INTERNATIONAL COMET QUARTERLY

Whole Number 145 JANUARY 2008 Vol. 30, No. 1

— *Table of Contents* —

SMITHSONIAN ASTROPHYSICAL OBSERVATORY
60 Garden Street · Cambridge, MA 02138 · U.S.A.

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

The regular (invoiced) subscription rate is US$60.00 per year for North American and for overseas surface-mail delivery (price includes the annual *Comet Handbook*; the price without the *Handbook* is US$45.00 per year). Subscribers who do not wish to be billed may subscribe at the special rate of US$45.00 per year for surface-mail delivery (rate is $30.00 without *Handbook*). Add $30.00/year to each of these rates for overseas airmail delivery. These rates became valid as of Nov. 2007. [The last set of digits (after the hyphen) on the top line of the mailing address label gives the Whole Number that signifies the last *ICQ* issue which will be sent under the current subscription status. An asterisk after these numbers indicates credit for the next annual Comet Handbook. The first five digits represent the subscriber's account number.] Make checks or money orders payable in U.S. funds (and drawn on a U.S. bank) to *International Comet Quarterly* and send to Mail Stop 18; Smithsonian Astrophysical Observatory; 60 Garden St.; Cambridge, MA 02138, U.S.A.

Credit cards may be used for payment of subscriptions, though a minimum of US$20.00 can be accepted for each charge. Credit-card orders may be placed by e-mail (to iausubs@cfa.harvard.edu), by fax (to USA 617-495-7231), or by telephone (to USA 617-495-7280, generally between 14:00 and 21:00 UT, Monday to Friday). When sending orders by fax or e-mail, please include the following information: (1) your name (as given on the credit card); (2) card type (MasterCard, Visa, or Discover); (3) credit-card number and expiration date; (4) address at which the card is registered; (5) which services you wish to subscribe to; (6) if the payment is for the renewal of a current or expired account, please include your account number.

Group subscription rates available upon request. Back issues are $15.00 each — *except* for "current" *Comet Handbooks*, which are available for $20.00 ($15.00 to subscribers if ordered with their *ICQ* subscription; see above). Up-to-date information concerning comet discoveries, orbital elements, and ephemerides can be obtained by subscribing to the *IAU Circulars* and/or the *Minor Planet Circulars* (via postal mail and also available via computer access); for further information, contact the above e-mail address (or the *ICQ* at the above postal address).

Manuscripts will be reviewed/refereed for possible publication; authors should first obtain a copy of "Information and Guidelines for Authors" from the *ICQ* website or from the Editor. Cometary observations should be sent to the Editor in Cambridge; again, see the *ICQ* website or contact the Editor for the proper format. Those who can send observational data (or manuscripts) in machine-readable form are encouraged to do so [especially through e-mail via the Internet (ICQ@CFA.HARVARD.EDU)]. The *ICQ* has extensive information for comet observers on the World Wide Web, including the Keys to Abbreviations used in data tabulation (see URL http://www.cfa.harvard.edu/icq/icq.html). The *ICQ* published a 225-page *Guide to Observing Comets* in early 1997 that is now out of print; a revised edition is in preparation.

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

+++++++++++

This issue is No. 145 of the publication originally called *The Comet* (founded March 1973) and is Vol. 30, No. 1, of the *ICQ*. *[ISSN 0736-6922]*

****

CORRIGENDA.

- In the *2007 Comet Handbook*, p. H118, *for* P/2006 U6 (Tichý) *read* P/2000 U6 (Tichý) [which is now 196P/Tichý, via its recovery as P/2008 C2]
- In the Oct. 2007 issue, page 144, "Tabulated CCD-Data Summary", lines 5 and 8, *for* 80- *read* 129-
- In the Oct. 2007 issue, page 150, there were two mistakes in the first sentence: *for* last 20 comets *read* last 82 comets; and *for* short-period comet *read* short-period asteroidal object (designated as a comet due to its orbit)

Exploding Comet 17P/Holmes

Zdenek Sekanina
Jet Propulsion Laboratory; California Institute of Technology; Pasadena, CA 91109; U.S.A.

Abstract. *The light curve and dust-halo expansion curve of comet 17P are constructed, examined, and compared with those of other comets that experienced outbursts. The 2007 megaburst of 17P is unrivaled as the most powerful event of this kind on record. The proposed scenario for the megaburst involves an exothermic reaction caused by a transition of water ice from low-density amorphous phase to cubic phase in a reservoir spread below a pancake-shaped thick layer of* 10^{14} *g of terrain on the nucleus' surface. The resulting explosion jettisoned this layer of inert mass into the atmosphere as a major fragment that began to crumble precipitously into a rapidly expanding cloud of microscopic dust immediately upon the lift-off. Fewer than 50 events of this magnitude would consume the entire comet.*

1. Introduction

The explosion of comet 17P/Holmes in late October 2007 has brought the issue of cometary outbursts once again to the forefront of scientific interest and debate. A particular point of contention is the question of whether an episode of this magnitude is so extraordinary as to defy comparison with less prominent flare-ups of other comets. Another critical point is the reference to the past behavior of comet 17P/Holmes, which was observed to experience two major outbursts some 10 weeks apart during its discovery return in 1892-1893.

To address these and other related issues, it is desirable to examine the properties of these events and establish similarities and diversities among them. This paper is intended to contribute to the understanding of these fascinating events.

2. Brightening, Flaring Up, Outbursts, Explosions, and Megabursts

Comet outbursts have a tendency to begin essentially the same way but continue to proceed in different ways. This in all probability depends on the contents and particle-size distribution of dust released during the active phase of outburst. The term *outburst* is used indiscriminately, regardless of whether the process is still *in progress* at the time of observation or what is seen is the outcome of an event that had already terminated. There are good reasons for this, since often it is difficult to determine the state of nuclear activity in real time, not to mention that increased activity may be intermittent.

Observationally, the early phase of an outburst is described by three parameters: the self-explanatory time of onset $t_{\rm onset}$; the rise time $\Delta t_{\rm rise}$, which is the time interval between the onset time and the time of peak brightness $t_{\rm peak}$ (an alternative parameter in lieu of the rise time); and the amplitude $\Delta H_{\rm peak}$, which is the difference between the magnitudes at the onset and at peak brightness. If the *intrinsic* peak brightness holds constant for a period of time on a plateau, then $t_{\rm peak}$, which is interpreted as the termination time of the event's active phase, is the time when the plateau is first reached (Sec. 5). Generally, the derived set of parameters describes the early phase of a given outburst satisfactorily, but not uniquely, because the same parametric set fits equally well a great variety of brightness-increase scenarios.

The late phase of an outburst is hard to characterize quantitatively, as especially dust-rich outbursts have a tendency to linger until eventually their effects become indiscriminately small. In powerful outbursts, the peak may extend into a prolonged plateau, along which the brightness subsides very gradually. For the short-period comets, traces of an outburst may be detected for more than one revolution about the sun. A long-term evolution could get particularly complex when the outburst accompanies a fragmentation event.

The appearance of a "stellar nucleus" and its steady expansion into a "disk" of nontrivial dimensions is the usual feature that describes the early phase of outburst evolution. The bright stellar nucleus is of course nothing but the first detection of the expanding cloud of ejecta that, to a greater or lesser degree, include dust particulates. The active phase can last from a fairly small fraction of a day to many tens of days. The duration of short outbursts is probably dictated by the comet's rotation period, with the "hot spot" active from sunrise to sunset, then cooling down on the dark side of the nucleus. It is more than likely that the source flares up again with the next sunrise, etc. Because the atmosphere is then already filled with dust, the detection of events recurring on short time scales is usually difficult, but their products may sometimes be observed as multiple inner halos or other discrete features. Outbursts with long rise times are almost invariably due to a sequence of intermittent episodes of increased activity arising from one or more regions on the nucleus.

Besides being an important physical process, the gradual expansion of a dust cloud or halo (not to be confused with incomplete halos — observed, *e.g.*, in comets C/1858 L1 or C/1995 O1) is also very helpful in our efforts to understand the event. Observations of the halo's growing diameter with time in the early phase of expansion provide an opportunity to determine the event's onset time with relatively high accuracy (a small fraction of a day), which is invaluable in correlation studies of fragmenting comets. As a bonus, the rate at which the cloud expands, in projection onto the plane of the sky, measures directly the expansion velocity whose magnitude is critical for the understanding of the physical processes involved. It turns out that the linear dependence on time that fits the cloud expansion in the early phase of evolution breaks down later, as the ejecta begin to display morphology, asymmetries, etc. For comets at larger heliocentric distances, such as 17P/Holmes, the apparent linearity is sustained longer, as it takes more time for the integrated effects of solar-radiation pressure to make an indelible imprint in particle motions. Especially if the expansion velocity is high, it may completely dominate the radiation-pressure effects for days or even weeks.

The amplitudes of frequent comet outbursts are about 1-2 magnitudes, equivalent to a brightening by a factor of a few. Of course, activity of comets changes constantly, but phenomenologically a brightening by less than 1 mag (a factor of $\sim$2 or less in brightness) is not considered an outburst, unless one is prepared to accept that comet activity consists of nothing but outbursts. Events with amplitudes of some 5-10 magnitudes (an increase by a factor of hundreds to thousands) are much less common, and such a comet becomes the object of great interest to observers. Events with amplitudes greater than 10 magnitudes (a factor of 10,000 or more) are entirely exceptional and, in the age of rapid communication, such an object becomes an instant sensation. To distinguish these events from "ordinary" outbursts, one can describe them as *explosions* or, like I do in this paper, as *megabursts*.

3. Brief History of Comet 17P/Holmes and Some of Its Nucleus' Properties

A member of the Jupiter family of short-period comets, this object orbits the sun at present between 2.05 and 5.2 AU with a period of about 7 years. Approaches to Jupiter are fairly common, with a close one, to 0.54 AU, having occurred in December 1908. An approach to 0.86 AU is due in April 2051. Discovered by Edwin Holmes (1839-1919)[1] in London on 1892 November 6, shortly before midnight UT, the comet was then in outburst. It was independently discovered by T. D. Anderson, Edinburgh, on November 8 and by J. E. Davidson, Mackay, Australia, on November 9. A second outburst, first reported by Palisa (1893), took place in mid-January 1893. During both events, the comet was visible to the naked eye as an expanding disk of light that gradually grew more nebulous.

Thanks largely to the careful and repeatedly updated orbital determination by Zwiers (1895, 1897, 1906), the comet was recovered in both 1899 and 1906 by, respectively, Perrine (1899) and Wolf (1906a, 1906b), but then lost for the next seven returns until Roemer (1964) recovered it as the first of several long-lost comets whose orbital motions had been integrated and perihelion times predicted by Marsden (1963).

Comet 17P/Holmes has been observed at each return since 1964, appearing — until the onset of the 2007 megaburst — always as an inconspicuous telescopic object. However, the temporal distribution of observations leaves much to be desired, at the early as well as recent apparitions, perhaps due in part to prevailing skepticism that the comet could ever again mimic its behavior in 1892-1893 in any significant measure. Indeed, in the light of the 2007 megaburst, one is perplexed to read, for example, that Barnard (1896), after having witnessed the two 1892-1893 outbursts, did not think that the comet "will ever be seen again" and believed that the object "was of only a temporary nature". The obvious lesson for one to learn from this is to be careful not to hastily "condemn" the comet once again.

Because comet 17P/Holmes was not at all observed at seven returns to perihelion and rather poorly observed at all the remaining returns except when discovered and at present, it cannot be argued that the comet never flared up to some degree (not necessarily as much as in 1892-1893 or 2007) during the 16 intervening revolutions about the sun. In fact, there is a report by Wolf (1906b) that is puzzling: only 25 hours prior to the recovery plate of 1906 August 29, on which the comet was plainly detected as an object of magnitude 15.5 with a round halo, this observer took, with the same 41-cm Bruce telescope of the Königstuhl Observatory, a 4.1-hour long exposure on which he found no trace of 17P/Holmes.

In the past several years, two independent investigations were published on the nuclear size of 17P/Holmes (Lamy *et al.* 2000; Snodgrass *et al.* 2006). They led to nearly identical results implying an average diameter of 3.3 km. Both papers assumed for the nucleus a geometric albedo of 4 percent and a phase coefficient of 0.035 mag/deg. Snodgrass *et al.* also made an effort to derive the rotation period, but all four of their potential solutions — between 7.2 and 12.8 hours — were weak, implying in any case an amplitude of only 0.3 mag. In studies of the megaburst, the knowledge of the nucleus is essential for estimating the comet's mass. With Richardson and Melosh's (2006) value for a bulk density of cometary nuclei, 0.4 g/cm^3, the mass of the nucleus of 17P comes out to be 7.5×10^{15} g, which in the following provides a crude upper limit on the mass of the dust and gas clouds released during the megaburst.

4. The Light Curve in the 1986-2007 Apparitions

The comet's brightness variations during the apparitions of 1986, 1993, 2000, and 2007 (with perihelion in March-May) can systematically be examined only along the outbound leg of the orbit. The objective is to establish the degree

---

[1] A. C. D. Crommelin wrote in the Jan. 1919 issue of the *J.B.A.A.* (**29**, 84-85), regarding "the lamented death of Mr. Edwin Holmes", that "Mr. Holmes was an original Member of the [British Astronomical] Association, and retired in 1918 at the age of 79". No formal obituary is known to have been published in the astronomical literature, though Arthur Mee (1919, *J.B.A.A.* **29**, 113) later added some kind remarks about Holmes. Guy Hurst has kindly reported his preliminary research (augmented by Gill Hallatt) into online genealogical/census records, revealing that an Edwin Alfred Holmes was born in the first quarter of 1839 in the Sheffield district of England, and a 1901 census reveals an Edwin A. Holmes (born Sheffield) living at 87 Hornsey Rise, Islington (just north of London) with his wife Selina (aged 57); also, a death is registered in Edmonton (just north of London) of an Edwin A. Holmes in the first quarter of 1919 at age 80. Further, the papers of E. A. Holmes in the Royal Greenwich Observatory archives (shelfmark *RGO 45/40*) have a photograph of "the late Edwin Alfred Holmes", and note his observatory as having been at Hornsey Rise via another photograph from May 1901. So there seems to be no doubt that these records all refer to the discoverer of comet 17P. Edwin Holmes can be found at age 12 in the 1851 census in Dudley, given as the son of James (an iron moulder) and Hannah Holmes. Edwin Holmes married Selina Stevens (of Saint Leonards, Shoreditch) on 1864 Mar. 28, and their child Ernest A. Holmes was born ca. 1875 in Islington. Edwin A. Holmes was listed as a glass merchant and glass cutter in Islington via the 1881 and 1891 censuses. – *Ed.*

of stability of the light curve from return to return during periods of normal (low) activity. In this paper the light curve is understood to be a plot of time, reckoned from perihelion, against a *normalized* magnitude H_Δ, which is corrected for personal and instrumental effects (to the extent possible) and referred to a geocentric distance Δ of 1 AU by subtracting the term of 5 log Δ.

The 2007 brightness data for comet 17P/Holmes have been collected primarily from the *International Comet Quarterly*'s website (`http://www.cfa.harvard.edu/icq/icq.html`), but most quiescent-phase magnitudes have come from the *Minor Planet Electronic Circulars*, with a few from the *International Astronomical Union Circulars* 8886 and 8887. The light curve through 2008 January 7, based on more than 500 observations and plotted in Figure 1, shows that in more than five months following perihelion, from mid-May to just before the megaburst began in late October 2007, the comet had been fading systematically by nearly three magnitudes. While the average rate was only 0.02 mag/day, the low orbital eccentricity and the resulting narrow range of heliocentric distances r imply a steep r^{-16} drop when measured this way. The whole light curve could be constructed thanks to the fact that K. Kadota's important set of CCD magnitudes could be calibrated by linking it, because of temporal overlap, with the post-megaburst naked-eye brightness estimates reported by a large number of observers. The comet is expected to be under observation for several more months.

◇ ◇ ◇

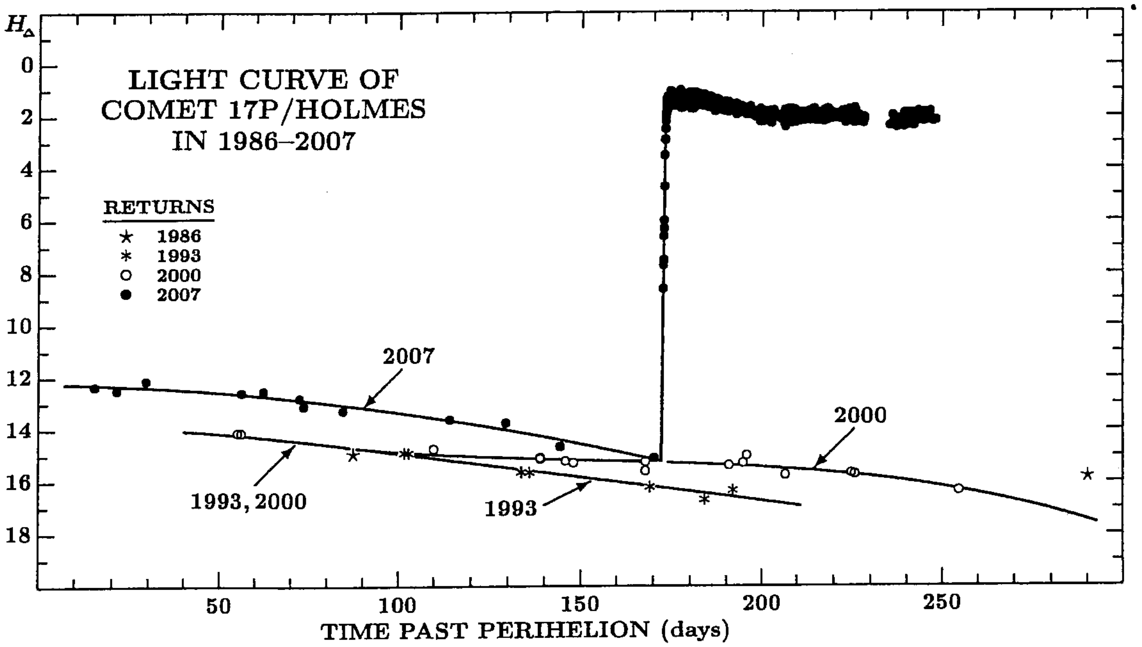


Figure 1. Light curve of comet 17P/Holmes at the apparitions during 1986-2007. The magnitudes H_Δ are visual magnitudes corrected for personal and instrumental effects and normalized to a unit geocentric distance. The observations are represented by apparition-specific symbols. Note the plateau persisting after the brightness peak.

◇ ◇ ◇

The 2000 light curve in Figure 1 is based on the magnitude data by six observers, five of which (including Kadota) used CCD detectors and one (M. Jäger) the photographic technique. The data were gathered partly from the *ICQ*, partly from the *Minor Planet Circulars*, and for Jäger from the journal *Schweifstern*. Jäger's observations were important, because they extended the covered arc by 50 days toward perihelion. Jäger's magnitude correction was determined by comparing his and Kadota's nearly-simultaneously-obtained magnitudes for six similarly faint comets observed in 2000 with the same instrumentation as 17P. It appears that the comet was somewhat fainter, but fading more slowly than in 2007.

The 1993 light curve is based on the CCD magnitudes from the *ICQ*, reported by two observers, J. W. Scotti and A. Nakamura. The data were linked to Kadota's "system" via Nakamura, who also observed the comet in 2000. Between 100 and 170 days after perihelion, the comet seems to have been systematically fainter than in 2007 by 1 to 1.5 mag.

Only two CCD magnitudes are available for 1986; a crude estimate from the recovery observation by J. Gibson (*IAUC* 4225) and another data point nearly 7 months later by Scotti, who used the same observing equipment as in 1993. Gibson's magnitude scale was simply assumed to be the same as Scotti's, and it appears that his estimate fits the light curves from 1993 and 2000 surprisingly well. On the other hand, Scotti's magnitude shows the comet to be about 1.5 mag brighter than indicated by the light curve of 2000. Even more importantly, comparison of Scotti's own 1986 and 1993 magnitudes suggests that 290 days after the 1986 perihelion the comet was intrinsically brighter by 0.3 mag than it was 134 days after the 1993 perihelion.

In summary, Figure 1 shows that the comet's activity, as described by its light curve, varies from return to return. It is not clear to what extent this is caused by the comet's changing perihelion distance, which decreased from 2.17-2.18

AU in 1993-2000 to 2.05 AU in 2007. However, one should be rather skeptical because in 1986, when the comet was brighter, the perihelion distance was nearly identical with that of 2000.

5. The Megaburst of 2007

As shown below, this event was fortunately caught fairly soon after its onset, as indicated (*IAUC* 8886) by the reported "nuclear" magnitude 8.4 at the time of discovery by J. A. Henríquez Santana on October 24.067 UT; by the high rate of brightening, 0.5 mag/hr, over a period of six hours (yielding magnitude 5.4 on October 24.317 UT); and by the descriptions of a stellar or almost-stellar appearance of the comet in confirmation images taken by R. Naves and M. Campas and by F. Kugel and C. Rinner within hours of discovery.

The available magnitudes are not very helpful in an effort to determine the event's precise onset time, as the slope of the light curve varies, becoming less steep with time as the plateau is being approached (Figure 1). A promising result was obtained by Hsieh *et al.* (2007) from photometry of images taken with the SuperWASP-North facility between Oct. 23.99 and 24.10 UT. They fitted the data on the assumption that the comet's brightening was due to an optically thick dust coma that was expanding at a constant rate and found that the outburst began on approximately Oct. 23.8 UT, or 172.3 days after perihelion.

An independent estimate for the onset time can be obtained from direct measurements of the dust halo's diameter (Sec. 2). However, care has to be taken of two complications, both of which are apparent from Figure 2, where I show one of many images of comet 17P/Holmes — this one taken on Nov. 4. The first complication is the gaseous outer coma, which extends far beyond the dust halo; it has no sharp boundaries and it should not be confused with the latter. The second complication is that the practically perfect roundness of the dust halo, commonly reported by observers in late October, was no longer preserved in images taken from early November on, as exemplified in Figure 2.

Wagner *et al.*'s observations (*IAUC* 8887) illustrate that, to an imaging observer, the dust halo could become contaminated by the gas coma even in the early phase of the event's evolution, when the gas coma was more difficult to separate from the dust halo than in November. In Wagner *et al.*'s spectra taken on October 25, the spatial continuum profile along the slit extended to a diameter of 1.5 arcmin, whereas the CN (0,0) emission was traced over a diameter of at least 4.8 arcmin.

The observed dust-coma roundness and its persistence are consistent with a source of great extent and an event of global proportions on the scale of the comet's nucleus (see Sections 8.3 and 9). Because the phase angle was small (17° or less), the earth faced the comet nearly head-on, with much foreshortening in the radial direction. Because 17P was nearly 2.5 AU from the sun, dust particles were subjected to relatively small solar-radiation pressure (only about $\frac{1}{6}$ that at 1 AU), whose temporally integrated effects were insignificant relative to the effects of the expansion velocity for at least one week after dust injection. Only over a longer period of time, into November, did the integrated effects of radiation pressure become noticeable.

◇ ◇ ◇

Table 1. Dust halo diameters in an early phase of the 2007 megaburst of comet 17P/Holmes.

Date October 2007 (UT)	Reported halo diameter apparent (arcsec)	linear (10^3 km)	Residual (10^3 km)	Observer (reference)
25.17	121	143	+20	C. Sherrod (Note 1)
25.18	90	106	−18	R. M. Wagner (IAUC 8887)
26.4	215	248	+18	J. Young (CBET 1111)
27.15	246	285	−9	J. M. Trigo-Rodriguez (CBET 1118)
27.41	255	301	−16	Sherrod (Note 1)
28.32	348	411	+16	Sherrod (Note 1)
29.12	408	481	+17	Sherrod (Note 1)
30.1	426	505	−44	Trigo-Rodriguez (CBET 1118)
30.19	482	568	+11	Sherrod (Note 1)
31.11	545	642	+5	Sherrod (Note 1)

Note 1. See http://www.arksky.org.

◇ ◇ ◇

To avoid the two problems mentioned above, I restricted the dust-halo-size data set only to the results obtained from CCD images or spectra taken before the end of October and with larger-aperture and/or Cassegrain-type telescopes that ensure high-enough spatial resolution. One measure of coma diameter was rejected, attributed to a contamination by the CN or C_2 coma. Table 1 presents the data set and the residuals from a linear fit yielding an onset time of October 23.7 ± 0.2 UT, or 172.2 days after perihelion (at 2.435 AU from the sun) and a projected expansion velocity of 0.50 ± 0.02 km/s. This onset time is in excellent agreement with Hsieh *et al.*'s (2007) determination from the light curve, and the expansion velocity is exactly in the middle of an interval derived by Snodgrass *et al.* (2007).

Figure 2. Image of comet 17P/Holmes taken by Michael Jäger (near Krems, Austria) on 2007 November 4.81 UT, about 12 days after the megaburst had begun. The image is a co-addition of five 6-min exposures taken with a 20-cm f/2.75 astrograph (German Sigma CCD camera with KAF6303 chip) and a blue filter from an "RGB set". The bar at the bottom indicates a scale of 45′; north is up and east is to the left. The diameter of the bright inner halo of dust is 1.05 million km; its northern and eastern boundaries are sharp, while its southern boundary is blurred and slightly elongated. The diffuse bluish-green gas coma extends well beyond the yellowish dust halo. The sun is in the north-northeastern direction. (Image courtesy of M. Jäger, reproduced with permission.)

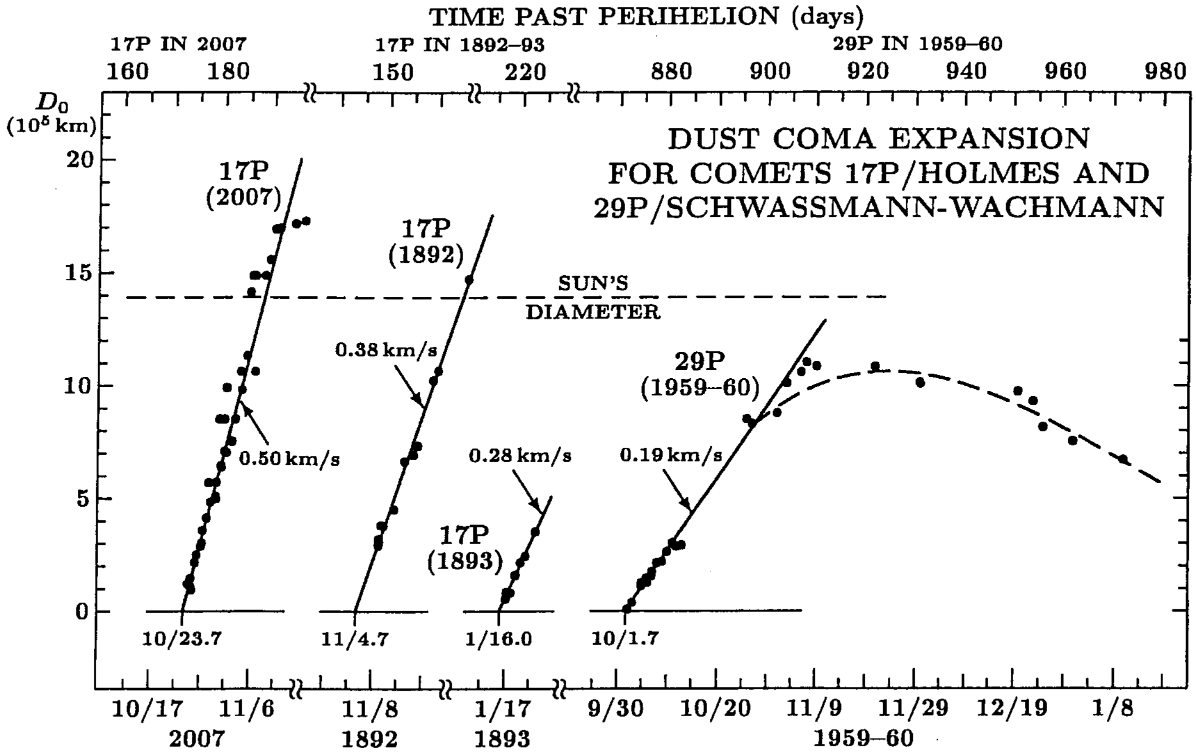


Figure 3. Dust coma expansion with time in the aftermath of an outburst; D_0 is the linear diameter of the dust coma or halo. The 2007 megaburst of comet 17P/Holmes is compared with the two outbursts of the same object in 1892 and 1893 and with an outburst of comet 29P/Schwassmann-Wachmann at the beginning of October 1959 as observed by Beyer (1962). The stagnation and subsequent decline in the coma dimensions in his data is an effect of the ever greater fraction of the coma's outer regions being unaccounted for as their surface brightness dropped below the detection limit.

◇ ◇ ◇

[text continued from page 6]

Figure 3 shows that the parameters derived from the expanding dust halo's dimensions in Table 1 during the early phase of the megaburst's evolution fit reasonably well a selected set of coma diameters reported from later days. However, as the surface brightness of the coma was steadily decreasing, the uncertainties in the size estimates were increasing with time, as did the effects of radiation pressure and other perturbing sources.

I now turn to the light curve of the megaburst in an effort to estimate the total mass of the dust population in the comet's atmosphere. As new particulates were constantly injected into the coma at high rates during the event's active phase, while none were for some time leaving it, the amount of dust kept growing in the coma until the major activity ceased (amounts of dust injected during periods of low activity can be neglected, given the comet's enormous brightness at the time). While one has no means of measuring the dust mass directly, the total cross-sectional area of the scattering particles is readily available from the brightness data, given that the coma is optically thin. The standard light curve, like that in Figure 1, falls short of providing information on the total cross-sectional area of dust because the normalized magnitude H_Δ does not account for the effects of heliocentric distance r. The appropriate quantity is the *intrinsic* magnitude H_0, which is corrected for both the geocentric and heliocentric distances. This magnitude, plotted in Figure 4, is related to the normalized magnitude H_Δ used in Figure 1 by applying the heliocentric correction

$$H_0 = H_\Delta - 5 \log r, \tag{1}$$

where r is in AU. Amazingly, the comet's intrinsic magnitude along the post-event plateau was between magnitudes 0 and −1! As shown in Figure 4, the time of active-phase termination of the megaburst is determined by the instant the peak magnitude $(H_0)_{\rm peak}$ has just been reached. The only effect that can complicate this straightforward exercise is particle fragmentation if it proceeds in parallel with dust injection and thereby increases the observed cross-sectional area. Thus, there is a tradeoff in the sense that the ease with which this information is obtained is balanced by the uncertainties in the particle-size distribution function and some optical-dust properties that must be estimated or assumed (geometric albedo, phase function, etc.).

One finds from Figure 4 that the plateau was approached in just about 24 hr after the onset and finally reached in another 19 hr or so, implying a rise time $\Delta t_{\rm rise} = 1.8 \pm 0.4$ days (estimated error), a peak normalized magnitude $(H_\Delta)_{\rm peak} = 1.4 \pm 0.2$ and a peak intrinsic magnitude $(H_0)_{\rm peak} = -0.53 \pm 0.12$. However, these results are preliminary, based on a selected set of 92 naked-eye observations, and the rise time is considered particularly uncertain. Since the

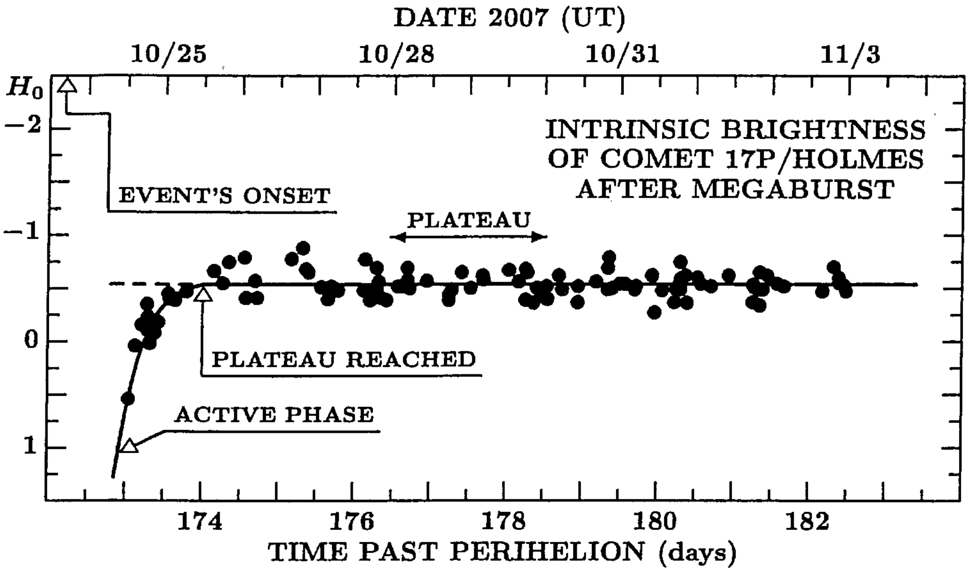


Figure 4. Close-up view of the temporal variations in the intrinsic magnitude H_0 of comet 17P/Holmes, normalized to the unit geocentric and heliocentric distances, during the megaburst in 2007. The perfectly flat plateau was reached at the time of peak brightness, 174 ± 0.5 days after perihelion, or around October 25.5 UT, when the active phase of the megaburst terminated. The plateau is determined by the intrinsic peak magnitude of −0.53 ± 0.12, based on a limited sample of 92 naked-eye observations used. The event's onset time is marked for reference.

◇ ◇ ◇

[text continued from page 8]

normalized magnitude at the very end of the quiescent phase is about 15.3, the amplitude of the megaburst is $\Delta H_{\rm peak} \simeq 14$ mag. To the extent that the contributions to the maximum visual brightness from both the dust released in the quiescent phase and the gas emissions can be neglected, the peak magnitude indeed measures the total cross-sectional area, $X_{\rm dust}$, of dust particles injected into the expanding cloud during the megaburst. With the heliocentric distance of 2.44 AU at the beginning of the plateau and the particles' geometric albedo of 4 percent, one finds from the relationship between the intrinsic magnitude and the cross-sectional area of a sunlight-scattering body

$$X_{\rm dust} = \frac{5.7 \times 10^7 \ {\rm km}^2}{\Phi(\alpha)}, \tag{2}$$

where $\alpha \leq 17^\circ$ is the phase angle and $\Phi(\alpha)$ is the dimensionless phase law normalized to $\Phi(0^\circ) = 1$. For the relevant values of α, $\Phi(\alpha) < 1$.

The enormous cross-sectional area, $X_{\rm dust}$, implies a major role for optically important, microscopic grains and suggests that the particle-size distribution function may be steeper than usual. This is convenient computationally because the total mass of injected dust depends on the minimum particle size, $h_{\rm min}$, that can be more easily constrained than the unknown maximum size, $h_{\rm max}$. Thus, I write for the differential distribution of particle diameters, h:

$$f(h)dh = n_0 h^{-k} dh, \tag{3}$$

where n_0 is a normalizing constant, and the power index $k > 4$. This distribution law gives for the total cross-sectional area of dust injected into the comet's atmosphere during the megaburst

$$X_{\rm dust} = \frac{1}{4}\pi n_0 \int_{h_{\rm min}}^{h_{\rm max}} h^{2-k} dh \simeq \frac{1}{4}\frac{\pi n_0}{k-3} h_{\rm min}^{3-k}, \tag{4}$$

and for the total mass $\mathcal{M}_{\rm dust}$ of this dust,

$$\mathcal{M}_{\rm dust} = \frac{1}{6}\pi n_0 \rho_{\rm dust} \int_{h_{\rm min}}^{h_{\rm max}} h^{3-k} dh \simeq \frac{2}{3}\rho_{\rm dust} X_{\rm dust} h_{\rm min} \frac{k-3}{k-4}, \tag{5}$$

where $\rho_{\rm dust}$ is the mean bulk density of the dust particulates. Because of the assumed predominance of microscopic dust in the coma, $\rho_{\rm dust}$ must be greater than the nucleus' bulk density (Sec. 3). I adopt $\rho_{\rm dust}/\Phi(\alpha) = 1.5$ g/cm^3. Equation 5 then yields mass $\mathcal{M}_{\rm dust}$ as a function of two parameters, $h_{\rm min}$ and k, as shown in Figure 5.

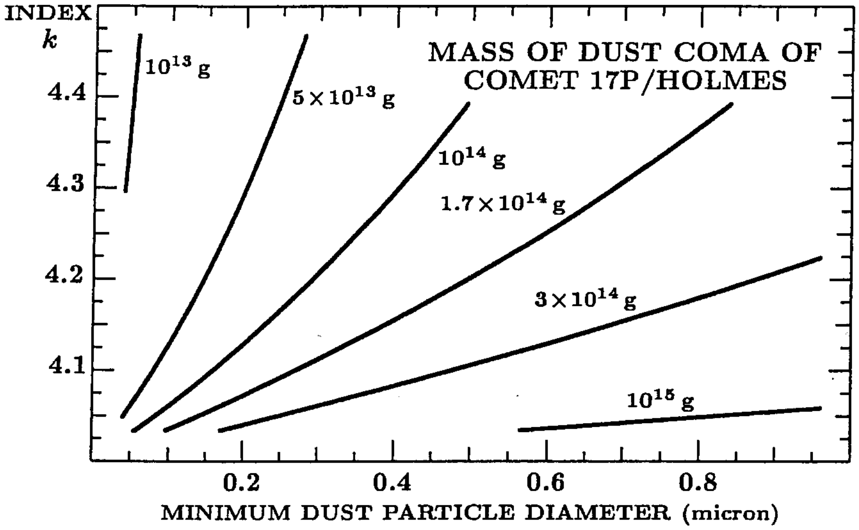


Figure 5. Mass of dust injected into the coma of comet 17P/Holmes in the aftermath of the megaburst, starting 2007 October 23, as a function of the minimum dust-particle diameter $h_{\rm min}$ and the power index k of the size distribution function $h^{-k}dh$. See Sec. 5 for more details.

◇ ◇ ◇

[text continued from page 9]

Because the dust cloud was reported to be distinctly yellow in color, the Rayleigh scattering by grains smaller than $\sim$ 0.1 micron in diameter did not prevail, which suggests from Figure 5 that the mass of the dust cloud was greater than 10^{13} g. A mass near 10^{15} g or greater would imply that a substantial fraction of the nucleus was injected into the coma, a scenario that seems unrealistic because there is no indication that the comet's existence has been threatened. Considering the options offered by Figure 5, I conclude that the total mass of injected dust was near 10^{14} g, or about 1-2 percent of the comet's total mass. With the provisional value of the rise time, the mass-injection rate of dust during the active phase comes out to be about

$$\dot{\mathcal{M}}_{\rm dust} \approx 6 - 7 \times 10^8 {\rm g/s}. \tag{6}$$

An additional mass was locked in the gas emissions, by which the dust injection was driven. Judging from the fairly high dust-expansion velocity of 0.5 km/s, the gas-emission rate may have been comparable, or nearly comparable, to the dust-injection rate. Combi *et al.*'s (2007) results are more in line with this expectation than the data based on the observations made more than 5 days after the event's onset (Salyk *et al.* 2007, Schleicher 2007).

As observing will continue until at least April 2008, the light curve (Figure 1) will remain incomplete for months, and it is too early to speculate about the megaburst's lingering effects over a long period of time. In Figure 6, a comparison of the observed brightness with the predicted light curve for a constant cross-sectional area of dust particles in the coma shows some, but no major, mismatch in that the observations run below the expected level, yet parallel to it since the second half of November.[2] The fact that, for nearly 60 days, about the same (rather than ever-decreasing) fraction of the dust ejecta has been reported may suggest their partial, but continuing, replenishment during the comet's diminishing post-event activity (Sec. 8.5).

6. Comparison With Outbursts of Comet 17P/Holmes in 1892-1893

Bobrovnikoff's (1943) extensive overview of the comet's discovery apparition with a complete list of references represents an excellent account of the observations made and offers their physically sound interpretation. Below I take issue with only a few specific conclusions made by Bobrovnikoff.

Since the comet was discovered in outburst, the amplitude of this event remains unknown, even though Richter's (1949) guess was a minimum of 4-5 magnitudes. However, the onset times of both outbursts can be determined with reasonable accuracy, thanks primarily to Barnard's (1896) meticulous measurements of the expanding coma. His coma-diameter data for the first outburst were in excellent agreement, and could be linked, with those by Denning (1893). Spectroscopic observations (e.g., Campbell 1893, Kammermann 1893a, Vogel 1893) consistently showed the continuous spectrum to dominate, with only a faint "green line" (C_2 emission band) sometimes also reported. Campbell (1893) noted that, on 1892 November 8 and 9, this feature was better seen outside "the bright parts" of the comet, that is, outside the cloud of injected dust. There is no doubt that Barnard measured the expanding dust coma and that therefore his observations were as helpful for determining the onset times in 1892-1893 as the data from Table 1 in 2007. Orlov

---

[2] A very preliminary examination of brightness observations of 17P from January-March 2008 suggests that this conclusion will probably apply for the comet's light curve during the entire period of time after the megaburst.

