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Photograph of Comet Mrkos 1957 V, taken by Alan McClure in California on 1957 August 19, 9-minute exposure beginning at 9:49 Pacific Daylight Time. (Print provided courtesy Dennis Milon, *Sky and Telescope*.)

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Manuscripts will be reviewed for possible publication; send typed, double-spaced copy to the Editor (Cambridge address above). Cometary observations also should be sent to the Editor in Cambridge.

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THE ASTROMETRY NETWORK OF THE INTERNATIONAL HALLEY WATCH

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INTRODUCTION

A most exciting period of cometary exploration is nearly upon us. Halley's comet will pass perihelion on 1986 Feb. 9, and a month later it will be met by a fleet of five international spacecraft. Periodic comet Giacobini-Zinner will pass perihelion on Sept. 5, 1985, and 6 days later will be met by a spacecraft that has been renamed the International Cometary Explorer (ICE). P/Halley is the only comet showing the full range of cometary phenomena and whose returns can be accurately predicted; P/Giacobini-Zinner is a peculiar comet and one of the few short-period comets exhibiting a pronounced tail near perihelion. Both comets will be extensively studied by ground-based observers and interplanetary spacecraft. The Soviets are planning two identical VEGA spacecraft that will fly through P/Halley after an en-route flyby of Venus in June 1985. The Japanese are sending two spacecraft that will fly by Halley's comet, and the ESA (European Space Agency) is sending its Giotto spacecraft to pass near the comet's nucleus. All five P/Halley spacecraft will encounter the comet in the period 1986 Mar. 8-14.

The International Halley Watch (IHW) is an established group of more than 800 professional and 2000 amateur astronomers, in 47 countries, dedicated to making coordinated observations of P/Halley during the current apparition. While the IHW was originally established only for P/Halley observations, at least some of the Halley Watch activities have been extended to include P/Giacobini-Zinner, as well. The two lead centers for the IHW are located at the Jet Propulsion Laboratory (under the direction of Ray L. Newburn, Jr.) and at the Remeis Observatory in Bamberg, West Germany (under the direction of Juergen Rahe).

THE ASTROMETRY NETWORK OF THE IHW

As one of the seven observing networks within the IHW, the Astrometry Network is charged with providing the accurate astrometric data on the comet's position that will be used to generate orbits and ephemeris information for ground-based observers and for the Japanese, Soviet, and European P/Halley spacecraft projects. The Discipline Specialists for Astrometry are Richard M. West (European Southern Observatory, Munich, West Germany), Brian G. Marsden (Smithsonian Astrophysical Observatory), Robert S. Harrington (U. S. Naval Observatory), and the present author. As of this writing, there are over 176 Astrometry Network members from 35 different countries.

With none of the P/Halley spacecraft capable of on-board navigation, the accuracy of the comet-spacecraft flybys is primarily dependent upon the comet's ephemeris accuracy. Hence, it is accurate ground-based observations of P/Halley that will be used to reduce the positional uncertainty of the comet-spacecraft encounters in March 1986. Unfortunately, the comet itself will be hidden behind the sun, near perihelion, from late January until late February. Hence, the important ground-based data taken in the few days between post-perihelion recovery and the last mid-course maneuver of each spacecraft is extremely critical. It is this last bit of accurate astrometric data that will permit a fine tuning of P/Halley's orbit, allowing one last spacecraft maneuver to be made before the final flyby of each spacecraft.

In late February and early March 1986, some observers will be asked to transmit their astrometric positions quickly to the orbit-determination center at JPL; experienced astrometric observers with on-site reduction and data communication facilities will reduce and communicate their important data within hours of taking the plates at the telescope. After verifying, weighting, and cataloguing these observations, we will update the existing orbit; the improved orbit and the observational data on which it was based will then be rapidly communicated to the P/Halley flight project centers. In the case of Giotto, a direct computer-to-computer link has already been established between JPL and the European Space Operations Center (ESOC) in Darmstadt, West Germany. Upon receipt of the data, the ESOC will compute orbital solutions and compare them with those of the Astrometry Network.

To improve upon the accuracy of the P/Halley astrometric observations, the Astrometry Network has constructed a special P/Halley star catalog for use in reducing the observations. This catalog was compiled through the joint efforts of Harrington in Washington, DC, and Arnold Klemola and Burton Jones at Lick Observatory. For a few degrees on either side of the comet's celestial path, from early 1984 until May 1986, the catalog stars have had their positions measured to a precision that is not available in most existing star catalogs. Since the comet's position is measured with respect to neighboring stars, the accuracy of the comet's positions will be improved along with those of the stars. In addition, many of the 1909-1911 P/Halley photographic plates have been remeasured and the position reductions made with respect to more modern star catalogs. Much of the 1835-1836 positional data have been re-reduced using such modern stellar positions. This re-reduction of the old data is being done by a number of international astronomers, including West, E. Bowell, G. Schwehm, E. Pereyra, G. Klare, T. Morley, and S. Roser.

RECENT RESULTS ON THE MOTION OF P/HALLEY

The recovery of comet Halley on 1982 October 16 at Mt. Palomar showed the comet's image to be only 9" away from our predicted ephemeris position. Recovered at a distance of more than 11 AU from the sun, the comet showed no obvious activity, and the initial observational accuracy was not limited by the uncertainty of the comet's center of mass within an extensive coma. The initial astrometric positions of P/Halley were generally accurate to within 1", with a series of 25 positions from La Silla, Chile, in late January 1984 achieving a heretofore-unrealizable root-mean-square (RMS) accuracy of less than 0".5 in both right ascension and declination. At this writing (1984 December), there have been more than 65 astrometric positions of P/Halley, including long sets of observations from Kitt Peak (Arizona), La Silla, and Mauna Kea (Canada-France-Hawaii telescope). There have also been recent observations from T. Seki in Japan, V. Shkodrov and T. Bonev in Bulgaria, and Zhang Bairong in China (Yunnan Observatory). Since its recovery in late 1982, P/Halley's apparent magnitude has been showing night-to-night brightness fluctuations of one magnitude or more, and more recently in 1984, there has been some indication that the comet is already active at more than 5 AU from the sun. [Indeed, it was probably also active at 11 AU; cf. ICQ 6, 98. -- Ed.]

Within the Astrometry Network of the IHW, the computer software for cometary orbit determination has been recently improved to include highly accurate and efficient numerical integration and differential correction techniques. Even general relativistic effects are included in the comet's equations of motion. Apart from the planetary perturbations, the largest perturbing forces that must be modeled in the comet's equations of motion are the so-called nongravitational effects. The outgassing of the cometary ices, as the comet approaches the sun, imparts a rocket-like thrust to the comet's nucleus. This rocket effect can add or subtract energy from the comet's orbital motion, depending upon whether the comet's nucleus is rotating in a direct or retro-

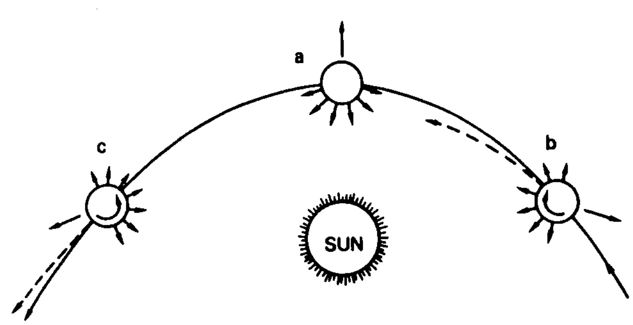

Figure 1

grade fashion, respectively. For example, in Figure 1a, the comet's nucleus is not rotating and the rocket thrust is directed away from the sun. However, the rotation of the nucleus, either in a retrograde or direct fashion (Figures 1b and 1c, respectively), introduces a thrust either in the direction of the comet's motion or contrary to it.

In practice, these nongravitational accelerations are included in the comet's equations of motion as radial and transverse nongravitational parameters (A_1 and A_2). The parameter A_1 is the radial rocket-like acceleration acting upon the comet's nucleus in the sun-comet direction (at a heliocentric distance of 1 AU), while A_2 is the corresponding acceleration acting perpendicular to the radial component and in the plane of the comet's orbit. (A third parameter, A_3, represents the normal to this plane, but its average effect has been found to be essentially negligible.) The appropriate values for these two parameters are determined by adjusting them and the comet's 6 orbital elements at a given epoch until the predicted motion of the comet can accurately fit, or predict, the actual astrometric data that have been reported. The successful modeling of these nongravitational forces is due primarily to the work of Marsden and Zdenek Sekanina, who in turn based their work on the theoretical work of Fred Whipple and Armand Delsemme. If these nongravitational accelerations were ignored in trying to predict the perihelion passage time (T) of P/Halley, one could expect a prediction error of 4 days.

At this writing, the most recent orbit for P/Halley is based upon 789 observations over the interval from 1835 Aug. 21 to 1984 Nov. 26. The weighted and unweighted RMS residuals are 1".95 and 2".94, respectively, and the corresponding set of osculating orbital elements (IHW orbit #18) is:

Epoch = 1986 Feb. 19.0 ET
T = 1986 Feb. 9.44148 ET
q = 0.5870993 AU
e = 0.9672727
Peri. = 111°.84661
Node = 58.14398
i = 162°.23933
A_1 = 0.1399 A_2 = 0.0155

The angular elements are referred to the ecliptic plane and the mean equinox of 1950.0, and the nongravitational parameters are given in units of 10^{-8} AU-(ephemeris day)$^{-2}$. The fact that A_2 is positive indicates that the comet's nucleus is rotating in a direct sense, and work by T. Kiang and this author suggests that the nongravitational acceleration affecting the motion of P/Halley has not changed significantly in many centuries.

This fact and the rather accurate ancient Chinese observations of P/Halley have allowed Kiang and Yeomans to trace the motion of Halley's comet back in time to 1404 B.C. However, the earliest apparition for which there are reliable observations is 240 B.C. The future motion of P/Halley has also been predicted. The next two predicted times of perihelion passage are 2061 July 28.692 and 2134 March 27.685. The latter apparition will include a close Earth approach down to 0.09 AU on May 7, 2134. Our great-great grandchildren will have plenty of time to prepare themselves for this celestial extravaganza. This 2134 close approach to Earth can only be compared to the circumstances in 374 A.D., when the comet passed within 0.09 AU of the earth, and again in 837 A.D., when the geocentric close approach was an extraordinary 0.03 AU.

RECENT RESULTS ON THE MOTION OF PERIODIC COMET GIACOBINI-ZINNER

P/Giacobini-Zinner was discovered at Nice (France) in late 1900 by M. Giacobini, and it was accidentally rediscovered by E. Zinner at Bamberg (Germany) in 1913. With an orbital period of 6.5 years, the comet has a favorable return approximately every 13 years. The comet was poorly observed at 3 perihelion passages (1940, 1966, 1979) and missed altogether in 1907, 1920, and 1953.

Recently the author updated earlier work on P/Giacobini-Zinner's orbit by including the observations made during the three most recent apparitions in 1972, 1979, and 1984. In addition to

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the four 1984 April 3 recovery observations from Kitt Peak, we included a prerecovery observation obtained on 1984 Jan. 28 at La Silla and 2 observations made at Cerro Tololo Interamerican Observatory on 1984 July 21. Each of the observations were weighted equally, and the following elements (IHW orbit #10) represent the most recent orbital results for P/Giacobini-Zinner:

Epoch = 1985 Sept. 12.0 ET
T = 1985 Sept. 5.24907 ET
q = 1.0282614 AU
e = 0.7075300
Peri. = 172°.48887
Node = 194.70595
i = 31.87829
A_1 = -0.0543 A_2 = -0.0465

The above orbital elements and nongravitational parameters were determined from 84 observations over the most recent three apparitions. After studying the motion of this comet over the entire observed period from 1900 to 1984, the author concluded that, unlike P/Halley, the nongravitational parameters for this comet are changing with time. In fact, A_2 changed sign (from + to -) sometime near the 1959 apparition, suggesting that the pattern of the comet's spin-pole precession changed markedly at that time. In a soon-to-be-published (A.J.) paper, Sekanina has used the time history of these nongravitational parameters to model the nucleus of this comet. He concludes that the comet may well be shaped like a fat pancake, with the largest radius being 1.25 km, and is rotating so fast (period about 1.7 hrs) that it may be structurally unstable; Sekanina notes that it therefore may be worthwhile to watch for nucleus splitting during the 1985 apparition.

P/Giacobini-Zinner is one of the most peculiar periodic comets in other respects, as well. From the Giacobinid meteor storms observed in 1933 and 1946, it is apparent that the dust from this comet is extremely fragile, low-density material; this is unlike the material of other comets that parent meteor showers. While it is probably not likely that the Giacobinid meteor shower will repeat in 1985 October, it may be worth watching for, anyway. If there is a Giacobinid meteor shower, it will occur on Oct. 8.55 UT, when the earth arrives at the comet's descending node some 26.5 days after the comet itself. At this time, the earth will pass 0.03 AU inside the comet's orbit, and if the meteor stream is at least that wide, there should be a meteor shower. However, if the past circumstances for possible Giacobinid meteor showers are any guide to the upcoming circumstances, then the stream is not that wide.

P/Halley and P/Giacobini-Zinner are two of the most interesting short-period comets, and we should count ourselves among the fortunate, since we will be able to examine them both from ground-based observations and from an international fleet of spacecraft. The Astrometry Network of the IHW is doing its collective best to see that telescopes on the ground, in Earth orbit, and in interplanetary space have the most accurate ephemerides to guide them.

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CORRIGENDA

+ On page 49 of the July 1983 issue (the cover), the photograph of comet IRAS-Araki-Alcock 1983d by Mrkos was accidentally turned upside-down by the printer. North is therefore to the left (and not to the right, as stated).
+ Further to the first corrigendum on p. 82 of the Oct. 1984 issue, the second column in the photometric tabulation (ICQ 4, 99-100) should, of course, read H_0 instead of H .
+ In the January 1985 issue, p. 24, column 2, line 21, for "3 magnitudes too faint" read "3 magnitudes too bright". In the same issue, p. 14, line 7, for "to observed comet Halley" read "to observe comet Halley". Also in the same issue, two misspellings occurred in the second column of page 15: line 29, for "creeped in" read "crept in"; line -6, for "even of" read "event of".

THE INTERNATIONAL COMETARY EXPLORER MISSION TO P/GIACOBINI-ZINNER AND P/HALLEY

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On September 11, 1985, at 11:00 UT, the in situ exploration of comets will begin with the pass of the International Cometary Explorer (ICE) spacecraft through the tail of periodic comet Giacobini-Zinner. The primary scientific goal of the ICE mission is to study the interaction of the solar wind with comets by penetrating the downstream plasma environment.

The ICE spacecraft began its scientific life in 1978 when it was launched as the Third International Sun-Earth Explorer (ISEE-3). The ISEE-3 spacecraft was placed in a halo orbit about the libration point between Earth and the sun. Moving the spacecraft from the halo orbit to the current intercept trajectory was not simple. The architect of these maneuvers was Robert Farquhar of the Goddard Space Flight Center. Five gravitational encounters with the moon were required, the last taking place on December 22, 1983, as shown in Figure 1. At this time, the spacecraft's mission was irreversibly altered and the name changed to ICE.

TRAJECTORY OF ISEE-3 AROUND THE MOON AS SEEN FROM THE EARTH

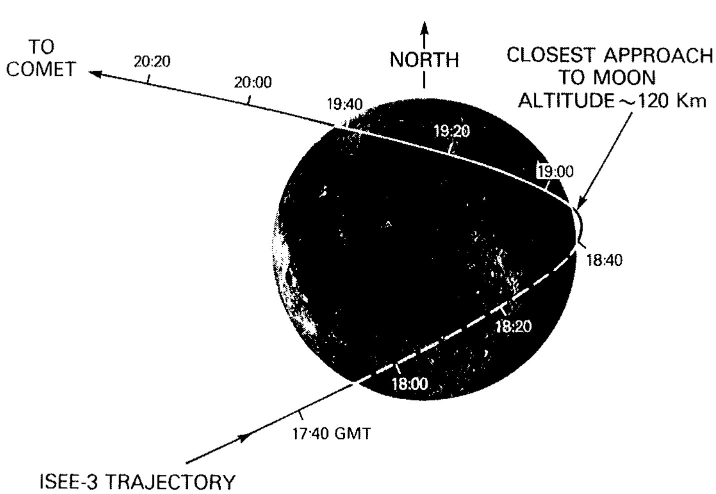

Figure 1. The final lunar swingby of the ISEE-3 spacecraft on December 22, 1983. During the maneuver, the spacecraft was in the moon's shadow and out of communication from Earth. The new name, the International Cometary Explorer, became official at this time.

