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Administrative

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Front cover photo

Both covers: a -3_m sporadic meteor photographed by Arkadiusz Olech from Poland. It was taken on 2004 August 11 at $20^h30^m45^s$ UT. It is a 10-min exposure on ISO 800 Fuji X-tra with a Praktica L2 and Vivitar $f/2.5$, f =28mm lens. The photo was taken in Ostrowik Station of Warsaw University Observatory. The whole image is on the back cover, with the meteor itself in colour on the front.

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` .

Cover design Rainer Arlt

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Editorial

Chris Trayner

Website

The IMO has had a website for years. It has done its job well, but by present-day standards it has started to look a bit dowdy. Some of you will have known that there was activity behind the scenes to improve it. This has borne fruit, and the revised IMO website is now live. It is at the same address, `www.imo.net`, but has a new, cleaner and more elegant look.

This has been a large project and has taken many months to complete. Most of this work has been done by Luc Bastiaens in Belgium. Others have helped, including Rainer Arlt, Geert Barentsen, Glenn van Olmen and Cis Verbeeck. Luc emphasises that he welcomes feedback to `webmaster@imo.net`.

One of the advantages of our internet-based global village is that we can share information. This is true when inputting it, as well as when reading it. The new website includes an on-line report form for meteor observations. Using this will avoid leaving out that one piece of information which others find essential. It is at `http://www.imo.net/visual/report/electronic`, though of course it is linked to from the general website.

IMC

The 2005 International Meteor Conference is almost upon us. Those who have been to IMCs before will know that they are enjoyable opportunities to talk face-to-face with people we normally meet only on paper or by email. I look forward to seeing you in Belgium. Those who haven't booked can attend next year — details will probably be announced around the turn of the year.

Bibcodes

In the last issue we announced the introduction of IMO bibcodes, and these are now printed at the bottom of every paper. With this issue we are also adding the bibcodes that NASA-ADS (the Astrophysical Database Service, `http://adswww.harvard.edu/`) uses. This procedure has been agreed with ADS; I am grateful to Carolyn Stern Grant, of ADS at Harvard, for her help in setting this up.

IMO bibcode WGN-334-editorial NASA-ADS bibcode 2005JIMO...33...93T

Ongoing meteor work

The April ζ-Draconids and fireball over Japan

Alexandra Terentjeva [1,2] *and Sergej Barabanov* [1,3]

A fireball photographed by the Japanese Fireball Network on 1994 May 8 (Shimoda et al, 1995) was caused by the known April ζ-Draconid meteor shower (No. 47 in Terentjeva, 1967).

1 Introduction

Shimoda et al. (1995) reported that a fireball of magnitude about -8 was photographed by the Japanese Fireball Network on 1994 May 8, $17^{\mathrm{h}}46^{\mathrm{m}}50^{\mathrm{s}}$ UT and presented the results of orbital calculations. The orbit of the meteoroid that produced this fireball with an aphelion ($q' = 4.737$ AU) near Jupiter's orbit and a perihelion ($q = 0.985$ AU) near the Earth's orbit has a large inclination ($i = 39\overset{\circ}{.}6$) (Table 1). Among objects with similar orbits the asteroids are almost absent. Their portion with $i > 30°$ is less than 1%.

2 Research results

In the catalogue of fireball streams (Terentjeva, 1989, 1990), no fireball streams exist associated with this fireball. However, research into orbital elements of minor meteorid streams with known catalogues showed that the fireball observed in Japan belongs to the ζ-Draconid meteoroid stream (No. 47 in Terentjeva, 1967). This meteor shower has activity from April 2 to 25 (Table 1). The May, June, August and September ζ-Draconids (Nos. 88, 91, 110, 126 in Terentjeva, 1966) all exist. In this case it is the April ζ-Draconid meteor shower.

A search for asteroids related to the ζ-Draconid meteoroid stream and the fireball that flew over Japan was not successful. Of all the asteroids (total number 264 759 on 2004 November 24), none have similar orbital elements and theoretical radiant coordinates for the given period of visibility.

