.3	L	5	55	3.2	2			SHA02

Comet Takamizawa-Levy 1994f [cont.]

DATE (UT)	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1994 07 06.23	! M	9.5	AC	41	L	4	83					HAL
1994 07 06.48	C	11.6	GA	60.0	Y	6		2.7		>0.15	85	NAKO1
1994 07 06.84	B	9.7	AA	15.6	L	10	54	5	3			KOS
1994 07 06.93	S	9.2	GA	11	L	7	32	5	3			BAR06
1994 07 06.95	S	10.4	AC	15.2	L	5	76	2	2			MOE
1994 07 07.17	Y	9.6	SC	25	T	4		& 1		?	100	ROQ
1994 07 07.29	S	10.0	AA	20	T	10	64	2.0	2			SPR
1994 07 07.92	S	10.7:	TI	10.0	B		25	2				KYS
1994 07 07.98	! S	10.5	VB	33.3	L	5	85	2.4	3			SHA02
1994 07 08.29	S	9.9	AA	20	T	10	81	3.0	3			SPR
1994 07 09.25	a M	10.2	NP	25.6	L	4	45	4.4	3			MOR
1994 07 09.29	S	10.2	AA	20	T	10	81	2.0	2			SPR
1994 07 09.94	S	10.4	AC	15.2	L	5	76	2	1			MOE
1994 07 09.95	S	10.5	TI	10.0	B		25	1.5	2			KYS
1994 07 09.96	! S	10.3	VB	20	R	14	40	3.4	3			SHA02
1994 07 10.25	a M	10.2	NP	25.6	L	4	67	5.1	3			MOR
1994 07 10.28	S	10.3	AA	20	T	10	81	2.0	2			SPR
1994 07 10.90	S	10.8:	TI	10.0	B		25	1.5				KYS
1994 07 10.93	S	10.6	AC	15.2	L	5	76	2	1			MOE
1994 07 10.95	S	10.3:	GA	11	L	7	40	3	1/			BAR06
1994 07 10.95	! S	10.6	VB	20	R	14	155	2.7	2			SHA02
1994 07 10.96	S	10.9	HS	20.3	T	10	93	1.0	3			HAS02
1994 07 11.29	S	10.6	AA	20	T	10	125	1.5	1/			SPR
1994 07 11.90	S	10.1	TI	10	B		25	1.9				FAB
1994 07 12.30	S	10.8	AA	20	T	10	125	2.5	1/			SPR
1994 07 12.90	S	10.7	HS	20.3	T	10	77	0.6	1			KAM01
1994 07 13.29	S	10.6	AA	20	T	10	125	2.0	2			SPR
1994 07 14.17	Y	11.2	SC	25	T	4		& 1		&0.01	100	ROQ
1994 07 14.28	S	10.8	AA	20	T	10	185	2.0	1/			SPR
1994 07 14.88	S	11.1	TI	11	L	8	54	1.5	2			KYS
1994 07 15.29	S	10.8	AA	20	T	10	185	2.0	2/			SPR
1994 07 15.92		[9.5	GA	25.0	C	5	120					CHE03
1994 07 17.95	S	10.6	VB	33.3	L	5	85	2.3	3			SHA02
1994 07 20.90	S	11.2	TI	10.0	B		25	1.5	4			ZNO
1994 07 29.85	! V	12.0	AA	20.0	T	2		& 5	7	0.17	85	MIK
1994 07 31.17	S	11.0:	AC	41	L	4	72					HAL
1994 07 31.20	a M	11.3	NP	25.6	L	4	111	1.9	3/			MOR
1994 08 03.47	a C	12.9	GA	60.0	Y	6		1.1			75	NAKO1
1994 08 07.19	a S	[12.0	NP	25.6	L	4	156					MOR

Comet Takamizawa 1994i

DATE (UT)	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1994 05 10.25	M	10.4	NP	20.	L	6	55	2.2	5			MOR
1994 05 13.04	S	9.9	AA	15.0	B		25	2.3	6			KEI
1994 05 14.26	M	10.2	NP	25.6	L	4	67	1.8	6			MOR
1994 05 15.03	S	9.8	AC	10.0	B		20	2.9	5			KEI
1994 05 20.03	B	10.3	AA	15.6	L	10	54	3	1			KOS
1994 05 26.83	B	10.3	AA	15.6	L	10	54	3	1			KOS
1994 05 28.85	B	10.2	AA	15.6	L	10	54	3	1			KOS
1994 05 31.86	B	9.9	AA	15.6	L	10	54	6	2			KOS
1994 06 01.85	B	9.8	AA	15.6	L	10	54	6	2			KOS
1994 06 02.59	S	10.0	AC	16	L	6	40	4	2			TOM
1994 06 04.85	B	9.7	AA	15.6	L	10	54	8	2			KOS
1994 06 07.85	B	9.8	AA	15.6	L	10	54	6	2			KOS
1994 06 11.41	S	10.4	AC	12.5	T	10	48		3			MOR
1994 06 12.31	S	10.4	AA	12.5	T	10	48		3			MOR
1994 07 02.22	a M	10.8	NP	25.6	L	4	67	2.9	4			MOR
1994 07 03.20	a M	10.8	NP	25.6	L	4	67	2.9	2/			MOR
1994 07 04.18	Y	11.4	SC	25	T	4		& 0.75		?	102	ROQ
1994 07 04.49	C	11.7	GA	60.0	Y	6		2.4		0.08	110	NAKO1
1994 07 06.18	! M	11.3	AC	41	L	4	83					HAL
1994 07 07.46	S	11.3	AC	25.4	L		71					SEA
1994 07 08.17	Y	10.4	SC	25	T	4		& 0.33		?	100	ROQ

Comet Takamizawa 1994i [cont.]

DATE (UT)	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1994 07 09.21	M	9.6	AC	25.6	L	4	67					MOR
1994 07 09.21	a M	10.7	NP	25.6	L	4	67	3.7	3			MOR
1994 07 10.20	S	9.6	AC	25.6	L	4	67					MOR
1994 07 10.20	a S	10.5	NP	25.6	L	4	67	3.7	3			MOR
1994 07 11.43	S	10.1	AC	10.0	B		25					SEA

Comet Nakamura-Nishimura-Machholz 1994m

DATE (UT)	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1994 07 01.03	S	9.1	GA	11	L	7	32	4	1			BAR06
1994 07 07.29	S	9.4	AA	20	T	10	64	3.0	3/			SPR
1994 07 07.42	S	9.7	NP	20	L	6	55					HAL
1994 07 07.76	C	11.6	GA	60.0	Y	6		3.2			320	NAK01
1994 07 07.89	w S	8.5	NP	6	R	5	20	4	4			MIL02
1994 07 07.91	S	9.5:	GA	12.0	R	5	25		1			CHE03
1994 07 07.93	S	9.6	AA	35	L	5	97	6	6			VAN04
1994 07 08.00	S	9.2	AA	20	R	14	40	3.9	3			SHA02
1994 07 08.00	S	10.2	AC	35	L	5	103	3.5	3			BRO04
1994 07 08.29	S	9.4	AA	20	T	10	64	2.5	3/			SPR
1994 07 08.73	S	10.1	HS	41.0	L	6	80	3.0	2			KOB01
1994 07 09.31	S	9.1	AA	10	R	5	27	3.0	3/			SPR
1994 07 09.42	M	10.0	NP	25.6	L	4	45	2.4	6/	0.17	180	MOR
1994 07 09.90	w S	8.6	NP	6	R	5	20	4	4			MIL02
1994 07 09.95	S	9.9	AC	15.2	L	5	42	3.5	2			MOE
1994 07 09.96	S	9.1	AA	20	R	14	40	3.9	2			SHA02
1994 07 10.00	S	9.9	AC	35	L	5	103	4.5	3			BRO04
1994 07 10.04	S	10.1	AA	15	R	15	85	& 2	3			DIE02
1994 07 10.15	S	10 :	HS	33.3	L	4	56	& 2.5				KRO02
1994 07 10.20	S	9.5:	HS	33.3	L	4	56	& 2.2	4			KRO02
1994 07 10.26	S	9.4	HS	33.3	L	4	56	2.9	3			KRO02
1994 07 10.32	S	9.2	AA	10	R	5	27	3.0	3			SPR
1994 07 10.41	M	9.3	NP	25.6	L	4	45	3.5	6	0.33	150	MOR
1994 07 10.93	S	9.9	AC	15.2	L	5	42	3	1			MOE
1994 07 10.94	S	9.0	S	20.3	T	10	50	3.5	1			KAM01
1994 07 10.94	S	9.3	AA	20	R	14	40	3.9	2			SHA02
1994 07 11.04	S	10.1	AA	15	R	15	85	& 2	3			DIE02
1994 07 11.29	S	9.0	AA	20	T	10	64	3.5	3/			SPR
1994 07 11.42	S	9.5:	NP	41	L	4	83					HAL
1994 07 11.93	S	9.8	AC	15.2	L	5	42	3.5	1			MOE
1994 07 11.95	S	9.5	AC	10.0	B		25	1.6	4			HAS02
1994 07 11.96	S	9.8	AC	15	R	15	85	& 3	3			DIE02
1994 07 11.99	S	9.7	AC	35	L	5	103	5.0	4			BRO04
1994 07 12.04	S	9.5	AA	20	R	14	40	4.3	2			SHA02
1994 07 12.18	S	9.1	S	33.3	L	4	56	4.2	3			KRO02
1994 07 12.29	S	9.4	AA	20	T	10	64	3.5	3/			SPR
1994 07 12.75	C	11.2	GA	60.0	Y	6		4.0			315	NAK01
1994 07 12.76	C	10.9	GA	10.0	A	4		5.0				NAK01
1994 07 12.88	M	9.5	TI	13	L	8	69	3	2/			HOR02
1994 07 12.89	w S	8.3:	NP	6	R	5	20	> 3	5			MIL02
1994 07 12.91	S	9.4	S	11	L	8	32	2.5	4			KYS
1994 07 12.92	S	9.4	AC	10.0	B		25	2.1	3			HAS02
1994 07 12.94	S	9.0	S	20.3	T	10	50	3.2	1/			KAM01
1994 07 12.95	S	9.2	GA	25.0	C	5	48	2.5	3			CHE03
1994 07 12.95	S	9.7	AC	15.2	L	5	42	4	1			MOE
1994 07 12.95	S	9.8	AC	15	R	15	85	& 3	3			DIE02
1994 07 13.00	S	9.5	AC	35	L	5	103	5.0	4			BRO04
1994 07 13.26	S	9.1	S	33.3	L	4	56	3.9	3			KRO02
1994 07 13.28	S	9.2	AA	20	T	10	64	3.0	3/			SPR
1994 07 13.93	S	9.2	S	11	L	8	32	2.5	3			KYS
1994 07 13.93	S	9.5	GA	25.0	C	5	48	3	3			CHE03
1994 07 13.94	M	9.5	TI	15	R	15	56	3	2			KUB
1994 07 13.94	S	9.5	AC	15.2	L	5	42	4.5	2			MOE
1994 07 14.29	S	9.0	AA	20	T	10	64	3.0	4			SPR
1994 07 14.87	S	9.5:	S	11	L	8	54	2	3			KYS

Comet Nakamura-Nishimura-Machholz 1994m [cont.]

DATE (UT)	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1994 07 15.04	S	9.0	AC	33.4	L	4	61	6	4			SZE02
1994 07 15.09	S	9.2:	AA	20	R	14	40	2	2			LAN03
1994 07 15.29	S	8.9	AA	20	T	10	64	3.5	4			SPR
1994 07 15.42	Y	12.1	SC	25	T	4		& 0.75		?	270	ROQ
1994 07 15.89	S	9.3	S	11	L	8	54	2.5	3			KYS
1994 07 15.92	S	9.8	AA	30.5	L	5	117	3.0	5			VIC
1994 07 15.93	S	9.1	GA	12.0	R	5	25	4	3			CHE03
1994 07 15.94	S	9.3	AC	15.2	L	5	42	4.5	3			MOE
1994 07 16.05	S	9.5	AC	13.0	L	6	36	3	2/			MEY
1994 07 16.06	B	10.0	CS	20.3	T	10	62	1.6	2	0.05	300	GAR02
1994 07 16.26	S	9.1	AA	30.5	R	15	176	3	2			AUG
1994 07 16.91	S	9.5:	S	11	L	8	54	2				KYS
1994 07 16.96	S	9.5	AA	20	R	14	40	2.9	2			SHA02
1994 07 17.29	S	9.0	AA	10	R	5	49	2.5	3			SPR
1994 07 17.95	S	9.1	AC	15.2	L	5	42	4.5	3			MOE
1994 07 17.97	S	9.1	AA	33.3	L	5	55	3.5	3			SHA02
1994 07 17.99	S	9.5	AA	20	R	14	40	2.5	2			LAN03
1994 07 18.29	S	9.0	AA	30.5	R	15	176	3	2			AUG
1994 07 18.95	S	9.3	AA	20	R	14	40	3.2	3			SHA02
1994 07 18.99	S	9.0	AC	15.2	L	5	42	4.5	3			MOE
1994 07 19.28	S	9.2	AA	20	T	10	64	2.5	2/			SPR
1994 07 19.94	S	9.1	AC	15.2	L	5	42	4.5	3			MOE
1994 07 19.95	S	9.5	AA	20	R	14	40	2.9	3			SHA02
1994 07 20.28	S	8.9	AA	20	T	10	64	2.0	2/			SPR
1994 07 20.88	S	9.7	TI	11	L	8	54	1.5	3			KYS
1994 07 20.92	M	9.6	TI	10.0	B		25	3.5	3			ZNO
1994 07 20.94	S	9.2	AC	15.2	L	5	42	4	3			MOE
1994 07 21.88	S	10.2	TI	11	L	8	54	1.5	4			KYS
1994 07 22.86	M	9.4	TI	10.0	B		25	3.5	4			ZNO
1994 07 25.88	S	10.8	TI	11	L	8	54	2	2			KYS
1994 07 26.86	S	10.5	TI	11	L	8	54	1.5	2			KYS
1994 07 26.87	S	10.1	TI	11	L	8	32	2	3			KYS
1994 07 26.90	S	8.8	AC	15.2	L	5	42	4	4			MOE
1994 07 27.28	S	8.9	AA	20	T	10	64	3.0	4/			SPR
1994 07 27.87	S	8.9	GA	12.0	R	5	57		3			CHE03
1994 07 27.93	S	8.6	GA	11	L	7	40	& 4	4			BAR06
1994 07 28.28	S	8.8	AA	20	T	10	64	3.5	3/			SPR
1994 07 28.86	M	9.0	TI	10.0	B		25	4	4			ZNO
1994 07 28.86	S	9.2:	GA	11	L	7	40	& 2	2/			BAR06
1994 07 28.87	S	9.9	TI	11	L	8	32	2.5	1			KYS
1994 07 28.88	B	9.4	GA	34.0	L	4	45	2.5	5			CHE03
1994 07 28.88	S	10.0	TI	11	L	8	54	2.5	2			KYS
1994 07 28.97	S	9.2	GA	11	L	7	40	2	3			BAR06
1994 07 29.25	S	8.9	AA	20	T	10	64	3.0	3			SPR
1994 07 29.86	S	8.7	GA	11	L	7	32	5	3			BAR06
1994 07 29.86	S	9.2	GA	12.0	R	5	57	2.0	3			CHE03
1994 07 29.86	S	9.6	TI	11	L	8	54	2	2			KYS
1994 07 29.87	M	9.1	TI	13	L	8	69	5	2			HOR02
1994 07 29.87	S	9.5	TI	11	L	8	32	2.3	3			KYS
1994 07 29.91	S	8.8	AC	15.2	L	5	42	4	3			MOE
1994 07 29.96	S	9.4	AA	10	B		14	4.7	3			SHA02
1994 07 29.97	S	9.5	AA	8.0	B		20	4.7	2			SHA02
1994 07 30.26	S	8.6	AA	10	R	5	27	3.0	2/			SPR
1994 07 30.85	M	9.1	TI	10.0	B		25	4	4			ZNO
1994 07 30.86	M	9.1	TI	13	L	8	69	5.5	3			HOR02
1994 07 30.86	S	9.0:	S	12.0	R	5	57		3			CHE03
1994 07 30.88	S	8.5	GA	11	L	7	32	5	2/			BAR06
1994 07 31.26	S	8.6	AA	20	T	10	64	4.0	2/			SPR
1994 07 31.27	M	8.6	AA	25.6	L	4	45		3/			MOR
1994 07 31.29	M	8.8	AA	8.0	B		20		3			MOR
1994 07 31.86	M	9.2	TI	13	L	8	69	5.5	3			HOR02
1994 07 31.92	S	9.5:	TI	10	B		25	3				FAB
1994 07 31.95	S	9.5	AA	33.3	L	5	55	3.1	2			SHA02
1994 08 01.27	S	8.3	AA	20	T	10	37	4.0	3/			SPR

Comet Nakamura-Nishimura-Machholz 1994m [cont.]