ISEE-3 SPACECRAFT

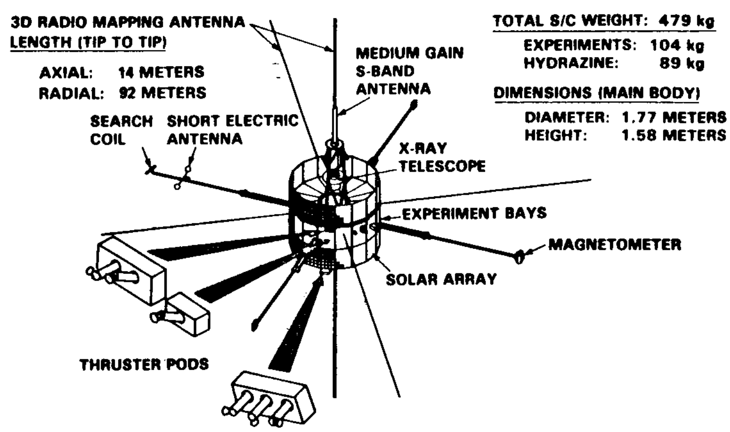

Figure 2. Schematic of the ICE (born as ISEE-3) spacecraft.

Because of the original mission, the particle and fields instrumentation is well-suited for the cometary mission. Some of the experiments thought to be major contributors to cometary physics are:

Helium Vector Magnetometer -- Obtains three high-accuracy, triaxial measurements per second in ranges extending from ± 0.00004 to ± 1.4 gauss. Principal Investigator: E. J. Smith, Jet Propulsion Laboratory.

Plasma Wave Experiment -- Samples 16 channels in electric field in one second, in the frequency range 20 Hz to 100 kHz. Principal Investigator: F. L. Scarf, TRW.

Radio Wave Experiment -- Samples the range 30 kHz to 1 MHz in 12 steps with each step change in frequency being 3 kHz. Samples the range 40 kHz to 2 MHz in 12 steps with each step change

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in frequency being 10 kHz. Each scan takes 56 seconds. Principal Investigator: J.-L. Steinberg, Observatoire de Meudon.

Plasma Electron Experiment -- Scans in 16 steps covering the energy range 5 eV to 1500 eV. Sampling takes 24 seconds. Principal Investigator: S. Bame, Los Alamos National Laboratory.

Plasma Ion Experiment -- Has velocity selector. Determines M/Q (mass/charge) in 25 steps for the range 4 to 50, and velocity in 25 steps for the range 20 km/s to 200 km/s. Complete set of measurements takes 20 minutes. Principal Investigator: K. W. Ogilvie, Goddard Space Flight Center, NASA.

The judgment of likely contributors for the cometary mission is subjective, and all experiments are candidates for operation during the encounter to the extent permitted by available spacecraft power and a suitable safety margin. Experiments not listed above are principally those measuring high-energy cosmic ray nuclei and electrons. ICE has no imaging capability nor experiments designed to detect dust particles; nevertheless, some experiments (e.g., the plasma-wave experiment) should provide data on dust particle impacts. The

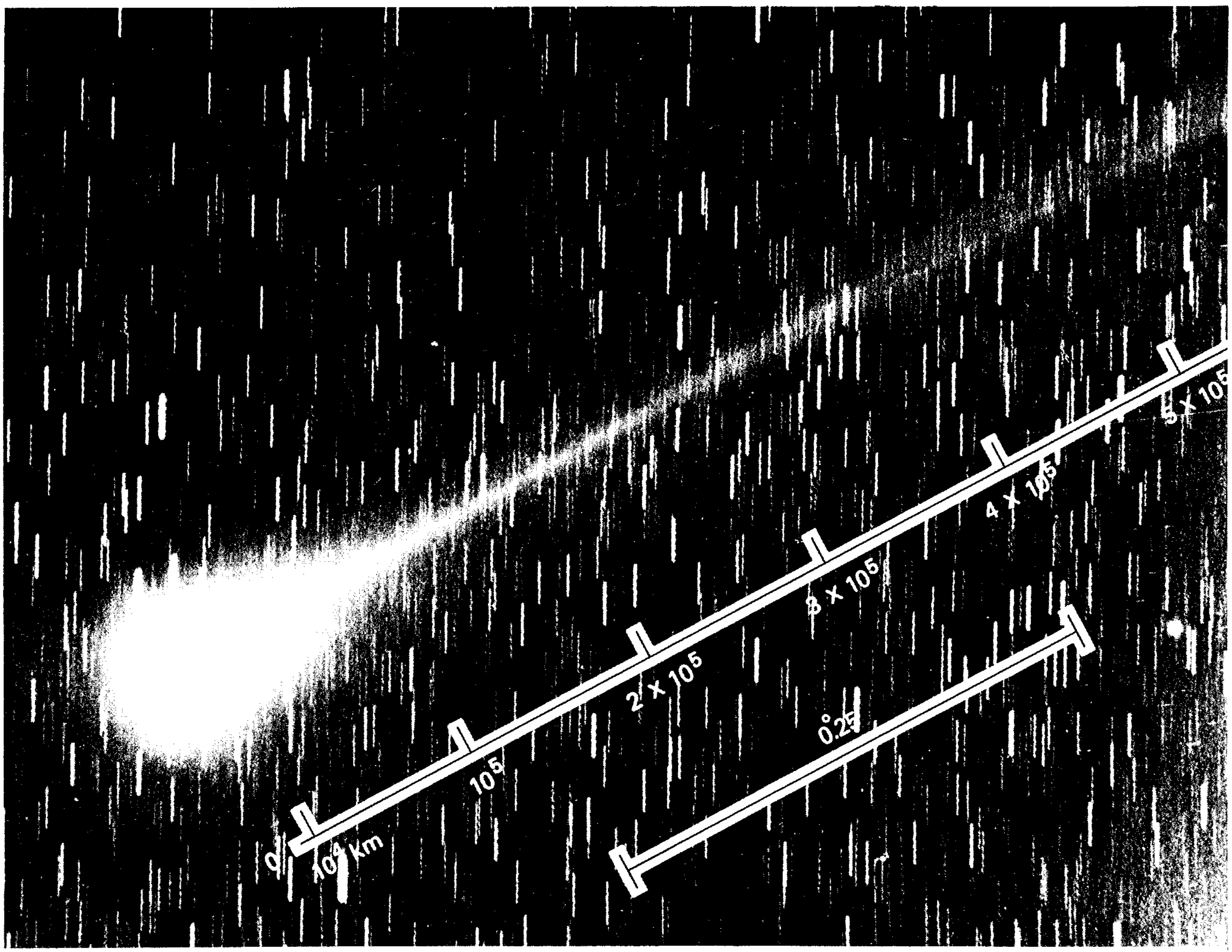

Figure 3. P/Giacobini-Zinner on October 26, 1959, as photographed by E. Roemer (Official U.S. Navy photograph). The linear and angular scales have been added.

ICE MISSION TO P/GIACOBINI-ZINNER AND P/HALLEY

TABLE I.

DISCOVERY AND RECOVERY OF PERIODIC COMET GIACOBINI-ZINNER

Apparition	Designation	First Observation	Observer/Institution	Approximate Magnitude	Reference
1	1900III (1900c)	Dec. 20, 1900	Giacobini/Observatoire de Nice	11	A.N. 154, 161
2	1913V (1913e)	Oct. 23, 1913	Zinner/Remeis-Sternwarte	9-10	A.N. 196, 167 & 353
3	1926VI (1926e)	Oct. 16, 1926	Schwassmann/Hamburger Sternwarte	14	A.N. 229, 122
4	1933III (1933c)	Apr. 23, 1933	Schorr/Hamburger Sternwarte	15	IAU Circ. 435
5	1940I (1939ℓ)	Oct. 15, 1939	Van Biesbroeck/Yerkes Observatory	15	IAU Circ. 797
6	1946V (1946c)	May 29, 1946	Jeffers/Lick Observatory	17	IAU Circ. 1046
7	1959VIII (1959b)	May 8, 1959	Roemer/U.S. Naval Observatory	20	IAU Circ. 1677
8	1966I (1965g)	Sept. 17, 1965	Roemer & Lloyd/U.S. Naval Observatory	20	IAU Circ. 1923
9	1972VI (1972d)	Mar. 11, 1972	Roemer & McCallister/University of Arizona	19	IAU Circ. 2390
10	1979III (1978h)	Apr. 30, 1978	Shao & Schwartz/Harvard College Observatory	20-21	IAU Circ. 3216
11	1985_ (1984e)	Apr. 3, 1984	Djorgovski & Spinrad/Berkeley Astronomical Dept. Will & Belton/Kitt Peak National Observatory	23	IAU Circ. 3937

General References: (1) "Listé Générale Des Comètes De L'Origine A 1948:, by M.F. Baldet, Annuaire du Bureau des Longitudes (1950).

(2) Catalogue of Cometary Orbits, 4th Ed., by B.G. Marsden, Smithsonian Astrophysical Observatory (1982).

spacecraft is shown schematically in Figure 2, which also lists weights and dimensions.

P/Giacobini-Zinner was discovered in 1900 by M. Giacobini at Nice, France, and rediscovered in 1913 by E. Zinner at Bamberg, Germany. For the current apparition, the comet was recovered on April 3, 1984; see Table I for discovery/recovery history. The comet has a period of 6.6 years, a perihelion distance of 1.03 AU, an orbital eccentricity of 0.71 and an inclination of 31.9. The ion tail begins to develop at 1.7 AU and ultimately attains a length > 500,000 km. The coma diameter is approximately 70,000 km. One of the best photographs (Figure 3) was obtained by Elizabeth Roemer on 1959 October 26. P/Giacobini-Zinner is responsible for the Draconid meteor showers. At the time of spacecraft encounter, the comet will be near perihelion and favorably situated for Earth-based observation at a distance of 0.47 AU.

The targeting strategy is being formulated with the aid of a baseline model (developed by M. B. Niedner of Goddard Space Flight Center) which starts with a gas-production rate at perihelion of 2.3×10^{28} molecules/s as derived from observed brightnesses. An extension of the model leads to a tail width at 55,000 km from the nucleus of approximately 5,000 km, a value compatible with the tail width as directly determined from the photograph shown in Figure 3. Factors to be considered are the targeting error, dust hazard, variable tail cross-section, variable location of the tail because of changing solar-wind velocity, and desire to avoid the wake region where the plasma tail may not be fully formed. The goal of probing the comet's interaction with the solar wind makes penetration of the bow shock, contact discontinuity, and current sheet (if these exist) desirable. The dust hazard will be evaluated on the basis of a dust model by N. Devine of NASA's Jet Propulsion Laboratory.

The provisional aim point is 10,000 km tailward of the nucleus and in the center of the main plasma tail. The passage is at 21 km/s, approximately normal to the ecliptic, and occurs south to north with respect to the comet. We expect definitively to test the current physical picture of the comet/solar-wind interaction as shown in Figure 4. A bow shock is expected because the comet is an obstacle in a supersonic and super-Alfvénic solar wind [cf. ICQ 5, 83, and 6, 3. -- Ed.]. Between the bow shock and the contact surface (containing the main plasma tail) is a region of mixed solar-wind and cometary plasma. The plasma tail is threaded by magnetic field captured from the solar wind and wrapped around the head region to form two lobes of opposite magnetic polarity. A current sheet separates the two lobes.

The ICE studies of P/Giacobini-Zinner are complementary to the exploration of Halley's comet in March 1986, and the ICE encounter provides a first test of spacecraft in a cometary environment. All the probes to P/Halley are being targeted for the sunward side, and two comets will then have been sampled. Clearly, the total value of the results from the six encounter spacecraft, other data from spacecraft above the earth's atmosphere, and from ground-based data collected by the International Halley Watch will be greater than the simple sum of the value of the individual projects. Some key dates in the exploration of comets are given in Table II.

ICE will also serve as an upstream monitor of solar-wind conditions for P/Halley during two time periods. The near-radial alignments occur on October 31, 1985, and March 28, 1986, when ICE will be 0.93 and 0.21 AU upstream, respectively.

The importance of supporting ground-based observations close to and simultaneously with the encounter on September 11 cannot be overemphasized, and the IHW has thus formulated plans for a limited "Giacobini-Zinner Watch" to be conducted by its Discipline networks.

For a few days in September 1985, P/Giacobini-Zinner and P/Halley are

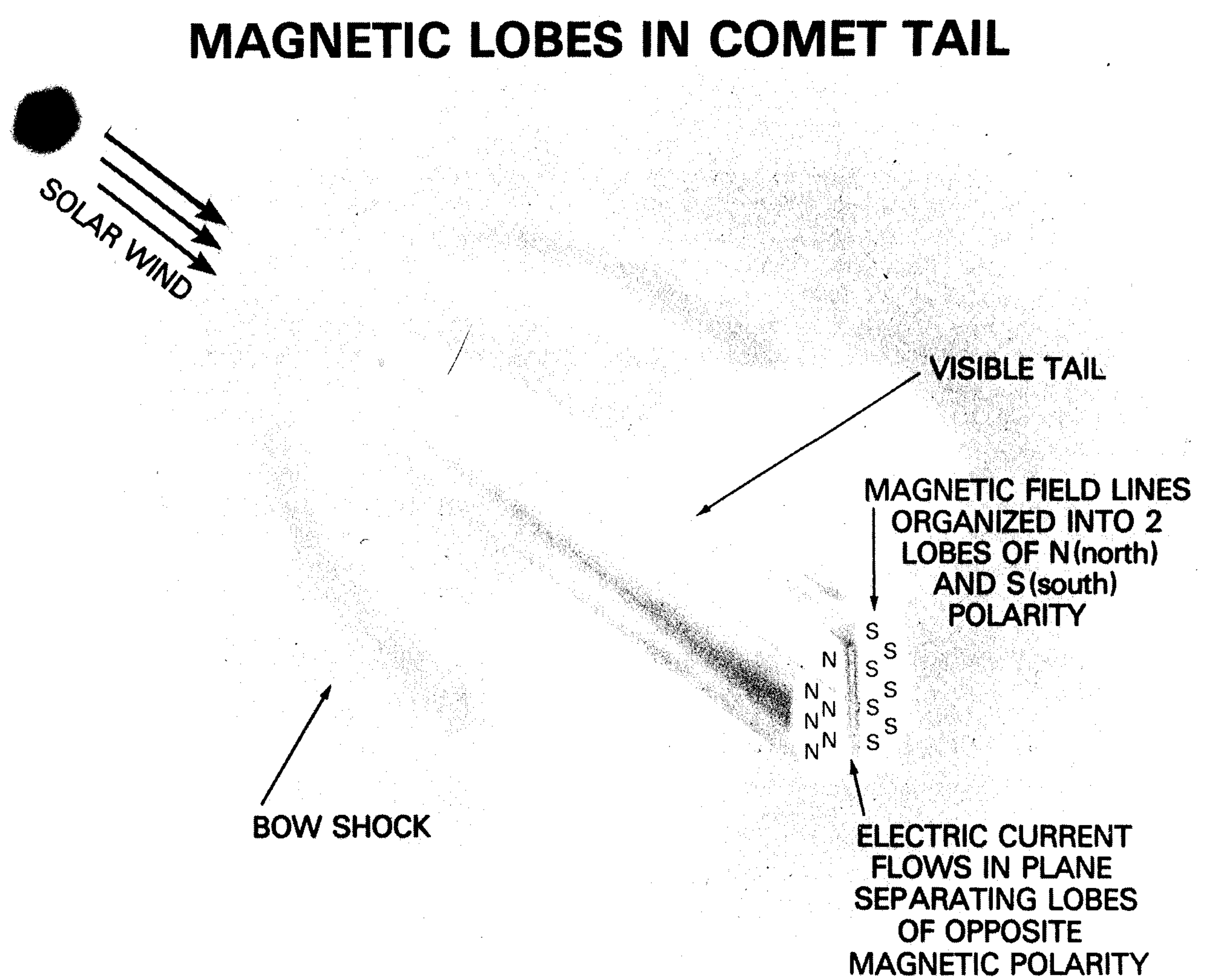

Figure 4. Diagram showing the principal features involved in the interaction of comets with the solar wind.

ICE MISSION TO P/GIACOBINI-ZINNER AND P/HALLEY

TABLE II.

KEY DATE SUMMARY

- o HALLEY'S COMET RECOVERED - OCT. 16, 1982
- o INTERNATIONAL COMETARY EXPLORER (ICE) "LAUNCHED" - DEC. 22, 1983 (NASA)
- o COMET GIACOBINI-ZINNER (G/Z) RECOVERED - APRIL 3, 1984
- o VEGA's (USSR) LAUNCHED -
  VEGA-1 DECEMBER 15, 1984
  VEGA-2 DECEMBER 21, 1984
- o MS-T5 (JAPAN) LAUNCHED - JAN. 7, 1985 - NAMED SAKIGAKE (FORERUNNER)
- o VEGA's ENCOUNTER VENUS - JUNE 1985
- o GIOTTO (ESA) LAUNCHED - JULY 1985
- o PLANET A (JAPAN) LAUNCHED - AUGUST 1985
- o COMET G/Z-ICE ENCOUNTER - SEPT. 11, 1985
- o G/Z AND HALLEY SEPARATED BY LESS THAN 2° ON SEPTEMBER 14, 1985
- o HALLEY INBOUND CLOSEST APPROACH - NOV. 27, 1985 (0.62 AU)
- o PROBABLE BEST VIEWING NEAR NEW MOONS OF DEC. 12, 1985 AND JAN. 10, 1986 (DECLINATION ≈ -2°)
- o SMM & PIONEER VENUS OBSERVATIONS CENTERED ON PERIHELION, FEB. 9, 1986
- o COMET HALLEY ENCOUNTERS - 1986

VEGA-1	MARCH 6
PLANET A	MARCH 7
MS-T5	MARCH 8
VEGA-2	MARCH 9
GIOTTO	MARCH 13

- o ASTRO 1 - MARCH 7-14, 1986
- o HALLEY OUTBOUND CLOSEST APPROACH - APRIL 11, 1986 (0.42 AU)
- o PROBABLE BEST VIEWING NEAR NEW MOONS OF MARCH 11, AND APRIL 9, 1986 (DECLINATION ≈ -32°)
- o INTERNATIONAL HALLEY WATCH (IHW) NETWORKS OBSERVING THROUGHOUT
- o EXPECT UNEXPECTED DISCOVERIES LEADING TO A "GOLDEN AGE OF COMETARY STUDIES"

close together in the morning sky. On September 14, the comets are separated by < 2°. P/Giacobini-Zinner and P/Halley should be approximately 8th and 12 magnitude, respectively, and present an historic opportunity for wide-field celestial photography.