As is well known, Astapovich revised an enormous amount of observational data on XIX century meteor radiants, collected by Denning during 1833–1899. Denning's catalogue includes 4 367 radiants, obtained from observations of 120 000 meteors over a 67 year interval. Astapovich was able, through a scrupulous critical analysis of the material, to exclude a large number of false radiants, which had been derived formally without taking into account a number of necessary criteria. That painstaking work resulted in 'The Principal Catalogue of XIX Century Meteor Radiants' (Astapovich, 1956), containing the data on 887 radiants of meteor showers. In this catalogue Astapovich gives the coordinates of the apparent radiant of the ζ-Draconid meteor shower (No. 596): $\alpha = 258°$, $\delta = +61°$ (Equinox 1875.0) which is active from 9 to 25 April (daily shift $\Delta > 0$, diameter of radiation area D = 2°). Most visual observations of this shower date from the last quarter of the XIX century.

Another interesting meteorite producing fireball photographed by the Prairie Fireball Network on 1970 March 15 relates to the ζ-Draconid meteor shower and the fireball that flew over Japan on 1994 May 8. Its meteoroid had an initial mass of 8.2 kg. Maximum magnitude was reached at an altitude of 48.7 km and was equal to $-9^{\mathrm{m}}.8$ (McCrosky et al., 1978). With respect to this fireball (as for a whole series of other fireballs), the conclusion on the basis of light curve analysis was that the terminal mass was ≥ 1.4 kg. The population of these objects with a total number of 39 and their relation with other Solar system minor bodies were investigated by Terentjeva (1989).

Among more than 60 000 radio meteor orbits available at the IAU Meteor Data Center, the seven Harvard radio orbits of meteor bodies belonging to the ζ-Draconids were found.

All data are presented in Table 1 (next page), and orbits are shown in Figure 1 (following page).

3 Conclusion

The studied minor bodies stream (probably of asteroid origin) consists of meteoroids with masses from a fraction of a gram to some kilograms. Those bodies meet the Earth around the perihelion and in the descending nodes of their orbits. On the Earth orbit (as long as all $q \simeq 1$ AU) they form a stream with a very narrow cross-section of 0.033 AU, but the range of longitudes of descending nodes is such that the Earth remains in this narrow stream over a long period from March 15 to May 8, i.e. 1.8 month. During this period (55 days), radiants of this meteoroid stream are located in the Draco constellation entirely in an arc of length $20\overset{\circ}{.}5$. The daily shift of radiant of the combined meteor shower on average is $\Delta = +0\overset{\circ}{.}37$.

Acknowledgments

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Table 1 – The April ζ-Draconid meteor stream

Name	Date (UT)	Corr. geocentric radiant		V_∞ km/s	a AU	e	q AU	q' AU	i	ω	Ω	π	Number in Source
		α	δ										
ζ-Draconids	Apr 2 - 25	262°.0	+60°.3	29.1	3.26	0.678	1.000	5.52	43°.7	187°.7	19°.1	206°.8	47 [1]
Fireball	1970 Mar 15.176	237.2	+63.2	26.5	2.56	0.62	0.969	4.15	38.1	201.3	354	195.3	[2]
Fireball	1994 May 8.741	301.6	+72.4	27.0	2.861	0.657	0.9851	4.737	39.6	158.5	48.0	206.5	[3]
*	1969 Mar 23.569	246	+70	23.3	2.578	0.615	0.993	4.16	32.5	188.9	2.5	191.4	3674 [4]
*	1969 Mar 24.656	254	+63	27.6	3.050	0.675	0.991	5.11	41.0	190.2	3.6	193.8	3865 [4]
*	1969 Apr 8.576	256	+63	27.4	3.322	0.700	0.997	5.65	40.3	189.2	18.3	207.5	4382 [4]
*	1965 Apr 9.007	243	+72	22.2	2.672	0.626	0.999	4.34	29.8	185.2	18.7	203.9	14901 [4]
*	1963 Apr 10.681	266	+65	25.7	2.531	0.604	1.002	4.06	38.3	181.5	19.9	201.4	7465 [4]
*	1962 Apr 11.752	277	+74	23.3	2.752	0.637	0.999	4.51	32.5	172.0	21.2	193.2	2167 [4]
*	1962 May 8.644	299	+67	28.4	2.591	0.619	0.987	4.19	43.7	160.6	47.4	208.0	2338 [4]

Note: The * sign designates radio meteor orbits. For the radio meteors the apparent coordinates of radiants are given. All orbital elements and coordinates of radiants are referred to the 1950.0 equinox, but the fireball 1994 May 8 is referred to the 2000.0 equinox.