DATE (UT)	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1994 08 01.87	M	9.4	TI	10.0	B		25	4	2			ZNO
1994 08 01.93	S	8.9:	AC	15.2	L	5	42	4	3			MOE
1994 08 01.93	S	9.3	AA	8.0	B		20	5.6	2			SHA02
1994 08 01.93	S	9.4	AA	20	R	14	40	3.5	2			SHA02
1994 08 01.95	S	8.6	AA	15	R	15	85	& 5	1			DIE02
1994 08 02.01	S	9.2	CS	20.3	T	10	80	1.5	2/			GAR02
1994 08 02.11	S	9.2	AA	8.0	B		10	6	1			LAN03
1994 08 02.25	S	8.0	AA	20	T	10	37	4.0	4			SPR
1994 08 02.91	S	8.7	AC	15.2	L	5	42	4.5	3			MOE
1994 08 02.92	S	8.8	AC	28.0	T	10	108	4	4			MOE
1994 08 02.95	S	8.5	AA	15	R	15	85	& 5	2			DIE02
1994 08 02.96	S	8.1	S	10.0	B		25	2.6	3			HAS02
1994 08 03.01	S	9.0	GA	11	L	7	32	4	2			BAR06
1994 08 03.02	S	9.1	CS	20.3	T	10	62	1.8	3	0.20	305	GAR02
1994 08 03.59	M	8.6	S	16.0	W	4	19		3			TSU02
1994 08 03.63	B	10.1	AC	20.0	L	4	40	7	3			OHM
1994 08 03.73	C	10.3	GA	60.0	Y	6		4.6				NAK01
1994 08 03.90	M	9.2	S	10	B		25	4	1			KUB
1994 08 03.91	S	8.6	AC	15.2	L	5	42	5.5	3			MOE
1994 08 03.92	S	8.5	S	20.3	T	10	50	4.0	1/			KAM01
1994 08 03.96	S	8.7	AC	15	R	15	85	& 6	2			DIE02
1994 08 03.98	S	9.2	AC	35	L	5	103	6.5	3			BRO04
1994 08 04.85	M	9.1	TI	13	L	8	69	8	3			HOR02
1994 08 04.85	S	8.8	GA	11	L	7	32	7.3	3			BAR06
1994 08 04.88	B	9.1	TI	11	L	8	32	3.5	2			KYS
1994 08 04.88	M	9.0	S	10	B		25	4	1			KUB
1994 08 04.89	S	9.0	TI	11	L	8	54	3.5	3			KYS
1994 08 04.91	S	8.5	AC	15.2	L	5	42	6	3			MOE
1994 08 04.92	S	8.8	AA	8.0	B	5	20	11	2/			MIL02
1994 08 05.02	S	8.5	S	10.0	B		25	2.5	3			HAS02
1994 08 05.40	S	8.5	NP	5.0	B		10					HAL
1994 08 05.67	C	10.9	HS	20.0	L	6		1.2				ITO02
1994 08 05.84	M	8.9	TI	10.0	B		25	4.5	2			ZNO
1994 08 05.86	M	9.0	TI	13	L	8	69	8	3			HOR02
1994 08 05.86	S	8.9	TI	11	L	8	32	3	3			KYS
1994 08 05.87	M	9.2	TI	13	L	8	69					DVO
1994 08 05.93	S	8.9	AA	10.0	B		20	4.1	3/			KEI
1994 08 05.94	S	8.7	GA	11	L	7	32	5	3			BAR06
1994 08 05.97	S	8.7	AC	15	R	15	85	& 6	2			DIE02
1994 08 05.98	S	9.1	AA	10	B		14	9	2			SHA02
1994 08 06.22	S	7.8	AA	20	T	10	37	4.0	3/			SPR
1994 08 06.25	S	8.9:	S	33.3	L	4	56	3.3	3			KRO02
1994 08 06.28	M	8.3	NP	8.0	B		20	9	3			MOR
1994 08 06.29	M	8.2:	NP	25.6	L	4	45	5	2/			MOR
1994 08 06.86	S	8.6	GA	11	L	7	32	5.7	2			BAR06
1994 08 06.91	S	8.5	AC	15.2	L	5	42	6	3			MOE
1994 08 06.94	S	9.0	AC	13.0	L	6	36	3	2/			MEY
1994 08 07.19	S	9 :	S	33.3	L	4	56	2.3	2			KRO02
1994 08 07.23	S	7.7	AA	20	T	10	37	4.0	3			SPR
1994 08 07.28	M	8.4	NP	8.0	B		20	9	2/			MOR
1994 08 07.29	S	8.6	NP	5.0	B		10					HAL
1994 08 07.85	S	9.2	TI	11	L	8	32	3	2			KYS
1994 08 07.86	S	9.3	TI	11	L	8	54	3	1			KYS
1994 08 07.87	S	8.6	GA	11	L	7	32	5	2/			BAR06
1994 08 07.93	S	9.0	AA	20	R	14	40	5	1			LAN03
1994 08 07.94	S	8.3	AC	15.2	L	5	42	7	3			MOE
1994 08 07.94	S	9.1	AA	20	R	14	40	5.1	2			SHA02
1994 08 08.20	S	8.0	S	33.3	L	4	56	6.1	2			KRO02
1994 08 08.87	S	8.8	AC	8	R	11	84	3	2			LAN02
1994 08 08.90	S	8.4	AC	15.2	L	5	42	7	3			MOE
1994 08 08.90	S	9.1	AA	20	R	14	40	4.1	2			SHA02
1994 08 08.91	S	8.5	AA	8.0	B		10	8	2			SHA02
1994 08 08.95	S	8.5	AA	15	R	15	85	& 6	1			DIE02
1994 08 08.96	S	8.4	AA	5.0	B		10	4.8	2/			KEI

Comet Nakamura-Nishimura-Machholz 1994m [cont.]

DATE (UT)	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1994 08 08.96	S	8.8	AA	10.0	B		20	4.8	4/	0.08	287	KEI
1994 08 09.00	S	8.9	AA	20	R	14	40	7	2			LAN03
1994 08 09.84	S	9.0	TI	11	L	8	32	3.5	1			KYS
1994 08 09.85	M	8.8	TI	10.0	B		25	5.5	2/	0.1		ZNO
1994 08 09.85	S	8.9	TI	11	L	8	54	4	1			KYS
1994 08 09.89	M	9.3	S	10	B		25	5	1			KUB
1994 08 09.91	B	9.7	TI	5.6	R	14	40	3	2			DEM
1994 08 09.94	S	8.8	AA	20	R	14	40	8	2			LAN03
1994 08 09.94	S	9.3	TI	10	B		25	3.5	0/			FAB
1994 08 09.98	S	8.7	AC	13.0	L	6	36	7	3			MEY
1994 08 10.24	S	7.6	AA	20	T	10	37	3.5	2/			SPR
1994 08 10.69	S	9.1	S	15.0	R	5	25	3.5	3			NAG02
1994 08 10.87	M	8.7	TI	8.0	B		10	5	3			ZNO
1994 08 10.88	S	7.9	AA	11	L	7	32	5	3			BAR06
1994 08 11.22	S	8.6	NP	5.0	B		10					HAL
1994 08 11.24	S	7.8	AA	20	T	10	37	3.0	2/			SPR
1994 08 11.75	S	9.3	S	15.0	R	5	25	4	3/			NAG02
1994 08 11.84	M	8.7	TI	10.0	B		25	6	3	0.08		ZNO
1994 08 11.86	S	8.5	AC	13.0	L	6	36	8	3			MEY
1994 08 11.88	M	9.5	TI	10	B		25	4				FAB
1994 08 12.26	S	7.8	AA	10	R	5	27	3.0	2/			SPR
1994 08 12.29	S	8.5	NP	8.0	B		20		1/			MOR
1994 08 12.57	S	9.1	S	15.0	B		25	4	3/			NAG02
1994 08 12.85	S	9.5	TI	11	L	8	54	3	2			KYS
1994 08 12.91	M	8.6	TI	8.0	B		10	6	3/			ZNO
1994 08 13.24	S	7.9	AA	10	R	5	27	3.0	2/			SPR
1994 08 13.31	S	7.9	AA	8.0	B		20	9	2			MOR
1994 08 13.86	M	9.0	S	10	B		25	3	0			KUB
1994 08 13.88	M	8.7	TI	10	B		25	4				FAB
1994 08 13.88	S	8.4	AC	13.0	L	6	36	5	3			MEY
1994 08 13.89	S	8.4	AC	15.2	L	5	42	6.5	3			MOE
1994 08 13.91	S	8.8	AA	20	R	14	40	6.7	1			SHA02
1994 08 13.93	S	8.5	AA	8.0	B		20	8	1			SHA02
1994 08 13.94	S	8.8	TI	11	L	8	32	5	3			KYS
1994 08 13.94	S	8.9	TI	11	L	8	54	4	2			KYS
1994 08 13.95	S	8.4	AC	15	R	15	85	& 7	1			DIE02
1994 08 13.99	S	8.4	AC	6.3	R	13	28	15	1/			CSU
1994 08 14.02	S	8.5	AA	33.3	L	5	55	4.2	2			SHA02
1994 08 14.06	M	8.9	S	10	B		25	4	1			KUB
1994 08 14.24	S	7.9	AA	20	T	10	37	3.0	2			SPR
1994 08 14.30	S	8.4	AA	8.0	B		20	9	1/			MOR
1994 08 14.73	M	8.0	S	16.0	W	4	19		4			TSU02
1994 08 14.92	M	9.1	TI	10	B		25	5	1/			FAB
1994 08 14.92	M	9.3	S	10	B		25	5	1			KUB
1994 08 14.93	S	8.7	AA	20	R	14	40	6	2			LAN03
1994 08 14.94	S	8.8	AC	35	L	5	103	6.0	2			BRO04
1994 08 14.99	S	8.3	AC	15	R	15	85	& 7	1			DIE02
1994 08 15.02	S	8.7	AA	33.3	L	5	55	4.1	1			SHA02
1994 08 15.22	S	8.0	AA	20	T	10	64	3.0	3/			SPR
1994 08 15.62	C	9.2	GA	8.0	R	6		7.2				NAK01
1994 08 15.87	S	8.8	TI	11	L	8	32	5	0			KYS
1994 08 15.90	S	8.6	AA	20	R	14	40	3.3	1			SHA02
1994 08 15.90	S	8.7	AA	10.0	B		25	1.4	2			HAS02
1994 08 15.92	S	8.3	AC	15.2	L	5	42	7	3			MOE
1994 08 15.97	S	8.3	AC	13.0	L	6	36	5.5	3			MEY
1994 08 16.02	S	8.5	AC	15	R	15	85	& 7	1			DIE02
1994 08 16.08	S	8.7	TI	11	L	8	32	5	1			KYS
1994 08 16.23	S	8.0	AA	20	T	10	64	3.0	2/			SPR
1994 08 16.75	S	8.9	S	15.0	R	5	25	4	3			NAG02
1994 08 16.83	S	9.4	TI	11	L	8	54	3.5	1			KYS
1994 08 16.98	S	8.2	AC	13.0	L	6	36	6	3/			MEY
1994 08 16.98	S	9.1	TI	10	B		25	5	2			FAB
1994 08 17.23	S	8.0	AA	20	T	10	64	3.0	2/			SPR
1994 08 18.02	S	8.8	AA	20	R	14	40	5	1			LAN03

Comet Nakamura-Nishimura-Machholz 1994m [cont.]

