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Front cover photo

The Meteoroids 2007 conference. A report on this can be found on page 53. Photo: Jürgen Rendtel.

Writing for WGN This Journal welcomes papers submitted for publication. All papers are reviewed for scientific content, and edited for English and style. Instructions for authors can be found in WGN **31:4**, 124–128, and at `http://www.imo.net/articles/writingforwgn.pdf` .

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Editorial — Short articles

Chris Trayner

Some magazines and journals aim for a very high visual quality, others don't. If you compare WGN with a glossy magazine, it is obvious that the latter has taken much more trouble about visual layout. Pictures are placed at exciting angles, the text often flows round them, and all pages are filled.

WGN does not attempt this. There are several reasons, not least the extra work. WGN (and indeed probably all the IMO) is run by people who are desparately short of spare time. (My own job is demanding and has to come before liesure activities like WGN, which is why —sadly— it often appears late.) Producing the visually smart layout of a glossy magazine takes a lot more time, and the editorial team cannot afford it.

Before I took over as Editor, we had an editorial meeting in Berlin. One of the decisions was the layout as you see it, with no attempt to fill pages. The reason was purely to save editing time. The extra time to fill pages is quite large. Articles often change at the last minute — authors email me saying they have just realised that a sentence has been left out, for instance. This can cause layout changes that propagate to the end of the article. If the next one follows it on the same page, this could propagate to the end of the issue. A change to the first article could require the entire issue to be adjusted, several hours' work.

However, this does not mean that the blank spaces at the end of articles cannot be used at all. Alastair McBeath has pointed out that these spaces can be used for short articles, less than a page. WGN is happy to publish short articles, but maybe some people feel that such small items are not welcome. We therefore encourage you to submit any such short pieces that you might wish write. They might be observations, or straightforward analyses of observations, for instance. There is no reason to keep them under a page, of course — if they are longer, they can be published in the normal way.

I am grateful to Alastair for suggesting this.

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IMO's digital WGN archive on DVD

The International Meteor Organization

The complete collection of WGN volumes 6–30 (1978–2002) is now available on one DVD with text-searchable PDF files! Price: 30 Euro or 40 US Dollar. This invaluable resource of meteor-related papers can be ordered through the IMO Treasurer or one of his assistants. Further details can be found on the publications area of the IMO website: `http://www.imo.net/imo/publications/backissues`.

There is generally one PDF file per WGN issue, and one directory per volume, containing the PDF files of this year. The files were OCR-ed, meaning they are text-searchable. And needless to say, there is a wealth of information in this collection.

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Letter — The Popov lightning detector

George John Drobnock [1]

Next year — 30 June 2008 — will be the 100th anniversary of the Tunguska explosion in the Siberia. The event created unusual atmospherics.

While researching a project, I came across an article about A. S. Popov (1859 – 1906). In 1895 Popov (Hannah, 1960) constructed a radio receiver for the detection of lightning discharges. The device apparently was manufactured and distributed to meteorological stations for research and (maybe) early storm warning. A picture of the device can be seen in (Eskom, 2004).

An article appeared in the (Vermeulen, 2002) indicating a Popov detector was in use in at the Transvaal Meteorological Station from 1904 onwards.

After the Tunguska explosion there have been references about reviewing various meteorological stations microbar graphs and indications of unusual barometric readings identified as occurring during and after the event, see (Whipple, 1930; Whipple, 1934; Krinov, 1963).

The question is, has any one found references to other meteorological (weather) stations in Europe/Asia during the year 1908 using a Popov lightning detector? If so, have the records been reviewed for data collected during the month of June 1908 indicating any unusual electrical discharges, a.k.a. VLF signatures, at the time of the Tunguska Event? Has any one seen or reviewed data that may have been detected with the Popov receiver 30 June 1908?

The data may be as a side note in a log. Or, just speculating, there may be an early mechanical clock recording chart indicating unusual electrical signatures.

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Letter — Meteor shower analysis and statistics

Sirko Molau [1]

In recent years, the number of video observers world-wide has been growing significantly. In most cases, they are not observing individually, but become part of a larger network of video cameras. Beside the IMO Video Meteor Network (Molau, 2001) I would like to mention the Japanese SonotaCo Network (SonotaCo, 2007) the Polish Fireball Network (PFN, 2007) and — most recently — also the Spanish Meteor Network (Trigo Rodriguez et al., 2007) The current scope of these networks differs slightly: whereas the first two concentrate on (minor) meteor shower activity, the latter two are chasing first of all fireballs, and analyse meteor showers only in second place.

Fireballs are singular events: even if you observe just a handful of these, you may obtain valuable information about their origin, and in the best case you may even track a meteorite dropper. Investigating minor showers, on the other hand, requires plenty of observations (at best from several years and locations) to establish a solid database. Hence, three steps need to be performed in the following order:

1. Establish a camera network.
2. Obtain a large and statistically significant data set.
3. Analyse the data for meteor shower activity and publish the results.

Even though this seems to be obvious, I recently got the impression, that the Spanish team tries to do step 3 before step 2 with respect to meteor shower analysis. In particular, I am referring to the paper of Trigo Rodriguez et al. in the last issue of WGN (Trigo Rodriguez et al., 2007).

The authors describe first results from a network, that consists of seven CCD and three non-intensified video cameras operated in northern and southern Spain in 2006. At first, the setup of the network is described, then the authors give a summary of observational highlights in 2006. They were able to record a number of fireballs in the course of the year, as could be seen from picturesque examples and a long fireball list. Later on the authors also comment on the activity of numerous minor meteor showers. As a highlight, Trigo Rodriguez derives flux rates and ZHRs for two unexpected outbursts (ORI and COM) from the video camera data.

Unfortunately, Trigo Rodriguez fails to give any details on the data set, which would make it easier to judge on the significance of the long list of minor showers and even 'unexpected radiants' presented. Without giving the observational basis, statements like 'σ Orionid activity was observed in late September' and 'our video cameras noticed an increase in the number of +1 to +3 meteors at $04^{h}45^{m}$' are questionable at least.

For Dec 25, $03^{h}30^{m}$–$04^{h}30^{m}$ UT, the authors report an outburst of the Coma Berenicids. From 12 showers meteors that two video cameras recorded, a breathtaking ZHR of 60 is derived. Unfortunately, the boundary conditions (number of sporadics and other shower meteors) are not given, so I checked the data of four cameras from the IMO Network (based in Italy, Slovenia and Finland) that observed with little or no interference by clouds on Dec 24/25 as well. If there was indeed significantly enhanced activity in the range +1 to +3 mag, we should have detected it as well. I used the radiant position ($\alpha = 181°$, $\delta = 25°$) for COM given by Trigo Rodriguez. The raw meteor counts (summed up over all four cameras) look as follows:

Dec 25	00^{h}–01^{h} UT:	3 SPO	2 ANT	1 COM
Dec 25	01^{h}–02^{h} UT:	8 SPO	6 ANT	2 COM
Dec 25	02^{h}–03^{h} UT:	23 SPO	1 ANT	3 COM
Dec 25	03^{h}–04^{h} UT:	16 SPO	0 ANT	2 COM
Dec 25	04^{h}–05^{h} UT:	16 SPO	1 ANT	2 COM
Dec 25	05^{h}–06^{h} UT:	12 SPO	2 ANT	2 COM

It is obvious, that the IMO Network did not observe any increase in COM activity at all. Without the full data set it is difficult to say, whether or not the Spanish cameras observed just a local activity fluctuation, but at least the ZHR figure of 60 seems most unlikely.

On the other hand, the authors report to have seen no activity from a new shower in Ursa Major around 2006 October 15, reported by Uehara (2006). This is interesting, since there is independent confirmation of this shower. When the Japanese observers reported their finding about unusual activity, I immediately checked the data of the IMO Network. It turned out, that this shower could indeed easily be traced in the IMO data set with over 200 shower members captured up to 2005. In fact, in my automated meteor shower search (Molau,

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2006b) it was the third strongest source after ORI and STA between solar longitude $\lambda_{\odot} = 201°$ and $204°$. It only slipped my meteor shower list because of its short duration. Now this is a real bullet proof, since the new shower was confirmed by two independent networks (SonotaCo and IMO Network) applying two completely different methods (individual radiant analysis from double station and statistical analysis from single station observation) using two different software packages (UFOCapture and MetRec). In fact, in 2006 alone another hundred shower members were recorded by the IMO Network.

Which brings me back to the question: why did the Spanish Network record not even a single meteor of this shower and questions its existence, when the IMO network recorded more than a hundred shower meteors in 2006 alone? This paradox is solved easily if you look at the data set. In a discussion at the MODWG mailing list, Trigo Rodriguez stated that the Spanish cameras recorded 'tens of meteors' between October 12 and 18 (Trigo Rodriguez, 2007). At the same time, the IMO Network recorded over three thousand meteors! That is, on average one out of thirty meteors originated from the unknown radiant in Ursa Major. Based on their small data set we would expect the Spanish observers to have observed one or two shower members at best.

In summary I would like to stress, that meteor shower analysis is a science based on statistics. Before someone claims on the existence or non-existence of a (minor) shower he should make sure, that the data set is appropriate for such a statement (i.e. not mixing up step 2 and 3 mentioned above) — otherwise its just reading tea leaves. In a scientific paper, at least the size of the underlying data set should be given that the reader may judge on the significance of the observations and results.

By the way, I agreed with the Japanese observers to propose the name τ Ursa Majorids (TUM) for the new shower in October as in my first posting to IMO-News in mid-November (Molau, 2006a).

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Conferences

Meteoroids 2007 in Barcelona

Jürgen Rendtel [1] *and David Asher* [2]

Some impressions and selected topics presented and discussed during the 'Meteoroids 2007' conference held in Barcelona from June 11 to 15 are summarized.

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In a delightful derivation, Martínez Picar (2007) determined the number N of people lunatic enough to attend a Radio Meteor School. The number N_2 with sufficient dedication to attend two meteor related conferences in immediate succession — namely the Barèges IMC and Meteoroids 2007 — we believe was 19. For the benefit of the 65 that attended Barèges only, and for anyone else who missed Barcelona, we present a description of the latter meeting, attempting to focus on talks most relevant to IMO work but mentioning a few others of general interest.