Sources: [1] — Terentjeva (1967); [2] — McCrosky *et al.* (1978); [3] — Shimoda *et al.* (1995); [4] — Lindblad (1994).

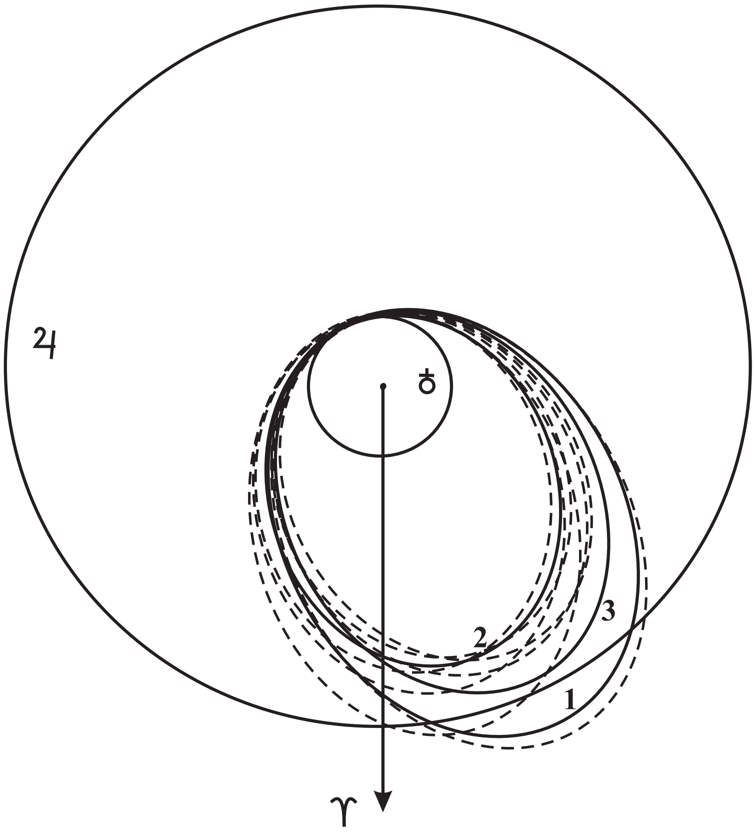

Figure 1 – The April ζ-Draconid meteor stream. 1 — ζ-Draconids; 2 — Fireball on 1970 March 15; 3 — Fireball on 1994 May 8; Broken lines — 7 radio meteor orbits. Orbits superimposed on the ecliptic plane.

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SPA Meteor Section Results: January-March 2003

Alastair McBeath[1]

Analyses and discussions from results collected by the SPA Meteor Section from January to March 2003 are presented. Comments on the continuing, indeed worsening, problems of radio meteor observing are given, together with brief remarks on further minor revisions to these report articles. The Section's final 2003 Quadrantid results are included. The radio results are unchanged from those previously published, with three probable maxima at: $12^{h} \pm 1^{h}$ UT on January 3 ($\lambda_{\odot}$ (eq. 2000.0) $= 282^{\circ}\!.65 \pm 0^{\circ}\!.042$; weak and not well confirmed); $23^{h}15^{m} \pm 4^{h}$ UT on January 3 ($\lambda_{\odot} = 283^{\circ}\!.128 \pm 0^{\circ}\!.17$; the strongest peak, but not clearly defined); and $10^{h} \pm 2^{h}$ UT on January 4 ($\lambda_{\odot} = 283^{\circ}\!.585 \pm 0^{\circ}\!.085$; well confirmed, although weaker than the $\sim 23^{h}$ UT one). Visually, two maxima were found, the marginally stronger at $01^{h}30^{m}$ UT on January 4 ($\lambda_{\odot} = 283^{\circ}\!.56$, mean ZHR $= 90 \pm 16$), the other at $\sim 10^{h} \pm 0^{h}\!.5$ UT on January 4 ($\lambda_{\odot} = 283^{\circ}\!.58 \pm 0^{\circ}\!.021$, mean ZHR at $10^{h}30^{m}$ UT $= 77 \pm 14$). Other significant highlights from the quarter were some interesting single-observer results on the γ-Normids in March, and a number of fireball, meteorite, and unusual meteoric non-event, reports, including a possible medium wave radio detection of a simultaneous fireball sound on February 1/2, a nonexistent 'meteor storm' report from February 9/10, some fascinating details on the infrasound detection of a fireball seen from the Netherlands and southern England on February 19/20 at $18^{h}13^{m}$ UT, and the Park Forest meteorite fall over the city of Chicago, USA, on March 26/27.