DATE (UT)	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1994 08 18.03	S	8.7	AA	20	R	14	40	4.5	1			SHA02
1994 08 18.23	S	8.1	AA	20	T	10	125	2.5	2			SPR
1994 08 18.76	S	8.9	S	15.0	R	5	25	4.5	3			NAG02
1994 08 20.88	S	8.6:	AC	15.2	L	5	42	5	3			MOE
1994 08 22.28	Y	10.0	SC	25	T	4		& 0.75	5	?	208	ROQ
1994 08 24.06	S	10.1	AA	20	R	14	112	3	0			LAN03
1994 08 27.20	S	8.5	NP	5.0	B		10					HAL
1994 08 27.21	S	7.5	AA	20	T	10	51	5.0	3/			SPR
1994 08 27.53	C	9.2	HS	20.0	L	6		2.4				ITO02
1994 08 27.80	S	8.4	AA	11	L	7	40	6	2/			BAR06
1994 08 27.82	S	8.3	AA	11	L	7	32	5	3			BAR06
1994 08 27.83	S	9.3	TI	11	L	8	32	4	3			KYS
1994 08 27.84	S	8.9	AC	10.0	B		25	3.2	2			HAS02
1994 08 27.84	S	9.3	AA	30.5	L	4	117	6	7			VIC
1994 08 27.85	B	8.8:	TI	5.6	R	14	40	7	2			DEM
1994 08 27.85	S	9.7	AA	33.4	L	4	61	2.5	5			SZE02
1994 08 27.90	S	8.4	AA	10.0	B		20	5.0	6			KEI
1994 08 27.90	S	8.4	AA	20	R	14	40	4.1	2			SHA02
1994 08 27.97	S	8.8	AA	20	R	14	40	4	2			LAN03
1994 08 28.08	S	10.0:	AA	33.4	L	4	61					SZE02
1994 08 28.58	S	8.9	S	15.0	B		25	5	3/			NAG02
1994 08 28.81	S	8.0	AA	11	L	7	32	8.0	4			BAR06
1994 08 28.84	S	9.0	AA	8.0	B	5	20	9	2			MIL02
1994 08 28.85	S	8.9	NP	8.0	B	5	20	9	2			MIL02
1994 08 28.86	S	8.4:	AA	33.4	L	4	61	25	6			SZE02
1994 08 28.86	S	9.3	AA	19.2	L	8	33	>10	3			MIL02
1994 08 28.88	S	8.3	AA	5.0	B		7	&12	4			MIK
1994 08 28.88	S	8.4	AC	15.2	L	5	42	8.5	3			MOE
1994 08 28.89	S	8.2	AA	5.0	B		10	8.4	4/			KEI
1994 08 28.90	B	8.6	TI	5.6	R	14	40	10	1			DEM
1994 08 28.93	S	8.2	AA	20	R	14	40	4.1	2			SHA02
1994 08 28.98	S	8.0	AA	10	B		14	9.4	2			SHA02
1994 08 29.21	S	7.7	AA	8.0	B		20	11	3			MOR
1994 08 29.82	S	8.2	AA	11	L	7	32	10	2			BAR06
1994 08 29.85	S	8.4	AC	15.2	L	5	42	8	4			MOE
1994 08 29.86	S	8.2	TI	11	L	8	32	6	3			KYS
1994 08 29.87	S	8.6	AA	8.0	R	5	11	7.0	2			HAS02
1994 08 30.00	S	8.0	AA	11	L	7	32	11.4	1/			BAR06
1994 08 30.02	S	8.5	AA	20	R	14	40	5	2			LAN03
1994 08 30.21	S	7.7	AA	10	R	5	27	4.5	3/			SPR
1994 08 30.83	S	8.1	AA	13.0	L	6	36	5.5	3/			MEY
1994 08 30.86	B	8.7	TI	5.6	R	14	40	8	2			DEM
1994 08 30.87	S	8.4	TI	11	L	8	32	4	3			KYS
1994 08 30.89	S	8.0	AA	11	L	7	32	6	2/			BAR06
1994 08 30.90	S	8.7	AA	33.3	L	5	55	3.5	2			SHA02
1994 08 31.21	S	7.8	AA	10	R	5	27	4.0	3/			SPR
1994 08 31.24	S	7.7	AA	8.0	B		20	11	2			MOR
1994 08 31.85	S	8.5	AA	11	L	7	32	9.4	2			BAR06
1994 08 31.86	B	8.5	TI	5.6	R	14	40	6	3			DEM
1994 08 31.89	S	8.7	AA	5.0	B		7	&10	5			MIK
1994 09 01.89	S	8.4	AA	5.0	B		10	5.7				KEI
1994 09 01.89	S	8.5	AA	10.0	B		20	6.0	2/	0.17	335	KEI
1994 09 01.89	S	8.8	AC	15	R	15	85	& 4	1			DIE02
1994 09 01.95	S	7.9	AA	13.0	L	6	36	7	3/			MEY
1994 09 02.82	S	8.2	AA	11	L	7	32	8.8	2			BAR06
1994 09 02.89	S	8.5	AA	10.0	B		20	6.5	3	0.25	337	KEI
1994 09 02.93	B	9.7	CS	20.3	T	10	62	5	4	0.36	58	GAR02
1994 09 03.04	S	9.0	AA	20	R	14	40	3.1	1			SHA02
1994 09 03.14	S	8.8:	S	33.3	L	4	56	4.9	3			KRO02
1994 09 03.19	S	7.8	AA	8.0	B		20	11	2			MOR
1994 09 03.51	S	9.2	AA	10.0	B		25	6	5			SEA
1994 09 03.61	S	8.8	S	15.0	R	5	25	6	4			NAG02
1994 09 03.65	M	7.6	S	16.0	W	4	19		2			TSU02
1994 09 03.80	S	8.8	TI	11	L	8	32	4	1/			KYS

Comet Nakamura-Nishimura-Machholz 1994m [cont.]

DATE (UT)	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1994 09 03.81	M	8.9	TI	11	L	8	54	3.5	1			KYS
1994 09 03.84	S	8.9	AA	11	L	7	40	5.7	1			BAR06
1994 09 03.86	B	9.8	CS	20.3	T	10	62	7	5	0.63	354	GAR02
1994 09 03.92	S	8.2	S	20.3	T	10	50	4	3			KAM01
1994 09 03.95	S	8.4	AC	15.2	L	5	42	8	3			MOE
1994 09 04 85	S	8.9	AA	5.0	B		7	& 8	3			MIK
1994 09 04.15	S	8.2	S	33.3	L	4	56	& 6	3			KRO02
1994 09 04.16	S	7.7	S	8.0	B		20	18	1			KRO02
1994 09 04.22	S	7.9	AA	8.0	B		20	11	2			MOR
1994 09 04.82	S	8.6	TI	3.0	B		6	& 5	0			KYS
1994 09 04.82	S	8.7	TI	10	B		25	6	1			KYS
1994 09 04.85	S	8.8	AA	10.0	B		25	7.1	2			HAS02
1994 09 04.86	M	9.3	TI	25	L	6	60	4	4			KYS
1994 09 04.86	S	8.6	AC	15.2	L	5	42	7.5	3			MOE
1994 09 04.88	S	8.9	NP	8.0	B	5	20	11	2/			MIL02
1994 09 04.91	S	9.5	NP	19.2	L	8	33	&10	3			MIL02
1994 09 05.17	Y	9.9	SC	25	T	4		1.5	7/			ROQ
1994 09 05.20	S	7.9	AA	20	T	10	37	5.5	3			SPR
1994 09 05.82	S	8.7	AC	44.5	L	4	146	8	4			SAR02
1994 09 05.82	S	8.9	AC	15.2	L	5	42	7	2			MOE
1994 09 05.88	S	8.5	AA	10.0	B		20	4.4	2/		360	KEI
1994 09 05.96	S	8.8	AC	15	R	15	85	& 4	1			DIE02
1994 09 05.96	S	8.9	AA	10	B		14	5.5	2			SHA02
1994 09 06.22	S	8.2	AA	20	T	10	37	5.0	2			SPR
1994 09 06.80	S	8.9	AA	11	L	7	40	4	2			BAR06
1994 09 06.81	B	9.2	TI	5.6	R	14	40	5	7			DEM
1994 09 06.81	S	8.7	AC	6.0	B		20	12	2			SAR02
1994 09 06.81	S	9.0	AC	6.0	B		20	5	6			BAK01
1994 09 06.84	S	9.7	AA	8.0	B		20	& 6	3			MIK
1994 09 06.86	S	9.1	AA	11	L	7	40	3	3			BAR06
1994 09 07.07	S	9.5	AA	20	R	14	40	3.0	1			SHA02
1994 09 07.09	S	7.9	S	8.0	B		20	14	1			KRO02
1994 09 07.15	c	16.5	FA	91.4	L	5		17.5				SCO01
1994 09 07.82	B	9.1	TI	5.6	R	14	40	4	3			DEM
1994 09 07.88	S	9.7	AA	11	L	7	40	& 4	3			BAR06
1994 09 08.16	S	7.5	S	8.0	B		20	16	1			KRO02
1994 09 08.19	Y	10.37	SC	25	T	4		& 0.83	3			ROQ
1994 09 08.83	B	9.2	TI	5.6	R	14	40	3	1			DEM
1994 09 08.86	S	9.5:	AA	33.3	L	5	55	2.5	1			SHA02
1994 09 08.92	S	10.0:	GA	11	L	7	40	& 5	1			BAR06
1994 09 09.05	S	9.5	AA	20	R	14	40	3.9	1			SHA02
1994 09 09.20	S	8.3	AA	20	T	10	64	3.0	2			SPR
1994 09 09.27	M	9.4	AC	41	L	4	72					HAL
1994 09 09.27	S	9.3	NP	5.0	B		10					HAL
1994 09 09.59	C	9.4	HS	20.0	L	6		2.4				ITO02
1994 09 09.59	S	8.8	S	15.0	R	5	25	5	3			NAG02
1994 09 09.64	C	9.8	GA	8.0	R	6		9.9			10	NAK01
1994 09 09.85	S	9.9	CS	20.3	T	10	62	4	3	0.52	37	GAR02
1994 09 09.87	S	8.6	AA	13.0	L	6	36	5.5	2/			MEY
1994 09 10.83	S	8.7	AA	13.0	L	6	36	4	2			MEY
1994 09 10.97	S	8.8	AA	20	R	14	40	6.0	1			SHA02
1994 09 11.22	S	8.6	AA	20	T	10	64	2.5	2			SPR
1994 09 11.26	S	8.5	AA	8.0	B		20	13	1/			MOR
1994 09 11.86	S	9.2	AC	15.2	L	5	42	5	2			MOE
1994 09 12.20	S	8.8	AA	20	T	10	64	2.0	1/			SPR
1994 09 12.88		[13 :		33.4	L	4	61					SZE02
1994 09 12.92	S	9.9	AA	33.3	L	5	85	3.8	1			SHA02
1994 09 25.47	a C	12.8	GA	60.0	Y	6		2.3		>0.10	26	NAK01
1994 09 27.46	S	10 :		8.0	B		20	2.5				CAM03
1994 09 28.18	! S	10.7	AC	20	L	6	49		0/			HAL

Comet Machholz 1994r

DATE (UT)	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1994 10 09.39	M	11.3	AC	41	L	4	72					HAL
1994 10 12.11	! V	11.9	YF	20.0	T	2		& 6	6			MIK
1994 10 12.11	! V	12.5	AA	20.0	T	2		& 6	6			MIK
1994 10 12.47	S	10.6	NP	25.6	L	4	45	5.0	1/			MOR
1994 10 16.13	! V	11.6	YF	20.0	T	2		& 7	6			MIK

Periodic Comet Encke

DATE (UT)	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1990 09 24.15	S	8.4	AA	8.0	B		20	4.1	3		315	KEI
1990 09 25.14	S	8.3	AA	8.0	B		20	3.0	3			KEI
1990 09 27.19	S	8.1	AA	8.0	B		20	3.6	3			KEI
1990 09 28.19	S	8.2	AA	8.0	B		20	3.0	4			KEI
1990 09 28.19	S	8.3	AA	5.0	B		10	3.0				KEI
1990 10 01.18	S	7.9	AA	8.0	B		20	3.6	4			KEI
1990 10 01.18	S	8.0	AA	5.0	B		10	3.6				KEI
1993 12 04.76	S	11.3	HS	15.0	B		25	2.2	1			KEI
1993 12 07.76	S	11.5:	HS	29.8	L	5	62	2.0				KEI
1993 12 09.88	S	11.3	HS	29.8	L	5	62	1.4	1/			KEI
1993 12 10.78	S	11.2	HS	29.8	L	5	62	3.2	3			KEI
1993 12 11.83	S	10.9	HS	15.0	B		25	3.4	3			KEI
1993 12 15.79	S	10.3	HS	15.0	B		25	3.1	3			KEI
1993 12 16.78	S	10.3	HS	15.0	B		25	3.1	2			KEI
1993 12 16.80	S	10.2	HS	10.0	B		20	3.1				KEI
1993 12 30.75	S	9.4	HS	10.0	B		20	4.1	3/			KEI
1993 12 31.76	S	9.2	HS	10.0	B		20	4.1	3			KEI
1994 01 02.77	S	9.1	HS	10.0	B		20	4.1	4			KEI
1994 01 03.76	S	9.1	AA	10.0	B		20	4.1	4/			KEI
1994 01 04.42	B	8.9	S	12.0	B		20	3	3/			HAS07
1994 01 04.75	S	8.8	AA	5.0	B		10	6.2				KEI
1994 01 04.75	S	8.9	AA	10.0	B		20	6.2	4/			KEI
1994 01 06.76	S	8.7	AA	10.0	B		20	4.9	4/			KEI
1994 01 06.78	S	8.7	AA	5.0	B		10	4.9				KEI
1994 01 07.77	S	8.5	AA	5.0	B		10	4.9	4			KEI
1994 01 07.77	S	8.6	AA	10.0	B		20	4.9	5			KEI
1994 01 10.81	S	8.3	AA	5.0	B		10	6.2	4			KEI
1994 01 10.81	S	8.4	AA	10.0	B		20	5.1	5			KEI
1994 01 11.78	S	8.3	AA	5.0	B		10	7.7	5			KEI
1994 01 11.78	S	8.4	AA	10.0	B		20	5.2	5			KEI
1994 01 13.77	S	8.4	AA	5.0	B		10	4.9	5/			KEI
1994 01 13.77	S	8.5	AA	10.0	B		20	4.2	6			KEI
1994 01 14.77	S	8.3	AA	5.0	B		10	7.4	7			KEI
1994 01 14.77	S	8.4	AA	10.0	B		20	3.9	6/			KEI
1994 01 16.81	S	8.4	AA	10.0	B		20	3.8	6			KEI
1994 01 17.76	S	8.0	HS	5.0	B		10	5.0	6			KEI
1994 01 19.78	S	7.7	AA	5.0	B		10	3.8	6			KEI
1994 01 19.78	S	7.9	AA	10.0	B		20	2.5	6/			KEI
1994 01 30.77	S	>6.0	AA	10.0	B		20					KEI
1994 06 05.75	C	17.6	GA	60.0	Y	6		0.2				NAK01
1994 07 03.69	a C	18.2	GA	60.0	Y	6			9			NAK01
1994 07 10.46	c	21.5	FA	91.4	L	5						SC001
1994 07 10.47	C	18.6	FA	91.4	L	5		0.30		&0.02	241	SC001
1994 07 12.74	C	18.3	GA	60.0	Y	6		0.2		0.04	234	NAK01
1994 08 03.62	C	18.7	GA	60.0	Y	6		0.2				NAK01
1994 08 15.67	a C	18.5	GA	60.0	Y	6		0.2				NAK01

Periodic Comet Tempel 1 (1993c)

DATE (UT)	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1994 04 14.54	S	10.7	AC	16	L	6	40	2	3			TOM
1994 04 28.86	B	10.3	AA	15.6	L	10	54	2	3			KOS
1994 04 28.90	S	10.5	AC	15	L	10	54	2	1			CSU
1994 04 29.84	B	10.3	AA	15.6	L	10	54	2	3			KOS
1994 04 30.86	B	10.2	AA	15.6	L	10	54	2	3			KOS

Periodic Comet Tempel 1 (1993c) [cont.]