The forthcoming α-Aurigid outburst on September 1 could turn out to be the scientific highlight of this meteor year, involving a rare encounter of the Earth with a dust trail of a long period comet (C/1911 N1 Kiess). Peter Jenniskens gave a talk on work by himself, Jérémie Vaubaillon and Esko Lyytinen (see also Jenniskens & Vaubaillon, 2007). Although the meteoroids involved were apparently released from the comet during the lifetime of Julius Caesar, the model successfully explains the recorded 20th century outbursts of this unusual shower, with these calculations confirmed independently in a poster by Danielle Moser and Bill Cooke.

Also worth looking out for in the next couple of years (see Rendtel, 2007) are one of the well known annual showers, the Orionids. Dust trail calculations by Mikiya Sato and Junichi Watanabe, presented at the meeting by Sato, provided a convincing explanation of the 2006 outburst in terms of material released at various specific returns of Comet 1P/Halley around three millennia ago. And apparently there may be more to come after the 2006 activity.

Masayuki Yamamoto's presentation included impressive photographs by various Japanese observers, and put forward an intriguing scientific question: why have persistent trains been harder to observe in the Geminids than in some other major showers such as the Leonids? This may relate to the unusual nature of (3200) Phaethon as a parent body. The talk also described the important observational campaign to obtain triangulation images of trains. Toshihiro Kasuga discussed the solar heating effect on the meteoroids in various showers and showed a depletion of volatile constituents in Geminids, obviously due to the small perihelion distance of approximately 0.14 AU. Certainly, the Geminids and their unusual parent object deserve continuous observation.

Figure 1 – Barcelona is famous for its architecture. Many modernistic buildings can be found in many parts of the city. Left: Jérémie Vaubaillon, right: Detlef Koschny.

The status and results of both the Czech and Spanish fireball networks were presented. Pavel Spurný demonstrated how the stations of the Czech network in Europe have been completely modernized. Furthermore, a recently established network of similar autonomous cameras in the Nullabor Plain in Australia will certainly increase the data sample soon, as well as yielding a higher chance of successful meteorite ground searches. The stations include not only high-resolution cameras but are combined with additional equipment which allows the determination of the exact time, the lightcurves

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(even under overcast skies) and therefore the dynamics of objects entering the Earth's atmosphere. The Spanish network, introduced by Josep Trigo-Rodríguez, started continuous observations in 2005 using all sky CCD cameras. A recent daylight fireball (2007 May 20) caused another meteorite fall in Spain (after the memorable bolide of 2004 January 4 — also in daytime — which produced the Villalbeto de la Peña fall). First specimens of the clearly achondritic meteorite found from the 2007 event were presented on the first day of the conference by Thomas Grau.

Impacts of large bodies into the Earth's atmosphere are regularly observed by satellites of the US Department of Defense. Data of these events have sometimes become available but after a delay. Doug ReVelle announced that this may change in the near future. Information such as the date, time, beginning and end of trajectory may become available to researchers. This may be an exciting development, although ReVelle's announcement and comments by Peter Brown left open the possibility of further changes until the data can be really used for studies.

An extension to traditional meteor observing that has gained popularity in recent years and that can be undertaken with modest aperture telescopes is the search for lunar impact flashes. Rob Suggs' interesting talk on the final morning showed that the number of detections is continually increasing. Of course, as well as sampling the incoming meteoroid flux, the work is important for studying impact processes and secondary lunar ejecta.

Most investigations concentrate on specific objects and meteoroid streams, while the sporadic meteors are considered as a background. In the mass range which is dominant in the sample of radar meteors, the sporadic sources deliver the largest portion of meteors. A comprehensive investigation of the data led to a better understanding of the antihelion, toroidal and helion sources but also to the detection of showers which are not included in the current working lists. Peter Brown analysed data of the CMOR radar of the University of Western Ontario and presented a list of 44 possible minor showers. A few showers were introduced in detail. A very nice animation of the locations and strengths of the observed sources throughout the entire year illustrated a part of the analysis. Of course, there is a close link to the results of the single station video meteor data presented by Sirko Molau at the IMC in 2006. A comparison of the two lists is still in progress and results will certainly add to the working list of meteor showers in the near future.

So overall, the meteor community continues to be very active in terms of observations and predictions. The theorists are also alive and well. Iwan Williams described work by himself and Daniel Jones demonstrating that orbits typical of the meteorite population can sometimes survive for tens of millions of years, which is necessary for consistency with some meteorites' cosmic ray exposure ages. Giovanni Valsecchi illustrated an elegant technique to evaluate the effectiveness of planetary encounters in dispersing streams. And Juraj Toth showed how streams can result from boulders on the surface of near-Earth asteroids — such as those observed by Hayabusa on (25143) Itokawa — being released by tidal forces during planetary encounters.

The conference ran smoothly, which was of great credit to the organisers, and the CosmoCaixa science museum turned out to be a perfect location. As well as the excellent conference facilities, the large exhibition area of the science museum itself proved well worth exploring. From the Foucault pendulum, whose progress could be followed by watching little metal posts arranged around a circle, one of which would be knocked over by the pendulum every few minutes, to many other inventive displays covering the physical and biological sciences (and also a meteorite field with Sikhote Alin specimens of considerable size), conference participants could relive their younger days as well as perhaps discovering something new.

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Draconids

SPA Meteor Section Results: 2005 radio Draconids

Alastair McBeath[1]

Radio results collected by the SPA Meteor Section over the 2005 Draconid outburst epoch are examined and discussed. A mean peak time for the event of $\sim 16^{\rm h}30^{\rm m} \pm 1{\rm h}$ UT on October 8 was found ($\lambda_\odot$ (eq. 2000.0) $= 195\overset{\circ}{.}42 \pm 0\overset{\circ}{.}04$), with an indication that it may have occurred due to a small 'normal visual' component, and a larger very faint meteor element, perhaps with much of the mid-range size particles missing.

1 Introduction

Although the Draconid parent comet, 21P/Giacobini-Zinner, reached its most recent perihelion passage on 2005 July 2, no expectations of enhanced activity from this occasional shower were announced as in force for its potential October 6–10 epoch. However, it was highlighted in the IMO's *Meteor Shower Calendar* (McBeath, 2004, pp. 12–13), and observers warned to be alert just in case, considering the shower's somewhat unpredictable nature from the recent past. In addition, Jérémie Vaubaillon, in collaboration with Peters Brown and Jenniskens, posted some details off the `www.imcce.fr` homepage in 2005 January, which indicated graphically that some weak Draconid activity might be possible between 2005 October 6–10 after all, perhaps with a modestly stronger increase, still probably with quite low rates, for an hour or two centred on $\sim 22^{\rm h}$ UT on October 7.

The 2005 Draconid outburst that actually happened, occurred close to the expected nodal passage, scheduled at around $16^{\rm h}$ UT on October 8. A strong radar response (visual-equivalent ZHRs estimated at ~ 150 were suggested), was detected by the University of Western Ontario's system, peaking at $17^{\rm h} \pm 1^{\rm h}$ UT then (Green, 2005), while preliminary IMO data (Arlt, 2005) indicated a much lower visual ZHR of $\sim 35 \pm 8$, centred at $\sim 16^{\rm h}$ UT.

As part of the on-going SPA Meteor Section analyses of radio data, the following details were extracted from the longer September–October examination covering the Sextantid to Draconid epochs, much of which is to be discussed separately later. Details from Radio Meteor Observation Bulletins 147 and 148 (2005 October and November respectively; see `www.rmob.org`) were used, thoughtfully supplied by Editor Chris Steyaert, where at least October 7–9 inclusive had been continuously covered. Observers active throughout this time included (data in RMOB 147 where not stated):

> Enric Fraile Algeciras (Spain), Jeff Brower (British Columbia, Canada), Gaspard De Wilde (Belgium), David Entwistle (England), Ghent University (Belgium), Patrice Guérin (France), Peter Knol (Netherlands), Sadao Okamoto (Japan), Mike Otte (Illinois, USA), Dave Swan (England), Istvan Tepliczky (Hungary; RMOB 148).

2 Results discussed

The usual strictures for examining the raw results were complied with, as discussed in these papers before, which reduced the viable datasets to eight. Of these, only four systems, all in Europe, recorded a positive signature around the time of the Draconid outburst detected elsewhere. For Sadao Okamoto in Japan, the radiant was very low to setting, but the absence of anything unusual in Jeff Brower's data from western Canada was more curious, given the strong Western Ontario radar response, also from Canada.

From the positive data, a mean peak time of October 8, $16^{\rm h}30^{\rm m} \pm 1^{\rm h}$ UT ($\lambda_\odot = 195\overset{\circ}{.}42 \pm 0\overset{\circ}{.}04$) was established (the seeming accuracy somewhat deceptive, due to the one-hour data recording intervals), with a spread in mildly anomalous echo counts between $13^{\rm h}$–$22^{\rm h}$ UT ($\lambda_\odot = 195\overset{\circ}{.}27$–$195\overset{\circ}{.}64$) on the same date. This pattern was asymmetric to the peak, even after considering the variable radiant elevation, suggesting a longer 'tail' to the outburst.

Further examinations were made using the general echo-count numbers, or reporting methods, as a rough guide to the possible nature of the meteors involved, in much the same way as outlined in (McBeath, 2006). Systems in Europe and North America using echo durations, or where the usual diurnal count range per hour was of the order of tens to less than about 150, recorded no significant Draconid signature. Those detecting general hourly count numbers of order tens of echoes, or where the typical diurnal echo counts were in the hundreds per hour, did find some sign of enhanced rates. These latter systems gave the strongest response overall. If the count numbers can be taken to indicate roughly meteoroid sizes or meteor brightnesses, this could be interpreted as meaning there may have been two elements to the 2005 Draconid event: a relatively small proportion of 'normal visual' meteors, and a much larger very faint meteor component. This implies, if correct, that the middle range, of faint visual to moderately faint radio meteors, may have been largely missing.