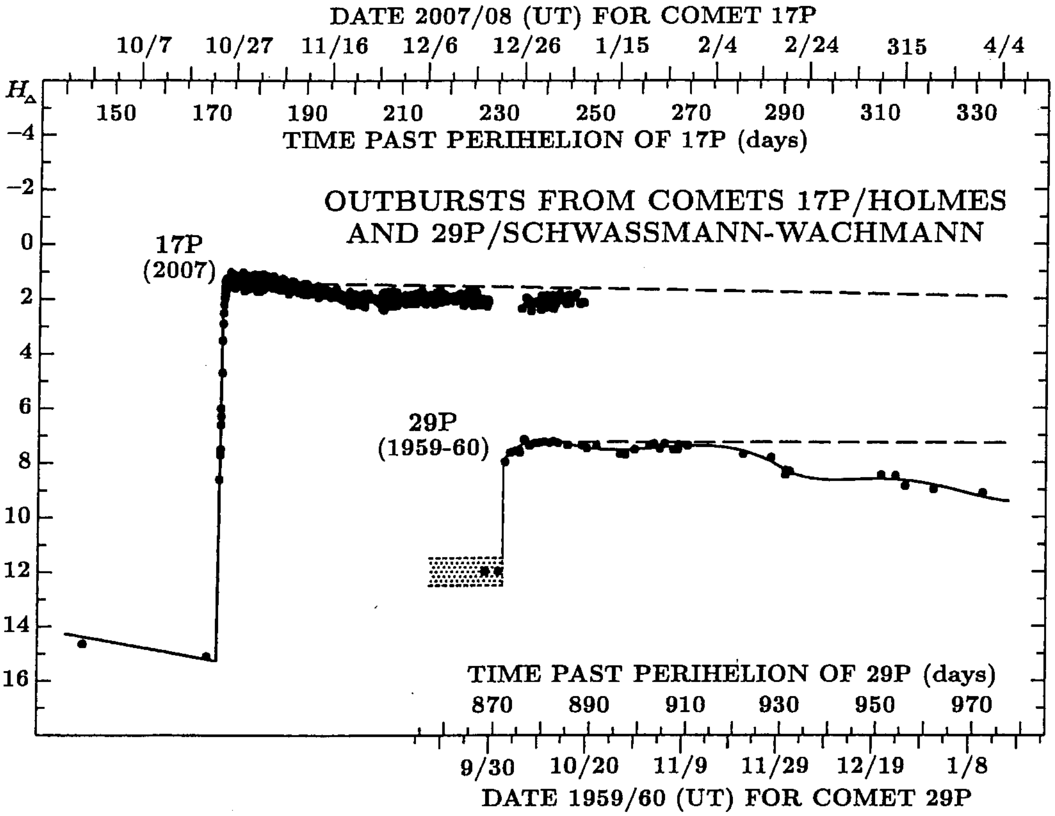


Figure 6. Light curve of the 2007 megaburst of comet 17P/Holmes compared with the light curve of comet 29P/Schwassmann-Wachmann as observed by Beyer (1962) around the time of its outburst at the beginning of October 1959. The magnitudes H_Δ are as in Figure 1. The dashed, nearly horizontal lines are the light curves predicted for the case of a constant cross-sectional area of dust particles in the coma. Note that both comets display a prolonged and very slow intrinsic fading along the plateau. The first two data points for comet 29P are crude guesses based on the available information provided by Beyer (1962) on the one hand and by Roemer (1959) on the other hand.

◇ ◇ ◇

[text continued from page 10]

(1940, 1945) combined Barnard's coma-diameter measurements with other observers' estimates and found that the comet developed two halos on both occasions: a high-speed one (0.95 km/s in November and 2.06 km/s in January) and a low-speed one (0.42 km/s in November and 0.38 km/s in January). My rigorous analysis shows that the high-speed features did not exist and that the expansion rates were somewhat lower for the low-speed halos: 0.38 ± 0.01 km/s with the onset on November 4.7 ± 0.4 UT, 143.7 days after perihelion at a heliocentric distance of 2.39 AU, and 0.28 ± 0.02 km/s with the onset on January 16.0 ± 0.2 UT, 216.0 days after perihelion at 2.64 AU from the sun. This result for the second event is in good agreement with that by Bobrovnikoff (1943), who from a total of 34 data from January 16-23, grouped into 10 normal places, found an expansion velocity of 0.27 km/s and the onset time of January 15.6 UT. From the onset time for the first event, it follows that the comet was discovered 2.3 days into the outburst. Apparently the last observation made before the second event began was that by Hough (1893) with the 47-cm equatorial of the Dearborn Observatory on January 15.1 UT, 0.9 day before the onset, when the comet appeared as a faint nebulosity.

As is the case with even the best-observed 19th-century comets, only rather fragmentary information is available on the light curve of comet 17P/Holmes in 1892-1893. Nevertheless, Bobrovnikoff (1943) compiled a list of 40 brightness estimates between November 10 and March 16 UT, while Richter (1949) provided more abbreviated information for the January event only, but the same data treated as total magnitudes by Bobrovnikoff were considered to be "nuclear" magnitudes by Richter. There are three types of useful data that can be used to obtain some idea on the comet's prominence in the sky shortly after the outbursts. The first is comparison with M31 (whose total visual magnitude is around 3.5),[3] close to which the comet was located in November. To my knowledge, the only observer who claimed

---

[3] as measured by S. J. O'Meara (1998) via the Morris/O'Meara "Modified Out" method, and separately via photoelectric photometry by de Vaucouleurs *et al.* (1991), with the involved reduction explained by Buta (1995) and Buta *et al.* (1995); Bortle (1984) measured total visual mag 4.4 via naked eye and the VBM method (cf. Green 1996), which underestimates the brightness of apparently large celestial objects, providing a lower (fainter) magnitude limit (The M31 magnitudes are published on p. 29 in this issue of the *ICQ*).

that the comet was considerably brighter (though smaller in size) than M31 was Copeland (1893) on November 10 UT. However, his conclusion may refer to the surface, rather than total, brightness of the two objects. Barnard (1896) said explicitly that with the naked eye on November 9.2 UT "the comet was just as bright, exactly, as the brightest part of the Great Nebula of Andromeda" and continued that on November 10.1 UT, it "was brighter to the naked eye than the brightest part of the Andromeda nebula." Elsewhere he remarked (Barnard 1892) that the next night (Nov. 11 UT) "it may possibly have been a little brighter yet." This suggests that the comet's brightness was apparently still increasing some 5-6 days after the event's onset. Two days later (Nov. 13 UT), Barnard (1896) noted, that to the naked eye, the comet was "certainly less bright" and this he confirmed on November 14.2 UT. On November 17 UT he noted that to the naked eye the comet "was still stellar but fainter," while five days later "it appeared much fainter than the Andromeda nebula." Engelhardt (1893) made a similar comment based on his observation of November 26.9 UT. Bobrovnikoff's (1943) composite light curve has a peak as late as November 12.9 UT, fully 8.2 days after the outburst's onset.

The second type of brightness data in 1892-1893 was comparison with the nearby stars. Because the comet had a sharp nuclear condensation in the early phase of expansion, there is a danger that these magnitudes do not refer to the total brightness. Barnard (1896) found with the naked eye on November 10.2 UT that "the comet looked like a small star and almost equal to ν Andromeda," whose visual magnitude is 4.5 (via the Hipparcos/Tycho spacecraft catalogue). On November 14 UT, Coit (1892) called the comet about $1\frac{1}{2}$ mag fainter than μ Andromedae, whose visual magnitude is 3.9. On January 17.2 UT, about one day after the onset of the second outburst, Barnard (1896) reported that the comet in "the finder . . . could not possibly be distinguished from an 8th magnitude star." This estimate may closely describe the total brightness, as according to Bobrovnikoff (1943) all observers stated that on January 17 UT "practically the whole light of the comet was concentrated in the nucleus," On the same night Barnard remarked that over a period of 2 hours "there was no question that the nucleus was brightening."

The third type of brightness information addressed the comet's visibility with the naked eye. A number of independent reports of this kind appears to be quite consistent. Barnard (1896) saw the comet via naked eye in the period of November 9-25 UT, but not on December 6 UT, as he specifically emphasized. Coit (1892) reported the comet to be distinctly visible to the naked eye on November 14 UT, while Kammermann (1893b) made such a sighting on November 15.7 UT, and Renz (1893) on November 23.7 UT. Gruss (1893) described the comet as larger but fainter on November 17 UT compared to November 13. Russell (1893) quoted Davidson, the independent discoverer, as saying that the comet was "just visible to the naked eye" on November 21 UT and, similarly, Updegraff (1892) found it barely visible to the unaided eye on November 26.2 UT. After the second outburst, Kobold (1893) saw the comet with the naked eye as a faint spot of light on January 16.9 UT. Kammermann (1893a) noticed that the brightness slightly increased between January 17.8 and 18.8 UT. This is consistent with the description by Holetschek (1917), who, reviewing his observations in Vienna, found the comet somewhat larger and brighter on January 18 UT compared with January 16 and again on January 20 UT compared with January 18, but not on January 23 UT compared with January 20. Lovett (1893) reported the comet visible to the naked eye on January 20.0 UT. Thus, the comet's brightness reached the peak some 4-5 days after the onset of the second outburst; in terms of the rise time, there is not much difference between the two 1892-1893 events. Lovett's result is, however, in sharp conflict with Bobrovnikoff's light curve that gives for this date the magnitude range of 6.9-7.2. It thus appears that the comet was then perhaps $1\frac{1}{2}$ to two magnitudes brighter than Bobrovnikoff claimed.

Reviewing and summarizing his observations two decades later, Barnard (1913) assigned the following magnitudes to the comet: 1892 Nov. 10, 4.8; Nov. 13, 5.1; Nov. 14, 5.2; Dec. 6, 12.5; 1893 Jan. 17, 7.9-8.1; Jan. 18, 7.8. The amplitude of the second outburst is rather uncertain. Few observations were made shortly before this episode occurred, as the comet became by then quite faint. Kobold (1893), observing on January 11 and 12, remarked that on the second night the comet could be fairly well seen near a 10th-mag star, but not in its immediate proximity. Holetschek (1917) adopted an apparent magnitude 15 for the period January 11-14. Guessing magnitude 5 for the peak brightness, one finds an amplitude of $\sim$ 10 magnitudes. Referring to a binocular observation by T. W. Backhouse on January 11.0 UT, Bobrovnikoff (1943) disagreed with Holetschek and concluded that the total increase in brightness amounted to only some 2.8 magnitudes and that it was by no means sudden. However, Barnard's (1896, 1913) description quoted above shows that the nucleus brightened fairly quickly. And if nearly all light of the comet at the time was in the nucleus, a conclusion that Bobrovnikoff subscribed to, the comet's brightness increase must have been rapid as well. The most probable amplitude of the second outburst can be estimated to be near 4-6 magnitudes.

Based on these data, the peak intrinsic magnitudes $(H_0)_{\rm peak}$ during the two outbursts of 1892-1893 are estimated at, respectively, 1.9 and 1.2, the cross-sectional area of injected dust $X_{\rm dust}$ at, respectively, 6 and 12×10^6 km$^2/\Phi$, and, on the same assumptions as before, the total mass of dust injected into the comet's atmosphere at, respectively, 1 and 2×10^{13} g. Together, the two events are believed to have accounted for only $\sim$ 30 percent of the mass of dust lost in the 2007 megaburst. With the approximate values for their rise times, the events' corresponding average mass-injection rates of dust become, respectively, 2 and 5×10^7 g/s.

It may come as a surprise that the peak intrinsic brightness and the amount of dust injected into the coma was greater during the second outburst given that the comet appeared brighter during the first one, when it was also longer visible to the naked eye. However, the comet was at much larger heliocentric and geocentric distances at the time of the second event, making it appear at equal intrinsic brightness 1.2 mag fainter than at the time of the first one. Thus, the period of naked-eye visibility during November should be compared with the visibility in a small telescope after mid-January. Indeed, Wilson (1893) reported the comet to be easily visible in the finder of the 41-cm refractor of the Goodsell Observatory until February 17 UT, more than four weeks after the outburst. Similarly, Backhouse observed the comet with his binoculars as late as February 10 UT (Bobrovnikoff 1943).

Contrary to the light curve presented by Bobrovnikoff (1943), there is a reason to believe that evidence on a brightness plateau after each outburst is hidden in the 1892-1893 data. The comet's expanding dimensions were the source of the observers' dilemma of fully accounting for the brightness contributions from remote areas of the coma, a task that even the most experienced ones were unprepared to handle. One can therefore argue that during the discovery apparition the comet's total magnitude was increasingly underestimated in the post-outburst periods of time.

Three additional points should be made on the 1892-1893 outbursts. First, referring to a photograph taken with a 15-cm Willard lens on November 11 UT, Barnard (1896, 1913) detected, toward the southeast of the comet, a faint hazy tail that widened out into an irregular mass 39′ in diameter, centered 48′ from the comet. The existence of this feature was confirmed the same night during low-power sweeps with the 30-cm reflector of the Lick Observatory, but it was never seen again. See Whipple (1984) for more recent efforts to examine this issue.

Observing the comet on 1892 November 23 UT, Renz (1893) noticed that two tail-like bands emanated from the condensation (which was about 20 arcsec in diameter) in the southeastern direction; they showed up only a little in the coma and did not extend beyond its boundaries. This description may refer to the same phenomenon observed extensively in the 2007 megaburst as streaks and interpreted to be tails of very small, disintegrating fragments that were too faint to detect (Sekanina 2007, Gaillard *et al.* 2007).

Richter (1949) asserted that the January 1893 event consisted of two successive outbursts separated from each other by less than 1.7 days. My examination of Richter's argument fails to confirm his conclusion, but such a scenario cannot be ruled out because multiple events that closely follow each other are notoriously difficult to recognize (Sec. 2).

7. Comparison With Outbursts of Other Comets

A great variety of outbursts is known to have been experienced by comets, including some of the most celebrated ones, such as 1P/Halley (e.g., Bobrovnikoff 1931; Green and Morris 1987; Feldman *et al.* 1986; Larson *et al.* 1990; West *et al.* 1991; Sekanina *et al.* 1992), C/1942 X1 (Whipple-Fedtke-Tevzadze; *e.g.*, Beyer 1947), C/1975 V1 (West; *e.g.*, Sekanina and Farrell 1978), and C/1995 O1 (Hale-Bopp; *e.g.*, Liller 2001). While, for gaining insight into the nature of outburst mechanisms, it is unnecessary to prepare a complete or near-complete list of flaring-up comets, it is useful to select some well-documented examples and describe the events in detail.

To a degree, this was done by Richter (1949) in his effort to find a potential relationship between comets and solar activity. He assembled data on several comets with outbursts, including 17P/Holmes, 12P/Pons-Brooks, C/1888 D1 (Sawerthal), C/1899 E1 (Swift), etc., and searched for correlations — unfortunately too tenuous by today's consensus.

The object of Richter's primary interest was comet 29P/Schwassmann-Wachmann, for which he compiled a large set of magnitude estimates, first from 1927 until 1939 (Richter 1941), later extending it until 1950 (Richter 1954), with a further extension until 1977 completed by Whipple (1980). Yet, perhaps the most homogeneous sample of magnitude data available for this comet was published by Beyer (1962), referring to a major flare-up that began in October 1959. I employ this data set below to provide an example of an explosive event in 29P to compare it with 17P.

7.1. Comparison With Comet 29P/Schwassmann-Wachmann

The light curves of the 2007 megaburst of 17P and the October 1959 outburst of 29P are shown side-by-side in Figure 6. The first two data points in the plot of 29P, shortly before the outburst began, are guesses based in part on Beyer's (1962) negative observations from September 27.92 and 30.96 UT, when the comet was fainter in his 26-cm refractor than visual magnitude 13.0 (a normalized magnitude H_Δ fainter than 9.5). According to Beyer (1962), neither a trace of a coma nor a starlike condensation brighter than magnitude 15.0 could be detected under the prevailing observing conditions on the 27th. On the 30th, the air was very clear but not steady and stars fainter than magnitude 13 could only be seen to flicker at times. Beyer referred to a communication from J. Schubart that on this date the comet failed to show on patrol plates at the Sonneberg Observatory, which can nearly reach magnitude 14 (cf. also Hoffmeister 1960). On the other hand, a stellar nuclear condensation of photographic magnitude 18.0 with some coma was exposed on a plate taken with a 102-cm reflector on September 25 (Roemer 1959, Roemer *et al.* 1966). Although the comet may have been fainter, Beyer's arguments and the fact that Roemer's nuclear magnitudes are known to be below the total brightness by 2-3 magnitudes for faint comets (and more for the brighter ones), make me adopt magnitude 15-16 for the brightness of 29P in late September 1959, which converts to a normalized magnitude 12 ± 0.5 in Figure 6. The comet had undergone a small outburst one month earlier, at the beginning of September, reaching photographic magnitude 12 in the images taken by Van Biesbroeck (1961) with a 208-cm reflector, but this event was already subsiding by September 8. Still, a quiescent, or low-activity, phase may not have been completely restored by the end of September.

While the amplitude of the October 1959 outburst of 29P, probably in the range of 4+ to 5+ magnitudes, is rather poorly known, the event is otherwise described very well. Beyer's (1962) measurements of the dust-coma diameter, presented on the right-hand side of Figure 3, show that it was seen to be steadily expanding for more than a month. Derived from the data obtained under favorable observing conditions, the expansion velocity was equal to 0.19 ± 0.01 km/s, while the onset time was found to be October 1.7 ± 0.2 UT, when the comet was 871.8 days past perihelion and 5.96 AU from the sun. Thus, the outburst began the night the comet was first detected by Beyer, only hours before his observation.

The light curves of the megaburst of 17P and the 29P event in Figure 6 display remarkable similarities. The latter shows a clear plateau extending, with a minor dip in the middle, over at least 40 days. The dip does not coincide with, and is not due to, the Moon's interference. Rather, there may have been a second outburst before the end of October, resupplying the coma with new dust. Morphologically, the dust coma of 29P differs from that in 17P, as even though it begins as a disklike feature, within weeks it starts showing a ring-shaped appendage, thus providing evidence on the rotational motion of the source with the comet's nucleus. Because of the nearly circular orbit of 29P, the temporal variations in the normalized magnitude H_Δ and the intrinsic magnitude H_0 are practically identical over the period of

100 or so days displayed in Figure 6, with the intrinsic brightness being greater by about 3.9 magnitudes. The peak intrinsic magnitude of 29P during this event was $(H_0)_{\rm peak} = 3.4$ and the rise time between 4 and 10 days. Calibrated with the optical constants used for the megaburst, the total cross-sectional area of injected dust is found to have been $X_{\rm dust} = 1.5 \times 10^6$ km$^2/\Phi$, where the phase effect is even less important than in the megaburst, considering the phase angle of 3°. The injected mass of dust is, accordingly, $\mathcal{M}_{\rm dust} \approx 2.7 \times 10^{12}$ g and the dust-mass-injection rate

$$\dot{\mathcal{M}}_{\rm dust} \approx 3 - 8 \times 10^6 {\rm g/s}. \qquad (7)$$

In terms of dust injection, the megaburst of 17P was nearly 40 times as powerful as this outburst of 29P. Although some outbursts of this comet have a greater amplitude than 5 magnitudes, the comet seldom becomes significantly brighter than during the October 1959 event (peak apparent visual magnitude 10.7). For example, the brightest entry in Richter's (1954) list is 9.4 photographic (close to 8.7 visual) during January 1946, which implies an injected mass of dust less than 10 times the amount above. Only if the particle-size distribution function for 29P is flatter, with large grains contributing a much greater fraction of mass, could the contrast between the two comets be mitigated. Fulle (1992) indeed found the average size distribution's power index for this comet to be $k = 3.3 \pm 0.3$ based on his examination of the comet's tail in a single 1989 image. He derived a dust-injection rate that is fully one order of magnitude *lower* than in expression 7 (above), but his results refer only to dust between 5 microns and 2 cm in diameter. In addition, the comet apparently was not in strong outburst when the 1989 image was taken. Even though the dust-injection rate must increase sharply during each major outburst, these events do not necessarily contribute significantly to the dust-mass loss because of their short duration, especially because 29P is now known to be continually active, even between outbursts (Jewitt 1990). In any case, because of the characteristic morphology, there is no doubt that these outbursts have a distinctly local, rather than global, character.

7.2. Comparison With Comet 41P/Tuttle-Giacobini-Kresák

Discovered in 1858, lost until accidentally rediscovered in 1907, and then lost again — in spite of orbit determination efforts (Pickering 1914; Crommelin 1928) — until 1951, when the comet's identity at the three apparitions spanning more than 90 years was conclusively established at last (e.g., Cunningham 1951; Kresák 1953). This is the beginning of the story of this intrinsically faint comet that eventually became best known for its enormous outbursts in 1973, 115 years after it had been first observed.

◇ ◇ ◇

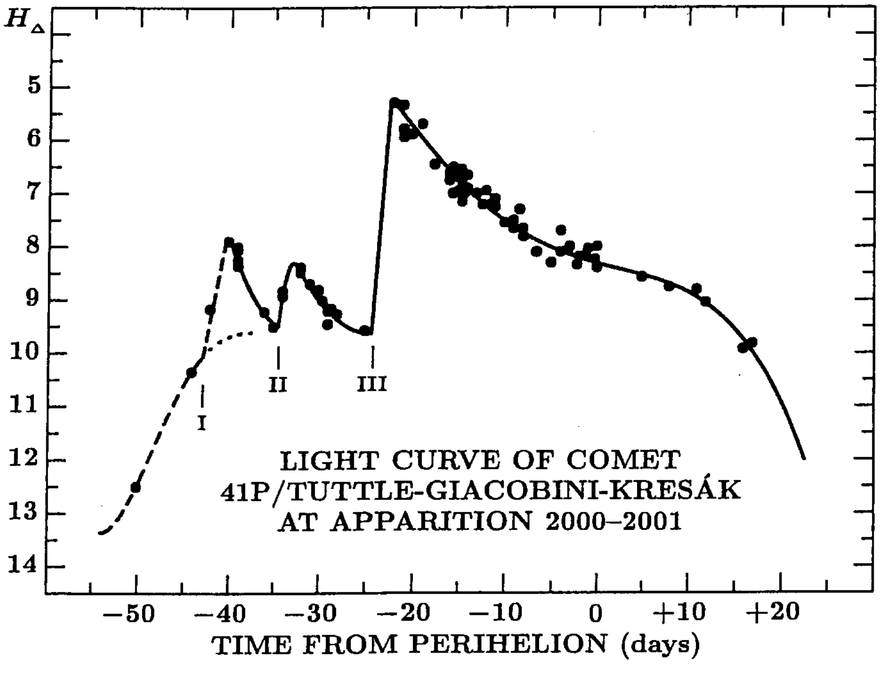


Figure 7. Light curve of comet 41P/Tuttle-Giacobini-Kresák at its 2000-2001 apparition. The magnitudes H_Δ are as in Figure 1. The onset times of outbursts II and III are, respectively, about 35 and 24 days before the perihelion passage, which occurred on 2001 Jan. 6.97 ET. The onset time, amplitude, and rise time of the first outburst are uncertain. Poor knowledge of the portion of the light curve up to the peak of the first outburst is emphasized by being drawn by a dashed curve. The dotted portion refers to the expected shape of the light curve in the absence of the first event. Note that all three outbursts took place earlier relative to perihelion than the first episode in 1973.

The two 1973 outbursts were described by Kresák (1974). According to his account, the first event began less than a week before perihelion. The rate of brightening was about 3 mag/day and the rate of subsequent fading some 1.2 mag/day. With an estimated amplitude of 9 magnitudes, the comet was back to its usual, low-activity phase only 11 days after the outburst had commenced. One month later, the comet flared up again. Kresák (1974) found that the amplitude was again 9 magnitudes, but the rise time was shorter and the brightness subsided rapidly to an elevated level about 3-4 magnitudes above normal, at which point the rate of fading slowed down considerably. The information on the second outburst was augmented by the data from spectrographic observations made on two nights near peak light (Fehrenbach 1973; Swings and Vreux 1973). Strong bands of C_2, C_3, and CN were detected as well as emissions of CH and CH^+, together with a weak to medium-strength continuum. This is consistent with the absence of a post-outburst plateau, as the subsiding branch of the light curve is essentially accounted for by the lifetimes of the detected daughter molecules, which at the heliocentric distances involved are on the order of a few days. Also consistent with the inconspicuous continuum is the absence of a sharply-bounded expanding dust halo.

The light curve of 41P covering both outbursts was published by Kresák (1974). An independent rendition of the light curves from the apparitions in 1951, 1962, and 1973, readily displaying the comet's dramatically changing behavior from return to return, has been available elsewhere (Sekanina 1984). More recently, the comet flared up again at the apparition of 2000-2001. The light curve based on the data collected mostly from the *International Comet Quarterly* is presented in Figure 7, which shows that this time the comet experienced *three* outbursts during a period of three weeks. Comparison with the apparition of 1973 reveals major differences, the only common features being the rapid rates of brightening and fading, again implying no post-outburst plateau and no dust-halo formation.

The first outburst of 2000-2001 is outcropping in Figure 7 from the steeply increasing light curve of the comet on its approach to the sun. Poorly covered by the observations, this segment of mounting activity up to the peak of the first outburst is depicted by a broken curve in Figure 7. The outbursts of 2000-2001 did not rival the 1973 events in terms of the amplitude or peak brightness. However, relative to perihelion, they all occurred before the first outburst of 1973 had.

With the exception of the rapid rate of brightness surge at the very beginning of each outburst of 41P, there appears to be no common ground with the megaburst of 17P, or, for that matter, with the presented example of such events in 29P. The inconspicuous continuum in the spectrum, implying a relatively low content of dust in the coma, is likely to be at the center of these differences.

◇ ◇ ◇

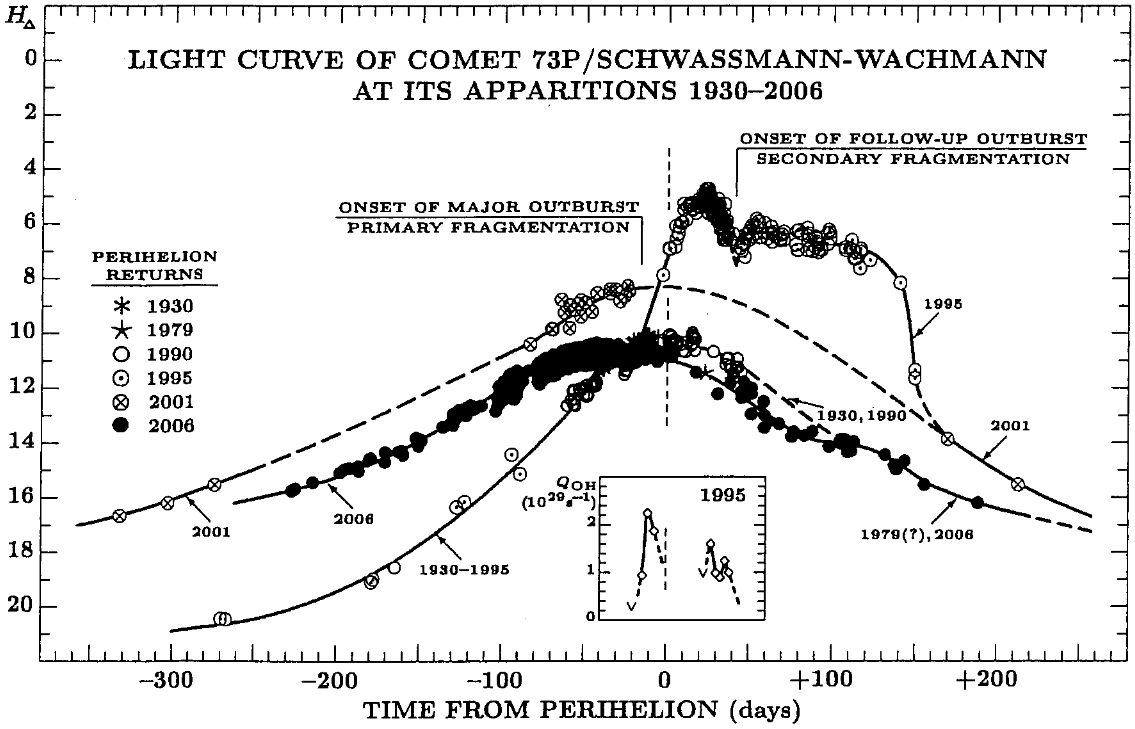


Figure 8. Light curve of comet 73P/Schwassmann-Wachmann at each of its six apparitions 1930, 1979, 1990, 1995, 2001, and 2006. As in Figures 1 and 6, plotted is the normalized magnitude H_Δ. In 1930, the comet's perihelion distance was 1.01 AU, while since 1979 it has remained at 0.93-0.94 AU. The onset times of the two 1995 outbursts coincided with the events of nuclear fragmentation (Sekanina 2005). After the comet split, the brightness refers to the principal fragment C. The 1995 perihelion occurred on September 22.89 ET; fragment C passed through its 2006 perihelion on June 6.96 ET. The inset shows the 1995 temporal variations in the hydroxyl production rate, measured by Crovisier et al. (1996).

7.3. Comparison With Comet 73P/Schwassmann-Wachmann

Discovered during a close approach to the earth in 1930, this is another intrinsically faint comet that after 12 weeks of observation was lost and missed for 9 revolutions about the sun, until it was rediscovered as a new comet in 1979. Its appearance remained unimpressive until 1995, when a sudden surge of OH emission was noticed at radio wavelengths in early September, some two weeks before perihelion (Crovisier *et al.* 1996). Given a small elongation from the sun, the magnitude observations were scant (with gaps) in September and early October 1995, yet indicating that the comet was brightening very slowly, but more or less steadily, for fully five weeks, then declining more rapidly (Figure 8). The observers' accounts (on the pages of the *International Comet Quarterly*) of the comet's appearance in late September and during October repeatedly described a strong nuclear condensation, teardrop shape of the coma, a parabolic envelope or hood, and a fanlike tail, but there was only a single reference to a bright (but elongated) disk of material. There were reports of additional flare-ups in this period of time, which explains the unusually long rise time (36 days for 73P vs. < 10 days for other comets examined in this investigation; cf. Sec. 8). Eight weeks after the onset of this series of events (with additional flare-ups and fading), a new upswing is apparent on the light curve, leading to a second, less conspicuous maximum (Figure 8), followed by a plateau that persisted for 10 weeks. Midway through this phase of evolution, Boehnhardt and Käufl (1995) reported that the comet began to display several nuclei.

Some of the nuclear fragments, reported by these and/or other observers, were short-lived, but four (A-D) were given official designations, with nucleus C being recognized as the principal component. When it returned 5 years later, the fragment C was much brighter than the parent comet at the previous apparitions (Figure 8), and another companion was detected. A recent investigation of the fragmentation sequence and hierarchy of this assemblage of nuclei (Sekanina 2005) showed that one of the fragments observed in 2001 (called F) had never been seen before and that all the companions separated from the principal nucleus in the period of time spanned by the 1995 outbursts.

During the comet's extremely favorable return of 2006, with the minimum geocentric distance of less than 0.1 AU, new products of the advancing fragmentation process appeared before the observers' eyes almost daily. More than 60 fragments were officially catalogued and hundreds of additional short-lived ones were imaged as the comet continued to break apart into second- and higher-generation boulder-sized pieces during further and further episodes of cascading fragmentation.

◇ ◇ ◇

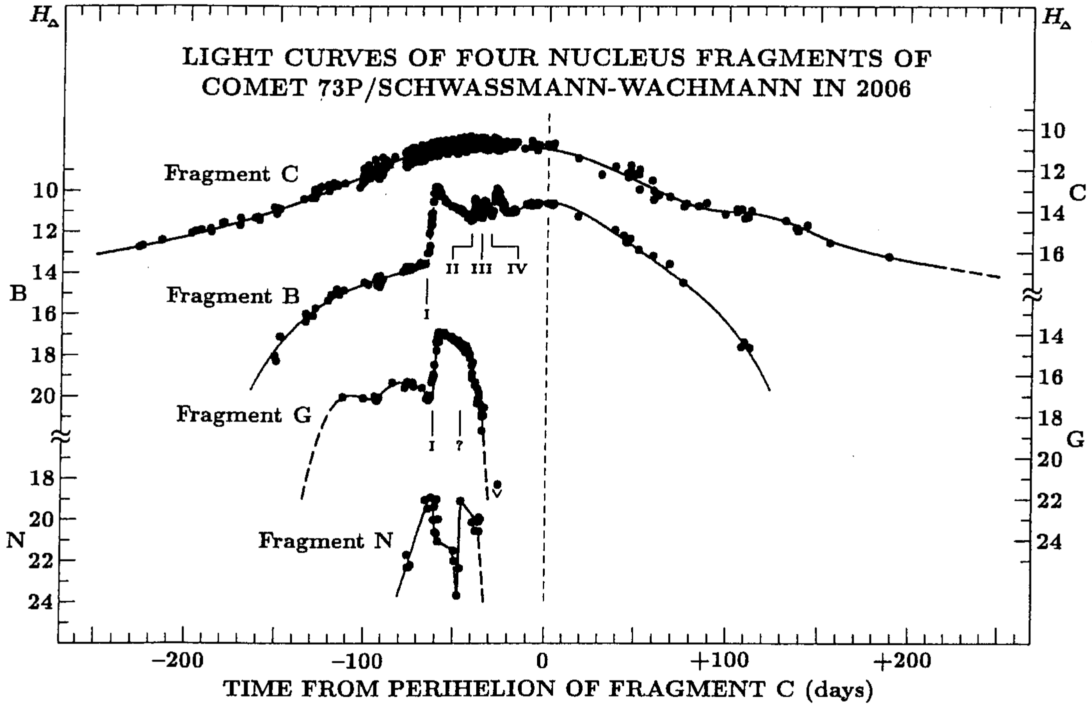


Figure 9. Light curves of four fragments of comet 73P/Schwassmann-Wachmann in 2006. The onset times of the outbursts of fragment B are, respectively, 66, $41\frac{1}{2}$, 36, and $30\frac{1}{2}$ days before perihelion of C (April 1, April 26, May 1, and May 7). The onset time of the major outburst of fragment G was $62\frac{1}{2}$ days before perihelion (April 5). A smaller outburst may have occurred 15 days later. The light curve for fragment B (upper-left scale) has been moved 3 magnitudes down relative to fragment C (upper-right scale) to avoid a congestion between the data points, as fragment B became brighter than C near the peaks of outbursts I and IV. The light curves of fragments G (lower-right scale) and N (lower-left scale) have been shifted similarly. The principal fragment C was at perihelion on 2006 June 6.96 ET, fragments B, G, and N followed, respectively, 0.97, 1.15, and 1.34 days later.

Closely associated with the rapid procession of breakup events was a series of outbursts, which with the exception of the principal nucleus were experienced by all fragments. The relatively smooth light curve of nucleus C is compared in Figure 9 with those of three companions, B, G, and N. Of these, B was the brightest and most persistent, while N was the faintest and of the shortest lifetime, its light curve consisting entirely of rapid fluctuations. On the other hand, on its approach to the sun in 2006, C was still significantly brighter than the presplit parent comet, but this lingering effect finally disappeared near and after perihelion (Figure 8).

◇ ◇ ◇

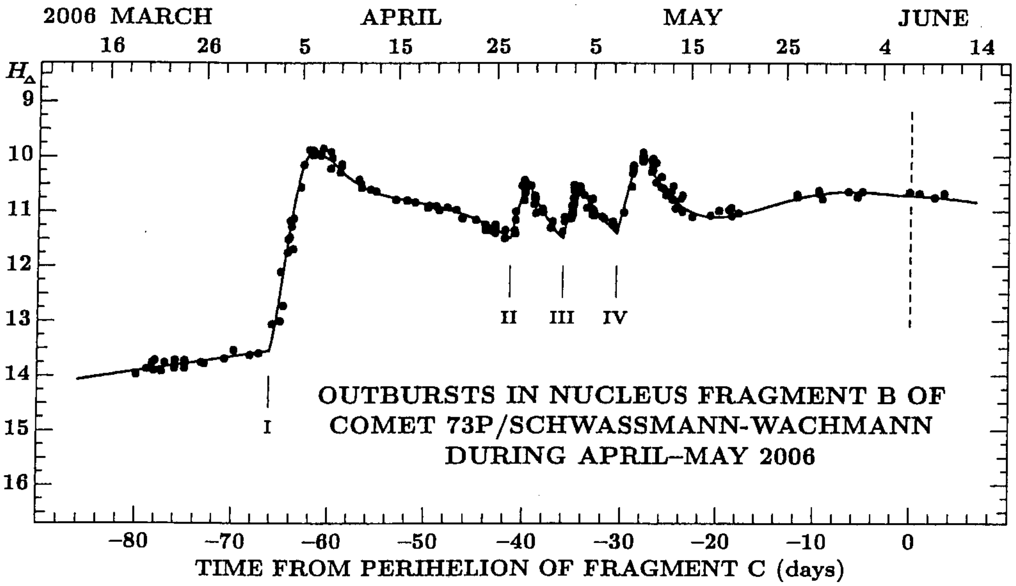


Figure 10. Close-up view of the light curve of fragment B of comet 73P/Schwassmann-Wachmann in April-May 2006, including the four outbursts. Even though the brightness subsides more slowly than it rises for each of them, no extended plateaus are apparent. Only selected observations, mutually consistent to within a few tenths of a magnitude, have been plotted.

◇ ◇ ◇

In terms of the production of higher-generation fragments, nucleus B was unquestionably the most prolific one, more so than nucleus G or the others. The runaway-like fragmentation of B was in five weeks accompanied by as many as four separate outbursts, whose sequence is fully resolved in close-up view in Figure 10. All outbursts of the companions exhibited the characteristic steep rise in brightness followed by a more gradual decline, but none was associated with the formation of a halo or a plateau, because there was not enough dust to sustain them.

Just as with 41P, the outbursts of comet 73P do not appear to have much in common with the megaburst of 17P. The displays of remarkable phenomena by 73P in both 1995 and 2006 document a very strong correlation between the outbursts and nuclear fragmentation for both the presplit parent nucleus and the assemblage of its fragments.

7.4. Comparison With Comet C/2001 A2 (LINEAR)

C/2001 A2 is a long-period comet, whose propensity for both flaring up and nuclear fragmentation (e.g., Jehin *et al.* 2002; Sekanina *et al.* 2002) was demonstrated extensively during a virtually uninterrupted period of observation between January and November 2001 approximately centered on the comet's passage through perihelion at 0.79 AU.

Until about three months before perihelion, the comet brightened at a fairly moderate rate (as an inverse fourth power of heliocentric distance), but then the rate increased and, less than two months before perihelion, a major outburst — of an estimated amplitude of 5 magnitudes — got underway. There was no plateau, but a higher level of activity was retained and a second outburst of a much smaller amplitude took place still before the comet reached perihelion. Two further outbursts, each about $1\frac{1}{2}$ magnitudes in amplitude, occurred between 10 and 50 days after perihelion. When last observed for photometry, at nearly 2.4 AU from the sun outbound, the comet was some 4 magnitudes, or 40 times, brighter intrinsically than at the same heliocentric distance on its way to perihelion. Thus, the behavior of the comet changed dramatically during its passage near the sun.

The nucleus' duplicity was first reported by Hergenrother *et al.* (2001) exactly one month after the first outburst. The nucleus designated as B, unquestionably the principal mass, was subsequently observed until mid-November, while companion A was seen over a period of only 20 days. Modeling the motion of A relative to B, Sekanina *et al.* (2002) determined that, within the uncertainties involved, the onset of the first outburst and the breakup of the parent nucleus into A and B coincided. It was also established that C, another fragment of the nucleus, separated from B at the time of the second outburst, and that three additional fragments, D, E, and F, all split off from what was left of B within four days of each other and nearly coinciding with the third outburst. This multiple breakup explains the unusually long rise time of the third outburst, exceeding by about five days the rise times of the other events. All these are remarkable correlations, which, nevertheless, need to be addressed in the context of two facts: (i) no outburst was observed to accompany the separation of G, the seventh nuclear fragment observed, and (ii) no known fragmentation event was associated with the last outburst. These issues are discussed in Sec. 8.2.

8. Explaining the Megaburst

The comparison of outbursts observed in the selected comets offers a wealth of information on this phenomenon in a number of ways. A list of active-phase parameters for 20 events summarized in Table 2 shows that, in any chosen category, the 2007 megaburst of 17P is unrivaled as the most powerful event of this kind on record. Before presenting a model for the megaburst, I address possible implications from the relationships (a) between outbursts and a halo formation and (b) between outbursts and nuclear fragmentation.