DATE (UT)		MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1994 04 30.95		S	10.0:	GA	11	L	7	40	3	3			BAR06
1994 05 01.24		M	10.1	NP	25.6	L	4	67	1.6	6			MOR
1994 05 04.86		B	10.1	AA	15.6	L	10	54	3	3			KOS
1994 05 05.96		S	10.0	GA	25.0	C	5	48	1.5	5			CHE03
1994 05 06.52		S	10.4	AC	16	L	6	40	4	4			TOM
1994 05 07.97		S	10.1	GA	25.0	C	5	48	2.0	3			CHE03
1994 05 09.90		B	10.0	AA	15.6	L	10	54	3	3			KOS
1994 05 10.25		M	10.2	NP	20.	L	6	55		6			MOR
1994 05 12.81		B	10.0	AA	15.6	L	10	54	3	3			KOS
1994 05 14.23		M	9.3	NP	25.6	L	4	45	2.6	6			MOR
1994 05 15.85		B	9.9	AA	15.6	L	10	54	4	3			KOS
1994 05 17.86		B	9.9	AA	15.6	L	10	54	4	3			KOS
1994 05 26.82		B	9.7	AA	15.6	L	10	54	4	3			KOS
1994 05 28.84		B	9.7	AA	15.6	L	10	54	5	3			KOS
1994 05 31.85		B	9.7	AA	15.6	L	10	54	5	4			KOS
1994 06 01.86		B	9.7	AA	15.6	L	10	54	5	4			KOS
1994 06 02.58		S	9.5:	AC	16	L	6	40	5	4			TOM
1994 06 04.84		B	9.7	AA	15.6	L	10	54	5	4			KOS
1994 06 07.84		B	9.8	AA	15.6	L	10	54	5	4			KOS
1994 06 08.84		B	9.8	AA	15.6	L	10	54	5	4			KOS
1994 06 26.85		B	9.8	AA	15.6	L	10	54	4	2			KOS
1994 06 29.15		S	11 :	HS	33.3	L	4	56	1.0	3			KRO02
1994 06 29.90		S	10.5:	GA	11	L	7	40	1.5	2/			BAR06
1994 06 30.14		S	9.1	S	33.3	L	4	56	1.8	2			KRO02
1994 06 30.95		S	10.1:	HS	33.3	L	5	85	1.7	3			SHA02
1994 07 01.13		S	9.5	S	33.3	L	4	56	1.6	3			KRO02
1994 07 01.25	a	M	9.7	NP	25.6	L	4	45	5.0	2/			MOR
1994 07 01.86		M	9.8	TI	10.0	B		25	3	3/			ZNO
1994 07 01.89		O	[10.0	S	11	L	8	32	& 2				KYS
1994 07 02.24	a	M	9.7	NP	25.6	L	4	45	5.0	2/			MOR
1994 07 02.85		B	10.2	AA	15.6	L	10	54	4	2			KOS
1994 07 03.22	a	M	9.9	NP	25.6	L	4	45	4.6	3			MOR
1994 07 03.90		S	9.8:	GA	11	L	7	40	2	3			BAR06
1994 07 04.49	a	C	11.1	GA	60.0	Y	6		3.2			135	NAK01
1994 07 06.18		Y	11.5	SC	25	T	4		& 0.55				ROQ
1994 07 06.21	!	S	10.1	AC	41	L	4	83					HAL
1994 07 07.90		O	[10.0	S	10.0	B		25	& 2				KYS
1994 07 09.23	a	M	9.9	NP	25.6	L	4	45	4.5	3			MOR
1994 07 10.17		Y	11.3	SC	25	T	4		& 0.58				ROQ
1994 07 10.22	a	M	9.9	NP	25.6	L	4	45	4.6	2/			MOR
1994 07 31.17		S	10.4:	AC	41	L	4	72					HAL
1994 07 31.24		M	10.2	AC	25.6	L	4	67	3.4	2/			MOR
1994 08 02.87		S	[9.6	CS	20.3	T	10	80	! 0.5				GAR02
1994 08 03.48	a	C	12.5	GA	60.0	Y	6		1.4			120	NAK01
1994 08 06.20	a	S	10.0	AC	25.6	L	4	67	2.7	2			MOR
1994 08 07.22	a	S	10.3	AC	25.6	L	4	67	3.0	2			MOR
1994 08 09.82		S	11.0:	TI	10.0	B		25	2				ZNO
1994 08 12.20	a	S	10.4	AC	25.6	L	4	111	2.5	1			MOR
1994 08 27.85		S	12.0	AC	20.3	T	10	80	1.0	2			GAR02
1994 08 29.17	a	S	11.4	AC	25.6	L	4	111	1.9	1			MOR
1994 09 03.16	a	S	11.5	AC	25.6	L	4	111	1.8	1			MOR
1994 09 03.84		S	11.8	AC	20.3	T	10	80	0.8	2			GAR02
1994 09 04.16	a	S	11.5	AC	25.6	L	4	111	1.8	1			MOR

Periodic Comet Tempel 2

DATE (UT)		MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1994 07 07.77	a	C	14.9	GA	60.0	Y	6		0.9				NAK01
1994 07 15.78	a	C	14.8	GA	60.0	Y	6		1.0				NAK01
1994 08 05.77		C	15.3	GA	60.0	Y	6		0.95				NAK01
1994 08 17.79		C	15.6	GA	60.0	Y	6		0.75				NAK01
1994 09 08.77		C	16.0	GA	60.0	Y	6		0.65				NAK01
1994 09 09.75		C	16.4	HS	20.0	L	6		0.6				ITO02
1994 09 13.74		C	16.5	GA	60.0	Y	6		0.6				NAK01

Periodic Comet Borrelly (1994l)

DATE (UT)	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1994 08 05.46	S	12.0	PC	20	L	6	122					HAL
1994 08 05.78	a C	13.2	GA	60.0	Y	6		1.2		0.05	235	NAK01
1994 08 06.46	a S	12.8	NP	25.6	L	4	156	1.1				MOR
1994 08 07.44	M	11.8	PC	41	L	4	72					HAL
1994 08 12.46	S	11.7	PC	20	L	6	122					HAL
1994 08 15.79	a C	12.6	GA	60.0	Y	6		1.55		0.06	244	NAK01
1994 08 30.45	Y	10.76	SC	25	T	4		& 0.73	6	?	160	ROQ
1994 09 03.10	S	12.4	AC	20.3	T	10	80	0.7	5			GAR02
1994 09 03.15	S	11.1	VB	33.3	L	5	120	1.1	2			SHA02
1994 09 03.44	M	10.6	AC	25.6	L	4	67					MOR
1994 09 03.44	a M	10.9	NP	25.6	L	4	67	2.2	4/			MOR
1994 09 03.74	C	12.5	HS	20.0	L	6		0.9				ITO02
1994 09 03.75	M	11.2	HS	16.0	W	4	49	2.5	3			TSU02
1994 09 03.78	C	11.8	GA	8.0	R	6		3.3			240	NAK01
1994 09 04.09	S	9.8	AA	20.3	T	10	51	1.4	2			HAS02
1994 09 04.45	a M	10.9:	NP	25.6	L	4	67	2.0				MOR
1994 09 05.10	O	[12.0	TI	13	L	8	69	! 1				HOR02
1994 09 05.11	S	9.8	AA	10.0	B		25	1.4	2			HAS02
1994 09 07.12	S	11.8	AC	44.5	L	4	146	2	7	0.1	150	BAK01
1994 09 07.12	S	12.0	AC	44.5	L	4	146	1.2	5/	0.15	140	SAR02
1994 09 08.40	M	9.9	AA	30.5	R	15	176	2.5	3			AUG
1994 09 08.46	Y	10.3	SC	25	T	4		& 0.83	8			ROQ
1994 09 08.78	a C	11.3	GA	60.0	Y	6		3.3			246	NAK01
1994 09 09.13	S	11.3	VB	33.3	L	5	85	0.6	3			SHA02
1994 09 09.43	M	11.5	PC	41	L	4	72					HAL
1994 09 09.73	C	12.4	HS	20.0	L	6		0.9				ITO02
1994 09 10.09	S	10.2	AC	13.0	L	6	36	3	2			MEY
1994 09 10.12	M	11.5:	TI	13	L	8	69	1.6	3			HOR02
1994 09 11.08	S	11.1	AC	20.3	T	10	62	1.5	3			GAR02
1994 09 11.12	S	10.9	AC	15.0	R	15	85	2.0	5			DIE02
1994 09 11.47	M	10.4	AC	25.6	L	4	67					MOR
1994 09 11.47	a M	10.7	NP	25.6	L	4	67	2.2	5			MOR
1994 09 12.09	S	10.2	AC	33.4	L	4	61	1.5	5			SZE02
1994 09 13.08	S	10.7	AC	33.4	L	4	61	3	5			SZE02
1994 09 13.11	M	10.6:	TI	13	L	8	69	2	3			HOR02
1994 09 13.12	S	9.7	AC	15.2	L	5	42	3.5	2			MOE
1994 09 13.13	S	10.7	AC	15.0	R	15	85	2.0	5			DIE02
1994 09 13.14	S	10.9	VB	33.3	L	5	85	1.1	4			SHA02
1994 09 13.16	S	11.2	AC	35	L	5	103	1.5	5			BRO04
1994 09 13.77	C	10.6	GA	8.0	R	6		7.4			240	NAK01
1994 09 14.09	S	9.6	AC	13.0	L	6	36	3	3			MEY
1994 09 14.46	Y	10.1	SC	25	T	4		& 0.7	8/			ROQ
1994 09 15.09	S	10.8:	GA	11	L	7	40	3	2			BAR06
1994 09 16.09	M	9.9	TI	13	L	8	69	2	3/			HOR02
1994 09 16.09	S	10.7	GA	11	L	7	40	3.5	3			BAR06
1994 09 16.10	S	10.6	AC	33.4	L	4	61	3.5	6	0.03	170	SZE02
1994 09 16.45	M	10.5	PC	41	L	4	72					HAL
1994 09 17.05	S	10.4	GA	11	L	7	40	3	4			BAR06
1994 09 17.06	S	10.3	GA	11	L	7	40	3.5	4			BAR06
1994 09 17.15	S	10.5	AC	15.0	R	15	85	2.0	6			DIE02
1994 09 17.16	S	10.9	HS	33.3	L	5	85	1.7	4			SHA02
1994 09 23.43	Y	9.5	SC	25	T	4		& 1.0	7/			ROQ
1994 09 24.46	M	10.1	NP	25.6	L	4	67	2.3	6/			MOR
1994 09 25.49	M	10.3	NP	25.6	L	4	67	2.3	6/			MOR
1994 10 01.80	S	9.5	NP	15.0	R	5	25	3	4/			NAG02
1994 10 02.47	M	9.0	AC	25.6	L	4	45	5.3	6			MOR
1994 10 02.48	M	9.5	PC	20	L	6	49					HAL
1994 10 03.47	M	8.9	AC	25.6	L	4	45					MOR
1994 10 03.47	M	9.2	NP	25.6	L	4	45	5	6			MOR
1994 10 04.10	S	8.8	AC	15.0	R	15	85	3	5			DIE02
1994 10 05.12	S	8.7	AC	15.0	R	15	85	3	5			DIE02
1994 10 05.17	S	9.3	S	10.0	B		25	2.1	3			HAS02
1994 10 06.79	S	8.9	S	15.0	R	5	25	3	4/			NAG02
1994 10 07.17	S	8.9	AC	15.0	R	15	85	3	5			DIE02

Periodic Comet Borrelly (1994l) [cont.]

DATE (UT)	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1994 10 07.47	M	8.5	AC	25.6	L	4	45					MOR
1994 10 07.47	M	8.8	NP	25.6	L	4	45	5.7	6	0.25	170	MOR
1994 10 08.12	S	8.6	AC	35	L	5	103	4	6			BRO04
1994 10 08.48	M	8.8	NP	25.6	L	4	45	4.5	6/	0.50	140	MOR
1994 10 09.42	M	9.3	CA	41	L	4	72					HAL
1994 10 09.47	M	8.8	NP	25.6	L	4	45	3.8	7	0.50	120	MOR
1994 10 10.18	S	8.8	AA	35	L	5	103	3	5			BRO04
1994 10 12.44	M	9.0	NP	25.6	L	4	45	4.4	7			MOR

Periodic Comet Schwassmann-Wachmann 2

DATE (UT)	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1993 12 11.04	S	11.4	HS	29.8	L	5	62	1.4	3/			KEI
1993 12 14.01	S	11.0	HS	15.0	B		25	1.3				KEI
1993 12 14.01	S	11.0	HS	29.8	L	5	62	1.3	4/			KEI
1993 12 23.13	S	11.2	HS	29.8	L	5	62	1.7	7			KEI
1993 12 23.13	S	11.2	HS	29.8	L	5	93	1.7	7			KEI
1994 01 04.92	S	11.1	HS	29.8	L	5	62	1.5	6			KEI
1994 01 05.97	S	11.2	HS	29.8	L	5	62	1.5	6			KEI
1994 01 08.96	S	11.1	HS	29.8	L	5	62	1.4	6/			KEI
1994 01 10.95	S	11.0	HS	15.0	B		25	1.5				KEI
1994 01 13.94	S	11.3	HS	29.8	L	5	62	1.2	6/			KEI
1994 01 16.96	S	10.7	AC	15.0	B		25	2.8	6			KEI
1994 01 17.02	S	10.5	AC	10.0	B		20	3.0				KEI
1994 01 30.86	S	10.8	AC	15.0	B		25	1.9	6/			KEI
1994 02 04.90	S	10.7	AC	10.0	B		20	1.7	5			KEI
1994 02 05.88	S	10.8	AC	15.0	B		25	1.7	5/		315	KEI
1994 02 07.85	S	10.7	AC	10.0	B		20	1.7				KEI
1994 02 07.85	S	10.8	AC	15.0	B		25	1.8	6			KEI
1994 02 09.97	S	10.7	AC	10.0	B		20	2.7	6			KEI
1994 02 16.03	S	10.7	AC	10.0	B		20	2.7				KEI
1994 02 27.85	S	10.9	HS	15.0	B		25	1.6	5			KEI
1994 03 02.91	S	11.1	HS	15.0	B		25	1.4	6			KEI
1994 03 03.85	S	11.3	HS	15.0	B		25	1.4				KEI
1994 03 06.00	S	11.8	AC	15.0	B		25	1.2				KEI
1994 03 10.86	S	11.7	AC	15.0	B		25	1.6	1/			KEI
1994 03 11.93	S	11.9	AC	15.0	B		25	1.6	2			KEI
1994 07 05.49	a C	14.6	GA	60.0	Y	6		0.7			115	NAK01

Periodic Comet Reinmuth 2 (1993g)

DATE (UT)	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1994 06 05.77	C	15.8	GA	60.0	Y	6		0.4			240	NAK01
1994 07 07.74	C	15.8	GA	60.0	Y	6		0.4			245	NAK01
1994 07 10.44	S	[13.3	NP	25.6	L	4	156					MOR
1994 07 15.75	C	15.2	GA	60.0	Y	6		0.75		0.03	245	NAK01
1994 08 03.69	C	15.5	GA	60.0	Y	6		0.45		0.03	245	NAK01
1994 08 05.64	C	15.4	HS	20.0	L	6		0.6				IT002
1994 08 07.35	S	13.2	AC	41	L	4	183					HAL
1994 08 07.42	S	[13.3	NP	25.6	L	4	156					MOR
1994 08 10.04	! V	15.3	YF	20.0	T	2		1.5	5			MIK
1994 08 14.42	S	13.4	AC	41	L	4	183					HAL
1994 08 15.72	C	15.2	GA	60.0	Y	6		0.65		0.05	243	NAK01
1994 08 16.08	! V	15.0	YF	20.0	T	2		1.5	5			MIK
1994 09 02.99	S	[13.0	HS	20.3	T	10	167	! 0.5				GAR02
1994 09 03.30	S	[13.3	NP	25.6	L	4	156					MOR
1994 09 03.65	C	15.0	HS	20.0	L	6		0.6				IT002
1994 09 04.01	S	[13.5	AC	20.3	T	10	167	! 0.5				GAR02
1994 09 04.88	O	[13.2	HS	25	L	6	150	! 1				KYS
1994 09 06.98	C	14.7	HS	65	L	4		0.6		0.07	243	PRA01
1994 09 06.98	c	15.9	HS	65	L	4		0.6		0.07	243	PRA01
1994 09 08.71	C	14.6	GA	60.0	Y	6		0.95		0.06	239	NAK01
1994 09 09.33	S	13.5	AC	41	L	4	183					HAL
1994 09 09.62	C	14.8	HS	20.0	L	6		0.6				IT002

Periodic Comet Reinmuth 2 (1993g) [cont.]

