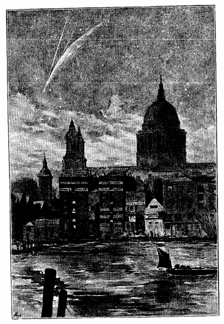


Donati's Comet, 1858.

THE COMET’S TALE

Newsletter of the Comet Section of the British Astronomical Association

Volume 4, No 2 (Issue 8), 1997 November

The Search for Comet P/Pons-Gambart

Andreas Kammerer, Ettlingen, Germany

It was an article by Alex Vincent in the newsletter of BAA's Comet Section which drew my attention to the then "lost" comets de Vico and Pons-Gambart. The author predicted the return of these comets for 1997-1999 and 1999-2000, respectively. As is known, comet de Vico was rediscovered in September, 1995, reaching 5 mag and displaying a very dynamic ion tail. Three years before another "lost" periodical comet, Swift-Tuttle, was rediscovered as it approached the sun, again observed by thousands of people, although the circumstances were as bad as they could be, with the comet at perihelion nearly on the opposite side of the sun. Most astronomers had anticipated this mother comet of the Perseids 12 years in advance. However, the orbit was not well determined and an investigation by Brian Marsden even showed a possible identity with comet Kegler in 1737, leading to his prediction of a probable perihelion date at the end of 1992. Several weeks before this date the comet was rediscovered heading towards the sun.

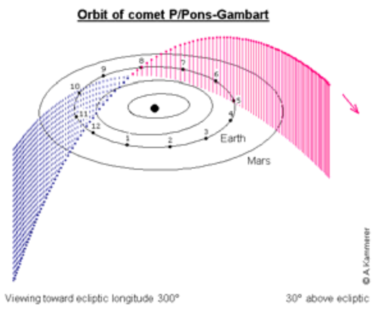
Now there is the possibility of rediscovering just another "lost" comet within the next few years. Because comet Pons-Gambart was observed for only one month its period too can only be determined with an uncertainty of several years.

Details about the apparition are poor: On June 21, 1827 Jean Louis Pons in Florence, Italy and Adolphe Gambart in Marseille, France independently discovered a comet in the constellation Cassiopeia. They did not make any remarks concerning the brightness, but it seems that the comet was of magnitude 5 to 6. The comet steadily grew fainter and the last observation already came on July 21 with an assumed brightness of about 8 mag.

First calculations assumed a parabolic orbit with perihelion date on June 8. But in 1917 Ogura showed that the comet really was of short period. He calculated two different periods of either 46 or 64 years. In 1978 S. Nakano reinvestigated the apparition of this comet and found a period of 57.5 +/- 10 years. All these calculations confirmed however, that the comet was hopelessly lost. Since 1827 it should have reached perihelion twice, but was not observed.

Then in 1979 I. Hasegawa found an interesting link. While investigating Chinese records of ancient comets he noted that a comet in 1110 had a very similar orbit to that of comet Pons-Gambart. More recently Kenji Muraoka determined a current orbital period of 56.15 years and proposed the likely return to perihelion for December 5, 1997. However, it has to be pointed out that his investigation still has an uncertainty of several years.

As a result, the circumstances for rediscovering comet Pons-Gambart are not any better than they were for comet Swift-Tuttle - with the latter having a higher intrinsic magnitude. However, with the help of a search ephemeris it should be possible to find this comet too, even in the case of the worst perihelion circumstances. These occur in the case the comet reaches perihelion in winter, with the comet never getting brighter than 8-9 mag and being situated uncomfortably for Northerners. In contrast, a perihelion date in mid-August will bring it close to the earth (minimum distance: 0.16 A.U.), with the comet perhaps as bright as 3-4 mag (Fig. 1).



Continued on page 4

Contents

Comet Section contacts

Director: Jonathan Shanklin, 11 City Road, CAMBRIDGE. CB1 1DP, England.
Phone: (+44) (0)1223 571250 (H) or (+44) (0)1223 251400 (W)
Fax: (+44) (0)1223 362616 (W)
E-Mail: JDS@AST.CAM.AC.UK or J.SHANKLIN@BAS.AC.UK
WWW page : http://www.ast.cam.ac.uk/~jds/

Assistant Director (Observations): (and also Editor of *The Astronomer* magazine) Guy Hurst, 16 Westminster Close, Kempshott Rise, BASINGSTOKE, Hampshire. RG22 4PP, England.
Phone & Fax: (+44) (0)1256 471074
E-Mail: GUY@TAHQ.DEMON.CO.UK *or* GMH@AST.STAR.RL.AC.UK

CCD Advisor: Nick James, 11 Tavistock Road, CHELMSFORD, Essex. CM1 5JL, England.
Phone: (+44) (0)1245 354366
E-mail: NDJ@ASTRO1.DEMON.CO.UK *or* NICK.JAMES@GMRC.GECM.COM

Photographic Advisor: Michael Hendrie, Overbury, 33 Lexden Road, West Bergholt, COLCHESTER, Essex, CO6 3BX, England
Phone: (+44) (0)1206 240021

Section news from the Director

Dear Section member,

Thankfully no new bright comets have been discovered, so I have been able to catch up a little on Section work, though pressure on my time has meant that this newsletter is a little later than intended. A paper on the comets of 1993 has been accepted for the Journal and I've made good progress on the comets of 1994. Despite requesting an improvement in reporting standards in the last newsletter, the majority of observers are still making mistakes in reporting their observations to Guy. This greatly increases the workload for Guy, so please try and submit observations exactly in TA or ICQ format if you are submitting by e-mail, or use the Section report forms if submitting by post. We will give a further briefing on submitting observations at the Section meeting in February. This meeting will concentrate on observational techniques and how to report observations, though there will be time for a few general talks as well. See the details on page ?.

Several deaths have occurred in the last six months. Stan Milbourn, a former Section Director died in August. A full obituary will appear in the Journal in due course. I have also just learnt of the death of Paul Doherty who was a long standing cometary observer. You will all have heard of the death of Gene Shoemaker; he will be sadly missed. Dr Jurgen Rahe, a leading NASA astronomer, was killed when a tree fell on his car during a severe storm near his home of Potomac, MD. He had been a co-leader of the International Halley Watch and was also involved with the Giotto, Clementine, Rosetta and NEAR missions.

Since the last newsletter observations or contributions have been received from the following BAA members:

James Abott, Mark Armstrong, Sally Beaumont, Denis Buczynski, Emilio Colombo, Eric Dinham, Mike Gainsford, Massimo Giuntoli, Werner Hasubick, Mike Hendrie, Colin Henshaw, Guy Hurst, Nick James, Albert Jones, Norman Kiernan, John Mackey, Glyn Marsh, Richard McKim, Haldun Menali, Martin Mobberley, Stewart Moore, Bob Neville, Detlev Niechoy, Brian O'Halloran, Gabriel Oksa, John Rogers, Jonathan Shanklin, Tony Tanti, Melvyn Taylor and Alex Vincent.

and also from: Jose Aguiar, Cornel Apetroaei, Alexandr Baransky, Sandro Baroni, John Bortle, Reinder Bouma, Haakon Dahle, Alfons Diepvens, Stephen Getliffe, Guus Gilein, Bjoern Granslo, Roberto Haver, Andreas Kammerer, Graham Keitch, Heinz Kerner, Mark Kidger, Atilla Kosa-Kiss, Martin Lehky, Romualdo Lourencon, Herman Mikuz, John O'Neil, Andrew Pearce, Oddleiv Skilbrei, Josep Trigo, Vince Tuboly, Graham Wolf, Seiichi Yoshida and Vittorio Zanotta (apologies for any omissions or miss-classifications).

Comets under observation were: 2P/Encke, 29P/Schwassmann-Wachmann 1, 43P/Wolf-Harrington, 46P/Wirtanen, 48P/Johnson, 78P/Gehrels 2, 81P/Wild 2, 103P/Hartley 2, C/Hale-Bopp (1995 O1), C/Evans-Drinkwater (1996 J1), C/Mueller (1997 D1), C/Mueller (1997 J1), C/Meunier-Dupouy (1997 J2), C/Tabur (1997 N1), C/Tilbrook (1997 O1) and C//Utsunomiya (1997 T1).

You will see a few changes to the format of the ephemerides in the observing supplement. I now give positions for both B1950 and J2000 epochs, and the times are in UT. I've increased the interval between positions to 5 days for the fainter comets and those not visible from the UK. Let me know if you like these changes and if there is anything else you'd like to see in the Newsletter. I look forward to seeing as many of you as possible at the Section meeting.

Jonathan Shanklin

Provisional Meeting Programme

Observing Techniques

Saturday, February 14

Institute of Astronomy, Cambridge

10:30	Doors open, refreshments available	
11:15	Tour of RGO and Observatories	
12:15	Lunch	
13:30	Jon Shanklin	Introduction
13:35	Jon Shanklin	Visual Observing
14:05	Guy Hurst	Reporting Observations
14:30	Mike Irwin	Discovering Kuiper Belt Objects
15:00	Members slot	
15:15	Tea	
15:45	Nick James	Comet image processing
16:15	Bob Neville	Determining CCD comet magnitudes
16:45	TBA	CCD astrometry
17:30	Observing if clear	

There is an entry charge of £1.00 to cover administration costs, tea, coffee and biscuits. A buffet lunch is available for £4.00 if you book in advance – please send bookings to me. The Churchill is just down the road and there are a couple of good pubs in Coton, about a mile away.

If you would like to speak please let me know. Some exhibition space is available and recent observations will be on display. If you would like to exhibit material, please let me know in advance. There will be stands by the BAA, CAA, CUAS and TA. The TA special supplement on Hale-Bopp and the CD ROM will be available for purchase.

The meeting will take place in the Hoyle building of the Institute of Astronomy. Cambridge rail and coach stations are a lengthy walk from the Observatories. The Birmingham train arrives at 10:29, London trains at 10:04 and 10:34 (fast from Kings Cross) and 10:06 and 10:57 (Liverpool Street). The Madingley Road park & ride bus is reasonably convenient for the Observatories. Car parking is available on site.

Comet Pons-Gambart

Continued from page 1

The accompanying search ephemeris (Table 1 and 2) give right ascension (in hours), declination (in degrees) and magnitude for various observing dates along the most promising orbital arc. Because of the orbital uncertainties the search should be extended to about +/- 5 degrees on either side of the arc (at times of small earth distances even more). Every column lists for a specific observation date the position and magnitude of the comet for distinct intervals to the perihelion. In this way, one can define the most promising arc for the search.

The listed magnitudes were derived by using the brightness parameters H10 = 7.5 mag, n = 4. It has to be stressed, however, that on average periodical comets show n>4. If this would be the case for comet Pons-Gambart, the actual magnitude could be much fainter than the listed value, especially with the comet far from the sun. Therefore, the listed magnitudes should be regarded as maximum values.