◇ ◇ ◇

Table 2. Active-phase parameters of the megaburst of comet 17P/Holmes and other cometary outbursts.[a]

		Onset of event			Peak			Post-	Expansion	Mass of
Comet[b]	Event	Date (UT)	$t_{\rm onset} - T$[c] (days)	$r_{\rm onset}$[d] (AU)	intrinsic magnitude (mag)	Amplitude (mag)	Rise time (days)	event plateau	velocity of dust (km/s)	injected dust (g)
17P	megaburst	2007 Oct 23.7	+172.2 ± 0.2	2.44	−0.53 ± 0.12	14 ± 0.5	1.8 ± 0.4	yes	0.50 ± 0.02	10^{14}
	discovery[e]	1892 Nov 4.7	+143.7 ± 0.4	2.39	1.9 ± 0.3	....	5–6	some	0.38 ± 0.01	10^{13}
	2nd	1893 Jan 16.0	+216.0 ± 0.2	2.64	1.2 ± 0.3	4–6	4–5	some	0.28 ± 0.02	2×10^{13}
29P	(Beyer)[f]	1959 Oct 1.7	+871.8 ± 0.2	5.96	3.4 ± 0.1	[4+]–[5+]	4–10	yes	0.19 ± 0.01	2.7×10^{12}
41P	#1[g]	1973 May 25.0	−5.0 ± 1.5	1.15	3.7 ± 0.4	9 ± 0.5	3.0 ± 0.5	no	≥0.5	....
	#2[g]	1973 Jul 5.0	+36.0 ± 1.0	1.24	3.5 ± 0.4	9 ± 0.5	2.0 ± 0.5	no	≥0.3	....
	I[h]	(2000 Nov 25)	(−43 ± 1)	(1.20)	(7.5 ± 0.5)	(2 ± 1)	(3 ± 1)	no	....	....
	II	2000 Dec 2.8	−35.2 ± 0.5	1.15	8.1 ± 0.3	1.5 ± 0.3	2.3 ± 0.4	no	....	....
	III	2000 Dec 14.0	−24.0 ± 1.0	1.10	5.1 ± 0.3	4.3 ± 0.3	2.0 ± 0.5	no	....	....
73P	major	1995 Sept 6.9	−16 ± 3	0.96	5.3 ± 0.3	5.0 ± 0.5	36 ± 4	no	....	....
	follow-up	1995 Nov 2.9	+41 ± 1	1.11	5.9 ± 0.2	1.4 ± 0.3	14 ± 5	yes	....	....
73P-B	I	2006 Apr 1.7	−66.2 ± 0.4	1.33	9.3 ± 0.3	3.7 ± 0.4	4.7 ± 0.7	no	....	....
	II	2006 Apr 26.4	−41.5 ± 0.5	1.12	10.2 ± 0.2	1.0 ± 0.3	1.7 ± 0.5	no	....	....
	III	2006 May 1.9	−36.0 ± 0.3	1.08	10.4 ± 0.2	0.9 ± 0.2	1.4 ± 0.4	no	....	....
	IV	2006 May 7.3	−30.6 ± 0.3	1.04	9.9 ± 0.2	1.3 ± 0.2	2.6 ± 0.5	no	....	....
73P-G	I	2006 Apr 5.5	−62.4 ± 0.4	1.30	13.5 ± 0.3	3.0 ± 0.4	5 ± 1	no	....	....
2001 A2	I	2001 Mar 28.5	−57.0 ± 1.0	1.31	6.4 ± 0.6	5 ± 0.6	3.0 ± 1.0	no	....	....
	II	2001 May 10.5	−14.0 ± 1.0	0.83	6.0 ± 0.2	1.1 ± 0.2	3.5 ± 1.0	no	....	....
	III	2001 Jun 5.0	+11.5 ± 1.0	0.81	5.4 ± 0.3	1.4 ± 0.3	8.0 ± 1.0	no	....	....
	IV	2001 Jul 11.5	+48.0 ± 1.0	1.19	6.2 ± 0.2	1.5 ± 0.2	2.5 ± 1.0	no	....	....

[a] All errors except for those of the expansion velocity entries and the onset time entries for comets 17P and 29P are estimated errors.

[b] Comet names: 17P = Holmes; 29P = Schwassmann-Wachmann; 41P = Tuttle-Giacobini-Kresák; 73P = Schwassmann-Wachmann; 73P-B and 73P-G = the comet's nucleus fragments B and G, respectively; 2001 A2 = LINEAR.

[c] Time of event's onset reckoned from the time of nearest perihelion passage; for fragments B and G of 73P, the reference time is the perihelion passage of the principal fragment C.

[d] Heliocentric distance of the comet at the time of onset.

[e] Comet discovered during this outburst.

[f] All information listed for this entry based on Beyer's (1962) physical observations.

[g] Based on the data presented by Kresák (1974).

[h] Parameters of this event are very uncertain, as discussed in Sec. 7.2.

◇ ◇ ◇

8.1. Relationship Between Outbursts and Halo Formation

Bobrovnikoff (1932) appears to be one of the first to get involved in a systematic investigation into halos in comets. His two primary objects of interest were 1P/Halley in 1910 and 1835-1836 and 12P/Pons-Brooks in 1883-1884, both of which he found to have exhibited numerous well-defined halos expanding with velocities of mostly near 0.5-0.6 km/s and moving under relatively low "repulsive accelerations" (solar radiation pressure). Bobrovnikoff emphasized that spectroscopic observations indicated that these were gas halos. During the 1986 apparition of Halley's comet, Schlosser *et al.* (1986) imaged the evolution of 15 prominent CN halos (which they called shells) and showed that the expansion velocities decreased from 1 km/s at 24 days after perihelion to 0.8 km/s by 36 days later. Subsequently, Schulz and Schlosser (1990) linked the CN halos to CN jets in a transition region about 80000 km from the nucleus and proposed that they both were produced by secondary sources made up of CHON particles.

The outbursts of comet 12P in 1883-1884 may have been a somewhat different story from that of 1P/Halley's CN halos. The evolution of the outburst on 1884 Jan. 1 was described in detail by Müller (1884a, 1884b) and by Vogel (1884), to whom both Bobrovnikoff (1932) and Richter (1949) referred in their studies. Both observers agreed that the three bands (of C_2) dominated the coma, but in the nuclear condensation and its immediate proximity the continuous spectrum prevailed. Vogel remarked that, as the outburst advanced in the evening of Jan. 1, the initially starlike nuclear condensation became a uniformly illuminated circular disk several arcseconds in diameter, whose spectrum was continuous. Vogel's two careful measurements of this disk's diameter made 33 minutes apart were used by Bobrovnikoff (1932) to derive an expansion velocity of 0.4-0.5 km/s. By the evening of Jan. 2, the nuclear condensation was much smaller, the disk from the previous night no longer visible. Müller (1884b), who observed the comet using both a photometer and a spectroscope, underscored that the main result of his photometric analysis of the data was the finding that the light coming from the nuclear condensation and its nearest outskirts between 1883 Nov. 10 and 1884 Jan. 14 had been primarily reflected sunlight, and that any intrinsic light had contributed only a minor part to the total brightness.

There are thus two types of product from an outburst. One type is a gas halo, which can come from the nucleus or from a secondary source, as described by Schulz and Schlosser (1990) for Halley's comet; the other type is a dust halo. These two products are apparently always present, as is illustrated by the fact that dust may be a carrier of the species needed for a gas halo, but depending on the mix (as well as on the detector used), one of them may be dominated by the other in the observations or not detected at all. Since 12P was obviously a dust-poor comet, the gas coma prevailed in its outbursts unless one took the pain to search for reflected sunlight. A relatively low dust content must also have been the reason for the observed character of the outbursts of 41P (Sec. 7.2) and C/2001 A2 (Sec. 7.4). In the case of the fragments of 73P, too little dust was involved regardless of whether it did or did not dominate the gas emissions.

The relationship between outbursts and a halo formation is therefore always positive, but rather large amounts of particulate matter are needed to display an expanding disk-like dust halo for many days or weeks after the event's onset. Even more dust is necessary to maintain a persisting post-outburst plateau in the light curve, as the halo's surface brightness continues to drop. Ultimately, it is the enormous mass of 10^{14} g carried in the dust cloud around 17P that is the key to understanding this megaburst.

8.2. Relationship Between Outbursts and Nuclear Fragmentation

In principle, the correlation between an outburst and a fragmentation event can be approached from one of two different generic standpoints. One is to consider the companion (or secondary) nucleus as a product of the standard (but highly variable) dust-emission process — namely, as the largest and most massive piece in the particle size/mass distribution of the population of dust ejecta. It is well-known that a size/mass limit to particles that can be accelerated away from the nucleus is determined by the equilibrium between the molecular drag force of the outflowing gas and the nucleus' gravitational attraction (e.g., Delsemme and Miller 1971). This limit increases with increasing radial outflow velocity, increasing mass-emission rate of gas per unit area of the source, and decreasing mass of the nucleus. Because for a given comet the gas-emission rate is the primary variable, the largest/most massive fragment of particulate ejecta during an outburst is greater than during "normal" activity, thus being easier to detect as a discrete mass.

The problem with this hypothesis is that the limit calculated from the appropriate condition is uncomfortably low compared to the expected sizes and masses of companion nuclei, and the approach becomes absurd for comets breaking up at very large heliocentric distances. If one finds a physical mechanism (Sec. 8.5) that is capable of providing the necessary power, it is conceptually feasible to turn the problem around and consider the separation of a large mass of refractory material from the rest of the nucleus and its lift-off into the atmosphere as the primary process, while the dust cloud is a product of the parallel, nearly simultaneous disintegration of some part of the lifting mass due to structural failure. The debris in the forming cloud has a certain particle size/mass distribution and a total cross-sectional area that is greater than that of the originally separating mass, thus causing, in general, a brightening or an outburst.

What happens in a particular case is determined by the response of the mass to the action of the forces involved in the process of separating and lifting. This response depends primarily on the mechanical strength: the more brittle the mass, the more crumbling it experiences and the greater amount of debris is generated. A variety of scenarios (cf. comet C/2001 A2 in Sec. 7.4) can be understood as a function of the size/mass-distribution law intrinsic to the population of the debris: the steeper the distribution's slope, the less likely the presence of a major fragment. There are two extreme scenarios. On the one hand, if the whole lifted mass is rather compact, little dust is released during the process and the fragmentation event is not accompanied by an outburst. On the other hand, if the lifted mass disintegrates in its entirety, the released amount of dust is enormous and the outcome is a major outburst with no detection of a sizable nuclear fragment. It is proposed that *the complete disintegration of a sizable mass of exceptionally poorly cemented refractory material splitting off from the nucleus of 17P into the atmosphere triggered the comet's megaburst.*

8.3. Pancake-Shaped Fragments of Split Comets and Layering on Cometary Nuclei

The nature of this mass is at this point a matter of conjecture. However, the observations and modeling of comets with multiple nuclei and the recent spacecraft-borne close-up imaging and interpretation of the surface morphology of cometary nuclei, especially that of 9P/Tempel, offer a breakthrough in an effort to understand these issues.

Table 3. Comparison of a major pancake-shaped nuclear fragment of a split comet with a thick layer on the nucleus of comet 9P/Tempel.

Object's property	Major pancake-shaped nuclear fragment (Sekanina 1982)	Thick layer on nucleus of 9P/Tempel	
		Thomas *et al.* (2007)	Belton *et al.* (2007)
Thickness (m)	~130[a]	$\lesssim$200	~50
Base area (km^2)	1.6	~6	~5
Mass (g)[b]	0.8×10^{14}	$\lesssim 4 \times 10^{14}$	$\sim 10^{14}$

[a] This is an average thickness, calculated as the volume-to-base area ratio of a fitted spherical segment.
[b] Derived from the volume assuming bulk density of 0.4 g/cm^3.

◇ ◇ ◇

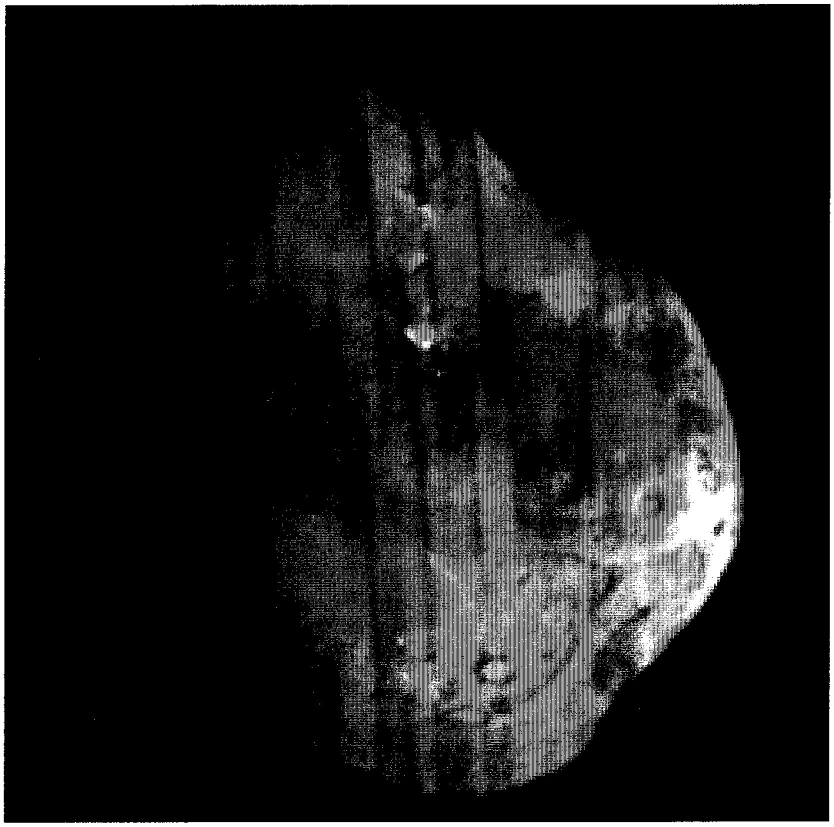


Figure 11. Image of the nucleus of comet 9P/Tempel taken by the impactor's targeting sensor of the Deep Impact probe about 5 minutes before crash on 2005 July 4. The image shows widespread thick layers of terrain bounded by steep scarps. The sun is to the right. From the top to the bottom, the nucleus is about about 7 km in size. (Image credit: NASA/JPL-Caltech/UMD.)

◇ ◇ ◇

[text continued from page 19]

A fragmentation model, consistent with the conservation-of-orbital-angular-momentum law and incorporating a nongravitational deceleration of a major fragment relative to the principal nucleus of a split comet as a parameter, was developed (Sekanina 1978, 1982) and applied to dozens of comets with multiple nuclei, including comets 73P and C/2001 A2 (Secs. 7.3 and 7.4), to derive the fragments' separation times (for correlations with the onset times of outbursts), separation velocities, and the decelerations. The separation velocities were found to be always very low, ~1 m/s. A major finding was the discovery of a discrepancy for *nearly spherical* fragments between their brightness and the nongravitational deceleration to which they were subjected: their light curves required much lower decelerations, while the computed decelerations implied much fainter objects. The proposed solution to this dilemma was to make each fragment *pancake-shaped* (Sekanina 1982), with its dimensions defined by the size of the parent nucleus as the thickness and the plane-of-fissure diameter of a spherical segment that fits the deceleration. In this scenario, the brightness is determined primarily by the maximum cross-sectional area of the tumbling pancake, whereas the deceleration is determined primarily by its minimum dimension (thickness). A typical deceleration derived for the major (persistent) fragments was 7×10^{-5} the solar gravitational attraction (Sekanina 1982), with the corresponding dimensions and mass shown below in Table 3. In conformity with the prevailing views in the 1980s, I assumed that the pancake-like nuclear fragments were jettisoned pieces of a purged insulating mantle with a spread reservoir of icy material attached to the base. Each pancake's release from the parent nucleus was accomplished by activation of an ice sheet by the penetrating heat wave and presumably assisted by nuclear rotation. However, each pancake's dimensions and mass are independent of its nature.

The images of 9P/Tempel returned by the *Deep Impact* spacecraft mission (cf. Figure 11) have provided strong evidence of nuclear layering (Thomas *et al.* 2007), which consists of extensive thick units (Table 3) as well as much thinner ones. A "talps" ("splat" spelled backwards) or "layered pile" model was published by Belton *et al.* (2007), who proposed that these layers are primordial and omnipresent on the nuclei of the Jupiter-family comets, even though they are less apparent on 19P/Borrelly and barely discernible on 81P/Wild. Further research should test the veracity of the talps hypothesis. By identifying pancake-shaped fragments as jettisoned layers, one can explain two phenomena that otherwise are difficult to understand: (i) cataclysmic fragmentation (such as for comet C/1999 S4), by all layers breaking loose as free-flying pancakes simultaneously; and (ii) large uncratered plains on the nucleus' surface, by their long-term protection against cosmic bombardment by layers that had been stacked on top of them, but were jettisoned just recently. Truly remarkable is the agreement in Table 3 between the estimated masses of a *typical* thick layer and a *typical* major pancake-shaped nuclear fragment, and also between them on the one hand and the mass of the dust cloud around 17P on the other hand (Sec. 5)! This correspondence suggests that *a thick layer* 10^{14} *g in mass jettisoned from the surface of 17P into the atmosphere as a major pancake-shaped fragment and disintegrating almost immediately into a cloud of dust* is a conceptual hypothesis for the megaburst that is worth pursuing further. It is noted that — given the sizes of the base areas in Table 3, which occupy between 10 and 35 percent of the comet's hemispheric surface area — the lifted pancake-like layers of terrain are truly extended sources of particulate debris. For example, if centered on a rotation pole, a mass of 6 km^2 would cover the nucleus' surface of comet 17P from latitude 90° down to latitude 40°, and its disintegration upon the lift-off would scatter microscopic ejecta into a wide cone with an apex angle of at least 100°. Such an enormous event, of nearly global proportions on the scale of the nucleus of comet 17P, is in sharp contrast to the local character of flare-ups known to occur episodically on the surface of comet 29P (Sec. 7.1). The signaled propensity for nearly spontaneous crumbling into mostly microscopic-sized particulate debris implies (Sec. 8.5) that the energy needed to pulverize the jettisoned mass was much lower than the energy associated with the dust cloud's expansion.

8.4. Kinetic Energy of the Expanding Cloud of Dust

A crude estimate for the kinetic energy acquired by the dust injected into the coma during the active phase of the megaburst can be obtained from the injected mass $\mathcal{M}_{\rm dust}$ and the expansion velocity $v_{\rm exp}$, both derived in Sec. 5:

$$E_{\rm exp} = \frac{1}{2}\mathcal{M}_{\rm dust} v_{\rm exp}^2 \approx 1.25 \times 10^{23} {\rm erg}. \tag{8}$$

By sheer coincidence, this number is on the same order of magnitude as the explosive energy of the Tunguska object (e.g., Ivanov 1963, Ben-Menahem 1975) and virtually identical with its new revised estimate (Boslough and Crawford 2008). However, the result (equation 8) is in fact an upper limit to the true kinetic energy of the expanding mass of dust in the atmosphere of 17P, because only a fraction of the injected particles reached the envelope of the cloud.

A more rigorous approach must use the dust-particle size-distribution function $f(h)dh$ from Sec. 5 and a size-dependent particle velocity $v(h)$, in which case the kinetic energy is

$$E_{\rm dust} = \frac{1}{2}\int_{h_{\rm min}}^{h_{\rm max}} \mu(h) v^2(h) f(h) dh, \tag{9}$$

where $\mu(h) = \frac{1}{6}\pi\rho_{\rm dust} h^3$ is the mass of a particle of diameter h and $v(h)$ is the terminal velocity acquired by this particle during its injection into the coma. Using a hydrodynamical approach to gas-dust interaction in cometary atmospheres, Probstein (1968) was the first to show that terminal velocities for tiny, microscopic dust that rapidly accommodates to the ambient gas flow are nearly independent of particle size, converging to a particular limiting value that is a function of the dust-to-gas mass ratio in the comet's head, whereas large dust is accelerated to lower terminal velocities that vary with $1/\sqrt{h}$. Both boundary conditions are satisfied by a simple law

$$v(h) = \frac{v_0}{1 + b\sqrt{h}}, \tag{10}$$

where v_0 and b are the coefficients that depend on the dust-to-gas mass ratio. The observed expansion velocity is obviously the terminal velocity of the smallest grains in the cloud,

$$v_{\rm exp} = \frac{v_0}{1 + b\sqrt{h_{\rm min}}}. \tag{11}$$

Inserting expressions 3 and 10 into equation 9, one again finds the result to be practically independent of the maximum particle diameter, $h_{\rm max}$, when $k > 4$. The kinetic energy is equal to

$$E_{\rm dust} = \frac{1}{12} n_0 \pi \rho_{\rm dust} v_0^2 \int_{h_{\rm min}}^{\infty} \frac{h^{3-k}}{\left(1+b\sqrt{h}\right)^2} dh. \tag{12}$$

After integration, one has

$$\begin{aligned} E_{\rm dust} &= \mathcal{M}_{\rm dust} v_0^2 (k-4) \left(b\sqrt{h_{\rm min}}\right)^{2k-8} B_{\left(1+b\sqrt{h_{\rm min}}\right)^{-1}}(2k-6, 8-2k) \\ &= E_{\rm exp}(2k-8)\Theta^{6-2k}(1-\Theta)^{2k-8} B_{\Theta}(2k-6, 8-2k), \end{aligned} \tag{13}$$

where for $0 < z < 1$

$$B_z(x,y) = \int_0^z t^{x-1}(1-t)^{y-1} dt \tag{14}$$

is the incomplete beta function and

$$\Theta = \frac{1}{1+b\sqrt{h_{\rm min}}} = \frac{v_{\rm exp}}{v_0} \tag{15}$$

is a dimensionless expansion-velocity coefficient. The correction factor $E_{\rm dust}/E_{\rm exp}$ depends only on the product of b and $h_{\rm min}$, but not on either of them individually. If $h_{\rm mean}$ is the diameter of a mean particle whose terminal velocity is exactly one-half the limiting velocity v_0, the coefficient b is

$$b = \frac{1}{\sqrt{h_{\rm mean}}}, \tag{16}$$

with v_0 then derived from Eq. (11). Taking, crudely, $h_{\rm mean} \approx \sqrt{h_{\rm min} h_{\rm max}}$, $h_{\rm min} \approx 0.1$ micron, and $h_{\rm max} \approx 2$ cm, one finds $b \approx 15$ cm$^{-1/2}$ and $\Theta \approx 0.955$. Keeping b constant but relaxing $h_{\rm min}$ to cover a range of particle diameters, say, from 0.02 to 0.5 micron (Figure 5), one gets Θ in the range of 0.90 to 0.98.

◇ ◇ ◇

Table 4. Correction factors $E_{\rm dust}/E_{\rm exp}$ for the kinetic energy of dust injected into the coma of 17P during the megaburst.

Power index, k	Dimensionless expansion-velocity coefficient Θ 0.90	0.92	0.94	0.96	0.98
4.02	0.066	0.072	0.080	0.092	*0.114*
4.05	0.155	0.168	0.186	*0.212*	0.257
4.10	0.278	0.300	*0.329*	0.370	0.438
4.20	0.459	*0.489*	0.528	0.581	0.663
4.40	*0.665*	0.698	0.737	0.786	0.854

◇ ◇ ◇

The correction factor $E_{\rm dust}/E_{\rm exp}$ is listed in Table 4 as a function of Θ and the power index k. For a constant injected mass of dust, Figure 5 shows that the minimum particle diameter and the power index are tightly correlated. For $\mathcal{M}_{\rm dust} = 10^{14}$ g, the correction factors for the relevant combinations of k and Θ are shown along the diagonal of Table 4 by slanted-type font. To avoid the dust-particle diameters much smaller than 0.1 micron (because of the absence of Rayleigh-type scattering) and the size-distribution functions that are too steep ($h^{-k}dh$, with k slightly exceeding 4, is already substantially steeper than the usual h^{-3} to $h^{-3.5}dh$), the preferred case in Table 4 is $k = 4.05$, $\Theta = 0.96$, which yields

$$E_{\rm dust} \simeq 0.2 E_{\rm exp} \simeq 2.5 \times 10^{22} {\rm erg}. \tag{17}$$

For comparison, the average solar-radiation energy impinging on an area Π (in km^2) of the nucleus' surface of comet 17P during a single revolution about the sun is

$$E_{\Re}(\Pi) = \frac{1}{4} S_0 \Pi \int_{(P_{\Re})} \frac{1}{r^2} dt = 1.078 \times 10^{23} p_{\Re}^{-1/2} \Pi, \tag{18}$$

where S_0 is the solar constant, $S_0 = 1.180 \times 10^{21}$ erg/km^2/day, r is the heliocentric distance, t is time, and $p_{\mathfrak{R}}$ and $P_{\mathfrak{R}}$ are, respectively, the orbital parameter (in AU) and the orbital period during the revolution $\mathfrak{R}$. The factor $\frac{1}{4}$ accounts for an effect of the comet's rotation, as the nucleus' cross-sectional area is one quarter of the total surface area.

During the current revolution about the sun, the entire surface of the nucleus, 34.2 km^2, receives an energy of 2.15 $\times$ 10^{24} erg from the sun. Because of the planetary perturbations, the orbit of 17P varies from return to return, and so does the total amount of impinging solar energy. However, these variations are very small. During the revolution centered on the 1892 return, for example, when the perihelion distance was 2.14 AU (compared to the current value of 2.05 AU), the comet received 2.12×10^{24} erg from the sun, assuming the same nuclear surface area; at the 1964 return, the perihelion distance was 2.35 AU and the energy received during that revolution was still 2.05×10^{24} erg. During the entire period of time between the 1892-1893 explosive events and the 2007 megaburst, the total energy impinging from the sun on the nucleus of comet 17P/Holmes was 3.4×10^{25} erg, nearly 1400 times the kinetic energy of dust injected into the atmosphere during the megaburst. Almost all of this received solar energy was reradiated back into space as thermal radiation if the nucleus' surface was kept at an orbit-averaged blackbody temperature of 148 K. The balance of the energy was used to sublimate water and other ices and to transfer heat into the nucleus' interior. For comparison, a black-body temperatures are 195°K at perihelion of 17P and 178°K at a heliocentric distance of the megaburst; the temperatures of water ice on the nucleus' surface at the subsolar point are 194°K and 191°K, respectively, at the two distances; and the corresponding nuclear surface-averaged temperatures of water ice are 180°K and 173°K.

8.5. Amorphous-to-Cubic Ice Phase Transition and Water Production

The very high kinetic energy of the megaburst of 17P requires an internal energy source. While there has been a number of mechanisms suggested over the years (for reviews, see e.g., Hughes 1990, 1991), I focus on the amorphous-to-cubic water ice-phase transition as a mechanism that appears to be consistent with, and favored by, the range of temperatures listed at the end of Sec. 8.4, as is apparent from the following.

First proposed as a potential source for triggering comet outbursts by Patashnick *et al.* (1974), the amorphous-to-cubic ice transition is strongly exothermic, with an energy-release rate per unit mass of $(dE/d\mathcal{M})_{\rm trans} = 24$ cal/g or 1.0×10^9 erg/g. The amount of information on amorphous water ice has recently grown exponentially, and it is impossible to present even an abridged overview of the results. From the astrophysical standpoint, the complexities of the water-ice transitions are apparent from laboratory work by Jenniskens and Blake (1994, 1996), who investigated the evolution, during warm-up, of vapor-deposited amorphous ice at a temperature of 15°K and an extremely low pressure of $\sim 10^{-7}$ torr. They confirmed the previously reported formation of high-density amorphous ice (1.17 g/cm^3), which persisted until 38°K. At the temperatures between 38°K and 68°K, a transition took place to low-density amorphous ice (0.94 g/cm^3), whose further heating caused its structure to change when the temperature reached 122°K to 136°K, depending on the experimental conditions. The crystallization began between 142°K and 160°K, and the formation of cubic ice, of the same density, eventually slowed down between 158°K and 170°K. A fraction of low-density amorphous ice did not crystallize, forming instead "restrained" amorphous ice that coexisted with cubic ice in a mix up to at least 178°K. At higher temperatures, at and above 213°K, both cubic ice and any traces of "restrained" amorphous ice got transformed into hexagonal ice. Jenniskens and Blake concluded that, in practice, the quoted temperatures must also depend on impurities such as dust inclusions, which in the amorphous-ice transition regime can assist the formation of more-complex organic molecules. Jenniskens and Blake speculated that the comets presumably originating in the so-called "Kuiper" (or Whipple) transneptunian belt (which presumably include 17P) should contain high-density amorphous ice, and that "restrained" amorphous ice could account for anomalous gas retention to warm up impure ices to temperatures in excess of 150°K.

The significance of the surface temperatures mentioned at the end of Sec. 8.4 is that they all exceed 160°K at heliocentric distances of up to that of the megaburst and even beyond. Over this arc of the orbit, a small fraction of the total solar energy is diffused as a heat wave into the nucleus, including a porous pancake-shaped layer, whose base is assumed to have previously been warmed up to temperatures exceeding 68°K (high-density to low-density amorphous-ice transition) but not to 160°K. Although the heat wave may retreat a little at larger distances from the sun, it continues to diffuse in during the subsequent orbits. Numerical models (e.g., Prialnik 1992) suggest that cumulatively the front of this heat wave should gradually penetrate, over a number of revolutions, ever deeper into the interior until the icy material at the pancake-shaped layer's base, some 50 meters below the surface, reaches a temperature of ~ 160°K. At that point, the transition from low-density amorphous ice to cubic ice begins, with large amounts of released energy rapidly heating up and sublimating the ice. To test, conservatively, whether this process is numerically feasible, I assume that all volatile material is only water ice, even though there may be 14 percent of carbon monoxide in the emissions (Salyk *et al.* 2007), which would increase the intensity of the process. In a water-only scenario, I first derive the temperature, Υ, reached by the crystallized ice. Writing for $C_{\rm ice}(\Upsilon)$, its specific heat (in erg/g/K) in the range $150°{\rm K} \le \Upsilon \le 240°{\rm K}$,

$$C_{\rm ice}(\Upsilon) = 8.68 \times 10^4 \Upsilon - 37.7 \Upsilon^2, \tag{19}$$

the condition determining the post-transition temperature $\Upsilon_{\rm trans}$ of the water-ice reservoir is

$$\int_{\Upsilon_{\rm pre}}^{\Upsilon_{\rm trans}} C_{\rm ice} d\Upsilon = (dE/d\mathcal{M})_{\rm trans} = 10^9, \tag{20}$$

where $\Upsilon_{\rm pre}$ is the temperature at the time the crystallization process sets in. For $\Upsilon_{\rm pre} = 160°{\rm K}$, the solution to equation 20 is $\Upsilon_{\rm trans} = 226°{\rm K}$. The sublimation rate of water ice from a unit area at this temperature is 2.4×10^{19} molecules/cm^2/s, more than two orders of magnitude higher than at the temperature of 160°K. Equivalent to the conditions at the subsolar point of a comet at 0.26 AU from the sun and implying a vapor pressure of 5 pascals, the high sublimation rate shows that, in order to satisfy a near-peak water-production rate of 1.2-1.4 × 10^{30} molecules/s (Combi *et al.* 2007) in Table 5, the emission area required was not more than 5.0-5.8 km^2, in excellent agreement with the estimated base area of the pancake-shaped layer (Table 3).

◇ ◇ ◇

Table 5. Reported water production rates for comet 17P after the onset of the megaburst.

Date 2007/08 (UT)	Distance from sun (AU)	Water production rate		Species and line/band observed	Aperture radius (10^3 km)	Observer(s) and reference
		10^{29} mol/s	10^6 g/s			
Oct 25	2.44	12	36	H (Lyman-α)	....	Combi *et al.* (2007)
Oct 27	2.45	14	42	H (Lyman-α)	....	Combi *et al.* (2007)
Oct 29–30	2.46	2.75	8.2	H_2O (2.9 μm hot bands)	....	Salyk *et al.* (2007)
Nov 1	2.47	3.5–5.5	10.4–16.4	OH (0–0)[a]	14.5–120.2	Schleicher (2007)
Nov 16	2.53	7.8	23	H (Lyman-α)	....	Combi *et al.* (2007)
Dec 3–5	2.60	0.23	0.68	OH (0–0)[a]	30.2–125.9	Schleicher (e-mail comm.)
Jan 1	2.72	0.078	0.23	OH (0–0)[a]	56.2	Schleicher (e-mail comm.)

[a] The vectorial model used to derive the water production rate.

◇ ◇ ◇

The described process continued with the evacuation, by rapid outgassing, of the space occupied by the icy sheet reservoir. A cave-in of the crumbling pancake of refractory material was prevented by the outflowing water vapor, which, rather remarkably, could lift fragments of up to about 50 meters in diameter into the atmosphere! Since this happens to be just about the thickness of the pancake-shaped layer (Table 3), it is apparent that, at the time of its lift-off from the surface, the body may not as yet have been broken completely into fine dust; rather, the forming cloud of debris may have still included fairly large chunks of material. Their disintegration intensified via in-flight particle fragmentation, a process that begins at the surface but is known to occur almost spontaneously even outside the near-nucleus molecular-drag zone and to lead to complex heterogeneities in the dust coma (e.g., Tuzzolino *et al.* 2004; Clark *et al.* 2004). This evidence is behind the stipulation in Sec. 8.2 that the mass jettisoned from the nucleus' surface into the atmosphere be *exceptionally poorly cemented*. Indeed, the gas pressure of 5 pascals is nearly two orders of magnitude lower than the tensile strength derived for comets by Greenberg *et al.* (1995) and consistent with the results from investigations of split comets. The extraordinary propensity for crumbling suggests that close-up morphology of the cloud of dust expanding from comet 17P — including the boundaries — should be very rugged, unlike the smooth outlines seen on the scale afforded to the terrestrial observers.

Also in an effort to understand this extremely low material strength, one should recognize the consequences of the primordial nature of the pancake-shaped layers, as advocated by Belton *et al.* (2007). If the layers are indeed primordial, the transition from high-density to low-density amorphous ice must have taken place some time in the past, leading to the ice reservoir's expansion. If the ice reservoir penetrated into the base of refractory terrain, as it must have, the expansion necessarily involved the pancake-shaped layer as well, which, at least near its bottom, must have been disturbed and severely damaged, lacking structural coherence from then on. In fact, cracks and fissures may with time have spread further into the layer's interior, thus facilitating its eventual disintegration under trivial pressures.

To compare the production rate of water with the injection rate of dust is more difficult, because the relevant production and injection times are not at all well known. An approach I pursue here is in terms of the total amount of water and dust in the atmosphere. For dust, the total mass was estimated in Sec. 5 to be 10^{14} g; for water, a lower limit to its total mass is determined as the product of the lifetime of water molecules and their mass production rate. For any distance r from the sun, the lifetime of water molecules $\tau_{\rm water}(r)$ is the reciprocal of the total photo rate coefficient for destruction of H_2O. For the quiet-sun regime, which is applicable to 2007, Huebner *et al.* (1992) derived a theoretical value, consistent with a number of observations, of

$$\tau_{\rm water}(r) = 0.97 r^2, \tag{21}$$

where r is in AU and $\tau_{\rm water}$ in days. Hence, at 2.44 AU, one finds $\tau_{\rm water} = 5.8$ days. The amount of water in the atmosphere at the time of the peak production rate (Table 5) was thus 7 × 10^{35} molecules and their mass $\mathcal{M}_{\rm water} \simeq 2 \times 10^{13}$ g, which is a lower limit to the total mass of water molecules in the coma in the immediate aftermath of the megaburst. The resulting estimated dust-to-water mass-production rate ratio is therefore < 5. It is noted that the dust-expansion velocity, equated in Sec. 8.4 with the terminal velocity of the smallest particles (adopted in Sec. 5 to have dimensions near 0.1 micron), can be now calculated from an expression (Sekanina 1981) based on Probstein's (1968) theory to provide another test for the presented model of the megaburst. As the expansion velocity of the dust cloud is a function of the dust-to-gas mass production-rate ratio (which is lower than the dust-to-water mass production-rate ratio), the *lower* limit derived from information gathered in this paper is 0.42 km/s, a satisfactory result.

Two final points: (i) the mass of water molecules in the coma after the megaburst suggests that the energy generated by water-ice crystallization was at least 2×10^{22} erg, an estimate that is close to the kinetic energy of the expanding dust cloud (Sec. 8.4), so that water-to-dust momentum transfer directly contributed to the visually most spectacular attribute of the event; and (ii) comparison of the observed water-production rates in Table 5 shows rather convincingly that, in terms of water release, the activity of the megaburst source was lingering longer than when measured by the rise time (Table 2) of the comet's light curve. When Schleicher's water-production rates are compared with theoretical sublimation rates from a standard emission model, the November 1 and December 3-5 data points imply greatly excessive rates of outgassing (equivalent, respectively, to sublimation areas of 110 km^2 and 15 km^2), while the January 1 data point yields an area of 6 km^2, equal to the estimated base area of the pancake-shaped layer from Table 3. This peculiar trend suggests that, in the aftermath of the megaburst, the crystallization process may have continued for a limited period of time in a newly opened short-lived emission source. This conclusion parallels Whipple's (1984) finding concerning the comet's 1892-1893 outbursts, both of which he found to have been activating (or reactivating) discrete regions on the nucleus' surface.

9. Conclusions

Analysis of the light curve, the dust-halo expansion curve, and the images of hydrogen and hydroxyl comae of comet 17P/Holmes provide the bulk of information on the megaburst of 2007, including its onset and evolution, the total mass lost by the comet during the event, and the expansion velocity of the dust cloud. The description in terms of these parameters requires a number of qualifications. By virtue of its nature, the megaburst was not, strictly speaking, a single event but consisted of a sequence of episodes that occurred simultaneously or in rapid succession. Secondary, tertiary, *etc.*, outbursts were hard to resolve because of scatter in both the light curve and the halo-expansion curve. Similarly, the water-production rates derived from observations of H or OH, the water's dissociation products, refer to times that include effects of the water molecules' long destruction lifetimes and are therefore shifted to later dates. Comparison of the brightness with the water-production data suggests that the megaburst's duration was shorter when measured by the injection of dust into the coma than by the lingering outgassing. This is one of the important aspects of the event that remains to be verified.

The megaburst began very much like any outburst, with a precipitous rise of brightness and the appearance of a sharp, stellar nuclear condensation, rapidly expanding into a planet-like disk. However, the light curve's 14-mag amplitude and subsequent plateau persisting in a coma of ever growing dimensions, more than 5 times the sun's size in early January 2008, were unique. There appears to be a problem with the dimensions and magnitudes of the comet that imply its unrealistically low surface brightness. Assuming for high-quality observing conditions a night-sky brightness of visual magnitude 21.0-21.5 per arcsec^2, an area of the sky of about 80 arcmin in diameter, indicated by observations from dark sites for the apparent diameter of 17P in early January, has a total visual magnitude of 2.86 to 3.36. From the reports to the *International Comet Quarterly* of 17 magnitude observations made with naked eye or a very small instrument during January 1-6 that showed the comet to be greater than 70 arcmin in diameter (an average of 80.2 ± 3.8 arcmin), the average magnitude was 3.6 ± 0.3, fainter than the night sky. Unless the reported magnitudes were corrected for the night-sky brightness, it appears that the comet's total brightness was underestimated by at least 0.5 mag and possibly by as much as 1 mag.

Comparison of an assortment of well-documented outbursts with the 2007 megaburst of 17P shows that this event is unrivaled as the most powerful event of this kind on record. I see no need for developing a radically new mechanism in order to explain the enormous magnitude of the explosion, even though I do consider the proposed scenario as tentative because support from detailed heat-diffusion calculations is still missing. Yet, I subscribe to the conceptual hypothesis of a thick, pancake-shaped layer of terrain, like the widespread areas on the nucleus of comet 9P/Tempel seen in the *Deep Impact* spacecraft images, being jettisoned into the atmosphere of comet 17P. Driven by an exothermic reaction caused by the transition of water ice from low-density amorphous phase to cubic phase in an underlying sheet reservoir, the jettisoned pancake of refractory material gave birth to a major fragment, which under more typical circumstances would end up slowly receding from the principal nucleus with a separation velocity of about 1 m/s and a differential nongravitational deceleration on the order of 10^{-5} the sun's gravitational acceleration. An important distinction in the case of comet 17P was that, rather than falling apart gradually, over hundreds of days or longer, this fragment failed to survive its separation from the nucleus and began to crumble precipitously into a cloud of dust immediately upon the lift-off from the surface. It is this behavior that distinguishes 17P from other split comets, a number of Jupiter-family members among them. The hypothesis — fitting all known constraints provided by the observations available at this time — implies that, for a given size of the pancake-shaped layer, the amplitude and peak brightness of the outburst should vary inversely with the residual size of the largest fragment: the smaller its dimensions, the greater amount of microscopic debris and the brighter the outburst. Comet 17P is an extreme case: no sizable fragment but a huge megaburst.