DATE (UT)	MM MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1994 09 10.94	S[13.3	AC	20.3	T	10	80	! 0.5				GAR02
1994 09 13.66	C 14.4	GA	60.0	Y	6		1.25		0.05	243	NAK01
1994 10 09.88	S 13.4	GA	44.5	L	5	156	0.5	3			HAS02

Periodic Comet Harrington (1994g)

DATE (UT)	MM MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1994 05 22.77	a C 17.5	GA	60.0	Y	6		0.25			250	NAK01
1994 06 05.76	C 17.2	GA	60.0	Y	6		0.3			240	NAK01
1994 07 07.71	C 16.7	GA	60.0	Y	6		0.3		0.02	245	NAK01
1994 07 15.74	C 16.3	GA	60.0	Y	6		0.4		0.04	248	NAK01
1994 08 03.71	C 16.2	GA	60.0	Y	6		0.4		0.04	248	NAK01
1994 08 07.39	S 13.1	AC	41	L	4	183					HAL
1994 08 14.45	S 13.2	AC	41	L	4	183					HAL
1994 08 15.71	C 15.3	GA	60.0	Y	6		0.55		0.06	250	NAK01
1994 09 03.08	S 13.3	AC	20.3	T	10	80	0.4	3			GAR02
1994 09 03.69	C 14.0	HS	20.0	L	6		0.9				ITO02
1994 09 07.03	S 14.1	AC	44.5	L	4	230	0.8	5/			SAR02
1994 09 07.03	S 14.1	AC	44.5	L	4	230	1	6			BAK01
1994 09 08.72	C 13.7	GA	60.0	Y	6		1.4		0.08	258	NAK01
1994 09 09.42	S 12.9	AC	41	L	4	72					HAL
1994 09 09.65	C 14.6	HS	20.0	L	6		0.7				ITO02
1994 09 11.04	S 13.2	AC	20.3	T	10	80	0.6	2			GAR02
1994 09 13.09	[13 :		33.4	L	4	214					SZE02
1994 09 13.67	C 13.8	GA	60.0	Y	6		1.4		0.08	257	NAK01
1994 10 07.30	M 12.0	NP	25.6	L	4	111	1.9	4			MOR
1994 10 08.28	M 12.0	NP	25.6	L	4	111	1.9	3			MOR
1994 10 09.36	M 12.5	AC	41	L	4	72		4			HAL
1994 10 09.92	S 13.4	HS	44.5	L	5	156	0.5	4			HAS02
1994 10 12.44	M 11.9	NP	25.6	L	4	111	2.0	3			MOR

Periodic Comet Wild 3 (1994b)

DATE (UT)	MM MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1994 04 13.78	C 19.1	GA	60.0	Y	6		0.2				NAK01
1994 05 08.69	C 18.3	GA	60.0	Y	6		0.25				NAK01
1994 05 16.68	C 18.3	GA	60.0	Y	6		0.25				NAK01
1994 06 01.58	C 18.0	GA	60.0	Y	6		0.25				NAK01
1994 07 04.56	a C 18.7	GA	60.0	Y	6		0.2				NAK01
1994 07 06.22	c 21.6	FA	91.4	L	5		0.27				SC001
1994 07 06.23	C 18.8	FA	91.4	L	5						SC001
1994 07 06.28	! S[13.5	AC	41	L	4	183	1				HAL
1994 07 10.20	c 21.4	FA	91.4	L	5		0.30		<0.01	83	SC001
1994 07 10.21	C 18.7	FA	91.4	L	5						SC001
1994 07 13.51	C 18.8	GA	60.0	Y	6		0.22				NAK01

Periodic Comet Bus (1993b)

DATE (UT)	MM MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1994 01 08.79	C 18.6	GA	60.0	Y	6		0.25				NAK01
1994 01 15.81	C 18.5	GA	60.0	Y	6		0.25				NAK01
1994 03 15.69	C 16.5	GA	60.0	Y	6		0.35				NAK01
1994 03 17.61	C 16.3	GA	60.0	Y	6		0.4			290	NAK01
1994 04 08.55	C 17.1	GA	60.0	Y	6		0.35				NAK01
1994 04 13.51	C 17.0	GA	60.0	Y	6		0.35				NAK01
1994 04 30.59	C 17.3	GA	60.0	Y	6		0.3				NAK01
1994 06 01.51	C 17.5	GA	60.0	Y	6		0.35			125	NAK01
1994 07 05.50	a C 18.0	GA	60.0	Y	6		0.3				NAK01
1994 07 08.18	C 18.1	FA	91.4	L	5		0.32		<0.01	121	SC001
1994 07 08.18	c 21.4	FA	91.4	L	5						SC001

Periodic Comet Machholz 2 (component A)

DATE (UT)		MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1994 08 14.02		S	9.1	AA	33.3	L	5	85	5.3	1			SHA02
1994 08 14.38		S	9.9	AC	41	L	4	83		3			HAL
1994 08 14.77		M	8.9	S	16.0	W	4	19		2			TSU02
1994 08 15.08		S	9.8	AA	33.3	L	5	85	1.9	0			SHA02
1994 08 15.77		C	9.8	GA	8.0	R	6		7.7				NAK01
1994 08 15.92		V	11.2	HS	65	L	4		+ 2.0		0.01	300	PRA01
1994 08 15.92		V	11.9	HS	65	L	4		+ 1.3				PRA01
1994 08 15.92		v	16.0	HS	65	L	4		4.5				PRA01
1994 08 15.93		S	9.8:	AC	15.2	L	5	42	4	1			MOE
1994 08 15.97	!	V	11.0	YF	20.0	T	2		& 6	6			MIK
1994 08 15.98		S	9.0	AC	13.0	L	6	36	3.5	1			MEY
1994 08 16.08		M	9.7	TI	13	L	8	69	5	2			HOR02
1994 08 16.23		S	10.5	AA	20	T	10	127	3.5	1			SPR
1994 08 16.90		C	12.9	HS	65	L	4		+ 1.3				PRA01
1994 08 16.90		c	16.2	HS	65	L	4		4.2				PRA01
1994 08 16.99		S	9.1	AC	13.0	L	6	36	3.5	1			MEY
1994 08 17.23		S	10.3	AA	20	T	10	127	2.5	0/			SPR
1994 08 18.04		S	8.6	S	20	R	14	40	3.7	0			SHA02
1994 08 18.04		S	8.8	HS	20	R	14	40	3.7	0			SHA02
1994 08 18.04		S	9.3	AA	20	R	14	40	3.7	0			SHA02
1994 08 19.07		S	8.2	AA	33.4	L	4	61	11	6	0.15	190	SZE02
1994 08 23.07		V	9.1	HS	65	L	4		+ 2.0		>0.14	295	PRA01
1994 08 23.07		V	9.5	HS	65	L	4		+ 1.3		>0.14	295	PRA01
1994 08 23.07		v	12.9	HS	65	L	4		6.0		>0.14	295	PRA01
1994 08 24.08		S	7.8	AA	20	R	14	40	4.5	3			LAN03
1994 08 24.09		S	7.8	AA	8.0	B		10	4	2			LAN03
1994 08 28.12	!	V	8.6	YF	20.0	T	2		& 8	7			MIK
1994 08 28.78		S	8.5	S	15.0	B		25	5	4/			NAG02
1994 08 28.97	!	S	8.4	AA	10	B		14	3.7	2			SHA02
1994 08 29.02		S	8.5	VB	20	R	14	40	3.9	3			SHA02
1994 08 29.05		S	8.5	VB	20	R	14	40	3.5	2			LAN03
1994 08 29.10		S	8.1	AA	33.4	L	4	61	20	6			SZE02
1994 08 30.05		S	7.2	AA	11	L	7	32	8.9	2			BAR06
1994 08 30.05		V	9.6	HS	65	L	4		+ 2.0		0.13	301	PRA01
1994 08 30.05		V	9.9	HS	65	L	4		+ 1.3		0.13	301	PRA01
1994 08 30.05		v	13.4	HS	65	L	4		9.0		0.13	301	PRA01
1994 08 30.08		S	8.3	AA	20	R	14	40	4.5	2			LAN03
1994 08 30.10		S	8.4	TI	11	L	8	32	3.5	2			KYS
1994 09 01.04		S	6.3	AA	11	L	7	32	4.5	6/			BAR06
1994 09 01.80		C	7.4	HS	8.0	R	6		12.4		0.52	299	NAK01
1994 09 02.42		S	7.0	SC	5.0	B		10					HAL
1994 09 02.43		S	8.3	S	33.3	L	4	56	4.2	5	0.12	293	KRO02
1994 09 02.46		Y	5.3	SC	25	T	4		4	4	0.03	303	ROQ
1994 09 03.07		S	6.5	AA	11	L	7	32	8	3			BAR06
1994 09 03.11		S	7.9	S	20	R	14	40	3.9	4			SHA02
1994 09 03.12		S	7.1	VB	8.0	B		10	4.7	4			SHA02
1994 09 03.14		B	7.4	CS	5.0	R		8	7	5			GAR02
1994 09 03.48	a	M	7.4	AA	8.0	B		20	12	7	3.0	290	MOR
1994 09 03.71		S	7.7	S	15.0	R	5	25	4.5	5/			NAG02
1994 09 03.77		C	9.0	HS	20.0	L	6		3.0				ITO02
1994 09 03.79		C	8.2	HS	8.0	R	6		11.1		0.43	298	NAK01
1994 09 03.80		M	7.7	S	3.5	B		7					TSU02
1994 09 04.06		M	8.1	TI	11	L	8	32	3.5	2			KYS
1994 09 04.06		S	6.8	AA	11	L	7	32	6.3	3	0.1	281	BAR06
1994 09 04.06		S	7.2	S	10.0	B		25	4.7	4			HAS02
1994 09 04.06		S	7.8	TI	5.0	B		7	4	2/			KYS
1994 09 04.09		S	7.6	TI	5.0	B		7	4	3			KYS
1994 09 04.14		B	7.4	CS	5.0	R		8	6	5			GAR02
1994 09 04.48	a	M	7.4	AA	8.0	B		20		7	2.5	270	MOR
1994 09 04.76		M	7.1	S	3.5	B		7					TSU02
1994 09 05.07		M	7.1	TI	8.0	B		10	3	6			HOR02
1994 09 05.08		V	7.3	HS	65	L	4		+ 2.0		>0.13	300	PRA01
1994 09 05.08		V	7.7	HS	65	L	4		+ 1.3		>0.13	300	PRA01
1994 09 05.08		v	10.8	HS	65	L	4		>10		>0.13	300	PRA01

Periodic Comet Machholz 2 (component A) [cont.]

DATE (UT)	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1994 09 05.10	S	6.6	S	10.0	B		25	2.9	4			HAS02
1994 09 05.12	S	6.8	AA	5.0	B		7	& 4	8	&1	310	MIK
1994 09 06.10	S	7.5	AC	15	R	15	85	& 5	8			DIE02
1994 09 06.11	S	7.2	AA	5.0	B		7	& 4	6			MIK
1994 09 07.04	S	7.0	AA	11	L	7	32	7.5	4			BAR06
1994 09 07.07	S	7.2	AC	6.0	B		20	5	6/			SAR02
1994 09 07.08				44.5	L	4	146	5	7	0.3	300	SAR02
1994 09 07.08				44.5	L	4	146	6	6	0.3	290	BAK01
1994 09 07.11	S	7.5	AA	5.0	B		7	& 4	6			MIK
1994 09 07.13	S	7.4	VB	8.0	B		10	4.7	3			SHA02
1994 09 07.16	S	7.2	VB	10	B		14	4.9	4			SHA02
1994 09 07.42	M	7.1	AA	7.6	R	12	38	5	4			AUG
1994 09 07.48	M	7.3	AA	8.0	B		20		6			MOR
1994 09 08.06	S	6.8:	AA	11	L	7	32	8.8	4			BAR06
1994 09 08.08	C	9.5	HS	65	L	4		+ 2.0		>0.10	297	PRA01
1994 09 08.08	C	10.0	HS	65	L	4		+ 1.3		>0.10	297	PRA01
1994 09 08.08	S	7.0	AA	11	L	7	40	7.8	4			BAR06
1994 09 08.08	c	13.1	HS	65	L	4		8.5		>0.10	297	PRA01
1994 09 08.09	M	7.6	TI	8.0	B		10	7	4			HOR02
1994 09 08.12	S	7.6	AA	5.0	B		7	& 4	5			MIK
1994 09 08.42	M	7.3	AA	7.6	R	12	38	8	4			AUG
1994 09 08.42	S	7.8	S	33.3	L	4	56	3.2	4	0.09	275	KRO02
1994 09 08.43	S	7.5	S	8.0	B		20	4	5			KRO02
1994 09 09.05	S	7.7	AA	11	L	7	32	6.5	3			BAR06
1994 09 09.11	S	7.3	AA	8.0	B		10	5.0	4			SHA02
1994 09 09.47	S	7.7	SC	5.0	B		10					HAL
1994 09 09.75	S	7.6	S	15.0	R	5	25	3.5	5			NAG02
1994 09 09.77	C	9.4	HS	20.0	L	6		3.0				ITO02
1994 09 10.05	S	7.4:	AA	11	L	7	32	6.5	3			BAR06
1994 09 10.07	S	7.5	AC	13.0	L	6	36	5	5			MEY
1994 09 10.08	M	7.6	TI	8.0	B		10	7	4			HOR02
1994 09 10.12	S	7.9	AA	5.0	B		7	& 4	6			MIK
1994 09 10.51	M	7.5	AA	8.0	B		20		5			MOR
1994 09 11.11	S	7.4	AC	35	L	5	49	7.0	7			BRO04
1994 09 11.12	S	7.2	AC	15	R	15	85	& 5	7			DIE02
1994 09 11.16	S	7.6	AA	30	R	18	95	3.5	5	0.05	35	LAN03
1994 09 11.46	M	7.4	AA	8.0	B		20	5	5	1.33	294	MOR
1994 09 11.78	S	7.7	S	15.0	R	5	25	4	5			NAG02
1994 09 12.11	S	9.2	AA	33.4	L	4	61	10	6/	0.13	300	SZE02
1994 09 13.09	M	8.1	TI	8.0	B		10	7	3			HOR02
1994 09 13.10	S	8.7	AA	33.4	L	4	61	12	6			SZE02
1994 09 13.11	S	7.3	AC	15	R	15	85	& 6	7	&0.50	35	DIE02
1994 09 13.11	S	7.6	AA	15.2	L	5	42	7.5	5			MOE
1994 09 13.11	S	8.2	VB	8.0	B		10	4.7	4			SHA02
1994 09 13.14	S	7.3	AC	35	L	5	49	7.0	7			BRO04
1994 09 13.15	S	8.5	AC	20	R	9	85	3.0	7			CAN03
1994 09 13.80	C	9.3	GA	8.0	R	6		12.7		0.77	296	NAK01
1994 09 14.08	S	7.5	AA	11	L	7	32	7.0	3			BAR06
1994 09 14.08	S	7.6	AC	13.0	L	6	36	5	5			MEY
1994 09 14.79	S	8.3	S	15.0	R	5	25	3.5	5			NAG02
1994 09 15.08	S	7.6	AA	11	L	7	32	7.7	3			BAR06
1994 09 15.36	a S	7.4	AA	8.0	R		20	& 7	5			GRE
1994 09 15.36	S	7.9	S	8.0	R		20	& 7	5			GRE
1994 09 15.77	B	8.6	S	20.0	L	4	40	8	3			OHM
1994 09 16.08	M	8.3	TI	13	L	8	69	4	4			HOR02
1994 09 16.08	S	8.4	AC	33.4	L	4	61	12	7			SZE02
1994 09 16.46	M	8.2	NP	5.0	B		10					HAL
1994 09 17.06	S	7.8	AA	11	L	7	32	7.0	3/			BAR06
1994 09 17.13	S	7.6	AC	15	R	15	85	& 5	7			DIE02
1994 09 18.08	S	7.8	AA	11	L	7	40	7.3	3			BAR06
1994 09 23.11	C	9.8	HS	65	L	4		+ 2.0		>0.10	295	PRA01
1994 09 23.11	C	10.2	HS	65	L	4		+ 1.3		>0.10	295	PRA01
1994 09 23.11	c	14.2	HS	65	L	4		7.0		>0.10	295	PRA01
1994 09 24.50	M	9.0	AA	25.6	L	4	45	4.2	3/			MOR

Periodic Comet Machholz 2 (component A) [cont.]