Such an interpretation seems to fit the early radar and visual reports, of a strong radar response, but a significantly less active visual display. Whether this, and the mean radio timing (as roughly midway between the radar and visual maximum centres), may infer a

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degree of mass-sorting within the 2005 Draconid stream filament, is uncertain.

The radio results from October 6–10 generally were also checked for unexpected signatures which might relate to other Draconid activity, the potential for which was suggested by Vaubaillon *et al.* (see Section 1 above here). However, nothing beyond the typical minor activity peaks around this period were traced, nor was any increase apparent in the late evening hours UT of October 7. The weak rates Vaubaillon *et al.* indicated as possible, may have passed as unrecognisably low in the radio data anyway.

3 Conclusion

Another element to a fascinating northern autumn spell during October–November 2005, the Draconid outburst demonstrated clearly the need for continued monitoring of this shower's possible activity period (aside from routine monitoring at other times more generally). The radio results covered here seem to fit with those preliminary ones made by other techniques, albeit the forward-scatter Draconid response may not have been as strong, nor as clear-cut, as some observers might have liked.

4 Acknowledgements

As normal, I am most grateful to all the observers whose data made this analysis practical.

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Ongoing meteor work

SPA Meteor Section Results: January-March 2004

Alastair McBeath[1]

Details from analyzed reports submitted to the SPA Meteor Section for the first quarter of 2004 are presented and discussed, with notes on some other events drawn to the Section's attention. A Quadrantid maximum in visual and radio results at about 04^{h} UT on January 4 can be implied, perhaps with visual ZHRs of order 150–230, though moonlight made this value less reliable than the ideal. Some details are given on a meteoritic daylight fireball over northern Spain on January 4 at $16^{h}46^{m}$ UT, and another fireball over Belgium-Germany on January 21, at $\sim 05^{h}33^{m}$ UT. A mysterious 'meteor storm' sighting from February 19/20 was almost certainly not meteoric, but the first observation of a meteor in the atmosphere of Mars from March 7, probably was. One more widely-seen fireball, this time for the UK, occurred around $22^{h}03^{m}$ UT on March 25/26, for which an approximate surface track could be established. An obituary for the author's father Peter McBeath (1923–2004), who died at the end of March, completes the article.

1 Introduction

Several leading meteor groups around the world found 2004 brought a distinct drop in observer interest and activity, which seems to be attributable in part to the passing of the last Leonid storm in 2002. Certainly, the SPA Meteor Section was no exception to this pattern, as while casual fireball sightings remained at a useful level from Britain, the amount of visual watching carried out from here fell significantly. The general problem can be seen in the lower visual totals in Table 1 compared to recent years, which has the monthly tallies for the first quarter of 2004. The problem will be demonstrated again in subsequent articles. Of course, the moonlit Quadrantid epoch was scarcely an assistance in this, along with the generally low meteor rates seen for much of the quarter, especially from the northern hemisphere sites most of our contributors routinely observe from.

By contrast, radio observations were more plentiful than ever before, with particular concentrations of operators active and producing viable results in Japan and Europe, though the European data continued to suffer the kinds of problems discussed in these results articles before. The raw radio data were processed and examined as usual, as last revised by (McBeath, 2004). The radio observers comprised:

Dirk Artoos (Belgium), Gilberto Klar Renner (Brazil), Bob White (England),

and the following Radio Meteor Observation Bulletin (RMOB) observers (website: `www.rmob.org`; data from RMOBs 126–131, 2004 January to June inclusive, provided courtesy of Editor Chris Steyaert):

Masami Aihara (Japan), Enric Fraile Algeciras (Spain), Mike Boschat (Nova Scotia, Canada), Jeff Brower (Colorado, USA), Baudoin Charue (Belgium), Maurice de Meyere (Belgium), Gaspard De Wilde (Belgium), Thierry Duhagon (France), Minoru Ehara (Japan), David Entwistle (England), Kenji Fujito (Japan), Valter Gennaro (Italy), Ghent University (Belgium), Patrice Guérin (France), Kimmo Lehtinen (Finland), Masahiko Matsuda (Kawaguchi Science Museum, Japan), Toshihide Miyake (Japan), Naoki Moriwaki (Japan), Kazuyuki Nagao (Japan), Stan Nelson (New Mexico, USA), Sadao Okamoto (Japan), Mike Otte (Illinois, USA), Shigeo Sambe (Japan), Robert Savard (Québec, Canada), Marcel Schneider (Luxembourg), SKiYMET radar (Norway), Hirofumi Sugimoto (Japan), Dave Swan (England), Istvan Tepliczky (Hungary), Ouyang TianJing (Hubei Province, China), Yung Cheich (Garfield) Tsao (Taiwan, China), Ilkka Yrjölä (Finland).

January's video results were received from Enrico Stomeo (Italy), while the visual watchers included:

American Meteor Society (AMS; website: `www.amsmeteors.org`) observers, details extracted from summaries in the AMS' journal *Meteor Trails* 23 (June 2004), received via Editor and observer Bob Lunsford (California, USA): George Gliba (West Virginia, USA), Javor Kac (Slovenia), Mike Linnolt (Hawaii, USA), Norman McLeod (Florida, USA), Kim Youmans (Georgia, USA);

Arbeitskreis Meteore (AKM; website: `www.meteoros.de`) reporters, from their journal *Meteoros* 7:4, 7:5 (both from 2004) and 8:1 (2005), sent in by Ina Rendtel, all in Germany: Christoph Gerber, Daniel Grün, Sven Näther, Jürgen Rendtel, Roland Winkler; Jay Brausch (North Dakota, USA), Terry Churms (England), Alastair McBeath (England), Jonathan Shanklin (Rothera, Antarctica and the Falkland Islands).

2 January

First order of business for the new year was the moonlit Quadrantid maximum, due on January 4 at about 06^{h} UT (McBeath, 2003b, p. 2). Although few observers were tempted outdoors to watch, of those who were not simply clouded-out, that is, some useful data were collected. The usual ZHR strictures had to be relaxed to allow watches where the LM was +5.0 or better, so as not to exclude most of the results, which may have inflated the peak rate values somewhat, but

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IMO bibcode WGN-353-mcbeath-spams2004a
NASA-ADS bibcode 2007JIMO...35...57M

Table 1 – Visual, video and radio hours' totals, visual and video meteor numbers recorded (with a partial breakdown of visual types), per month. Of the video trails in January, 84 were Quadrantids.

	Visual				Video		Radio
Month	Hours	QUA	VIR	Meteors	Hours	Meteors	Hours
January	$20^{\mathrm{h}}.7$	221	0	359	$2^{\mathrm{h}}.1$	93	12837
February	$22^{\mathrm{h}}.3$	—	13	143	—	—	9217
March	$20^{\mathrm{h}}.8$	—	19	123	—	—	10597

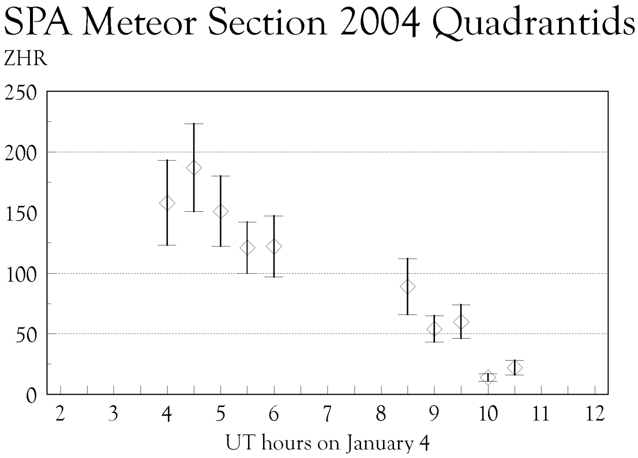

Figure 1 – Visual Quadrantid mean ZHRs on January 4, computed using $r = 2.1$, where the LM was at least +5.0, cloud cover < 20%, and the radiant at 30° elevation or better, with standard error bars appended.

the overall pattern shown by Figure 1 seems reasonable enough compared to past returns. The highest ZHR was achieved at $04^{\mathrm{h}}35^{\mathrm{m}} \pm 45^{\mathrm{m}}$ UT on January 4 ($\lambda_\odot = 283^\circ\!.09 \pm 0^\circ\!.03$ (eq. 2000.0)), at $\sim 190 \pm 40$, higher than we might ordinarily have expected, and somewhat earlier than anticipated, if correct. The small data sample, plus the lack of results before $03^{\mathrm{h}}30^{\mathrm{m}}$ UT, made both the timing and strength more uncertain.

The radio results, illustrated by Figures 2, 3 and 4, gave a sharp, strong response in most European and Japanese datasets, but a lesser peak for North America. This general point seemed to support an earlier maximum than expected, and the weighted mean radio peak, using chiefly those data which showed a pronounced main echo count spike, was at $03^{\mathrm{h}}55^{\mathrm{m}} \pm 1^{\mathrm{h}}$ UT on January 4 ($\lambda_\odot = 283^\circ\!.06 \pm 0^\circ\!.04$). The weighted mean of all the peaks was slightly earlier, at $03^{\mathrm{h}}30^{\mathrm{m}} \pm 1^{\mathrm{h}}$ UT ($\lambda_\odot = 283^\circ\!. \pm 0^\circ\!.04$). Overall, a maximum around $04^{\mathrm{h}} \pm 1^{\mathrm{h}}$ UT for both visual and radio Quadrantid maxima seemed plausible, around two hours earlier than predicted.

The strong radio signature may be indicative that the visual ZHRs were close to the actual levels, perhaps indeed showing another high Quadrantid return. This also supported the first impressions of Hiroshi Ogawa (2004), of an unusually strong radio peak, though this was suggested at around 05^{h} UT on January 4. Enrico Stomeo's video results suggested condition-corrected video Quadrantid activity may have been marginally higher around 05^{h} UT than 04^{h}, but the difference was not especially significant.