For the nucleus of comet 17P, the megaburst was a nearly global event, affecting a significant fraction of its surface. The expanding cloud of dust had a broad vectorial distribution of velocities, the particles moving away from the nucleus in a wide cone of directions. When viewed from great distance, the flow of debris was lacking the morphology that is associated with collimated ejections of dust from small isolated sources of emission on the nucleus. On smaller scales, however, the motions of particles must have been locally non-uniform, reflecting the stochastic nature of the progressing fragmentation process. The event's unprecedented magnitude challenged observers to make a variety of observations, many of which have not as yet been published. They will eventually constrain this and other models more tightly than they are at this time. The morphological evolution of the coma is an example of the event's features that I left unaddressed.

As of now (mid-January 2008), there is no sign of a second major outburst, so it appears ever more likely that the history will not be repeated and the pair of outbursts from 1892-1893 will remain unmatched. On the other hand, it was shown in this paper that, in terms of the total mass of dust injected into the atmosphere, the 2007 megaburst was more powerful than the two 1892-1893 outbursts combined. Yet, the remarkable similarity of appearance of comet 17P during the explosive events in 1892-1893 and 2007 strongly suggests that the same mechanism and the same nuclear properties were involved. The lower peak intrinsic brightness implies smaller pancake-shaped fragments in 1892-1893. The lower expansion velocities (Table 2, Figure 3) suggest that the events of 1892-1893 were also less energetic. The pairing of the outbursts is equally inconsequential, as it merely indicates that either the fragment broke up into two while still on the surface, and only a part of it was crumbled and jettisoned immediately, or else that there were two separate fragments with nearly the same thermal history.

It is estimated that comet 17P lost more than 1.5×10^{14} g, or > 2 percent of its mass, in the megaburst and its aftermath. Thus, fewer than 50 events of this magnitude would consume the entire comet. I propose that "peeling off" and jettisoning of pancake-shaped layers of nucleus' terrain, one by is an efficient — perhaps the most efficient — fragmentation process that eventually leads to the comet's demise. The nucleus will disintegrate completely if it is layered throughout its interior, or it will turn into an essentially inert asteroidal object if a nontrivial compact core survives after all layers have been discarded.

Acknowledgements

I thank D. W. E. Green and B. G. Marsden for reading the manucript of this paper and for their most helpful comments, to Dr. Green also for his editorial work. This research was carried out at the Jet Propulsion Laboratory, California Institute of Technology, under a contract with the National Aeronautics and Space Administration.

REFERENCES

Barnard, E. E. (1892). "Photographic and Visual Observations of Comet f 1892 (Holmes)", *Astron. J.* **12**, 127.

Barnard, E. E. (1896). "Photographic and Visual Observations of Holmes' Comet", *Astrophys. J.* **3**, 41-46.

Barnard, E. E. (1913). "Comet III 1892 (Holmes)", *Publ. Lick Obs.* **11**, 26-31.

Belton, M. J. S.; P. Thomas; J. Veverka; P. Schultz; M. F. A'Hearn; L. Feaga; T. Farnham; O. Groussin; J.-Y. Li; C. Lisse; L. McFadden; J. Sunshine; K. J. Meech; W. A. Delamere; and J. Kissel (2007). "The Internal Structure of Jupiter Family Cometary Nuclei from Deep Impact Observations: The 'Talps' or 'layered pile' model", *Icarus* **187**, 332-344.

Ben-Menahem, A. (1975). "Source Parameters of the Siberian Explosion on June 30, 1908, from Analysis and Synthesis of Seismic Signals at Four Stations", *Phys. Earth Planet. Interiors* **11**, 1-35.

Beyer, M. (1947). "Physische Beobachtungen von Kometen. VI", *Astron. Nachr.* **275**, 237-250.

Beyer, M. (1962). "Physische Beobachtungen von Kometen. XII", *Astron. Nachr.* **286**, 219-240.

Bobrovnikoff, N. T. (1931). "Halley's Comet in Its Apparition of 1909-1911", *Publ. Lick Obs.* **17**, 305-482.

Bobrovnikoff, N. T. (1932). "On the Phenomena of Halos in Comets", *Publ. Astron. Soc. Pacific* **44**, 296-307.

Bobrovnikoff, N. T. (1943). "The Periodic Comet 17P/Holmes (1892 III)", *Pop. Astron.* **51**, 542-551.

Boehnhardt, H.; and H. U. Käufl (1995). "Comet 73P/Schwassmann-Wachmann 3", *IAU Circ.* 6274.

Bortle, J. E. (1984). "On Visual Magnitudes", *Deep Sky* **2**(4), 30-31.

Boslough, M.; and D. Crawford (2008). "Low-Altitude Airbursts and the Impact Threat", *Int. J. Impact Eng.*, in press.

Buta, R. (1995). "Integrated Magnitudes and Color Indices of Bright Galaxies", *Astrophys. Lett. and Comm.* **31**, 109.

Buta, R.; H. G. Corwin, Jr.; G. de Vaucouleurs; A. de Vaucouleurs; and G. Longo (1995). "Integrated Photoelectric Magnitudes and Color Indices of Bright Galaxies in the Johnson *UBV* System", *Astron. J.* **109**, 517-542.

Campbell, W. W. (1893). "The Spectrum of Holmes' Comet", *Publ. Astron. Soc. Pacific* **5**, 99-100.

Clark, B. C.; S. F. Green; T. E. Economou; S. A. Sandford; M. E. Zolensky; N. McBride; and D. E. Brownlee (2004). "Release and Fragmentation of Aggregates to Produce Heterogeneous, Lumpy Coma Streams", *J. Geophys. Res.* **109**, E12S03.

Coit, J. B. (1892). "Observations of Comet f 1892 (Holmes)", *Astron. J.* **12**, 126.

Combi, M. R.; J. T. T. Maekinen; J.-L. Bertaux; E. Quemerais; and S. Ferron (2007). "Comet 17P/Holmes", *IAU Circ.* 8905.

Copeland, R. (1893). "Weitere Mitteilungen über den Cometen 1892 . . . (Holmes Nov. 6). Auszug aus Edinburgh Circular Nr. 32", *Astron. Nachr.* **131**, 133-134.

Crommelin, A. C. D. (1928). "Comet Notes", *Observatory* **51**, 353-354.

Crovisier, J.; D. Bockelée-Morvan; E. Gérard; H. Rauer; N. Biver; P. Colom; and L. Jorda (1996). "What Happened to Comet 73P/Schwassmann-Wachmann 3?", *Astron. Astrophys.* **310**, L17-L20.

Cunningham, L. E. (1951). "Comet Notes", *Publ. Astron. Soc. Pacific* **63**, 209-211.

de Vaucouleurs, G.; A. de Vaucouleurs; H. G. Corwin, Jr.; R. J. Buta; G. Paturel; and P. Fouque (1991). *Third Reference Catalogue of Bright Galaxies* (Berlin: Springer-Verlag), 2069 pp.; **2**, 51.

Delsemme, A. H.; and D. C. Miller (1971). "Physico-Chemical Phenomena in Comets. III. The Continuum of Comet Burnham (1960 II)", *Planet. Space Sci.* **19**, 1229-1257.

Denning, W. F. (1893). "Holmes' Comet (1892 III)", *Observatory* **16**, 142-144.

Engelhardt, B. von (1893). "Beobachtungen des Cometen 1892 . . . (Holmes Nov. 6)", *Astron. Nachr.* **131**, 209-210.

Fehrenbach, C. (1973). "Periodic Comet Tuttle-Giacobini-Kresák (1973b)", *IAU Circ.* 2556.

Feldman, P. D.; M. F. A'Hearn; M. C. Festou; L. A. McFadden; H. A. Weaver; and T. N. Woods (1986). "Is CO_2 Responsible for the Outbursts of Comet Halley?", *Nature* **324**, 433-436.

Fulle, M. (1992). "Dust from Short-Period Comet P/Schwassmann-Wachmann 1 and Replenishment of the Interplanetary Dust Cloud", *Nature* **359**, 42-44.

Gaillard, B.; J. Lecacheux; and F. Colas (2007). "Comet 17P/Holmes", *Central Bureau Elec. Tel.* 1123.

Green, D. W. E. (1996). "On the History of Total-Visual-Magnitude Estimation Methods", *Int. Comet Quart.* **18**, 199.

Green, D. W. E.; and C. S. Morris (1987). "The Visual Brightness Behavior of P/Halley During 1981-1987", *Astron. Astrophys.* **187**, 560-568.

Greenberg, J. M.; H. Mizutani; and T. Yamamoto (1995). "A New Derivation of the Tensile Strength of Cometary Nuclei: Application to Comet Shoemaker-Levy 9", *Astron. Astrophys.* **295**, L35-L38.

Gruss, G. (1893). "Beobachtungen von Cometen", *Astron. Nachr.* **131**, 207-210.

Hergenrother, C. W.; M. Chamberlain; and Y. Chamberlain (2001). "Comet C/2001 A2 (LINEAR)", *IAU Circ.* 7616.

Hoffmeister, C. (1960). In "Jahresberichte deutscher astronomischer Institute für 1959: Sonneberg Sternwarte", *Mitt. Astron. Ges.* **12**, 130-134.

Holetschek, J. (1917). "Untersuchungen über die Grösse und Helligkeit der Kometen und ihrer Schweife. V. Teil. Die minder hellen periodischen Kometen", *Denkschr. Kaiserl. Akad. Wiss. Wien*, Math.-Naturwiss. Kl., **94**, 91-94.

Hough, G. W. (1893). "Filar-Micrometer Observations of Comet f 1892 (Holmes)", *Astron. J.* **13**, 15-16.

Hsieh, H. H.; A. Fitzsimmons; and D. L. Pollacco (2007). "Comet 17P/Holmes", *IAU Circ.* 8897.

Huebner, W. F.; J. J. Keady; and S. P. Lyon (1992). "Solar Photo Rates for Planetary Atmospheres and Atmospheric Pollutants", *Astrophys. Space Sci.* **195**, 1-289.

Hughes, D. W. (1990). "Cometary Outbursts: A Review", *Quart. J. Roy. Astron. Soc.* **31**, 69-94.

Hughes, D. W. (1991). "Possible Mechanisms for Cometary Outbursts", in *Comets in the Post-Halley Era*, R. L. Newburn, Jr., M. Neugebauer, and J. Rahe, eds., Kluwer, Dordrecht, Netherlands, pp. 825-851.

Ivanov, K. G. (1963). "The Height of the Explosion of the Tunguska Meteorite", *Soviet Astron.* **7**, 251-252.

Jehin, E.; H. Boehnhardt; Z. Sekanina; X. Bonfils; O. Schütz; J.-L. Beuzit; M. Billeres; G. J. Garradd; P. Leissy; F. Marchis; A. Más; L. Origlia; D. Scarpa; D. Thomas; and G. P. Tozzi (2002). "Split Comet C/2001 A2 (LINEAR)", *Earth Moon Plan.* **90**, 147-151.

Jenniskens, P.; and D. F. Blake (1994). "Structural Transitions in Amorphous Water Ice and Astrophysical Implications", *Science* **265**, 753-756.

Jenniskens, P.; and D. F. Blake (1996). "Crystallization of Amorphous Water Ice in the Solar System", *Astrophys. J.* **473**, 1104-1113.

Jewitt, D. (1990). "The Persistent Coma of Comet P/Schwassmann-Wachmann 1", *Astrophys. J.* **351**, 277-286.

Kammermann, A. (1893a). "Beobachtungen des Cometen 1892 III (Holmes)", *Astron. Nachr.* **132**, 61-62.

Kammermann, A. (1893b). "Beobachtungen des Cometen 1892 . . . (Holmes Nov. 6)", *Astron. Nachr.* **131**, 195-196.

Kobold, H. (1893). "Beobachtungen des Cometen 1892 III (Holmes)", *Astron. Nachr.* **132**, 93-94.

Kresák, L'. (1953). "The Periodic Comet Tuttle (1858 III)-Giacobini (1907 III)-Kresák (1951 IV)", *Bull. Astron. Inst. Czech.* **4**, 27-35.

Kresák, L'. (1974). "The Outbursts of Periodic Comet Tuttle-Giacobini-Kresák", *Bull. Astron. Inst. Czech.* **25**, 293-304.

Lamy, P. L.; I. Toth; H. A. Weaver; C. Delahodde; L. Jorda; and M. F. A'Hearn (2000). "The Nucleus of 13 Short-Period Comets", *Bull. Amer. Astron. Soc.* **32**, 1061. (Abstract.)

Larson, H. P.; H.-Y. Hu; M. J. Mumma; and H. A. Weaver (1990). "Outbursts of H_2O in Comet P/Halley", *Icarus* **86**, 129-151.

Liller, W. (2001). "CCD Photometry of Comet C/1995 O1 (Hale-Bopp): 1995-2000", *Int. Comet Quart.* **23**, 93-97.

Lovett, E. O. (1893). "Filar-Micrometer Observations of Comet f 1892", *Astron. J.* **13**, 27-28.

Marsden, B. G. (1963). "On the Orbits of Some Long-Lost Comets", *Astron. J.* **68**, 795-801.

Müller, G. (1884a). "Über einen zweiten merkwürdigen Lichtausbruch an dem Cometen Pons-Brooks 1884 Jan. 1", *Astron. Nachr.* **107**, 381-384.

Müller, G. (1884b). "Photometrische Beobachtungen des Cometen Pons-Brooks", *Astron. Nachr.* **108**, 161-170.

O'Meara, S. J. (1998). *The Messier Objects* (Cambridge: Sky Publishing Corp.), pp. 34, 110.

Orlov, S. V. (1940). "Exceptional Comets. I. Comet 1892 III", *Astron. Zh.* **17**, 8-12 (in Russian).

Orlov, S. V. (1945). *The Head of a Comet and a New Classification of Cometary Forms*, (Moscow: Gov. Publ. House "Soviet Science"), 95 pp. (in Russian).

Palisa, J. (1893). "Ueber eine plötzliche Aenderung im Aussehen des Cometen 1892 III (Holmes)", *Astron. Nachr.* **132**, 15-16 and 31-32.

Patashnick, H.; G. Rupprecht; and D. W. Schuerman (1974). "Energy Source for Comet Outbursts", *Nature* **250**, 313-314.

Perrine, C. D. (1899). "Rediscovery and Observation of Holmes's Comet d 1899 = 1892 III", *Astron. J.* **20**, 72.

Pickering, W. H. (1914). "The Comet of 1858 III", *Astron. Nachr.* **198**, 471-472.

Prialnik, D. (1992). "Crystallization, Sublimation, and Gas Release in the Interior of the Porous Comet Nucleus", *Astrophys. J.* **388**, 196-202.

Probstein, R. F. (1968). "The Dusty Gas Dynamics of Comet Heads", in *Problems of Hydrodynamics and Continuum Mechanics*, F. Bisshopp *et al.*, eds., Soc. Industr. Appl. Math., Philadelphia, pp. 568-583

Renz, F. (1893). "Beobachtungen des Cometen 1892 . . . (Holmes Nov. 6)", *Astron. Nachr.* **131**, 209-210.

Richardson, J. E.; and H. J. Melosh (2006). "Modeling of the Ballistic Behavior of Solid Ejecta from the Deep Impact Cratering Event", *37th Annual Lunar and Planetary Science Conference*, No. 1836. (Abstract.)

Richter, N. (1941). "Helligkeitsschwankungen der Kometen und Sonnentätigkeit. I. Erster Schwassmann-Wachmannscher Komet (1925 II)", *Astron. Nachr.* **271**, 207-215.

Richter, N. (1949). "Helligkeitsschwankungen der Kometen und Sonnentätigkeit. II. Statistik und Theorie abnormer Lichtausbrüche von Kometenkernen", *Astron. Nachr.* **277**, 12-30.

Richter, N. (1954). "Die Helligkeitsausbrüche des Kometen 1925 II und ihre Zusammenhänge mit der Sonnentätigkeit", *Astron. Nachr.* **281**, 241-254.

Roemer, E. (1959). "Comet Notes", *Publ. Astron. Soc. Pacific* **71**, 546-549.

Roemer, E. (1964). "Comet Notes", *Publ. Astron. Soc. Pacific* **76**, 358-361.

Roemer, E.; M. Thomas; and R. E. Lloyd (1966). "Observations of Comets, Minor Planets, and Jupiter VIII", *Astron. J.* **71**, 591-601.

Russell, H. C. (1893). "Schreiben von Herrn Director der Sternwarte in Sydney, betreffend Comet 1892 III (Holmes)", *Astron. Nachr.* **131**, 391-392.

Salyk, C.; G. A. Blake; M. J. Mumma; B. P. Bonev; M. A. DiSanti; G. L. Villanueva; Y. Radeva; K. Magee-Sauer; and E. L. Gibb (2007). "Comet 17P/Holmes", *IAU Circ.* 8890.

Schleicher, D. (2007). "Comet 17P/Holmes", *IAU Circ.* 8889.

Schlosser, W.; R. Schulz; and P. Koczet (1986). "The Cyan Shells of Comet P/Halley", in *Proceedings of the 20th ESLAB Symposium on the Exploration of Halley's Comet*, ESA SP-250, B. Battrick, E. J. Rolfe, and R. Reinhard, eds., ESTEC, Noordwijk, vol. 3, pp. 495-498.

Schulz, R.; and W. Schlosser (1990). "CN Jets as Progenitors of CN Shells in the Coma of Comet P/Halley", in *Formation of Stars and Planets, and the Evolution of the Solar System*, B. Battrick, ed., ESA SP-315, ESTEC, Noordwijk, pp. 121-125.

Sekanina, Z. (1978). "Relative Motions of Fragments of the Split Comets. II. Separation Velocities and Differential Decelerations for Extensively Observed Comets", *Icarus* **33**, 173-185.

Sekanina, Z. (1981). "Distribution and Activity of Discrete Emission Areas on the Nucleus of Periodic Comet Swift-Tuttle", *Astron. J.* **86**, 1741-1773.

Sekanina, Z. (1982). "The Problem of Split Comets in Review", in *Comets*, L. L. Wilkening, ed., Univ. Arizona, Tucson, pp. 251-287.

Sekanina, Z. (1984). "Disappearance and Disintegration of Comets", *Icarus* **58**, 81-100.

Sekanina, Z. (2005). "Comet 73P/Schwassmann-Wachmann: Nucleus Fragmentation, Its Light-Curve Signature, and Close Approach to Earth in 2006", *Int. Comet Quart.* **27**, 225-240.

Sekanina, Z. (2007). "Comet 17P/Holmes", *Central Bureau Elec. Tel.* 1118.

Sekanina, Z.; and J. A. Farrell (1978). "Comet West 1976 VI: Discrete Bursts of Dust, Split Nucleus, Flare-Ups, and Particle Evaporation", *Astron. J.* **83**, 1675-1680.

Sekanina, Z.; S. M. Larson; O. Hainaut; A. Smette; and R. M. West (1992). "Major Outburst of Periodic Comet Halley at a Heliocentric Distance of 14 AU", *Astron. Astrophys.* **263**, 367-386.

Sekanina, Z.; E. Jehin; H. Boehnhardt; X. Bonfils; O. Schuetz; and D. Thomas (2002). "Recurring Outbursts and Nuclear Fragmentation of Comet C/2001 A2 (LINEAR)", *Astrophys. J.* **572**, 679-684.

Snodgrass, C.; A. Fitzsimmons; H. Boehnhardt; T. Lister; T. Naylor; and C. Bell (2007). "Comet 17P/Holmes", *Central Bureau Elec. Tel.* 1111.

Snodgrass, C.; S. C. Lowry; and A. Fitzsimmons (2006). "Photometry of Cometary Nuclei: Rotation Rates, Colours and a Comparison with the Kuiper Belt Objects", *Mon. Not. Roy. Astron. Soc.* **373**, 1590-1602.

Swings, J.-P.; and J.-M. Vreux (1973). "Observations Spectrographiques de la Comète 1973b Immédiatement Après Son Violent Sursaut de Brillance de Juillet 1973", *Bull. Soc. Roy. Sci. Liège* **42**, 593-597.

Thomas, P. C.; J. Veverka; M. J. S. Belton; A. Hidy; M. F. A'Hearn; T. L. Farnham; O. Groussin; J.-Y. Li; L. McFadden; J. Sunshine; D. Wellnitz; C. Lisse; P. Schultz; K. J. Meech; and W. A. Delamere (2007). "The Shape, Topography, and Geology of Tempel 1 from Deep Impact Observations", *Icarus* **187**, 4-15.

Tuzzolino, A. J.; T. E. Economou; B. C. Clark; P. Tsou; D. E. Brownlee; S. F. Green; J. A. M. McDonnell; N. McBride; and M. T. S. H. Colwell (2004). "Dust Measurements in the Coma of Comet 81P/Wild 2 by the Dust Flux Monitor Instrument", *Science* **304**, 1776-1780.

Updegraff, M. (1892). "Observations of Comet f 1892", *Astron. J.* **12**, 148.

Van Biesbroeck, G. (1961). "Comet Observations", *Astron. J.* **66**, 96-102.

Vogel, H. C. (1884). "Einige Beobachtungen über den Cometen Pons-Brooks, insbesondere über das Spectrum desselben", *Astron. Nachr.* **108**, 21-26.

Vogel, H. C. (1893). "Ueber das Spectrum des Cometen 1892 III (Holmes)", *Astron. Nachr.* **131**, 373-374.

West, R. M.; O. Hainaut; and A. Smette (1991). "Post-Perihelion Observations of P/Halley. III. An Outburst at 14.3 AU", *Astron. Astrophys.* **246**, L77-L80.

Whipple, F. L. (1980). "Rotation and Outbursts of Comet P/Schwassmann-Wachmann 1", *Astron. J.* **85**, 305-313.

Whipple, F. L. (1984). "Comet P/Holmes, 1892 III: A Case of Duplicity?", *Icarus* **60**, 522-531.

Wilson, H. C. (1893). "Observations of Comets 1892 III and g 1892", *Astron. J.* **13**, 61-62.

Wolf, M. (1906a). "Auffindung des Holmesschen Kometen 1906f", *Astron. Nachr.* **172**, 223-224.

Wolf, M. (1906b). "Photographische Aufnahmen von kleinen Planeten und Kometen", *Astron. Nachr.* **172**, 255-256.

Zwiers, H. J. (1895). "Definitive Bahnbestimmung des Cometen 1892 III (Holmes)", *Astron. Nachr.* **138**, 65-78.

Zwiers, H. J. (1897). "Nachtrag zur Bahnbestimmung des Cometen 1892 III (Holmes)", *Astron. Nachr.* **142**, 257-264.

Zwiers, H. J. (1906). "Rückkehr des Holmesschen Kometen in 1906", *Astron. Nachr.* **171**, 65-72.

Photometry of Deep-Sky Objects

For explanation of the tabulated data below, see the explanation in the tabulated data on comets in the section following this section. The previous batch of photometry of *ICQ*-recommended deep-sky objects appeared in the Oct. 2007 issue, pp. 130-131. While M31 is not in the *ICQ* list of recommended deep-sky objects (see *ICQ* **20**, 98; **16**, 129; and **26**, 3), data are presented below, including some new determinations of its total magnitude, because of the relevant discussion of the brightness of comet 17P during its in 1892-1893 (see Sekanina's preceding article in this issue). We encourage other regular comet photometrists to contribute both visual and CCD magnitudes of the recommended deep-sky objects.

See also the *ICQ* website: `http://www.cfa.harvard.edu/icq/icqproject.html`.

John Bortle's observation of M31 below was published in 1984 in *Deep Sky* **2**(4), 31; no date was provided, and no reference-star catalogue was provided, though he stated that he used photoelectric-V comparison-star magnitudes.

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

◇ *NGC 224 = M31* ⟹ 2008 Feb. 16.45: unfiltered photometry in bright moonlight, using a rectangular aperture of 3°.06 × 0°.96; `StellaNavigator` ver. 8.1 software used for comp.-star magnitudes; comp. stars have $B-V = +0.51$, $+0.76$, and $+0.82$ [NAG08]. Feb. 28: obs. from elev. 5500 ft; very clear and dark; seven comp. stars used; ranging in mag from 2.1 to 4.6; the bright inner core seen under full moonlight — evidently a week earlier — has total visual mag 4.5; comp. stars β, δ, 51, μ, π, ν, and θ And [OME].

◇ ◇ ◇

Visual Data

NGC 224 = M31

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
2008 02 28		S	3.4	HV	5.0	N		1					OME
2008 02 28		M	3.9	HV	5.0	N		1					OME
pre-1985		B	4.4		0.0	E		1					BOR

NGC 6712

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
2007 11 03.79		S	8.7	TI	32	L	5	76	3	2/			MAR02

NGC 6760

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
2007 11 03.80		S	9.1	TI	32	L	5	76	2	2			MAR02

NGC 6934

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
2007 11 03.83		M	9.6	TI	32	L	5	76	1.5	4			MAR02

NGC 7078

DATE (UT)	N	MM	MAG.	RF	AP.	T	F/	PWR	COMA	DC	TAIL	PA	OBS.
2007 11 03.84		M	6.8	S	32	L	5	76	4	6			MAR02

◇ ◇ ◇

CCD Data

NGC 224 = M31

DATE (UT)	n	M	MAG.	RF	AP.	T	f/	EXP.	COMA	DC	TAIL	PA	APERTUR	Chp	Sfw	C	P	Cam	OBS.
2008 02 16.45	x	C	3.5	TJ	2.5	A	6	a 30	138				S 3.1 d	K16	SI5	5		MCV	NAG08

Tabulation of Comet Observations

This issue is devoted to the unexpected bright outburst of comet 17P/Holmes, beginning with Zdenek Sekanina's article and continuing with the observations presented here. We are making an exception to the new policy (instigated in Jan. 2007) of only summarizing the tabulated photometry: we will publish in the April 2008 issue all of the contributed tabulated photometry on comet 17P — both those summarized in the last couple of issues of the *ICQ* and those contributed more recently. Due to constraints on the size of a bound copy produced by our printer, the tabulated visual and CCD photometric data of 17P will appear in the April issue. While the descriptive information for the 17P observations that were made up to the end of Jan. 2008 appear in this issue, the descriptive information for 17P observations made from Feb. 2008 through April 2008 will be published in the April 2008 issue, as usual. The 17P tabulated data that are summarized beginning on page 49 of this issue are being posted immediately at the *ICQ* website, as is now the usual practice; they will retain the record of publication of this January issue (*ICQ* Whole No. 145) even though they will be printed in the April issue. Due to time constraints, those observations contributed on paper (which include some 17P data) will appear in the April issue, where 17P data only will continue to be published in full tabulated form. As this has been a remarkable apparition of a very noteworthy comet, there may be some considerable future value to a printed record of these data.

New magnitude reference tabulation codes: `HC` = photographic R-band magnitudes from Hubble Space Telescope Guide Star Catalogue; `ST` = list of star magnitudes compiled by Brian Skiff and posted at website URL `http://www.tass-survey.org/tass/refs/skiff_photom.tbl` (submitted by R. D. Schwartz, who presumed this to be a culled list of the brighter standards from Landolt's lists).

New CCD camera tabulation codes: `Nik` = Nikon D50 digital SLR camera; `STX` = SBIG ST8-XME.

New CCD-camera-chip tabulation code: `K6M` = KAF-1603ME (Kodak).

New tabulation code for computer software used for the photometric reduction of CCD images: `Mir` = Mira; `PHO` = PHOTOM software developed by a student of R. D. Schwartz at the University of Missouri at St. Louis to reduce aperture measurements, and Schwartz's own software program to produce magnitudes.

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

See the July 2001 issue (page 98) for explanations of the abbreviations used in the descriptive information.

◇ *Comet 2P/Encke* ⟹ 2007 Apr. 8.77, 13.78, and 14.78: *Guide 7.0* software used for comp.-star mags [SAN07].

◇ *Comet 8P/Tuttle* ⟹ 2007 Sept. 14.88: obs. from Alps in southern France (elev. 1400-2600 m) [BIV]. Nov. 2.47, 9.48, 18.72, 29.53, 29.59, Dec. 1.58, 5.48, 9.73, 17.67, 30.52, 2008 Jan. 1.45, 4.43, and 5.46: `Guide 8.0` software used for comp.-star mags [YOS02]. 2007 Nov. 2.47: $B-V$ values of comp. stars were +0.46, +0.61, and +0.85 [YOS02]. Nov. 3.43: diffuse [YOS04]. Nov. 3.85: from dark mountain skies, the coma appears large and diffuse [GON05]. Nov. 9.48: $B-V$ values of comp. stars were +0.57, +0.66, and +0.66 [YOS02]. Nov. 9.96: seen as a fairly large diffuse object of quite-low surface brightness; the comet was also detected on an unguided 30-sec image using a digital SLR camera (Canon 400D + 100-mm.-f.l. lens at $f/2$); dark sky [GRA04]. Nov. 11.44: comp. star has $B-V = +0.56$ [TSU02]. Nov. 11.44, 19.39, 23.46, Dec. 16.62, 30.52, and 2008 Jan. 4.49: `Guide 8.0` software used for comp.-star mags [TSU02]. 2007 Nov. 14.69, 22.45, Dec. 3.43, 4.44, 5.46, 7.47, 9.41, 14.55, 16.38, 18.47, 26.54, 30.49, 2008 Jan. 1.38, 2.44, 4.40, 6.42, 9.50, and 13.39: `StellaNavigator` ver. 8.1 software used for comp.-star mags [NAG08]. Nov. 14.69: $B-V$ values of comp. stars were +0.59, +0.63, and +0.67 [NAG08]. Nov. 19.39: comp. star has $B-V = +0.51$ [TSU02]. Nov. 22.45: $B-V$ values of comp. stars were +0.67, +0.74, and +0.75 [NAG08]. Nov. 23.46: comp. star has $B-V = +0.49$ [TSU02]. Nov. 28.77: very diffuse coma with a small, significantly brighter central cond. [KAM01]. Nov. 29.59: $B-V$ values of comp. stars were +0.57, +0.60, and +0.70 [YOS02]. Nov. 29.90: "comet close to star of mag 10.0; coma dia. possibly underestimated" [SCH04]. Nov. 30.00-2008 Jan. 11.99: comp.-star mags are V_T values from *Guide 8.0* software (Project Pluto, 168 Ridge Rd., Bowdoinham, ME) [BOR].

Dec. 2.86: comet also weakly visible w/ 15×80 B [SCH04]. Dec. 3.85: faint and large outer halo [MEY]. Dec. 3.85 and 7.81: ill-defined coma [MEY]. Dec. 4.02: diffuse, ill-defined coma of low surface brightness [GRA04]. Dec. 5.46: $B-V$ values of comp. stars were +0.67, +0.70, and +0.84 [NAG08]. Dec. 5.49, 9.46, 17.46, 26.39, 30.45, 31.39, 2008 Jan. 2.41, 4.39, 8.46, and 15.46: `Guide 8.0` software used for comp.-star mags [MIY01]. 2007 Dec. 5.53, 7.67, 9.59, 13.55, 16.58, 17.61, 30.41, 31.41, 2008 Jan. 1.52, 3.42, 4.48, and 6.39: `The Sky` ver. 5 software used for comp.-star mags [MIT]. 2007 Dec. 5.64, 9.80, 26.44, Jan. 6.59, and 9.59: `Guide 8.0` software used for comp.-star mags [NAG04]. Dec. 7.47: $B-V$ values of comp. stars were +0.65, +0.68, +0.82, and +0.90 [NAG08]. Dec. 8-10: site of the IRAM telescope at Pico-Veleta, southern Spain [BIV]. Dec. 8.12: comet very close to stars of mag 11 and 12 [COM]. Dec. 8.45 and 9.45: the comet's appearance has completely changed in one month; diffuse, but moderately condensed in the center; bright and large through a small monocular [YOS04]. Dec. 8.78: found first with 25×100 B (which showed a pseudo-nucleus of mag 11), then seen w/ Canon IS 18×50 B, and finally w/ handheld 7×50 B [KAR02]. Dec. 8.93: light pollution [HOR03]. Dec. 9.73: w/ 9×63 B, surprisingly large, medium-condensed coma [KAM01]. Dec. 9.73: $B-V$ values of comp. stars were +0.34, +0.60, and +0.60 [YOS02]. Dec. 10.93: comet close to star of mag 8.3 [SCH04]. Dec. 11.70: w/ 10×50 B, comet appeared faint and showed a diffuse, extended coma (surface brightness similar to M33, although the latter object was considerably larger in angular extent) [GRA04]. Dec. 17.88: faint in 7×50 B, but easily seen through the larger instrument; the surface brightness of 8P was markedly higher than M33; quite favorable conditions despite first-quarter Moon [GRA04]. Dec. 18.47: $B-V$ values of comp. stars were +0.56, +0.63, and +0.68 [NAG08]. Dec. 19.22: w/ 7×50 B, easily visible and comparable to M81 in appearance; comet showed a considerably higher surface brightness than 17P; dark sky [GRA04]. Dec. 22.76: strong moonlight and slightly hazy sky, but comet well visible near zenith [BOU]. Dec. 25.70: well visible despite an almost-full Moon low in E sky [GRA04]. Dec. 28.13: comet seen w/o difficulty despite a quite-low alt. and moonlight [GRA04]. Dec. 28.72: w/ 32-cm *f*/5 L (45×), coma dia. 10′, DC = 6 [PIL01]. Dec. 28.76: "comet close to star of mag 7.0; underestimation?" [SCH04]. Dec. 28.77: w/ 9×63 B, rather diffuse; however, towards the center, coma is significantly condensed [KAM01]. Dec. 28.85: moonlight [GON06]. Dec. 28.97: comp. stars have $V =$ 6.5 ($B-V = +0.20$) and 5.78 (−0.08) [GOI]. Dec. 29.77: comet smaller, but with higher surface brightness, than nearby M33; both objects also faintly visible w/ naked eye [BOU]. Dec. 29.77: also visible w/ naked eye [DIJ]. Dec. 29.78: on CCD images, a tail is visible (but not very prominent) in p.a. ~ 70° [QVA]. Dec. 30.49: $B-V$ values of comp. stars were +0.57, +0.57, and +0.79 [NAG08]. Dec. 30.77: comet close to M33 [BUS01]. Dec. 30.78: "nice view — comet next to M33" [DIJ]. Dec. 30.79: comet close to M33; w/ 15×80 B, coma of ~ 25′ (DC = 4/) [SCH04]. Dec. 30.80, 2008 Jan. 3.79, and 9.84: mountain location, very clear sky [GON05]. Dec. 30.86: using 8×50 R and 7×50 B, the comet was of similar total brightness as the nearby galaxy M33, but it appeared smaller and more condensed than M33; 8P also seen through 3×18 R, but not detected w/ naked eye; a short-exposure image (6 sec at ISO 800) using Canon EOS 400D camera (+ 100-mm-f.l. *f*/2 lens) gave a reasonable representation of how the view looked through small instruments, although the greenish color of the comet was not seen visually [GRA04]. Dec. 30.91: both M33 and 8P faintly visible w/ naked eye [GIL01]. Dec. 30.93: "comet was flying by the Triangulum galaxy M33, and they were at their closest now, only 20′ separation; the much larger and elongated M33 possessed a significantly lower surface brightness than the round fuzz-ball comet, which was easier to see; I could glimpse comet 8P with my naked eyes together with 17P exactly at the same time! (their separation was only 22°, so when I stared at a point between them and to the right of the connecting line, I could hold them both w/ averted vision — two short-period comets seen simultaneously without optical aid!)" [KAR02]. Dec. 30.95: passage of M33 — coma showed a higher surface brightness than the significantly larger galaxy [KAM01]. Dec. 31.38 and 2008 Jan. 3.34: very dark sky at sea level in Hawaii; easy naked-eye object [MOR]. Dec. 31.47: "unexpectedly, comet is moderately condensed; it was near the bright galaxy M33, within the same field-of-view; M33 was a very hard object due to the light pollution [YOS04].

◇ ◇ ◇

CCD image showing the greenish coma of comet 8P/Tuttle below the large galaxy M33, takenon on 2007 Dec. 31.1 UT by James McGaha (Tucson, AZ, U.S.A.) with a Canon 20Da camera (+ 500-mm-f.l. E-180 f/2.8 lens; 600-sec exposure at ISO 800). Image copyright 2007 by J. McGaha.

◇ ◇ ◇

2008 Jan. 1.02: comp. stars have $V = 6.21$ ($B-V = +0.41$) and 7.00 (+0.90) [AMO01]. Jan. 1.67: very clear sky but strong city lights [XU]. Jan. 1.99: site of the IRAM telescope at Pico-Veleta, southern Spain [BIV]. Jan. 2.65, 3.63, and 4.65: small-city light pollution [NOV01]. Jan. 2.73: w/ 20-cm T (50×), rather diffuse coma, which brightened considerably towards center (small inner coma); at 161×, small knot of material of mag ~ 11.5-12.0 [KAM01]. Jan. 3.44 and 4.44: diffuse when viewed in the city light pollution, but strongly condensed when viewed at the mountain location and visible with naked eyes [YOS04]. Jan. 3.83: w/ 8×50 R and 10×50 B, the comet showed a diffuse coma and was markedly easier to see than M33 and NGC 7789 [GRA04]. Jan. 3.99: comp. stars have $V = 5.55$ ($B-V = +0.31$) and 5.88 (+0.56) [GOI]. Jan. 5.48 and 6.47: very bad conditions due to the terrible city light pollution; extremely difficult to see a 5th-mag comet [YOS04]. Jan. 5.97: comp. stars have $V = 5.88$ ($B-V = +0.62$) and 6.01 (+0.56) [AMO01]. Jan. 6.00: comp. stars have $V = 5.88$ ($B-V = +0.56$) and 6.52 (+0.30) [AMO01]. Jan. 6.74: w/ 30-cm T (75×), rather diffuse coma, which brightened considerably towards center; at 242×, false nucleus of mag 13.5 within bright central cond. [KAM01]. Jan. 6.78: near sea level; clear sky [GON05]. Jan. 6.97, 7.97, and 8.98: comp. stars have $V = 5.63$ ($B-V = +0.53$) and 5.88 (+0.56) [GOI]. Jan. 6.98, 8.02, and 9.01: comp. stars have $V = 5.43$ ($B-V = +0.15$), 5.88 (+0.62), and 6.01 (+0.56) [AMO01]. Jan. 8.76: w/ 20-cm T (50×), the coma showed the same morphology as two nights ago; at 161×, stellar false nucleus of mag 13.0 [KAM01]. Jan. 9.50: $B-V$ values of comp. stars were +0.51, +0.60, and +0.67 [NAG08]. Jan. 11.74: light pollution [KAR02]. Jan. 11.85: obs. from Gatyska, Poleski National Park; comet alt. 15° [PAR03]. Jan. 12.75: comet between two stars [SCH04]. Jan. 14.97, 15.97, and 20.10: moonlight [AMO01]. Jan. 14.97: comp. stars have $V = 5.20$ ($B-V = +0.60$) and 5.88 (+1.26) [AMO01]. Jan. 15.97: comp. stars have $V = 5.20$ ($B-V = +0.60$), 5.88 (+1.26), and 6.22 (+0.94) [AMO01]. Jan. 20.10: comp. stars have $V = 5.83$ ($B-V = +0.48$) and 6.11 (+1.11); clouds [AMO01]. Jan. 21.07: comp. stars have $V = 5.83$ ($B-V = +0.43$) and 6.42 (0.43); moonlight interference [GOI] Jan. 25.00: comp. stars have $V = 6.67$ ($B-V = +0.16$) and 6.37 (+0.03) [GOI]. Jan. 28.03: comp. stars have $V = 6.01$ ($B-V = +0.92$) and 6.49 (+0.52) [AMO01]. Jan. 29.98: comp. stars have $V = 6.67$ ($B-V = +0.16$) and 7.20 (−0.01) [GOI].

⋄ *Comet 17P/Holmes* ⟹ 2007 May 19.75: comp. star has $B-V = +1.06$ [KAD02]. May 25.77: $B-V$ values of comp. stars were +0.70, +0.52, and +0.91 [KAD02]. June 2.74: comp. star has $B-V = +0.65$; obs. made through thin clouds [KAD02]. June 19.43: "measurement is of an extremely faint suspect, which unfortunately could not be confirmed as being the comet" [HAL]. June 22.73: $B-V$ values of comp. stars were +0.88 and +0.87 [KAD02]. June 29.75: $B-V$ values of comp. stars were +0.54 and +0.67 [KAD02]. July 5.77: comp. star has $B-V = +0.56$ [KAD02]. July 15.78: $B-V$ values of comp. stars were +0.59 and +0.68 [KAD02]. July 27.73: $B-V$ values of comp. stars were +0.85 and +0.46; coma involved with a star [KAD02]. Aug. 26.70: comp. star has $B-V = +0.81$ [KAD02]. Sept. 25.71: comp. star has $B-V = +0.86$ [KAD02].