References:
Gary W. Kronk: Comets. A descriptive catalog. Hillside, 1984.
Gary W. Kronk: Comet Homepage, 1997.
Alex Vincent: Lost Periodical Comets. Newsletter of the Comet Section of the British Astronomical Association, 1994.
S.K. Vsekhsvyatskii: Physical Characteristics of Comets. Jerusalem 1964.

(andreas.kammerer@x400.lfuka.um.bwl.de)

Table 1: Search ephemeris for comet P/Pons-Gambart (Jan.-June) (Equinox 2000.0)

	Jan 1	Jan 11	Jan 21	Jan 31	Feb 10	Feb 20	Mar 2	Mar 12	Mar 22	Apr 1	Apr 11	Apr 21	May 1	May 11	May 21	May 31	Jun 10	Jun 20	Jun 30
-160	3.0/-38 13 mag	2.8/-35 13 mag	2.7/-33 14 mag	2.7/-30 14 mag	2.7/-27 14 mag	2.8/-25 14 mag	2.9/-22 14 mag	3.0/-20 14 mag	3.1/-18 14 mag	3.3/-16 14 mag	3.4/-15 14 mag	3.6/-13 14 mag	3.8/-12 14 mag	4.0/-11 14 mag	4.1/-11 14 mag	4.3/-10 14 mag	4.5/-10 14 mag	4.7/-10 14 mag	4.9/-10 14 mag
-150	2.8/-39 13 mag	2.6/-36 13 mag	2.5/-33 13 mag	2.5/-30 13 mag	2.5/-27 14 mag	2.6/-25 14 mag	2.7/-22 14 mag	2.8/-20 14 mag	3.0/-18 14 mag	3.1/-16 14 mag	3.3/-15 14 mag	3.5/-13 14 mag	3.7/-12 14 mag	3.8/-11 14 mag	4.0/-11 14 mag	4.2/-10 14 mag	4.4/-10 14 mag	4.6/-10 14 mag	4.8/-10 14 mag
-140	2.5/-40 13 mag	2.3/-37 13 mag	2.3/-34 13 mag	2.3/-31 13 mag	2.3/-28 13 mag	2.4/-25 13 mag	2.5/-23 13 mag	2.6/-20 13 mag	2.8/-18 14 mag	3.0/-16 14 mag	3.1/-15 14 mag	3.3/-13 14 mag	3.5/-12 14 mag	3.7/-11 14 mag	3.9/-11 14 mag	4.1/-10 14 mag	4.3/-10 14 mag	4.6/-10 14 mag	4.8/-10 14 mag
-130	2.1/-41 12 mag	2.0/-37 13 mag	2.0/-34 13 mag	2.0/-31 13 mag	2.1/-28 13 mag	2.2/-25 13 mag	2.3/-23 13 mag	2.5/-20 13 mag	2.6/-18 13 mag	2.8/-16 13 mag	3.0/-15 13 mag	3.2/-13 13 mag	3.4/-12 13 mag	3.6/-11 13 mag	3.8/-11 13 mag	4.0/-10 13 mag	4.2/-10 13 mag	4.5/-10 13 mag	4.7/-10 13 mag
-120	1.8/-41 12 mag	1.7/-38 12 mag	1.7/-34 12 mag	1.7/-31 13 mag	1.8/-28 13 mag	1.9/-25 13 mag	2.1/-23 13 mag	2.3/-20 13 mag	2.4/-18 13 mag	2.6/-16 13 mag	2.8/-15 13 mag	3.0/-13 13 mag	3.3/-12 13 mag	3.5/-11 13 mag	3.7/-11 13 mag	3.9/-10 13 mag	4.1/-10 13 mag	4.4/-10 13 mag	4.6/-10 13 mag
-110	1.4/-42 12 mag	1.3/-38 12 mag	1.3/-34 12 mag	1.4/-31 12 mag	1.5/-28 12 mag	1.7/-25 12 mag	1.9/-23 12 mag	2.0/-20 13 mag	2.2/-18 13 mag	2.4/-16 13 mag	2.6/-15 13 mag	2.9/-13 13 mag	3.1/-12 13 mag	3.3/-11 13 mag	3.6/-10 13 mag	3.8/-10 13 mag	4.0/-10 13 mag	4.2/-10 13 mag	4.5/-10 12 mag
-100	0.9/-42 11 mag	0.9/-38 12 mag	1.0/-34 12 mag	1.1/-31 12 mag	1.2/-28 12 mag	1.4/-25 12 mag	1.6/-23 12 mag	1.8/-20 12 mag	2.0/-18 12 mag	2.2/-16 12 mag	2.5/-15 12 mag	2.7/-13 12 mag	2.9/-12 12 mag	3.2/-11 12 mag	3.4/-10 12 mag	3.6/-10 12 mag	3.9/- 9 12 mag	4.1/-10 12 mag	4.4/-10 12 mag
-90	0.4/-42 11 mag	0.5/-38 11 mag	0.6/-34 11 mag	0.7/-31 11 mag	0.9/-28 12 mag	1.1/-25 12 mag	1.3/-22 12 mag	1.5/-20 12 mag	1.8/-18 12 mag	2.0/-16 12 mag	2.2/-14 12 mag	2.5/-13 12 mag	2.7/-12 12 mag	3.0/-11 12 mag	3.2/-10 12 mag	3.5/- 9 12 mag	3.7/- 9 12 mag	4.0/- 9 12 mag	4.2/-10 12 mag
-80	23.9/-41 11 mag	0.0/-37 11 mag	0.2/-33 11 mag	0.4/-30 11 mag	0.6/-27 11 mag	0.8/-24 11 mag	1.0/-22 11 mag	1.3/-20 11 mag	1.5/-17 11 mag	1.8/-16 11 mag	2.0/-14 11 mag	2.3/-12 11 mag	2.5/-11 11 mag	2.8/-10 11 mag	3.1/- 9 11 mag	3.3/- 9 11 mag	3.6/- 9 11 mag	3.8/- 9 11 mag	4.1/- 9 11 mag
-70	23.4/-39 10 mag	23.5/-36 10 mag	23.7/-32 11 mag	24.0/-29 11 mag	0.2/-26 11 mag	0.5/-24 11 mag	0.7/-21 11 mag	1.0/-19 11 mag	1.2/-17 11 mag	1.5/-15 11 mag	1.8/-13 11 mag	2.0/-12 11 mag	2.3/-10 11 mag	2.6/- 9 11 mag	2.8/- 9 11 mag	3.1/- 8 11 mag	3.4/- 8 11 mag	3.7/- 8 11 mag	4.0/- 9 10 mag
-60	22.8/-37 10 mag	23.0/-34 10 mag	23.3/-31 10 mag	23.5/-28 10 mag	23.8/-25 10 mag	0.1/-23 10 mag	0.4/-20 10 mag	0.6/-18 10 mag	0.9/-16 10 mag	1.2/-14 10 mag	1.5/-12 10 mag	1.8/-11 10 mag	2.0/-10 10 mag	2.3/- 9 10 mag	2.6/- 8 10 mag	2.9/- 7 10 mag	3.2/- 7 10 mag	3.5/- 7 10 mag	3.8/- 8 10 mag
-50	22.2/-35 9 mag	22.5/-32 10 mag	22.8/-29 10 mag	23.1/-26 10 mag	23.4/-24 10 mag	23.7/-21 10 mag	24.0/-19 10 mag	0.3/-17 10 mag	0.6/-15 10 mag	0.9/-13 10 mag	1.2/-11 10 mag	1.5/-10 10 mag	1.8/- 8 10 mag	2.1/- 7 10 mag	2.4/- 6 10 mag	2.7/- 6 10 mag	3.0/- 5 9 mag	3.3/- 6 9 mag	3.6/- 6 9 mag
-40	21.7/-32 9 mag	22.0/-29 9 mag	22.3/-27 9 mag	22.6/-24 9 mag	23.0/-22 9 mag	23.3/-20 9 mag	23.6/-18 9 mag	23.9/-15 9 mag	0.2/-13 9 mag	0.5/-12 9 mag	0.8/-10 9 mag	1.1/- 8 9 mag	1.4/- 7 9 mag	1.7/- 6 9 mag	2.1/- 5 9 mag	2.4/- 4 9 mag	2.7/- 3 9 mag	3.0/- 3 9 mag	3.4/- 4 8 mag
-30	21.1/-28 9 mag	21.5/-26 9 mag	21.8/-24 9 mag	22.2/-22 9 mag	22.5/-20 9 mag	22.8/-18 9 mag	23.1/-16 9 mag	23.5/-14 9 mag	23.8/-12 9 mag	0.1/-10 9 mag	0.4/- 8 9 mag	0.8/- 6 9 mag	1.1/- 5 9 mag	1.4/- 3 9 mag	1.7/- 2 8 mag	2.1/- 1 8 mag	2.4/- 0 8 mag	2.8/- 0 8 mag	3.1/- 0 8 mag
-20	20.6/-24 8 mag	20.9/-22 8 mag	21.3/-21 8 mag	21.7/-19 8 mag	22.0/-17 8 mag	22.4/-15 8 mag	22.7/-13 8 mag	23.0/-11 8 mag	23.4/- 9 8 mag	23.7/- 7 8 mag	0.0/- 5 8 mag	0.4/- 3 8 mag	0.7/- 1 8 mag	1.0/- 0 8 mag	1.4/+ 1 8 mag	1.7/+ 2 8 mag	2.1/+ 4 7 mag	2.5/+ 5 7 mag	2.9/+ 5 7 mag
-10	20.0/-19 8 mag	20.4/-18 8 mag	20.8/-17 8 mag	21.2/-15 8 mag	21.5/-14 8 mag	21.9/-12 8 mag	22.2/-10 8 mag	22.6/- 8 8 mag	22.9/- 6 8 mag	23.2/- 4 8 mag	23.6/- 2 8 mag	23.9/+ 0 8 mag	0.3/+ 2 7 mag	0.6/+ 4 7 mag	1.0/+ 7 7 mag	1.3/+ 9 7 mag	1.7/+11 7 mag	2.2/+14 6 mag	2.7/+17 6 mag
0	19.5/-15 8 mag	19.9/-14 8 mag	20.3/-13 8 mag	20.6/-12 8 mag	21.0/-10 8 mag	21.4/- 8 8 mag	21.7/- 6 8 mag	22.1/- 4 8 mag	22.4/- 2 8 mag	22.8/- 0 8 mag	23.1/+ 2 7 mag	23.4/+ 5 7 mag	23.8/+ 8 7 mag	0.2/+11 7 mag	0.5/+15 7 mag	0.9/+19 6 mag	1.4/+24 6 mag	1.9/+30 6 mag	2.6/+37 5 mag
10	19.0/-11 8 mag	19.4/-10 8 mag	19.8/- 9 8 mag	20.1/- 8 8 mag	20.5/- 6 8 mag	20.9/- 4 8 mag	21.2/- 2 8 mag	21.6/- 0 8 mag	21.9/+ 2 8 mag	22.3/+ 5 7 mag	22.6/+ 8 7 mag	23.0/+11 7 mag	23.3/+16 7 mag	23.7/+21 7 mag	0.1/+26 6 mag	0.5/+33 6 mag	1.0/+42 6 mag	1.7/+53 5 mag	3.0/+67 5 mag
20	18.5/- 6 8 mag	18.9/- 6 8 mag	19.3/- 5 8 mag	19.6/- 4 8 mag	20.0/- 2 8 mag	20.4/- 0 8 mag	20.7/+ 1 8 mag	21.1/+ 4 8 mag	21.4/+ 7 8 mag	21.7/+11 8 mag	22.1/+15 7 mag	22.4/+20 7 mag	22.8/+26 7 mag	23.1/+33 7 mag	23.5/+41 6 mag	23.9/+52 6 mag	0.5/+65 6 mag	2.0/+79 6 mag	10.2/+80 6 mag
30	18.1/- 3 9 mag	18.4/- 2 9 mag	18.8/- 1 9 mag	19.2/- 0 9 mag	19.5/+ 1 8 mag	19.9/+ 3 8 mag	20.2/+ 6 8 mag	20.5/+ 9 8 mag	20.9/+13 8 mag	21.2/+17 8 mag	21.5/+23 8 mag	21.8/+30 7 mag	22.1/+38 7 mag	22.4/+47 7 mag	22.7/+58 7 mag	22.9/+72 7 mag	22.7/+86 7 mag	12.0/+79 7 mag	12.1/+66 7 mag
40	17.6/+ 0 9 mag	18.0/+ 0 9 mag	18.3/+ 1 9 mag	18.7/+ 3 9 mag	19.0/+ 5 9 mag	19.4/+ 7 9 mag	19.7/+11 9 mag	20.0/+14 8 mag	20.3/+19 8 mag	20.6/+25 8 mag	20.9/+32 8 mag	21.1/+40 8 mag	21.3/+50 8 mag	21.4/+61 7 mag	21.1/+74 7 mag	18.0/+84 7 mag	12.9/+78 7 mag	12.2/+67 8 mag	12.2/+57 8 mag
50	17.2/+ 3 10 mag	17.6/+ 4 10 mag	17.9/+ 5 10 mag	18.2/+ 6 9 mag	18.5/+ 9 9 mag	18.9/+12 9 mag	19.2/+15 9 mag	19.4/+20 9 mag	19.7/+26 9 mag	19.9/+32 8 mag	20.1/+41 8 mag	20.2/+50 8 mag	20.1/+61 8 mag	19.4/+72 8 mag	16.8/+79 8 mag	13.5/+76 8 mag	12.4/+67 8 mag	12.1/+59 8 mag	12.2/+51 9 mag
60	16.9/+ 5 10 mag	17.2/+ 6 10 mag	17.5/+ 8 10 mag	17.8/+10 10 mag	18.1/+12 10 mag	18.4/+16 10 mag	18.6/+20 9 mag	18.8/+25 9 mag	19.0/+32 9 mag	19.2/+39 9 mag	19.2/+48 9 mag	19.0/+58 9 mag	18.2/+68 9 mag	16.4/+74 9 mag	13.9/+73 9 mag	12.6/+67 9 mag	12.1/+60 9 mag	12.0/+53 9 mag	12.1/+47 9 mag
70	16.5/+ 8 11 mag	16.8/+ 9 10 mag	17.1/+10 10 mag	17.3/+13 10 mag	17.6/+15 10 mag	17.8/+19 10 mag	18.1/+24 10 mag	18.2/+30 10 mag	18.3/+37 9 mag	18.3/+45 9 mag	18.1/+54 9 mag	17.5/+63 9 mag	16.2/+69 9 mag	14.3/+70 9 mag	12.9/+67 9 mag	12.2/+61 10 mag	12.0/+55 10 mag	11.9/+49 10 mag	11.9/+44 10 mag
80	16.2/+10 11 mag	16.4/+11 11 mag	16.7/+13 11 mag	16.9/+15 11 mag	17.2/+18 10 mag	17.3/+22 10 mag	17.5/+27 10 mag	17.6/+34 10 mag	17.6/+41 10 mag	17.4/+49 10 mag	16.9/+57 10 mag	16.0/+64 10 mag	14.6/+67 10 mag	13.3/+65 10 mag	12.4/+61 10 mag	12.0/+56 10 mag	11.8/+51 10 mag	11.8/+46 10 mag	11.8/+42 11 mag
90	15.9/+12 11 mag	16.1/+13 11 mag	16.3/+15 11 mag	16.5/+17 11 mag	16.7/+21 11 mag	16.9/+25 11 mag	16.9/+30 10 mag	16.9/+37 10 mag	16.8/+44 10 mag	16.4/+51 10 mag	15.8/+58 10 mag	14.8/+62 10 mag	13.6/+63 10 mag	12.7/+60 10 mag	12.1/+57 11 mag	11.8/+52 11 mag	11.7/+48 11 mag	11.7/+44 11 mag	11.7/+40 11 mag
100	15.6/+13 12 mag	15.8/+14 12 mag	16.0/+16 12 mag	16.2/+19 11 mag	16.3/+23 11 mag	16.4/+27 11 mag	16.4/+32 11 mag	16.3/+39 11 mag	16.1/+45 11 mag	15.6/+52 11 mag	14.9/+57 11 mag	13.9/+59 11 mag	13.0/+59 11 mag	12.3/+57 11 mag	11.9/+53 11 mag	11.7/+49 11 mag	11.6/+46 11 mag	11.6/+42 12 mag	11.6/+39 12 mag