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1 Introduction

The quarter's main highlight promised to be the perfectly moonless Quadrantid epoch, although as outlined already in the Section's preliminary report (McBeath, 2003b), conditions were not ideal for either our visual or radio observers. Final details from the Section's view of the 2003 Quadrantids are given here, along with other highlights from January to March, notably a number of fireball and meteorite events, a few meteoric oddities and non-events, plus an interesting run of γ-Normid data from an observer in Australia.

Information on the revised schedule of these results articles, including notes on the amended programme for handling the raw radio data, was all given previously (McBeath, 2004). The methods outlined there remained valid throughout 2003. In general, an increased number of radio observers encountered less helpful observing conditions during the year than previously. The problems of overnight transmitter shutdowns, particularly for European observers, have been rehearsed repeatedly in these papers in recent times. It is clear that the difficulty is growing progressively worse, such that there seems now little real prospect that details on shower maxima falling between roughly 23^{h}–02^{h} UT can be recovered from many European radio results.

Several observers also had severe radio reception problems generally. British radio observers have found such for some time, commonly producing very 'spiky' results graphs from this country, and investigations suggest this effect is due to the growing amount of unshielded broadcast noise emissions from various electrical devices, especially where these are in relatively close proximity to one another. In other words, the problems stem from the modern urban and suburban environments most observers live, work and observe in. Some of the Radio Meteor Observation Bulletin (RMOB) workers, and others reporting radio data to the Section, have tried moving equipment, changing frequencies, using filters or other shielding devices, but typically with limited success. One, Michael Krocil of the Czech Republic, wrote in 2003 May's RMOB (issue 118) that he had decided to stop radio meteor monitoring because of just such difficulties. It is clear looking at the changing list of names of those providing radio reports over the years, as well as from personal correspondence, that he is far from the only one to have made this decision.

Obviously, this is not a healthy state of affairs. Our admiration must go to all those who continue to attempt monitoring radio meteors in the face of these problems, and in the knowledge of how extremely awkward, and sometimes unreliable, the analysis of radio data remains (even without any reception difficulties). This is why all the radio workers who provide data are listed in these articles, even though some of their data may be unusable, since as the old adage has it, 'it is better to have tried and failed, than never to have tried at all.'

One change has been made to these quarterly reports for 2003, concerning the video data. Although the amount of such material has increased dramatically in recent times, very little of the information the Section has received provided anything other than hours and total trail numbers recorded. This was not felt useful enough to warrant continued reporting. Consequently in future, only that video data where numbers of specific shower and sporadic meteors have been given over a particular time interval, or where other derived information, such as radiant details, was provided, will be included.

2 The quarter's totals and observers

Table 1 gives the monthly tallies for the first quarter of 2003.

In the following lists of observers, those people active

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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, 25 were Quadrantids.

Month	Visual	QUA	VIR	Meteors	Video	Video meteors	Radio
January	105^{h}	772	1	1374	$8\overset{h}{.}35$	40	9444^{h}
February	$35\overset{h}{.}6$	—	23	198	—	—	7000^{h}
March	$44\overset{h}{.}5$	—	45	300	—	—	7830^{h}

only during the Quadrantid period who were recorded earlier (McBeath, 2003b), are not re-listed here. Those reporting since, or who provided data at other times too, are given below.