[The author is Comet Scientist for the ICE project. The Flight Director is Robert Farquhar and the Project Scientist is Tycho von Rosenvinge. Astrometric and orbital work is being carried out in collaboration with Donald Yeomans of the Jet Propulsion Laboratory.]

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EDITOR'S NOTE: Due to space limitations in this issue, our planned article on the general naked-eye visibility of Halley's comet will be published in the July issue.

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UNIVERSAL TIME (UT): This time based on the Greenwich meridian is used throughout the ICQ; it is 24-hour time, from midnight to midnight. In North America, add the following numbers to standard times to convert to UT: EST, 5; CST, 6; MST, 7; PST, 8. For daylight savings time, add 4, 5, 6, and 7 hours, respectively.

SOME THOUGHTS ON LIMITING VISUAL STELLAR AND COMETARY MAGNITUDES WITH VARIOUS APERTURES

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The apparent visual detection by S. O'Meara (1985a) of P/Halley on January 23 and 24 raises many questions, concerning both the limiting visual magnitudes with telescopes of various apertures and the physical nature of the (varying?) brightness of Halley's comet. Since this topic is of key importance to the cometary brightness tabulation by the ICQ, this article discusses the O'Meara observations and provides an introduction to the entire issue of limiting visual stellar magnitudes; a more in-depth paper discussing the limiting stellar magnitude problem is in preparation (Green 1985).

I. O'MEARA'S SIGHTING OF P/HALLEY

Upon hearing, only days before O'Meara left Cambridge for Hawaii, of his plans to try finding P/Halley visually this past January, the author tried to dissuade O'Meara from attempting the search: Knowing that astronomers were having difficulty photographing the comet even in December with large telescopes, it seemed unsound for anyone to try locating P/Halley visually with a telescope as small as a 24-inch-aperture reflector. Little visual observing has been done of comets at magnitudes fainter than 14, and Morris (1985a) accurately predicted problems that might arise concerning an early visual sighting of P/Halley.

Mild shock describes the author's state, around noon on Jan. 23, following a telephone call from O'Meara at Mauna Kea, in which O'Meara stated that he had, indeed, seen P/Halley visually the previous night with the 24-inch reflector. Even allowing for O'Meara's unusually-good eyesight and for the superior observing conditions at Mauna Kea (elevation 13,800 feet), there were two basic issues to be addressed: (1) the true brightness of P/Halley, and (2) all previous studies indicating that the visual magnitude limit for a 24-inch (61-cm) reflector could not be much fainter than 16.5 (the least conservative study gives a value near 17.5). And, of course, a comet of a given total magnitude is generally much harder to see visually than a star of the same magnitude, due to the effect of an integrated magnitude over a large surface area. O'Meara reported seeing the comet as an essentially stellar object with perhaps the slightest trace of a tenuous coma, so it is difficult to say how much the total magnitude and the visibility was affected by any coma contribution. Indeed, the faint coma had been seen, with reported diameters ranging up to 16", since at least last October by CCD observers.

O'Meara has established himself as a keen-eyed amateur astronomer, through a decade of observing intricate features on the planets (e.g., cf. O'Meara 1978, Robinson 1980, O'Meara 1984a) and in the inner comae of many comets (cf. O'Meara 1983, 1984b, 1985b). A test conducted at the Harvard College Observatory (HCO) a couple of years ago to test O'Meara's eyesight revealed some interesting results; brief mention of that test is given here, with further details to be published later by O'Meara (1985c).

O'Meara has baffled planetary astronomers with his detailed drawings of the planets, obtained using the 9-inch Clark refractor at the HCO in Cambridge, MA; the A.L.P.O. held back from publishing his observations, only to find that small details in O'Meara's drawings were indeed real, especially those concerning the so-called 'spokes' of Saturn. This brought to mind the story concerning the B.A.A.'s reluctance to publish, for the same reasons, drawings of Jupiter by George Alcock, when later photographs with large telescopes showed that Alcock really was seeing amazingly small details in the cloud features of that planet (Morris 1981). Michael Rudenko and the author devised an experiment to test the eyesight of O'Meara.

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Harvard University's Science Center is located 1 km from HCO in Cambridge and is one of the tallest buildings in the area. Rudenko calculated how large a drawn circle would be to approximate closely, at a distance of 1 km, the apparent size of Uranus' disk as seen from Earth (4"). Two artists were then instructed to draw markings inside 7 pre-drawn circles to simulate possible cloud markings on Uranus; the artists were told what type of cloud colors and markings might be realistic, then were given full freedom to draw whatever bands or spots (in any orientation), with varying intensities, they wished. Neither Rudenko, O'Meara, nor the author saw the drawings beforehand, and one of the artists placed all of the drawings on a railing atop the Science Center building so that they faced the 9-inch Clark dome at HCO.

Using the 9-inch refractor, each observer then drew as much detail as could be seen in the simulated Uranus drawings. Later, when the 3 observers' drawings were intercompared and compared with the original artists' drawings, it was seen that O'Meara consistently saw much smaller details than did Rudenko and the author; O'Meara drew accurate details on the order of 0.5 arcsec.

Such tests are, of course, important in verifying visual acuity. Just as in the case of resolution, the only way scientifically to test limiting magnitudes for a particular visual observer is to use blind-field experiments. So, when O'Meara notified the author of his apparent sighting of P/Halley, O'Meara was encouraged to verify his observation and his limiting magnitude by observing a second night with other observers present. (Incidentally, O'Meara did try an unsupervised naked-eye blind-field test at Mauna Kea by drawing an unknown field of stars and he later found that he was consistently seeing stars to magnitude 8.4.) O'Meara had arranged his visual attempt at a time coinciding with a scheduled observing run by J. Pasachoff, D. Cruikshank, and C. Chapman on the 88-inch Mauna Kea reflector. Those three observers, plus a fourth (Jim Pomeroy, a site survey observer for the National New Technology Telescope), aided considerably in attempts to verify the observation of faint stars and P/Halley by O'Meara. Discussions by the author with the 3 astronomers helped in the preparation of this article (Chapman 1985, Cruikshank 1985, Pasachoff 1985).

On Jan. 23, O'Meara used an enlarged copy of the Palomar Sky Survey (POSS) print for the P/Halley region, which contained a pre-drawn line representing the predicted motion for the comet, to search for comet 1982i. That photocopy of the POSS print apparently had stars fainter than about 19th magnitude lost in the reproduction. Surprisingly, O'Meara drew in some fainter stars that he could see which were not on his chart; a POSS print of the P/Halley field, used by Cruikshank and Pasachoff at the 88-inch telescope, indicated that O'Meara had correctly drawn stars in their proper positions in the vicinity of mag 20. At the 24-inch reflector, O'Meara located the comet's image visually in the correct location (as verified by CCD images obtained at the 88-inch reflector) and followed its motion in the proper direction, noting that the "stellar comet was surrounded by a nearly imperceptible smudge of coma". Cruikshank and Pasachoff congratulated O'Meara, but stated that they could not definitely see diffuseness on their CCD monitors at the 88-inch telescope; however, once back in Honolulu to reduce the CCD data, the astronomers did, indeed, find diffuseness, with a 5" coma appearing on a 3-minute CCD exposure.

O'Meara estimated a visual magnitude of 19.6 at Jan. 23.35 UT, using the chart for SA 51 published by Everhart (1984). In fact, O'Meara noted seeing a star labelled "204" (magnitude 20.4), as well as stars labelled "191" (mag 19.1) and brighter; the faintest stars O'Meara saw were, of course, at the extreme limit of averted vision, and considerable effort was exerted to obtain enough observation of the stars' positions to convince him of their reality.

Although extremely fatigued from a lack of sleep, O'Meara tried again on Jan. 24 to find P/Halley, this time with Pomeroy, Pasachoff, and Chapman later visiting the 24-inch dome to attempt to confirm the sighting. Contrary to an erroneous report (Anonymous 1985), these other three observers did not look for the comet, but wanted to confirm the visual magnitude limits. Pasachoff could not make out stars fainter than mag 17 on Everhart's chart, but Pomeroy could see all stars brighter than 18.5 and some stars down to mag 19.1. Also, Chapman was fairly confident that he himself was seeing 18th-magnitude stars; Chapman is also confident "that a keen-eyed observer could have seen an object as faint as Halley's comet on that particular night with that telescope (with the total visual magnitude of the comet then being near 19.5)". It should be noted here that neither Pasachoff nor Chapman were using oxygen, whereas bottled oxygen was being used extensively by Pomeroy and O'Meara. Also, age enters as an obvious factor, with O'Meara and Pomeroy being in their 20s, and thus some 20 years younger than the other astronomers.

O'Meara apparently was able to follow P/Halley's motion again on the second night and he reports recording stars to the limit of the POSS chart, although he could not make out the 204 star. Chapman and Pasachoff did suggest and semi-supervise a blind-field test of O'Meara's eyesight on this same night, and O'Meara was apparently seeing stars, of which he had no prior knowledge, consistently down to mag 18 or 18.5, even with the severe eye-strain present. Chapman and Pasachoff make the following remarks with respect to this: (1) The blind-field test was not controlled absolutely, and is therefore not a definitive test. (2) The tests do indicate that it was plausible that O'Meara and Pomeroy both saw 19th-magnitude stars visually; Pomeroy's sighting of stars down to and including mag 19.1 (while he was rather continuously breathing bottled oxygen) was particularly notable because he did not have a great deal of experience as an astronomical observer.

There is little reason to assume that Everhart's chart with its comparison stars are very much in error. The stellar magnitudes are from I. King, as published by Chiu (1980), and the carefully measured stellar diameters from visual plates at Lick are said to have a mean error of $V < 0.1$, down to magnitude 21. King's initial photoelectric data go fainter than mag 18.5, so the extrapolation to the range used by the observers at Mauna Kea was not more than 2 to 3 magnitudes. Two possible problems, however, could be present in the Everhart charts: (1) misidentification of some stars by either Everhart or Chiu, and (2) variability of some sequence stars. Unfortunately, O'Meara's detection of only one SA star fainter than mag 19.1 does not lend strong support to his seeing stars as faint as 20.4; caution must be used until more concrete results are available. (Note that this caution does not necessarily express doubt concerning O'Meara's sighting of P/Halley.)

When asked if his magnitude estimate might be on the faint side due to the effect of integrated magnitude over a 5" coma, O'Meara replied that the coma was so tenuous that it would not contribute much more than 0.1 mag; his value of 19.6 is, in fact, his estimate of the nuclear condensation's brightness. The astronomers at the 88-inch reflector did obtain an unfiltered CCD magnitude of 19.8 for P/Halley's integrated image obtained with a 3-min exposure; while they also used the Selected Area sequence after Chiu, with V source magnitudes, it is not clear exactly what type of magnitude they actually obtained.

II. LIMITING VISUAL STELLAR MAGNITUDES

When O'Meara's report was received, the immediate response of some professional astronomers was to declare the sighting of 19th- and 20th-magnitude stars visually with so small a telescope as impossible. And, indeed, it was not easy to find references in the published literature concerning limiting magnitude values for various apertures. The author decided to send some 25-30 letters to selected professional and amateur astronomers worldwide to request information concerning limiting magnitudes, and the response has been quite encouraging.

The picture that is developing is that due credit has not been given the human eye as an astronomical detector. Observers are today consistently reporting sightings of stars much fainter than can be found in the literature; this may be due to better available optics and reflective coatings today, among other factors. Interesting discussions of the eye as a detector in astronomy have been provided by Roach and Jamnick (1958), by Kuehn and Schmeidler (1975), and by Bowen (1984). Problems concerning visual observing (especially with respect to observing the planets) are discussed in some detail by Giffen and Chapman.

Perhaps the first attempt at studying limiting visual magnitudes was that by Pogson (1856). Rather limited studies on limiting visual magnitudes with various apertures were performed by Bowen (1947), Kelley et al. (1953), Rosebrugh (1950), and Sinnott (1973). A more thorough study is that by Kolman et al. (1976). And yet these studies give simple logarithmic formulae which consistently are too conservative. Even Russell (1917) determined in a laboratory that the unaided human eye could definitely see stars as faint as mag 8.5, and perhaps even to mag 8.9. Curtis (1901) concluded that he could definitely see, with the naked eye, stars as faint as magnitude 8.5 (see also Hughes 1983). And observers today are confirming that this is, indeed, the case under nearly-perfect observing conditions. Indeed, there are many variables involved in the problem of determining limiting visual stellar magnitudes, once telescopes enter the discussion (e.g., cf. Baum 1962; Steffey 1974; Jahn 1975a, b). It should not be startling to find that a simple logarithmic formula will not accurately describe limiting magnitudes for large varieties of telescopes and observing locations/conditions.

Perhaps the most ignored variable, however, is the individual observer. It is well-known that experienced visual observers will see much fainter than beginners (e.g., cf. MacRobert 1984) -- and many professional astronomers fall into the beginner category. On 1985 Feb. 16 ("not the best possible conditions") at Table Mountain Observatory, using the 24-inch reflector, Morris (1985b) could see stars to magnitude 18.3, while other, less-experienced visual observers could only make out stars near mag 17.7; the limit at that location on a better night may have been between mag 18.5 and 19.0 for Morris, in his opinion. It appears that, with less artifical lighting and less atmosphere at Mauna Kea, it is reasonable to assume that one could perhaps see another magnitude fainter.

And, yes, the atmospheric seeing condition does make a substantial difference as to limiting magnitude! The atmosphere tends to smear stellar images out, with sizes of such images generally increasing toward observing sites at lower elevations. For very faint, limiting magnitudes, any smearing of the stellar image will tend to make a given star impossible to see; a steady collection of light by the eye in a very small location on the sky (i.e., as close to a point source as possible) is essential -- very much a factor due to seeing.

Some further limiting visual magnitudes reported to the author thus far are listed in Table I. Of particular interest are some notes by Brian Warner (1985): "When I worked at McDonald Observatory (1967-72) and was guiding on faint stars, I often amused myself in

TABLE I. SELECTED SHORT LIST OF VISUAL STELLAR MAGNITUDE LIMITS.

Instrument		Limiting	
Aperture	Type	Magnitude	Observer (Reference)
0.7 cm	naked eye	8.4	O'Meara (1985a); see text
16x50	binoculars	12.0	Bortle (1985)
6-inch	reflector	fainter than 15	Mayer (1974)
27.9-cm	Cassegrain	15.9	di Cicco (1985)
31.7-cm	reflector	16.3	Bortle (1985)
45.7-cm	reflector	17.3	Cragg (1985)
53-cm	reflector	17.5	Verdenet (1985)
82-inch	reflector	fainter than 20.5?	Warner (1985); see text

checking how faint I could see with the 82-inch Struve reflector. I found that, with a completely dark sky (and absence of bright star in the 6′ field of view) and excellent seeing, I could see all of the stars on my finding charts which were Polaroid copies of the paper version of the Palomar Sky Survey red plates. I never found exactly what the magnitude limit of these finding charts was, but it was presumably about V = 20.5. Verification of this limit can be obtained from my paper published in P.A.S.P. 83, 817, 1971, where you will see that I was able to center WY Sge in a 7"-diameter diaphragm on the 82-inch and then measured it to be at V = 19.3. You will appreciate that the additional optics in a photometer, and the difficulty of seeing a star in a very small diaphragm, will significantly lower the ability to see fainter objects. Incidentally, the guide eyepiece on the 82-inch photometer was an Erfle, so with simpler optics (and a freshly aluminized mirror), I may well have been able to see fainter than V = 20.5."

The author encourages experienced readers to try determining their limiting visual stellar magnitudes, but with two guidelines: (1) only the best possible observing conditions should be utilized, including sites far from artificial lighting, and (2) the Everhart (1984) fields should be used for uniformity; such charts as those used by the AAVSO do not usually have magnitudes (especially those fainter than about 12) determined to sufficiently-high accuracy (cf. Green and Morris 1982).