There was no sign of the secondary, mainly radio,

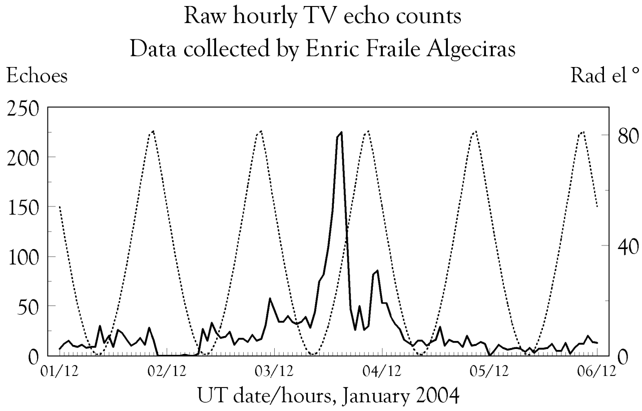

Figure 2 – Raw hourly TV echo counts over the 2004 Quadrantid maximum, in data collected by Enric Fraile Algeciras. In all the radio graphs given here, the thicker, irregular line, keyed to the left-hand y-axis, shows the raw hourly echo count values, while the thinner, daily-symmetrical, curve (keyed to the right-hand y-axis) gives the Quadrantid radiant elevation for each observer's site. All the graphs were from data collected continuously, and drops to zero showed either times when the system was suffering equipment problems or was otherwise not operating, or where interference intervened, unless noted. The dominance of the Quadrantids is clearly shown.

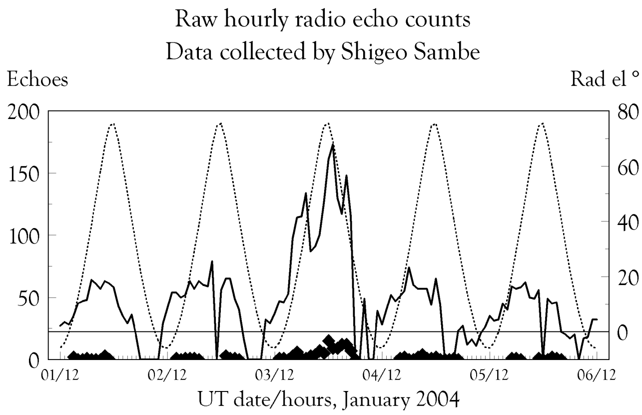

Figure 3 – As Figure 2, but with raw radio counts collected by Shigeo Sambe. The thickest line close to the x-axis gives counts of very long-duration echoes (> 20s), keyed to the left-hand y-axis. Very few of these were registered per hour (zero-count hours do not show on this graph), but the Quadrantid maximum in the early hours UT of January 4 is nicely picked-out thus.

maximum however, found most recently in 2001, but possibly again in 2003 (McBeath, 2003a, 2005). Too few magnitude and train details were available to make an examination of them practical this time.

Scarcely was this event over, than a spectacular, magnitude −15/−18, meteorite-dropping fireball came down over northern Spain, at $16^{\mathrm{h}}46^{\mathrm{m}}45^{\mathrm{s}} \pm 10^{\mathrm{s}}$ UT on January 4. It was very widely-seen in daylight, and was imaged and video recorded from several places. The

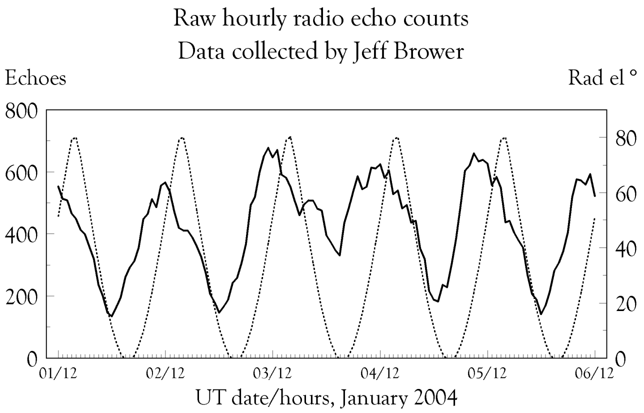

Figure 4 – As Figure 2, but showing raw radio counts from data collected by Jeff Brower. The Quadrantid peak was badly-timed for observers in North America.

images meant global media sources picked up the story quickly, and generated a lot of interest, including among SPA correspondents, although no eye-witness reports were received directly by the Meteor Section. As usual with media sources, some unhelpful material was circulated among the facts, including (among other confusions) that the object had been a Quadrantid, and that it had started fires on the ground. With an atmospheric velocity of just 15 ± 5 km/s, the body cannot have been a Quadrantid, that speculation resulting solely from the date of its occurrence. Equally, and unsurprisingly, no ground fires could be identified connected with it, this element presumably resulting from the media wishing to 'spice up' the tale - as if a brilliant daytime fireball was not enough of a story!

The interest generated allowed an atmospheric trajectory to be swiftly established at least, and by late January, two small, chondritic meteorites believed to be associated with the fireball had been recovered from the mountains in Palencia province. More detailed reviews in English, with images, can be found off the Spanish Fireball network homepage, `www.spmn.uji.es`, a copy of which material is also available on the Dutch Meteor Society's website, `www.dmsweb.org`.

Mid-January brought a scattering of UK fireball reports, but none were well seen, unlike another very bright event around 05^h33^m UT on January 21, whose trajectory probably carried it over southern Belgium to adjoining parts of Germany. Witnesses across Belgium, western Germany and the Netherlands spotted it, though unfortunately no British sightings were received. A report in Dutch with an English summary can be found on the DMS website.

Only radio data were presented from the January 20 – 26 interval, covering the postulated minor January Coma Berenicids (McBeath, 2001b), and nothing unexpected was found in those, although the minor radio peaks during this spell from the Forward Scatter Meteor Year details (McBeath, 2001a), did seem present in most of the usable results, much as normal.

3 February

February turned out to be surprisingly quiet meteorically, after January's excitements, but there was one

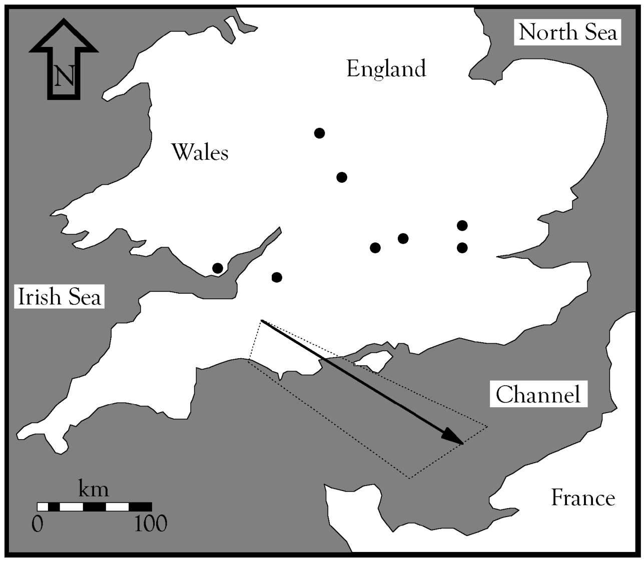

Figure 5 – A sketch map of part of the British Isles and north-west France, giving the location of the observers of the March 25/26 fireball (filled circles; some represent multiple observers at sites too close together to show separately at this scale), and the most probable projected surface track for the fireball (the arrowed line). The dashed box surrounding the fireball's track gives the outlying possible area within which the witness reports indicated the fireball occurred.

curious report from Wiltshire in England from February 19/20, around 21^h–22^h UT. Two people reported seeing 'hundreds' of slow-moving meteors (actually called 'comments', presumably a mis-spelling of 'comets'?) in gaps in the clouds for a forty-minute spell during the indicated hour. This was oddly reminiscent of a similar report from 2003 February 9/10 and 10/11, discussed in (McBeath, 2005). As in 2003, no confirming observations could be found from anywhere else, and no radio observers detected anything except the usual low February activity simultaneously. An oddity, certainly.

4 March

In March, as Jonathan Shanklin was nearing the end of a spell working on the Antarctic Peninsula, he managed a couple of one-hour meteor watches from the Rothera base there, at latitude $-67^\circ\!.57$, on March 4/5 and 16/17. An unusual continent to observe from, perhaps the first time formal visual meteor observing has been carried out from there, and at an unusually high latitude. We wondered if anyone knew of any similar high-latitude visual meteor observing, from closer to either pole?

A unique event from an even colder clime occurred on March 7, although it was not announced until mid-2005: the surface imaging of the first probable meteor in the atmosphere of Mars. The meteor was observed by the NASA rover 'Spirit', and the subsequent analysis suggested the meteor belonged to an annual shower with a radiant in Cepheus, produced by material shed from Comet 144P/Wiseman-Skiff. These Martian Cepheids were further predicted to produce an outburst for any surface observers still active there on 2007 December 20.

For details, see Selsis *et al.* (2005) or the webpage cited by Vaubaillon (2005).

Much of March passed fairly quietly meteorically other than this, aside from a few poorly-seen fireballs, plus the typical minor shower activity, until late month. March 25/26, $22^{h}03^{m} \pm 2^{m}$ UT, brought a fragmenting, magnitude $-5/-7$ event for witnesses scattered across southern England and Wales. Reports were received from observers at ten sites between Cardiff in South Wales to London, and as far north in England as Birmingham, although there were media claims of other witnesses elsewhere in South Wales and East Anglia which could not be traced. Figure 5 shows the locations of those people reporting to the SPA, with the likely surface track for the fireball.

Analysing the reports received (all purely visual), suggested the meteor started at around 120 km altitude above the Street area of Somerset, England, $\sim 50\overset{\circ}{.}9$ N, $2\overset{\circ}{.}8$ W, and flew on a south-east trend from there out over the Channel, finishing at about 100 km altitude well out to sea, some 50 km north-west of Fécamp in Normandy, France, at $\sim 50°$ N, $0\overset{\circ}{.}35$ W. The end-point was only a best-estimate, however. The fireball seemed to have had a very shallow angle of approach, roughly 5° from the horizontal, so its atmospheric trajectory length and that of its projected surface track were similarly estimated at approximately 210 km in each case. Various angular speed or flight-duration estimates, and the appearance of a probable persistent train in several reports, were consistent with a high velocity particle, perhaps in the range $\sim 57 \pm 10$ km/s.