DATE (UT)	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1994 09 25.49	S	9.0	AA	25.6	L	4	45	4.4	2/			MOR
1994 09 25.83	S	9.4	HS	41.0	L	6	80	4	3			KOB01
1994 09 30.83	S	9.7	HS	41.0	L	6	80	3.5	3			KOB01
1994 10 02.49	S	9.1	AC	20	L	6	49					HAL
1994 10 02.51	M	9.1	AA	25.6	L	4	45	4.6	4			MOR
1994 10 02.81	C	10.5	HS	8.0	R	6		7.5				NAK01
1994 10 02.82	C	10.7	HS	60.0	Y	6		3.9		>0.13	298	NAK01
1994 10 03.49	M	9.2	AA	25.6	L	4	45	4.6	3/			MOR
1994 10 05.14	C	11.6	HS	65	L	4		+ 2.0		>0.11	296	PRA01
1994 10 05.14	C	12.2	HS	65	L	4		+ 1.3		>0.11	296	PRA01
1994 10 05.14	c	15.4	HS	65	L	4		6		>0.11	296	PRA01
1994 10 06.10	S	10.2	AC	33.4	L	4	61	9	1			SZE02
1994 10 06.10	S	10.2	AC	33.4	L	4	61	9	1			SZE02
1994 10 07.51	M	9.6	NP	25.6	L	4	45	4.0	3			MOR
1994 10 08.52	M	9.6	NP	25.6	L	4	45	4.0	3			MOR
1994 10 09.48	S	10.2	AC	41	L	4	72					HAL
1994 10 09.51	M	10.1	NP	25.6	L	4	67	2.9	3			MOR
1994 10 10.10	S	[10.5	AC	33.4	L	4	61					SZE02
1994 10 10.10	S	[10.5	AC	33.4	L	4	61					SZE02
1994 10 10.18	S	10.0	AC	20.3	T	10	51	5.4	3			HAS02
1994 10 12.16	! V	10.8	AA	20.0	T	2		& 6	7/	0.33	285	MIK
1994 10 12.50	M	10.2	NP	25.6	L	4	45	3.1	3			MOR
1994 10 16.51	S	11.0	NP	25.6	L	4	111		2			MOR

Periodic Comet Machholz 2 (component B)

DATE (UT)	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1994 09 03.15	S	[10.1	HS	33.3	L	5	85					SHA02
1994 09 08.79	C	15.9	HS	60.0	Y	6		0.7				NAK01
1994 09 09.16	S	11.1	VB	33.3	L	5	120	1.8	2			SHA02
1994 09 09.47	S	12.0	AC	41	L	4	72		1/			HAL
1994 09 09.77	C	14.1	HS	20.0	L	6		0.9				IT002
1994 09 11.50	S	11.9	NP	25.6	L	4	156	1.4	1/			MOR
1994 09 13.10	S	12.1	AC	33.4	L	4	214	0.2	1			SZE02
1994 09 13.16	S	11.4	VB	33.3	L	5	120	1.7	1			SHA02
1994 09 13.80	a C	14.4	GA	60.0	Y	6		1.75				NAK01
1994 09 24.52	S	12.2	NP	25.6	L	4	156	1.4	1/			MOR
1994 09 25.51	S	12.2	NP	25.6	L	4	156	1.4	1/			MOR
1994 10 02.52	S	12.5:	NP	25.6	L	4	156					MOR
1994 10 02.82	C	13.9	HS	60.0	Y	6		0.9				NAK01
1994 10 03.50	S	12.5:	NP	25.6	L	4	156		1/			MOR
1994 10 07.52	S	13.0:	NP	25.6	L	4	156	0.9	1			MOR
1994 10 09.50	S	13.0:	NP	25.6	L	4	156	0.7	1			MOR

Periodic Comet Machholz 2 (component C)

DATE (UT)	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1994 09 03.79	C	15.6	HS	20.0	L	6		0.6				IT002
1994 09 09.80	C	15.4	HS	20.0	L	6		0.6				IT002
1994 09 11.51	S	12.8:	NP	25.6	L	4	156	1.0	1			MOR

Periodic Comet Machholz 2 (component D)

DATE (UT)	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1994 09 01.80	C	12.5	HS	8.0	R	6		3.1				NAK01
1994 09 02.46	S	11.1	NP	20	L	6	49					HAL
1994 09 03.49	S	11.5	NP	25.6	L	4	111	2.1	1			MOR
1994 09 03.79	C	12.7	HS	8.0	R	6		4.8				NAK01
1994 09 03.79	C	14.8	HS	20.0	L	6		0.9				IT002
1994 09 04.50	S	11.5	NP	25.6	L	4	111	3.0	1			MOR
1994 09 07.11	S	12.6	AC	44.5	L	4	146	1.8	3			SAR02
1994 09 07.11	S	12.8	AC	44.5	L	4	146	2	3			BAK01
1994 09 08.80	C	13.1	HS	60.0	Y	6		1.9				NAK01
1994 09 09.47	S	11.4	AC	41	L	4	72		1/			HAL

Periodic Comet Machholz 2 (component D) [cont.]

DATE (UT)	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1994 09 09.80	C	14.4	HS	20.0	L	6		0.9				IT002
1994 09 11.46	S	11.3	NP	25.6	L	4	67	3.3	1/			MOR
1994 09 13.81	a C	13.1	GA	60.0	Y	6		2.8				NAK01
1994 09 16.09	S	9.7	AC	33.4	L	4	61	9	1			SZE02
1994 09 16.46	S	10.7	PC	41	L	4	72		2/			HAL
1994 09 23.13	C	10.0	HS	65	L	4		+ 2.0		>0.13	291	PRA01
1994 09 23.13	C	10.6	HS	65	L	4		+ 1.3		>0.13	291	PRA01
1994 09 23.13	c	13.4	HS	65	L	4		7.0		>0.13	291	PRA01
1994 09 24.50	M	8.8	AA	25.6	L	4	45	2.1	7			MOR
1994 09 25.50	M	8.6	AA	25.6	L	4	45	2.9	7			MOR
1994 09 25.79	S	9.0	S	15.0	R	5	25	3	4/			NAG02
1994 09 25.83	S	9.0	HS	41.0	L	6	80	3	5	0.08	295	KOB01
1994 09 30.83	S	9.9	HS	41.0	L	6	80	2	3			KOB01
1994 10 02.49	S	9.5	AC	20	L	6	49					HAL
1994 10 02.51	S	9.6	AA	25.6	L	4	45	4.6	2/			MOR
1994 10 02.81	C	11.5	HS	8.0	R	6		4.9				NAK01
1994 10 02.82	C	11.6	HS	60.0	Y	6		3.2		>0.09	293	NAK01
1994 10 03.49	S	9.8	AA	25.6	L	4	45	4.6	2			MOR
1994 10 05.14	C	12.3	HS	65	L	4		+ 2.0		>0.09	291	PRA01
1994 10 05.14	C	12.8	HS	65	L	4		+ 1.3		>0.09	291	PRA01
1994 10 05.14	c	17.6	HS	65	L	4		6		>0.09	291	PRA01
1994 10 07.51	S	10.4	NP	25.6	L	4	45	4.0	1			MOR
1994 10 08.52	S	11.2	NP	25.6	L	4	67	3.6	1			MOR
1994 10 09.48	S	11.0	AC	41	L	4	72					HAL
1994 10 09.51	S	11.3	NP	25.6	L	4	67	2.6	1			MOR
1994 10 12.16	! V	12.2	AA	20.0	T	2		& 4	6			MIK
1994 10 12.50	S	11.3	NP	25.6	L	4	67	1.9	1/			MOR
1994 10 16.51	S	12.2	NP	25.6	L	4	111		0/			MOR

Periodic Comet Machholz 2 (component E)

DATE (UT)	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1994 09 08.80	C	15.8	HS	60.0	Y	6		0.75				NAK01
1994 09 11.50	S	12.2	NP	25.6	L	4	111	2.1	1			MOR
1994 09 13.81	a C	15.7	GA	60.0	Y	6		1.0				NAK01
1994 09 24.51	S	12.8	NP	25.6	L	4	156	0.8	0/			MOR
1994 09 25.52	S	12.8	NP	25.6	L	4	156	0.8	0/			MOR
1994 10 02.52	S	12.8:	NP	25.6	L	4	156					MOR
1994 10 03.50	S	12.8:	NP	25.6	L	4	156		1			MOR
1994 10 09.50	S	13.3:	NP	25.6	L	4	156	0.7	1			MOR

Periodic Comet Brooks 2 (1994j)

DATE (UT)	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1994 05 08.78	a C	18.2:	GA	60.0	Y	6		0.3				NAK01
1994 05 19.77	C	17.8	EC	60.0	Y	6		0.35			240	NAK01
1994 05 22.78	a C	17.7	GA	60.0	Y	6		0.3			250	NAK01
1994 06 05.78	C	17.5	GA	60.0	Y	6		0.3			250	NAK01
1994 07 07.75	C	17.4	GA	60.0	Y	6		0.3			245	NAK01
1994 07 10.45	S	[13.3	NP	25.6	L	4	156					MOR
1994 07 15.76	C	17.3	GA	60.0	Y	6		0.25		0.02	243	NAK01
1994 08 03.72	C	16.7	GA	60.0	Y	6		0.35		0.03	243	NAK01
1994 08 05.71	C	16.5	HS	20.0	L	6		0.6				IT002
1994 08 06.44	S	13.7	NP	25.6	L	4	156	1				MOR
1994 08 07.42	S	[13.7	AC	41	L	4	183	1				HAL
1994 08 07.43	S	[13.7	NP	25.6	L	4	156					MOR
1994 08 14.46	S	13.8	AC	41	L	4	183					HAL
1994 08 15.73	C	16.6	GA	60.0	Y	6		0.4		0.04	250	NAK01
1994 09 03.04	S	[13.3	AC	20.3	T	10	167	! 0.5				GAR02
1994 09 04.43	S	[13.3	NP	25.6	L	4	156					MOR
1994 09 08.76	C	15.9	GA	60.0	Y	6		0.6		0.04	251	NAK01
1994 09 09.40	S	13.9	AC	41	L	4	183					HAL
1994 09 09.67	C	16.7	HS	20.0	L	6		0.4				IT002
1994 09 11.00	S	[13.5	AC	20.3	T	10	167	! 0.5				GAR02

Periodic Comet Brooks 2 (1994j) [cont.]

DATE (UT)	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1994 09 13.69	C	15.8	GA	60.0	Y	6		0.7		0.04	248	NAK01
1994 09 16.44	S	13.8	AC	41	L	4	183					HAL
1994 10 01.00	S	[13.5	AC	44.5	L	4	230					SAR02
1994 10 01.00	S	[13.5	AC	44.5	L	4	230					SAR02

Periodic Comet Reinmuth 1 (1994p)

DATE (UT)	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1994 09 07.35	C	20.5	FA	91.4	L	5						SC001
1994 09 07.40	c	21.8	FA	91.4	L	5		0.15		<0.01	260	SC001

Periodic Comet Russell 2 (1994e)

DATE (UT)	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1994 05 16.71	C	19.3	GA	60.0	Y	6		0.2				NAK01
1994 06 01.60	C	18.7	GA	60.0	Y	6		0.2				NAK01
1994 07 11.54	C	18.5	GA	60.0	Y	6		0.2				NAK01

Periodic Comet Kushida (1994a)

DATE (UT)	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1994 01 13.99	S	9.8	AC	10.0	B		20	3.9	2/			KEI
1994 01 14.06	S	9.6	HS	5.0	B		10	5.9				KEI
1994 01 14.06	S	9.6	HS	10.0	B		20	4.9	2			KEI
1994 01 17.02	S	9.7	AC	10.0	B		20	6.8	1/			KEI
1994 01 21.10	S	9.6	AC	10.0	B		20	7.5	3			KEI
1994 02 04.92	S	9.4	AC	10.0	B		20	4.6	3			KEI
1994 02 05.95	S	9.0	AC	3.2	B		6	6.9				KEI
1994 02 05.95	S	9.1	AC	5.0	B		10	6.9				KEI
1994 02 05.95	S	9.2	AC	10.0	B		20	5.8	2			KEI
1994 02 07.99	S	9.0	AC	5.0	B		10	5.8	3			KEI
1994 02 07.99	S	9.1	AA	10.0	B		20	5.8	3			KEI
1994 02 09.98	S	9.1	AC	10.0	B		20	4.6	3			KEI
1994 02 16.02	S	9.1	AA	10.0	B		20	4.6	2/			KEI
1994 03 02.91	S	9.1	AA	10.0	B		20	4.4	3			KEI
1994 03 03.92	S	9.4	AC	10.0	B		20	5.5	3			KEI
1994 03 05.95	S	9.4	AC	10.0	B		20	4.4	1/			KEI
1994 03 07.03	S	9.5	AC	10.0	B		20	5.0	2/			KEI
1994 03 10.88	S	10.2	AC	10.0	B		20	3.6	1/			KEI
1994 03 11.95	S	10.6	AC	10.0	B		20	2.9	1			KEI
1994 03 11.95	S	10.8	AC	15.0	B		25	2.4	2			KEI
1994 03 13.88	S	11.1	AC	15.0	B		25	2.8	2			KEI
1994 03 16.98	S	11.2	AC	15.0	B		25	3.5	2			KEI
1994 07 05.18	c	22.7	FA	91.4	L	5		0.22				SC001
1994 07 05.19	C	19.7	FA	91.4	L	5						SC001

Periodic Comet Schaumasse (1992x)

DATE (UT)	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1993 02 26.90	S	8.5:	AA	10.0	B		20	10.4	0			KEI
1993 03 18.84	S	7.5:	AA	5.0	B		10	8.4				KEI

Periodic Comet Maury (1994h)

DATE (UT)	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1994 05 19.76	C	17.1	EC	60.0	Y	6		0.35			240	NAK01
1994 07 07.72	C	18.1	GA	60.0	Y	6		0.25			245	NAK01
1994 07 09.43	c	21.8	FA	91.4	L	5		0.30		&0.02	241	SC001
1994 07 09.44	C	17.7	FA	91.4	L	5						SC001
1994 08 03.66	C	18.4	GA	60.0	Y	6		0.25			240	NAK01
1994 08 17.71	C	17.9	GA	60.0	Y	6		0.35			245	NAK01
1994 09 08.68	C	17.4	GA	60.0	Y	6		0.4			255	NAK01

Periodic Comet Helin-Roman-Crockett (1988 XIII)