Oct. 21.60: comp. star has $B-V = +0.51$ [KAD02]. Oct. 24.54: "easy naked-eye object; the appearance was completely stellar, even when viewed at highest magnification through a telescope" [HAL]. Oct. 24.61: comp. star has $B-V = +1.08$; exp. time 0.12 sec [KAD02]. Oct. 24.89: clearly brighter than δ Per; w/ 20×90 B, DC = 9, slight red color [SCA02]. Oct. 25.0: narrowband-filtered photometry obtained w/ a 25-cm $f/12$ reflector (CCD image scale 0″.6/pixel; seeing ~ 2″.7 FWHM) yields total mag ~ 2.2 w/ a red filter (for the dust/continuum, centered at 647 nm, w/ FWHM = 10nm) and ~ 3.5 w/ a blue filter (for the dust/continuum, centered at 450 nm, w/ FWHM = 10nm); the photometric profile of the coma shows an asymmetric distribution, with a sharp central cond. nearly 8″ in dia., offset almost 10″ offset toward SW from the outer faint coma (whose total dia. was ~ 50″; 'color index' of the dust (blue continuum minus red continuum) was ~ +1.4; stacking of 90 red-filtered and 50 blue-filtered 10-sec exposures shows consistently the presence of a plume-like feature extending almost 15″ toward SW [Giovanni Sostero and Ernesto Guido, Remanzacco, Italy]. Oct. 25.22: w/ 41-cm $f/4$ L (70×), coma dia. 1′.3 [HAL]. Oct. 25.35: 0.5-sec CCD exposures; inner coma of dia. 14″; outer coma of dia. 79″; comp. star GSC 3334518 from *GSC 1.1* ("I calibrated this star in *R* using a fit in CAA, which uses ~ 50 stars from USNO-A2.0 to get an *R* mag; I then use this derived mag to set the zero point in *Mira* softwhere, where I did the photometry") [MCG]. Oct. 25.53: "distinctly brighter than during previous morning; a distinct brightening, and increase in coma dia., was observed during the course of the night"; w/ 41-cm $f/4$ L (70×), coma dia. 1′.5 [HAL]. Oct. 25.61, 31.52, Nov. 2.63, 3.72, 7.67, 18.45, 30.60, and Dec. 5.52: `Guide 8.0` software used for comp.-star mags [TSU02]. Oct. 25.89: w/ 11×80 B, coma dia. 1′.5, DC = 9 [LAB02]. Oct. 25.91: apparently-stellar object in Perseus (DC = 9); to naked eye, the comet looks like a star, but w/ 20×90 B, diffuse coma of dia. 3′ w/ a slight red color [SCA02].

Oct. 26-2008 Feb. 11: ref. code `TJ` uncertain; comp.-star mags taken from *Guide 8.0* (Project Pluto) software, which simply states "Johnson *V*" magnitudes from the Hipparcos/Tycho satellite project [BOR]. Oct. 26.07: w/ 15×70 B, coma dia. 6′.2 (outer envelope or halo), DC = 8; w/ 41-cm $f/5$ L (57×), coma dia. 2′.9; outer envelope or halo has dia. 5′.8 [BOR]. Oct. 26.19: "bright moonlight (full moon 35° away); w/ 41-cm $f/4$ L (70×), coma dia. 3′.4, and there is a hint of a faint outer halo surrounding this (measured) inner coma" [HAL]. Oct. 26.84: obs. from Guangzhou, China; strong moonlight and city light pollution; clouds; extremely hazy sky [XU]. Oct. 26.86: w/ 20×90 B, coma extends to ~ 10′; a CCD color image shows a greenish faint outer coma surrounding an inner coma that extends to at least 15′ [SCA02]. Oct. 26.91: w/ 11×80 B, coma dia. 4′, DC = 8 [LAB02]. Oct. 27.0 and Nov. 23.82: moonlight [HOR03]. Oct. 27.11: "bright moonlight; the outer halo that was suspected the previous night is now definitely detectable telescopically [HAL]. Oct. 27.25-Dec. 3.27: source of Hipparcos-satellite magnitudes was Simbad website [OME]. Oct. 27.71: $B-V$ values of comp. stars were +1.05 and +0.74; inner bright coma of dia. 5′.0, outer faint coma of dia. 16′, no tail; central cond. of mag 7.2-7.8 (total mag 2.6) [KAD02]. Oct. 27.86: w/ 11×80 B, coma dia. 5′ [LAB02]. Oct. 27.9 and Dec. 26.83: moonlight; fog [HOR03]. Oct. 27.99: w/ 15×70 B, coma dia. 7′.5, DC = 7-8; w/ 41-cm $f/5$ L (57×), coma dia. 6′.3, DC = 7 [BOR]. Oct. 28.50: $B-V$ values of comp. stars were +0.67, +0.50, and +0.45 [KAD02]. Oct. 28.81: w/ 11×80 B, coma dia. 4′, DC = 9 [LAB02]. Oct. 28.98: w/ 15×70 B, coma dia. 8′.5, DC = 7 (outer envelope or halo has dia. 15′); w/ 41-cm $f/5$ L (57×), coma dia. 7′.2, DC = 6 (outer envelope or halo has dia. 13′) [BOR].

Oct. 29.77: round coma with clear central cond. of mag ~ 8.0 [RIE]. Oct. 29.79: w/ 44-cm $f/5$ L (63×), coma dia. 11′.8 [HAS02]. Oct. 29.95: w/ 11×80 B, coma dia. 8′, DC = 9 [LAB02]. Oct. 29.99: w/ 15×70 B, coma dia. 9′, DC = 7; outer envelope or halo has dia. 12′ [BOR]. Oct. 30.09: outer halo of dia. 25′ via 12×50 B, with inner coma of dia. 10′ [HAL]. Oct. 30.10: w/ 20-cm L (42×), bright false nucleus with fanlike central cond. of ~ 2′.5; yellow inner coma of size ~ 8′ (sharp at sunlit side in p.a. 0°-90°, and more diffuse at opposite side in p.a. 180°-270°); very weak outer coma of size ~ 20′ [SCH04]. Oct. 30.79: w/ 30-cm L (39×), bright false nucleus of mag ~ 8.0 w/ fanlike central cond. of size ~

2′.5 in p.a. 165°-255°; yellow inner coma of size ~ 10′ (sharp at sunlit side in p.a. 0°-90°, and more diffuse at opposite side in p.a. 180°-270°); very weak outer coma of size ~ 20′ [SCH04]. Oct. 30.79: w/ 21×100 B, bright false nucleus of mag 7.9 w/ fanlike pattern in p.a. 210°; round, yellow, inner coma of size ~ 9′ (more diffuse at p.a. 270°); at ~ 2′ from false nucleus, a half-circular dark band starts roughly at p.a. 90°; very weak outer coma of size ~ 18′ [BUS01]. Oct. 30.84: w/ 11×80 B, coma dia. 12′, DC = 9 [LAB02]. Oct. 30.86: w/ 20×90 B, there is a strong false nucleus, extended ~ 2′ in p.a. 220°; an intense inner coma is surrounded by an outer, large green coma that extends at least 30′; no tail visible [SCA02]. Oct. 30.98: w/ 15×70 B, coma dia. 11′, DC = 6-7 (outer coma dia. 23′); w/ 41-cm *f*/5 L (57×), coma dia. 7′.2, DC = 6 [BOR]. Oct. 31.78: large-scale 'bulb' structure seen with optocenter 1′ in p.a. 211° from central cond.; thin stream of material in bulb emerging about 1′.5 from the central cond. in p.a. 211°; coma seems to have an outer-edge dust shell ~ 1′ wide [SRB]. Oct. 31.78 and Nov. 1.72: large, circular coma whose outer edge is elongated in p.a. 211°; center of the coma shifted by 18″ in p.a. 211° from the central cond.; brightness measurements for apertures $\leq$ 1′.6 were centered on cond., but center of coma preferred when larger apertures used; the brightness of the 'bulb' was measured in a circular aperture centered at the optocenter for aperture size 1′.2 in tab. data; other large-scale structures in the coma were visible after image processing; curved dust structures surrounded the central cond. and bulb [SRB]. Oct. 31.80: compact, disk-like coma w/ bright central part (dia. 9′) and faint outer halo (dia. ~ 35′) [HOR02]. Oct. 31.82: compact, disk-like coma w/ bright central part (dia. 8′) and faint outer halo (dia. ~ 30′) [HOR03]. Oct. 31.87: w/ 44-cm *f*/5 L (63×), coma dia. 10′.2 [HAS02].

Nov. 1.04: w/ 12.0-cm *f*/8 R (111×), the comet showed a disk of size 10′ and an outer diffuse halo; the disk appeared brown-yellow and the halo blue-green; at 25×, coma dia. 24′ [SKI]. Nov. 1.05: w/ 15×70 B, coma dia. 12′; outer envelope or halo has dia. 27′ [BOR]. Nov. 1.08: w/ 7×50 B, tab. mag est. refers to the disk-like inner coma of 10′; w/ 15.2-cm L, the outer diffuse coma was detected fairly easily; the MM = 'N' tab. est. refers to an apparently stellar false nucleus; no tail was seen [GRA04]. Nov. 1.09: comp. stars have V = 1.79 (B–V = +0.48) and 3.01 (–0.13) [AMO01]. Nov. 1.09, 7.08, 16.04, 20.03, 22.06, 23.04, 27.03, 29.04, 30.07, Dec. 13.98, 14.98, and 2008 Jan. 6.00: light pollution [AMO01]. 2007 Nov. 1.09 and 7.08: clouds [AMO01]. Nov. 1.09, 7.08, 16.04, and 20.03: comet alt. 8° [AMO01]. Nov. 1.7, 4.83, 5.8, 12.9, 18.88, and 19.80: light pollution [HOR03]. Nov. 1.72: large-scale 'bulb' structure w/ optocenter located 1′.2 in p.a. 211° from central cond.; two or three thin streams of material ~ 1′.5 long seen in 'bulb' in p.a. 211° (only the brightest stream is emerging from the central cond.; streams continue farther into coma with total length ~ 6′); outer-edge dust shell of the coma ~ 1′ wide [SRB]. Nov. 1.76: "similar in brightness as Algol (which was not at minimum); w/ 20×80 B, the comet was a circular disk with uniform brightness except for the central cond., which was elongated NNE-SSW; a pseudo-nucleus was offset towards NNE in the central cond.; a dark arc spanning ~ 150° followed just inside the rim on the NE side of the disk, giving impression of 'half-annularity'; the 7.6-mag star HD 23104 was situated just at the rim on the W side of the disk"; coma dia. 14′, DC = 7 [KAR02]. Nov. 1.80, 2.5, 3.5, 7.7, 8.67, 9.46, 9.6, 12.46, 12.56, 17.48, 18.75, 20.53, 21.54, 22.72, 28.67, 29.5, Dec. 1.60, 5.49, 7.54, 8.49, 9.73, 14.60, 17.68, 30.53, 2008 Jan. 1.48, 4.42, and 5.52: `Guide 8.0` software used for comp.-star mags [YOS02]. 2007 Nov. 1.84 and 28.73: obs. from Valašské Meziříčí Observatory; no extinction correction applied; experimental measurement with Nikon D50 DSLR camera; original color RAW (NEF) files converted to gray-scale FITS with binning factor 3 [SRB]. Nov. 1.84: four comp. stars in the same field-of-view; CCD placed in the focus of coudé refractor; large, circular coma; center of the coma shifted by 18″ in p.a. 217° from the central cond.; possible outer coma size > 25′; brightness measurements w/ aperture dia. $\leq$ 2′.3 were centered at cond., but center of coma preferred when using larger apertures; large-scale 'bulb'-tail-like structure with optocenter shifted 1′.1 in p.a. 211° from the central cond.; when brightness of the 'bulb' measured was measured in a circular apertures centered at the optocenter, mag 5.9 was obtained; stream of material in 'bulb'; other large-scale structures in coma visible after image processing [SRB]. Nov. 1.84: w/ 11×80 B, coma dia. 25′, DC = 8 [LAB02]. Nov. 1.85: w/ 20.3-cm T, faint outer coma dia. 33′ and inner-disk dia. 12′; starlike central cond. of mag 10.8; bright oval region extends 2′.3 from center in p.a. 220°; three main tail-like radial features were visible, extending 0°.6 from center in p.a. 170°, 210°, and 270° [GON05]. Nov. 1.85, 3.8, 7.82, 9.95, 14.03, 17.01, 27.81, Dec. 5.02, 11.81, 26.78, and 2008 Jan. 26.83: mountain location, very clear sky [GON05]. 2007 Nov. 1.89: w/ 44-cm *f*/5 L (63×), coma dia. 12′.8 [HAS02]. Nov. 1.90: "well visible w/ unaided eyes; w/ 9×63 B, coma more diffuse, but still of high surface brightness with a significantly brighter central region (dia. ~ 1/4 of the coma's dia.), the bright coma was surrounded by a faint outer coma of dia. 40′; no tail detected; with 30-cm T (75×), stellar false nucleus of mag 9.5, which sat on the NNE-top of the slightly elliptical (NNE-SSW), significantly brighter, central region; the central region was slightly displaced towards SSW, the false nucleus to the NNE; the outer coma was surprisingly well visible" [KAM01]. Nov. 1.92: w/ naked eye, mag 2.9, coma dia. 19′, DC = 4-5 [MAR02]. Nov. 1.96-1.97: estimates based on comp. w/ α, γ and δ Per; similar m_1 result if additionally using α UMi and δ Cas [PER01]. Nov. 1.98: w/ 15×70 B, coma dia. 13′, DC = 6; outer envelope or halo has dia. 35′; w/ 41-cm *f*/5 L (57×), coma dia. 11′.2, DC = 5-6 [BOR].

Nov. 2.09: using 7×50 B, MM = 'M' est. is of the inner coma (size 12′); w/ 7.0-cm R (20×), inner coma showed an elliptical central cond. 4′ in length and directed towards p.a. 220°; glow from the outer coma was clearly fainter than M42 and brighter than M33 [GRA04]. Nov. 2.145: "crystal-clear skies w/ excellent transparency; limiting mag was 5.3; it is quite amazing how much more one can see with the Moon finally out of the way; unlike a week ago when the comet appeared mainly stellar — like a nova that appeared in northern Perseus — the comet now appears to the eye like a little circular cloud; in my 7×35 B, 17P looks like a large and super-bright version of M13 (dia. est. as at least 20′); comet no longer had a distinct yellowish glow — rather it now appears with more of a whitish coloration; total mag 2.4 w/ naked eye (Marfak and δ Per used as comp. stars)" [Joe Rao, Putnam Valley, NY, U.S.A.]. Nov. 2.17: outer bright coma with dia. $\simeq$ 15′ with (still) a finger of brighter material in the middle of this 15′ coma that is pointing SW-ward, and (again) the NE round coma boundary is notably sharp, whereas the SW coma is not so round, not sharp, and fades into the background; also seems to be a very faint diffuse coma outside the bright 15′ coma in 20×80 B [GRE]. Nov. 2.17: outer halo of dia. 36′ and inner coma of dia. 13′ w/ 12×50 B; in 41-cm L, there are indications of a faint tail extending ≈ 12′ from the 'edge' of the outer halo [HAL]. Nov. 2.50: $B-V$ values of comp. stars were +0.56, +0.63, and +0.85 [YOS02]. Nov. 2.60, 3.62, 7.70, 16.77, Dec. 2.62, 5.69, 9.78, 2008 Jan. 6.63, and 9.61: `Guide 8.0` software used for comp.-star mags [NAG04]. 2007 Nov. 2.82: w/ 44-cm $f/5$ L (63×), coma dia. 10′.7 [HAS02]. Nov. 2.83: clearly more active than previous night; via naked eye, a bright coma is visible w/ a central cond. (DC = 7); w/ 25-cm $f/4.8$ L (48×), an ion tail is visible for ∼ 0°.5 w/ some filaments; also, the outer green coma is faintly visible; a co-added CCD image (100 thirty-sec exposures) w/ the 25-cm L (+ R_c filter) on Nov. 2.80 clearly shows some peculiar structure in the central region, with four brighter structures in p.a. 220° [SCA02]. Nov. 2.90: w/ 30.5-cm $f/5$ L (214×), coma dia. 15′ [GOB01]. Nov. 2.96, 4.01, 5.01, 6.07, 7.08, 8.10, and 9.16: comp. w/ α, γ, δ, and ϵ Per, α UMi, β Tri, and δ Cas [PER01]. Nov. 2.99: w/ 6×30 B, coma dia. 40′ [MAR02].

◇ ◇ ◇

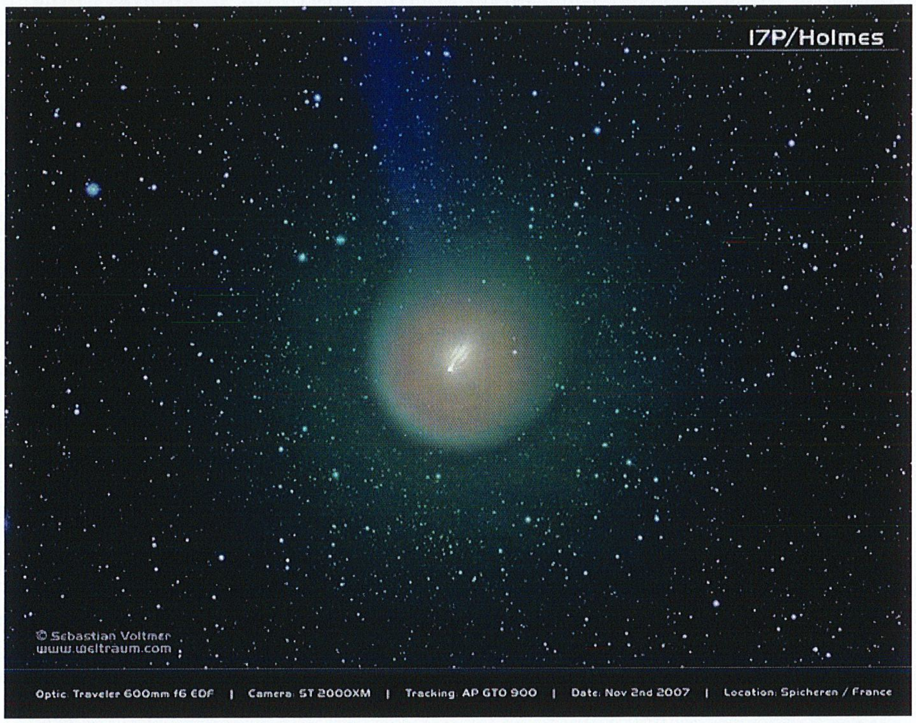


Image of comet 17P/Holmes taken by Sebastian Voltmer (Saarbrücken, Germany) with a 4.1-inch f/6 refractor (+ SBIG ST-2000XM CCD camera) from Spicheren, France; 42-min exposure beginning on 2007 Nov. 2.88 (field size 60′, north is up). Image processed to highlight the comet's bright golden core (with jets and streamers), its greenish halo, and its emerging faint blue tail. Image copyright 2007 by S. Voltmer.

◇ ◇ ◇

Nov. 3.46, 6.82, 7.53, 8.81, 11.83, 14.80, 16.81, 18.81, 23.43, Dec. 2.81, 3.51, 5.52, 9.44, 13.67, 15.51, 16.52, 17.52, 26.40, 30.46, 31.41, 2008 Jan. 2.42, 4.40, 8.46, 15.46, 25.47, and 31.47: `Guide 8.0` software used for comp.-star mags [MIY01]. 2007 Nov. 3.48: "w/ 40-cm telescope, comet is a huge round disk; the rim of the N half is sharp, while the rim of the S half is dim, melting into the background sky — so the impression is that of a jellyfish!; the central bright core's dia. is a quarter that of the disk; a faint stellar nuclear cond. is located at the N edge of the central core; the disk is flat w/ no structures, even at high magnification; the disk is gray with no transparency, so it looks like smoke"; through a 10×70 monocular, outer faint gas coma has dia. 36′, and the bright dust disk has dia. 15′; at dark obs. site w/ naked eyes, object looks cometary w/ strong cond. [YOS04]. Nov. 3.50: $B-V$ values of comp. stars were +0.56, +0.63, and +0.85 [YOS02]. Nov. 3.55: $B-V$ values of comp. stars were +1.04 and +0.55 [KAD02]. Nov. 3.62, 7.6, 8.57, 11.50, 12.6, 13.53, 14.6, 15.6, 16.58, 17.55, 18.53, 19.67, 20.72, 22.61, 23.66, Dec. 1.60, 2.56, 3.56, 5.51, 6.55, 7.52, 9.57, 11.56, 13.54, 14.58, 16.59, 17.60, 20.58, 30.39, 31.39, 2008 Jan. 1.52, 4.49, 5.63, 10.48, and 26.47: **The Sky** ver. 5 software used for comp.-star mags [MIT]. 2007 Nov. 3.62: w/ 30.4-cm L (79×), mag of central cond. 11.0 (ref: TJ) and 12′-long tail in p.a. 215° [NAG04]. Nov. 3.74: "comet had a circular, high-surface-brightness inner coma of dia. 16′, which contained a fuzzy, 4′ × 3′ central cond., elongated towards p.a. 205°; a faint, non-stellar pseudo-nucleus of about 11th mag was situated on the N side of the central cond.; the inner coma's S-SW edge was fuzzy compared to the opposite edge on the N-NE, which was sharply defined; the N part of the inner coma's interior contained a darker, triangular cavity whose N-NE edge followed inside the inner coma's rim; the bright inner coma was surrounded by a very faint outer coma whose shell appeared slightly thinner than the inner coma but had no sharp boundaries" (its overall dia. was ∼ 40′); w/ 25×100 B, coma dia. 40′, DC = 6 [KAR02]. Nov. 3.8: w/ 20-cm T (77×), faint outer coma of dia. 35′; inner disk of dia. 16′; starlike central cond. of mag 11.0; bright oval region extends 2′.5 from center in p.a. 220°; inner-coma disk's boundary from p.a. 140° to 290° is becoming diffuse compared to the distinct N boundary; three main tail-like radial features were visible — in p.a. 170° (extending 0°.9 from center), 210° (extending 0°.9), and 270° (extending 0°.6) [GON05]. Nov. 3.83:

coma bigger and more diffuse than at previous obs.; tab. coma dia. is the yellow inner coma; w/ 21×100 B, a weak outer coma of size ~ 26' is visible [BUS01]. Nov. 3.84: weak outer coma of dia. ~ 25' [RIE]. Nov. 3.87: "obs. during brief clear period; tab. coma dia. (7×50 B) is basically the dust coma" [BOU]. Nov. 3.87: w/ 15×60 B, outer coma 34'; some annular structure in dust coma visible; onset of (gas) tail in p.a. 205° [DIJ]. Nov. 3.88: w/ 11×80 B, coma dia. 25', DC = 6 [LAB02]. Nov. 3.92: in 7×50 B and 12.0-cm R, outer halo of dia. 40'; using 12.0-cm *f*/8 R (111×), the size of the inner disk was 14'; at 25×, coma dia. 30'; dark sky [SKI]. Nov. 3.94: w/ 10×50 B, inner coma of size ~ 20' and very weak outer coma of size ~ 50'; w/ 20-cm L (42×), false nucleus of mag ~ 9 w/ fanlike central cond. of size ~ 5'; coma of size ~ 15' w/ sharp edge and dark band at p.a. 300°-70° and diffuse edge at p.a. 140°-250° [SCH04]. Nov. 3.95: in 7×50 B, coma dia. ~ 40', DC = D6; surface brightness of inner disk-like coma (size ~ 15') appeared fainter than previously, but still considerably brighter than the bulge of M31; brightness of the outer diffuse coma was comparable to M33 [GRA04].

Nov. 4.01: similar m_1 via in-focus naked-eye estimate [PER01]. Nov. 4.09: w/ 15×70 B, coma dia. 18', DC = 5 [BOR]. Nov. 4.09, 5.32, 7.05, 11.93, and 14.00: tail p.a. is direction of the coma's anti-solar elongation [BOR]. Nov. 4.20: "0.8-deg tail/coma extension in p.a. 240° seen in 25×100 B; the sheer size of the outer coma makes it tough to differentiate between a tail and an elongated structure" [CRE01]. Nov. 4.21: outer halo of dia. 40' and inner coma of dia. 15' w/ 12×50 B [HAL]. Nov. 4.23: w/ 20×80 B, outer bright coma dia. ≃ 16' [GRE]. Nov. 4.50: apparent naked-eye fading from mag 2.1 to 3.0 in 24 hr was strongly influenced by obs. tonight from a large city (even though it is clearly visible with naked eyes, it looks almost stellar in the light-polluted sky) [YOS04]. Nov. 5.26: w/ 20×80 B, outer bright coma dia. ≃ 20', and its surface brightness seems lower than previously [GRE]. Nov. 5.73: w/ 10×50 B, coma dia. 14'.6 [HAS02]. Nov. 5.79: large, circular coma elongated in p.a. 206°; the center of the coma is shifted by 1'.4 in p.a. 208° from the central cond.; brightness measurements w/ aperture ≤ 1'.6 were centered on central cond., but the center of the coma preferred when larger apertures used; large-scale 'bulb' structure w/ optocenter located 1'.9 from the central cond. in p.a. 206°; brightness of the 'bulb' measured in circular apertures 1'.6 and 0'.8 centered on optocenter yielded mags 5.9 and 7.4, respectively; three streams of material > 2' long seen in the 'bulb' in p.a. 206°-212°; the brightest stream, > 4' long in p.a. 210° (30" wide), emerges from the central cond. and is slightly curved in the nuclear region; other large-scale structures visible in coma after image processing; curved dust structures surrounding the central cond. and 'bulb'; outer-edge dust shell of the coma w/ thickness of ~ 1'.5 [SRB]. Nov. 5.81: "w/ unaided eyes, bright and small nebular object; w/ 9×63 B, significantly-more-diffuse coma of dia. 22' (most diffuse towards SW) and DC = 6, w/ the central region less conspicuous; no outer coma and no tail detected (but sky a bit hazy); w/ 30-cm T (75×), coma still disk-like, but the borders more diffuse (NNE best-defined, SSW most diffuse); surface brightness has dropped; coma dia. 19'; elliptical (NNE-SSW) central region, also with lower surface brightness; false nucleus of mag 10.5; no outer coma detected" [KAM01]. Nov. 5.84: w/ 44-cm *f*/5 L (63×), coma dia. 18'.8 [HAS02]. Nov. 5.85: w/ 11×80 B, coma dia. 40', DC = 6 [LAB02]. Nov. 5.93: w/ 30.5-cm *f*/5 L (60×), coma dia. 18' [GOB01]. Nov. 5.98: w/ 15×70 B, coma dia. 19', DC = 5; w/ 41-cm *f*/5 L (57×), coma dia. 13'.6, DC = 5 [BOR].

Nov. 6.01: w/ 20-cm L (42×), diffuse false nucleus with fan-like central cond. of size ~ 5'; big coma of size ~ 25' w/ sharp edge and dark bend at sunlit side in p.a. 320°-70°, and diffuse edge with very weak tails ~ 0°.6 long in p.a. 205° and 0°.4 in p.a. 180° [SCH04]. Nov. 6.01: "in 7×50 B, comet rather sharply defined in the solar direction, but looked elongated and more diffuse in the anti-solar direction; the tab. coma dia. refers to the dust component; only a hint of the outer coma w/ dia. ~ 25' was visible under suburban conditions" [BOU]. Nov. 6.06: in 7×50 B, outer coma ≈ 24' (lost some of coma due to city lights) [DIJ]. Nov. 6.09: w/ 20×80 B, surface-brightness gradient of coma has smoothed out a lot — still a central-ish faint cond., with brighter material emanating toward the SW, but this central area doesn't dominate as much as in past days; 20'-22' outer coma not so well-defined, but still better defined and much more extended toward the NE (vs. the SW) [GRE]. Nov. 6.73: coma dia. 19' w/ 10×50 B [MEY]. Nov. 6.77: in 10×50 B, coma dia. ~ 24' (in 20×60 B, hints of an extended gas coma about twice this dia.); fountain still visible, as well as the pseudo-nucleus [GIL01]. Nov. 6.79: w/ 15×60 B, only a hint of outer coma visible [DIJ]. Nov. 6.79: w/ 15×80 B, shaped like a jellyfish; coma with broad tail in p.a. 215°-290° (maximum 0°.7 long) [RIE]. Nov. 6.83: "comet is growing in size, becoming more diffuse and slowly dimming; w/ 7×50 B, inner coma or envelope some 22' in dia.", DC = 5 [KAR02]. Nov. 6.89: w/ 9×63 B, coma dia. 24', DC = 6 [KAM01].

Nov. 7.05: w/ 15×70 B, coma dia. 18', DC = 5-6 [BOR]. Nov. 7.08, 16.04, 20.03, 22.06, 23.04, 27.03, 29.04, 30.07, Dec. 13.98, 14.98, and 2008 Jan. 1.05: comp. stars have V = 3.01 (−0.13) and 4.23 (−0.06) [AMO01]. 2007 Nov. 7.08: "dry conditions (rare at this location, allowing naked-eye limiting mag 6.3 at alt. 26°, in spite of being 30 km from Lisboa's ever-increasing light pollution); nevertheless, even tonight's nice sky is a far cry from what I enjoyed here less than 20 years ago!" [PER01]. Nov. 7.18: w/ 12×50 B, very faint outer halo of dia. 57', and inner coma of dia. 22' [HAL]. Nov. 7.20: w/ Swan-band filter, comet looked definitely larger; w/ 10×50 B, coma dia. ~ 24'; in 20×60 B, parts of a gas tail faintly visible (in 37-cm L w/ Swan-band filter, two streamers of this tail were visible) [GIL01]. Nov. 7.49: naked-eye impression, gazing at the comet directly, is faint, but looking around the comet area (averted vision), it appears as bright as δ Per [YOS04]. Nov. 7.70: w/ 30.4-cm L (79×), mag of central cond. 10.9 (ref: TJ) [NAG04]. Nov. 7.82: in 25×100 B, outer coma's surface brightness appears much fainter than four days ago, est. dia. 55'; inner disk of dia. 21'; bright oval region extends 6'.5 from center in p.a. 220°; three main tail-like features were visible — in p.a. 195° (extending 1°.7 from center), 210° (extending 1°.7), and 240° (extending 1°.3); in 20-cm T (77×), starlike central cond. of mag 12.2 [GON05]. Nov. 7.88: the photometric aperture includes the 'outer' coma (dia. 19'); four Tycho/Hipparcos-catalogue ref. stars in mag range V = 7-9.5 [QVA]. Nov. 7.89: w/ 30.5-cm *f*/5 L (60×), coma dia. 21' [GOB01]. Nov. 7.92: w/ 11×80 B, coma dia. 16', DC = 5, tail 60' long [LAB02].

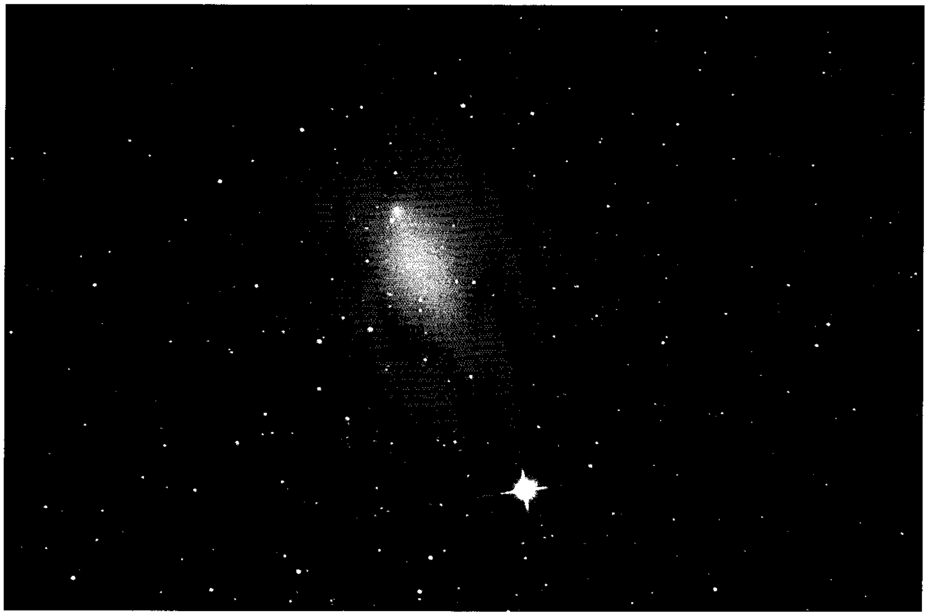
Nov. 8.02: w/ 10×50 B, impression of very weak tail of length ~ 0°.6 in p.a. 200°; w/ 30-cm L (39×), false nucleus very diffuse and elongated central cond. [SCH04]. Nov. 8.04: w/ 7×50 B, coma dia. 21' and 0°.5 tail barely visible in p.a. 220°; the disk-like dust coma contained an oval and more diffuse central cond.; outer coma not detected (M33 was seen as a faint glow) [GRA04]. Nov. 8.13: w/ 41-cm *f*/5 L (57×), coma dia. 23′, DC = 5 [BOR]. Nov. 9.16: obs. after weak weather-front passage [PER01]. Nov. 9.19: w/ 12×50 B, very faint outer halo of dia. 60′, and inner coma of dia. 25′ [HAL]. Nov. 9.46: *B–V* values of comp. stars were +0.56, +0.63 and +0.85 [YOS02]. Nov. 9.72: w/ 10×56 B, coma dia. ∼ 23′, DC = 4/ [BUS01]. Nov. 9.95: in 25×100 B, faint outer coma of dia. 55′; inner disk of dia. 25′ (elongated towards the diffuse S boundary); bright oval region extends 7′ from center in p.a. 210°; the morphology of the tail is complex after the recent DE; the old radial features are detached from the coma, the longest one extending 2°.2 from center towards p.a. 190°; in 10-cm M (65×), starlike central cond. of mag 12.5 [GON05]. Nov. 9.98: w/ 10×70 B, tail very faint; outer coma not seen w/ certainty [GRA04].

Nov. 10 to 2008 Jan. 31: "I stopped down a 5×50 finder, to aperture 22 mm, in order to get all the light to the pupil of the eye, and also to dim the image to levels where the eye is most sensitive to slight brightness differences; however, in doing so, I increased the *f*/ratio" [PER01]. Nov. 10.01: w/ 7×50 B, coma dia. 25′ [SKI]. Nov. 10.10: "comp. w/ α, γ, δ, and ϵ Per, β Tri, δ and ϵ Cas; uncertainty in m_1 w/ 5×22 monocular and VSS method is ± 0.3 mag (as opposed to ± 0.1 mag for VBM and Modified-Out methods)" [PER01]. Nov. 10.55: comet visible to naked eye through layer of thin horizon cloud [SEA]. Nov. 10.87: w/ 7×50 B, other coma was glimpsed (tab. dia. refers to outer coma), its surface brightness being much inferior to that of M33; tail was faint but certainly seen; subsequent photographs showed both the tail and the outer diffuse coma; dark sky (M33 visible to naked eye) [GRA04]. Nov. 10.89: w/ naked eye, total mag 2.4, coma dia. 25′, DC = 4; w/ 7×50 B, coma dia. ≈ 80′ [MAR02]. Nov. 11.05: w/ 41-cm *f*/5 L (57×), coma dia. 23′, DC = 5 [BOR]. Nov. 11.15: "as the coma gets larger, in-focus naked-eye estimates become increasingly inappropriate, as it is difficult to have the eye respond to the total brightness of objects much larger than 20′ or so (even if using more averted vision than usual); however, the VBM method (with a 3-diopters lens), is now perhaps even less adequate due to the comet's angular proximity to α Per; nevertheless, both naked-eye estimates are still believed to be good to ± 0.1-0.2 mag; w/ 5×22 monocular, uncertainty in m_1 is ± 0.3 mag with VSS method, as opposed to ± 0.1 mag for VBM and Modified-Out methods" [PER01]. Nov. 11.15, 15.13, 15.99: comp. w/ α, γ, δ, and ϵ Per, δ and ϵ Cas [PER01]. Nov. 11.15: w/ 20-cm *f*/10 T (62×), coma dia. > 30′, false nucleus of mag ∼ 11.5 [SOU01]. Nov. 11.21: w/ 20×80 B, comet appears like it did in Barnard's 1892 Dec. Lick Obs. photo; coma becoming less round (SW side "eroding"), and overall DC is lowering as comp. to previous nights; none of my binoculars with attached eyepieces can properly be used to estimate the brightness of this large coma; fairly uniform coma brightness in 7×18 B w/ very low DC [GRE]. Nov. 11.57: through 25×100 B, outer edge of coma closest to N horizon appeared very sharp and distinct, whereas the opposite side was quite indistinct; column-like feature extended from central region of coma out to uppermost edge, appearing rather like a comet tail without definite head (it did not extend beyond the boundary of coma, however); in 6×35 B, comet seemed slightly elongated ⊥ to N horizon [SEA]. Nov. 11.79: in 20×60 B, 8′ bright spot in p.a. 215° still visible; no tail seen [GIL01]. Nov. 11.80: w/ 8×40 B, very weak fanlike tail in p.a. 205°-240° of length ∼ 0°.5 [RIE]. Nov. 11.81: w/ 20-cm L (42×), diffuse false nucleus of mag ∼ 11 in slightly elongated coma (size ∼ 30′), which is diffuse in p.a. 170°-240°; two very weak tails of length ∼ 0°.5 in p.a. 190° and ∼ 0°.4 in p.a. 210° [SCH04]. Nov. 11.93: w/ 15×70 B, coma dia. 24′, DC = 5 [BOR]. Nov. 11.94: large, bright, still well-defined coma (SSW most diffuse); coma steadily brightening towards center; no outer coma and no tail detected; w/ 9×63 B, coma dia. 29′, DC = 5/ [KAM01].

Nov. 12.13: observing w/ Michael Rudenko from Pelham, MA, U.S.A., in much darker skies (most of other obs. in late Oct. and in Nov. from suburban Boston site), and had wonderful views of the inner coma through Rudenko's 6-inch *f*/8 comet-hunting R, which showed a faint, not-quite-stellar cond. near the head of "knobbish" brighter area in central part of coma and numerous faint stars wonderfully visible through the coma (this cond. was more difficult to see in his 5-inch R, and not really visible in my 20×80 B, w/ DC perhaps 3 in the latter instrument w/ bright outer coma dia. now ≃ 25′-30′); comet in rich star field near α Per [GRE]. Nov. 12.21: w/ 12×50 B, coma dia. 30′ [HAL]. Nov. 12.55: "in 25.4-cm L (71×), central 'column' appeared very clear, but edge of coma not quite as sharp as in 25×100 B; coma had a somewhat 'frosted' look" [SEA]. Nov. 12.73: w/ 10×50 B, coma dia. 32′ [HAS02]. Nov. 12.78: w/ 10×50 B, weak tail of length ∼ 0°.8 in p.a. 200° [SCH04]. Nov. 12.97: coma with smooth brightness increase towards center; small central cond.; w/ 9×63 B, coma dia. 31′, DC = 6 [KAM01]. Nov. 12.97: w/ 7×50 B, coma dia. 28′ [SKI]. Nov. 13.04: w/ 7×50 B, coma dia. 30′, DC = 4; an oval central area of size ∼ 15′ × 7′ was seen within the disk-like coma [GRA04]. Nov. 13.22: in 40-cm T (295×), there is no sign of a star-like central cond.; there is a patch of diffuse material; N edge of coma is extremely sharp [MOR]. Nov. 14.00: w/ 15×70 B, coma dia. 29′, DC = 5 [BOR]. Nov. 14.00: coma somewhat oval-shaped; edge more diffuse in the anti-solar direction [BOU]. Nov. 14.03: in 25×100 B, faint outer coma was not perceptible; inner disk of size 31′ (elongated towards the diffuse S boundary); bright oval region extends 11′ from center in p.a. 205°; tail-like radial feature extending 0°.6 from center in p.a. 200°; in 20-cm T (77×, starlike central cond. of mag 12.7 [GON05]. Nov. 14.17: "coma dia. ∼ 28′ in 10×50 B and 20×60 B; coma more transparent than before, as there are several stars visible shining through the coma in 20× 60 B; 'fountain' still visible" [GIL01]. Nov. 14.22: comp. w/ α, γ, δ, and ϵ Per [PER01]. Nov. 14.23: comet only ≈ 2° from α Per, making more difficult obs.; naked-eye estimate made in Holetschek-style "impression" fashion via averted vision [GRE]. Nov. 14.64, 18.52, 19.61, 20.52, 21.54, 22.40, 22.47, 23.51, 25.49, 26.41, Dec. 1.40, 2.51, 3.44, 3.60, 4.42, 5.5, 7.41, 7.51, 9.40, 13.74, 14.56, 15.59, 16.39, 17.57, 18.5, 26.55, 30.54, 2008 Jan. 1.38, 4.41, 6.41, 9.53, 13.40, 27.43, and 31.43: `StellaNavigator` ver. 8.1 software used for comp.-star mags [NAG08]. 2007 Nov. 14.64: *B–V* values of comp. stars were +0.51, +0.51, and +0.59 [NAG08]. Nov. 14.91: w/ 20-cm L (42×), diffuse coma (27′) with fanlike cond. in p.a. 175°-210° [SCH04].