Most witnesses mentioned the meteor was fragmenting along much of its flight, though such a long, fast, shallow-angled path strongly counted against any surviving meteorites. The very high end height made calculating any potential fall zone almost impossible too, but on simple geometric considerations alone, any surviving fragments following the probable centre-line, would have landed in the Mediterranean Sea, perhaps 60 km off the north-west tip of Cap Corse, Corsica. This was just a best-guess, however.

5 Obituary: Peter McBeath (1923–2004)

As some of you will already know, my father Peter died peacefully at home in his sleep on 2004 March 30, after a five-year battle with cancer. He was 81. Although not an SPA member, nor an amateur astronomer in the strictest sense, he had a lifelong fascination with science, particularly botany, microscopy, photography and radio, and maintained an interest in astronomy, encouraging both my mother (who died in 1979) and myself in our astronomical pursuits. Indeed, he was instrumental in discovering and helping me join the then-JAS, as the SPA was formerly known, back in 1975. Without his support, it is unlikely I would have become, or remained, so heavily committed to meteor science.

He was always keen to try some astrophotography of significant events, and we observed together some of the great auroral storms and noctilucent cloud displays during the last 15 years of his life in particular, as well as watching and photographing various lunar and solar eclipses, comets Hale-Bopp and Ikeya-Zhang, the Leonid fireball night of 1998, and the 1999 Leonid storm. Although increasingly too ill for much astronomical activity since late 2002, he enjoyed views of the Mercury transit and the sunrise solar eclipse in 2003 May. Indeed, one of his eclipse images featured on the special SPA eclipse webpage immediately after the latter event. His last astro-effort was some image-processing of a telephoto shot of the Moon near Venus on 2004 January 24/25, taken the evening he last returned home from a bout of hospital treatment.

His enthusiasm, ability, inventiveness and charm will remain with all who knew him. And he has been, and will remain, deeply missed, especially by myself.

6 Conclusion

An interesting, if personally very difficult, quarter, showing once again the power of unexpected fireballs to catch the public's imagination, even when the session's major shower was badly affected by the Moon. That event also demonstrated the utility of radio observations at such a time. As ever, all contributors are gratefully thanked for their efforts represented here.

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SPA Meteor Section Results: April-June 2004

Alastair McBeath[1]

Results presented to the SPA Meteor Section from the second quarter of 2004 are analyzed and discussed, along with some relevant items that generated correspondence from Society members and others. A very approximate radio confirmation was possible of a Lyrid peak in the early hours UT of April 22, before the anticipated ideal maximum time, along with an η Aquarid peak around May 5. Some notes are given on a brilliant fireball over the Franco-Belgian border at $21^{h}57^{m} \pm 1^{m}$ UT on May 20, together with an unusual fireball-like, though actually non-meteoric, event or events over or near Spain and Portugal in the late evening hours UT of June 1/2, plus a meteorite fall in Auckland, New Zealand, on June 11, reported as hot to the touch on arrival. Maxima from the June daytime streams were recorded by radio on June 6, 8 and 10–12, much as found in the Forward Scatter Meteor Year analyses previously. The June Boötid visual outburst on June 23 was not detected in the radio results, although moderate maxima probably due to the β Taurids were, on June 22, 25 and 28, again largely as recorded before.

1 Introduction

With a mixture of moonless (Lyrid), moonlit (η Aquarid) and daytime shower maxima, plus a possible June Boötid return, it was a surprisingly quiet spell generally in actuality, particularly visually, as Table 1 shows. The June radio tally was much better than in recent years however, with far less Sporadic-E interference than has been found for some time, and radio observing overall formed the backbone of the received results. As normal, radio analyses from the raw counts were performed under the modified strictures described in (McBeath, 2004).

Radio observations were received from

Dirk Artoos (Belgium), Bob White (England),

and Radio Meteor Observation Bulletin operators (website: `www.rmob.org`; data from RMOBs 129–132, 2004 April to July inclusive, submitted by Editor Chris Steyaert):

Masami Aihara (Japan), Enric Fraile Algeciras (Spain), Mike Boschat (Nova Scotia, Canada), Jeff Brower (Colorado, USA), Baudoin Charue (Belgium), Gaspard De Wilde (Belgium), Minoru Ehara (Japan), David Entwistle (England), Kenji Fujito (Japan), Ghent University (Belgium), Patrice Guérin (France), Steve Hansen (Massachusetts, USA), Masaru Kubota (Japan), Kimmo Lehtinen (Finland), Masahiko Matsuda (Kawaguchi Science Museum, Japan), Toshihide Miyake (Japan), Naoki Moriwaki (Japan), Kazuyuki Nagao (Japan), Stan Nelson (New Mexico, USA), Sadao Okamoto (Japan), Mike Otte (Illinois, USA), Shigeo Sambe (Japan), Robert Savard (Québec, Canada), Marcel Schneider (Luxembourg), SKiYMET radar (Norway), Dave Swan (England), Istvan Tepliczky (Hungary), Ouyang TianJing (Hubei Province, China), Yung Cheich (Garfield) Tsao (Taiwan, China), Ilkka Yrjölä (Finland).

Video results came from:

Enrico Stomeo (Italy), and three IMO Video Meteor Network reporters (data from the *Arbeitskreis Meteore* — AKM — journal *Meteoros* 7:7 (2004), provided by Ina Rendtel; website `www.meteoros.de`), Sirko Molau (Germany), Jörg Strunk (Germany) and Stane Slavec (Slovenia).

Visual observations were made by:

AKM watchers (observations from *Meteoros* 7:6–7:8 inclusive - all 2004 - and 8:1 from 2005, via Ina Rendtel again), all in Germany where not stated: Pierre Bader, Christoph Gerber, Ralf Kuschnik, Sirko Molau, Sven Näther, Jürgen Rendtel (Germany and Canary Islands); Valentin Grigore (Romania), Bob Lunsford (California, USA), Alastair McBeath (England), Jonathan Shanklin (England).

2 April

As implied by the Introduction, April continued the modestly quiet spell meteorically from the preceding quarter. Aside from a few scattered fireball sightings, the most interesting of which nearest the UK was a brilliant event seen (and heard, by a ship's crew offshore) from Denmark at $2^{h}40^{m}$ UT on April 20/21 (Bakmann, 2004), the moonless Lyrid epoch was expected to be the month's main event. Unfortunately, the weather took a hand, and very few observers recorded much of the shower at all. Enrico Stomeo managed to video a few on the expected maximum night, April 21/22, and some were spotted visually then by the AKM watchers, plus Jonathan Shanklin in the UK (then recently returned from his spell in Antarctica). From these details, and an assumed $r = 2.9$, mean ZHRs of $\sim 15 \pm 5$ were found between $\sim 0^{h}$–3^{h} UT on April 22 ($\lambda_{\odot} = 32\overset{\circ}{.}15$–$32\overset{\circ}{.}27$ (eq. 2000.0)). No clearer peak was apparent within that time-band. This was loosely in-line with the preliminary IMO findings (Arlt, 2004a) and the Polish results (Mularczyk, 2005), but without the higher peak at $\sim 0^{h}15^{m}$ UT ($\lambda_{\odot} = 32\overset{\circ}{.}16$), ZHR $= 21 \pm 3$, in the IMO data.

In the radio results, while a peak in echo counts was present in all the viable observations that continuously covered the April 20–26 period, at $\lambda_{\odot} \sim 32°$, this was not always the strongest peak found during that interval, and no useful consensus on a maximum time for the Lyrids could be established beyond this. Taking just the period from midday UT on April 21 to the same time on April 22, maxima were detected probably

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IMO bibcode WGN-353-mcbeath-spams2004b
NASA-ADS bibcode 2007JIMO...35...61M

Table 1 – Visual, video and radio hours' totals, visual and video meteor numbers recorded (with a partial breakdown of visual types), per month. Six of the video trails in April were Lyrids, 13 of those in June were Boötids.

	Visual					Video		Radio
Month	Hours	LYR	VIR	SAG	Meteors	Hours	Meteors	Hours
April	$28^{h}\!.3$	99	19	6	259	$2^{h}\!.6$	9	8304
May	$15^{h}\!.9$	—	—	18	134	—	—	9066
		JBO		SAG				
June	$22^{h}\!.3$	23	—	16	177	$27^{h}\!.8$	85	11973

due to the Lyrids between $\sim 17^{h}$–9^{h} UT ($\lambda_\odot = 31\overset{\circ}{.}87$–$32\overset{\circ}{.}51$). The midpoint of all these was $\sim 1^{h}$ UT on April 22, but with a possible error of $\pm 8^{h}$ (equivalent to $\lambda_\odot = 32\overset{\circ}{.}19 \pm 0\overset{\circ}{.}32$)! The weighted mean of the radio peak times on April 21/22 was April 22 at $2^{h}50^{m} \pm 1^{h}$ UT ($\lambda_\odot = 32\overset{\circ}{.}27 \pm 0\overset{\circ}{.}04$). Although both these suggested timings fell within the visual 'peak' interval, they cannot be considered especially reliable. However, it is interesting that in all these cases, the Lyrid maximum was apparent before the ideal time of $\sim 4^{h}$ UT on April 22 (McBeath, 2003, pp. 3–4), and with lower or somewhat lower ZHRs than the best seen from 1988–2000 (Dubietis & Arlt, 2001).

Quite why the radio results should have produced this vague pattern is uncertain. A surprising number of datasets showing otherwise reasonable diurnal echo count patterns (with a peak around 6^{h} local solar time, and a trough $\sim 12^{h}$ later, chiefly due to the sporadics), gave no clear Lyrid signature at all. That is, not simply a lack of a peak, but sometimes no distinct increase when the Lyrid radiant was above the local horizon. This may suggest lower Lyrid rates than normal generally, or that activity remained present at a stable level right across the shower's best. On a broader view, the results from the whole April 20–26 interval were comparable overall to those found previously (McBeath, 2001), at least.

No obvious signature due to the π Puppids could be ascertained near their expected maximum on April 23 (McBeath, 2003, p. 5) in the radio observations. The $\sim 9^{h}$ UT peak should have favoured Japanese reports, assuming it kept to time, but even from there, the radiant did not rise by more than $\sim 15°$, so this absence was unsurprising.