Of course, the limiting magnitudes of comets vary considerably due to brightness integration over widely-differing coma morphologies. When a comet is far from the sun and faint, however, the coma contributes less and less to the total magnitude, and the comet′s brightness approaches its true nuclear magnitude. It is appropriate here to note Sekanina′s (1976) detailed study of cometary "nuclear" magnitudes, notably those obtained by Elizabeth Roemer: Even when Roemer was observing nuclear condensations that appeared stellar or essentially stellar, it is likely that the actual nucleus was yet some 3 magnitudes fainter, in the cases of comets at large heliocentric distances. P/Halley has almost certainly had coma particles "contaminating" the light from the nuclear condensation even prior to its 1982 recovery (Green 1984). Exactly what O′Meara′s magnitude estimate really measured is uncertain; while an aperture effect is probably not very relevant due to the essentially-stellar appearance of the comet, such correction might be considered. In any case, it is difficult to assess the contribution of the coma to the total brightness. Diffuse objects (galaxies) near mag 17 have been glimpsed in a 24-inch reflector previously (McDonald 1973).

In closing, it is interesting to look briefly at a calculation concerning the amount of light available to the eye through a 24-inch reflector, in lieu of the O′Meara sighting of P/Halley near mag 19.5. To determine the number of photons, N, available per unit time to the eye, we can use an equation of form

$$N = b\ r\ A\ t\ f(m)\ C, \qquad (1)$$

where b is the bandpass for the human eye (approximately 100 nm for the region of most efficient detection); r is the transmission through atmosphere, optics, and reflective coatings; A is the light-collecting area; t is the storage time for collecting photons (the eye can store low-light photons for perhaps 0.1 s = 1 ds; cf. Baum 1962); f(m) is the decrease in brightness for the stellar magnitude, m, being discussed:

$$f(m) = 2.512^{-m}, \qquad (2)$$

and C is the value for incident stellar radiation of a 0-magnitude "standard" star atop the earth′s atmosphere. For this rough calculation, one can take C = 10000 photons/s/nm per square cm, after the value obtained for Vega at 555.6 nm by Hayes and Latham (1975). For a 24-inch reflector, we can assume two reflections (90% transmission each) plus the eyepiece elements; the telescope optics and the opacity of the atmosphere make r the most uncertain variable.

For the unaided eye of an observer atop Mauna Kea, let us take A = 0.36

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square cm, and f(m) = 0.00025 for magnitude 9.0 [after Curtis (1901), Russell (1917), and more recent studies]. We then get a fraction of 9.0 photons/ds -- the fraction being, say, 9.0r′, due to the transmission variable -- for the amount of light visible to the eye at that magnitude level. If one then calculates the same light level for a 20th-magnitude star for the 24-inch reflector, one finds N = 3.0r photons/ds. This comparison shows a difference of less than an order of magnitude, although N is quite small and the difference (9.0r′ vs. 3.0r) uncomfortably large; this suggests both that caution should be exercised and that further careful (and more exhaustive) tests be conducted concerning limiting visual magnitudes.

Prior to O′Meara′s observing run at Mauna Kea, little had been done to test and publish accurate limiting visual magnitudes for experienced observers using a wide variety of telescopes. It appears that it may not be an impossible feat, after all, to see stars to 20th magnitude under the best conditions with such a small telescope. The eye does seem to be a much better detector of low-light levels than astronomers have been assuming for years; further work will determine just how limited the eye really is.

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COMMENTS ON THE P/HALLEY PHOTOGRAPH PUBLISHED ON THE COVER OF THE JANUARY ISSUE

Following the published distribution of Tsutomu Seki's 1984 Sept. 22 photograph of Halley's comet (in Japanese publications, on page 1 of the Jan. issue of the ICQ, and in the January issue of Sky and Telescope), several people have commented to the Editor that the faintest stars in that photograph are several magnitudes brighter than those at the limit of the Palomar Sky Survey, and that -- if a true photographic copy -- the alledged image of P/Halley could not be anywhere near magnitude 20.5. Seki has been the most consistent astrometric observer of P/Halley in recent months, and the accuracy of his positions (combined with his difficult recovery of P/Tsuchinshan 1 last year at mag 20.5) in September suggested most strongly that Seki had obtained quite genuine photographic images of P/Halley in September.

I asked Seki, via S. Nakano, if any of his September images of P/Halley could be reproduced on a print for publication in the ICQ. Seki did send me a couple of prints, one of which Dennis di Cicco borrowed for publication in Sky and Telescope; indeed, we were surprised how strong the comet's image appeared. The problem of the Japanese/English language barrier apparently contributed strongly to a misunderstanding: we found out subsequently that Seki had used some darkroom tricks to bring out the extremely faint image of P/Halley on his Sept. 22 exposure. We asked Seki, again via Nakano, to write a brief description of his new telescope, his astrometric program, and his reproduction of the Sept. 22 image of P/Halley. Seki's reply was in Japanese, and we thank Ikko Fushiki (Harvard-Smithsonian Center for Astrophysics) for translating the following Letter. -- Daniel W. E. Green (3/13/85)

LETTER TO THE EDITOR

It was 1967, the year of comet Ikeya-Seki (1967n), when I began photographic observations of comets. I had taken photographs of comet Ikeya-Seki (1965f) in 1965, but those were less serious pictures intended for appreciation. Beginning in 1967, I used a Nikon comparator to determine the positions of comets on photographs taken with the 15-cm reflector (focal length = 1000 mm), measureable to units of 0.001 mm. I generally have used the SAO Star Catalog, although I now use the AGK3 for stars in the northern celestial hemisphere.

I began using the 22-cm reflector in 1970, and the 40-cm reflector was completed in 1977. Goto Optical Company's 60-cm astronomical telescope (fork-style mount) and a 7-m dome were built in 1980, thanks to the contribution from Mr. Seizo Goto. I now use these for observations, as I patrol minor planets and attempt to recover and follow periodic comets. My observatory is located on a mountain peak along the sea, some 40 km from Kochi City. There is little light pollution and the seeing is good. I take photographs at the direct focus of the 60-cm reflector (f/4, focal length = 2400 mm) and guide using a 20-cm refractor (focal length = 2400 mm) at 300x. The photographic limit is near magnitude 20 to 20.5 with exposures between 30 and 60 minutes. I use the North Polar Sequence for magnitude comparison, and often rely on my experiences for stars fainter than magnitude 20; the error may amount to about 0.5 mag.

The photograph of P/Halley I took on September 22 last year was very dark [due to sky background], and the image small. Frankly speaking, when the photograph is so dark, the image vanishes when it is seen through a comparator. If it were brighter than mag 20, it would be noticeable; however, when it is fainter, I first look at it through an extremely-high-quality loupe to ascertain its relative position to nearby faint stars. I then measure its position by looking through the comparator once again. Hence, there may arise a measurement error of about $0''.5$.

When the comet is so faint, its image does not appear on ordinarily-developed photographic prints. When urged by journalists to supply prints for publication, I darkened the vastly enlarged image, took its picture again, and made magnified developments. In published pictures in astronomical journals and in newspapers, the images of faint stars disappeared, while that of comet Halley looked bright. I note that these pictures seemed very unnatural to those with knowledge of the details of P/Halley's appearance. I think that academic arguments should be based on accurately measured observational data [such as astrometric positions, spectra, etc.], and that pictures [such as my Sept. 22 print as published in the ICQ and in Sky and Telescope] intended solely for appreciation should be considered differently.

P/Halley has become considerably brighter since late January (1985), and has thereby become visible on my recent photographs as seen in my comparator. I certainly think that the accuracy of my positional measurements has improved. However, even recent photographs show the comet as a small image, with an apparent coma diameter of about 2", on hypersensitized 2415 film exposed for 45 minutes with the 60-cm reflector. I am not likely to obtain successful images of the comet unless such P/Halley photographs are taken on nights with very good seeing. These photographs will be presented at the "Japan Comet Observers Meeting", to be held in late March 1985 in Sendai City.

At my Geisei Observatory, we report all of our observed data and discoveries to Mr. Syuichi Nakano and Mr. Takeshi Urata to computationally verify our results; we intend to publish only firm results. It was a great encouragement to have received various kinds of advice from Dr. Brian Marsden some 15 years ago concerning the results of my astrometric positions of comet Perrine-Mrkos, and I am grateful for his generosity to amateur astronomers.

Tsutomu Seki
Geisei, Japan
1985 February 20

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TABULATION OF COMET OBSERVATIONS

OBSERVATIONS BY RICHARD A. KEEN:

Mr. Keen has compiled his observations of comets, which cover more than 2 decades, for publication in the ICQ, and most of these are listed in this issue. Keen provides the following comments:

"Since 1970, I have employed a binocular version of the Sidgwick method, whereby the in-focus (or slightly defocussed) image of the comet viewed through one half of the binocular is compared with the out-of-focus reference star image in the other half. A naked-eye version of this technique was used for comet IRAS-Araki-Alcock 1983d. These binocular techniques, noted by K in the method column, are described in detail by Keen (1984, Comet News Service 84-1, p. 2). Naked-eye Bobrovnikoff estimates were made by simply removing my eyeglasses, which (unfortunately!) defocusses both cometary and stellar images to 2 degrees diameter. The in-focus technique was used in the special case of comet West 1976 VI near perihelion on 1976 Feb. 22-24, when the image of the nearly stellar coma (as seen in 7x35 binoculars) in bright twilight was compared with the appearance of Mercury under similar conditions at other times.

"The observations were made near Philadelphia from 1961-1964, and Chicago from 1965-1968; in both locations, city lighting reduced naked-eye limiting magnitudes to about 5.5 on clear nights. I observed from the Panama Canal Zone during 1969-1970, with limiting magnitudes typically 6.0-6.5. Since 1971, the observing has been done from various locations in or near Boulder, CO. Since May 1984, all observations have been made from an elevation of 9000 feet near Mt. Thorodin, CO. The references sources for some of the early rough magnitude estimates were only stellar diameters from Skalnate Pleso atlas charts; such magnitude estimates are only given to half a magnitude. A correction for differential atmospheric extinction, corresponding to 0.20 mag/air mass (Allen 1963, Astrophysical Quantities, Athlone, London, p. 122) has been applied to those relatively few cases in which the effect exceeds 0.1 magnitude; such a correction has been denoted in the tabulation by an exclamation mark (!).

"Visually, many comets appear to have a nearly stellar central condensation (sometimes erroneously called the nucleus) embedded within the larger, diffuse coma. For any particular comet at any given time, the portion of the comet that appears to make up this central condensation will depend on the aperture and magnification used. Increasing magnifications will, in general, reveal the true diffuse nature of ever more of the condensation, leaving less to appear "stellar". Thus, the estimated magnitude of the central condensation will increase as the magnification increases. Because of the strong dependence of "nuclear" magnitudes on instrumental factors [and because the term "nuclear magnitude" is so vague and ill-defined -- Ed.], it is the general policy of the ICQ to publish only total coma magnitudes.

"It has been suggested that a different philosophy prevailed among observers during the 19th century (e.g., Marcus 1983, Comet News Service 83-4, p. 5; Bortle 1983, Comet News Service 83-1, p. 4): namely, that the central condensation actually represents the true nucleus, or solid portion, of the comet, and that its magnitude is more significant than that of its transient atmosphere, or coma. The differences in observational methodologies needs to be considered when interpreting older observations. Since central condensation magnitudes actually represent the inner portions of the coma, rather than the nucleus, they might bear some intrument-dependent relation to the total coma magnitude. I have made simultaneous central condensation and total-magnitude estimates for 3 bright comets (Ikeya-Seki 1965f, Bennett 1969i, and West 1975n), and the differences between the two magnitude estimates are summarized in Table I, below; it is not clear what this will show, but it is hopeful that there may be some future use for such observational data. Listed for each of the three comets are the mean difference (central condensation minus total magnitude) for n different observing dates, along with the range of the individual differences. Comet 1965f was observed with 6x30 binoculars, comets 1969i and 1975n with the naked eye. In all cases, the same instrument was used for both magnitude estimates. An attempt was made to find a dependence of daily differences on geocentric, heliocentric, and perihelion distances, but none was found among this small sample of observations. The only systematic factor appears to be the consistently smaller magnitude differences for comet 1969i. The grand average difference of 1.0 magnitude implies, by current standards, some early observers may have underestimated the total brightnesses of naked-eye comets by about one magnitude. However, the interpreters of early observations should be certain how those observations were made before applying any corrections."

Richard Keen's Table I

Comet	Mag. Diff.	Range	n
1965f	1.2	0.5-1.7	6
1969i	0.6	0.5-0.8	3
1975n	1.1	0.9-1.7	8
Average	1.0	0.5-1.7	3

DESCRIPTIVE INFORMATION CONCERNING COMETS (to complement the tabulated data):

Seki-Lines (1962 III): Keen noted the tail as "bifurcated" during Apr. 15-20, as "fan-shaped" during Apr. 22-25, and as "narrow, straight" during May 4-10.

Ikeya (1963 I): Keen noted a 2′-diameter condensation on Feb. 23 and 28, and a 1′-diameter condensation on Feb. 24 and Mar. 4-19, in a 15-cm f/5 reflector. He also noted the comet as visible to the naked eye on Feb. 24 and 28 and on Mar. 9 and 11. The tail was "very faint" on Feb. 28 and Mar. 4.

Alcock (1963 III): Keen noted a 1′ central condensation on May 19 and June 14.

Ikeya (1964 VIII): Keen saw the comet via naked eye on Aug. 4.

Ikeya-Seki (1965 VIII): Keen found the comet's head behind clouds on Oct. 31. He noted the tail as 0°.5 wide on Oct. 26 and 2° wide on Oct. 27.

Kilston (1966 V): Keen noted a 13th-mag central condensation during Aug. 17-24, and a 12th-mag central condensation on Aug. 26.

Ikeya-Seki (1968 I): Keen observed an "elongated coma" on Mar. 23.

Tago-Sato-Kosaka (1969 IX): Keen found a 0.8-long type-II tail to the "left of the type-I tail" on Jan. 24 and he found a faint type-II tail on Jan. 27, each time in binoculars.

Bennett (1970 II): Keen reported cloud and twilight interference on Mar. 17-18 and on Mar. 28-30; the comet was only 3 above the horizon on Mar. 16. He noted a "fan-like jet in p.a. 180° from the nucleus" on Apr. 16 in a 15-cm f/5 reflector at 120x.

Kohoutek (1973 XII): The tail was "fan-shaped" on 1973 Nov. 28.

Bradfield (1974 III): "Possible faint tail in p.a. 180°" reported by Keen on May 16. He also noted a "central condensation about 15" in diameter" as seen in a 15-cm reflector on Apr. 1, when the total coma diameter was 2′.

Kobayashi-Berger-Milon (1975 IX): Keen noted a "possible faint tail" and a coma diameter of 8′ in his 15-cm f/5 reflector (28x) on July 31.

Suzuki-Saigusa-Mori (1975 X): Keen reported it as "visible with naked eye" on Oct. 27.

West (1976 VI): Keen saw the comet in "bright twilight, 27 minutes after sunset" on Feb. 22; he reported it as being "visible with naked eye" on Feb. 23. Keen noted the tail as "bifurcated near head" on Feb. 24. He noted a "15 type-I tail" on Mar. 5. The comet was still "faintly visible to naked eye" on May 1.

Bradfield (1980 XV): Keen noted "tail bifurcated near head" in a 32-cm reflector at 78x.

Levy-Rudenko (1984t): Marco Cavagna (CAV) reported glimpsing "an intense disk-like central condensation 10" in diameter" with a 25.4-cm f/4 reflector at 79x on Dec. 9.71. James A. DeYoung (DEY) found the "coma fan shaped" on Nov. 29. G. Antonio Milani (MIL02) found an asymmetric coma and a possible sunward fan on Dec. 23, and "quasi-stellar condensations" of mag 10.5 on Dec. 21 and 25.

P/Arend-Rigaux (1984k): A. Pearce (PEA) found the comet as a "small, slightly diffuse spot" on Dec. 29. On Dec. 31, Charles Morris (MOR) found the coma "parabolic with a condensation at the focus. The coma expanded to 1.9′ and was slightly elongated toward p.a. 300°." More remarked that the "comet may have experienced a nuclear outburst just prior to" his Jan. 20 observation; on Feb. 16, he noted the "comet had a stellar condensation (mag about 15) surrounded by a uniform, circular, diffuse disk with well-defined edges [as seen in the 61-cm Cassegrain telescope at Table Mountain Observatory]. On most other dates, the comet looked like a fuzzy star in the 25-cm reflector." Pearce noted a "star-like condensation" on Jan. 27. Alan Hale (HAL) remarks:

"My observation on Jan. 14.30 was quite possibly made during a nuclear outburst. The comet was almost completely stellar and I was not even sure I was seeing it until I watched it move. The faint estimate was quite possibly due to the fact that I saw almost no coma. The comet was significantly more 'cometary' when observed on Jan. 16.41."

P/Tsuchinshan 1 (1984p): Hale noted "when observed on Feb. 24.40, it had faded significantly from my observation on Feb. 20.32."

P/Halley (1982i): Morris assumed the comet was approximately stellar in providing his "upper limit" magnitude estimate on Feb. 16.

P/Schwassmann-Wachmann 1 (in 1976): The following remarks are by John Bortle (BOR). On Nov. 13.11, there was a "small, faint, slight condensation"; there was a "faint, slight condensation" on Nov. 14. The comet was "very faint and circular" on Nov. 15. A "new nuclear condensation of mag 13.8" appeared on Nov. 17, and a "strong nuclear condensation of diameter 10", with a stellar-appearing nucleus" was visible on Nov. 19. "No such nucleus" and "condensation ill-defined" was reported on Nov. 21. The coma may have been elongated NW-SE on Nov. 22. A new nuclear condensation of mag 13.3 was seen on Dec. 14. "Stellar nuclei" of magnitudes 13.5, 13.7, and 14.1 were seen on Dec. 14.99, 16.06, and 24.99, respectively. A 30" condensation was observed on Dec. 19, a "new nucleus" of mag 14.1 was seen on Dec. 24, and a sharp condensation was noted on Dec. 27.