Radio results came from Dirk Artoos (Belgium), the Belorussian Radio Observers (Ivan Bruykhanov, Alexey Gain, Roman Grabovsky, Zahar Lapitski, Leonid Molchanov and Kiril Ushakov; data via observer Ivan Sergey), Bob White (England), and the following RMOB observers (website: `www.rmob.org`; data from RMOBs 114–117, 2003 January to April inclusive, courtesy of editor Chris Steyaert):

> Enric Fraile Algeciras (Spain), Mike Boschat (Nova Scotia, Canada), Walter Boschin (Italy; with Diego Ganzini, Alessandro and Giuseppe Candolini), Jeff Brower (Colorado, USA), Maurice de Meyere (Belgium), Thierry Duhagon (France), Minoru Ehara (Japan), Kenji Fujito (Japan), Ghent University (Belgium), Patrice Guérin (France), Steve Hansen (Massachussetts, USA), Michael Krocil (Czech Republic), Toshihide Miyake (Japan), Naoki Moriwaki (Japan), Stan Nelson (New Mexico, USA), Robert Obraz (Croatia), Sadao Okamoto (Japan), Robert Savard (Quebec, Canada), Hironobu Shida (Japan), SKiYMET radar (Norway), Dave Swan (England), Istvan Tepliczky (Hungary), Pierre Terrier (France), Yung Cheich (Garfield) Tsao (Taiwan, China), Bruce Young (Queensland, Australia).

Visual observations were received from:

> *American Meteor Society* (AMS; see their website: `www.amsmeteors.org`) reporters, details extracted from summaries in the AMS' journal Meteor Trails 20 (September 2003), via editor and active observer Bob Lunsford (California, USA): Mark Fox (Colorado, USA), George Gliba (West Virginia, USA), Amir Hassanzadeh (Iran), Edwin Jones (Arizona, USA), Javor Kac (Slovenia), Thomas Lazuka (Illinois, USA), Felix Martinez (Virginia, USA), Paul Martsching (Iowa, USA), Bruce McCurdy (Alberta, Canada), David Swann (Texas, USA), Kim Youmans (Georgia, USA); Arbeitskreis Meteore (AKM; website: `www.meteoros.de`) watchers, reported in their journal Meteoros 6 : 3–6 : 5(2003) inclusive, sent in by Ina Rendtel, in Germany where not stated: Frank Enzlein, Christoph Gerber, Daniel Grün, Sven Näther, Jürgen Rendtel, Roland Winkler, Oliver Wusk (Queensland, Australia); Terry Churms (England).

3 January

Radio details for the Quadrantids have not changed significantly since the Section's preliminary report on the shower was published (McBeath, 2003b). Thus the suggestion of finding three probable radio maxima within the shower remains. These maxima were at: $12^{h} \pm$ 1h UT on January 3($\lambda_\odot = 282\overset{\circ}{.}65 \pm 0\overset{\circ}{.}042$), the weakest and least well confirmed; $23^{h}15^{m} \pm 4$h UT on January 3($\lambda_\odot = 283\overset{\circ}{.}128 \pm 0\overset{\circ}{.}17$), the strongest peak overall, but which timing could not be closely established; and $10^{h} \pm 2$h UT on January 4($\lambda_\odot = 283\overset{\circ}{.}585 \pm 0\overset{\circ}{.}085$), a well-confirmed peak, but not as strong as the $\sim 23^{h}$ UT one.

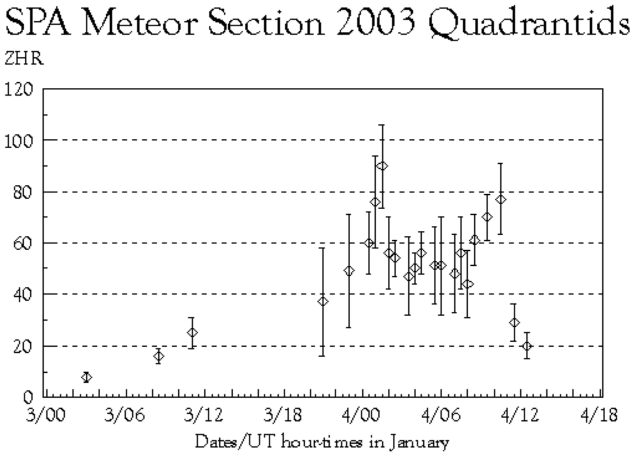

Figure 1 – Final mean Quadrantid ZHRs on 2003 January 3 and 4, computed using an assumed $r = 2.1$, for observations made where the LM was +5.0 or better (most no worse than +5.5), cloud cover was less than 20%, and the radiant elevation was at least 10° (most had a minimum radiant elevation of 20°), with standard error bars appended.