3 May

With full Moon on May 4, visual observers were always going to struggle to cover the η Aquarids, whose maximum was due around May 5 (McBeath, 2003, p. 3). For the first time since 1993, no η Aquarids were reported to the Section by this method. Consequently, it was left to the radio enthusiasts to provide details on what happened in 2004.

Unfortunately, rather like the Lyrids, no strong consensus on a clear, single maximum was apparent. Examining the often subtle day-to-day differences in activity between May 3–10 showed the best-confirmed peak was at $\lambda_\odot \sim 45°$ (May 5), with that at $\lambda_\odot \sim 44°$ (May 4) only marginally behind. A majority of the results showed somewhat lesser, but still enhanced, activity persisted till $\lambda_\odot \sim 50°$ (May 10). This was much as seen before (McBeath, 2001), though the 2004 peak was not so well-defined. Such lower maximum rates would fit the pattern suggested by Dubietis (2003), where η Aquarid activity would be expected to be rising from its latest rates-trough in 2001–2002, towards its next peak, in circa 2008–2010.

Of the few fireballs seen during the month, that on May 20/21 at $21^{h}57^{m} \pm 1^{m}$ UT, widely seen from Belgium, northern France and the Netherlands, was the most impressive. Reaching magnitude $-15/-20$ at best, it flew roughly north-west to south-east near the Franco-Belgian border, passing almost overhead at Lille, where sonic booms were heard. A report in French, plus some excellent images, can be traced via the `users.skynet.be` or the `www.astro.oma.be` webpages. Though it might have been seen from southern England, no UK sightings of it were received.

4 June

June brought sightings and other information to the Section, collected by a British airline pilot, concerning a fireball-like event he and several other pilots had witnessed over the Bay of Biscay off Bordeaux in south-west France, around $22^{h}05^{m}$ UT on June 1/2. It left a smoky trail after it, and was of an unusually long duration, around two to three minutes. Most oddly, some witnesses suggested it had markedly changed course, something unlikely even for a man-made re-entry, let alone a natural meteor.

A largely identical object was later seen by ground witnesses over Andalucia, southern Spain, heading over the border into south-east Portugal, around $23^{h}19^{m}$ UT, where it turned and headed north over land, roughly paralleling the Portuguese coast! It was detected by radar over Portugal, changing its height and speed significantly several times, with height ranges of 2 100 to 12 100 m, and speeds of 120 to 900 km/h. It crossed into Galicia, northern Spain at $\sim 23^{h}44^{m}$ UT. These timings over Portugal are not certain to be in UT, however, as a holidaying Dutch amateur astronomer reported a very similar event from west-central Portugal at $\sim 22^{h}10^{m}$ UT (a definite UT timing), suggesting either two distinct events, or some mis-correction in the timings.

Clearly, the object (or objects) was neither a natural fireball, nor one due to a man-made object re-entering the atmosphere. French air traffic control reported the $\sim 22^{h}05^{m}$ UT airliner sightings as probably due to an unannounced missile launch from France or somewhere

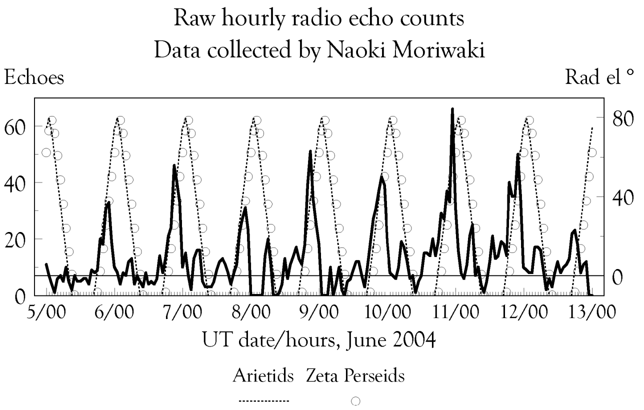

Figure 1 – Raw hourly radio echo counts over the main 2004 June daytime stream maxima, in data collected by Naoki Moriwaki. In all the radio graphs given here, the thicker, irregular line, keyed to the left-hand y-axis, shows the raw hourly echo count values, while the daily-symmetrical symbol curves (keyed to the right-hand y-axis) give the two leading daylight shower radiant elevations for each observer's site. All the graphs were from data collected continuously, and drops to zero showed either times when the system was suffering equipment problems or was otherwise not operating, or where interference intervened.

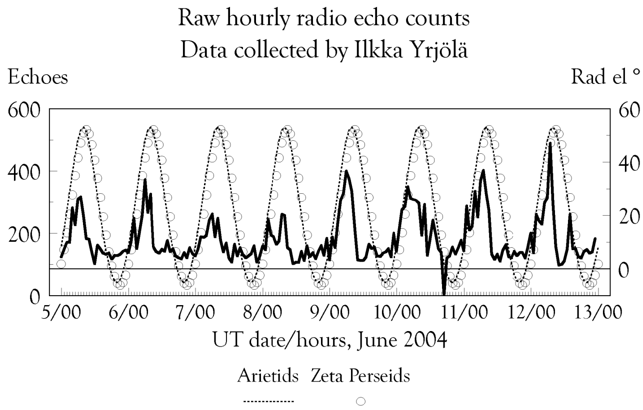

Figure 2 – As Figure 1, but from data collected by Ilkka Yrjölä.

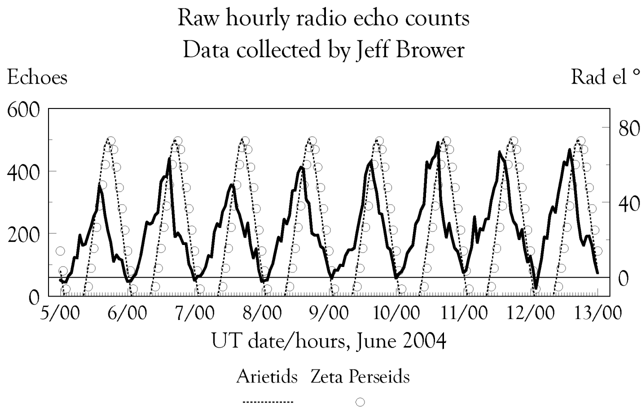

Figure 3 – As Figure 1, but showing raw radio counts from data collected by Jeff Brower.

nearby, not an altogether reassuring statement in its impreciseness, especially as it flew directly over occupied commercial airspace. It also seems whoever had launched the 'missile' had not bothered to warn anyone in advance, as the Portuguese military were apparently set on alert by the incursion into their airspace. Exactly what it was remained unknown, though one plausible explanation was that it may have been a flight by a supposedly 'secret' Aurora project hypersonic aircraft. Exactly a month earlier, on May 1, airforces from Norway to the Franco-German border were scrambled to alert when a similar unidentified craft was picked up on radar. Not so very 'secret', of course, but that may have been entirely the point in both instances.

I am most grateful to pilot Nick Hoare, and meteor colleagues Marco Langbroek, Urijan Poerink, Josep Trigo-Rodriguez and Jérémie Vaubaillon for valuable information and discussions concerning this whole incident. It is something fireball analysts need to be aware of, in case of any similar future apparitions.

Moving on to something more meteoric, which also created correspondence to the Section, the meteorite fall that struck a house in a suburb of Auckland, North Island, New Zealand, at about $21^{h}30^{m}$ UT on June 11 ($9^{h}30^{m}$ a.m. on June 12, local time). Early reports suggested the object was stony, weighing ~ 1.3 kg, and that it had crashed through the house roof and a ceiling into the living room. It was reported as hot to the touch when the homeowners recovered it from the floor, though there was no indication it had scorched anything it hit prior to being picked-up. Theory suggests small meteorites like this should be cool, or at ambient temperature, when they reach the surface, but there have been a few reports like this one over the years. Until we have actual temperature measurements from a series of just-landed meteorites, it might be helpful to keep a more open mind on the topic than has often been the case in the past. Believing that something should be true, because that is how we currently think the universe works, should not be an excuse for not examining each case like this on its merits.

The period over the main June daytime stream maxima, from the Arietids (due on June 7) and ζ Perseids (June 9; both timings as given by (McBeath, 2003, p. 3)), was not nearly so badly affected by Sporadic-E interference for northern hemisphere radio observers as has often been the case in recent years. A good consensus in the viable datasets during the examined June 5–12 interval found the stronger peaks at $\lambda_\odot \sim 76°$ (June 6; in almost 90% of the results, 16 of 18), 78° (June 8; $\sim$ 80%, 15 of 18), and 80°–81° (June 10–12; 85–95% respectively, 16 and 18 of 19), with generally heightened activity present as a background from $\sim$ 78°–82°. The $\lambda_\odot \sim 78°$ peak was somewhat weaker than the others, while the $\lambda_\odot \sim 80°–81°$ peaks were generally a little stronger. The patterns were, as normal, not always clear-cut between different systems. Figures 1–3 demonstrate some sample activity graphs.

The peaks did not fit especially closely to the predicted maxima, though these latter remain based on the best-available published radar studies, mainly from the 1960s. Often the first two peaks have been up to a day late compared to predictions in more recent times (assuming they belonged to the named showers, of course). In 2004 though, they were seemingly a day early. Exactly which shower may produce the third peak is not certain. However, the Forward Scatter Meteor Year analyses routinely produced three maxima within the $\lambda_\odot = 75°–82°$ interval, generally at $\sim$ 75°–76°, 78°–79°

and 81°–82° or 83°, so this pattern was very much the expected one. It did make a change to have it so relatively clearly found for once, with little atmospheric interference.

No potential June Lyrids were reported from mid-month, by when attention was switching to the potential for another June Boötid return anyway. Two peaks were possible, on June 23, sometime between $\sim 10^{\rm h}$–$19^{\rm h}$ UT (the predictions were summarized in (Arlt, 2004b)), or on June 27, around $1^{\rm h}$–$2^{\rm h}$ UT (McBeath, 2003, p. 6). A brief event, producing ZHRs $\sim 50 \pm 7$, was found in IMO visual data, centred near $13^{\rm h}15^{\rm m}$ UT on June 23, though activity seemed to be above about half this level for only a few hours in the preliminary results (Arlt, 2004c).