Shoemaker (1984s): Cavagna found the coma elongated in p.a. 40° on Nov. 24, with a star-like central condensation of mag 13.1. Pearce noted a possible tail on Jan. 11; on Nov. 31, he remarked: "prominent central condensation; comet elongated east-west, extending some 2' in p.a. 80°." Pearce also noted a "slight condensation toward centre" on Jan. 27.

P/Schaumasse (1984m): Pearce found the comet "very diffuse" on Dec. 30, Jan. 22, and Jan. 27; he found it especially difficult to see on the last date. He also noted a "faint outer coma" on Jan. 23. Pearce noted the comet as "very large and diffuse" and "possibly elongated" on Dec. 29.

NEW ADDITIONS TO THE OBSERVER KEY (cf. ICQ 7, 17):

BUT		WADE BUTLER, AUSTRALIA
CON	05	DARRELL CONGER, WV, U.S.A.
GUA		CARLO GUALDONI, ITALY
LOC		A. LOCKE, AUSTRALIA
MCC03	05	MICHAEL MC CANTS, TX, U.S.A.
MEA		PHILIP MEAD, AUSTRALIA
MID	05	TOM MIDDLEBROOK, TX, U.S.A.
MIL03	05	MARTIN P. MILLER, CA, U.S.A.
REI01		JOHANN REIFBERGER, AUSTRIA
RIC	05	CHARLES L. RICKER, MI, U.S.A.

NEW ADDITIONS TO THE REFERENCE KEY:

E = One of E. Everhart's 3 Selected Area charts (1984, Sky Telesc. 67, p. 28).
EA = Selected Area 51: From Everhart (1984, Sky Telesc. 67, pp. 28-30).
EB = Selected Area 57: From Everhart (1984, Sky Telesc. 67, pp. 28-30).
EC = Selected Area 68: From Everhart (1984, Sky Telesc. 67, pp. 28-30).
OH = From listing of bright stars in Observers' Handbook, R.A.S.C.
[unsatisfactory new additions to the reference key:]
UL = Specific comet or planet mentioned as magnitude reference, but comparison object not above horizon at same time as comet OR no catalog listed
US = Skalnate Pleso Atlas

NEW ADDITION TO THE METHODS KEY:
K = "Modified" Sidgwick method, using binoculars with the comet in-focus in one eyepiece and with the comparison stars out-of-focus in the other eyepiece (cf. R. A. Keen 1985, ICQ 7, 48 [above]).

NOTE: A new "flag" has been inserted after the date for some observations (in the same place an asterisk is sometimes given to denote a revision of a previously-published observation): an exclamation mark (!) denotes that the observer has already corrected his magnitude estimate for atmospheric extinction in some manner.

(3200) 1983 TB

The following observations are published here because there has been speculation that this minor planet might be in its final stages as a comet which has lost most of its volatile ices. This past December, 1983 TB had a most favorable opposition, and none of the observations by astronomers indicated any evidence for a coma; the IAU Minor Planet Center thus decided in February to officially number the object as minor planet (3200). Alan Hale notes of his observations below: "I did not see any kind of brightness fluctuations which would be indicative of rotation."

DATE (UT)	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1984 12 12.33	B	12.9	AA	20	L	6	122		9			HAL
1984 12 15.28	B	12.9	AA	20	L	6	122		9			HAL
1984 12 17.26	B	12.8	AA	20	L	6	122		9			HAL
1984 12 18.01	I	12.9	AC	32	L	6	68	0.0	9			BOR
1984 12 23.29	B	13.2:	AA	20	L	6	122		9			HAL
1984 12 24.00	I	13.1	AC	32	L	6	68	0.0	9			BOR
1984 12 24.23	B	13.5	AA	20	L	6	122		9			HAL

Comet Seki (1961 VIII)

DATE (UT)	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1961 11 10.42				7.6	L	10	30	20				KEE
1961 11 10.42	B	4.7	SP	3.0	B		6					KEE
1961 11 11.42				7.6	L	10	30	20				KEE
1961 11 11.42	B	4.5	SP	3.0	B		6					KEE
1961 11 12.42				7.6	L	10	30	20				KEE
1961 11 12.42	B	4.0:	SP	3.0	B		6					KEE

Comet Seki-Lines (1962 III)

DATE (UT)	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1962 03 02.01	B	6.5:	US	5.0	R	4	5					KEE
1962 03 03.01	B	6.5:	US	5.0	R	4	5					KEE
1962 03 04.00	B	6.0:	US	5.0	R	4	5					KEE
1962 03 05.00	B	5.5:	US	5.0	R	4	5					KEE
1962 03 11.00	B	5.0:	US	5.0	R	4	5					KEE
1962 04 10.03	B	2.9	SP	5.0	R	4	5		9	12		KEE
1962 04 11.03	B	3.4	SP	5.0	R	4	5			8		KEE
1962 04 15.04	B	3.9	SP	5.0	R	4	5		8	0.33		KEE
1962 04 16.04	B	4.3	SP	5.0	R	4	5			0.25		KEE
1962 04 17.05	B	4.5	SP	5.0	R	4	5		8	0.67		KEE
1962 04 20.04	B	5.2	SP	5.0	R	4	5		6	0.50		KEE
1962 04 22.03	B	5.6	SP	5.0	R	4	5		6	0.75		KEE
1962 04 24.05	B	6.0	SP	5.0	R	4	5		6	0.83		KEE
1962 04 25.06	B	6.1	SP	5.0	R	4	5			1.25		KEE
1962 04 26.06	B	6.3	SP	5.0	R	4	5			0.50		KEE

Comet Seki-Lines (1962 III) Cont.

DATE (UT)	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1962 04 27.06	B	6.5	SP	5.0	R	4	5			0.67		KEE
1962 04 28.06	B	6.6	SP	5.0	R	4	5			0.50		KEE
1962 05 04.06	S	7.5:	US	15	L	5	40			0.08		KEE
1962 05 05.06	S	7.5:	US	15	L	5	40		5	0.25		KEE
1962 05 08.07	S	8.0:	US	15	L	5	40		5	0.25		KEE
1962 05 10.06	S	8.0:	US	15	L	5	40			0.50		KEE

Comet Ikeya (1963 I)

DATE (UT)	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1963 02 23.00	B	4.5:	SP	5.0	R	4	75					KEE
1963 02 23.00				15	L	5	27	5				KEE
1963 02 24.01	B	4.0	SP	5.0	R	4	5					KEE
1963 02 28.01	B	4.0	SP	5.0	R	4	5					KEE
1963 02 28.01				15	L	5	27	6		0.42		KEE
1963 03 04.02	B	4.3	SP	5.0	R	4	5					KEE
1963 03 04.02				15	L	5	27	4		0.33		KEE
1963 03 09.03	B	4.5	SP	5.0	R	4	5					KEE
1963 03 09.03				15	L	5	27	4		0.33		KEE
1963 03 11.02				15	L	5	27	4		0.25		KEE
1963 03 11.02	B	4.4	SP	5.0	R	4	5					KEE
1963 03 15.03	B	4.5	SP	5.0	R	4	5					KEE
1963 03 15.03				15	L	5	27	4		0.25		KEE
1963 03 18.02	B	4.4	SP	5.0	R	4	5					KEE
1963 03 18.02				15	L	5	27	3		0.25		KEE
1963 03 19.02				15	L	5	27	3		0.33		KEE
1963 03 19.02	B	4.4	SP	5.0	R	4	5					KEE
1963 03 23.02				15	L	5	27			0.50		KEE
1963 03 23.02	B	4.5	SP	5.0	R	4	5					KEE
1963 06 23.32	S	9 :		15	L	5	27	12				KEE

Comet Alcock (1963 III)

DATE (UT)	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1963 03 28.37	B	9 :		15	L	5	27	4				KEE
1963 04 21.21	B	8.0:	US	5.0	R	4	5	5				KEE
1963 04 28.23	B	7.5:	US	5.0	R	4	5	6				KEE
1963 05 12.19	B	7.5:	US	5.0	R	4	5	5				KEE
1963 05 19.18	B	5.5:	US	5.0	R	4	5	10				KEE
1963 05 25.27	B	6.5:	US	5.0	R	4	5	13				KEE
1963 06 14.15	B	6.0:	US	5.0	R	4	5	7				KEE

Comet Ikeya (1964 VIII)

DATE (UT)	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1964 07 31.37	S	5 :	SP	15	L	5	27	5				KEE
1964 08 04.37				15	L	5	27	9		0.67		KEE
1964 08 04.37	B	4.3	SP	5.0	R	4	5					KEE
1964 08 07.38	S	4 :	SP	15	L	5	27	8				KEE

Comet Ikeya-Seki (1965 VIII)

DATE (UT)	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1965 10 26.48	! I	2.1	OH	3.0	B		6					KEE
1965 10 26.48	! B	1.1	OH	3.0	B		6			9		KEE

Comet Ikeya-Seki (1965 VIII) Cont.

DATE (UT)	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1965 10 27.48	! I	2.3	OH	3.0	B		6					KEE
1965 10 27.48	! B	1.3	OH	3.0	B		6			16		KEE
1965 10 28.48	! B	2.5	OH	3.0	B		6			17		KEE
1965 10 28.48	! I	3.0	OH	3.0	B		6					KEE
1965 10 31.47				3.0	B		6			19		KEE
1965 11 01.47	I	4.5	SP	3.0	B		6					KEE
1965 11 01.47	B	3.3	SP	3.0	B		6			23		KEE
1965 11 02.47	B	3.5	SP	3.0	B		6			25		KEE
1965 11 02.47	I	5.0	SP	3.0	B		6					KEE
1965 11 04.47	B	3.8	SP	3.0	B		6			26		KEE
1965 11 04.47	I	5.5	SP	3.0	B		6					KEE
1965 11 14.46	B	6.0:	SP	15	L	8	42			1		KEE

Comet Kilston (1966 V)

DATE (UT)	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1966 08 16.27	S	10.5:		47	R	15	220					KEE
1966 08 17.17	S	10.5:		47	R	15	220					KEE
1966 08 18.11	S	10.5:		47	R	15	220	0.4				KEE
1966 08 19.13	S	10.5:		47	R	15	220	0.4				KEE
1966 08 20.22	S	10.5:		47	R	15	220					KEE
1966 08 24.15	S	10.0:		47	R	15	220	0.5				KEE
1966 08 26.20	S	10.0:		47	R	15	220					KEE

Comet Rudnicki (1967 II)

DATE (UT)	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1966 12 18.97	S	8.0:	US	15	L	5	42	3				KEE
1966 12 25.97	S	7.0:	US	15	L	5	42	4				KEE
1966 12 26.96	S	7.0:	US	15	L	5	42	3				KEE
1966 12 27.95	S	7.0:	US	15	L	5	42	2				KEE
1966 12 29.96	S	7.0:	US	15	L	5	42	3				KEE
1966 12 30.96	S	6.5:	US	15	L	5	42	3				KEE

Comet Ikeya-Seki (1968 I)

DATE (UT)	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1968 03 23.20	S	7.5:	US	15	L	5	42	3		?		KEE
1968 03 24.12	S	7.5:	US	15	L	5	42					KEE
1968 03 25.21	S	7.5:	US	15	L	5	42	2		0.08		KEE

Comet Honda (1968 VI)

DATE (UT)	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1968 09 06.17	S	6 :	US	3.0	B		6					KEE
1968 09 25.19	S	7 :	US	5.0	R	4	5					KEE

Comet Tago-Sato-Kosaka (1969 IX)

DATE (UT)	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1970 01 16.03	B	3.5:	US	0.9	E		1					KEE
1970 01 18.01				3.0	B		6			1.0		KEE
1970 01 18.01	B	3.5:	US	0.9	E		1					KEE
1970 01 22.03	B	4.0:	US	0.9	E		1					KEE
1970 01 22.03				3.0	B		6			1.5		KEE

Comet Tago-Sato-Kosaka (1969 IX) Cont.

DATE (UT)	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1970 01 24.02	B	4.0:	US	0.9	E		1					KEE
1970 01 24.02				3.0	B		6			1.5		KEE
1970 01 25.06	B	4.5:	US	0.9	E		1					KEE
1970 01 26.10	B	4.5:	US	0.9	E		1					KEE
1970 01 26.10				3.0	B		6			0.5		KEE
1970 01 27.05	B	4.5:	US	0.9	E		1					KEE
1970 01 27.05				3.0	B		6			1.25		KEE
1970 01 30.07	B	5.0:	US	0.9	E		1					KEE
1970 01 30.07				3.0	B		6			0.75		KEE
1970 01 31.05				3.0	B		6			1.0		KEE
1970 01 31.05	B	5.0:	US	0.9	E		1					KEE
1970 02 01.09	B	5.5:	US	0.9	E		1					KEE
1970 02 01.09				3.0	B		6			0.75		KEE
1970 02 02.04	K	5.5:	US	3.0	B		6			1.0		KEE
1970 02 03.14	K	5.5:	US	3.0	B		6					KEE
1970 02 04.10	K	5.8	SP	3.0	B		6					KEE
1970 02 05.09	K	5.8	SP	3.0	B		6			0.5		KEE
1970 02 06.10	K	6.0	SP	3.0	B		6					KEE
1970 02 07.14	K	5.4	SP	3.0	B		6					KEE
1970 02 08.06	K	5.7	SP	3.0	B		6					KEE
1970 02 09.10	K	5.6	SP	3.0	B		6			0.75		KEE
1970 02 10.11	K	5.3	SP	3.0	B		6					KEE
1970 02 11.03	K	5.4	SP	3.0	B		6					KEE
1970 02 12.09	K	5.7	SP	3.0	B		6					KEE
1970 02 13.07	K	5.9	SP	3.0	B		6					KEE
1970 02 14.05	K	6.2	SP	3.0	B		6					KEE
1970 02 15.11	K	6.4	SP	3.0	B		6					KEE
1970 02 16.05	K	6.6	SP	3.0	B		6					KEE
1970 02 20.05	K	7.0:	US	3.0	B		6					KEE
1970 02 22.07	K	7.5:	US	3.0	B		6					KEE

Comet Bennett (1970 II)

DATE (UT)	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1970 03 16.43	! B	0.0:	OH	0.9	E		1			5		KEE
1970 03 17.45	! B	0.0	OH	0.9	E		1			1		KEE
1970 03 18.45	! B	0.2	OH	0.9	E		1			1		KEE
1970 03 19.44	! B	0.0	OH	0.9	E		1			4		KEE
1970 03 20.44	! B	0.0	OH	0.9	E		1			4		KEE
1970 03 21.44	! B	0.3	OH	0.9	E		1			4		KEE
1970 03 28.45	! B	0.7	OH	0.9	E		1			2		KEE
1970 03 29.44	! B	0.7	OH	0.9	E		1			3		KEE
1970 03 30.44	! B	1.2	OH	0.9	E		1			2		KEE
1970 03 31.41	! B	0.8	OH	0.9	E		1			5		KEE
1970 04 02.43	! B	1.1	OH	0.9	E		1			5		KEE
1970 04 04.42	! B	1.3	OH	0.9	E		1			13		KEE
1970 04 05.42	! B	1.5	OH	0.9	E		1			12		KEE
1970 04 16.38	! B	2.5	OH	0.9	E		1			7		KEE

Comet Toba (1971 V)

DATE (UT)	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1971 05 13.40	S	7.5:	US	15	L	5	42	4				KEE

Comet Kohoutek (1973 XII)

DATE (UT)	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1973 11 13.50	S	7.0:	US	15	L	5	48	4		0.17		KEE
1973 12 05.53	S	5.0:	US	15	L	5	48	2		0.58		KEE
1973 12 15.55	S	3.5:	US	5.0	R	4	5					KEE
1974 01 12.06	B	3.5:	US	0.9	E		1			10		KEE
1974 01 15.08	K	4.5	SP	3.0	B		6			5		KEE
1974 01 16.09	K	3.9	SP	3.0	B		6			4		KEE
1974 01 19.08	K	4.7	SP	3.0	B		6					KEE
1974 01 25.10	K	5.4	SP	3.0	B		6			8		KEE
1974 01 26.11	K	5.6	SP	3.0	B		6			2		KEE
1974 01 28.08	K	5.8	SP	3.0	B		6			2		KEE
1974 01 29.11	S	6.2	SP	5.0	R	4	5					KEE

Comet Bradfield (1974 III)

DATE (UT)	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1974 04 01.18	K	4.6	SP	3.0	B		6			1.0		KEE
1974 04 08.19	K	5.4	SP	3.0	B		6			2.0		KEE
1974 04 12.23	K	5.6	SP	3.0	B		6			1.0		KEE
1974 04 15.24	K	6.3	SP	3.0	B		6					KEE
1974 04 15.24				15	L	5	40	3		0.5		KEE
1974 04 16.49	K	6.7	S	3.0	B		6					KEE
1974 05 16.32	S	9.0	S	15	L	5	40	3		?	180	KEE