Table 2: Search ephemeris for comet P/Pons-Gambart (July-Dec.) (Equinox 2000.0)

	Jul 10	Jul 20	Jul 30	Aug 9	Aug 19	Aug 29	Sep 8	Sep 18	Sep 28	Oct 8	Oct 18	Oct 28	Nov 7	Nov 17	Nov 27	Dec 7	Dec 17	Dec 27
-160	5.1/-11 14 mag	5.3/-12 14 mag	5.4/-13 14 mag	5.6/-14 14 mag	5.7/-16 14 mag	5.8/-18 14 mag	5.9/-20 14 mag	5.9/-23 14 mag	5.9/-26 13 mag	5.8/-30 13 mag	5.7/-33 13 mag	5.5/-37 13 mag	5.1/-40 13 mag	4.7/-42 13 mag	4.3/-43 13 mag	3.9/-43 13 mag	3.5/-41 13 mag	3.2/-39 13 mag
-150	5.0/-11 14 mag	5.2/-12 14 mag	5.4/-13 14 mag	5.5/-14 14 mag	5.7/-16 14 mag	5.8/-19 13 mag	5.8/-21 13 mag	5.9/-24 13 mag	5.9/-28 13 mag	5.8/-31 13 mag	5.6/-35 13 mag	5.4/-39 13 mag	5.0/-42 13 mag	4.6/-44 13 mag	4.1/-45 13 mag	3.6/-44 13 mag	3.2/-43 13 mag	2.9/-40 13 mag
-140	4.9/-11 13 mag	5.1/-12 13 mag	5.3/-13 13 mag	5.5/-15 13 mag	5.6/-17 13 mag	5.7/-19 13 mag	5.8/-22 13 mag	5.8/-25 13 mag	5.8/-29 13 mag	5.7/-33 13 mag	5.5/-37 13 mag	5.2/-41 12 mag	4.8/-44 12 mag	4.3/-46 12 mag	3.8/-47 12 mag	3.3/-46 13 mag	2.9/-44 13 mag	2.6/-41 13 mag
-130	4.9/-11 13 mag	5.1/-12 13 mag	5.2/-13 13 mag	5.4/-15 13 mag	5.6/-17 13 mag	5.7/-20 13 mag	5.8/-23 13 mag	5.8/-26 12 mag	5.8/-30 12 mag	5.7/-35 12 mag	5.4/-39 12 mag	5.1/-43 12 mag	4.6/-47 12 mag	4.1/-49 12 mag	3.5/-49 12 mag	2.9/-48 12 mag	2.5/-45 12 mag	2.2/-42 12 mag
-120	4.8/-11 13 mag	5.0/-12 13 mag	5.2/-13 13 mag	5.4/-15 13 mag	5.5/-18 12 mag	5.6/-20 12 mag	5.7/-24 12 mag	5.7/-28 12 mag	5.7/-32 12 mag	5.6/-37 12 mag	5.3/-42 12 mag	4.9/-46 12 mag	4.4/-50 12 mag	3.7/-52 12 mag	3.1/-51 12 mag	2.5/-49 12 mag	2.1/-47 12 mag	1.9/-43 12 mag
-110	4.7/-11 12 mag	4.9/-12 12 mag	5.1/-14 12 mag	5.3/-16 12 mag	5.4/-18 12 mag	5.6/-21 12 mag	5.7/-25 12 mag	5.7/-29 12 mag	5.7/-34 11 mag	5.5/-40 11 mag	5.2/-45 11 mag	4.7/-50 11 mag	4.0/-53 11 mag	3.3/-55 11 mag	2.6/-54 11 mag	2.0/-51 11 mag	1.6/-48 12 mag	1.4/-44 12 mag
-100	4.6/-11 12 mag	4.8/-12 12 mag	5.0/-14 12 mag	5.2/-16 12 mag	5.4/-19 11 mag	5.5/-22 11 mag	5.6/-26 11 mag	5.7/-31 11 mag	5.6/-37 11 mag	5.4/-43 11 mag	5.0/-49 11 mag	4.4/-54 11 mag	3.6/-57 11 mag	2.7/-58 11 mag	1.9/-56 11 mag	1.4/-52 11 mag	1.1/-48 11 mag	0.9/-44 11 mag
-90	4.5/-11 11 mag	4.7/-12 11 mag	4.9/-14 11 mag	5.1/-16 11 mag	5.3/-19 11 mag	5.5/-23 11 mag	5.6/-28 11 mag	5.6/-34 10 mag	5.5/-40 10 mag	5.3/-47 10 mag	4.8/-54 10 mag	4.0/-59 10 mag	2.9/-62 10 mag	1.9/-60 10 mag	1.1/-57 11 mag	0.7/-53 11 mag	0.5/-48 11 mag	0.4/-44 11 mag
-80	4.4/-10 11 mag	4.6/-12 11 mag	4.8/-14 11 mag	5.1/-16 11 mag	5.3/-20 10 mag	5.4/-25 10 mag	5.5/-30 10 mag	5.6/-37 10 mag	5.5/-45 10 mag	5.1/-53 10 mag	4.4/-60 10 mag	3.3/-65 10 mag	1.9/-65 10 mag	0.8/-62 10 mag	0.2/-58 10 mag	23.9/-52 10 mag	23.8/-47 10 mag	23.9/-43 11 mag
-70	4.2/-10 10 mag	4.5/-11 10 mag	4.7/-14 10 mag	5.0/-17 10 mag	5.2/-21 10 mag	5.4/-26 10 mag	5.5/-33 9 mag	5.5/-41 9 mag	5.4/-50 9 mag	4.9/-60 9 mag	3.8/-68 9 mag	1.9/-71 9 mag	0.3/-68 9 mag	23.5/-62 9 mag	23.2/-56 10 mag	23.1/-51 10 mag	23.1/-46 10 mag	23.3/-42 10 mag
-60	4.1/- 9 10 mag	4.4/-11 10 mag	4.6/-13 9 mag	4.9/-17 9 mag	5.2/-22 9 mag	5.4/-28 9 mag	5.5/-36 8 mag	5.6/-47 8 mag	5.4/-59 8 mag	4.5/-70 8 mag	2.1/-77 8 mag	23.4/-73 9 mag	22.4/-66 9 mag	22.1/-59 9 mag	22.1/-53 9 mag	22.3/-48 9 mag	22.4/-43 10 mag	22.7/-39 10 mag
-50	3.9/- 7 9 mag	4.2/- 9 9 mag	4.5/-12 9 mag	4.8/-17 8 mag	5.1/-23 8 mag	5.4/-31 8 mag	5.6/-42 8 mag	5.8/-56 7 mag	5.5/-71 7 mag	2.6/-83 7 mag	21.3/-78 8 mag	20.7/-68 8 mag	20.8/-60 8 mag	21.0/-54 9 mag	21.2/-48 9 mag	21.5/-44 9 mag	21.8/-40 9 mag	22.1/-37 9 mag
-40	3.7/- 5 8 mag	4.1/- 7 8 mag	4.4/-11 8 mag	4.8/-16 7 mag	5.2/-24 7 mag	5.6/-35 7 mag	6.1/-51 6 mag	6.9/-70 6 mag	12.0/-86 7 mag	18.0/-75 7 mag	18.7/-65 7 mag	19.2/-57 8 mag	19.7/-51 8 mag	20.1/-46 8 mag	20.4/-42 8 mag	20.8/-39 9 mag	21.1/-36 9 mag	21.5/-33 9 mag
-30	3.5/- 1 7 mag	4.0/- 3 7 mag	4.4/- 7 7 mag	4.9/-14 6 mag	5.6/-25 6 mag	6.5/-43 5 mag	8.6/-65 5 mag	13.4/-71 5 mag	16.1/-62 6 mag	17.2/-54 6 mag	17.8/-48 7 mag	18.4/-44 7 mag	18.9/-41 8 mag	19.3/-38 8 mag	19.7/-36 8 mag	20.2/-33 8 mag	20.5/-31 8 mag	20.9/-29 8 mag
-20	3.4/+ 5 6 mag	3.9/+ 4 6 mag	4.6/+ 1 5 mag	5.5/- 6 5 mag	7.2/-23 4 mag	10.5/-44 4 mag	13.6/-44 4 mag	15.2/-40 5 mag	16.1/-37 6 mag	16.8/-35 6 mag	17.3/-33 7 mag	17.8/-32 7 mag	18.3/-31 7 mag	18.7/-30 8 mag	19.2/-29 8 mag	19.6/-27 8 mag	20.0/-26 8 mag	20.4/-25 8 mag
-10	3.3/+20 5 mag	4.1/+23 5 mag	5.5/+26 4 mag	8.4/+24 3 mag	11.8/+ 6 3 mag	13.6/- 6 4 mag	14.6/-13 5 mag	15.3/-16 6 mag	15.9/-18 6 mag	16.4/-20 6 mag	16.9/-21 7 mag	17.3/-22 7 mag	17.8/-22 7 mag	18.2/-22 7 mag	18.6/-22 8 mag	19.0/-22 8 mag	19.4/-21 8 mag	19.8/-20 8 mag
0	3.6/+48 5 mag	6.0/+60 4 mag	10.1/+56 4 mag	12.4/+36 4 mag	13.5/+19 5 mag	14.2/+ 8 5 mag	14.7/+ 1 6 mag	15.2/- 3 6 mag	15.6/- 7 6 mag	16.1/-10 7 mag	16.5/-12 7 mag	16.9/-13 7 mag	17.3/-15 7 mag	17.7/-15 7 mag	18.1/-16 8 mag	18.5/-16 8 mag	18.9/-16 8 mag	19.3/-15 8 mag