The IMO video data from three European stations detected weak activity on both June 22 and 23, but the visual peak was in European daylight, so was not covered thus. Video rates were better on June 22/23, with a curious concentration of 7 of the 11 recorded June Boötid trails between $20^{\rm h}19^{\rm m}$–$2^{\rm h}11^{\rm m}$ UT, occurring from $23^{\rm h}50^{\rm m}$–$0^{\rm h}30^{\rm m}$ UT, perhaps suggestive of a minor filament passage then. Unfortunately, no visual data were available from this interval for comparison. The video Boötid data were reported most fully in German in *Meteoros* 7:7, but also in English translation, with the detailed June 22/23 meteor breakdown, by (Molau, 2004). Much lower visual rates were seen from the Boötids away from their peak between the UT evening hours of June 22/23, to the early morning UT hours of June 23/24. No discernible June Boötid activity was found in visual results from June 26/27 in our European observations at least, nor elsewhere (Arlt, personal communication, 2004 July).

Due to the predictions, and the visual-video detected Boötid rates, the usual June Boötid/β Taurid spell from late June, examined as part of the Section's radio analyses, was extended in 2004 to cover from $12^{\rm h}$ UT on June 20 to $12^{\rm h}$ UT on June 30. In previous investigations, two main periods of activity were identified (McBeath, 2001): $\lambda_\odot = 89°$–$97°$ (equivalent to 2004 June 20–28), the best phase a moderate peak around $\lambda_\odot = 91°$–$93°$ (plus at $\lambda_\odot = 95°$–$96°$ in 1998, due to the June Boötid outburst that year); and $\lambda_\odot = 99°$, weak and sometimes extending from $\lambda_\odot \sim 98°$–$100°$, equating to 2004 June 29 to July 1.

The 2004 investigation found a general level of mostly weakly-enhanced echo counts from $\lambda_\odot \sim 90°$ to 98° in most datasets. Three modestly stronger peaks were apparent within that, at $\lambda_\odot \sim 91°$ (June 22; in 75% of the results, 13 of 17 datasets), 94° (June 25; the strongest peak of the three, found in 85% of the viable data, 14 of 16 results), and 97° (June 28; in 70% of the results, 12 of 17). As there is a rough antiphase correlation between the radiant elevations of the β Taurids and June Boötids, it is reasonably certain that all three peaks resulted mainly from the β Taurids. The June 22 peak was followed by a notably weaker one the next day, but the elevated echo counts were sufficiently coincidental in time to suggest the Boötids were probably not involved.

Radio results from June 22 and 23 were then more closely examined, over the established visual Boötid peak, and the possible video filament event on June 22/23, but nothing unexpected was found at the relevant times which could be attributed to this source. Consequently, the visual and video June Boötid activity could not be confirmed - actually could not even be detected - in the radio data. Why this should have been so is unknown.

5 Conclusion

A busy quarter after a slow start, with a number of unusual events in it, including some strangely unhelpful radio results at times - especially frustrating, given the less frequent interference than for some years! Despite this, some useful information was collected, and even negative reports like the June Boötids in the radio data, have their own value, albeit finding the reasons for this is not presently practical. Many thanks go to all the contributing observers, as always, with good fortune for your next efforts.

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1991 November 5: No meteor outburst, but what was it?

Peter Jenniskens [1]

Unusual CCD images taken at the Canada-France-Hawaii telescope in 1991, and initially thought to be meteors, have been shown not to be. It is here suggested that they were, instead, interference patterns generated in the telescope.

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On November 5, 1991, it was reported that a meteor outburst had been seen from Mauna Kea, Hawaii, by a telescope operator at the 3.6 m Canada-France-Hawaii Telescope (Brown et al., 1992). After recording a set of two unusual CCD images, he ran outside when the idea occurred to him that the images might be due to a shower of meteors. He proceeded to see three small flashes of light in the direction where the telescope was pointing, as well as some meteors. The event raised considerable attention and several tentative confirmations were received. On request, M. Cailloux and B. Fort of the Observatoire Midi-Pyrenées in Toulouse kindly made the CCD frames available for analysis. These covered a tiny patch of sky ($7' \times 7'$ wide), imaged through an I-band filter, which showed a pattern of four bands radiating from a point just outside the field of view. The bands had interesting small structures that were mistaken for meteors. It was immediately clear that this pattern was not due to meteors and the available visual and radio forward meteor scatter observations were consistent with normal sporadic and annual shower activity in November (Jenniskens et al., 1993).

After this conclusion, the 'then what else was it?' question remained. Some time ago, I came across an image that may shed light on this mystery. This image (Figure 1) was made on 2004 January 20, and was published by by Bill Allen at the nice Asteroid/Comet Connection website (Allen, 2004). The image was taken by Francesco Manca and Augusta Testa at Sormano Observatory in Italy when observing the minor body 2003 YM137 (marked by two thin vertical lines near the center).

This image has the same pattern of stripes and bands seen in the CFHT image 13 years ago. The pattern was ascribed to a light source just outside the field of view causing an interference pattern by reflections inside the telescope. In this case, the light source was identified: the bright star Pollux, located at the lower right edge of the field of view.

Figure 1 – 2003 YM137 near the bright star Pollux in an image taken by Francesco Manca and Augusta Testa at Sormano Observatory in Italy. From: ACC website.

I now conclude that the pattern of bands and stripes in the Hawaiian images on November 5, 1991, was an interference pattern caused by reflections inside the telescope due to a bright light source just outside the field of view. The source of the CFHT images is not identified, but might have been reflected sunlight off a satellite in orbit.

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History

Meteor Beliefs Project: Shakespeare revisited and the Elizabethan stage's 'blazing star'

Andrei Dorian Gheorghe [1] *and Alastair McBeath* [2]

Some fresh Shakespearean citations of meteors, further to those given previously in the Project, are presented, along with a discussion of the Elizabethan stage's use of the 'blazing star', with especial reference to the great comet of 1577.

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1 Introduction

We first examined some meteoric imagery from William Shakespeare's (1564–1616) plays much earlier in the Project (McBeath & Gheorghe, 2003). We were aware then that we had only covered some of the items available, and we have returned here with a few more, using the fact that the first came from *A Midsummer Night's Dream* as our excuse to present these in the June journal.

In addition, we have given some notes on the Elizabethan stage prop, the blazing star. Although this object was intended as representing something cometary in nature, not strictly meteoric, we have allowed its inclusion partly because of the medieval and later common confusion between comets and meteors, but partly because it is still of interest regarding meteoric appearances and popular interpretations, and some of its stage usage was directly linked to the great daylight comet of 1577, a very significant body in terms of the progress of cometary and astronomical science. We are indebted to Project correspondent Roy Watson for drawing our attention to the Elizabethan 'blazing star' initially, and for mentioning the first quoted section from *Midsummer Night's Dream* below.

We should note that the 'Elizabethan' period in England refers to the reign of Queen Elizabeth I, 1558–1603. The 'Jacobean' period followed this, named from the reign of King James I of England (1603–1625), who was simultaneously King James VI of Scotland. Other relevant notes on Shakespeare can be found in our earlier Meteor Beliefs Project article on his plays. We have again given all the Shakespearean citations from Craig (1911).

2 *A Midsummer Night's Dream*

In Act II, Scene I, Oberon, King of the Fairies, was conversing with his chief assistant Puck, in a wood near Athens. Queen of the Fairies, Titania, and her entourage, had just departed. Oberon was plotting to trick Titania with a love potion, and was speaking as part of the preamble to instructing Puck on fetching the essential herb for this charm, Love-in-idleness. Lines 149–154 (op. cit., p. 190):

> Since once I sat upon a promontory,
> And heard a mermaid on a dolphin's back
> Uttering such dulcet and harmonious breath,
> That the rude sea grew civil at her song,
> And certain stars shot madly from their spheres
> To hear the sea-maid's music.

There is a splendid, typically crisp, pen, ink and watercolour of this meteoric passage from 1908, by English illustrator Arthur Rackham (1867–1939). It shows a mermaid sitting combing her windblown hair on dolphin-back, the dolphin not drawn realistically, but as a fish-like creature, exactly as shown in Classical Greek and, especially, Roman art. Six 'cometary' meteors of different sizes, with curving tails, are placed above a rough sea to the upper left, descending from left to right. A roundel with a bow-armed Cupid is to the centre top, and a similar roundel with a copied contemporary illustration of Elizabeth I is to the centre bottom. The work can be seen in full colour at about two-thirds actual size on p. 166 of Hamilton (1995).

Subsequent lines in the play went on to describe how Cupid's arrow of love was shot at a maiden, but missed, and hit the flower Love-in-idleness instead, also known as the pansy. The flower turned from white to purple in colour as a result. The arrow-shot seemed quite meteoric too. Lines 161–162 (Craig, 1911, p. 190), again spoken by Oberon:

> But I might see young Cupid's fiery shaft
> Quenched in the chaste beams of the wat'ry moon.

3 *The Life and Death of King John*

Returning to more normal themes from the *Dream*'s meteoric positivity, Act III, Scene III, was set at the French King's tent in France, near Angiers. The Dauphin Lewis was conversing with Cardinal Pandulph, the Pope's Legate. They were discussing the English King John. Pandulph was speaking. Lines 153–159 (op. cit., p. 398):

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No natural exhalation in the sky,
No scope of nature, no distemper'd day,
No common wind, no customed event,
But they will pluck away his natural cause
And call them meteors, prodigies, and signs,
Abortives, presages, and tongues of heaven,
Plainly denouncing vengeance upon John.

Then in Act V, Scene II, there were meteors used as symbolic of something more than normally astounding. On a plain near St Edmundsbury in England, at the French camp, a group of armed men were meeting, including Lewis the Dauphin again, with the English nobles the Earl of Salisbury, the Earl of Pembroke, and the Lord Bigot, plus the French Lord Melun. Salisbury and the Dauphin had just concluded a pact for Salisbury to rise in armed revolt against King John. Salisbury was in tears at the prospect of civil war, as the Dauphin spoke. Lines 49–53 (op. cit., p. 406):

But this effusion of such manly drops,
This shower, blown up by tempest of the soul,
Startles mine eyes, and makes me more amaz'd
Than had I seen the vaulty top of heaven
Figur'd quite o'er with burning meteors.