Additional visual results have allowed a reassessment of those findings however. The final magnitude distribution (given in Table 2) has not substantially changed, although the corrected Quadrantid mean magnitude value is marginally fainter now (+2.11 as opposed to the preliminary +1.97).

Figure 1 gives a revised graph of visual Quadrantid ZHRs on January 3–4. Although there are now a good many more datapoints between 0^{h} and 10^{h} UT on January 4, some are still not ideally-derived, with a few using poor LM-value skies or where the Quadrantid radiant elevation was low. This means there remain some doubts over the exact values, and even relative strengths, of some, but the pattern overall is probably reasonably sound.

Taking the strongest peak ZHR value of 90 ± 16 at $01^{h}30^{m}$ UT on January 4($\lambda_\odot = 283\overset{\circ}{.}56$), ZHRs remained at or above half this peak value for around twelve hours, between January 3, 23^{h} and January 4, 11^{h} UT ($\lambda_\odot = 283\overset{\circ}{.}12$ to $283\overset{\circ}{.}63$). Neither the start

Table 2 – Final global magnitude distributions for the 2003 Quadrantids and January sporadics seen under better sky conditions (cloud cover < 20%, LM = +5.5 or better), including mean LMs and $\overline{m}_{6.5}$ (the mean magnitude corrected to an LM +6.5 sky).

Shower	−3−	−2	−1	0	+1	+2	+3	+4	+5+	Tot	LM	$\overline{m}_{6.5}$
QUA	2	7.5	18.5	28	60.5	83.5	65	39	9	313	+6.26	+2.11
SPO	0	0	0	4	11.5	22.5	30.5	22	12.5	103	+6.33	+3.10

nor end of this interval were sharply-defined however. Towards the end, rates rose again to a second visual maximum at about $10^h \pm 0\overset{h}{.}5$ UT on January 4($\lambda_\odot = 283\overset{\circ}{.}58 \pm 0\overset{\circ}{.}021$), with the highest ZHRs found of 77 ± 14 at $\sim 10^h30^m$ UT. The first peak's data was unaltered, but the second maximum was found to be marginally weaker and a little later now than in the first analysis.

Whether the precipitous ZHR drop immediately after the second peak was a genuine effect or an artifact is a moot point, as the 11^h30^m UT datapoint resulted from just a single observer. The radio data could be interpreted as showing a very rapid decline in activity between 11^h and 13^h UT, certainly.

Nothing in the final visual results supported a maximum as early as $\sim 23^h$ UT on January 3, as the radio results implied. The radio data was a computed estimate based on the mean peak times found in numerous datasets, none of which were able to give a clear consensus on a peak otherwise, so this is not too surprising. In giving such a broad error band for the radio timing, an attempt to take this into account had been made. Overall, a visual peak approximately 1.5^h later than anticipated (using the predicted January 4, 00^h UT value from (McBeath, 2003a, p. 2) seems the most likely main Quadrantid maximum timing.

Few viable radio datasets were available to allow a review of the January 20–26 period, hunting for any activity from the possible minor January Coma Berenicids (cf. (McBeath, 2001b)). Those that were gave no consensus on when any minor peaks might have happened within those dates, nor was anything beyond the usual diurnal activity curves noted. Oddly, even the minor peak previously apparent around January 23–24 ($\lambda_\odot = 303°$–$304°$), which had been found for some years (McBeath, 2001a), did not seem to be present. As the period coincided with the waning gibbous Moon, it is unsurprising there are almost no visual data from this epoch at all.

Among a scattering of fireball reports during the month, that around 19^h51^m UT on January 27–28 over North Africa, but widely seen from southern Spain, attracted most interest. The Section received a number of casual and media reports from the expatriate British community in Andalucia on it, but the Spanish Photographic Meteor Network produced the most detailed report, in WGN (Trigo-Rodriguez et al., 2003), indicating it reached absolute magnitude −17 at best.