10	7.5/+76 5 mag	11.3/+64 5 mag	12.6/+47 5 mag	13.2/+33 6 mag	13.7/+23 6 mag	14.2/+15 6 mag	14.6/+ 9 7 mag	15.0/+ 4 7 mag	15.4/+ 0 7 mag	15.7/- 2 7 mag	16.1/- 5 7 mag	16.5/- 7 8 mag	16.9/- 8 8 mag	17.3/-10 8 mag	17.7/-10 8 mag	18.0/-11 8 mag	18.4/-11 8 mag	18.8/-11 8 mag
20	11.9/+66 6 mag	12.5/+52 6 mag	12.9/+41 6 mag	13.3/+32 7 mag	13.7/+24 7 mag	14.0/+18 7 mag	14.4/+13 7 mag	14.7/+ 9 8 mag	15.1/+ 5 8 mag	15.4/+ 2 8 mag	15.8/+ 0 8 mag	16.1/- 2 8 mag	16.5/- 3 8 mag	16.8/- 5 8 mag	17.2/- 6 8 mag	17.6/- 6 8 mag	18.0/- 7 8 mag	18.3/- 7 8 mag
30	12.4/+55 7 mag	12.6/+46 7 mag	12.9/+37 7 mag	13.2/+31 8 mag	13.5/+25 8 mag	13.8/+20 8 mag	14.1/+16 8 mag	14.4/+12 8 mag	14.8/+ 9 8 mag	15.1/+ 6 8 mag	15.4/+ 4 9 mag	15.8/+ 1 9 mag	16.1/+ 0 9 mag	16.5/- 1 9 mag	16.8/- 2 9 mag	17.2/- 2 9 mag	17.5/- 3 9 mag	17.9/- 3 9 mag
40	12.4/+49 8 mag	12.6/+42 8 mag	12.8/+36 8 mag	13.1/+30 8 mag	13.3/+25 9 mag	13.6/+21 9 mag	13.9/+18 9 mag	14.2/+14 9 mag	14.5/+11 9 mag	14.8/+ 9 9 mag	15.1/+ 7 9 mag	15.4/+ 5 9 mag	15.8/+ 3 9 mag	16.1/+ 2 9 mag	16.4/+ 1 9 mag	16.8/+ 0 9 mag	17.1/+ 0 9 mag	17.5/+ 0 9 mag
50	12.3/+45 9 mag	12.5/+39 9 mag	12.7/+34 9 mag	12.9/+30 9 mag	13.2/+26 9 mag	13.4/+22 9 mag	13.7/+19 10 mag	14.0/+16 10 mag	14.2/+13 10 mag	14.5/+11 10 mag	14.8/+ 9 10 mag	15.1/+ 7 10 mag	15.4/+ 6 10 mag	15.8/+ 4 10 mag	16.1/+ 3 10 mag	16.4/+ 3 10 mag	16.7/+ 3 10 mag	17.1/+ 3 10 mag
60	12.2/+42 10 mag	12.3/+37 10 mag	12.5/+33 10 mag	12.8/+29 10 mag	13.0/+26 10 mag	13.2/+23 10 mag	13.5/+20 10 mag	13.7/+17 10 mag	14.0/+15 10 mag	14.3/+13 10 mag	14.6/+11 10 mag	14.9/+ 9 10 mag	15.2/+ 8 10 mag	15.5/+ 7 10 mag	15.8/+ 6 10 mag	16.1/+ 5 10 mag	16.4/+ 5 10 mag	16.7/+ 5 10 mag
70	12.1/+40 10 mag	12.2/+36 10 mag	12.4/+32 10 mag	12.6/+29 11 mag	12.8/+26 11 mag	13.1/+23 11 mag	13.3/+20 11 mag	13.6/+18 11 mag	13.8/+16 11 mag	14.1/+14 11 mag	14.3/+12 11 mag	14.6/+11 11 mag	14.9/+ 9 11 mag	15.2/+ 8 11 mag	15.5/+ 8 11 mag	15.8/+ 7 11 mag	16.1/+ 7 11 mag	16.4/+ 7 11 mag
80	12.0/+38 11 mag	12.1/+35 11 mag	12.3/+31 11 mag	12.5/+28 11 mag	12.7/+26 11 mag	12.9/+23 11 mag	13.1/+21 11 mag	13.4/+19 11 mag	13.6/+17 11 mag	13.9/+15 11 mag	14.1/+13 11 mag	14.4/+12 11 mag	14.7/+11 11 mag	14.9/+10 11 mag	15.2/+ 9 11 mag	15.5/+ 9 11 mag	15.8/+ 9 11 mag	16.0/+ 9 11 mag
90	11.9/+37 11 mag	12.0/+34 11 mag	12.2/+31 12 mag	12.4/+28 12 mag	12.6/+26 12 mag	12.8/+23 12 mag	13.0/+21 12 mag	13.2/+19 12 mag	13.5/+17 12 mag	13.7/+16 12 mag	13.9/+14 12 mag	14.2/+13 12 mag	14.5/+12 12 mag	14.7/+11 12 mag	15.0/+11 12 mag	15.2/+10 12 mag	15.5/+11 12 mag	15.7/+11 11 mag
100	11.8/+36 12 mag	11.9/+33 12 mag	12.1/+30 12 mag	12.2/+28 12 mag	12.4/+26 12 mag	12.6/+23 12 mag	12.9/+21 12 mag	13.1/+20 12 mag	13.3/+18 12 mag	13.5/+16 12 mag	13.8/+15 12 mag	14.0/+14 12 mag	14.3/+13 12 mag	14.5/+12 12 mag	14.7/+12 12 mag	15.0/+12 12 mag	15.2/+12 12 mag	15.4/+13 12 mag

Natural Catastrophes during Bronze Age Civilisations: Archaeological, Geological and Astronomical Perspectives.

A Conference organised by the Society for Interdisciplinary Studies

The Society organised a meeting at Fitzwilliam College, Cambridge over the weekend of July 12/13 to discuss the possibility that Bronze Age civilisations had been molded by the impact of celestial bodies on the surface of the Earth. Many of the lecturers seemed to be the converted, though the archaeologists seemed to be more worried by the dating of events than by what caused them. I attended the Saturday lectures, which were mostly connected with presenting the astronomical ideas behind catastrophism. I've added a few comments of my own in square brackets [].

The first speaker was Mark Bailey (Armagh) who gave a resume of current cometary theories. He identified six groups: long period comets, short period comets (comprising Jupiter family and Halley type), Centaurs, Kuiper-belt objects and Near-Earth objects (NEOs, including 2P/Encke). The first three and last are mostly small objects, but the Centaurs and KBOs are large, up to 800 km in diameter. The other group of small solar system bodies are the asteroids, with the main belt being the remains of an unformed planet. There is an ongoing process of collisional fragmentation and resonant scattering which can take 0.5 - 2.5 My to put objects on earth crossing orbits. This creation of asteroid families can therefore lead to surges in NEOs. The number of fragments is proportional to d^{-3} which is a much steeper distribution than the background, implying that there are many more small objects than might be predicted by extrapolating the curve of large objects; this is to some extent confirmed by Spacewatch observations. The time scale of the surges is long in terms of our civilisation, but kilometre sized objects can be expected to hit the Earth once every 10^5 years.