Nov. 15.03: "large, rather condensed object — easily visible despite proximity of α Per; in 15.6-cm L (29×), the elongated coma measured ≈ 25′ × 30′, w/ an inner brighter (also somewhat elongated) core 8′ in dia.; the coma was shaped very much like a large jellyfish, rather sharply defined in the solar direction, but very diffuse in the anti-solar direction" [BOU]. Nov. 15.22: comet looks the same as yesterday, only a little bigger; w/o glasses, α Per begins to interfere with obs. [GIL01]. Nov. 15.84: w/ 10×50 B, coma dia. 35′.6 [HAS02]. Nov. 16.18: some hindrance from α Per [GIL01]. Nov. 16.54: comet getting diffuse, and more weakly condensed, day by day; while visible w/ naked eyes, impossible to est. the mag [YOS04]. Nov. 16.77: w/ 30.4-cm L (79×), mag of central cond. 11.6 (ref: TJ) and 18′-long tail in p.a. 205° [NAG04]. Nov. 16.79: clear sky, but some haze [QVA]. Nov. 16.82: w/ 10×50 B, coma dia. 37′.8 [HAS02]. Nov. 16.83: w/ 20-cm L (42×), diffuse coma (24′) with sharp side toward the sun and diffuse toward the tail [SCH04]. Nov. 16.86: w/ 9×63 B, coma dia. 38′, DC = 5 [KAM01]. Nov. 16.9: comet close to α Per [HOR02]. Nov. 17.01: comet still seen separated from α Per [GIL01]. Nov. 17.01: in 20-cm T (77×), faint outer coma was not perceptible; inner disk of size 35′ (elongated towards the diffuse S boundary); bright oval region extends 17′ from center in p.a. 205°; tail-like feature extending 0°.7 from center in p.a. 200°; starlike central cond. of mag 12.5 [GON05]. Nov. 17.07: w/ 15×70 B, coma dia. 34′, DC = 5 [BOR]. Nov. 17.25: naked-eye estimate too difficult because comet only ≈ 1° from α Per; the comet has become even more diffuse as seen in 20×80 B, with coma dia. ≃ 30′-35′, with same asymmetry as before noted w/ NE round coma having a sharp boundary, vs. diffuse SW coma, and a brighter fannish area visible from the center of the coma towards the SW; used my 1×35 monocular (composed of two 35-mm B objective lenses, which was created in a cardboard tube ten years ago for estimating C/1995 O1, C/1996 B2, and total lunar eclipses) for mag est., but still very time-consuming to measure; comet just past zenith [GRE]. Nov. 17.55: finally, the rim of the coma has touched α Per; large, diffuse object; w/ naked eyes, only a faint diffuse patch visible next to α Per [YOS04]. Nov. 17.66: $B-V$ values of comp. stars were +0.53 and +0.52 [KAD02]. Nov. 17.85, 18.61, 20.63, 2008 Jan. 2.65, 3.63, and 4.65: small-city light pollution [NOV01]. Nov. 17.90: w/ 20-cm L (42×), diffuse coma (28′) with very weak and diffuse false nucleus and fanlike cond. in p.a. 190°-210° [SCH04].

◇ ◇ ◇



CCD image of comet 17P taken by Syuichi Nakano (Sumoto, Japan) on 2007 Nov. 18.706 (30-sec exposure) with a 25-cm f/4.8 reflector (+ Canon Kiss digital camera). Field-of-view is 1°.1 × 0°.74. The bright star is second-magnitude α Per. Image copyright 2007 by S. Nakano.

◇ ◇ ◇

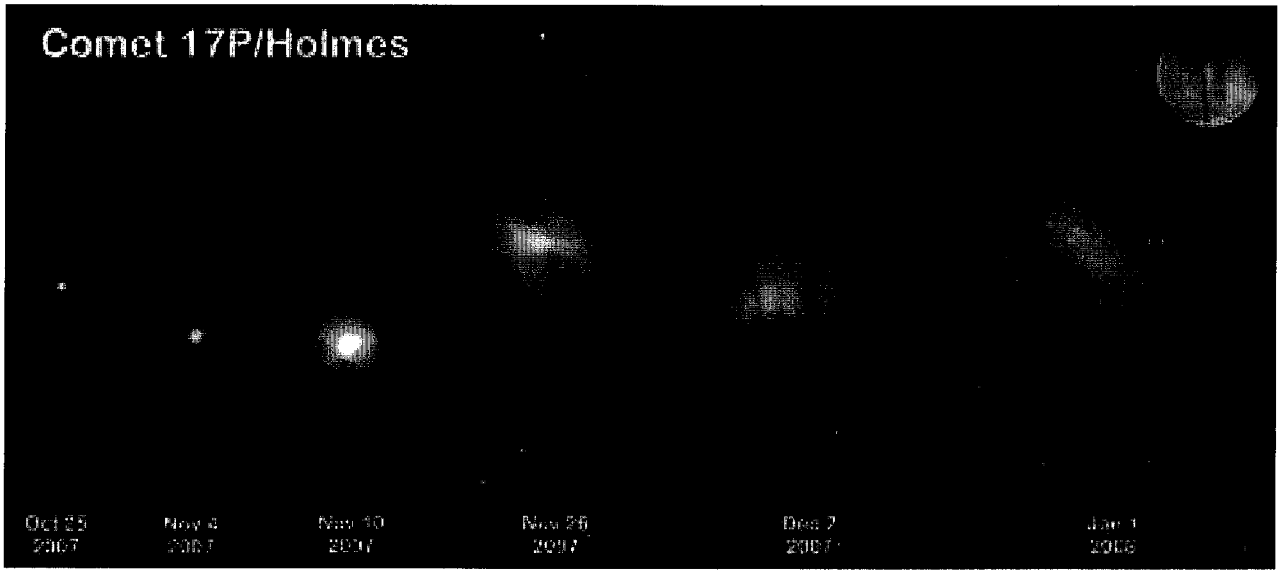
Nov. 18.05: comp. w/ γ, δ and ϵ Per, δ and ϵ Cas [PER01]. Nov. 18.15 and 30.08: comp. stars have V = 3.17 ($B-V$ = −0.18) and 3.95 (+0.74) [GOI]. Nov. 18.31: comet located very close to α Per, and a formal naked-eye m_1 measurement is not feasible ('guesstimated' $m_1 \sim 3$); w/ 12×50 B, coma dia. 35′ [HAL]. Nov. 18.45: comp. star has $B-V$ = +0.60 [TSU02]. Nov. 18.55 and 19.71: outer faint coma is overlapping α Per, but the central bright core is separate from the star, so it is not difficult to est. the total mag w/ VSS method — but the dia. est. may be influenced by the star [YOS04]. Nov. 18.81: "comet becoming more diffuse; elongated in roughly N-S direction, measuring some 30′ × 40′; S edge very diffuse, just touching α Per" [BOU]. Nov. 18.81: comet close to α Per; no VBM estimate possible [MEY]. Nov. 18.94: "too near to α Per for brightness estimate; w/ 9×63 B, elliptical coma (34′ × 37′), DC = 3/; w/ 30-cm T (75×), very large, slightly parabolic coma (NNE well-defined, SSW most diffuse); central cond. (w/o false nucleus) of dia. 20″ was displaced ~ 1/6 coma dia. to NNE (it sat on the NNE-tip of the very elliptical central region, which stretched ~ 1/2 coma dia. to the SSW, and was ~ 1/6 coma dia. wide)" [KAM01]. Nov. 19.27, 19.28: comet's core only about half a degree from second-mag star α Per, making mag estimate very difficult; in binoculars, α Per was just to one side of the "fan spine" emanating toward the SW from the comet's nuclear cond. (the cond. not being noticed, but known from previous obs. and from photos), and α Per was clearly inside the comet's huge coma; encroaching clouds forced measurements more quickly than would have liked [GRE]. Nov. 19.73: α Per in outer coma [HOR02]. Nov. 19.73, 26.70, Dec. 18.88, and 20.68: moonlight [HOR02]. Nov. 19.90: easily seen w/ naked eye, and m_1 est. obtained when nearby α Per was placed just behind the top of a post; w/ 7×50 B, the coma appeared much larger and brighter than the bright part of M31, showing a somewhat-brighter, oval, central region of size ~ 15′ × 10′; the 'mean' brightness of the coma was est. as halfway between two nearby stars of mag 4.96 and 5.56 (ref: TK) when these stars were defocused to 12′ (the tab. m_1 was derived from 5.26–5log(35/12); α Per was located just within the visible part of the coma; sky fairly dark despite the almost-10-day-old Moon [GRA04].

Nov. 20.03, 22.06, and 23.04: moonlight [AMO01]. Nov. 20.14: comp. stars have $V = 3.95$ ($B-V = +0.74$) and 3.13 (−0.18); comet alt. 18°; moonlight; w/ 22-cm $f/6.5$ L (36×), total mag 3.7, coma dia. 40′, DC = 1, tail 0°.5 long in p.a. 210° [GOI]. Nov. 20.87: in 25×100 B, coma of size 37′ × 48′ (elongated towards the diffuse S boundary); inner brighter region extends 23′ from central cond. in p.a. 195°; tail-like feature extending 1°.2 from center in p.a. 195° [GON05]. Nov. 20.87 and 22.84: urban light pollution; moonlight [GON05]. Nov. 21.05, 21.98, 23.85, 25.08, and 26.86: moonlight [DIJ]. Nov. 21.08: 3×40 opera monocular [SOU01]. Nov. 21.09: w/ 10×50 B, coma dia. 40′, DC = 3, tail in p.a. 200° [PIL01]. Nov. 21.18: good transparency with scattered cumulus [PER01]. Nov. 21.47: sky very clear, but large Moon shines overhead, so the comet looks very faint, yet the very large diffuse coma is visible [YOS04]. Nov. 21.73: w/ 10×50 B, coma dia. 36′.4 [HAS02]. Nov. 21.75: haze, moonlight [SCA02]. Nov. 21.97: moonlight; comet well visible near zenith; elongated roughly in N-S direction w/ dimensions 30′ × 40′ [BOU]. Nov. 22.06: comet alt. 11° [AMO01]. Nov. 22.21: in 10×50 B, coma dia. ~ 40′ × 30′ [GIL01]. Nov. 22.40: $B-V$ values of comp. stars were +0.50, +0.50, and +0.51 [NAG08]. Nov. 22.88: "strong moonlight; brightness probably underestimated due to not enough defocusing range; still waiting for the low-power opera glasses" [MEY]. Nov. 23.03: w/ 15×70 B, coma dia. 41′, DC = 3 [BOR]. Nov. 23.04: comet alt. 9° [AMO01]. Nov. 23.21: nearly full moon some 30° away; comet faintly visible to naked eye, now pulling away from α Per; used right side of a pair of 12×50 B, in which the eyepiece was detached so that it could be racked out far enough to do a proper total-mag est. (none of the observer's five pairs of binoculars permit the eyepieces to be racked out even *nearly* far enough); even in 20×80 B, the DC is now very low ($\approx$ 1) [GRE]. Nov. 23.95, 24.98, 27.01, 27.83, and 28.87: comp. w/ γ, δ and ϵ Per, δ and ϵ Cas [PER01]. Nov. 23.95, 24.98, 27.01: moonlight [PER01]. Nov. 24.04: w/ 7×50 B, clearly oval — about 30′ × 45′ in size w/ major axis directed N-S; surface brightness of coma comparable to the nebula surrounding the θ Ori complex; comet clearly visible to naked eye despite a full Moon [GRA04]. Nov. 24.10, 27.09, and Dec. 16.98: moonlight interference [GOI]. Nov. 24.10 and 27.09: comp. stars have $V = 4.05$ ($B-V = +0.59$) and 3.95 (+0.74) [GOI]. Nov. 24.27: difficult obs. w/ full moon only some 25°-30° away; uncertainty in m_1 is perhaps ± 0.3 mag [GRE]. Nov. 24.98: "the comet is an easy naked-eye object in spite of moonlight, appearing as a completely diffuse (DC = 0) circular patch; in 5×22 monocular, an elongated inner-coma (superimposed on a larger circular coma) is rather less obvious than on the previous night" [PER01].

Nov. 25.71: "comet is becoming very diffuse, but easy to see in very transparant sky after showers; moon low in E, obscured by clouds" [BOU]. Nov. 25.89: moonlight; also still visible w/ naked eye [DIJ]. Nov. 26.00: "comp. essentially with γ and δ Per; ϵ Per, and δ and ϵ Cas, were at very different angular distances from the Moon and thus seen against a different sky background (nevertheless, the m_1 est. does not change whether including or discarding comparisons against these stars; the comet is an easy naked-eye object in spite of moonlight, appearing as a diffuse circular patch" [PER01]. Nov. 26.73: w/ 10×50 B, coma dia. 40′ [HAS02]. Nov. 26.80: moonlight [GON06]. Nov. 26.93: in 10×50 B, coma dia. ~ 47′ × 30′ [GIL01]. Nov. 27.01: "the comet appears as a diffuse (DC = 1) patch ~ 0°.8 in dia. to the naked eye" [PER01]. Nov. 27.03, 29.04, and 30.07: comet alt. 13° [AMO01]. Nov. 27.05: possibly obs. through thin cirrus; w/ 12×50 B, coma dia. 45′ [HAL]. Nov. 27.67: w/ 6×30 R, comet appeared elongated and ~ 35′ × 50′ in size, w/ major axis in N-S direction (its surface brightness similar to the bulge of M31); obs. before moonrise in twilight (solar alt. −12°) and w/ some interference from altostratus clouds, the comet was nevertheless easily seen w/ naked eye [GRA04]. Nov. 27.76 and 28.79: w/ 10×50 B, coma dia. 41′ [HAS02]. Nov. 27.81: in 25×100 B, coma of size 40′ × 48′ (elongated towards the diffuse S boundary); inner brighter region extends 23′ from central cond. in p.a. 190°; broad tail-like feature extending 1°.2 from center in p.a. 190°; obs. made after the end of astron. twilight and before moonrise [GON05]. Nov. 27.83: "to the naked eye, the comet appears more condensed (DC = 2); yet, the outer coma edges (dia. 0°.6 ± 0°.2) are rather-less-sharply defined, as compared to the previous night (when the Moon was interfering)" [PER01]. Nov. 27.84: w/ 9×63 B, DC = 2, very large and diffuse coma (43′ × 46′), w/ large elliptical (NNE-SSW) central brightening; NNE best-defined, SSW most diffuse [KAM01]. Nov. 27.92: coma clearly elongated, measuring some 35′ × 45′, roughly in a N-S direction; very clear sky w/ moon obscured by cloud [BOU]. Nov. 27.93: comet easily seen w/ naked eye as a large diffuse object, despite moonlight [BOU].

Nov. 28.63: very clear sky but moonlight and city lights [XU]. Nov. 28.73: obs. from Valašské Meziříčí Observatory; five comparison stars in the same field-of-view; large asymmetric coma elongated in p.a. 183° (44′ × 68′); brightness measurements for aperture dia. $\leq$ 34′.85 were centered at cond., but center of coma preferred when using larger apertures; large-scale 'bulb'-tail-like structure > 25′ long in p.a. 183° w/ optocenter shifted 5′.5 from the central cond. in p.a. 183°; brightness of the 'bulb' measured in two circular apertures of dia. 13′.05 and 6′.55, centered at the optocenter, yielded mags 4.4 and 5.7, respectively. [SRB]. Nov. 28.75: w/ unaided eyes, well visible nebular object; w/ 9×63 B, large, very diffuse (DC = 1/) coma of size 44′ × 49′, w/ N best-defined, S fan-like; slightly brighter, very elliptical (N-S) central region; w/ 30-cm T (75×), extremely large coma with very low surface brightness w/ still-well-defined N part; very elliptical (N-S) slightly brighter central region; central cond. of dia. 45″ w/o false nucleus at the N tip of the central region, which stretched for ~ 1/2 coma dia. to the S; central cond. displaced to the N for ~ 1/6 coma dia. [KAM01]. Nov. 28.79, Dec. 5.79, 25.71, and 27.72: "tab. coma size always for minor axis" [HAS02]. Nov. 28.87: via naked eye, dia. 0°.8, DC = 2 [PER01]. Nov. 29.08, 30.08, and Dec. 3.04: w/ 11×80 B, coma dia. > 1° [SOU01]. Nov. 29.08 and Dec. 2.06: comp. stars have $V = 3.17$ ($B-V = -0.18$) and 4.05 (+0.59) [GOI]. Nov. 29.50: $B-V$ values of comp. stars were +0.48, +0.66 and +0.70 [YOS02]. Nov. 29.74: w/ 10×56 B, coma size ~ 47′ (DC = 4) [BUS01]. Nov. 29.80: in 10×50 B, coma dia. ~ 60′ × 40′ [GIL01]. Nov. 29.81: "in 15.6-cm L (29×), the comet is clearly elongated some 45′ × 60′ in dia.; the coma boundary is rather well defined in the solar direction, but totally diffuse in the anti-solar direction; brighter inner coma also clearly elongated, forming a narrowing spine towards p.a. 190° (this was the center of a very diffuse tail feature extending some 0°.8 towards p.a. 190°)" [BOU]. Nov. 29.84: w/ 20-cm L (42×), diffuse coma (size ~ 36′ × 42′) w/ very weak false nucleus and elongated central cond. in p.a. 160°-170° [SCH04]. Nov. 29.90, 30.82, Dec. 1.88, 2.89, 4.10, 5.08, 9.94, 10.93, 11.89, and 13.04: comp. w/ γ, δ, and τ Per, δ and ϵ Cas [PER01]. Nov. 29.90: via naked eye, dia. 0°.9, DC = 2 [PER01]. Nov. 29.98, 30.99, Dec. 2.13, 5.14, 6.99, 9.02, and 12.99: tab. tail length is actually major axis of elongated coma (for which the p.a. is also given), whereas tab. coma dia. is minor axis of same [BOR]. Nov. 30.82: via naked eye, dia. ~ 0°.8, DC = 1 [PER01].

◇ ◇ ◇



Composite collage of CCD images of comet 17P taken by Jimmy Westlake (Steamboat Springs, CO, U.S.A.) on six nights from 2007 Oct. 25 to 2008 Jan. 1, showing the expanding coma and the decreasing degree of condensation. Westlake used a Fuji FinePix S2 Pro digital camera and a Nikkor 300-mm f/2.8 telephoto lens (piggyback-guided on a Celestron 11-inch telescope). Each comet image is reproduced here at the same scale, and an image of the waning gibbous moon — taken with the same equipment on Nov. 26 — is inset at top right to the same scale as the comet. All images were shot at ISO 800 except for Oct. 25 (ISO 400); the UT dates (and exposure times) for each comet image are as follows: 2007 Oct. 25.27 (62 sec); Nov. 5.23 (10 sec); 11.15 (69 sec); 27.06 (122 sec); Dec. 3.20 (125 sec); 2008 Jan. 2.17 (185 sec) [note that the labelled dates are local time].

◇ ◇ ◇

Dec. 1.79: in 25×100 B, coma of size 45′ × 55′ (elongated towards the diffuse S boundary); inner brighter region extends 23′ from central cond. in p.a. 185° [GON05]. Dec. 1.79, 8.78, and 2008 Jan. 10.80: suburban location, clear sky [GON05]. 2007 Dec. 1.88: "via naked eye, dia. ~ 1°.0, DC = 1/; as in all my previous obs. of this and other comets, dia. are measured along the so-called 'latus rectum' (*i.e.*, the cord running through the pseudo-nucleus and $\perp$ the coma's major axis); it is also appropriate to note that the coma seen visually is somewhat different from what current CCD images show; w/ 5×22 monocular, the coma appears as a huge 50′, nearly-circular brightness plateau surrounded by a narrow, annular outer coma with diffuse edges; a broad dust tail has been obvious since the Moon stopped interfering a couple of nights ago; however, the comet is in a rich Milky Way field, and star-alignments are numerous, so it is perhaps pointless to spend much time tracing such features visually when images can do it much better; the 'leading' sharp edge of the coma, so prominent in current CCD images is not obvious with the instrument used for the m_1 estimate; another fact worth mentioning is the distinct light-green color of the in-focus comet, as compared to the white extra-focal stellar images" [PER01]. Dec. 1.99: w/ 9×63 B, very large, very diffuse (DC = 1) coma of size 57′ × 50′; N part well-defined, S part fanning out; large, elliptical central region only marginally brighter [KAM01]. Dec. 2.04: in 7×50 B, comet clearly elongated, measuring some 40′ × 55′ along a roughly N-S axis [BOU]. Dec. 2.06 and 9.99: light pollution [GOI]. Dec. 2.60: very bright, easily visible, due to the clear sky; the central bright blob looks bar-like, extending N-S, surrounded by an extraordinary huge coma [YOS04]. Dec. 2.76: handheld 7×50 B showed the huge coma elongated N-S, which became gradually slightly brighter towards the center; slightly hazy sky between fog clouds that eventually covered the whole sky [KAR02]. Dec. 2.80: in 10×50 B, coma dia. ~ 64′ × 40′ [GIL01]. Dec. 2.85: w/ 20-cm L (42×), diffuse coma (size ~ 40′ × 50′) w/ very weak false nucleus and elongated central cond. in p.a. 170° [SCH04]. Dec. 2.89: w/ naked eye, dia. ~ 0°.9, DC = 1 [PER01]. Dec. 3.10, 7.08, and 12.23: w/ 12×50 B, coma dia. 50′ [HAL]. Dec. 3.86: w/ 7×50 B, coma clearly elongated towards p.a. 170°, measuring some 45′ × 60′; very faint tail ~ 1°.1 in p.a. 170° [BOU]. Dec. 3.87: w/ 10×56 B, coma size ~ 52′ (DC = 3) [BUS01]. Dec. 3.95: comet large and elliptical — w/ naked eye, better visible than M31; w/ 10×50 B, short fuzzy tail to the S and coma boundary better defined in the solar direction [COM]. Dec. 4.06: w/ naked eye, comet seen to be somewhat brighter than the apparent diffuse glow from the double cluster (NGC 869/NGC 884); mag est. obtained from the defocused view of the comet and the comp. stars (δ Per and ϵ Cas) as seen through +3-diopter spectacles (the observer has normal vision); w/ 6×30 R and 10×50 B, the coma was of moderate surface brightness and somewhat inferior to the central part of M31 (coma showed a brighter inner region that appeared diffuse and very elongated, plus a parabola-shaped outer coma that was sharply defined in sunward direction) [GRA04]. Dec. 4.10: w/ naked eye, dia. ~ 1°.0, DC = 2/ [PER01].

Dec. 5.02: in 25×100 B, coma of size 47′ × 65′ (elongated towards the diffuse S boundary); inner brighter region extends 30′ from central cond. in p.a. 180°; broad tail-like feature extending 1°.2 from center in p.a. 180° [GON05]. Dec. 5.08: w/ naked eye, dia. ~ 57′, DC = 2 [PER01]. Dec. 5.49: *B–V* values of comp. stars were +0.53, +0.63, and +0.70 [NAG08]. Dec. 5.79: w/ 44-cm *f*/5 L (63×), coma dia. 47′ [HAS02]. Dec. 5.86: w/ 10×56 B, coma size ~ 55′ (DC = 2/) [BUS01]. Dec. 5.99: in 7×50 B, coma dia. ~ 50′ × 70′, elongated towards p.a. 170° [BOU]. Dec. 6.99: w/ naked eye, coma dia. 70′, DC = 3 [BOR]. Dec. 7.08: obs. hurried due to oncoming clouds; possibly obs. through thin cirrus [HAL]. Dec. 7.41: *B–V* values of comp. stars were +0.53, +0.56, and +0.70 [NAG08]. Dec. 7.73: w/ 10×56 B, coma size ~ 57′ (DC = 2/) [BUS01]. Dec. 7.94: in 7×50 B, coma dia. ~ 50′ × 65′, elongated towards p.a. 165° [BOU]. Dec. 7.95: in 7×50 B, coma clearly elongated towards p.a. 165° [DIJ]. Dec. 8-10: site of the IRAM telescope at Pico-Veleta, southern Spain [BIV]. Dec. 8.64 and 9.47: "amazingly bright from a mountain location!; much brighter, and much more attractive, than the double cluster *h* and χ Per (comet looks like a round planetary nebula w/ naked eyes; however, it also looks like a moderately condensed object — DC = 4 or so — because it is so bright, so it does not seem diffuse); because I am nearsighted, it is easy to est. the total mag using VSS method just taking off my glasses; it looks like a jellyfish, similar to the photos, through the 10×70 monocular; the view through a 40-cm telescope is fantastic, w/ the transparent envelope covering the whole field-of-view (the rim of the envelope is very clear w/ high magnif.); no nuclear cond. visible w/ 40-cm telescope" [YOS04]. Dec. 8.78 and 11.81: in 25×100 B, coma of size 52′ × 70′ (elongated towards the diffuse S boundary) [GON05]. Dec. 8.78: in 25×100 B, inner brighter region extends 30′ from central cond. in p.a. 175°; broad tail-like feature extending 1°.2 from center in p.a. 175° [GON05]. Dec. 8.85: w/ naked eye, the comet appeared larger and brighter than the visible part of M31 and somewhat brighter than the double cluster (its angular extent of ~ 60′ was comparable to the Pleiades); comet only briefly obs. as the sky was about to clear; dark-sky site [GRA04]. Dec. 8.88: "comet is still impressive; coma 60′ × 50′ in size and elongated N-S; 7×50 B showed a central 'spine' within the parabolic-shaped coma (the spine was probably the former central cond., which was not evident anymore); comet reminded me of a jellyfish!; even naked eyes showed the N border of the comet sharper than the S" [KAR02]. Dec. 9.72: w/ 9×63 B, very large, very diffuse (DC = 1) coma of size 52′ × 60′ showing the same morphology as on Dec. 1 [KAM01]. Dec. 9.73: w/ 10×56 B, coma size ~ 56′ (DC = 2/) [BUS01]. Dec. 9.75: in 15.6-cm L (24×), coma dia. ~ 55′ × 75′, still fairly sharply defined in the solar direction, but totally diffuse in the anti-solar direction; very faint and diffuse tail, extending about 1°.3 from ill-defined central cond. in p.a. 165° [BOU]. Dec. 9.94: w/ naked eye, dia. ~ 1°.1, DC = 2 [PER01]. Dec. 9.99: comp. stars have $V = 3.77$ ($B–V = +0.40$) and 3.93 (+0.71) [GOI].

Dec. 10.88: w/ 15×80 B, round coma w/ elongated central cond. [SCH04]. Dec. 10.93: two 6th-mag stars in outer coma; w/ naked eye, dia. ~ 1°.1, DC = 3; three stars of mag 6.4-6.7 glimpsed around the comet [PER01]. Dec. 11.70: using 10×50 B, the comet showed a coma w/ a tail-like central region (roughly oriented N-S) and a 'U'-shaped outer coma; the surface brightness of the central part was fainter than the bulge of M31 but brighter than M33, while the intensity of the outer coma was comparable to M33; comet easily seen w/ naked eye and brighter than the combined glow of NGC 869 and NGC 884 [GRA04]. Dec. 11.76: still easily visible to naked eye as a large diffuse object w/ some cond.; brighter than M31 [BOU]. Dec. 11.81: in 25×100 B, inner brighter region extends 35′ from central cond. in p.a. 170°; broad tail-like feature extending 1°.2 from center in p.a. 170° [GON05]. Dec. 11.81: w/ 10×56 B, coma size ~ 58′ (DC = 2/) [BUS01]. Dec. 11.89: two 6th-mag stars in outer coma; w/ naked eye, dia. ~ 1°.1, DC = 2/; thin cirrus elsewhere in the sky [PER01]. Dec. 11.90: in 10×50 B and 20×60 B, coma dia. ~ 75′ × 60′ [GIL01]. Dec. 11.90: w/ 4×30 B, coma size 60′ × 75′ (DC = 2) [RIE]. Dec. 12.83: w/ 6.5×44 B, coma size ~ 57′ × 70′ (DC = 2/) [BUS01]. Dec. 13.04: stars of mag 5.5 and 6.7 in coma; w/ naked eye, dia. ~ 1°.1, DC = 2/ [PER01]. Dec. 13.05: w/ naked eye, the comet was easily visible due to a dark sky and appeared slightly larger and brighter than the Praesepe cluster (M44) [GRA04]. Dec. 13.63 and 15.60: diffuse and faint due to the light pollution in the large city Yokohama (very different from the view at the mountain location); yet, it is still visible w/ naked eyes [YOS04]. Dec. 13.78: in 7×50 B, large elongated object w/ dimensions of ~ 60′ × 70′; hint of a very faint tail extending some 1°.2 in p.a. 160° from very ill-defined central cond. [BOU]. Dec. 13.91, 15.95, 28.78, 2008 Jan. 1.96, 6.75, 8.79, and 13.97: "mag estimated by switching between my glasses for distance/reading" [KAM01]. 2007 Dec. 13.91: w/ 9×63 B, very large, very diffuse (DC = 1) coma of size 55′ × 70′, w/ unchanged morphology [KAM01]. Dec. 14.12: w/ naked eye, dia. ~ 75′, DC = 1/; several stars near the limit of naked-eye visibility in and around coma [PER01]. Dec. 14.12 and 15.16: comp. w/ γ, δ, and τ Per, and ϵ Cas [PER01].

Dec. 15.16: w/ naked eye, dia. ~ 1°.2, DC = 1 [PER01]. Dec. 15.78: w/ 15×80 B, round coma of size ~ 70′ and very weak dust tail in p.a. 165° [SCH04]. Dec. 15.90: w/ 6.5×44 B, coma size ~ 60′ × 75′ (DC = 2) [BUS01]. Dec. 15.95: w/ 9×63 B, very large, very diffuse (DC = 0/) coma of size 54′ × 68′ w/ unchanged morphology [KAM01]. Dec. 16.00: "coma's angular size estimated as 70′ × 55′ w/ naked eyes; similar to the double star cluster in brightness; the central jet along the major axis had become more diffuse and fainter since last week as seen with 7×50 B" [KAR02]. Dec. 16.13, 26.81, 27.88, 29.88, 30.93, 2008 Jan. 1.08, and 4.03: comp. w/ γ and τ Per, and ϵ Cas [PER01]. 2007 Dec. 16.13: in 5×22 monocular, coma edges are getting rather diffuse and ill-defined; w/ naked eye, dia. ~ 1°.2, DC = 2 [PER01]. Dec. 16.75: light pollution [HOR02]. Dec. 16.98: comp. stars have $V = 4.05$ ($B–V = +0.55$) and 3.93 (+0.71) [GOI]. Dec. 17.66 and 18.68: "extremely hard to observe comet in the large city of Yokohama; it is easier to see the comet w/ naked eyes than w/ 10×66 monocular due to its very large size; it is a strange experience to see a comet visible w/ naked eyes but difficult to find using a telescope" [YOS04]. Dec. 17.66: hazy sky caused difficulty in determining comet size [YOS04]. Dec. 17.89: using 6×30 R, surface brightness of comet markedly inferior to the central parts of M31 and M42; w/ naked eye, fairly easily seen and slightly brighter than the double cluster; first-quarter Moon [GRA04]. Dec. 17.91: w/ 6.5×44 B, coma size ~ 60′ × 70′ (DC = 2) [BUS01]. Dec. 18.51: *B–V* values of comp. stars were +0.53, +0.86, and +0.88 [NAG08]. Dec. 18.68: clear sky; comet obs. after moonset [YOS04]. Dec. 19.00: "I have no doubt that the 0.3-mag drop in m_1 in < 1 day is entirely due to the fact that the first-quarter moon is high in the sky tonight, whereas it was setting last night and the comet was much more easily seen then; the totally diffuse nature of the very extended coma makes it susceptible to quick drops in visibility as the sky-background brightness increases" [GRE]. Dec. 19.22: using naked eye, comet appeared slightly fainter than M44; w/ 3×18 R, the comet showed an oval coma of fairly low surface brightness; this instrument was constructed from a camera lens (Canon EF 70- to 200-mm-f.l. *f*/4 L) set at f.l. slightly more than 70-mm and w/ a 24-mm ocular (Televue Panoptic); this combination gave a sufficient amount of defocusing and a very wide field (> 20°) of good optical quality; dark sky (made a couple of hr after moonset) [GRA04].

◇ ◇ ◇

Wide-field CCD image by James McGaha on 2007 Dec. 31.1 showing comet 17P at upper left, the galaxy M31 at upper right, and comet 8P just below the galaxy M33 at bottom and right-of-center. McGaha used a a Canon 5D camera (+ 50-mm-f.l. f/1.4 lens; 600-sec exposure at ISO 800). Compare with the close-up image of comet 8P and M33 on page 31 of this issue of the ICQ. Image copyright 2007 by J. McGaha.

◇ ◇ ◇

Dec. 21.05: w/ 8×50 R, only faintly seen as a pale, oval object; the instrument was made from a 200-mm-f.l. *f*/4 camera lens w/ a 24-mm eyepiece; comet not detected w/ naked eye due to a quite-bright sky background in moonlight [GRA04]. Dec. 25.69: using 3×18 R and 7×50 B, comet was seen as an oval glow of low surface brightness (but somewhat higher than that of M33); 17P was also seen w/ naked eye despite a 16-day-old Moon low in E sky; obs. site at lat. 64° N [GRA04]. Dec. 25.71: w/ 10×50 B, coma dia. 72′ [HAS02]. Dec. 25.96: obs. made from reasonably dark skies in north-central Long Island (NY, U.S.A.), before moonrise; this obs. shows how low the surface brightness has gotten as the comet has spread out, and how faint the VBM method makes the comet; the comet was easily detected by naked eye, but unfortunately binoculars or other optical instruments were not available [GRE]. Dec. 26.78: in 25×100 B, coma of size 65′ × 90′ (elongated towards the diffuse S boundary); inner brighter region extends 38′ from central cond. in p.a. 150°; broad tail-like feature extending 2°.2 from center in p.a. 150°; obs. made before moonrise [GON05]. Dec. 26.81: w/ naked eye, dia. ~ 1°.1, DC = 1 [PER01]. Dec. 27.07: "overall coma now very pale and vague; this overall appearance has remained ever since (in fact, the coma has grown even more pale and vague)"; w/ 12×50 B, coma dia. 70′ [HAL]. Dec. 27.72: w/ 10×50 B, coma dia. 68′ [HAS02]. Dec. 27.88 and 29.88: "coma edges ill-defined; tab. dia. is a conservative estimate" [PER01]. Dec. 27.88: w/ naked eye, dia. ~ 70′, DC = 2/ [PER01]. Dec. 28.12: w/ naked eye, faintly visible and a more challenging object than M44, but clearly seen using 3×18 R; moonlight [GRA04]. Dec. 28.75: still very easily visible with naked eye; w/ 15×80 B, coma of size ~ 1°.2 × 1°.6; elongated central cond. of size ~ 1° in p.a. 160° [SCH04]. Dec. 28.78: w/ 9×63 B, very large, very diffuse (DC = 0) coma of size 55′ × 72′ (elongated along p.a. 155°), w/ now-totally-diffuse borders; central region no longer definitely distinguishable [KAM01]. Dec. 28.80: coma elongated toward p.a. 140° [MAR02]. Dec. 28.81, 29.90, 31.03, 2008 Jan. 1.01, 1.99, and 4.05: site of the IRAM telescope at Pico-Veleta, southern Spain [BIV]. 2007 Dec. 28.97: comp. stars have $V = 4.05$ ($B-V = +0.55$) and 4.11 (+0.44) [GOI]. Dec. 29.71: city lights [RZE]. Dec. 29.76: comet still easily visible w/ naked eye as a large, diffuse object w/ slight cond.; in 7×50 B, 17P appears more-or-less elliptical w/ very-ill-defined edges and rough dimensions of 60′ × 90′, elongated towards p.a. 145° [BOU]. Dec. 29.78: w/ 6.5×44 B, coma size ~ 65′ × 80′ (DC = 1/) [BUS01]. Dec. 29.87 and 30.83: obs. from Kongens Lyngby, Denmark [COM]. Dec. 29.88: thin cirrus elsewhere in the sky; average transparency; w/ naked eye, dia. ~ 65′, DC = 2/ [PER01]. Dec. 30.22: obs. made from usual location in suburban Boston, with it's light-polluted sky (plus snow cover), and w/ last-quarter moon rising in east; comet alt. ~ 45° in NW; though the comet was easy to see in binoculars, one really needs a dark sky now to properly estimate its brightness (thus the colon after the mag estimate, despite clear skies; the uncertainty of the mag estimate was perhaps ± 0.4 mag due to the extreme nature that the monocular's eyepiece must be defocussed) [GRE]. Dec. 30.44: very large and indistinct; brightness estimate little more than a guess [SEA]. Dec. 30.47 and 31.47: "extremely diffuse; uncertain how large the comet's coma extends due to light pollution (I only managed to see the faint nebulous patch around the position on Dec. 30 in a hazy sky; on Dec. 31, w/ a clear sky, the central bright part was clearly visible, extending elliptically" [YOS04]. Dec. 30.54: $B-V$ values of comp. stars were +0.60, +0.61, and +0.72 [NAG08]. Dec. 30.78: coma dia. ~ 1°.0 × 1°.5, elongated towards p.a. 145° [BOU]. Dec. 30.81: in 25×100 B, coma of size 75′ × 95′ (elongated towards the diffuse S boundary); inner brighter region extends 50′ from central cond. in p.a. 145°; broad tail-like feature extending 2°.5 from center in p.a. 145° [GON05]. Dec. 30.86: also faintly seen w/ naked eye; some light pollution from Oslo, otherwise favorable conditions; as a comparison to the 8P/M33 image taken this same night, this comet was also imaged (exp. 6 sec at ISO 800) using the same equipment (Canon EOS 400D camera + 100-mm-f.l. $f/2$ objective; field-of-view 13° × 8°.5) [GRA04]. Dec. 30.91: in 10×50 B, coma dia. ~ 85′ × 60′ [GIL01]. Dec. 30.93: w/ naked eye, dia. ~ 1°.3, DC = 2/ [PER01]. Dec. 30.93: "comet was a huge (1°.3 × 1°.0) ghostly stain of light in Perseus; appeared slightly fainter than the double star cluster; comet seen via naked eye together w/ comet 8P exactly at the same time; their separation was only 22°, so when I stared at a point between them and to the right of the connecting line, I could hold them both with averted vision — two short-period comets seen simultaneously without optical aid!" [KAR02]. Dec. 30.94: w/ 9×63 B, very large, extremely diffuse (DC = 0) coma of size 45′ × 75′ w/ very vague borders; central region not distinguishable [KAM01]. Dec. 31.10: simultaneously visible to naked eye along with comet 8P/Tuttle [HAL]. Dec. 31.10 and 2008 Jan. 2.11: w/ 12×50 B, coma dia. 65′ [HAL]. Dec. 31.38: very dark sky at sea level in Hawaii; easy naked-eye object [MOR]. Dec. 31.79: coma elongated toward p.a. 135° [MAR02].

2008 Jan. 1.08: "good transparency; in 5×22 monocular, the outer coma was suspected to 90′, yet was extremely vague beyond the tab. 60′ size; the sharp outline and parabolic shape apparent in current images is not perceived in the instrument used for the m_1 estimate; the comet is still an easy naked-eye object (dia. ~ 80′, DC = 2)" [PER01]. Jan. 1.83, 3.84, and 25.74: elliptical coma [HOR02]. Jan. 1.96: w/ 9×63 B, very large, extremely diffuse (DC = 0) coma of size 50′ × 75′ (major axis in p.a. 135°) w/o a definite central region [KAM01]. Jan. 2.80: w/ 4×30 B, coma size ~ 70′ × 85′ [RIE]. Jan. 3.18 and 31.08: obs. made from rural Hubbardston, MA, U.S.A. (central Massachusetts) under fairly dark skies; by late Jan., comet no longer visible from suburban Boston (site of most of earlier 17P observations by this observer) due to low surface brightness [GRE]. Jan. 3.46: "city light pollution caused comet to appear faint, which caused my fainter mag est." [YOS04]. Jan. 3.80: in 25×100 B, coma of size 80′ × 100′ (elongated towards the diffuse S boundary); inner brighter region extends 50′ from central cond. in p.a. 140°; broad tail-like feature extending 2°.5 from center in p.a. 140° [GON05]. Jan. 3.83: elongated coma w/ major axis directed towards ≈ 160°; visible to naked eye despite some light pollution [GRA04]. Jan. 3.97: w/ naked eye, coma dia. ~ 85′, DC = 1 [BOR]. Jan. 3.99 and 6.97: comp. stars have V = 4.31 ($B-V$ = −0.06) and 4.11 (+0.44) [GOI]. Jan. 4.03: "several stars in coma (the brightest being mag 6.6) hampering the DC estimate; the comet remains an easy naked-eye object (dia. ~ 1°.3, DC = 2)" [PER01]. Jan. 4.45: "very bright from a mountain location!; easy object w/ naked eyes, and extraordinarily large" [YOS04].