4 The First Part of *King Henry the Fourth*

Finally, returning with two more negative uses of portentous meteors in this play, the first in the eponymous Henry's opening speech, at its beginning. Henry was addressing a crowd of various people at the Palace in London, referring to the ending of civil war in England. Act I, Scene I, lines 7–16 (op. cit., p. 442):

No more shall trenching war channel her fields,
Nor bruise her flowerets with the armed hoofs
Of hostile paces: those opposed eyes,
Which, like the meteors of a troubled heaven,
All of one nature, of one substance bred,
Did lately meet in the intestine shock
And furious close of civil butchery,
Shall now, in mutual well-beseeming ranks,
March all one way, and be no more oppos'd
Against acquaintances, kindred and allies.

In Act V, Scene I, at the King's camp near Shrewsbury, Henry, his son (also Henry) and various leading courtiers were present. The King and Prince were discussing the appearance of the sky and the fitful wind, portending a stormy day. The Earl of Worcester and his aide joined the group, and the King criticized the Earl for bringing him back to the battlefield. Lines 15–21 (op. cit., pp. 467–468):

...will you again unknit
This churlish knot of all-abhorred war,
And move in that obedient orb again
Where you did give a fair and natural light,
And be no more an exhal'd meteor,
A prodigy of fear and a portent
Of broached mischief to the unborn times?

5 The Elizabethan stage's 'blazing star'

As noted briefly in our discussion of William Fulke's 16th century book on meteors (McBeath & Gheorghe, 2007, especially p. 24), comets were known as *blazing stars* in Britain by that time. The Oxford English Dictionary (Simpson & Weiner, 1989, Volume II, p. 271) gave 1502 as the earliest published English use of the term, citing 'Arnold's Chronicle' as source. This text is known mainly from its 1811 revised reprint, as 'The Customs of London', and other texts suggest its original publication was 1503, but we can be certain the phrase was well-established by the Elizabethan period.

Given the portentous nature attributed to comets, it is not surprising such 'blazing stars' would appear for dramatic effect in plays of the time, and this was indeed the case, including in Shakespeare's *All's Well That Ends Well* (Act I, Scene III, lines 90–91), and John Webster's (circa 1582 to circa the 1630s) *White Devil*, Act III, Scene III, lines 262–263, and Act V, Scene VI, lines 131–133 (Brown, 1966, pp. 79 and 176 respectively), for instance. *White Devil* was first published in 1612.

However, it was not simply in speeches that the blazing star featured. At the end of the stage directions preceding Act V, Scene III, of *The Revenger's Tragedy* (1607 or 1608, probably written by Cyril Tourneur, who flourished in the early 1600s - see (Foakes, 1966)), is the surprising note: *A blazing star appeareth* (op. cit., p. 121). Foakes' footnote to this line (ibid.) included the comments, 'How the flare was managed we do not know, but a blazing star seems to have been a traditional effect at the open-air theatres of the time'. This note implied some kind of pyrotechnic object was used to represent the comet, presumably one capable of burning unassisted for a while, as the object was noticed and discussed by the actors in some detail from lines 14–28 of this Scene. Shortly after, these banqueters to whom the star had shown itself were all slain, confirming its evil portent.

It is not difficult to imagine the impression such a stage firework could have created, nor how it might have reinforced the unhappy nature of meteors as well as comets, suspended in mid-air from 'the heavens', the platform above the stage from which various spirits, deities or signs in the sky could be lowered into view during a performance. It is clear fireworks of different sorts were used in the Elizabethan and Jacobean theatres at least, along with more mundane painted images of signs (Chambers, 1951, pp. 76–77 and 109–110).

A particularly interesting example of a genuinely historical 'blazing star' reused in the theatre, was the great comet of 1577, C/1577 VI. This brilliant daylight comet was very widely observed, and featured in numerous artworks of the period, often shown passing near the crescent Moon, with an enormous curved tail. It also provoked a flood of scientific and pseudo-scientific texts, most notably on the scientific side, Tycho Brahe's detailed study *De Mundi*, published in 1588, which demonstrated for the first time that a comet orbited beyond the Moon, and was not an atmospheric object, as had been believed previously. For details, see (Olson, 1985, pp. 45–46 and Figures 40–41) and especially (Yeomans, 1991, pp. 33–42).

In plays, it became associated with an ill-fated historical alliance between Portuguese and Italian troops, prior to a campaign in Morocco. Especially in England, it was linked with presaging the death of Thomas Stukeley at the Battle of Alcazar during this campaign in Morocco in 1578. George Peele's *The Battle of Alcazar* (published in 1594; see (Bekkaoui, 2001)) dealt with events around all this, but more information on the comet and its perceived effects were in the anonymous 1605 play *The Famous History of the Life and Death of Captain Thomas Stukeley*, for obvious reasons commonly known just as *Stukeley* (Simpson, 1878). Simpson's work also contained an extensive biography of Stukeley from contemporary sources, as well as some ballads of his life, aside from the play. Pages 123–124 of this source covered the relevant biographical period, while pp. 247–250 of the play contained the blazing star's appearance and effects. It is fascinating how this 1577 comet was used to reinforce the old negative beliefs in comets in the plays, reflecting common beliefs linked to the actual events, while it caused a still greater upset in the scientific world, beginning to smash the ancient 'crystalline spheres' the planets were once thought to orbit in.

6 Conclusion

The Elizabethan and Jacobean periods saw many changes of very different character across Europe, not least of which was the work of Tycho Brahe, beginning the changes that led to Copernicus, Kepler and Newton. The uncertainty this caused was reflected in the period's plays, including a mixture of reassurances of the ancient meteoric and cometary beliefs, but also using new pyrotechnic knowledge to bring the things to life in the theatre, and the appearance of a great, real, comet, attached to historical events. We should not presume too much for the plays though, which, as nowadays, were intended primarily as popular entertainments, to help people forget for a while the real world.

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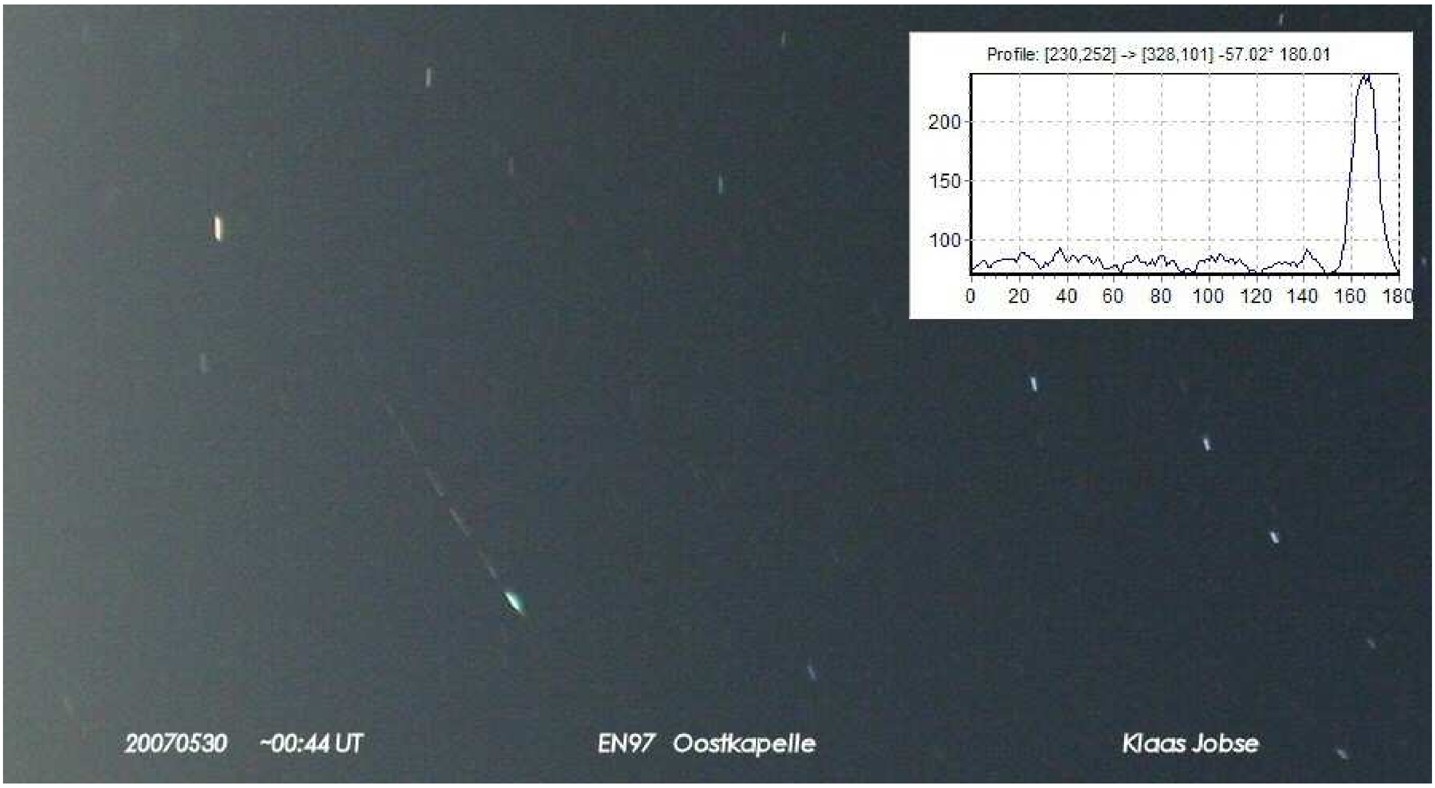
A $m = -6$ sporadic with a flare



Taken on 2007 May 30 at about $00^{\mathrm{h}}44^{\mathrm{m}}$ UT.
Camera: Canon 350D set to ISO 400, lens $f = 55$ mm, $f/4.5$, 186 second exposure.
This meteor from Klaas Jobse was taken by the All-Sky Station EN97 at Oostkapelle.
Top: the meteor is down to the left of the central obstruction. Bottom: enlargement with light curve.