Comet Kobayashi-Berger-Milon (1975 IX)

DATE (UT)	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1975 07 31.33	B	4.8	SP	0.9	E		1					KEE
1975 08 01.19	B	4.8	SP	0.9	E		1					KEE
1975 08 03.28	B	4.9	SP	0.9	E		1					KEE
1975 08 04.20	B	4.7	SP	0.9	E		1					KEE
1975 08 05.25	B	4.6	SP	0.9	E		1					KEE
1975 08 07.21	B	4.8	SP	0.9	E		1					KEE
1975 08 08.23	B	4.7	SP	0.9	E		1					KEE
1975 08 09.25	B	4.7	SP	0.9	E		1					KEE
1975 08 10.23	B	4.8	SP	0.9	E		1					KEE
1975 08 15.19	K	5.3	SP	3.0	B		6					KEE
1975 08 25.14	K	4.3	SP	3.0	B		6					KEE
1975 08 26.15	K	4.3	SP	3.0	B		6			1.17		KEE
1975 09 01.13				15	L	5	28			1.67		KEE
1975 09 01.13	K	4.3	SP	3.0	B		6					KEE

Comet Suzuki-Saigusa-Mori (1975 X)

DATE (UT)	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1975 10 27.50	* K	5.5	SP	3.5	B		7	15				KEE
1975 10 27.50				15	L	5	28			0.33	335	KEE

Comet Mori-Sato-Fujikawa (1975 XII)

DATE (UT)	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1975 10 27.52	S	8.5:	S	15	L	5	28	4				KEE
1975 10 30.40	* S	8.6	S	15	L	5	28	4				KEE
1975 11 11.45	S	8.2	S	15	L	5	28					KEE

Comet West (1976 VI)

DATE (UT)	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1976 02 22.05	I-	1 :	UL	3.5	B		7					KEE
1976 02 23.05	I-	1 :	UL	3.5	B		7			0.25		KEE
1976 02 24.05	I-	1 :	UL	3.5	B		7	1		0.17		KEE
1976 03 05.49	! B	0.0	SP	0.9	E		1			23		KEE
1976 03 06.49	! B	0.4	SP	0.9	E		1			30		KEE
1976 03 07.49	! B	0.6	SP	0.9	E		1			29		KEE
1976 03 08.50	! B	0.6	SP	0.9	E		1			29		KEE
1976 03 09.48	! B	0.8	SP	0.9	E		1			30		KEE
1976 03 10.48	! B	1.0	SP	0.9	E		1			28		KEE
1976 03 13.47	! B	1.6	SP	0.9	E		1			20		KEE
1976 03 19.46	! B	2.3	SP	0.9	E		1			6		KEE
1976 03 21.46	B	3 :	SP	0.9	E		1			4		KEE
1976 03 24.38	B	3 :	SP	0.9	E		1			3		KEE
1976 03 27.35	K	4.0	SP	3.0	B		6			2		KEE
1976 04 05.48	K	4.8	SP	3.5	B		7			2.5		KEE
1976 04 10.42	B	5.5	SP	0.9	E		1					KEE
1976 04 10.42				15	L	3	16			4.5		KEE
1976 04 18.45	K	6.1	SP	3.5	B		7					KEE
1976 04 21.38	K	6.3	SP	3.5	B		7					KEE
1976 04 25.40	B	6.0	SP	0.9	E		1					KEE
1976 05 01.38	K	6.3	SP	5.0	B		7			2.0		KEE

Comet Bradfield (1979 X)

DATE (UT)	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1980 01 31.13	K	5.5	SP	3.5	B		7					KEE
1980 02 05.06	K	7.0	S	3.5	B		7					KEE
1980 02 09.17	S	8.2	S	15	L	3	16					KEE
1980 02 12.15	S	8.1	S	15	L	3	28					KEE
1980 02 19.16	S	8.7	S	15	L	3	28					KEE
1980 02 23.13	S	9.2	S	32	L	4	45					KEE

Comet Bradfield (1980 XV)

DATE (UT)	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1981 01 05.04	S	3.0:	SP	3.5	B		7			3		KEE
1981 01 07.05	B	3.7	SP	0.9	E		1					KEE
1981 01 08.06	B	4.0	SP	0.9	E		1					KEE
1981 01 09.06	S	4.8	SP	3.0	B		6					KEE
1981 01 10.06	S	5.1	SP	3.0	B		6					KEE
1981 01 11.07	S	5.5	SP	15	L	3	16			0.5		KEE
1981 01 13.06	S	4.8	SP	3.0	B		6					KEE
1981 01 14.06	S	5.1	SP	3.0	B		6					KEE
1981 01 21.05	S	7.1	S	11	L	4	16					KEE
1981 01 22.05	S	7.1	S	11	L	4	16					KEE

Comet Panther (1981 II)

DATE (UT)	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1981 01 07.07	S	9.2	S	32	L	4	78					KEE
1981 03 12.27	S	9.1	S	32	L	4	78					KEE

Comet Austin (1984i)

DATE (UT)	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1984 08 28.51	S	5.9	S	5.0	B		10					HAL
1984 08 31.51	S	6.1	S	5.0	B		10			1		HAL
1984 09 02.14	B	6.5	AA	10.0	B		14	2.6	4			HAS02
1984 09 03.11	B	6.6	AA	10.0	B		14	2.6	5			HAS02
1984 09 04.51	S	6.8	S	5.0	B		10			1.5		HAL
1984 09 14.14	B	7.8	S	10.0	B		14	5.4	4			HAS02
1984 09 29.10	B	7.9	S	8.0	B		20	7.5	3			KOC01
1984 09 29.11	B	8.8	S	20.5	L	4	52	6.0	3			KOC01
1984 09 30.11	B	8.5	S	10.0	B		14	6.7	2			HAS02
1984 09 30.13	B	8.5	S	20.5	L	4	52	6.5	2			KOC01
1984 10 02.95	B	8.5	S	10.0	B		14	7.0	2			HAS02
1984 10 16.85	S	10.5	S	12.7	T	10	60	4.0	2			HAS02
1984 10 18.85	S	8.5	A	8.0	B		20	8	0/			BOU
1984 10 18.86	S	8.4	A	15.6	L	5	24	8	1			BOU
1984 10 21.92	S	8.5	A	8.0	B		20					BOU
1984 10 21.92	S	8.5	A	15.6	L	5	24	8	1	0.35	93	BOU
1984 10 24.01	S	8.6	A	15.6	L	5	24	9	0/	0.4	85	BOU
1984 10 27.84	S	8.6	A	10.8	L		20	8	0/			BOU
1984 10 28.82	S	8.8	A	10.8	L		20	9	0/			BOU
1984 10 29.87				25.4	J	6	48			0.3	68	BOU
1984 10 29.87	S	8.8	A	10.8	L		20	8	0/			BOU
1984 10 30.91	S	8.7	A	8.0	B		15	10	1			BOU
1984 10 30.91				25.4	J	6	48			0.3	71	BOU
1984 11 02.04	S	8.9	A	8.0	B		15	9	0/			BOU
1984 11 12.75	S	11.3	A	22.5	R	10	55					COM
1984 11 22.83				25.4	J	6	48	& 8.5	0			BUS01
1984 11 24.86				25.4	J	6	48	& 5.5				BOU

Comet Levy-Rudenko (1984t)

DATE (UT)	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1984 11 17.01	M	9.6	AA	15	L	8	38	1.6	3			DEY
1984 11 17.98	M	9.3	AA	15	L	8	38	1.8	3			DEY
1984 11 18.15	S	9.8	AA	20	L	6	61		4			HAL
1984 11 20.84	S	9.1	AC	25.4	L	4	49	2.6	3/			CAV
1984 11 20.96	M	9.4	AA	30.5	R	15	83	1.9	4			DEY
1984 11 21.02	M	9.3	AA	15	L	8	38	1.9	4			DEY
1984 11 21.78	S	8.8	A	15.6	L	5	29	2.8	4			BOU
1984 11 21.96	M	9.3	AA	30.5	R	15	83	1.9	3			DEY
1984 11 22.97	M	9.3	AA	15	L	8	38	2.0	3			DEY
1984 11 23.97	M	9.0	AA	15	L	8	38	2.2	4			DEY
1984 11 24.75	S	9.5	AA	20	L	4	76	2	4			GUA
1984 11 24.80	S	8.4	A	15.6	L	5	29	3.6	5			BOU
1984 11 24.96	M	9.1	AA	15	L	8	38	2.3	4			DEY
1984 11 25.72	S	8.1	A	22.5	R	10	55		7			COM
1984 11 25.97	M	9.0	AA	15	L	8	38	2.4	5			DEY
1984 11 26.83	S	8.2	A	8.0	B		20		1/			BOU
1984 11 26.83	S	8.3	A	8.0	B		20					BUS01
1984 11 26.99	M	9.2	AA	15	L	8	38	3.3	5			DEY
1984 11 27.97	M	8.9	AA	15	L	8	38	2.9	4			DEY
1984 11 29.11	S	9.2	S	20	L	10	77	3	1			DUC
1984 11 29.97	M	8.6	AA	30.5	R	15	83	2.8	6			DEY
1984 11 30.72	S	7.9	A	25.4	J	6	72					BUS01
1984 11 30.77	S	8.8	A	25.4	L		70	2.5	5/			KUI
1984 11 30.98	M	8.8	AA	30.5	R	15	83	1.8	5			DEY

Comet Levy-Rudenko (1984t) Cont.

DATE (UT)	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1984 12 02.97	S	9.1	AC	6	R	15	50	1.5				MOR03
1984 12 03.99	M	8.6	AA	15	L	8	38	2.5	5			DEY
1984 12 04.10	S	8.8	S	20	L	10	77	3	1			DUC
1984 12 08.71	S	8.5	AA	8.0	B	5	20	3	2			MIL02
1984 12 08.96	M	8.5	AA	15	L	8	38	2.7	4			DEY
1984 12 09.70	S	8.5	AA	8.0	B	5	20	4	3			MIL02
1984 12 09.71	S	8.5	AA	20	L	4	40	2.7	5			GUA
1984 12 09.71	S	8.6	AA	25.4	L	4	49	2.7	4			CAV
1984 12 11.97	M	8.4	AA	15	L	8	38	2.9	4			DEY
1984 12 12.10	M	8.3	NP	8.0	B		20	4.7	7/	0.53	60	MOR
1984 12 12.10	M	8.4	S	25.6	L	4	45	4.7	6	0.53	60	MOR
1984 12 12.75	S	8.5	AA	5.0	B		10					REI01
1984 12 13.08	S	8.4	S	20	L	10	77	3	1			DUC
1984 12 13.72	S	8.7	AA	5.0	B		10					REI01
1984 12 14.08	S	8.4	S	20	L	10	77	3	1			DUC
1984 12 15.72	S	8.3	AA	8.0	B	5	20		2			MIL02
1984 12 15.97	M	8.4	AA	15	L	8	38	3.1	3			DEY
1984 12 17.97	M	8.5	AA	30.5	R	15	83	2.4	4			DEY
1984 12 18.72	S	8.0	A	8.0	B		15					FEI
1984 12 18.80	S	7.6	A	15.6	L	5	29		5			BOU
1984 12 21.71	S	8.3	AA	8.0	B	5	20	5	3			MIL02
1984 12 21.73	S	7.7	A	6.7	R		12	5	5/			BUS01
1984 12 22.58	S	8.2	S	13.1	R	7	27	4	4			MAC
1984 12 22.71	S	8.3	AA	8.0	B	5	20	4	3			MIL02
1984 12 22.79	S	7.5	A	8.0	B		20		4/	0.4	60	BOU
1984 12 22.79	S	7.7	A	5.0	B		7		7			COM
1984 12 22.98	M	8.5	AA	15	L	8	38	2.9	6			DEY
1984 12 23.08	M	8.2	S	8.0	B		20		7			MOR
1984 12 23.72	S	8.2	AA	8.0	B	5	20	5	3			MIL02
1984 12 23.97	M	8.4	AA	15	L	8	38	3.2	5			DEY
1984 12 24.58	S	8.3	S	13.1	R	7	27	4	5			MAC
1984 12 25.58	S	8.2	S	13.1	R	7	27	4	5			MAC
1984 12 25.71	S	8.1	AA	8.0	B	5	20	6	4			MIL02
1984 12 25.72	S	8.2	A	8.0	B		15	5	5			FEI
1984 12 25.73	S	7.6	A	10.8	L		18	5	6			BUS01
1984 12 25.75	S	8.2	A	11.5	L		36	4	4			KUI
1984 12 25.75	S	8.0	A	8.0	B		20		6			COM
1984 12 25.75	S	7.5	A	8.0	B		20	6	3/	0.3	65	BOU
1984 12 26.47	M	8.7	AA	15	L	8	38	3.2	5			DEY
1984 12 28.10	S	8.3	S	20	L	10	77	3.5	2			DUC
1984 12 28.55	S	8.2	S	20	L	10	77	4	3			DUC
1984 12 29.46	M	8.6	AA	15	L	8	38	4.7	4			DEY
1984 12 29.56	S	8.0	AA	20	L	6	61			0.3		HAL
1984 12 29.57	S	8.4	S	13.1	R	7	27	5	5			MAC
1984 12 29.58	S	8.3	S	20	L	10	77	4	3			DUC
1984 12 29.97	M	8.7	AA	30.5	R	15	83	2.0	3			DEY
1984 12 29.97	M	8.4	AA	10.8	R		40	3.7	3			DEY
1984 12 30.19	S	8.4	A	8.0	B		20		7			COM
1984 12 30.19	S	7.5	A	8.0	B		20	6	4			BOU
1984 12 30.57	S	8.2	S	20	L	10	77	4.5	3			DUC
1984 12 30.71	S	7.9	AA	8.0	B	5	20					MIL02
1984 12 31.54	S	8.3	AA	8.0	B		20		8			MOR
1984 12 31.55	M	8.1	AA	25.6	L	4	45	3.5	7			MOR
1985 01 01.58	S	8.5	S	25.4	L	4	32	6	5			MAC
1985 01 02.56	S	8.3	S	20	L	10	77	5	4			DUC

Comet Levy-Rudenko (1984t) Cont.

DATE (UT)	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1985 01 03.55	M	7.8	AA	8.0	B		20		6/	0.28	15	MOR
1985 01 03.57	S	8.2	S	25.4	L	4	32	6	6			MAC
1985 01 04.47	S	8.3	AC	6	R	15	36	3.5	2			MOR03
1985 01 05.47	S	8.5	AC	6	R	15	36	3	2			MOR03
1985 01 06.47	M	8.4	AA	15	L	8	38	5.0	4			DEY
1985 01 09.45	S	8.1	AC	6	R	15	36	3				MOR03
1985 01 11.58	S	8.5	S	20	L	10	77	5.5	4			DUC
1985 01 12.75	S	8.2	A	8.0	B		20		2			BOU
1985 01 13.43	M	8.3	AA	15	L	8	38	3.0	4			DEY
1985 01 14.47	M	8.3	AA	15	L	8	38	4.8	5			DEY
1985 01 15.43	S	8.9	AC	6	R	15	36	3.5				MOR03
1985 01 15.47	M	8.2	AA	15	L	8	38	5.3	5			DEY
1985 01 15.52	S	8.6	S	20	L	10	77	5	4			DUC
1985 01 16.45	M	8.2	AA	15	L	8	38	4.5	4			DEY
1985 01 18.53	M	7.8	AA	8.0	B		20	4.5	5	0.50	305	MOR
1985 01 19.54	S	7.7	AA	5.0	B		10					HAL
1985 01 20.53	M	8.1	AA	8.0	B		20	4.1	5	0.33	320	MOR
1985 01 21.46	M	8.5	AA	15	L	8	38	5.5	3			DEY
1985 01 23.46	M	8.5	AA	15	L	8	38	4.3	3			DEY
1985 01 26.44	M	8.9	AA	15	L	8	38	4.3	2			DEY
1985 01 27.75	S	7.5	AA	8.0	B	5	20	8	2			MIL02
1985 01 28.23	S	8.1	A	11.5	L		22	6.5	3			KUI
1985 01 28.44	S	8.0	AA	5.0	B		12		3			MOR
1985 01 29.44	M	9.2	AA	15	L	8	38	3.0	2			DEY
1985 01 30.40	M	9.0	AA	15	L	8	38	3.8	2			DEY
1985 01 31.52	M	8.2	AA	25.6	L	4	45	6.7	5			MOR
1985 01 31.53	S	8.0	AA	8.0	B		20	7.5	4			MOR
1985 02 10.01	M	8.8	AA	15	L	8	38	5.9	3			DEY
1985 02 10.20	S	8.2	AA	5.0	B		12		2			MOR
1985 02 13.25	S	8.1	NP	8.0	B		20	8	3			MOR
1985 02 14.45	M	9.2	AA	15	L	8	38	3.8	1			DEY
1985 02 16.46	M	9.5:	AA	15	L	8	38	3.6	1			DEY
1985 02 17.03	M	9.1	AA	15	L	8	38	5.8	4			DEY
1985 02 19.89	S	9.7	AC	8.0	B		20	7	3			CAV
1985 02 19.93	S	8.6	AA	8.0	B	5	20	7	2			MIL02
1985 02 20.15	M	9.8	AA	15	L	8	38	2.3	2			DEY
1985 02 20.28	S	8.6	AA	20	L	6	61		2			HAL
1985 02 23.48	S	8.8	AA	8.0	B		20	10	1			MOR
1985 02 23.54	S	8.8	AA	25.6	L	4	45	9	2			MOR
1985 02 24.29	S	8.8	AA	25.6	L	4	45	8	2			MOR
1985 02 24.30	M	9.9	AA	15	L	8	38	4.9	3			DEY
1985 03 01.49	S	9.6	AA	25.6	L	4	45	3.9	1			MOR