He then gave some recent results of theoretical studies. Centaurs can evolve onto short period orbits, of which about 5% can evolve into earth crossing objects on a time scale of 15,000 years; non gravitational forces increase the chance of this happening. They can remain Earth crossing for 5000 years, which gives the chance of dense meteor streams of 1500 times the mass of the Halley streams and could increase the mass of the zodiacal cloud by 15 times. There could also be stratospheric dust loading which implies climatic cooling. Sungrazing is a common end state, not only for NEAs but also HT comets. 2P/Encke will become one in the near future, 98P/Machholz 1(an ex HT) in about 12,000 years and 1P/Halley in perhaps 10^5 years. [The recent discovery of a second group of sungrazing comets by SOHO lends support to this theory.] He predicts that there should be a large number (~3000) extinct long period comets on Halley type orbits. [The recent discovery of 1997 MD10 is perhaps one of these objects.] One giant comet moves into the inner solar system every 10^5 years.

Concluding his talk he emphasised that giant comets do exist and comprise around 0.1% of the comet population. They can evolve into earth crossing or sungrazing orbits and create massive meteor streams. Finally he speculated that perhaps ring markings on some prehistoric stones represent comets. During the discussion a questioner commented that there was much mythology of objects falling into the sun such as Phaeton and Icarus [though they actually fell to Earth]. There are also passages in the bible suggesting that stones fell from the heavens.

Bill Napier (Armagh) started his talk by saying that Brandt & Chapman in their book noted that one Tunguska event occurred every 2000 years and there was nothing to worry about. Clube & Napier however suggested that much bigger events occur every 500 years and there is everything to worry about as there will also be a few dozen in the 10 MT range (the equivalent of Tunguska). Such airbursts leave little trace after as little as 50 years. Spacewatch shows an excess of sub kilometre bodies, in agreement with fireball surveys. A 1000 MT event would create a 5 metre ocean wave, which would build to 50 - 200 metres near shore and travel 20 km inland; the pressure wave would be 4 psi overpressure up to 250 km from the epicenter. 20% of the Earth's land surface has experienced Tunguska like events in the last 5000 years.

Most of the mass flux comes in the largest 2 or 3 objects, there is evidence for a giant comet in the inner solar system within the last 10 - 20,000 years. Fortunately the Kreutz progenitor was inclined at 144 degrees to the ecliptic or there would be lots of debris hitting us. The zodiacal cloud has a lifetime of only 20,000 years as observations show only 2 tonnes/second coming in to it and 40 tonnes/second leaving it. The Stohl streams comprising of Taurids, 2P/Encke and other comets and asteroids have a short dynamical lifetime so the night sky must have looked very different 5000 years ago. There is evidence for fireball swarms: the Lunar seismometer events of 1975 June 26 - 30, 12 fireball storms are recorded in Chinese annals (of which 5 were seen in daylight), radar observations of comet nuclei showing boulder sized objects (IAA, Wilson) and historical peaks in the 11th Century.

All this would give rise to stratospheric dustings: 10^{14}g would lead to a 2° C cooling and this might explain some of the flickering in the Vostok ice core [though glaciologists think it more likely to be natural climatic variability]. He showed a picture of the Newgrange stones which shows a feature very similar to the haloes in Hale-Bopp and pondered that maybe megalithic roofed structures (such as seen in the UK, Turkey and North America) were shelters ?

Duncan Steel (Spaceguard Australia), the next speaker, came up with some original ideas on the origin of Stonehenge. He suggested that the axis of Stonehenge originally pointed further to the north and therefore couldn't be a luni-solar observatory. He thought it might be connected with cosmic events from the break-up of the precursor of comet 2P/Encke. The earliest stage of Stonehenge consisted of a circular bank, Aubrey holes and the two heel stones and he thought that the bank was a shield for meteor observers against light pollution from camp fires. [This was partly based on a photograph of Canadian observers with a shield around them; in this case the time of year was winter and the shield was actually against the wind.]. The Cursus next to Stonehenge is actually a much bigger construction than Stonehenge I and required ten times as much effort to build (around 10% of the GDP). The Cursus was built between 3500 and 3300 BC and has an inclination of 55°, whilst Stonehenge I was built between 3200 and 2800 BC and has an inclination of 55°. The period of the comet might have been such that major storms occurred at intervals of 19 years. Stonehenge II, built between 2200 and 1100 BC was just a ritual temple and the 19 year period might have been interpreted as of lunar origin.

[I actually visited the site the next day and viewed it from the standpoint of a meteor observer. One might expect a meteor observatory to be at the highest point in the area, but the Cursus is on a sloping hillside and Stonehenge is in a low valley. The Cursus is rather a wide feature and I couldn't see any obvious way that it could be used to observe meteors or comets. I didn't visit the Stonehenge site itself as there are far too many tourists there, but virtually none of them made it the few hundred metres to the Cursus. What did strike me was an alternative possibility to explain the origin and location of megalithic circles - they could mark the sites of observed meteor falls. In this case one might expect to find the remains of impact pits at the centre of each feature.]

He pointed out that one of the original sources of a print showing a Leonid storm came from Daniel and the Revelation by Uriah Smith. He went on to suggest that when corrected for observing geometry and Faraday rotation of daytime echoes, 90 - 95% of radar meteors come from helion/antehelion sources which are associated with comet 2P/Encke. IRAS showed that many comets have trails associated with them. [Ref Icarus 95, 180, 1992 - comet trails]. It would take between 6 and 24 hours for the Earth to transit a trail. If comet Encke had a semi-major axis of 2.15 - 2.20 AU (P ~3.16 years) this would give rise to trail crossing every 19 years. It is possible to integrate the orbit of comet Encke back in time and find out when its associated trail intersected the Earth. This might have happened in 200 AD and 0 AD, however the orbit is not known well enough to go back more than a few hundred years so its not really possible to tell what might have happened around 3000 BC. In 3500 BC the intersection of the ascending node of the orbit would occur in daylight and by 3200 BC the intersection of the descending node would occur at night. The core of the trail would contain Tunguska sized objects and such meteor storms would be truly terrifying experiences.

He concluded by suggesting that long barrows were air-raid shelters and the Aubrey holes were for the meteor observers to stand in!

Following a question in another talk he commented that the US Space Command planned a launch in 1999 to visit two NEAs. The US search programs were currently only covering <1% of the northern sky and there was no southern program.

Gerrit Verschuur (Memphis) concluded the morning session with an 'eminent persons' talk on some implications of impact catastrophes. He started by outlining the solar system formation - how impacts gave Venus its slow rotation and created the Earth-Moon system with Earth's inclination of 23.5 degrees. Interstellar comets gave rise to our oceans - he had a 'gut feeling' that comets must form in regions around giant stars and that the solar system might have included largish objects from the beginning, rather than the usual idea of aggregation of small fluffy particles. A planet formed between Mars and Jupiter which subsequently broke up. Mars without a moon had a larger range of orbital inclinations that the Earth. He couldn't accept the Oort cloud.

Bronze age civilisations were destroyed by abrupt climate change caused by impacts, which would also cause tsunamis round the coast. He gave a list of 'hits' which included the 1176 AD event, the wiping out of South Island, New Zealand and the 1879? Chicago fires. [It seemed a very uncritical list, which included many entries gleaned from the internet, though he did qualify it by saying that the degree of authenticity ranged from Tunguska downwards]. The sky is filled with cosmic debris, but mankind has an illusion of invulnerability and is always hopeful so won't act to do anything about the risk. As an example he had counted only 3 deaths in the sequence of the destruction of Dallas in the film 'Asteroid'. What we needed was a small event that would kill a million people.

The afternoon session moved on to cover archaeology, geology and climatology. Marie-Agnes Courty (Paris-Grignon) described work she had carried out in the middle east on sites from the 3rd millennium BC. A layer of tephra was originally dated at 2250 BC, coincident with the fall of the Akad empire, but was now dated at 2350 BC. It was associated with increased aridity and the decline of empire. The tephra could have come from Turkey, a few hundred kilometres away, but the deposit was well sorted and yet the grains were inhomogeneous and there was a sequence of a few cm of yellow dust overlying a fired layer, which was found over several thousand km^2. She had also found calcite spherules, which she suggested had similarities to the Orguiel carbonaceous chondrite and the KT boundary event. Possibly crystallisation from a vapour could explain some of the tailed spherules, inclusion of soil fragments and nickel-iron whiskers. There was a peak of carbon black, perhaps implying a wildfire, but no conclusively extra-terrestrial material. A volcanic event was improbable, anthropogenic possible, but didn't explain the spherule layer and a cosmic event not that convincing; misinterpretation was a possibility. It might be worth looking for links with ice core events to explain the feature.

Mike Baillie (Queen's, Belfast) described his analysis of Irish tree rings, in particular looking at extremes of climate. Some of these coincided with volcanoes such as 1882 Krakatoa, 1912 Katmai and 1628 BC Santorini. There was poor growth for several years following 1628 BC and this can be linked to the decline of civilisation in the Aegean. Many of the narrow ring events link with acid layers in the Greenland Camp Century core. A tree ring event in 2354 to 2345 BC has no equivalent in the Greenland core. The wood of the rings takes on a diffuse appearance and the rings become unclear; the trees could have been standing in a bog. Tephra in the peat was dated to around 2320 which is not close enough. The Lisbon earthquake of 1755 AD gave rise to raised water levels across Europe and maybe volcanic events could do the same. Coincidentally Archbishop Usher had dated the flood to 2349, Irish annals gave the flood as 2341 and Chinese to 2349.

Tree rings showed a narrow event in 540 AD, which was general throughout the northern hemisphere. The dust veil index gave an event in 536 AD (dim sun etc) as well as famines and plagues, and possibly there were multiple events. The Dye core is missing around 540, but there is no good evidence for a volcano in 540 AD, so perhaps there was a cosmic event. This would tie in with Bailey, Napier & Clube's suggestion of events between 400 and 600 AD.

Temperature sensitive chronologies suggest that both the 1628 BC and 1159 BC events occurred during the middle of a cold period. Did volcanoes just happen in the middle of the cold period ? Perhaps Gaia causes volcanoes to go off to counteract the cold? [However volcanoes actually lead to additional cooling]. Ice core workers have a naive faith in using their own dating techniques when tree ring data does better. The dates may link to the collapse of Egyptian and Chinese dynasties.