DATE (UT)	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1994 09 06.34	c	22.0	FA	91.4	L	5		0.20				SC001
1994 09 06.36	C	19.8	FA	91.4	L	5						SC001

Periodic Comet Schwassmann-Wachmann 1

DATE (UT)	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1993 01 22.55	P	14 :		16.0	H	3			9			KON03
1993 01 22.57	P	15 :		20	L	5		< 0.2	8/			TSU02
1993 01 22.69	P	13.5:		20	L	5		0.2	9			OTO
1993 01 26.58	P	14.5:		20	L	5		0.3	4			TSU02
1993 02 10.42	P	13.0:		20	L	5		1.5	3			OTO
1993 02 12.50	P	13 :		16.0	W	4		< 0.2	9			TSU02
1993 02 13.53	P	12.5:		16.0	W	4		0.3	7			TSU02
1993 02 15.43	P	12.7:		16.0	H	3		0.7	6			KON03
1993 02 15.54	P	13.5:		20	L	5		1	4			OTO
1993 02 19.56	P	13 :		16.0	W	4		0.6	3			TSU02
1993 02 20.50	P	12.5:		16.0	H	3		1	5			KON03
1993 02 24.51	P	13.5:		16.0	H	3		1.5	3			KON03
1993 03 10.45	P	13 :		20	L	5		0.6	3			TSU02
1993 03 13.49	P	13 :		20	L	5		1	2			TSU02
1993 03 18.45	P	13.5:		16.0	H	3		2	2			KON03
1993 04 09.46	P	14.5:		20	L	5		1.2	1			OTO
1993 04 14.48	P	12.5:		16.0	W	4		0.4	8			TSU02
1993 05 15.49	P	[15 :		16.0	W	4						TSU02
1993 09 16.81	P	[15 :		20	L	5						TSU02
1993 09 25.79	P	[15 :		20	L	5						TSU02
1993 10 13.79	P	15 :		16.0	W	4		0.3	5			TSU02
1993 10 26.79	P	15 :		20	L	5		0.2	2			OTO
1993 10 27.81	P	13 :		20	L	5		0.2	9			OTO
1993 11 09.67	P	13 :		25	L	4		1.5	4			KON03
1993 11 09.75	P	12.5:		20	L	5		1	2			OTO
1993 11 09.75	P	13.5:		20	L	5		1	2			OTO
1993 11 15.61	P	13 :		16.0	W	4		1.2	1			TSU02
1993 11 15.71	P	15 :		20	L	5		1	0/			OTO
1993 12 10.68	P	14.5:		21.0	H	3		3	2			OTO
1993 12 12.54	P	15.5:		16.0	W	4		0.5	3			TSU02
1993 12 15.75	P	15 :		21.0	H	3		3	1			OTO
1994 09 13.12	&	[13 :		33.4	L	4	214					SZE02
1994 09 16.11	&	[13 :		33.4	L	4	214					SZE02
1994 10 12.13	! V	14.9	AA	20.0	T	2		& 1	4			MIK
1994 10 16.14	! V	14.6	AA	20.0	T	2		& 1	4			MIK

Periodic Comet Shoemaker-Levy 9 (1993e)

DATE (UT)	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1994 05 27.89	S	13.7	GA	28	T	6	93	0.4	8			FOG
1994 07 06.26	! S	[13.5	AC	41	L	4	183					HAL

Periodic Comet Helin-Lawrence (1993l)

DATE (UT)	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1994 08 03.64	C	17.3	GA	60.0	Y	6		0.3			250	NAK01
1994 08 15.69	C	16.8	GA	60.0	Y	6		0.35			255	NAK01
1994 09 08.56	C	16.9	GA	60.0	Y	6		0.35			255	NAK01
1994 09 25.50	a C	17.2	GA	60.0	Y	6		0.35				NAK01

Periodic Comet Shoemaker 4 (1994k)

DATE (UT)	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1994 07 02.58	C	15.9	GA	60.0	Y	6		0.55				NAK01
1994 07 07.58	a C	16.1	GA	60.0	Y	6		0.4				NAK01
1994 07 13.55	C	16.0	GA	60.0	Y	6		0.5				NAK01
1994 08 26.50	C	17.1	GA	60.0	Y	6		0.25				NAK01

The Light Curve of Periodic Comet Wirtanen

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Abstract. The light curve of Periodic Comet Wirtanen has been analyzed for the 1986 and 1991 apparitions, the only two monitored by visual observers. The comet's light curve displays a rapid rise of the order of five magnitudes between 73 and 45 days prior to perihelion. From 45 days pre-perihelion to ~ 16 days post-perihelion, the comet brightens at a rate of approximately 0.022 magnitude per day. After reaching peak brightness, the comet fades by ~0.031 mag per day. The comet's intrinsic brightness was 0.5-0.7 mag fainter during the 1991 apparition than in 1986. There are indications that this comet may have experienced brightness flares of about one magnitude in 1986.

Periodic Comet Wirtanen (P/Wirtanen) was discovered photographically as a 17th-magnitude object on 1948 January 15 by Carl A. Wirtanen (Lick Observatory, California). As summarized by Kronk (1984), the comet remained faint, never becoming brighter than 15th magnitude, during the apparitions prior 1986. P/Wirtanen has had two recent close approaches to Jupiter, one in 1972 and another in 1984. This reduced the comet's perihelion distance (q) from 1.61 to 1.26 AU and then to 1.08 AU. The final reduction in q brought the comet within reach of the visual observer. As a result, the comet was observed visually by a number of observers both in 1986 and 1991. The physical properties of P/Wirtanen are of considerable interest, because it is a potential target of the European Space Agency's Rosetta mission. This paper summarizes the light curves of P/Wirtanen from the 1986 and 1991 apparitions.

The Magnitude Data

All of the magnitude data used in this study, with the exception of four estimates, were obtained from *The International Comet Quarterly* (*ICQ* Numbers 58-60; 62-63 for the 1986 apparition; and 80-82 and 84 for the 1991 apparition). In addition to the *ICQ* data, a single visual estimate for the 1986 apparition — not reported in the *ICQ* — was obtained from J. Bortle (private communication and also published on *IAUC* 4193). In addition, the photographic recovery magnitudes from 1985 and 1991 were obtained from *IAUCs* 4139 and 5303, respectively.

The two apparitions required different approaches for the selection of observations. For the 1991 apparition (1991 XVI = 1991s), a standard approach was used of selecting those observers having made a specified minimum number of magnitude estimates. For P/Wirtanen 1991 XVI, a minimum of five magnitude estimates (made on different nights) were required. The advantage of this approach is that the observations of different observers can be compared over time. Observer biases can be estimated and corrected. A total of 60 observations made by seven observers met the selection criterion. Two photographic recovery magnitudes, made by Seki, were also included. Thus, a total of 62 observations were selected for the study. The observers are summarized in Table 1.

The 1986 apparition (1986 VI = 1985q) posed a more difficult data selection problem. Fewer observations were made during this earlier apparition. In large measure, this was because P/Halley was at its peak brightness during P/Wirtanen's period of visibility. Many observers who would have followed P/Wirtanen were travelling to observe P/Halley. In fact, only 11 observations, made by two observers, would have qualified using the criteria applied in the 1991 apparition data selection. This is insufficient to fully document the apparition. It was decided to accept all reasonably consistent observations. In all, 29 observations by 10 observers were selected. In addition, the photographic recovery (nuclear, m_2) magnitude estimate by Gilmore and Kilmartin was also used, bringing the total number of observations to 30. *Table 1* lists the observers.

It is interesting to note that five observers provided data for both apparitions. [A sixth observer (Keen; *ICQ* observer code KEE) also observed the comet during both apparitions, but made only one observation in 1991.] In every case, the same instrumentation was used for both apparitions.

Data Analysis

The 1991 apparition of P/Wirtanen was evaluated first because of the greater number of observations. Two approaches were tried initially. These included applying no aperture correction to the magnitude estimates and using the standard-aperture corrections suggested by Morris (1973). Both approaches resulted in about a one magnitude scatter and neither were considered completely satisfactory.

To improve the light curve, individual observer corrections were derived by intercomparing the observations of different observers. The derived corrections are listed in *Table 1* and the resulting light curve is shown in *Figure 1a*. The scatter in the light curve has been reduced to about half a magnitude. An exception is the four pre-perihelion (pre-T) points that are about one magnitude brighter than the other observations. These observations are all by a single observer (Nakamura, NAK01), his only pre-T data. Although Nakamura's pre-T observations are not consistent with

(text cont. on page 180)

Table 1. Summary of P/Wirtanen Observers

Observer	Number of Observations 1986 VI	Number of Observations 1991 XVI	Personal Correction (magnitude)
J. E. Bortle (BOR)	1	5	+0.3
R. J. Bouma (BOU)	6	-	0.0 a
A. C. Gilmore/P. M. Kilmartin	1	-	0.0 a,p
A. Hale (HAL)	3	9	-0.1
W. Hasubick (HAS02)	2	-	0.0 a
R. A. Keen (KEE)	2	(1)	0.0
V. L. Korneyev (KOR01)	-	14	+0.2
J. Linder (LIN02)	1	-	0.0 a
J. C. Merlin (MER)	1	-	0.0 a
R. J. Modic (MOD)	-	6	0.0 s
C. S. Morris (MOR)	5	9	0.0
W. C. Morrison (MOR03)	4	8	-0.4
A. Nakamura (NAK01)	4	9	0.0
T. Seki	-	2	0.0 a,p
Total	30	62	

Notes:
[a]A correction of 0.0 is assumed.
[p]Photographic magnitude estimate. The Seki estimates are total magnitudes (m_1). The Gilmore and Kilmartin estimate is a nuclear magnitude (m_2). Photographic magnitudes are typically fainter than corresponding visual estimates.
[s]Modic's last observation, at $t = +82$ days, was made with a larger instrument. This observation was corrected -0.6 mag, based on Modic's own intercomparisons with his smaller telescope.

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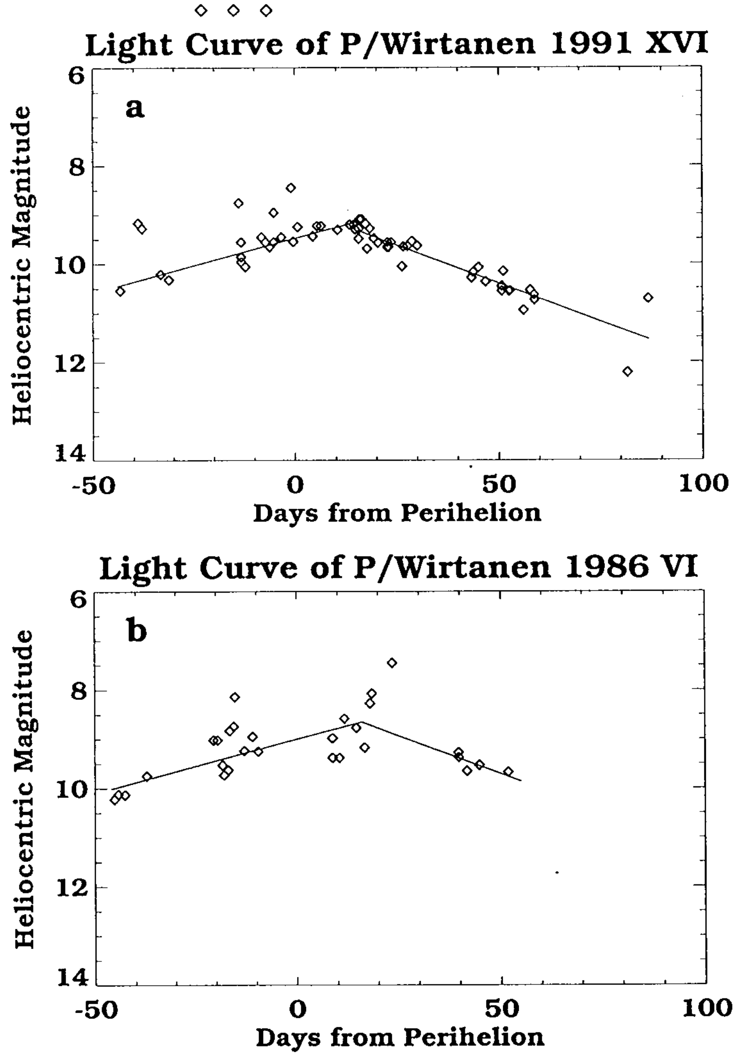

Figure 1.

(text cont. from page 178) other observers, his post-T data are in good agreement with the other magnitude estimates. Using information supplied by Nakamura (private communication), possible systematic differences (*e.g.*, comparison stars, observing location, *etc.*) in his pre- and post-T estimates were investigated. However, the reason for the discrepancy in Nakamura's pre-T data remains a mystery. It is possible, but seems unlikely, that all these observations represent brightness flares. Nakamura (private communication) reports that his field notes do not indicate anything in the comet's morphology to suggest brightness flares at the time of his observations.

It was not possible, due to the small number of observations, to derive observer-specific corrections for the 1986 analysis. Instead, the corrections obtained for the 1991 apparition were used for those observers who observed the comet at both apparitions. This approach gave acceptable results. A correction for Keen was estimated using his single 1991 observation. All other observers were assumed to require no correction. The light curve for the 1986 apparition is depicted in *Figure 1b*. As will be discussed below, there is a suggestion that P/Wirtanen experienced flares in brightness in 1986. However, the brightest observation (at $t = +24$ days, where t is the time in days from T) was the only magnitude estimate made by Linder (LIN02). Thus, there is no way to calibrate this observation to know whether the comet was really this bright. (A comparison of Linder's observations of other comets made during the same period indicates that his magnitude estimates are reasonably consistent with other observers.) This illustrates the difficulty when only one or two observations are available from a given observer.

Interpretation of the Light Curves

The light curve constructed from the 1991 observations (*Figure 1a*) clearly shows that the comet reaches peak brightness about 16 days after T. Prior to reaching its maximum brightness, the comet is brightening at a rate of ~0.022 (+ 0.003 standard error) mag per day (based on a linear regression). The decline in brightness (0.031 + 0.003 mag per day) is steeper. The 1991 heliocentric magnitude data (excluding Mr. Nakamura's pre-T observations) can be represented by the following formulae:

Time from Perihelion (days)	
-43 to $+16$	$9.13 - 0.022(t - 16)$
$+16$ to $+87$	$9.34 + 0.031(t - 16)$

This fit is shown in *Figure 1a*. These equations do not have the same value at $t = +16$ days, because there is approximately a 0.5-mag drop in brightness between $t = +16$ and $+20$ days.

The linear regression results for the 1986 apparition show a rise in brightness of 0.019 (+0.005) mag per day and a decline of 0.037 (+0.010) mag per day, excluding the apparent flare at $t = +24$ days. These values are within errors of 1991 parameters. Because the 1991 parameters are better determined, these have been adopted to represent the 1986 data in the formulae below and in *Figure 1b*.