Comet Shoemaker (1984f)

DATE (UT)	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1985 01 18.56	S	13.0	AC	25.6	L	4	156	& 1				MOR
1985 01 20.55	S	13.0	AC	25.6	L	4	111	1.0	6			MOR
1985 02 16.52	S	12.2	AA	20	L	6	122	0.8	6/			HAL
1985 02 23.50	S	12.4	AC	25.6	L	4	111	0.9	6			MOR
1985 03 01.46	M	12.3	AC	25.6	L	4	111	0.8	6			MOR

Comet Shoemaker (1984s)

DATE (UT)	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1984 11 17.18	S	11.1	AC	15	L	8	38	1.5	6			DEY
1984 11 19.10	S	12.5	AC	15	R	5	62	1.0	2			MOR03
1984 11 24.83	S	10.5	A	25.4	J	6	59	2.2	4			BOU
1984 11 24.83	S	10.6	A	15.6	L	5	29					BOU
1984 11 24.87	S	11.0	AC	20	L	4	76	1.1	8			GUA
1984 11 24.89	S	10.8	AC	25.4	L	4	79	1.2	9	?	40	CAV
1984 11 25.77	S	11.5	A	22.5	R	10	55		4			COM
1984 11 26.94	S	10.5	A	25.4	J	6	59	2	5/			BUS01
1984 11 26.95	S	10.6	A	25.4	J	6	59	1.5	5			BOU
1984 11 31.71	S	10.8	AC	25	L	9	71	1.8	6		80	PEA
1984 12 01.72	S	10.6	AC	25	L	9	71	1.75	6	0.05	78	PEA
1984 12 12.14	M	10.4	NP	25.6	L	4	67	1.4	8	0.07	50	MOR
1984 12 13.21	S	9.5	S	20	L	10	77	3	1			DUC
1984 12 14.46	S	10.4	AC	8.0	B		15					SEA
1984 12 17.46	S	10.3	AC	8.0	B		15					SEA
1984 12 20.55	S	10.3	AC	15.2	L	5	72	1.2	5		50	PEA
1984 12 21.46	S	10.4	AC	8.0	B		15					SEA
1984 12 21.56	S	10.3	AC	15.2	L	5	72	1.2	4/	0.08	52	PEA
1984 12 22.46	S	10.7	A	20	L	6	50		6			LOV
1984 12 22.83	S	9.8	A	25.4	J	6	48	2.5	4/			BOU
1984 12 22.87	S	10.0	A	25.4	J	6	48		4			COM
1984 12 23.19	M	10.7	NP	25.6	L	4	67	1.6	7	0.10	80	MOR
1984 12 23.77	S	9.8	A	8.0	B		20		0/			BOU
1984 12 23.80	S	10.3	A	25.4	J	6	126		4/			COM
1984 12 23.80	S	9.9	A	25.4	J	6	59		4/			BOU
1984 12 25.79	S	9.9	A	25.4	J	6	48	2.3	5			BOU
1984 12 25.79	S	10.4	A	25.4	J	6	48		5			COM
1984 12 27.88	S	10.3	A	25.4	J	6	48		7	0.25		COM
1984 12 27.88	S	9.7	A	25.4	J	6	48	2.3	6	0.17	45	BOU
1984 12 28.93	S	9.7	A	25.4	J	6	48	2.8	3/			BOU
1984 12 28.93	S	10.6	A	25.4	J	6	48		7			COM
1985 01 10.56	S	10.4	VN	15.2	L	5	30	0.8				PEA
1985 01 11.55	S	10.4	VN	15.2	L	5	30	1				PEA
1985 01 12.55	S	10.5	VN	15.2	L	5	30	1				PEA
1985 01 15.48	S	10.8	A	20	L	6	50		5			LOV
1985 01 16.24	M	10.3	AC	25.6	L	4	67	1.1	8	0.05	40	MOR
1985 01 16.44	S	10.7	A	20	L	6	50	2.0	5			LOV
1985 01 27.72	S	11.7	VN	41	L	4	86	1.1	3			PEA
1985 02 10.18	M	11.3	NP	25.6	L	4	111		5			MOR
1985 02 13.15	S	11.9	NP	25.6	L	4	111	2.2	3			MOR
1985 02 24.20	S	12.8	NP	25.6	L	4	111	1.4	5			MOR

Periodic Comet Encke (1971 II = 1980 XI)

DATE (UT)	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1970 11 20.07	S	11 :		6.3	R	6	21					KEE
1970 11 26.04	S	10 :		6.3	R	6	21		3			KEE
1970 12 18.02	S	7 :	US	6.3	R	6	21					KEE
1980 11 11.52	S	6.7	S	15	L	3	16					KEE

Periodic Comet Clark (1983w)

DATE (UT)	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1984 07 04.42	! S	10.9	AC	25.6	L	4	67	1.7	3/			MOR
1984 07 26.33	S	11.0	AA	20	L	6	61					HAL

Periodic Comet d'Arrest (1976 XI)

DATE (UT)	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1976 08 13.33	S	7 :	US	3.5	B		7	20				KEE
1976 08 16.21	K	6.3	SP	3.5	B		7					KEE
1976 08 20.30	B	5.7	SP	0.9	E		1					KEE
1976 08 21.36	B	5.6	SP	0.9	E		1	30				KEE
1976 08 22.35	B	5.5	SP	0.9	E		1					KEE
1976 08 23.37	B	5.6	SP	0.9	E		1					KEE
1976 08 25.35	B	5.7	SP	0.9	E		1					KEE
1976 08 26.38	B	5.5	SP	0.9	E		1					KEE
1976 08 28.40	B	5.6	SP	0.9	E		1					KEE
1976 08 29.35	B	5.3	SP	0.9	E		1					KEE
1976 10 29.29	S	8 :	S	15	L	3	29	8				KEE

Periodic Comet Kopff (1983 XIII)

DATE (UT)	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1983 07 29.21	S	7.9	S	15	L	3	17					KEE

Periodic Comet Arend-Rigaux (1984k)

DATE (UT)	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1984 11 24.42	S	12.5	AA	20	L	6	122	0.5	4/			HAL
1984 12 01.16	S	12.6:	A	25.4	J	6	59					BOU
1984 12 02.41	S	12.4	AA	20	L	6	122		6			HAL
1984 12 22.98	S	13.0:	A	40.6	L		102		5			COM
1984 12 22.98	S	12.6	A	40.6	L		102	1	6			BOU
1984 12 23.44	S	12.3	AA	20	L	6	122					HAL
1984 12 23.94	S	12.1	A	25.4	J	6	73		2/			BOU
1984 12 26.02	S	11.9	A	25.4	J	6	59	1.5	3/			BOU
1984 12 26.02	S	12.4	A	25.4	J	6	59		3			COM
1984 12 27.01	S	12.6	A	40.6	L		82		1			COM
1984 12 28.01	S	12.3	A	40.6	L		82		3			BOU
1984 12 29.13	S	12.4	A	25.4	J	6	59		1			COM
1984 12 29.13	S	12.0	A	25.4	J	6	59	1.4	4			BOU
1984 12 29.42	S	12.3	AA	20	L	6	122					HAL
1984 12 29.71	S	12.4	AC	15.2	L	5	72	0.8				PEA
1984 12 30.16	S	12.1	A	25.4	J	6	59		4			BOU
1984 12 30.16	S	12.5	A	25.4	J	6	59		1/			COM
1984 12 30.72	S	12.3	AC	15.2	L	5	72	0.7				PEA
1984 12 31.48	M	11.8	AC	25.6	L	4	111	0.63	6/	?	300	MOR
1985 01 03.50	S	11.8	AC	25.6	L	4	111	1.3	4			MOR
1985 01 14.30	S	12.5	AA	20	L	6	122	0.2	8			HAL
1985 01 15.25	M	12.0	NP	25.6	L	4	111	0.8	7			MOR
1985 01 16.22	M	12.2	NP	25.6	L	4	111	1.0	7			MOR
1985 01 18.48	M	12.2	NP	25.6	L	4	111	0.7	4/			MOR
1985 01 19.42	S	12.1	AA	20	L	6	122					HAL
1985 01 20.47	M	12.0	NP	25.6	L	4	111	0.7	7/	0.05	260	MOR
1985 01 27.73	S	12.2	VN	41	L	4	86	1.2	4			PEA
1985 01 31.51	S	11.9	NP	25.6	L	4	111	0.8	7			MOR
1985 02 13.19	S	13.3	NP	25.6	L	4	156	0.74	4			MOR
1985 02 16.45	M	14.4	AC	61.0	C	16	271	0.65	7			MOR
1985 02 24.34	M	13.3	NP	47.0	L	4	145		7/			MOR
1985 02 24.35	M	13.3	NP	25.6	L	4	111		7/			MOR

Periodic Comet Tsuchinshan 1 (1984p)

DATE (UT)	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1984 12 23.00	S	12.3	A	40.6	L		82		4			COM
1984 12 23.00	S	12.4	A	40.6	L		82	1.75	1			BOU
1984 12 23.95	S	12.4	A	40.6	L		82	2	1			BOU
1984 12 23.95	S	12.2	A	40.6	L		82		2			BOU
1984 12 26.03	S	12.4	A	25.4	J	6	59					COM
1984 12 26.03	S	12.2	A	25.4	J	6	59	2	1			BOU
1984 12 27.02	S	12.5	A	40.6	L		67		2			COM
1984 12 28.02	S	11.9	A	40.6	L		67	2.7	0/			BOU
1984 12 28.02	S	12.0	A	25.4	J	6	59	2.3	0			BOU
1984 12 29.13	S	11.5	A	25.4	J	6	48	3.5	0/			BOU
1984 12 29.13	S	12.3	A	25.4	J	6	48		2			COM
1984 12 29.49	S	11.2	AA	20	L	6	61	2	1			HAL
1984 12 30.17	S	12.3	A	25.4	J	6	48		2/			COM
1984 12 30.17	S	11.4	A	25.4	J	6	48	3.5	0/			BOU
1984 12 31.45	M	10.8	AC	25.6	L	4	67	2.9	3			MOR
1985 01 01.47	S	10.7	AA	20	L	6	61		1			HAL
1985 01 03.52	S	11.0	AC	25.6	L	4	67	3.5	2			MOR
1985 01 15.26	S	11.1	NP	25.6	L	4	67	3.4	1/			MOR
1985 01 16.26	S	11.2	NP	25.6	L	4	67	3.4	1/			MOR
1985 01 18.50	M	10.7	NP	25.6	L	4	67	3.8	3			MOR
1985 01 19.45	S	10.6	AA	20	L	6	61		1			HAL
1985 01 20.48	M	10.7	NP	25.6	L	4	45	5.9	3			MOR
1985 01 22.75	S	11.5	VN	15.2	L	5	72	2	2			PEA
1985 01 23.76	S	11.3	VN	15.2	L	5	30	2.5	2			PEA
1985 01 27.74	S	11.1	VN	41	L	4	67	3.2	2			PEA
1985 01 28.43	S	10.6	NP	20.0	L	7	44	4.5	2			MOR
1985 02 13.21	S	10.4	NP	25.6	L	4	67	4.8	3			MOR
1985 02 16.44	S	10.2	AA	20	L	6	61		3/			HAL
1985 02 17.08	M	11.7	AC	15	L	8	38	1.2	2			DEY
1985 02 20.32	S	10.2	AA	20	L	6	61		2			HAL
1985 02 23.50	S	11.2	NP	25.6	L	4	67	3.4	2			MOR
1985 02 24.26	S	11.0	NP	25.6	L	4	67	4.7	1/			MOR
1985 03 01.51	S	11.3	NP	25.6	L	4	67	3.5	1			MOR

Periodic Comet Takamizawa (1984j)

DATE (UT)	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1984 08 01.43	S	9.3	S	20	L	6	61					HAL
1984 08 20.86	S	10.5	AA	20.5	L	4	52	1.2	3			HAS02
1984 08 20.86	S	10.5	AA	20.5	L	4	90		3			KOC01
1984 08 21.31	S	10.2	S	20	L	6	61		6			HAL
1984 08 21.90	S	10.5	AA	12.7	T	10	51	1.2	2			HAS02
1984 08 26.31	M	10.4	S	20	L	6	61		6/			HAL
1984 08 31.31	M	10.6	S	20	L	6	61					HAL
1984 09 01.86	S	10.7	AA	12.7	T	10	60	2.4	1			HAS02

Periodic Comet Faye (1984h)

DATE (UT)	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1984 11 02.10	S	13.4	A	40.6	L		126	0.5	4			BOU
1984 12 26.06	S	14.0	A	40.6	L		126	0.5				BOU
1984 12 26.06	S	14.1:	A	40.6	L		126					COM

Periodic Comet Wolf-Harrington (1984g)

DATE (UT)	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1984 10 29.10	S	12.0	A	25.4	J	6	73	1.5	1			BOU
1984 10 30.14	S	12.1	A	25.4	J	6	73	1.5	1/			BOU
1984 10 31.10	S	12.1	A	25.4	J	6	73	1.5	1/			BOU
1984 10 31.10	S	12.0	A	40.6	L		82	1.5	2/			BOU
1984 11 01.09	S	12.2	A	25.4	J	6	90		1/			BOU
1984 11 02.11	S	12.0	A	40.6	L		82	1.3	3			BOU
1984 11 02.12	S	12.1	A	25.4	J	6	73		1/			BOU
1984 12 26.15	S	13.7	A	40.6	L		126	0.9	1			BOU
1984 12 26.15	S	13.8:	A	40.6	L		126		1			COM

Periodic Comet Shoemaker 1 (1984q)

DATE (UT)	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1984 10 27.82	S	10.8	A	25.4	J	6	59	2.5	2			BOU
1984 10 28.79	S	10.7	A	25.4	J	6	48					BOU
1984 10 29.85	S	10.7	A	25.4	J	6	48	3	2			BOU
1984 10 30.89	S	10.7	A	25.4	J	6	48	3.5	2			BOU
1984 10 31.98	S	10.7	A	25.4	J	6	48	3.5	2			BOU
1984 11 01.99	S	10.8	A	25.4	J	6	48	3	3			BOU
1984 11 18.21	S	11.7	AA	20	L	6	61		1			HAL
1984 11 19.11	S	12.6	AC	15	R	5	62	1.1	0			MOR03
1984 11 24.18	S	11.6	AA	20	L	6	61		1			HAL
1984 11 25.73	S	12.0	A	22.5	R	10	55		1			COM
1984 11 26.93	S	11.8	A	25.4	J	6	59	1.8	1			BOU
1984 11 26.93	S	11.8	A	25.4	J	6	59	2.5	1			BUS01
1984 12 23.16	S	[12.0	NP	25.6	L	4	111					MOR
1984 12 23.83	S	13.6	A	40.6	L		126		0			BOU
1984 12 23.84	S	13.6:	A	40.6	L		126					COM
1984 12 25.84	S	13.7	A	40.6	L		126					COM
1984 12 25.84	S	13.8	A	40.6	L		126	0.6	0			BOU

Periodic Comet Schaumasse (1984m)

DATE (UT)	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1984 10 30.13	S	9.6	A	25.4	J	6	48	4	1			BOU
1984 10 30.15	S	9.5	A	10.8	L	4	20		0			BOU
1984 10 31.12	S	9.5	A	25.4	J	6	48	4	1/			BOU
1984 11 01.10	S	9.8	A	25.4	J	6	48		1			BOU
1984 11 02.13	S	9.6	A	25.4	J	6	48	5	1			BOU
1984 11 02.14	S	9.5	A	8.0	B		15	& 8	0			BOU
1984 11 19.44	S	10.2	AC	15	R	5	31	2.9	1			MOR03
1984 11 21.15	S	10.1	AC	25.4	L	4	49	3.1	1			CAV
1984 11 22.52	S	9.7	S	20	L	10	77	2	0			DUC
1984 11 23.54	S	9.6	S	20	L	10	77	2	0			DUC
1984 11 26.46	S	9.6	S	20	L	10	77	2	0			DUC
1984 11 29.52	S	9.6	S	20	L	10	77	2	0			DUC
1984 12 01.21	S	9.2	A	25.4	J	6	48	4.5	2			BOU
1984 12 02.56	S	9.5:	AA	20	L	6	61		3			HAL
1984 12 04.52	S	9.5	S	20	L	10	77	2.5	1			DUC
1984 12 04.71	S	9.4	AA	8.0	B		15					SEA
1984 12 20.76	S	9.8	AA	8.0	B		15		1			SEA
1984 12 21.76	S	9.8	AA	8.0	B		15					SEA
1984 12 24.42	M	10.9	AC	15	L	8	38	0.8	2			DEY
1984 12 24.50	S	9.6	AC	25.6	L	4	45	3.9	2			MOR
1984 12 26.16	S	10.3	A	25.4	J	6	48		6			COM

Periodic Comet Schaumasse (1984m) Cont.