The next speaker was the organiser of the conference, Benny Peiser (Liverpool). There are 4 or 5 impact craters dated to 4000 BP; these include the Argentinean Rio Quarto craters where the main crater is 4.5 x 1 km and there are several smaller elongate craters. Only this one would be big enough to have global effects. Most cultures have flood legends and fireball reports. There is a Chinese legend of 10 suns that would destroy the world. There are only two well investigated events - Tunguska and the KT event. Scientists need to define what features are associated with impact events so that researchers know what to look for. Features include: blast, fires, earthquakes, tsunamis, dust veils, acid rain and ozone depletion. Tunguska had twice the energy yield of the Barringer crater. The age of the Chad craters is proven at either 12,000 BC or 36 My. Tektite strewn fields are linked to impacts. In Mesopotamia, events of general destruction occurred in 2300, 1600 and 1200 BC. The event in 2300 was global, though there are dating problems, so linking it with the end of the first urban phase may be wrong. There are lake level changes throughout Africa ~5000 BP. He carried out an abstract search of archaeological events dated between 2500 and 2000 BC and found a common event at 2350 +/- which included destruction layers, site abandonment, tephra layers, seismic events etc.

The final speaker that I heard was Bruce Masse (Hawaii), who spoke about various myths and legends and their possible relation to impacts. He made a list of 1400 tales recorded over the past 4000 years. The AD 1301 return of 1P/Halley coincided with a major eruption of Heliakala and in Hawaiian legend, Ku is the comet god, which bears a passing resemblance to comet Donati. The explanation of the flood could be a) local, b) psychological, c) a single global event. Several myths have horned serpents, dragons or fishes with glowing eyes appearing before the flood, sometimes appearing twice with a delay of a few months. These could refer to comets. Flood myths suggest that the flood began at or near full moon, in late April or early May. Possible dates between -2810 and -2900 are found in Chinese, Egyptian and middle eastern calendars. Other celestial events, which included conjunctions and a move of a Pleiad star to the Plough, presaged the flood. There are links to a partial solar eclipse (one occurred on -2807 May 10) and to Aquarius, Pisces and the Pleiades (there was a quadruple conjunction on the Aquarius/Pisces border in -2807). Other events include a dark sun, hurricane winds for a week or two, strong earthquakes, torrential rain for 5 - 7 days, with such large drops that it was difficult to breath (maybe 50 mm/hr) and was hot or warm; tsunami such that people had to flee to hilly locations (suggesting a wave 200 m high penetrating 50 - 100 km from the coast); it was light at midnight (cf Tunguska). Taken together such tales imply an impact in the southern ocean, near the Greenwich meridian. 75 - 95% of the population died, but numbers would recover within about 100 years, perhaps leading to migrations. The Pleiades are linked to the origin of fire, therefore it was a north Taurid object that caused the event! He concluded by mentioning an earlier event at 3800 to 3900 BC, coincident with the date for the Argentinean Rio Quarto impact, which is described in Indian legends.

Talks continued on Sunday, though I was not able to attend for these. Mostly they concentrated on the philosophical implications of a potentially catastrophic environment. One or two, including some of the poster papers had an astronomical content. One paper suggested that glacial features known as eskers and drumlins are actually cometary debris, created when the rotating jets from a comet's nucleus hit the earth!

Letters

Spectroscopy

As a postscript to my piece in the May '97 newsletter, it is worth pointing out that in the event Hale-Bopp did not oblige with a spectacular display of spectroscopic fireworks; despite its brightness, it has actually not been a suitable target for ‘nylon curtain spectrometry’. The comet was out of range of my permanently-mounted 0.32-m Newtonian due to a line of trees immediately to the north, so I was unable to try the method on this occasion. However, using a hand-held 10x80 with a 15° flint glass objective prism sellotaped over the top of the dew-cap, I recorded the following on 11th April: “Spectrum exactly as before, a pure continuum extremely bright & intense with no hint whatever of dark gaps or of bright emission bands, the colours vivid all the way from dark red to deep violet-blue”, with identical results on 8 other dates from 30th March to 30th April (all referring to the head, of course). A very similar result was suggested by a quite different method of observation on 23rd March, when the comet displayed a surprisingly small difference in brightness when viewed through narrow-band filters centred, respectively, on 515 nm which transmits the brightest C_2 band, and 500 nm which falls entirely in a dark gap between the main emission bands.

The conclusion seems clear that, for all the spectacle Hale-Bopp undeniably provided in other respects, it was an extra-ordinarily dull & inactive specimen in these terms. Whatever the professionals may have been seeing with their large apertures & powerful spectrographs, in small instruments the comet’s spectrum was visually indistinguishable from a pure solar continuum. This, of course, is entirely in keeping with the huge visual brightness of the dust-tail compared with that of the plasma-tail, in such marked contrast with Hyakutake last year. However, most comets brighter than about 6th mag should provide something worth measuring by the ‘nylon curtain’ method when within 1 AU of the sun, so we shouldn’t have too long to wait for other suitable candidates. Meanwhile, if anyway wants further details or explanation of the method, please send an A4 sae to Christopher Taylor at: Mathematics Dept., Harris Manchester College, Oxford. OX1 3TD.

Christopher Taylor

Tales from the Past

This section gives a few excerpts from past BAA Journals, RAS Monthly Notices and Sky & Telescope

100 Years Ago: The comet Section report for the 1896/97 session comments “The comets which have been visible during the year have not been of the class which arouses enthusiasm, but have required very considerable optical power for their adequate observation.” At the 1897 October 27 meeting an ephemeris for the new comet [Perrine 1897 U1] was written on the blackboard for Members to copy.

50 Years Ago: The annual report of the Section noted that six comets had been observed by five observers and that Section membership was a nominal 20. Sky & Tel noted that several comets were visible over the year. Eight had been discovered up to July, but none were visible to the naked eye. The previous record had been 13 in 1932. [Provisional letters up to ‘n’ were assigned in 1932, 1939 and 1947, but not all of these were confirmed.]

Professional Tales

Many of the scientific magazines have articles about comets in them and this regular feature is intended to help you find the ones you've missed. If you find others let me know and I'll put them in the next issue so that everyone can look them up.

Science, 1997 May 9. Robert Brown *et al* look at the surface composition of Kuiper Belt Object 1993 SC using the Keck I telescope in the near infra-red. The strongly red continuum has several prominent absorption features. By analogy with Pluto and Triton they suggest that these may be due to CH_4, C_2H_6, C_2H_4 or C_2H_2 and that the red continuum may indicate more complex hydrocarbons. Another paper in the same issue, by Roman M H∫berli *et al*, comes up with an explanation for the X-ray emission from comets, first seen in comet Hyakutake (1996 B2). They suggest that it is caused by highly charged solar-wind ions capturing electrons from molecules or atoms in the comet's coma. Modeling the process gives a good fit to observations and they suggest that detailed X-ray observations of comets could give another way of monitoring the solar wind.

Old text books often give another perspective on present day theories. I recently obtained a copy of R A Lyttleton's book on comets, published in 1952. In it I discovered that P/Shoemaker-Levy 9 was not the first 'string-of-pearls' comet. This title was given to comet 1882 R1 which broke up near the time of perihelion into at least six star-like knots or condensations. I also read that Professor Challis (who had used the observation of comets as an excuse for not discovering Neptune) had observed the splitting of Biela's comet with the Northumberland refractor in 1846. At first he thought he was seeing things, two days later he still thought his eyes were deceiving him and not until 10 days had elapsed did he feel sufficiently convinced to publish his findings; but by then it had been established elsewhere and Challis lost the chance to be first in the field. He apparently attributed this slowness to confirm his suspicions to the pressing claims on his attention of the search for the theoretical planet Neptune! Ideas about comets have changed substantially since the book was written. Lyttleton didn't think that the coma and tail are produced by sublimation : 'Another class of hypothesis simply accepts, without explanation, the existence of comets in the solar system and is concerned solely with their structure and development. The coma and the tail are considered to be produced by the warming effect of the sun's radiation as the comet approaches perihelion. Theories of this kind amount to little more than descriptive accounts of a purely *ad hoc* character without providing any real explanation.' He didn't think much of what is now known as the Oort cloud either: 'Yet another obscurant idea dating back indefinitely is that a vast assembly of comets associated with the sun subsists in the form of a nebulous shell at 10^4 or 10^5 astronomical units distance (where it would be quite beyond the possibility of observational detection), and that the few comets seen are rare members of this cloud that happen to be deflected inwards to a sufficient extent through chance perturbations by passing stars. The question as to how the alleged comets got there, lately estimated to be 10^{11} in number - recalling Kepler's view that 'there are as many comets in the sky as fishes in the sea' - and all the additional unnatural requirements that have to be introduced to explain away the abundant difficulties and contradictions that appear as soon as the idea is subjected to test, are dealt with simply by confident assertion that there is evidence tending to support the necessary saving clauses but always without the smallest attempt to say what the evidence is.' I wonder what the future will say about the Big Bang theory. Perhaps gamma ray bursters are Hoyle's sites of continuous creation of matter!

Several spacecraft are being targeted to visit comets. NASA plans to send Stardust to 81P/Wild 2 (and you can send your name to it as well by writing to the Planetary Society). Deep Space 4 will visit 9P/Tempel 1 in December 2004 and return samples. Contour will fly past 2P/Encke, 73P/Schwassmann-Wachmann 3 and 6P/d'Arrest between 2003 and 2008. ESA is sending Rosetta to 46P/Wirtanen in 2012 and Japan also has plans for a cometary mission.

Jonathan Shanklin

Review of comet observations for 1997 May - 1997 October

The information in this report is a synopsis of material gleaned from IAU circulars 6655 - 6771 and The Astronomer (1997 May - 1997 October). Note that the figures quoted here are rounded off from their original published accuracy. Lightcurves for the brighter comets are from observations submitted to The Astronomer and the Director. A full report of the comets seen during the year will be published in the Journal in due course.

2P/Encke put on a brief show for southern hemisphere observers during June and July as it made its closest approach to the earth since discovery. A bit fainter than expected it faded from 7th to 10th magnitude, becoming very diffuse. The observations give a preliminary light curve of 11.8 + 5 log d + 18.6 log r.

29P/Schwassmann-Wachmann 1 outburst to around 11th mag in late May, just as it was becoming lost in the twilight. This comet seems to spend a lot of time in outburst and is worth monitoring with CCD cameras on a regular basis. Observers are encouraged to check the comet at every opportunity over the coming apparition. It is in Virgo and a finding chart is included in the Observing Supplement.

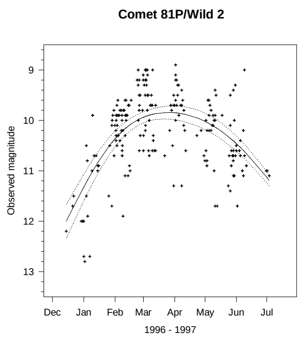
43P/Wolf-Harrington has been visible in the early morning since August. A small faint object, it peaked at around 13^{m} and is now slowly fading. Observations received so far give a preliminary light curve of 8.9 + 5 log d + [15] log r

48P/Johnson was observed twice in August at mag 14.

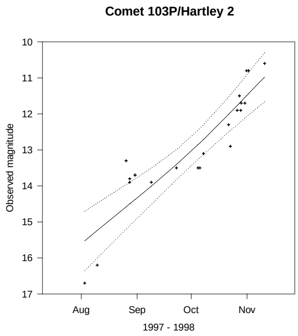
65P/Gunn was brighter than expected in September, but at around 13th mag few observations were made.