Jan. 5.83 and 6.82: w/ 2.5×30 B, coma size ~ 70′ × 85′ [BUS01]. Jan. 6.00: comp. stars have V = 3.80 ($B-V$ = +0.98) and 4.23 (+0.34); averted vision [AMO01]. Jan. 6.73, 7.72, and 8.81: w/ 3.5×15 O, coma dia. 70′ × 55′ [MEY]. Jan. 6.75: w/ 9×63 B, extremely large, extremely diffuse (DC = 0) coma of size 50′ × 80′ w/o a significant central region; w/ 30-cm T (75×), the coma showed as a large glow of low surface brightness, which faded very gradually into the sky background (a boundary could only be glimpsed in the NW sector); central region only marginally brighter w/o a recognizable center [KAM01]. Jan. 6.81: obs. at locatoin near sea level location, clear sky [GON05]. Jan. 6.88: w/ 7×50 B, strong central cond. [SCA02]. Jan. 7.80: comet size is ~ 1°.5 × 1°.8, elongated in p.a. 128° [DIJ]. Jan. 7.81: w/ 6.5×44 B, coma size ~ 70′ × 80′ (DC = 0/) [BUS01]. Jan. 7.97: comp. stars have V = 4.05 ($B-V$ = +0.59) and 4.11 (+0.44) [GOI]. Jan. 7.98: coma size 45′ × 80′; tail p.a. ≈ 145°; w/ naked eye, coma dia. ~ 90′, DC = 0/ [BOR]. Jan. 8.79: comet not immediately recognizable; w/ 9×63 B, extremely large, extremely diffuse (DC = 0); ill-defined coma of size 55′ × 75′ (major axis in p.a. 130°) w/o a significant central region [KAM01]. Jan. 8.97: comp. stars have V = 4.23 ($B-V$ = −0.06) and 4.11 (+0.44) [GOI]. Jan. 9.11 and 15.16: w/ 12×50 B, coma dia. 80′ [HAL]. Jan. 9.53: $B-V$ values of comp. stars were +0.51, +0.52, and +0.53 [NAG08]. Jan. 9.61: coma dia. 82′ × 77′, elongated in p.a. 120°-300° [NAG04]. Jan. 9.74: w/ 3.5×15 O, coma dia. 80′ × 55′ [MEY]. Jan. 9.76: very elongated, structureless object, close to Algol [COM]. Jan. 9.92: in 25×100 B, coma of size 70′ × 90′ (elongated towards the diffuse S boundary); broad tail-like feature extending 1°.8 from center in p.a. 130° [GON05]. Jan. 9.92 and 10.80: inner brighter region extends 35′ from central cond. in p.a. 130° [GON05]. Jan. 9.99: coma size 55′ × 80′; w/ naked eye, coma dia. ~ 85′, DC = 1 [BOR].

Jan. 10.45: very large and diffuse; some haze in sky [SEA]. Jan. 10.80: in 25×100 B, coma of size 70′ × 80′ (elongated towards the diffuse SE boundary) [GON05]. Jan. 11.74: "light pollution; comet was difficult to view via naked eye from the city of Vasteras (population 130000); being located near zenith made the obs. possible" [KAR02]. Jan. 11.86: obs. from Gatyska, Poleski National Park; used 3×24 B as monocular [PAR03]. Jan. 11.89: "comet visible as a faint glow and not detected w/ naked eye; obs. was challenging due to a rather bright sky background" [GRA04]. Jan. 11.98: w/ naked eye, coma size ≈ 2°, DC = 1; w/ 3×25 B, coma size ≈ 100′; w/ 10×50 B, coma size 1°.0 × 1°.5, DC = 2, extended toward p.a. 130° [BOR]. Jan. 12.03: "comp. w/ τ Per and ϵ Cas; coma extension difficult to assess, given the proximity to β Per (could be as large as 1°.4 — the tab. dia. being a conservative estimate); further, as the rather-ill-defined outer coma edges could translate into larger uncertainty in the m_1 estimate, I have been making additional m_1 estimates w/ different defocusings (to match the range of uncertainty in the coma dia.); nevertheless, I still get m_1 within ~ ± 0.1 mag of the value I report; the comet remains an easy naked-eye object (dia. ~ 1°.1, DC = 1) — in fact, it was even visible from indoors through a double-glazed glass window as I was beginning dark adaptation before going outside to make the obs." [PER01]. Jan. 12.76: w/ 3.5×15 O, coma dia. 70′ × 55′ [MEY]. Jan. 13.45: weak moonlight [SEA]. Jan. 13.90: comet very elongated; difficult — close to Algol, and some town light pollution; obs. from Kongens Lyngby, Denmark [COM]. Jan. 13.91: "large, very diffuse object, somewhat elongated towards ≈ p.a. 130°; nearby Algol is starting to to interfere" [BOU]. Jan. 13.97: comet rather difficult; w/ 9×63 B, extremely large, extremely diffuse (DC = 0) coma of size 50′ × 80′ [KAM01]. Jan. 15.16: first-quarter moon in sky [HAL]. Jan. 15.78: moonlight [PAR03]. Jan. 15.97: moonlight interference [SOU01]. Jan. 18.83: comp. w/ τ and π Per; Moon near comet, behind house; uncertainty in m_1 ± 0.2 mag, essentially due to ill-defined coma edges and comet being near limit of visibility [PER01].

◇ ◇ ◇

CCD image produced from seventeen co-added 30-sec exposures of comet 17P taken by S. Nakano on 2008 Jan. 5.588 UT with a 10.2-cm f/6.5 refractor (+ Canon Kiss digital camera); field-of-view is 114′ × 76′. The coma's size here is ~ 65′; note how it has become very diffuse with a much lower surface brightness, as compared to Nakano's image published on page 37 of this issue.

◇ ◇ ◇

Jan. 24.83: β Per hampering coma dia. and m_1 estimate; comet still seen with the naked eye; thin cirrus nearby [PER01]. Jan. 24.83, 25.87, and 26.81: comp. w/ γ, τ and π Per, plus ϵ Cas [PER01]. Jan. 24.98: comp. stars have V = 4.23 ($B-V$ = −0.06) and 4.94 (+0.07) [GOI]. Jan. 25.74: comet close to Algol [HOR02]. Jan. 25.77: very close to Algol [SCA02]. Jan. 25.80: w/ 2.5×30 B, coma larger than ~ 70′ × 75′ [BUS01]. Jan. 25.87: "β Per hampering est.; a small, non-stellar central cond. is visible; I took great care to check whether this was a ghost from β Per, and it is visible at the same location while moving the instrument around the field; this feature is similarly visible in 14×100 B and via naked eye, and there is no background star at the current position; maybe the fading coma (or the dimmed coma due to β Per) is leaving this inner area more prominent, by contrast; for many weeks the coma has looked very uniform, with a flat brightness profile in the 5×22 monocular, so tonight it was quite a dramatic change; thin cirrus nearby" [PER01]. Jan. 25.99: w/ 10×50 B, coma size ≈ 55′ × 70′, elongated in ≈ 130°; DC = 0 [BOR]. Jan. 26.76: "using 8×50 R and 7×50 B, the comet appeared as an elongated glow of about the same surface brightness as M33; this was not an easy obs. for several reasons — 17P's faint glow and location near Algol, some light pollution, and interference from high clouds; the comet was, however, seen w/ certainty, and also faintly detected using 3×18 R" [GRA04]. Jan. 26.81: "β Per no longer a significant nuisance; comet near limit of naked-eye visibility, whilst a nearby star of mag 6.0 (combined mag of double star) is easily seen" [PER01]. Jan. 26.83: in 25×100 B, coma of size 80′ × 105′ (elongated towards the diffuse SE boundary); inner brighter region extends 40′ from central cond. in p.a. 120° [GON05]. Jan. 28.92: comp. w/ τ and π Per, plus ϵ Cas; 25′ central cond. superimposed on an extraordinarily large and faint outer coma; star of mag 7 in coma, plus bright stars near edge; comet visible w/ naked eye [PER01]. Jan. 29.21: m_1 measurement not obtained due to poor sky conditions; w/ 12×50 B, coma dia. 55′ [HAL]. Jan. 29.74: coma dia. 85′ × 70′; easy w/ naked eye [MEY]. Jan. 30.76: still faintly visible w/ naked eye, next to Algol, as a very large and diffuse glow, somewhat elongated towards roughly p.a. 120° [BOU]. Jan. 31.00: w/ 10×50 B, coma size ≈ 60′ × 92′, elongated in ≈ 115°; DC = 0 [BOR]. Jan. 31.95: comp. chiefly with τ and π Per; large central cond. superimposed on a larger and fainter outer coma; stars of mag 6-7 around coma hampering dia. est.; comet visible w/ naked eye [PER01].

Feb. 1.10, 3.18, and 9.17: w/ 12×50 B, coma dia. 70′ [HAL]. Feb. 1.77: w/ 2.5×30 B, coma size ~ 65′ × 75′ [BUS01]. Feb. 2.09: w/ 15×70 B, coma size ≈ 65′ × 80′, elongated in ≈ 80°; DC = 0-1 [BOR]. Feb. 2.76: w/ 2.5×30 B, coma size ~ 70′ × 80′ [BUS01]. Feb. 6.87: difficult est. due to large, diffuse coma [SCH04]. Feb. 11.01: w/ naked eye, coma size ≈ 2°, DC = 0 [BOR].

◇ *Comet 29P/Schwassmann-Wachmann* ⟹ 2007 Nov. 3.63: "visible unexpectedly; diffuse, but not extremely faint" [YOS04]. Nov. 29.56, 2008 Jan. 5.51, and 16.65: `Guide 8.0` software used for comp.-star mags [YOS02]. Nov. 29.56: $B-V$ values of comp. stars were +0.54, +0.54, and +0.72 [YOS02]. Dec. 8.68 and 9.73: diffuse [YOS04]. Dec. 30.80: new outburst; comet virtually stellar; close to star of mag 13.9 (ref. TA) [BOU]. Dec. 30.80: no coma visible [DIJ]. Dec. 31.10: comp. stars have $V = 12.64$ and 13.18 [GOI]. Dec. 31.91: site of the IRAM telescope at Pico-Veleta (elev. 2900 m), southern Spain; outburst [BIV]. 2008 Jan. 3.87: "in evolution after the recent outburst"; comp.-star mags taken from Henden photometry near CD Gem [GON05]. Jan. 4.43: "large, moderately condensed, and easy to see" [YOS04]. Jan. 5.99: short tail curved clockwise [BAR06]. Jan. 7.12: comp. stars have $V = 12.58$ ($B-V = +0.26$) and 12.66 (−0.41) [GOI]. Jan. 13.85: new outburst; strongly condensed; mountain location, very clear sky [GON05]. Jan. 13.93: almost-stellar appearance, w/ only a hint of surrounding nebulosity [BOU]. Jan. 16.00: comp. stars have $V = 10.42$ ($B-V = +0.02$) and 11.43 (+0.67); moonlight [AMO01]. Jan. 16.65: $B-V$ values of comp. stars were +0.47, +0.54, and +0.54 [YOS02]. Jan. 27.89: "interesting coma, in evolution after the last three consecutive outbursts" [GON05].

◇ *Comet 46P/Wirtanen* ⟹ 2007 Nov. 3.42: "unexpectedly, it was already bright and large; clearly visible even at somewhat-low alt." [YOS04]. Nov. 7.92: motion checked during a 90-min period [GON05]. Nov. 7.92 and 2008 Jan. 29.82: mountain location, very clear sky [GON05]. Nov. 9.41: $B-V$ values of comp. stars were +0.63, +0.74, and +0.77 [YOS02]. Nov. 9.41, 2008 Jan. 1.39, and 5.44: `Guide 8.0` software used for comp.-star mags [YOS02]. Nov. 17.98: comp. stars have $V = 12.13$ ($B-V = +0.26$) and 12.91 [GOI]. Nov. 19.74: fan-like tail open in p.a. 60°-118° [BAR06]. Nov. 28.98: comp. stars have $V = 12.69$ ($B-V = -0.60$) and 12.39 [GOI]. Dec. 1.98: comp. stars have $V = 11.66$ ($B-V = +0.22$) and 12.48 [GOI]. Dec. 6.39: comp. star has $B-V = +0.50$ [TSU02]. Dec. 6.39, Dec. 26.44, and 2008 Jan. 2.42: `Guide 8.0` software used for comp.-star mags [TSU02]. Dec. 9.42: "very diffuse; I obs. comet while light snow was falling, and obs. was disturbed by clouds frequently" [YOS04]. Dec. 9.97: comp. stars have $V = 11.05$ ($B-V = +0.27$) and 11.59 (+0.41) [GOI]. Dec. 12.98: comp. stars have $V = 11.33$ ($B-V = +0.47$) and 12.04 (+0.72) [AMO01]. Dec. 14.97: comp. stars have $V = 11.29$ ($B-V = +0.37$) and 11.72 (+0.12) [AMO01]. Dec. 16.99 and 21.97: moonlight interference [GOI]. Dec. 16.99: comp. stars have $V = 10.57$ ($B-V = +0.42$) and 10.88 (+0.57) [GOI]. Dec. 18.42: $B-V$ values of comp. stars were +0.55, +0.55, and +0.72 [NAG08]. Dec. 18.42, 30.40, and Jan. 4.39: `StellaNavigator` ver. 8.1 software used for comp.-star mags [NAG08]. Dec. 21.97: comp. stars have $V = 10.52$ ($B-V = +0.77$) and 10.40 (+0.82) [GOI]. Dec. 26.41: `Guide 8.0` software used for comp.-star mags [NAG04]. Dec. 26.44: comp. star has $B-V = +0.68$ [TSU02]. Dec. 26.80: elongated coma [GON05]. Dec. 30.40: $B-V$ values of comp. stars were +0.66, +0.74, and +0.78 [NAG08]. 2008 Jan. 2.42: comp. star has $B-V = +0.43$ [TSU02]. Jan. 4.39: "surprisingly bright and large!; central cond. strong" [YOS04]. Jan. 5.98 and 6.97: comp. stars have $V = 8.95$ ($B-V = +0.43$), 9.21 (+0.12), and 9.53 (+0.48) [AMO01]. Jan. 8.02: comp. stars have $V = 8.95$ ($B-V = +0.43$) and 9.31 (+0.49) [AMO01]. Jan. 8.97: comp. stars have $V = 9.31$ ($B-V = +0.49$) and 9.41 (+0.31) [GOI]. Jan. 8.97: comp. stars have $V = 9.31$ ($B-V = +0.49$) and 10.01 (+0.81) [AMO01]. Jan. 15.97: comp. stars have $V = 9.87$ ($B-V = +0.54$) and 10.13 (+0.52); moonlight [AMO01]. Jan. 25.73: 9.1-mag star in coma [HOR02]. Jan. 26.81, 27.80, and 29.82: zodiacal light [GON05]. Jan. 30.97: comp. stars have $V = 7.74$ ($B-V = +0.27$) and 9.49 (+0.27) [GOI].

◇ *Comet 50P/Arend* ⟹ 2007 Nov. 2.55: `Guide 8.0` software used for comp.-star mags; $B-V$ values of comp. stars were +0.49, +0.88, and +0.93 [YOS02]. Nov. 29.97: round, condensed coma; conic-like tail open (near the head of comet) in p.a. 140°-222° [BAR06]. Dec. 8.65: visible w/ an excellent clear sky; very faint and small [YOS04]. Dec. 11.82: "very faint, small, somewhat-condensed object seen near expected position; checked Digitized Sky Survey image; no unambiguous motion detected over 40-min period, because comet moved very slowly (11″/hr); session terminated by incoming low cloud from the North Sea; comp. stars used from Henden sequence of GK Per" [BOU]. Dec. 26.52: `Guide 8.0` software used for comp.-star mags; comp. star has $B-V = +0.71$ [TSU02]. 2008 Jan. 4.50: "unexpectedly, the small, strongly condensed object was still visible" [YOS04]. Jan. 5.86: star-like central cond.; fan-like tail open in p.a. 44°-176° [BAR06].

◇ *Comet 74P/Smirnova-Chernykh* ⟹ 2007 Nov. 19.97: short tail curved anti-clockwise [BAR06]. 2008 Jan. 5.97: conic-like tail open in p.a. 239°-295° [BAR06].

◇ *Comet 93P/Lovas* ⟹ 2007 Nov. 3.44: `Guide 8.0` software used for comp.-star mags; $B-V$ values of comp. stars were +0.68, +0.77, and +0.83 [YOS02]. Nov. 3.47: "very bright and easy to see, probably because it was located overhead" [YOS04]. Nov. 3.89: comp.-star mags taken from Henden photometry near DZ Psc [GON05]. Nov. 20.00: fan-like tail open in p.a. 82°-180° [BAR06]. Nov. 30.55, Dec. 26.48, and 2008 Jan. 2.53: `Guide 8.0` software used for comp.-star mags [TSU02]. Nov. 30.55: comp. star has $B-V = +0.97$ [TSU02]. Dec. 5.50 and 9.48: `Guide 8.0` software used for comp.-star mags [MIY01]. Dec. 7.48 and 18.45: `StellaNavigator` ver. 8.1 software used for comp.-star mags [NAG08]. Dec. 7.48: $B-V$ values of comp. stars were +0.54, +0.62, and +0.83 [NAG08]. Dec. 8.50 and 9.47: moderately condensed, bright, and easy to see [YOS04]. Dec. 18.45: $B-V$ values of comp. stars were +0.82, +0.86, and +0.92 [NAG08]. Dec. 26.48: comp. star has $B-V = +0.58$ [TSU02]. 2008 Jan. 2.53: comp. star has $B-V = +0.42$ [TSU02]. Jan. 4.42: "still bright and easy to see" [YOS04]. Jan. 9.99: comp. stars have $V = 13.04$ and 13.26 [GOI].

◇ *Comet 96P/Machholz* ⟹ 2007 Apr. 15.10: *Guide 7.0* software used for comp.-star mags [SAN07]. Apr. 21.08: *Guide 8.0* software used for comp.-star mags [NAG09].

◇ *Comet 99P/Kowal* ⟹ 2007 Aug. 14.44: astrometric CCD images obtained w/ 50-cm Uppsala D show a 13″ moderately condensed circular coma of size 13″ and mag 17.4 [R. H. McNaught, Siding Spring Observatory, Australia].

◇ *Comet 110P/Hartley* ⟹ 2007 Nov. 3.66: not visible; through thin clouds [YOS04]. Nov. 20.01: comet close to star of mag 15.6 [BAR06]. Dec. 9.51: moderately condensed [YOS04]. Dec. 26.58: `Guide 8.0` software used for comp.-star mags; comp. star has $B-V = +0.42$ [TSU02]. 2008 Jan. 4.51: strongly condensed [YOS04].

⋄ *Comet 128P/Shoemaker-Holt* ⟹ 2008 Jan. 5.16: star-like central cond.; fan-like coma; comet close to star of mag 12.4 [BAR06].

⋄ *Comet 139P/Väisälä-Oterma* ⟹ 2008 Jan. 2.50: `Guide 8.0` software used for comp.-star mags; comp. star has $B-V = +0.42$ [TSU02].

⋄ *Comet 173P/Mueller* ⟹ 2008 Jan. 2.70: `Guide 8.0` software used for comp.-star mags; comp. star has $B-V = +0.59$ [TSU02].

⋄ *Comet 180P/2006 U3 (NEAT)* ⟹ 2007 Dec. 6.48-6.50: four stacked 30-sec CCD exposures with the Catalina 0.68-m D in Arizona in $3''$-$5''$ seeing show a $10''$ coma with a well-defined nuclear condensation and a broad, diffuse $10''$-$12''$ tail in p.a. 290° (mag 18.9-19.2); four stacked 1-min unfiltered exposures during Dec. 6.52-6.53 show the tail length to be $14''$-$16''$ (mag 18.5-19.0) [R. E. Hill, University of Arizona].

⋄ *Comet 188P/2007 J7 (LINEAR-Mueller)* ⟹ 2007 Nov. 3.43: not visible; close to an 11th-mag star [YOS04]. Nov. 30.45 and Dec. 26.44: `Guide 8.0` software used for comp.-star mags [TSU02]. Nov. 30.45: comp. star has $B-V = +0.86$ [TSU02]. Dec. 26.44: comp. star has $B-V = +0.44$ [TSU02].

⋄ *Comet 190P/2007 O2 (Mueller)* ⟹ 2007 Dec. 5.58 and 26.65: `Guide 8.0` software used for comp.-star mags [TSU02]. Dec. 5.58: comp. star has $B-V = +0.55$ [TSU02]. Dec. 26.65: comp. star has $B-V = +0.79$ [TSU02].

⋄ *Comet 191P/2007 N1 (McNaught)* ⟹ 2007 Nov. 3.48: `Guide 8.0` software used for comp.-star mags; $B-V$ values of comp. stars were +0.60, +0.74, and +0.91 [YOS02]. Nov. 17.11: nearby field stars checked via Digitized Sky Survey; comp.-star mags taken from Henden photometry near GRB 000911 [GON05]. Dec. 8.64 and 9.49: unexpectedly bright and clearly visible; motion confirmed during 3 hr on Dec. 8 [YOS04].

⋄ *Comet 192P/2007 T3 (Shoemaker-Levy)* ⟹ 2007 Dec. 26.39 and 2008 Jan. 2.38: `Guide 8.0` software used for comp.-star mags [TSU02]. 2007 Dec. 26.39: comp. star has $B-V = +0.56$ [TSU02]. 2008 Jan. 2.38: comp. star has $B-V = +0.48$ [TSU02]. Jan. 4.39: unexpectedly bright [YOS04]. Jan. 27.82: motion checked during a 40-min period; nearby field stars checked via Digitized Sky Survey; mountain location, very clear sky; zodiacal light [GON05].

⋄ *Comet C/2005 L3 (McNaught)* ⟹ 2007 Sept. 14.82: obs. from Alps in southern France (elev. 1400-2600 m) [BIV].

⋄ *Comet C/2006 K1 (McNaught)* ⟹ 2007 Dec. 11.54: astrometric CCD images obtained w/ 50-cm Uppsala D show a narrow tail $1'.0$ long in p.a. 220°, and a quite-asymmetric inner coma; total mag 16.0 [R. H. McNaught, Siding Spring Observatory, Australia].

⋄ *Comet C/2006 M4 (SWAN)* ⟹ 2006 Oct. 10.74, 14.75, and 26.73: *Guide 8.0* software used for comp.-star mags [MAJ01]. Oct. 31.45: obs. from Sihui, China; moonlight and thin clouds [XU]. Dec. 10.47: obs. from northern Guangzhou, China; extremely clear sky; slight light pollution in direction of comet (barely seen) [XU].

⋄ *Comet C/2006 OF$_2$ (Broughton)* ⟹ 2007 Nov. 2.43: `Guide 8.0` software used for comp.-star mags; $B-V$ values of comp. stars were +0.44, +0.50, and +0.88 [YOS02]. Nov. 3.40: difficult to see due to the hazy sky and a nearby 14th-mag star [YOS04]. Nov. 13.90: comp.-star mags taken from Henden photometry near HU Aqr [GON05]. Nov. 30.42: `Guide 8.0` software used for comp.-star mags; comp. star has $B-V = +0.31$ [TSU02]. Dec. 5.79: ephemeris from Minor Planet Center website; checked with Digitized Sky Survey; limiting stellar mag 15.5 [HAS02].

⋄ *Comet C/2006 P1 (McNaught)* ⟹ 2007 Jan. 12.57 and 14.53: daytime obs. w/ 25.6-cm L (42×, 84×), with interfering cirrus (bright background); rough comparison to Venus [BIV].

⋄ *Comet C/2006 Q1 (McNaught)* ⟹ 2007 Dec. 9.77: extremely low [YOS04]. Dec. 30.02: comp. stars have $V =$ 12.68 and 12.55; moonlight interference [GOI].

⋄ *Comet C/2006 S5 (Hill)* ⟹ 2007 Nov. 3.65: not visible through thin clouds; possibly affected by a nearby 14th-mag star [YOS04]. Nov. 17.08: nearby field stars checked via Digitized Sky Survey [GON05]. Nov. 17.08 and 2008 Jan. 27.93: comp.-star mags taken from Henden photometry near U Gem [GON05]. Dec. 8.70 and 9.74: fairly bright, clearly visible 2008 Jan. 4.49: near a star, but well visible [YOS04].

⋄ *Comet C/2006 VZ$_{13}$ (LINEAR)* ⟹ 2007 June 19.98 and July 8.89: *Guide 8.0* software used for comp.-star mags [MAJ01]. June 22.94, July 5.90, 7.86, 13.92, 15.90, 16.93, 17.91, 20.88, 23.92, and 25.86: *Guide 7.0* software used for comp.-star mags [SAN07]. July 7.94, 10.87, and 20.92: *Guide 8.0* software used for comp.-star mags [SZA]. July 11.95: *Guide 8.0* software used for comp.-star mags [TOT03].

⋄ *Comet C/2006 W3 (Christensen)* ⟹ 2007 Nov. 3.51: `Guide 8.0` software used for comp.-star mags; $B-V$ values of comp. stars were +0.44, +0.48, and +0.66 [YOS02]. Dec. 4.97: nearby field stars checked via Digitized Sky Survey; motion checked during a 90-min period; comp.-star mags taken from Henden photometry near BY Cam; mountain location, very clear sky [GON05]. Dec. 8.67: "unexpectedly bright; easily visible w/ an excellent clear sky" [YOS04]. 2008 Jan. 4.52: near a star [YOS04].

⋄ *Comet C/2007 E1 (Garradd)* ⟹ 2007 Apr. 7.95, 8.95, 12.82, and 13.85: *Guide 7.0* software used for comp.-star mags [SAN07]. Apr. 13.81: *Guide 8.0* software used for comp.-star mags [MAJ01 and NAG09].

◇ *Comet C/2007 E2 (Lovejoy)* ⟹ 2007 Apr. 4.81: low alt.; w/ 25-cm f/5 L + CCD, total mag 9.8 (ref: Tycho-2 cat.), coma dia. 3'.5, no tail; astrometric obs. contributed to Minor Planet Center [KAD02]. Apr. 14.08, 27.92, May 9.85, and 12.89: *Guide 7.0* software used for comp.-star mags [SAN07]. Apr. 16.08: *Guide 8.0* software used for comp.-star mags [NAG09]. Apr. 17.04, 20.04, May 7.87, and 12.88: *Guide 7.0* software used for comp.-star mags [MAJ01]. Apr. 26.95 and May 17.02: *Guide 8.0* software used for comp.-star mags [TOT03]. Apr. 27.04: *Guide 7.0* software used for comp.-star mags [SAR02].

◇ *Comet C/2007 F1 (LONEOS)* ⟹ 2007 Sept. 19.82: w/ 25-cm f/5 L + CCD, in twilight and at low alt., through clouds; total mag $\approx$ 10.6, coma dia. 1'.5, no tail; astrometric obs. contributed to Minor Planet Center [KAD02]. Oct. 4.78: coma elongated in p.a. 350° [BUS01]. Oct. 13.72, 19.73, and 21.73: very low; light pollution [HOR03]. Oct. 15.73 and 19.72: low; dusk [HOR02]. Oct. 15.73: very low [HOR03]. Oct. 15.73: low alt.; twilight [SRB]. Oct. 18.74: only faintly seen due to twilight (solar alt. $\sim -13°$) and light pollution [GRA04]. Nov. 6.42: tail very faint and indefinite; comet somewhat brighter with Swan-band filter [SEA]. Nov. 6.95: comp. stars have $V = 6.58$ ($B-V = +0.10$), 6.90 (+0.07), and 6.72 (+0.67) [GOI]. Nov. 8.94: comp. stars have $V = 6.64$ ($B-V = +0.14$) and 6.90 (+0.33) [AMO01]. Nov. 9.44: "comet in outburst!; tail distinct and impressive; first $40'$ very obvious" [SEA]. Nov. 9.94: comp. stars have $V = 7.85$ ($B-V = +0.04$) and 8.32 (+0.39) [GOI]. Nov. 9.95: clouds interfering; comet alt. $\sim 8°$ [SOU01]. Nov. 10.43: "comet and tail dramatically fainter than on previous evening; in 25.4-cm L (71×, 114×), no definite central cond., but the brighter center of coma may have been slightly elongated $\perp$ to axis of tail; there appeared to be a slighter brighter 'spine' in tail" [SEA]. Nov. 10.94: clouds interfering [SOU01]. Nov. 10.95: comp. stars have $V = 7.40$ ($B-V = +0.46$) and 8.32 (+0.11) [GOI]. Nov. 15.96: comp. stars have $V = 7.87$ ($B-V = +0.09$) and 8.06 (+0.05) [AMO01]. Nov. 17.95: comp. stars have $V = 8.14$ ($B-V = +0.50$) and 8.42 (+0.15) [GOI]. Nov. 19.96: comp. stars have $V = 8.77$ ($B-V = +0.65$) and 9.10 (+0.46); moonlight [AMO01]. Nov. 20.96: comp. stars have $V = 8.18$ ($B-V = +0.35$) and 8.55 (+0.07) [GOI]. Nov. 20.96 and 23.94: moonlight interference [GOI]. Nov. 23.94: comp. stars have $V = 8.96$ ($B-V = -0.02$) and 9.04 (+0.22) [GOI]. Nov. 27.96: comp. stars have $V = 9.50$ ($B-V = +0.36$) and 9.27 (+0.27) [GOI]. Nov. 28.95: comp. stars have $V = 9.58$ ($B-V = +0.60$) and 9.27 (+0.27) [GOI]. Nov. 30.96: comp. stars have $V = 8.98$ ($B-V = +0.27$) and 9.87 (+0.12) [AMO01]. Dec. 1.96: comp. stars have $V = 9.78$ ($B-V = +0.63$) and 10.38 (+0.07) [GOI].

◇ *Comet P/2007 H1 (McNaught)* ⟹ 2007 Nov. 3.45: "difficult to see due to the hazy sky; perhaps the comet has faded" [YOS04]. Nov. 3.46: `Guide 8.0` software used for comp.-star mags; $B-V$ values of comp. stars were +0.49, +0.50, and +0.67 [YOS02]. Nov. 3.91: comp.-star mags taken from Henden photometry near WW Cet [GON05]. Nov. 30.49: `Guide 8.0` software used for comp.-star mags; comp. star has $B-V = +0.49$ [TSU02]. Dec. 8.48 and 9.45: "faint, but still easy to see" [YOS04].

◇ *Comet C/2007 P1 (McNaught)* ⟹ 2007 Aug. 14.82: five stacked 60-sec astrometric CCD images obtained w/ 50-cm Uppsala D show a very diffuse coma $\sim 20''$ across w/ total mag 18, extended in p.a. 340° [R. H. McNaught, Siding Spring Observatory, Australia].

◇ *Comet C/2007 Q3 (Siding Spring)* ⟹ 2007 Dec. 28.54: astrometric CCD images obtained w/ 50-cm Uppsala D show a $15''$ tail in p.a. 315° and total mag 16.6 [R. H. McNaught, Siding Spring Observatory, Australia].

◇ *Comet C/2007 T1 (McNaught)* ⟹ 2007 Nov. 6.43: comet somewhat enhanced through Swan-band filter [SEA]. Nov. 9.96: comp. stars have $V = 9.97$ ($B-V = +0.04$) and 10.26 (+0.39) [GOI]. Nov. 17.94: comp. stars have $V = 9.63$ ($B-V = +0.51$) and 9.79 (+0.51) [GOI]. Dec. 29.32 and 30.32: moonlight interference [GOI]. Dec. 29.32: comp. stars have $V = 9.21$ ($B-V = +0.10$) and 8.66 (+0.82) [GOI]. Dec. 30.32: comp. stars have $V = 9.15$ ($B-V = +0.38$) and 8.91 (+0.09) [GOI]. 2008 Jan. 6.31: comp. stars have $V = 7.26$ ($B-V = +0.37$) and 8.76 (+1.03) [AMO01]. Jan. 7.30 and 9.26: comp. stars have $V = 7.82$ ($B-V = +0.18$) and 8.77 (+0.31) [AMO01]. Jan. 8.31: comp. stars have $V = 8.63$ ($B-V = +0.41$) and 7.82 (+0.18) [GOI]. Jan. 10.30: comp. stars have $V = 8.14$ ($B-V = +0.24$) and 9.14 (+0.38) [GOI]. Jan. 28.03: comp. stars have $V = 8.54$ ($B-V = +0.08$) and 9.85 (+0.41) [AMO01]. Jan. 30.10: comp. stars have $V = 9.18$ ($B-V = +0.10$) and 8.65 (+0.34) [GOI].

◇ *Comet P/2007 T2 (Kowalski)* ⟹ 2007 Nov. 7.45: w/ 70-cm reflector + CCD, no discernible nucleus; object has a long, narrow and evenly intense coma [G. Hug, Eskridge, KS, U.S.A.].

◇ *Comet P/2007 V1 (Larson)* ⟹ 2007 Dec. 26.56: `Guide 8.0` software used for comp.-star mags; comp. star has $B-V = +0.90$ [TSU02].

◇ *Comet C/2007 W1 (Boattini)* ⟹ 2007 Dec. 9.84: `Guide 8.0` software used for comp.-star mags; $B-V$ values of comp. stars were +0.56, +0.58, and +0.73 [YOS02]. 2008 Jan. 5.16: drop-shaped coma; short, straight tail [BAR06].

◇ ◇ ◇

ICQ Website Notes

In addition to posting all of the tabulated *ICQ* data now at the *ICQ* website, we are posting more and more articles and other items that appear in this printed version. Note also that there is a webpage devoted to comet 17P/Holmes with numerous images posted there, including scanned images of photographs taken E. Barnard during the comet's 1892 outburst, which show a remarkable similarity to the comet's morphology at its 2007 outburst — indicating that the same process causing the outbursting is at work over more than a century. – *Ed.*

Key to observers with observations published in this issue, *with 2-digit numbers between Observer Code and Observer's Name indicating source [16 = Japanese observers (via Akimasa Nakamura, Kuma, Ehime); 32 = Hungarian observers (via Krisztián Sárneczky, Budapest); etc.]:*

AM001	35	Alexandre Amorim, Brazil
BAR06	37	Alexandr R. Baransky, Ukraine
BIV		Nicolas Biver, France
BOH02	18	Jerzy Bohusz, Gdynia, Poland
BOR		John E. Bortle, NY, U.S.A.
BOU		Reinder J. Bouma, Netherlands
BRU	42	Ivan S. Brukhanov, Belarus
BUS01	11	E. P. Bus, The Netherlands
CHE03	33	Kazimieras T. Cernis, Lithuania
*CHE09		Dmitry Chestnov, Moscow, Russia
CHR	18	A. Chrapek, Pikulice, Poland
COM	11	Georg Comello, The Netherlands
CRE01		Phillip J. Creed, OH, U.S.A.
DER	18	Oskar Deren, Poland
DES01		Jose G. de Souza Aguiar, Brazil
DIE02		Alfons Diepvens, Belgium
DIJ		Edwin van Dijk, The Netherlands
DOR02	18	Dariusz Dorosz, Poland
FIL04	18	Marcin Filipek, Poland
GIA01		Antonio Giambersio, Italy
GIL01	11	Guus Gilein, The Netherlands
GOB01		Franck Gobet, Cestas, France
*GOI		Marco A. C. Goiato, Brazil
GON05		Juan Jose Gonzalez, Spain
GON06		Virgilio Gonano, Udine, Italy
GRA04	24	Bjoern Haakon Granslo, Norway
GRE		Daniel W. E. Green, U.S.A.
HAD01	32	Csaba Hadházi, Hungary
HAL		Alan Hale, U.S.A.
HAS02		Werner Hasubick, Germany
HOR02	23	Kamil Hornoch, Czech Republic
HOR03	23	Petr Horalek, Czech Republic
IVA03	37	Vladimir M. Ivanov, Russia
*IWA03		Yoshitaka Iwashiro, Japan
JAR02	18	Maciej Jarmoc, Bialystok, Poland
KAD02	16	Ken-ichi Kadota, Ageo, Japan
KAM01		Andreas Kammerer, Germany
KAN	06	Kiyotaka Kanai, Isesaki, Japan
KAR02	21	Timo Karhula, Virsbo, Sweden
KIS03	18	Adam Kisielewicz, Poland
KOR01	19	Valeriy L. Korneev, Russia
KOU	23	Jakub Koukal, Czech Republic
KOZ02	42	Alexandr Kozlovski, Russia
KWI	18	Maciej Kwinta, Krakow, Poland
LAB02		C. Labordena, Castellon, Spain
LEG	18	Marian Legutko, Gliwice, Poland
LEH		Martin Lehky, Czech Republic
LIN04		Michael Linnolt, HI, U.S.A.
MAJ01	32	L. Majzik, Tápióbicske, Hungary
MAN02	23	Roman Maňák, Lipov, Czech Rep.
MAR02	13	Jose Carvajal Martinez, Spain
MAR12	18	Leszek Marcinek, Poland
MCA		S. J. McAndrew, NSW, Australia
MCG		James McGaha, Tucson, AZ, U.S.A.
MEY	28	Maik Meyer, Germany
MIT	16	Shigeo Mitsuma, Honjo, Japan
MIY01	16	Osamu Miyazaki, Ishioka, Japan
MOM	16	Masahiko Momose, Shiojiri, Japan
MOR		Charles S. Morris, U.S.A.
MOR09		Philippe Morel, France
NAG04	16	Kazuro Nagashima, Nara, Japan
NAG08	16	Yoshimi Nagai, Gunma, Japan
NAG09	32	Miklós Nagy, Csenger, Hungary
NEV	42	Vitali S. Nevski, Belarus
NOV01		Artyom O. Novichonok, Russia
OME	05	Stephen O'Meara, MA, U.S.A.
PAR03	18	Mieczyslaw L. Paradowski, Poland
PER01		Alfredo J. S. Pereira, Portugal
PIL01		Uwe Pilz, Leipzig, Germany
POW01	18	Jacek Powichrowski, Poland
QVA	24	Jan Qvam, Borrevannet, Norway
RIE	11	Hermanus Rietveld, Netherlands
ROB06		Walter Ruben Robledo, Argentina
RZE	18	Zbigniew Rzepka, Lublin, Poland
SAN07	32	G. Sánta, Kisujszállás, Hungary
SAR02	32	K. Sárneczky, Budapest, Hungary
SCA02		Toni Scarmato, Calabria, Italy
SCH04	11	Alex H. Scholten, Netherlands
*SCH16		Richard D. Schwartz, WA, U.S.A.
SCI		Tomasz Sciezor, Poland
SEA	14	David A. J. Seargent, Australia
SEM02	42	Andrey S. Semenyuta, Kazakstan
SER	42	Ivan M. Sergey, Belarus
SHU	42	Sergey E. Shurpakov, Belarus
SIC01	18	Zbigniew Siciarz, Poland
SIK01	18	Mieczyslaw Sikora, Poland
SIW	18	Ryszard Siwiec, Poland
SKI	24	Oddleiv Skilbrei, Norway
SMY	18	Jaroslaw Smyslo, Poland
SOU01	35	Willian C. de Souza, Brazil
SPE01	18	Jerzy Speil, Poland
SRB	23	Jiri Srba, Vsetin, Czech Rep.
SWI	18	Mariusz Swietnicki, Poland
SWI01	18	Stanislaw Swierczynski, Poland
SZA		Sándor Szabó, Sopron, Hungary
TOT03	32	Zoltán Tóth, Hungary
TSU02	16	Mitsunori Tsumura, Japan
URB01	23	Ľubomír Urbančok, Slovak Rep.
WHE01		Russell O. Wheeler, OK, USA
XU		Wentao Xu, Guangzhou, China
YOS02	16	Katsumi Yoshimoto, Hirao, Japan
YOS04	16	S. Yoshida, Kanagawa, Japan
ZAN01	11	W. T. Zanstra, The Netherlands

NOTE: *The tabulated CCD data summary begins on page 56 of this issue.*

◇ ◇ ◇

Tabulated Visual-Data Summary

As begun the July 2007 issue, we now publish summaries of contributed tabulated data instead of publishing each line of observation that is contributed to the *ICQ*; the following format serves the purpose of summarizing all the comets that had data reported with their observational arcs for each observer. The full 80-character observation records are posted at the *ICQ* website (`http://www.cfa.harvard.edu/icq/icqobs.html`), and are available upon request by e-mail to the *ICQ* Editor.

The tabulation below lists, for each comet, the first and last observation (with associated total visual magnitude estimate) for each observer, listed in alphabetical order of the observers within each comet's listing (the usual 3-letter, 2-digit observer code coming under the column `Obs.`, whose key is provided above). The final column (separated by a slash, /, from the observer code) provides the number of individual 80-character observation records entered into the *ICQ* archive from that observer for the particular comet for this issue; when only one observation was submitted by a specific observer for a given comet, the last column is left blank (with no slash mark after the observer code).