DATE (UT)	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1984 12 26.17	S	10.0	A	25.4	J	6	48	2.5	1/			BOU
1984 12 28.55	S	9.8	S	20	L	10	77	3	1			DUC
1984 12 29.15	S	9.7	A	25.4	J	6	48	3.0	1/			BOU
1984 12 29.15	S	10.3	A	25.4	J	6	48		6			COM
1984 12 29.47	M	11.5	AC	15	L	8	38	0.6	2			DEY
1984 12 29.57	S	10.0	S	20	L	10	77	3	1			DUC
1984 12 29.80	S	9.6	AA	15.2	L	5	30	4.5	2			PEA
1984 12 30.18	S	10.3	A	25.4	J	6	48		6			COM
1984 12 30.18	S	9.6	A	25.4	J	6	48	3.0	2			BOU
1984 12 30.55	S	10.0	S	20	L	10	77	3.5	1			DUC
1984 12 30.80	S	9.8	AC	15.2	L	5	30	4.5	1/			PEA
1984 12 31.51	S	9.8	AC	25.6	L	4	45	3.4	2			MOR
1985 01 18.51	S	10.1	AC	25.6	L	4	67	4.2	2			MOR
1985 01 20.51	S	10.1	AC	25.6	L	4	67	3.7	2			MOR
1985 01 22.78	S	10.2	AC	15.2	L	5	30	3.4	1			PEA
1985 01 23.78	S	10.2	AC	15.2	L	5	30	3.5	1			PEA
1985 01 27.79	S	10.6	AC	41	L	4	67	4	1			PEA
1985 01 31.56	S	10.7	AC	25.6	L	4	67	4.1	1			MOR

Periodic Comet Halley (1982i)

DATE (UT)	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1985 01 23.35	I	19.6	EA	61.0	C	13	400	& 0.08	9			OME
1985 02 16.25		[18.0	EA	61.0	C	16	375					MOR

Periodic Comet Tuttle (1980 XIII)

DATE (UT)	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1980 11 17.40	S	8.2	S	15	L	3	27					KEE
1980 12 04.54	S	8.0	S	15	L	3	27					KEE

Periodic Comet Neujmin 1 (1984c)

DATE (UT)	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1984 10 19.50	S	12.5	AC	25	L	8	80	1.0	7			WOO
1984 10 20.50	S	12.7	AC	25	L	8	80	0.75	8			WOO

Periodic Comet Schwassmann-Wachmann 1

DATE (UT)	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1976 11 13.11	S	12.1	A	32	L	6	88	0.9	0/			BOR
1976 11 14.11	S	12.1	A	32	L	6	88	1.4	1			BOR
1976 11 15.02	S	12.0	A	32	L	6	88	1.8	1			BOR
1976 11 17.07	S	12.0	A	32	L	6	88	1.4	2/			BOR
1976 11 19.10	S	11.8	A	32	L	6	88	1.6				BOR
1976 11 21.09	S	11.9	A	32	L	6	88	1.7	2/			BOR
1976 11 22.12	S	11.9	A	32	L	6	88	1.8	2	?		BOR
1976 12 14.00	S	12.1	A	32	L	6	110	1.7	0			BOR
1976 12 14.99	S	12.3	A	32	L	6	110	1.5				BOR
1976 12 16.06	S	12.3	A	32	L	6	110	1.5	2			BOR
1976 12 19.00	S	12.4	A	32	L	6	110	1.2	3			BOR
1976 12 20.00	S	12.6	A	32	L	6	110	1.0	2/			BOR
1976 12 24.99	S	12.4	A	32	L	6	110	& 1.1	3			BOR
1976 12 27.17	S	12.4	A	32	L	6	110	1.3	3/			BOR
1977 01 09.00	S	[13.5	A	32	L	6	110					BOR

Periodic Comet Schwassmann-Wachmann 1 (Cont.)

DATE (UT)	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1977 01 11.99	S	[13.5	A	32	L	6	110					BOR
1977 01 17.98	S	[13.0	A	32	L	6	88					BOR
1977 01 19.99	S	[13.0	A	32	L	6	110					BOR
1977 01 21.04	S	[13.0	A	32	L	6	110					BOR
1977 02 07.06	S	[13.0	A	32	L	6	110					BOR
1977 02 11.01	S	[13.0	A	32	L	6	146					BOR
1977 02 14.07	S	[13.0	A	32	L	6	110					BOR
1977 02 16.03	S	[13.0	A	32	L	6	110					BOR
1977 02 17.00	S	[13.0	A	32	L	6	88					BOR
1977 02 23.04	S	[12.0	A	32	L	6	110					BOR
1977 03 09.02	S	[12.5	A	32	L	6	110					BOR
1977 03 10.02	S	[12.5	A	32	L	6	146					BOR
1977 03 12.03	S	[12.0	A	32	L	6	146					BOR
1977 03 17.04	S	[12.3	A	32	L	6	146					BOR
1977 11 12.12	S	[13.0	A	32	L	6	146					BOR
1981 05 08.20		13 :		32	L	4	78	1.5				KEE
1982 02 22.50		13 :		32	L	4	78					KEE
1985 02 24.55	S	[12.8	AA	20	L	6	122					HAL

Periodic Comet Crommelin (1983n)

DATE (UT)	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1984 01 25.77	S	10.8	A	25.4	J	6	59	2.5	1/			BOU
1984 01 31.76	S	9.7	A	25.4	J	6	59		3			BOU
1984 01 31.76	S	9.7	A	15.6	L	5	36	3				BOU
1984 02 05.75	S	10.5	A	25.4	J	6	74	2.5	2/			POI
1984 02 18.79	S	8.0:	A	25.4	J	6	59					BOU
1984 02 19.78	S	8.1	A	15.6	L	5	36	4.5	3/			BOU
1984 02 19.79	S	8.3	A	8.0	B		20	6	1			BOU
1984 02 29.79	S	9.0	A	25.4	J	6	76	1.5	6			POI
1984 03 08.80	S	8.1	A	15.6	L	5	29	3	3			BOU

Periodic Comet Hartley-IRAS (1983v)

DATE (UT)	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
1984 01 04.73	S	10.6	AC	25.4	L	4	79	1.6	2			CAV
1984 03 31.84	S	10.2	A	25.4	J	6	59					BOU
1984 03 31.86	S	10.1	A	25.4	J	6	48	3	1/			BOU
1984 04 17.86	S	12.3:	A	25.4	J	6	59		0			FEI
1984 04 17.87	S	11.8:	A	25.4	J	6	73	1.5	0/			BOU
1984 04 22.95	S	10.8	A	25.4	J	6	48	3	1			BOU
1984 04 23.96	S	11.1:	A	15.6	L	5	45	2	0/			BOU
1984 04 23.97	S	11.0	A	25.4	J	6	48	2.5	0/			BOU
1984 04 25.90	S	10.9	A	25.4	J	6	48	3	1			BOU
1984 04 25.90	S	11.4	A	25.4	J	6	73	2.3	1/			BOU
1984 04 25.90	S	11.1	A	25.4	J	6	59					BOU
1984 04 25.91	S	11.6	A	25.4	J	6	90					BOU
1984 04 26.89	S	10.9	A	25.4	J	6	48	2.8	1			BOU
1984 04 27.90	S	11.1	A	25.4	J	6	48		1			BOU

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MEETING NOTICE: A. Fraknoi, Astronomical Society of the Pacific (ASP), writes that a special symposium entitled "New Directions in Asteroid and Comet Research" will be held with the 97th Scientific Meeting of the ASP in Flagstaff, Arizona, during 1985 June 25-27. For further information and a registration packet, write: Summer Meeting, A.S.P., 1290 24th Ave., San Francisco, CA 94122.

RECENT NEWS AND RESEARCH CONCERNING COMETS

Daniel W. E. Green
Harvard-Smithsonian Center for Astrophysics

There have been absolutely no comet discoveries or recoveries since late November (at the time of this writing); in fact, this is the longest such period in several years -- already 4 months. Observers have been following several other comets, however, some of which have been bright enough for portable amateur telescopes to detect. P/Tsuchinshan 1 1984p, P/Arend-Rigaux 1984k, comet Levy-Rudenko 1984t, P/Schaumasse 1984m, and comet Shoemaker 1984s have all been fairly bright, and have been followed in the last few months by visual observers with small telescopes. P/Arend-Rigaux has exhibited a rather strong coma to observers, indicating that there is yet considerable cometary activity in this object (which has been thought to be on the verge of becoming an extinct comet).

P/Halley 1982i is brightening very gradually; Stephen O'Meara reported the first visual detection of the comet at its current return (see page 40). Its total visual magnitude became brighter than mag 20 apparently sometime in January, and appears to be near 18.5 as of this writing. Several CCD observers have reported P/Halley's exhibiting of an asymmetric coma during the past six months, some indicating that the asymmetry pointed in the solar direction. Coma diameters in this same period have been reported generally in the 3"-6" range, although one observation last October placed that diameter near 16" (Kitt Peak, Arizona; cf. IAUC 4029). P/Halley no longer appears to be exhibiting the large amplitudes of magnitude variation that have been reported over the past couple of years; observations made at several observatories in January and February indicate that such variations are now under half a magnitude. Spectra obtained with the 4.5-m Multiple-Mirror Telescope at Whipple Observatory indicate evidence for very weak CN emission in mid-February (cf. P. A. Wehinger, IAU Circ. 4041).

An interesting note was published by W. Wisniewski and T. Fay on IAU Circ. 4041: Their observations of P/Arend-Rigaux with the Catalina 1.5-m reflector (Tucson, AZ) on eight nights in January and February indicate variability of 0.6 magnitude, with a best fit of 27 hours, 12 minutes for a rotation period. They suggest that the amplitude may have been even larger, but was masked by contribution of the coma in the 12"-diameter diaphragm.

Readers are reminded of the Third American Workshop on Cometary Astronomy (AWCA), to be held on June 17 in Tucson, Arizona. Further information was published with the announcement in the Jan. issue, page 16.

Word has been received that the Soviet astronomer Sergei Vsekhsyvatskii (b. 1905), noted for his Physical Characteristics of Comets, died last Oct. 4.

Corrigendum: In this column for the last issue, it was stated that 1984 was a record year for new discoveries -- this is true, but it tied the record set in 1975 (which was also 13, not 12 as stated). -- Daniel W. E. Green (3/20/85)

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LUNAR PHASES: Following is a list of lunar phases, provided as a convenience to readers, for 1985-86; the list is from Planetary and Lunar Coordinates for the Years 1984-2000 (U.S. Naval Observatory, U.S. Government Printing Office).

1985

New Moon	1st quarter	Full Moon	Last quart.
		Jan. 7 02 16	Jan. 13 23 27
Jan. 21 02 28	Jan. 29 03 29	Feb. 5 15 19	Feb. 12 07 57
Feb. 19 18 43	Feb. 27 23 41	Mar. 7 02 13	Mar. 13 17 34
Mar. 21 11 59	Mar. 29 16 11	Apr. 5 11 32	Apr. 12 04 41
Apr. 20 05 22	Apr. 28 04 25	May 4 19 53	May 11 17 34
May 19 21 41	May 27 12 56	June 3 03 50	June 10 08 19
June 18 11 58	June 25 18 53	July 2 12 08	July 10 00 49
July 17 23 56	July 24 23 39	July 31 21 41	Aug. 8 18 29
Aug. 16 10 06	Aug. 23 04 36	Aug. 30 09 27	Sept. 7 12 16
Sept. 14 19 20	Sept. 21 11 03	Sept. 29 00 08	Oct. 7 05 04
Oct. 14 04 33	Oct. 20 20 13	Oct. 28 17 38	Nov. 5 20 07
Nov. 12 14 20	Nov. 19 09 04	Nov. 27 12 42	Dec. 5 09 01
Dec. 12 00 54	Dec. 19 01 58	Dec. 27 07 30	

1986

			Jan. 3 19 47
Jan. 10 12 22	Jan. 17 22 13	Jan. 26 00 31	Feb. 2 04 41
Feb. 9 00 55	Feb. 16 19 55	Feb. 24 15 02	Mar. 3 12 17
Mar. 10 14 52	Mar. 18 16 39	Mar. 26 03 02	Apr. 1 19 30
Apr. 9 06 08	Apr. 17 10 35	Apr. 24 12 46	May 1 03 22
May 8 22 10	May 17 01 00	May 23 20 45	May 30 12 55
June 7 14 00	June 15 12 00	June 22 03 42	June 29 00 53
July 7 04 55	July 14 20 10	July 21 10 40	July 28 15 34
Aug. 5 18 36	Aug. 13 02 21	Aug. 19 18 54	Aug. 27 08 38
Sept. 4 07 10	Sept. 11 07 41	Sept. 18 05 34	Sept. 26 03 17
Oct. 3 18 55	Oct. 10 13 28	Oct. 17 19 22	Oct. 25 22 26
Nov. 2 06 02	Nov. 8 21 11	Nov. 16 12 12	Nov. 24 16 50
Dec. 1 16 43	Dec. 8 08 01	Dec. 16 07 04	Dec. 24 09 17
Dec. 31 03 10			

EPHEMERIS FOR P/GIACOBINI-ZINNER 1984e (from orbital elements by D. K. Yeomans on p. 34 of this issue; total visual magnitude based on absolute magnitude = 9.6 and 2.5n = 12, extrapolated from study by D. D. Meisel and C. S. Morris 1976, in The Study of Comets, NASA SP-393, Part 1, pp. 410ff).

Date ET	R. A. (1950)	Decl.	Delta	r	Elong.	Mag.
1985 05 05	20 00.14	+20 20.0	1.511	1.885	94.8	13.8
1985 05 10	20 08.83	+22 30.0				
1985 05 15	20 17.70	+24 46.0	1.370	1.794	96.6	13.3
1985 05 20	20 26.79	+27 07.8				
1985 05 25	20 36.17	+29 34.7	1.241	1.702	97.6	12.8
1985 05 30	20 45.93	+32 06.2				
1985 06 04	20 56.18	+34 41.7	1.123	1.610	97.6	12.3
1985 06 09	21 07.07	+37 20.4				
1985 06 14	21 18.76	+40 01.5	1.015	1.520	96.9	11.8
1985 06 19	21 31.48	+42 43.5				
1985 06 24	21 45.53	+45 25.1	0.918	1.431	95.3	11.3
1985 06 29	22 01.28	+48 04.3				
1985 07 04	22 19.24	+50 39.0	0.828	1.346	93.2	10.7
1985 07 09	22 40.00	+53 05.9				
1985 07 14	23 04.22	+55 20.9	0.745	1.266	90.6	10.2
1985 07 19	23 32.64	+57 17.6				
1985 07 24	00 05.85	+58 47.6	0.668	1.193	87.7	9.6
1985 07 29	00 43.99	+59 40.0				
1985 08 03	01 26.30	+59 42.1	0.598	1.130	84.8	9.1
1985 08 08	02 10.87	+58 41.8				
1985 08 13	02 55.02	+56 30.1	0.537	1.080	82.1	8.7
1985 08 18	03 36.26	+53 04.2				
1985 08 23	04 13.04	+48 27.6	0.492	1.045	80.1	8.3
1985 08 28	04 44.92	+42 50.2				
1985 09 02	05 12.19	+36 26.4	0.468	1.029	79.2	8.1
1985 09 07	05 35.46	+29 33.8				
1985 09 12	05 55.36	+22 30.9	0.472	1.033	79.8	8.1
1985 09 17	06 12.43	+15 34.6				
1985 09 22	06 27.13	+08 57.7	0.500	1.055	81.8	8.4
1985 09 27	06 39.81	+02 48.8				
1985 10 02	06 50.70	-02 48.5	0.547	1.096	84.8	8.8
1985 10 07	06 59.98	-07 53.7				
1985 10 12	07 07.73	-12 28.2	0.604	1.151	88.3	9.2
1985 10 17	07 14.00	-16 34.4				
1985 10 22	07 18.83	-20 14.7	0.666	1.218	92.1	9.7
1985 10 27	07 22.25	-23 31.2				
1985 11 01	07 24.27	-26 26.1	0.728	1.293	96.3	10.3
1985 11 06	07 24.89	-29 00.7				
1985 11 11	07 24.12	-31 16.0	0.789	1.376	100.7	10.7
1985 11 16	07 21.98	-33 12.0				
1985 11 21	07 18.57	-34 48.9	0.848	1.462	105.3	11.2
1985 11 26	07 13.99	-36 06.4				
1985 12 01	07 08.42	-37 04.5	0.908	1.551	109.9	11.7
1985 12 06	07 02.05	-37 42.9				
1985 12 11	06 55.11	-38 01.6	0.971	1.642	114.2	12.1
1985 12 16	06 47.88	-38 00.7				
1985 12 21	06 40.65	-37 41.0	1.040	1.734	117.9	12.6
1985 12 26	06 33.70	-37 04.0				
1985 12 31	06 27.23	-36 11.2	1.117	1.826	120.6	13.0