78P/Gehrels 2 peaked at around 12th mag in October; but again few observers were following it. The observations give a preliminary light curve of 6.9 + 5 log d + [15] log r.

81P/Wild 2 continued its slow fading reported in the last issue and was lost to southern hemisphere observers in early July when it was 11th mag. The observations give a preliminary light curve of 6.2 + 5 log d + 14.2 log r.



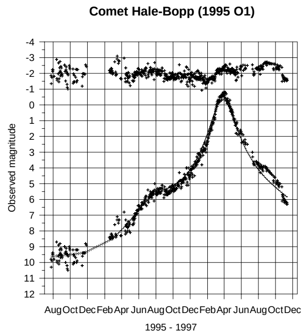
103P/Hartley seemed rather slow to start brightening, but eventually began to follow more or less the same light curve as at the last return. It should now be around 9th mag and will remain this bright for several months. Observations received so far give a preliminary light curve of 9.7 + 5 log d + 18.1 log r and combining them with those from the previous apparition gives 8.9 + 5 log d + 18.8 log r.



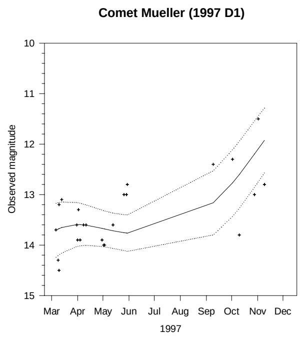
104P/Kowal 2 is a little brighter than expected at 14th mag and may become visible at around 13th mag later in the year.

C/1995 O1 (Hale-Bopp) has now disappeared from view to northern hemisphere observers and will not be seen again from the UK for another 2380 years. Although it was a 'great comet', it is not yet THE great comet of 1997 - there is still a month to go! In total I've now received 3100 visual magnitude observations of the comet and some 600 drawings, images and photographs. Nick James is preparing a paper on the comet for the Journal.

The comet continued to fade slowly after perihelion, but in the second half of October it suddenly faded by about 1 mag dropping below naked visibility after 16 months. The equation -0.7 + 5 log d + 7.5 log r fits the available observations, but there are long period variations about this mean curve of around a magnitude.



Comet Evans-Drinkwater (1996 J1) was observed to have fragmented into two after conjunction and was brighter than expected in the summer, although it was only 13th magnitude at best.

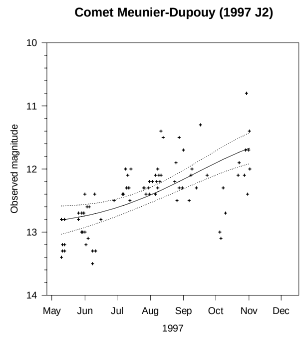


Asteroidal images of 1996 N2 133P/Elst-Pizarro from previous apparitions have been found (1979 OW7, and also in 1985) and the comet has been given permanent cometary (133) and asteroid numbers (7968) and also named as asteroid Elst-Pizarro

Comet Mueller (1997 D1) was very difficult to see when it reappeared from conjunction and the early light curve clearly overestimated its rate of brightening. It should peak at around 11th mag if the preliminary light curve of 9.0 + 5 log d + 5.1 log r holds, however 13th magnitude seems more likely at the moment.

55P/Tempel-Tuttle (1997 E1) has not yet been recovered after solar conjunction. The parent comet of the Leonids, it will not reach perihelion until 1998 Feb 28 when it may get as bright as 9^m. It will pass 0.35 AU from the earth in mid February when it gets within 8° of the pole.

C/Mueller (1997 J1) was visible at around 13th mag in the early summer.



1997 J2 Meunier-Dupouy was an accidental discovery by two independent French amateurs who were imaging 1997 J1 with CCD cameras. First reported by Michel Meunier on May 7.9 it was also found by P Dupouy and J F Lahitte the next day. It is a slow moving, distant comet and will remain on view for another year, reaching 11th mag at best during December. The observations received so far give a preliminary light curve of 5.7 + 5 log d + 6.3 log r

1997 L1 Xinglong was a faint, distant comet, discovered with the Beijing Astronomical Observatory 0.6-m Schmidt during the course of an asteroid survey, and originally thought to be an asteroid. Observations with the 1.8-m reflector of the Dominion Astrophysical Observatory showed its cometary nature.

1997 L2 SOHO was one of only two non sungrazing comets discovered by the satellite so far.

It was not observed by other means.

1997 M2 131P/Mueller 2 was independently recovered by Japanese observers A Sugie and A Nakamura, both using 0.60-m reflectors and CCDs. The comet was 0.26 days behind the prediction by K Muraoka in the ICQ Handbook.

Asteroid 1997 MD10 is on an eccentric cometary orbit with a period of 124 years and perihelion distance of 1.5 AU, though no sign of a coma has been seen so far. It may be one of the many extinct Halley type comets that are expected on dynamical grounds.

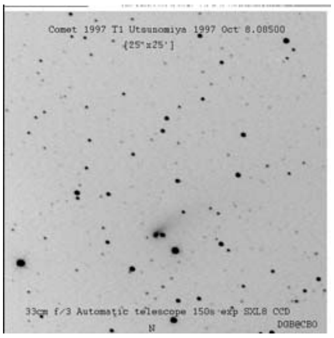
1997 N1 Tabur was discovered by Vello Tabur of Wanniassa, ACT, Australia. At discovery the comet was around 10th mag, with a diffuse coma, however it didn't brighten much as it approached perihelion and became more diffuse, suggesting that it was becoming extinct. I made some tentative observations of it after perihelion as it emerged into the northern twilight, but no confirming observations have been made. Combining the pre-perihelion observations with my own post-perihelion ones gives a light curve of 9.4 + 5 log d + 7.3 log r.

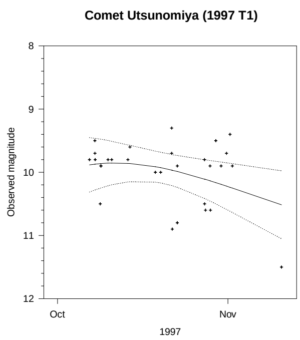
1997 N2 132P/Helin-Roman-Alu 2 was recovered by Carl Hergenrother using a CCD camera on the SAO 1.2-m reflector on Mt Hopkins.

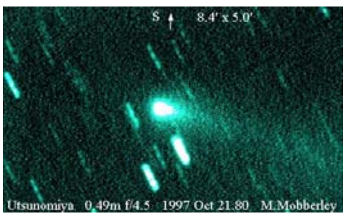
1997 O1 Tilbrook was discovered by Jason Tilbrook, Clare, S Australia whilst observing TV Crv. 10th mag at discovery, it was only a southern hemisphere object and faded as it approached conjunction.

1997 P2 Spacewatch was another comet discovered by the automated search program on the Spacewatch telescope on Kitt Peak. It is a distant comet with a strongly hyperbolic orbit following an approach to Jupiter at the beginning of February. The only comet with a greater eccentricity was comet Bowell 1980 E1 which was well observed by the Section.

1997 T1 Utsunomiya was discovered by Syogo Utsunomiya of Azamihara, Minami-Oguni cho, Aso-gun, Kumamoto-ken, Japan. Unusually it was relatively bright when it was found at high northern declination with 25x150B. Early observations showed a strongly condensed coma, with a short tail (image by Denis Buczynski). Now at its brightest (image by Martin Mobberley), it will fade, though may become visible after conjunction next year.







1997 T3 was discovered by a team of observers from the DLR Institute of Planetary Exploration, Berlin during the course of the Uppsala-DLR Trojan Survey. It is in a distant elliptical orbit with a period of 19.7 years.

1997 V1 P/Larsen is a 17th mag comet discovered by Jeff Larsen on images taken with the Spacewatch telescope. Another distant periodic comet it has a period of 10.8 years.

Thirty two sungrazing comets have now been discovered by the LASCO coronographs on the SOHO spacecraft and it will soon eclipse the Shoemaker-Levy team as the leading cometary discoverer. The comets are: 1996 B3, 1996 D1, 1996 F2, 1996 H1, 1996 M1, 1996 M2, 1996 O1, 1996 O2, 1996 O3, 1996 O4, 1996 Q2, 1996 Q3, 1996 S3, 1996 X1, 1996 X2, 1996 Y1, 1997 B2, 1997 K1, 1997 L3, 1997 L4, 1997 M1, 1997 P1, 1997 Q1, 1997 Q2, 1997 R1, 1997 R2, 1997 R3, 1997 S1, 1997 T2, 1997 T4, 1997 T5 and 1997 V2. These are among the intrinsically faintest comets ever seen, with an absolute magnitude of around 20. They mostly represent minor fragments from the Kreutz group of sungrazing comets whose orbital evolution has been described by Brian Marsden (AJ 1967, 72:1170, 1989 98:2306). These comets have perihelion distance, q < 0.02 AU, longitude of perihelion, L (L = longitude of ascending node + arctan(tan(argument of perihelion) * cos(inclination)) around 282 degrees and latitude of perihelion, B (B = arcsin(sin(argument of perihelion) * sin(inclination)) around 35 degrees. Only the larger objects survive perihelion, and then only if q > 0.005 AU.

The comets probably originated from the breakup of a comet seen in -371, which was reported to have fragmented into two parts by the Greek historian Ephorus. This breakup seems to have given rise to two main comets, one of which had a period of around 350 years and the other a period of around twice this. The shorter period object returned in the 1st, 4th, 8th and 11th centuries and may be identical with the comet of 1487. The 11th century return seems to have caused further breakup which gave rise to sub-group I of the Kreutz sungrazers. This group includes 1843 D1 (Great March Comet), comet Pereyra (1963 R1) and more recently the Solwind and SMM objects, plus 1997 L4 discovered by SOHO (and probably 1996 H1, 1996 M1, 1996 M2, 1996 X2, 1996 Y1, 1997 K1, 1997 M1, 1997 R1, 1997 R2, 1997 R3, 1997 S1, 1997 T4 and 1997 T5). The longer period object returned in the 4th century and in 1106 when it also broke up, to give rise to sub-group II comets including 1882 R1 (Great September Comet) and Ikeya-Seki (1965 S1), plus 1997 L3 (and probably 1997 Q1and 1997 Q2) discovered by SOHO. Comet White-Ortiz-Bolelli (1970 K1) appears to be belong to a slightly different sub-group of this grouping and may represent an earlier breakup. Some new groupings appear to be possible from the SOHO objects: 1996 O1, 1996 O3, 1996 O4, 1996 Q2, 1996 Q3, 1996 X1 and 1997 P1 appear to form a group with B around 28°, 1996 O2 and 1996 S3 have L around 272 and 1996 F2, 1997 T2 and 1997 V2 have L > 285 and q > 0.008.

Three of the SOHO comets (1996 B3, 1996 D1 and 1997 B2) appear to belong to a slightly different group of sungrazers as they have L around 270 and B around 50, rather than the 282 and 35 expected for the Kreutz group.