Comet 2P/Encke

First Date UT	Mag.	Last Date UT	Mag.	Obs. / No.
2007 04 04.78	8.0:	2007 04 14.79	7.0:	DOR02/ 4
2007 02 18.76	12.1			PAR03
2007 04 08.77	8.3	2007 04 14.78	7.7	SAN07/ 3

Comet 4P/Faye

First Date UT	Mag.	Last Date UT	Mag.	Obs. / No.
2006 08 24.99	11.9	2006 08 26.94	12.1	BOH02/ 2
2006 12 15.72	11.5	2007 01 19.74	12.0	CHR / 6
2006 08 20.01	11.5:	2006 12 19.84	11.0:	DOR02/ 21
2006 09 15.89	11.6	2007 02 17.79	12.5:	FIL04/ 22
2006 09 26.88	11.7			JAR02
2006 10 19.93	10.6	2006 11 16.80	10.7	KWI / 4
2006 07 29.01	12.2:	2007 02 16.86	12.0	PAR03/ 19
2006 08 27.92	12.5	2006 09 23.91	11.2	POW01/ 4
2006 09 15.93	11.9:	2006 12 14.82	11.5:	SCI / 23
2006 09 23.87	11.1			SIC01
2007 03 06.78	12.6	2007 04 14.82	14.4	TOT03/ 4

Comet 8P/Tuttle

First Date UT	Mag.	Last Date UT	Mag.	Obs. / No.
2008 01 01.02	6.4	2008 01 28.03	6.4	AMO01/ 15
2007 09 14.88	15.2:	2008 01 12.79	7.1:	BIV / 16
2007 11 30.00	10.5	2008 01 11.99	5.5	BOR / 15
2007 11 15.04	10.3	2008 01 13.77	6.1	BOU / 17
2007 11 11.85	10.5:	2008 01 07.77	5.8	BUS01/ 15
2007 12 29.84	6.2	2008 01 04.71	6.0	CHE03/ 2
2008 01 03.63	5.9			CHE09
2007 12 08.12	9.0:	2008 01 09.76	5.9	COM / 5
2007 12 11.86	8.6	2008 01 07.94	5.9	DIE02/ 10
2007 12 05.95	9.0	2008 01 09.78	5.7	DIJ / 14
2007 11 16.99	10.2	2007 12 30.91	5.8	GIL01/ 4
2007 12 28.97	6.2	2008 01 29.98	6.7	GOI / 9
2007 11 03.85	12.1	2008 01 29.79	6.5	GON05/ 24
2007 12 28.85	6.5			GON06
2007 11 09.96	11.8	2008 01 03.83	5.7	GRA04/ 10
2007 12 13.23	7.8	2008 01 04.14	6.1	GRE / 2
2007 11 28.72	10.5	2008 01 08.79	5.7	HAS02/ 9
2007 11 27.72	9.3	2008 01 08.86	5.2	HOR02/ 10
2007 12 08.93	8.3	2007 12 29.74	5.8	HOR03/ 5

Comet 8P/Tuttle [cont.]

First Date UT	Mag.	Last Date UT	Mag.	Obs. / No.
2008 01 02.46	5.6			IWA03
2007 11 28.77	10.0	2008 01 13.75	6.2	KAM01/ 11
2007 12 08.78	8.8	2008 01 11.74	6.2	KAR02/ 4
2008 01 01.71	5.7	2008 01 02.88	5.7	KOR01/ 2
2007 11 01.83	13.1	2008 01 12.77	5.8	LAB02/ 6
2007 11 28.81	9.2	2008 01 08.71	5.5	LEH / 3
2008 01 06.22	5.7	2008 01 27.23	7.4	LIN04/ 2
2007 11 10.81	11.2	2007 12 31.80	5.7	MAR02/ 3
2007 12 01.88	9.3	2008 01 09.76	5.9	MEY / 10
2007 12 05.53	9.9	2008 01 06.39	5.9	MIT / 12
2007 12 05.49	10.4	2008 01 15.46	5.6	MIY01/ 10
2008 01 02.50	6.3			MOM
2007 12 31.38	6.0	2008 01 03.34	6.0	MOR / 3
2007 12 05.64	10.0	2008 01 09.59	6.5	NAG04/ 5
2007 12 03.43	9.5	2008 01 13.39	5.8	NAG08/ 11
2007 11 17.90	10.6	2008 01 14.71	6.1	NEV / 6
2007 12 01.79	9.5:	2008 01 04.65	5.9	NOV01/ 8
2007 11 02.89	11.6	2008 01 12.80	5.9	PAR03/ 7
2007 12 09.71	7.9	2008 01 07.82	5.7	PIL01/ 4
2008 01 02.81	5.6	2008 01 06.77	5.5	RIE / 3
2007 11 11.81	10.6	2008 01 12.75	6.2	SCH04/ 19
2007 12 30.43	6.0	2008 01 27.44	6.7	SEA / 7
2008 01 01.75	7.2	2008 01 03.70	7.0	SEM02/ 2
2008 01 04.77	6.5	2008 01 05.70	6.4	SER / 2
2008 01 02.64	5.9	2008 01 14.72	6.4	SHU / 7
2007 12 27.99	6.5	2008 01 10.06	5.9	SOU01/ 3
2007 12 16.62	9.9	2008 01 04.49	6.0	TSU02/ 3
2008 01 01.68	5.8			XU
2007 11 18.72	11.0	2008 01 05.46	5.7	YOS02/ 9
2007 11 03.43	13.1	2008 01 06.47	5.6:	YOS04/ 12
2007 12 29.77	5.6	2008 01 07.77	5.9	ZAN01/ 4

Comet 17P/Holmes

First Date UT	Mag.	Last Date UT	Mag.	Obs. / No.
2007 11 01.08	3.3	2008 01 06.00	4.0:	AMO01/ 15
2007 10 24.83	2.8	2008 01 12.77	3.7	BIV / 53
2007 10 26.07	2.7	2008 02 11.01	4.3	BOR / 87
2007 11 03.87	2.5	2008 01 30.76	4.1	BOU / 38
2007 10 30.71	2.9	2007 11 02.82	2.9	BRU / 4
2007 10 29.87	2.3	2008 02 10.77	4.4	BUS01/ 56
2007 11 02.67	2.4	2008 01 04.80	4.0:	CHE03/ 14
2007 10 24.87	2.9	2008 01 01.66	4.0	CHE09/ 2
2007 11 04.90	2.7	2008 01 13.90	4.2	COM / 14
2007 11 04.20	2.6	2007 12 27.04	3.4	CRE01/ 2
2007 11 06.14	2.5	2008 01 06.75	3.6	DIE02/ 27
2007 11 03.87	2.4	2008 01 30.96	4.1	DIJ / 58
2007 11 03.87	2.6	2007 11 05.87	2.6	GIA01/ 2
2007 11 03.82	2.6	2008 01 12.75	3.7	GIL01/ 19
2007 11 02.90	2.9	2007 11 21.85	3.8	GOB01/ 13
2007 11 18.15	3.4	2008 03 26.95	5.8	GOI / 19
2007 11 01.79	2.3	2008 04 23.92	[6.2	GON05/ 49
2007 11 14.80	3.0	2007 11 26.80	3.7	GON06/ 2
2007 11 01.08	2.3	2008 02 09.82	4.1	GRA04/ 32
2007 11 01.22	2.5	2008 02 12.16	4.6	GRE / 35
2007 05 23.43	[14.0:	2008 02 09.17	4.0	HAL / 27
2007 10 28.92	2.5	2008 02 02.77	4.3	HAS02/ 21
2007 10 31.79	2.5	2008 01 25.74	4.3	HOR02/ 35
2007 10 27.00	2.1	2007 12 29.75	3.3	HOR03/ 22
2007 11 07.71	2.4	2008 01 05.65	3.5	IVA03/ 22
2007 11 01.90	2.5	2008 01 13.97	4.2	KAM01/ 18
2007 10 27.80	2.6	2007 12 30.49	3.5	KAN / 37
2007 11 01.76	2.2	2008 01 11.74	3.8:	KAR02/ 9

Comet 17P/Holmes [cont.]

First Date UT	Mag.	Last Date UT	Mag.	Obs. / No.
2008 01 01.68	3.4	2008 01 02.84	3.5	KOR01/ 2
2007 10 26.78	2.9:	2007 11 26.87	3.6:	KOU / 27
2007 10 24.71	2.8	2007 10 30.63	2.5	KOZ02/ 6
2007 10 25.89	2.5	2008 01 27.78	3.8	LAB02/ 22
2007 10 27.76	2.6	2008 02 27.79	4.8	LEH / 31
2007 10 31.90	2.5	2007 11 27.81	3.4:	MAN02/ 8
2007 11 01.92	2.4	2007 12 31.79	3.4	MAR02/ 6
2007 11 06.73	2.6	2008 01 29.74	4.0	MEY / 35
2007 11 03.62	2.5	2008 01 26.47	5.2	MIT / 42
2007 11 03.46	2.4	2008 03 08.49	5.8	MIY01/ 47
2007 10 29.11	2.0	2007 12 31.38	2.9	MOR / 20
2007 11 06.07	2.6	2007 12 15.98	3.2	MOR09/ 20
2007 11 02.60	2.7	2008 02 10.61	5.9	NAG04/ 8
2007 11 03.60	2.7	2008 03 05.42	5.5:	NAG08/ 47
2007 11 02.68	2.6	2008 02 03.72	4.8	NEV / 9
2007 10 31.91	2.7	2008 01 04.65	3.9	NOV01/ 17
2007 10 27.25	2.9	2008 02 29.25	4.6	OME / 17
2007 10 31.74	2.4	2008 03 26.80	5.5:	PAR03/ 45
2007 11 01.96	2.4	2008 03 06.95	5.2	PER01/ 77
2007 11 06.72	2.4	2008 01 07.79	3.4	PIL01/ 13
2007 11 07.96	2.8	2007 11 16.79	3.5	QVA / 2
2007 10 29.77	2.4	2008 02 02.79	4.1	RIE / 22
2007 10 31.81	3.0	2007 12 29.71	4.0:	RZE / 18
2007 10 24.83	2.6	2007 12 14.82	2.8	SCA02/ 34
2007 10 30.10	2.4	2008 02 10.92	4.9	SCH04/ 44
2007 11 10.55	2.8	2008 02 09.44	4.7	SEA / 11
2007 10 24.93	2.5	2008 01 05.77	4.5	SER / 10
2007 10 30.64	2.7	2008 01 14.72	4.1	SHU / 16
2007 11 01.04	2.1	2007 11 12.97	2.7	SKI / 4
2007 11 01.15	2.5	2008 01 15.97	4.2:	SOU01/ 25
2007 10 31.52	2.1	2007 12 05.52	3.0	TSU02/ 6
2007 10 29.76	2.3	2007 11 06.75	3.2	URB01/ 4
2007 10 31.43	2.5	2007 11 16.42	3.3	WHE01/ 12
2007 10 26.84	2.4	2007 11 28.63	3.3	XU / 6
2007 11 01.80	2.6	2008 03 10.55	5.7	YOS02/ 35
2007 11 03.48	2.1	2008 03 05.45	4.7	YOS04/ 48
2007 10 30.74	2.1	2008 02 11.92	6.2	ZAN01/ 40

Comet 29P/Schwassmann-Wachmann

First Date UT	Mag.	Last Date UT	Mag.	Obs. / No.
2008 01 16.00	11.0:			AMO01
2007 12 30.89	12.7	2007 12 31.91	12.4	BIV / 3
2007 12 30.80	13.3	2008 01 30.86	11.9	BOU / 3
2007 12 30.80	13.6			DIJ
2007 02 06.83	12.5:			DOR02
2006 10 17.91	11.7			FIL04
2008 01 07.12	12.6			GOI
2008 01 03.87	12.2	2008 01 27.89	11.6	GON05/ 4
2007 11 03.00	[15.7			MAR02
2008 01 14.90	11.3			NEV
2007 02 16.89	12.2	2008 01 11.89	11.8	PAR03/ 5
2007 03 11.84	13.5	2007 04 08.81	13.6	TOT03/ 2
2008 01 05.51	12.7			YOS02
2007 11 03.63	14.2	2008 01 04.43	12.8	YOS04/ 4

Comet 46P/Wirtanen

First Date UT	Mag.	Last Date UT	Mag.	Obs. / No.
2007 12 12.98	11.5	2008 01 15.97	9.8	AMO01/ 9
2007 12 30.81	12.6:			BIV
2007 12 11.75	10.8	2008 01 30.76	8.7	BOU / 4

Comet 46P/Wirtanen [cont.]

First Date UT	Mag.	Last Date UT	Mag.	Obs. / No.
2008 01 06.75	9.7			DIE02
2007 11 17.98	12.5	2008 01 30.97	8.6	GOI / 8
2007 11 07.92	12.7	2008 01 29.82	8.6	GON05/ 14
2007 11 28.71	11.3	2007 12 05.78	10.9	HAS02/ 2
2008 01 25.73	8.7	2008 02 03.80	8.8	HOR02/ 2
2008 02 02.82	8.9	2008 02 09.77	8.9	HOR03/ 4
2007 11 10.79	12.1	2008 01 27.79	8.9	LAB02/ 3
2008 01 25.81	8.9			LEH
2007 11 02.82	[15.2			MAR02
2008 01 29.73	8.9			MEY
2007 12 26.41	11.0			NAG04
2008 01 04.39	9.3			NAG08
2008 01 04.68	9.5			NEV
2007 12 22.72	10.0:	2008 01 04.77	9.4:	PAR03/ 3
2008 01 06.78	9.3	2008 01 09.76	8.8	SCH04/ 2
2007 12 10.46	10.4	2008 01 10.46	9.4	SEA / 3
2008 01 03.72	9.8	2008 01 06.71	9.5	SHU / 3
2007 12 05.43	12.0	2008 01 05.44	9.4	YOS02/ 3
2007 11 03.42	13.7	2008 01 04.39	9.6	YOS04/ 3

Comet 50P/Arend

First Date UT	Mag.	Last Date UT	Mag.	Obs. / No.
2007 12 11.82	14.5:			BOU
2007 11 02.96	[15.6			MAR02
2007 12 08.65	15.0	2008 01 04.50	14.6	YOS04/ 3

Comet 76P/West-Kohoutek-Ikemura

First Date UT	Mag.	Last Date UT	Mag.	Obs. / No.
2006 12 03.19	12.7:			PAR03

Comet 87P/Bus

First Date UT	Mag.	Last Date UT	Mag.	Obs. / No.
2007 04 17.88	[15.8			TOT03

Comet 93P/Lovas

First Date UT	Mag.	Last Date UT	Mag.	Obs. / No.
2002 12 11.78	13.1	2007 12 30.82	13.4	BOU / 2
2007 12 30.83	13.4			DIJ
2007 12 16.79	13.1:			GIL01
2007 11 03.89	13.0	2007 12 04.89	12.7	GON05/ 2
2007 11 01.84	12.5	2007 11 10.99	12.3	LAB02/ 2
2007 11 02.94	13.2			MAR02
2007 12 05.50	12.5	2007 12 09.48	11.6	MIY01/ 2
2007 11 02.92	13.6	2007 11 02.92	13.6	PAR03/ 2
2007 11 03.47	13.6	2008 01 04.42	13.3	YOS04/ 4

Comet 96P/Machholz

First Date UT	Mag.	Last Date UT	Mag.	Obs. / No.
2007 04 14.08	7.7	2007 04 26.04	10.5	DOR02/ 9
2007 11 02.78	[12.1			MAR02
2007 04 21.08	8.5			NAG09
2007 04 14.09	8.0	2007 05 13.00	11.8	PAR03/ 6
2007 04 15.10	8.0:			SAN07
2007 05 17.03	13.2			TOT03

Comet 110P/Hartley

First Date UT	Mag.	Last Date UT	Mag.	Obs. / No.
2007 11 03.01	[14.8			MAR02
2007 12 29.88	[14.2			PAR03
2007 11 03.66	[13.0:	2008 01 04.51	14.5	YOS04/ 3

Comet 129P/Shoemaker-Levy

First Date UT	Mag.	Last Date UT	Mag.	Obs. / No.
1998 01 31.68	14.4			YOS04

Comet 181P/Shoemaker-Levy

First Date UT	Mag.	Last Date UT	Mag.	Obs. / No.
2006 12 09.74	12.8			PAR03

Comet 185P/Petriew

First Date UT	Mag.	Last Date UT	Mag.	Obs. / No.
2007 02 18.73	11.2			PAR03
2007 03 11.76	12.3			TOT03

Comet 188P/LINEAR-Mueller

First Date UT	Mag.	Last Date UT	Mag.	Obs. / No.
2007 11 02.88	[15.6			MAR02
2007 11 03.43	[14.3			YOS04

Comet 191P/McNaught

First Date UT	Mag.	Last Date UT	Mag.	Obs. / No.
2007 11 17.11	14.0			GON05
2007 12 08.64	14.1	2007 12 09.49	14.2	YOS04/ 2

Comet 192P/Shoemaker-Levy

First Date UT	Mag.	Last Date UT	Mag.	Obs. / No.
2008 01 27.82	13.3			GON05
2008 01 04.39	13.4			YOS04

Comet C/2003 WT_42 (LINEAR)

First Date UT	Mag.	Last Date UT	Mag.	Obs. / No.
2007 04 13.94	15.3	2007 04 17.89	15.5	TOT03/ 2

Comet C/2005 L3 (McNaught)

First Date UT	Mag.	Last Date UT	Mag.	Obs. / No.
2007 09 14.82	14.9			BIV
2007 11 02.81	[14.5			MAR02

Comet P/2006 HR_30 (Siding Spring)

First Date UT	Mag.	Last Date UT	Mag.	Obs. / No.
2007 02 14.84	12.2:			FIL04

Comet C/2006 L1 (Garradd)

First Date UT	Mag.	Last Date UT	Mag.	Obs. / No.
2006 12 16.70	10.7	2006 12 26.70	11.5	CHR / 3
2006 10 31.11	10.0:	2006 12 17.77	9.5	DOR02/ 7
2006 10 26.14	11.7	2006 12 25.93	10.7	FIL04/ 9
2006 10 31.11	10.5	2007 02 18.83	13.4	PAR03/ 9
2006 10 20.10	11.4			POW01
2006 12 11.90	11.3:	2006 12 16.83	11.5:	SCI / 3

Comet C/2006 L2 (McNaught)

First Date UT	Mag.	Last Date UT	Mag.	Obs. / No.
2007 11 02.96	[14.7			MAR02
2006 12 09.68	11.0	2007 02 18.81	12.5	PAR03/ 3

Comet C/2006 M4 (SWAN)

First Date UT	Mag.	Last Date UT	Mag.	Obs. / No.
2006 10 22.72	6.4	2006 10 26.75	4.8	DER / 2
2006 09 21.08	7.2	2006 12 16.70	9.6	DOR02/ 31
2006 09 25.12	6.5:	2006 12 15.75	11.7	FIL04/ 12
2006 09 26.16	6.3			JAR02
2006 10 19.77	6.1			KIS03
2006 10 18.76	6.9	2006 11 26.73	8.7	KWI / 12
2006 10 25.77	4.8	2006 10 26.76	5.4:	LEG / 2
2006 10 10.74	6.4	2006 10 26.73	4.8	MAJ01/ 3
2006 10 08.73	6.0:	2006 11 24.69	8.3:	MAR12/ 11
2006 09 23.10	6.9	2006 12 09.72	9.7	PAR03/ 15
2006 09 21.10	7.0	2006 10 20.11	6.1	POW01/ 11
2006 10 08.73	6.5	2006 12 11.69	10.8:	SCI / 22
2006 09 24.10	6.8			SIC01
2006 10 10.73	6.5	2006 10 17.75	6.5	SIK01/ 3
2006 10 17.73	6.0	2006 11 15.77	7.3	SIW / 6
2006 10 17.76	6.8	2006 11 07.76	7.6	SPE01/ 5
2006 10 06.74	5.9	2006 10 30.73	5.8	SWI / 3
2006 10 17.72	6.8	2006 11 15.70	7.6	SWI01/ 9
2006 10 31.45	5.3	2006 12 10.47	9.2	XU / 2

Comet C/2006 OF_2 (Broughton)

First Date UT	Mag.	Last Date UT	Mag.	Obs. / No.
2007 11 13.90	13.5			GON05
2007 12 05.79	13.8			HAS02
2007 11 02.83	14.9			MAR02
2007 11 03.40	13.9	2007 12 09.44	[14.3	YOS04/ 2

Comet C/2006 P1 (McNaught)

First Date UT	Mag.	Last Date UT	Mag.	Obs. / No.
2007 01 09.71	-2.2:	2007 01 14.53	-4 :	BIV / 5
2007 01 11.27	-2.0:	2007 01 14.66	-3.5:	SCI / 3
2007 01 12.63	-2.0:			SMY
2007 01 12.63	-3.0:	2007 01 14.57	-5.0:	SWI / 2

Comet C/2006 Q1 (McNaught)

First Date UT	Mag.	Last Date UT	Mag.	Obs. / No.
2007 12 30.30	12.6			GOI
2008 01 13.17	[12.3			ROB06
2007 12 09.77	12.5			YOS04

Comet C/2006 S5 (Hill)

First Date UT	Mag.	Last Date UT	Mag.	Obs. / No.
2008 01 30.88	13.6			BOU
2007 11 17.08	13.3	2008 01 27.93	13.5	GON05/ 2
2007 11 03.01	13.2			MAR02
2008 01 14.92	13.8			NEV
2007 12 29.89	13.4			PAR03
2007 11 03.65	[13.1:	2008 01 04.49	13.4	YOS04/ 4

Comet C/2006 V1 (Catalina)

First Date UT	Mag.	Last Date UT	Mag.	Obs. / No.
2007 04 13.83	15.5			TOT03

Comet C/2006 VZ_13 (LINEAR)

First Date UT	Mag.	Last Date UT	Mag.	Obs. / No.
2007 05 20.08	12.8	2007 08 11.85	9.5	BIV / 22
2007 07 14.82	8.4			CHR
2007 06 04.96	12.5	2007 07 30.87	9.0:	DOR02/ 15
2007 06 10.93	10.4	2007 07 14.90	8.5	FIL04/ 2
2007 07 17.90	7.9			KIS03
2007 07 11.88	7.9	2007 07 14.90	8.1	LEG / 2
2007 06 19.98	9.8	2007 07 08.89	7.6	MAJ01/ 2
2007 07 08.88	7.5	2007 07 19.87	7.5	MAR12/ 3
2007 04 21.05	12.0	2007 08 02.84	8.7:	PAR03/ 16
2007 06 22.94	9.5	2007 07 25.86	8.2	SAN07/ 10
2007 07 08.92	8.5:	2007 07 24.89	8.0	SCI / 10
2007 07 17.93	8.1			SIK01
2007 07 22.98	8.4	2007 07 23.98	8.3	SMY / 2
2007 07 14.94	8.2	2007 07 18.93	8.3	SPE01/ 3
2007 07 06.88	8.3	2007 07 22.88	8.5	SWI01/ 12
2007 07 07.94	7.8	2007 07 20.92	8.1	SZA / 4
2007 05 17.06	13.2	2007 07 11.95	8.1	TOT03/ 2

Comet C/2006 W3 (Christensen)

First Date UT	Mag.	Last Date UT	Mag.	Obs. / No.
2007 12 04.97	14.3			GON05
2007 12 08.67	14.5	2008 01 04.52	15.2	YOS04/ 3

Comet C/2006 WD_4 (Lemmon)

First Date UT	Mag.	Last Date UT	Mag.	Obs. / No.
2007 06 10.90	13.0:	2007 06 11.91	13.4:	PAR03/ 2

Comet C/2006 XA_1 (LINEAR)

First Date UT	Mag.	Last Date UT	Mag.	Obs. / No.
2007 04 13.83	12.3			PAR03
2007 03 11.84	15.2	2007 05 18.84	12.8	TOT03/ 5

Comet C/2007 E1 (Garradd)

First Date UT	Mag.	Last Date UT	Mag.	Obs. / No.
2007 04 13.76	10.4	2007 05 04.82	11.9	CHR / 4
2007 04 11.80	9.8	2007 05 05.83	11.2	DOR02/ 9
2007 04 13.81	9.7	2007 05 12.86	10.6	MAJ01/ 3
2007 04 13.81	8.8			NAG09
2007 04 13.84	10.3	2007 05 05.87	10.1	PAR03/ 7

Comet C/2007 E1 (Garradd) [cont.]

First Date UT	Mag.	Last Date UT	Mag.	Obs. / No.
2007 04 07.95	8.5:	2007 04 13.85	9.1	SAN07/ 4
2007 04 11.85	11.4			SZA
2007 04 05.83	12.6	2007 05 18.85	11.5	TOT03/ 6

Comet C/2007 E2 (Lovejoy)

First Date UT	Mag.	Last Date UT	Mag.	Obs. / No.
2007 05 05.91	9.3	2007 05 20.06	9.8	BIV / 5
2007 04 14.08	9.8	2007 05 13.81	10.2	CHR / 6
2007 04 13.08	8.7	2007 05 22.92	10.8	DOR02/ 16
2007 04 27.02	9.2	2007 05 19.90	10.0	FIL04/ 3
2007 04 23.08	8.0			HAD01
2007 05 19.87	10.4			JAR02
2007 04 17.04	8.3	2007 05 12.88	8.9	MAJ01/ 4
2007 04 16.08	8.2			NAG09
2007 04 14.08	8.8	2007 06 16.97	12.9:	PAR03/ 14
2007 05 06.90	10.1			PIL01
2007 04 14.08	8.1	2007 05 12.89	8.7	SAN07/ 4
2007 04 27.04	8.1			SAR02
2007 04 26.08	8.4	2007 04 27.07	8.9	SCI / 2
2007 04 26.95	9.0	2007 05 17.02	9.5	TOT03/ 2

Comet C/2007 F1 (LONEOS)

First Date UT	Mag.	Last Date UT	Mag.	Obs. / No.
2007 11 08.94	6.7	2007 11 30.96	9.3:	AMO01/ 6
2007 10 14.78	6.8	2007 10 23.76	5.5	BIV / 12
2007 10 04.78	7.2	2007 10 22.75	5.5	BUS01/ 5
2007 10 15.72	6.8	2007 10 16.71	6.8	CHR / 2
2007 11 16.98	8.3	2007 12 02.94	9.4	DES01/ 11
2007 09 20.09	10.5:	2007 10 17.71	6.0:	DOR02/ 10
2007 10 16.72	6.7			FIL04
2007 11 06.95	6.7	2007 12 01.96	10.1	GOI / 9
2007 10 18.74	6.1			GRA04
2007 10 15.73	7.1	2007 10 19.72	5.7	HOR02/ 2
2007 10 13.72	6.9	2007 10 21.73	4.6	HOR03/ 4
2007 10 14.74	6.3:			LEG
2007 10 15.71	6.4			MAR12
2007 10 13.77	6.4	2007 10 20.76	5.5	RIE / 2
2007 10 13.76	6.7	2007 10 22.76	5.6	SCH04/ 5
2007 10 13.72	7.0:	2007 10 16.71	6.3	SCI / 4
2007 11 06.42	6.4	2007 11 14.42	8.1	SEA / 8
2007 10 14.74	6.8	2007 10 21.72	5.7	SIW / 2
2007 11 07.93	7.5	2007 11 28.93	9.6	SOU01/ 5
2007 10 16.72	6.5	2007 10 26.69	5.1	SWI / 2
2007 04 13.84	[16.0			TOT03
2007 10 14.85	6.2	2007 10 15.85	6.2	URB01/ 2

Comet P/2007 H1 (McNaught)

First Date UT	Mag.	Last Date UT	Mag.	Obs. / No.
2007 10 10.83	13.0:			DOR02
2007 11 03.91	13.2			GON05
2007 11 02.84	14.9			MAR02
2007 09 15.95	13.3:			PAR03
2007 11 03.45	13.3	2008 01 04.41	[13.7	YOS04/ 4

Comet C/2007 T1 (McNaught)

First Date UT	Mag.	Last Date UT	Mag.	Obs. /	No.
2008 01 06.28	8.5	2008 01 28.03	9.0	AMO01/	7
2007 10 14.81	11.5			BIV	
2007 10 14.74	11.5:			DOR02	
2007 11 09.96	10.1	2008 01 30.10	9.1	GOI /	7
2007 11 02.78	[12.5			MAR02	
2008 01 13.18	8.7			ROB06	
2007 11 06.43	10.0	2008 01 11.48	8.3	SEA /	5

◇ ◇ ◇

Tabulated CCD-Data Summary

The tabulation below lists, for each comet, the first and last observation, with associated CCD magnitude measurement and "passband" (the one-letter code following the magnitude being the "magnitude method", which for CCDs has `C` = unfiltered CCD, `k` = Cousins R-band, etc.) for each observer, listed in alphabetical order of the observers within each comet's listing (the usual 3-letter, 2-digit observer code coming under the column `Obs.`, whose key is provided above). The final column (separated by a slash, /, from the observer code) provides the number of individual 129-character observation records entered into the *ICQ* archive from that observer for the particular comet for this issue; when only one observation was submitted by a specific observer for a given comet, the last column is left blank (with no slash mark after the observer code). The complete observations in their 129-column form are posted at the *ICQ* website and can be obtained directly by request from the *ICQ* Editor. See the remarks on pages 96 and 105 of the July 2007 issue, and page 140 of this issue, for additional information on this new summary tabulation.

Comet 8P/Tuttle

First Date UT	Mag.	Last Date UT	Mag.	Obs. /	No.
2007 11 14.69	12.2 C	2008 01 09.50	7.2 C	NAG08/	7
2007 11 03.79	12.7 v	2007 12 29.78	5.8 V	QVA /	7
2007 11 02.95	14.5 C	2007 12 20.98	10.0 C	SHU /	3
2007 11 11.44	13.1 C	2007 11 23.46	11.9 C	TSU02/	3
2007 11 02.47	13.6 C	2007 12 09.73	9.3 C	YOS02/	4

Comet 17P/Holmes

First Date UT	Mag.	Last Date UT	Mag.	Obs. /	No.
2007 05 19.75	14.8 C	2007 11 17.66	2.7 C	KAD02/	16
2007 10 25.35	2.2 k	2007 10 25.35	4.0 k	MCG /	3
2007 11 14.64	2.7 C	2008 03 01.51	4.2:C	NAG08/	8
2007 11 07.88	3.0 v			QVA	
2007 10 26.18	2.6 H	2007 10 26.18	4.1 B	SCH16/	4
2008 03 09.77	14.6 C	2008 03 27.75	13.9 C	SHU /	2
2007 10 31.78	2.3 k	2007 11 28.73	8.2 C	SRB /	38
2007 11 18.45	2.7 C			TSU02	
2007 11 02.50	2.6 C	2007 11 29.50	11.8 c	YOS02/	7

Comet 26P/Grigg-Skjellerup

First Date UT	Mag.	Last Date UT	Mag.	Obs. /	No.
2008 01 10.64	18.3 C	2008 01 11.64	18.5 C	MCA /	4

Comet 29P/Schwassmann-Wachmann

First Date UT	Mag.	Last Date UT	Mag.	Obs. /	No.
2008 01 05.99	13.3 c			BAR06	
2007 11 18.02	16.0 C	2008 01 04.91	13.1 C	NEV /	3

Comet 29P/Schwassmann-Wachmann [cont.]

First Date UT	Mag.	Last Date UT	Mag.	Obs. / No.
2007 12 02.08	14.4 V	2007 12 17.89	15.1 V	QVA / 2
2007 11 02.96	16.6 C	2008 01 05.98	12.1 C	SHU / 5
2007 11 29.56	13.9 C	2008 01 16.65	11.7 C	YOS02/ 2

Comet 44P/Reinmuth

First Date UT	Mag.	Last Date UT	Mag.	Obs. / No.
2007 11 19.86	16.5 C			BAR06

Comet 46P/Wirtanen

First Date UT	Mag.	Last Date UT	Mag.	Obs. / No.
2007 11 19.74	14.5 C	2008 01 05.76	15.2 c	BAR06/ 4
2007 12 18.42	11.6 C	2007 12 30.40	10.8 C	NAG08/ 2
2007 12 06.39	12.1 C	2008 01 02.42	11.2 C	TSU02/ 3
2007 11 09.41	14.0 C			YOS02

Comet 50P/Arend

First Date UT	Mag.	Last Date UT	Mag.	Obs. / No.
2007 11 29.96	15.4 C	2008 01 05.86	18.2 c	BAR06/ 4
2008 01 02.82	16.5 C			NEV
2007 11 04.95	15.6 v			QVA
2007 11 06.72	15.8 C	2008 01 05.91	15.9 C	SHU / 5
2007 12 26.52	16.6 C			TSU02
2007 11 02.55	15.7 C			YOS02

Comet 65P/Gunn

First Date UT	Mag.	Last Date UT	Mag.	Obs. / No.
2008 01 05.02	17.3 C	2008 01 14.99	16.9 C	NEV / 2

Comet 74P/Smirnova-Chernykh

First Date UT	Mag.	Last Date UT	Mag.	Obs. / No.
2007 11 19.97	17.1 C	2008 01 05.97	17.2 C	BAR06/ 2
2007 11 17.96	17.3 C	2008 01 04.87	17.3 C	NEV / 2
2007 11 06.93	16.9 C	2008 01 04.95	16.1 C	SHU / 2

Comet 79P/du Toit-Hartley

First Date UT	Mag.	Last Date UT	Mag.	Obs. / No.
2008 01 02.93	18.0 C			NEV

Comet 93P/Lovas

First Date UT	Mag.	Last Date UT	Mag.	Obs. / No.
2007 11 19.79	14.0 C	2008 01 05.84	14.3 C	BAR06/ 6
2007 12 07.48	13.6 C	2007 12 18.45	13.5 C	NAG08/ 2
2008 01 02.79	14.7 C			NEV
2007 11 03.83	13.6 V			QVA
2007 11 02.76	13.3 C	2008 01 14.88	14.4 C	SHU / 7
2007 11 30.55	14.0 C	2008 01 02.53	14.0 C	TSU02/ 3
2007 11 03.44	13.4 C			YOS02

Comet 110P/Hartley

First Date UT	Mag.	Last Date UT	Mag.	Obs. / No.
2007 11 20.01	15.9 C			BAR06
2007 11 17.99	16.1 C	2008 01 14.86	14.9 C	NEV / 3
2007 09 17.05	17.3 C	2008 01 05.96	14.1 C	SHU / 5
2007 12 26.58	15.0 C			TSU02

Comet 124P/Mrkos

First Date UT	Mag.	Last Date UT	Mag.	Obs. / No.
2008 01 05.13	17.8 C			NEV

Comet 128P/Shoemaker-Holt

First Date UT	Mag.	Last Date UT	Mag.	Obs. / No.
2008 01 05.07	17.6 C			BAR06

Comet 139P/Vaisala-Oterma

First Date UT	Mag.	Last Date UT	Mag.	Obs. / No.
2008 01 04.92	[18.0 C			BAR06
2008 01 02.50	18.3 C			TSU02

Comet 173P/Mueller

First Date UT	Mag.	Last Date UT	Mag.	Obs. / No.
2008 01 02.70	18.9 C			TSU02

Comet 179P/Jedicke

First Date UT	Mag.	Last Date UT	Mag.	Obs. / No.
2008 01 04.92	18.2 C			BAR06

Comet 188P/LINEAR-Mueller

First Date UT	Mag.	Last Date UT	Mag.	Obs. / No.
2008 01 04.84	16.3 C			BAR06
2008 01 04.75	16.8 C			NEV
2007 11 30.45	16.2 C	2007 12 26.44	16.5 C	TSU02/ 2

Comet 190P/Mueller

First Date UT	Mag.	Last Date UT	Mag.	Obs. / No.
2007 12 05.58	18.2 C	2007 12 26.65	18.9 C	TSU02/ 2

Comet 191P/McNaught

First Date UT	Mag.	Last Date UT	Mag.	Obs. / No.
2008 01 02.77	16.6 C			NEV
2007 11 02.81	15.1 C	2007 11 06.77	15.1 C	SHU / 2
2007 11 03.48	15.3 C			YOS02

Comet 192P/Shoemaker-Levy

First Date UT	Mag.	Last Date UT	Mag.	Obs. / No.
2007 12 26.39	15.5 C	2008 01 02.38	15.3 C	TSU02/ 2

Comet C/2005 EL_173 (LONEOS)

First Date UT	Mag.	Last Date UT	Mag.	Obs. / No.
2007 12 02.51	17.1 C	2007 12 30.48	17.7 C	MCA / 6

Comet C/2006 K1 (McNaught)

First Date UT	Mag.	Last Date UT	Mag.	Obs. / No.
2007 12 26.53	17.2 C	2007 12 29.48	16.9 C	MCA / 5

Comet C/2006 OF_2 (Broughton)

First Date UT	Mag.	Last Date UT	Mag.	Obs. / No.
2007 11 02.80	13.9 C	2007 11 06.81	14.9 C	SHU / 2
2007 11 30.42	14.8 C			TSU02
2007 11 02.43	14.6 C			YOS02

Comet C/2006 Q1 (McNaught)

First Date UT	Mag.	Last Date UT	Mag.	Obs. / No.
2007 12 07.59	15.0 C	2008 01 10.52	15.0 C	MCA / 12

Comet C/2006 S5 (Hill)

First Date UT	Mag.	Last Date UT	Mag.	Obs. / No.
2008 01 02.94	14.7 C	2008 01 14.94	14.5 C	NEV / 2
2007 11 06.87	16.0 C	2008 01 06.05	14.4 C	SHU / 3

Comet C/2006 U6 (Spacewatch)

First Date UT	Mag.	Last Date UT	Mag.	Obs. / No.
2007 12 02.46	16.6 C	2007 12 29.52	16.6 C	MCA / 6

Comet C/2006 VZ_13 (LINEAR)

First Date UT	Mag.	Last Date UT	Mag.	Obs. / No.
2007 12 14.63	18.1 C	2007 12 14.64	18.1 C	MCA / 2

Comet C/2006 W3 (Christensen)

First Date UT	Mag.	Last Date UT	Mag.	Obs. / No.
2008 01 04.85	15.3 C			NEV
2008 01 03.93	14.5 C	2008 01 06.91	14.3 C	SHU / 3
2007 11 03.51	15.5 C			YOS02

Comet C/2007 B2 (Skiff)

First Date UT	Mag.	Last Date UT	Mag.	Obs. / No.
2008 01 05.16	15.5 C			NEV

Comet P/2007 C2 (Catalina)

First Date UT	Mag.	Last Date UT	Mag.	Obs. / No.
2008 01 04.98	17.5 C			NEV

Comet C/2007 F1 (LONEOS)

First Date UT	Mag.	Last Date UT	Mag.	Obs. / No.
2007 10 15.73	8.6 k	2007 10 15.73	11.8 k	SRB / 6

Comet P/2007 H1 (McNaught)

First Date UT	Mag.	Last Date UT	Mag.	Obs. / No.
2007 11 02.83	13.4 C			SHU
2007 11 30.49	14.9 C			TSU02
2007 11 03.46	14.2 C			YOS02

Comet C/2007 N3 (Lulin)

First Date UT	Mag.	Last Date UT	Mag.	Obs. / No.
2007 11 19.71	16.8 C			BAR06

Comet C/2007 Q3 (Siding Spring)

First Date UT	Mag.	Last Date UT	Mag.	Obs. / No.
2007 12 02.59	17.0 C	2008 01 06.51	16.7 C	MCA / 16

Comet C/2007 T1 (McNaught)

First Date UT	Mag.	Last Date UT	Mag.	Obs. / No.
2008 01 10.72	13.6 C	2008 01 15.72	14.0 C	MCA / 5

Comet C/2007 U1 (LINEAR)

First Date UT	Mag.	Last Date UT	Mag.	Obs. / No.
2008 01 05.00	15.6 C	2008 01 06.00	14.2 C	SHU / 2

Comet P/2007 V1 (Larson)

First Date UT	Mag.	Last Date UT	Mag.	Obs. / No.
2008 01 04.98	17.7 C			BAR06
2007 12 26.56	18.6 C			TSU02

Comet C/2007 W1 (Boattini)

First Date UT	Mag.	Last Date UT	Mag.	Obs. / No.
2007 11 30.14	17.1 C	2008 01 05.16	17.7 c	BAR06/ 5
2007 12 14.69	17.2 C	2008 01 15.70	16.3 C	MCA / 10
2008 01 05.17	16.5 C			NEV
2007 12 09.84	17.6 C			YOS02

Comet C/2007 Y1 (LINEAR)

First Date UT	Mag.	Last Date UT	Mag.	Obs. / No.
2008 01 03.06	17.3 C	2008 01 05.10	18.6 c	BAR06/ 4
2007 12 28.62	18.2 C	2008 01 15.64	18.0 C	MCA / 11

Comet C/2007 Y2 (McNaught)

First Date UT	Mag.	Last Date UT	Mag.	Obs. / No.
2008 01 07.44	18.5 C	2008 01 27.58	18.5 C	MCA / 9

Comet C/2008 A1 (McNaught)

First Date UT	Mag.	Last Date UT	Mag.	Obs. / No.
2008 01 11.44	16.1 C	2008 01 27.62	16.2 C	MCA / 5