Time from Perihelion (days)	
-45 to $+16$	$8.65 - 0.022(t - 16)$
$+16$ to $+52$	$8.65 + 0.031(t - 16)$

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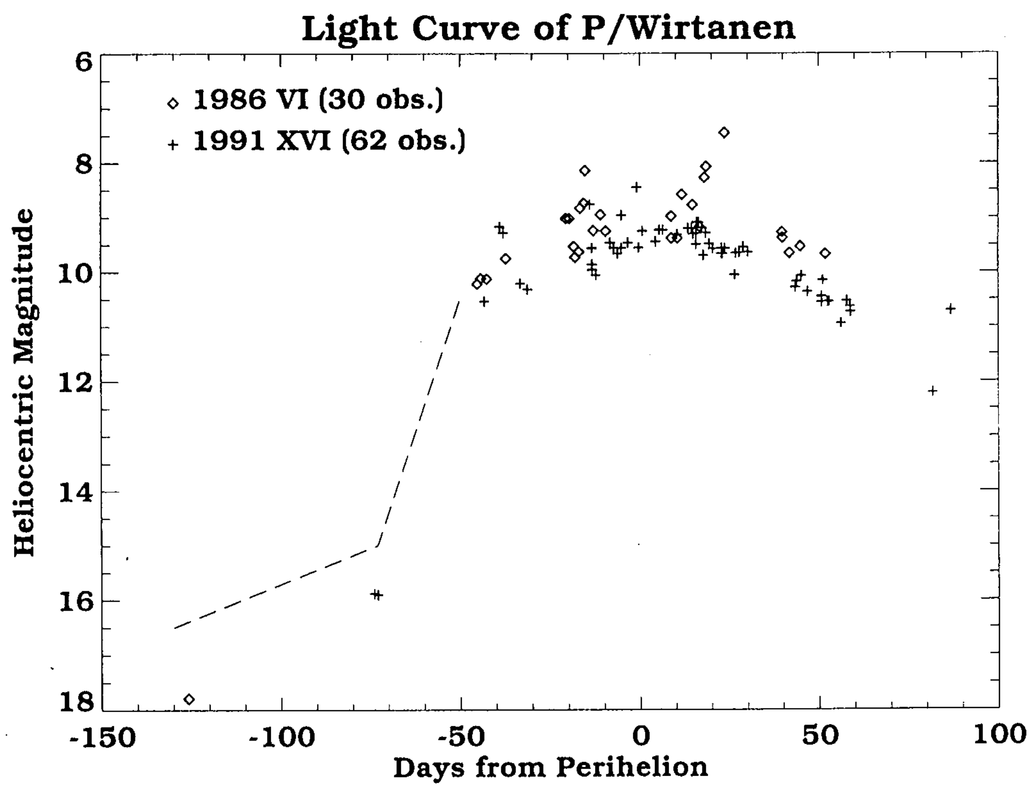

Figure 2.

Clearly, the comet was 0.5-0.7 mag brighter than in 1991. A decrease in intrinsic brightness during the first few apparitions at a closer q is not unexpected.

The question as to whether or not this comet experiences significant brightness flares (> 0.5 mag in amplitude) is unresolved. There is no conclusive evidence in the 1991 apparition to support this possibility. However, in the 1986 apparition there are indications that flares or longer-period brightenings may have occurred. The most obvious example is the Linder observation at $t = +24$ days. Just prior to that, there are two observations at $t \simeq +18$ days by Bouma (BOU) and Hasubick (HAS03) that are significantly brighter than their other observations. In Hasubick's case, the comet brightened by more than a magnitude in eight days. There is one complication. This is the only observation for which each observer used binoculars. The other possible flare occurred at $t = -15$ days. Using the same instrument, Keen found the comet's heliocentric magnitude to be 0.8 mag brighter than when observed 24 days later. (The comet should have brightened during this period instead of fading.)

The Composite Light Curve

Figure 2 shows a composite light curve with data from both apparitions included. In addition to the visual estimates, the photographic-recovery observations are displayed. The dashed line in *Figure 2* depicts the estimated light curve prior to the visual observations. Rather than a smooth increase in brightness, P/Wirtanen apparently undergoes a very rapid brightening between $t = -73$ and $+45$ days. The comet's intrinsic brightness increases by a factor of ~100 during this four-week period. This is preceded by a more gradual brightening.

Summary

It has been demonstrated that the light curve of P/Wirtanen is quite complex. This comet displays a rapid pre-T surge in brightness, followed by a more gradual brightening until $t \simeq +16$ days. A somewhat steeper falloff then follows. Although not conclusive, there is evidence to support the possibility of brightness variations in 1986 of more than 0.5 magnitude. In 1991, there was a 0.5-mag fading between $t = +16$ and $+20$ days, which was possibly associated with the shutdown of a vent on the nucleus. In general, the slopes of the two light curves agree. However, the comet's intrinsic brightness faded 0.5-0.7 mag from 1986 to 1991.

The author thanks Akimasa Nakamura for providing details of his 1991 observations and John E. Bortle for supplying his 1986 observation. This work was performed at the Jet Propulsion Laboratory, California Institute of Technology, under contract with the National Aeronautics and Space Administration.

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PERIODIC COMETS FOR THE VISUAL OBSERVER IN 1995

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Visual comet observers should find 1995 to be a moderately busy year, with at least two or three short-period comets becoming bright enough for observation with binoculars, one or two additional objects within range of small telescopes, and several others that may become accessible to larger instruments. Ephemerides for all of the following objects are given in the *ICQ 1995 Comet Handbook* (Nakano and Green 1994).

THE BRIGHTER COMETS

P/Borrelly 1994l. Having already passed perihelion on 1994 November 1 ($q = 1.365$ AU) under favorable circumstances, this comet begins 1995 well placed in the morning sky, near a declination (δ) of +59°, and probably as bright as m_1 ~8-9. It will likely fade by perhaps 1-2 magnitudes by the time it is at opposition in early February, by which time it will have moved north to $\delta = +69°$ and will be located 5° west of the galaxy M81. Following this, the comet will begin moving south and will probably fade fairly rapidly, dropping below the threshold for visual observations by about the end of March.

P/Clark. With an orbital period of almost exactly $5\frac{1}{2}$ years, successive returns of this comet alternate between favorable and unfavorable, with the viewing conditions at each return being almost identical to those of two returns previous. The 1995 return (perihelion May 31, $q = 1.553$ AU) is thus very similar to those in 1973 (discovery) and 1984. During 1984 several visual observations of the comet were obtained, and a peak brightness of $m_1 \sim 10\frac{1}{2}$ was reached. A similar peak brightness may thus be expected for 1995.

If P/Clark does behave similarly to its 1984 return, visual observations, at m_1 ~12, should commence about April. Peak brightness should occur in late June and early July, as the comet approaches opposition in late July. Afterward, visual observations should remain possible through August and into early September. Although observations should be possible from both hemispheres, observers in the southern hemisphere are favored, since the comet remains in the southern sky throughout the apparition; a peak southerly declination of −41° will be reached in early August.

P/d'Arrest. The 1995 return of this comet is very favorable, being the best since 1976. During the 1976 return, the comet came to within 0.15 AU of the earth and reached a peak brightness of 5th magnitude. The perihelion date in 1995 (July 27) is 16 days earlier than that in 1976 — but more importantly, the comet's present perihelion distance (q = 1.346 AU) is somewhat larger than it was then (1.164 AU). Thus, P/d'Arrest is unlikely to reach naked-eye visibility in 1995, but it should become easily visible in small binoculars.

It has been well documented at previous returns that P/d'Arrest exhibits a strongly-asymmetric light curve with respect to perihelion, being significantly brighter after perihelion than it is at a corresponding time before. Based upon an analysis by Bortle (1983a), who examined both the 1976 and 1982 returns, the comet should become visually accessible (at $m_1 \sim 12\frac{1}{2}$-13) by about mid-June, brightening to 10th magnitude by early July and to 8th magnitude by the time of perihelion. The closest approach to Earth occurs in early August at Δ = 0.41 AU, and the comet should reach its peak brightness of $m_1 \sim 6.5$ at about the same time. After this, the comet should commence a slow fading, growing more diffuse as it does so, while at the same time traveling south. A peak southerly declination of −35° will be reached when the comet is at opposition in early October, by which time it will probably have faded to $m_1 \sim$ 8-9. Visual observations may be possible until about the end of 1995, although by that time the comet will be very diffuse, and observations will be quite difficult.

P/Honda-Mrkos-Pajdušáková. Perihelion passage for this comet occurs on December 25, at q = 0.532 AU. It will be accessible in the evening sky during December, brightening from ~ 12th magnitude near the beginning of the month to ~ 8th magnitude (possibly 7th) around perihelion passage. The comet's elongation will remain near 40° during most of this period, although this drops to near 30° by perihelion. Visibilitity will cease at about the end of the month, as the comet enters the solar glare. After inferior conjunction occurs in mid-January 1996, the comet enters the morning sky near the end of that month, and subsequently passes 0.17 AU from the earth in early February. Observations of the comet at previous returns suggests that it exhibits a relatively steep light curve, and it will probably be no brighter than $m_1 \sim$ 8-10 when it is closest to Earth.

THE FAINTER COMETS

P/Schwassmann-Wachmann 1. This object emerges into the morning sky about September 1994, is at opposition in early February 1995, and thereafter remains in the evening sky until about June. It again emerges into the morning sky about October, enroute to another opposition in late February 1996. The comet appeared to remain in a state of low outburst ($m_1 \sim 13$) throughout much of the 1993-94 opposition, and observers should be on the lookout for a continuation of such activity during the 1994-95 and 1995-96 viewing seasons.

P/Tuttle-Giacobini-Kresák. This comet is at perihelion on July 28, at q = 1.065 AU. The 1995 return of this object is rather unfavorable, with the elongation remaining near 40° (in the evening sky) around the time of perihelion passage. Since the comet will be south of the sun, any successful visual observation attempts will probably be limited to the southern hemisphere. The comet is not expected to become any brighter than 13th magnitude, although since two significant outbursts (each 9- to 10-mag strong) were observed at the 1973 return the possibility of an enhanced brightness does exist. No such activity has been observed on any subsequent return, and it should be noted that in 1984 the comet passed through perihelion under geometry virtually identical to that in 1995 without being recovered.

P/Schwassman-Wachmann 3. Perihelion passage for this comet is expected to occur on September 22, at q = 0.933 AU. Viewing geometry at the 1995 return is somewhat similar to that in 1979, the comet's first observed return since its discovery in 1930. The comet reached a peak brightness of 12th magnitude in 1979, and thus a similar peak brightness may be expected to occur in September and October 1995. Because the comet remains near an elongation of 40° (in the evening sky) and is well south of the sun throughout the period of visibility, successful observations will probably be restricted to observers in the southern hemisphere.

P/Jackson-Neujmin. This comet was reported to be 12th magnitude when discovered in 1936, but it has not been especially well observed since then; thus brightness predictions for the 1995 return are necessarily uncertain. The 1995 perihelion date (October 6) is only 3 days later than that in 1936, and since the perihelion distance is now somewhat smaller (1.381 AU, *vs.* 1.463 AU in 1936) it would seem that visual observations should be possible at this return. If the comet follows a "normal" light curve the period of visibility may extend from perhaps late July until late November, with peak brightness occurring toward the end of September. The comet is at opposition in mid-August.

P/Churyumov-Gerasimenko. This comet passes perihelion on 1996 January 17, at q = 1.300 AU. While the 1995-96 return is not especially favorable, visual observations should be possible — although the comet will remain rather faint. The comet will already have passed through opposition at the end of August, thus will be in the evening sky throughout its period of visibility.

From observations made at the favorable and well-observed return in 1982, Bortle (1983b) determined that the comet's peak heliocentric brightness occurs almost 2 months after perihelion. Applying Bortle's formula to the current return suggests that the comet will become visually observable (at about 13th magnitude) near the end of November, brightening to $m_1 \sim 12.5$ by the end of the year. It should gain perhaps another half-magnitude by the time it reaches peak brightness around February 1996.

(2060) Chiron. This object emerges into the morning sky during the last two months of 1994, enroute to opposition in mid-March 1995, after which it will remain in the evening sky until about July. This is the last opposition to occur prior to perihelion passage, which takes place on 1996 February 14 ($q = 8.454$ AU). Chiron should be at least 15th magnitude, and thus within range of larger visual instruments, around the time of opposition. While it will probably appear starlike, suitably equipped observers may wish to attempt viewing the faint coma which has been imaged with larger telescopes during the past several years. Observers may also wish to monitor the object for small outbursts (~1 mag) which have occasionally been exhibited in the past.

Following solar conjunction, Chiron should again be visible after it emerges into the morning sky about the beginning of December. Opposition will occur at the end of March 1996.

REFERENCES

Bortle, J. E. (1983a). *Sky Tel.* **65**, 565

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Φ Φ Φ

The Last 25 Comets to Receive Provisional Letter Designations

Listed below, for handy reference, are the last 25 comets which have been given letter designations (1989a is the first comet to be discovered/recovered in 1989, 1989b is the second comet..., etc.). After the "equal sign" is given the name, preceded by a star (⋆) if the comet is a new discovery (compared to a recovery from predictions of a previously-known short-period comet); a 'sharp' sign (#) is used to indicate a 're-discovery' of a comet that had been lost for many years (or one significantly off from the prediction). Also given are such values as the orbital period (in years) for periodic comets, date of perihelion, T (month/date/year), and the perihelion distance (q, in AU). Four-digit numbers in the second-to-last column indicate the *IAU Circular* containing the discovery/recovery announcement. The last column lists the 3-digit code for short-period comets as used internally in archival data (first 3 characters), and which should be used by those observers contributing data in computer-readable form. [This list updates that in the July 1994 issue, p. 123.]

Desig.			*Comet*	*P*	*T*	*q*	*IAUC*	P/ code
1993p	=	⋆	Mueller		3/26/94	0.97	5846	
1993q	=		P/Urata-Niijima	6.6	7/13/93	1.46	5882	639
1993r	=	#	P/Spitaler	7.1	1/28/94	2.1	5885	605
1993s	=	⋆	P/Mueller 5	13.8	9/10/94	4.3	5891	955
1993t	=	⋆	P/Kushida-Muramatsu	7.4	12/7/93	2.7	5903	649
1993u	=		P/Wiseman-Skiff	6.5	6/4/93	1.5	5908	641
1993v	=	⋆	McNaught-Russell		3/31/94	0.87	5910	
1994a	=	⋆	P/Kushida	7.3	12/12/93	1.4	5918	731
1994b	=		P/Wild 3	6.9	7/21/94	2.3	5933	632
1994c	=	⋆	Mueller		12/16/93	1.9	5948	
1994d	=	⋆	Shoemaker-Levy		5/27/94	1.16	5962	
1994e	=		P/Russell 2	7.4	10/27/94	2.3	5967	719
1994f	=	⋆	Takamizawa-Levy		5/23/94	1.35	5974	
1994g	=		P/Harrington	6.8	8/23/94	1.57	5982	623
1994h	=		P/Maury	8.7	3/18/94	2.0	5984	810
1994i	=	⋆	Takamizawa		6/28/94	1.95	5986	
1994j	=		P/Brooks 2	6.9	9/1/94	1.8	5988	702
1994k	=	⋆	P/Shoemaker 4	15.4	10/31/94	2.9	5991	956
1994l	=		P/Borrelly	6.9	11/1/94	1.4	6009	610
1994m	=	⋆	Nakamura-Nishimura-Machholz		7/10/94	1.2	6013	
1994n	=	⋆	P/McNaught-Hartley	20.7	12/7/94	2.5	6014	957
1994o	=	⋆	P/Machholz 2	5.2	9/18/94	0.75	6053	650
1994p	=		P/Reinmuth 1	7.3	9/3/95	1.9	6072	707
1994q	=		P/Longmore	7.0	10/9/95	2.4	6084	629
1994r	=	⋆	Machholz		10/3/94	1.8	6091	