The exact orbit of the comets on their return depends very much on what the solar system barycentre is doing at the time and this is largely controlled by the position of Jupiter and Saturn. The breakup velocities were probably very small and objects may have remained gravitationally bound in orbit round each other or even in contact.

SOHO has discovered two comets that are not sungrazers. These are 1997 H2 and 1997 L2, though neither has been observed by other means. It observed comet 96P/Machholz 1 at perihelion, and found it a little brighter than expected and has also observed comets 45P/Honda-Mrkos-Pajdusakova and Hyakutake (1996 B2).

For the latest information on discoveries and the brightness of comets see the section www page: http://www.ast.cam.ac.uk/~jds

Comet Prospects for 1998

Although now long gone from the northern hemisphere, comet Hale-Bopp is still predicted to be the brightest comet of 1998, though there is always the chance of something better coming along. A couple of long period comets discovered in 1997 are still visible and there are several reasonable returns of short period comets. Recent theories on the structure of comets suggest that any comet could fragment at any time, so it is worth keeping an eye on some of the fainter periodic comets, which are often ignored. Ephemerides for new and currently observable comets are published in the *Circulars*, in this Newsletter and on the Section and CBAT web pages, with predictions for returns in the Handbook[1] and on Seiichi Yoshida's web pages[2]. Complete ephemerides and magnitude parameters for all comets predicted to be brighter than about 18^m are given in the International Comet Quarterly Handbook[3]; details of subscription to the ICQ are available from me.

Comet Hale-Bopp (1995 O1), the great comet of 1997, is fading very slowly and could still be 7^m at the beginning of the year, fading to 11^m by the year's end. The catch is that it is only easily observable from southern hemisphere locations. Thanks to its high southern declination of more than 50 degrees, UK observers will need to arrange a foreign holiday if they want to see it again.

Comet Mueller (1997 D1) is a new comet discovered on plates taken by Jean Mueller for the 2nd Palomar Sky Survey with the 1.2m Oschin Schmidt Camera on 1997 Feb 17th. The object was initially reported as 16th mag, but appeared brighter to visual observers, though when recovered after solar conjunction it was fainter than expected. At perihelion on 1997 October 12, it should fade from around 11^m at the beginning of the year to 15^m at the end of April whilst completing a loop in Eridanus and Cetus. UK observers may be able to follow it until mid February and southern hemisphere observers until March, after which the solar elongation becomes too small. Recent observations suggest it is fading away and may be difficult to observe.

Comet Meunier-Dupouy (1997 J2) was accidentally discovered by French amateur astronomers who were imaging comet Mueller 1997 J1. Michel Meunier reported a comet 6' SW of 1997 J1 on May 7.9, moving more slowly and perhaps 0.5 mag brighter. Independently another pair of French amateurs P Dupouy and J F Lahitte reported it the next day. It should remain visible for the entire year, starting at around 11^m and then fading from a peak of 10^m in July to 13^m. Initially heading south-eastward through Cygnus into Pegasus it changes direction and heads more rapidly south and a little west through Equuleus and Capricornus. It is at opposition in August, but its southern declination means that UK observers will loose it after early November.

21P/Giacobini-Zinner, the parent comet of the October Draconid meteors, should be visible from August until the end of the year, brightening from 14^m to 9^m. It is an evening object and at its best at the end of November. Starting off in Hercules and accelerating into Aquila, it then moves through the zodiacal constellations of Capricornus and Aquarius. An increasingly southern declination means that UK observers will loose it towards the end of the year. The comet was first discovered by Giacobini at Nice observatory in December 1900 and was thought to have a period of 6.8 years. The next two returns were expected to be difficult to observe, but in October 1913, Zinner, of Bamberg, Germany, discovered a comet whilst observing variable stars in Scutum. This turned out to be the same comet, but the period had been incorrectly determined. The comet was missed at three unfavourable returns, so this will be the thirteenth apparition of the comet.

29P/Schwassmann-Wachmann 1 is an annual comet which has frequent outbursts and seems to be more often active than not at the moment, though it rarely gets brighter than 12^m. In the first half of 1997 it was in outburst for several months. The randomly spaced outbursts may be due to a thermal heat wave propagating into the nucleus and triggering sublimation of CO inside the comet. This year it is at opposition in April in Virgo and should be observable until June. It is then in conjunction until September and will be observable in Libra for the rest of the year. This comet is an ideal target for those equipped with CCDs and it should be observed at every opportunity. Unfortunately opportunities for UK observers may be limited as its altitude does not exceed 20° during its period of visibility from this country.

43P/Wolf-Harrington was at perihelion at the end of September 1997, and will be observable in Hydra as it fades from 13^m to 15^m. UK observers will loose it in mid January, but southern hemisphere observers may be able to follow it till March.

55P/Tempel-Tuttle (1997 E1), the parent comet of the Leonids, was recovered by observers using the Keck 10m telescope on March 4.6 and confirmed using the ESO 3.5m NTT at mag 22 on March 7.3. At the start of the year it is in Canes Venatici, heading swiftly north towards the pole. Initially a morning object it brightens rapidly as heads towards a relatively close approach to the earth in mid January, when it may reach 8^m. It then heads rapidly south again, passing through Andromeda in late January and into Pisces. Intrinsically it is quite a faint comet and by the time it reaches perihelion at the end of February will be over 1 AU from the earth, so it will not put on as good a show as is expected from the meteors it has produced. The solar elongation becomes too small for observation past early March.

The comet was originally discovered on 1865 December 19 by William Tempel in Marseilles and on 1866 January 6 by Horace Tuttle from Harvard. The comet was then around 6^m and reached perihelion on January 12 when it was 5^m. It faded and was last seen on February 9. Once the orbit was calculated it was realised that it was very similar to that of the Leonids and previous returns of the comet were found in 1366 (when it made a very close approach to earth, 0.0229 AU, and reached 3^m) and 1699. It wasn't really looked for in 1899, and couldn't be found in 1932. At its last return, it was eventually recovered some three months after perihelion in 1965 June.

88P/Howell might be observable from April, when it is at opposition in Virgo, but it is usually brighter after perihelion, which occurs at the end of September. It is unlikely to be brighter than 11^m and could be fainter as it fades to the year's end. With a low inclination orbit, the comet sticks to the zodiacal constellations and can be found in Scorpius at perihelion, moving onwards to Capricornus at the end of the year. UK observers will loose it after early June, after which it belongs to more southerly located observers. The comet was discovered in 1981 by Ellen Howell with the 0.46-m Palomar Schmidt. It passed 0.6 AU from Jupiter in 1978, which reduced the perihelion distance, but the biggest change to its orbit occurred in 1585 when an encounter reduced q from 4.7 to 2.4 AU.

103P/Hartley 2 is another comet left over from 1997. It is an evening object and will slowly fade from 7^m - 8^m in late December when it was at perihelion to 14^m by the end of April. Beginning the year in Aquarius it moves rapidly eastwards, reaching Monoceros in April, remaining an evening object.

104P/Kowal 2 may be visible for a short while at the beginning of the year (see observing supplement).

A number of fainter comets may be of interest to CCD observers. These include: 78P/Gehrels 2 (a left over from 1997) and 62P/Tsuchinshan 1 (13^m, April), 68P/Klemola (14^m, September), 80P/Peters-Hartley (14^m, July), 93P/Lovas (13^m, October) and 95P/Chiron (opposition early May in Libra, 15^m). Ephemerides for these can be found on the Comet Section or CBAT WWW pages. CCD V magnitudes of Chiron would be of particular interest as observations show that its absolute magnitude varies erratically.

Several other comets return to perihelion during 1997, however they are unlikely to become bright enough to observe or are poorly placed. These include: 49P/Arend-Rigaux, 98P/Takamizawa and D/Harrington-Wilson which have unfavorable returns and 83P/Russell 1, 129P/Shoemaker-Levy 3 (1996 U1), 130P/McNaught-Hughes (1997 H1), P/Shoemaker-Levy 7 (1991 V2), P/Kowal-Vavrova (1983 J3) and Montani (1997 G2) which are intrinsically faint or distant comets. D/Harrington-Wilson (1952 B1) was only observed at its discovery apparition and is probably lost as it came within 0.6 AU of Jupiter in 1961 which would have changed an already uncertain orbit.

Looking ahead, 1999 sees favorable returns of comets 10P/Tempel 2, 37P/Forbes and P/Machholz 2 (1994 P1). Of these the best are Tempel 2, which should reach 9^m in the summer and Machholz 2 which should reach 8^m late in the year.

References

1. Taylor, G. E., *The Handbook of the British Astronomical Association for 1998*, (1997).
2. http://www.info.waseda.ac.jp/muraoka/members/seiichi/index.html
3. Nakano, S. and Green D. W. E., Eds, *International Comet Quarterly 1998 Comet Handbook*, (1997).
4. Shanklin, J. D., *Observing Guide to Comets*, (1996).
5. Marsden, B. G. *Catalogue of Cometary Orbits*, 11th edition, IAU CBAT, (1996).
6. Kronk, G. W., *Comets A Descriptive Catalogue*, Enslow, (1984).
7. Ridley, H. B., *Prospects for Comets* (Annual series).

Jonathan Shanklin

Comets reaching perihelion in 1998

Comet	T	q	P	N	H1	K1
130P/McNaught-Hughes	Feb 23.8	2.12	6.69	1	10.0	15
55P/Tempel-Tuttle	Feb 28.1	0.98	33.2	4	10.0	25
104P/Kowal 2	Mar 02.2	1.40	6.18	2	10.0	15
129P/Shoemaker-Levy 3	Mar 04.8	2.82	7.25	1	11.0	10
C/Meunier-Dupouy (1997 J2)	Mar 10.3	3.05			1.8	12
D/Harrington-Wilson	Apr 11.0	1.89	6.71	1	12.0	10
C/Montani (1997 G2)	Apr 16.3	3.08			8.0	10
62P/Tsuchinshan 1	Apr 19.1	1.50	6.64	5	8.0	25
68P/Klemola	May 01.7	1.75	10.8	3	10.0	10
49P/Arend-Rigaux	Jul 12.6	1.37	6.61	7	11.3	11
80P/Peters-Hartley	Aug 11.7	1.62	8.12	3	8.5	15
P/Shoemaker-Levy 7	Aug 25.3	1.70	6.89	1	14.0	15
83P/Russell 1	Aug 26.1	2.18	7.64	2	14.0	15
88P/Howell	Sep 27.2	1.41	5.57	4	8.0	15
93P/Lovas 1	Oct 14.2	1.69	9.14	2	9.5	15
98P/Takamizawa	Nov 08.0	1.59	7.21	2	9.0	20
P/Kowal-Vavrova	Nov 15.2	2.58	15.6	1	10.5	10
21P/Giacobini-Zinner	Nov 21.3	1.03	6.61	12	9.0	15

The date of perihelion (T), perihelion distance (q), period (P), the number of previously observed returns (N) and the magnitude parameters H1 and K1 are given for each comet.

Note: $m_1 = H1 + 5.0 * \log(\Delta) + K1 * \log(r)$