4 February

February 1/2 brought a bright fireball report from a suburb of Cork city in Ireland, at 01^h40^m UT. There is nothing very unusual about this, and as the night was generally cloudy, no other sightings of it were received, which is again rather commonplace. What set this event apart was that one witness outdoors saw the meteor and heard a relatively loud hissing noise simultaneously, shortly before the fireball exploded in a late flare. Another witness at the same location, but indoors, heard the noise without being aware there was even a fireball. A third witness indoors, but in another part of the house, and listening to a radio tuned to BBC Radio Five Live (which broadcasts at 693 and 909 kHz on medium wave), reported that the signal was briefly interrupted by an unusual electronic 'whooshing' sound, effectively at the same time as the other two witnesses reported hearing their noises. While the medium wave radio band is subject to all manner of atmospheric interference overnight, the witness realised this was something significantly different to those 'normal' effects. In the absence of other data, it is difficult to be certain, but the outdoor witness described the meteor's track as heading directly towards/over the house, so it certainly seems plausible this may represent a new potential frequency for some simultaneous meteor sounds to be detected at, perhaps suggesting a broader frequency range is involved than just the VLF/ELF ones that have been implicated previously. This does assume that all three witnesses detected the same sound from the same cause, and that it did originate with the meteor. The evidence available supports the idea this may indeed have been so.

Occasionally, curious events are reported to the Section, which may or may not have a meteoric cause. One such came in for February 9/10, where a lone witness in Birmingham, England reported seeing roughly one 'silvery meteor' a second between about 23^h30^m to 00^h15^m UT, with a similar effect observed around the same time the next night, but the 'meteors' then were apparently many fewer. Checks with various people quickly showed no unusual radio or visual meteor activity had been recorded by regular northern hemisphere meteor observers on either night (remembering the southern hemisphere α-Centaurid shower was scheduled to peak on February 8), and the event was not pursued further. Among the reports back, an auroral display was recorded from Scotland not long before this 'meteor storm' was claimed on February 9/10, but this does not seem to have been seen in England at all, indeed probably not by observers much south of Edinburgh. Meanwhile, over in Bulgaria, Eva Bojurova and Valentin Velkov commented there had been problems caused there on and after February 4, by the Bulgarian media picking up on a casual remark made on TV about the minor Virginid shower. These media sources had seemingly reinterpreted this as meaning there would be a meteor storm on every night from February to April! Whether this related to the English 'event' is unknown, as is the nature of the original report. Not a missed meteor storm at least.

After this, media reports were forwarded suggesting a brilliant fireball had passed over or near County Donegal, Ireland around $06^{\rm h}$ UT on February 12/13, which should have been visible from a large part of Ireland and Northern Ireland where skies were clear. Unfortunately, no actual eye witness reports were secured on it, and no useful details, other than to imply it may have been moving roughly south-south-east to north-north-west, could be derived.

Two fireballs were reported from February 19/20, at $18^{\rm h}13^{\rm m}$ and $20^{\rm h}53^{\rm m}$ UT, as recorded by the Dutch Meteor Society (website: `www.dmsweb.org`). Both were seen by several witnesses in the Netherlands, and both were in the magnitude range of $-5/-7$. The first was independently reported by an observer in London too, but of still greater interest was that Marco Langbroek of the DMS mentioned this meteor was recorded by infrasound detectors at Deelen and De Bilt in Holland. The various data point to this meteor having passed over the northern Netherlands. Laslo Evers of the Royal Dutch Meteorological Institute provided details of this infrasound detection, and those of other meteors, as well as more information on the subject and its detectors, at `www.knmi.nl/~evers`. While parts of these texts are in Dutch, enough is also in English to be useful for non-Dutch speakers, and the numerical and graphical images are valuable on their own.

5 March

March began with a meteoric non-event, when the predictions of possibly strong activity on March 1–2 due to meteoroids shed by Comet Bradfield (C/1976 D1), came to nothing. It was never a possibility for most of our usual observers anyway, as with a postulated radiant declination of $-64°$, only southern hemisphere watchers could have seen it anyway. See Rendtel (2003) for more notes.

One observer reporting from the southern hemisphere was Oliver Wusk of the AKM, near Brisbane, Australia during the first half of March. He provided a useful dataset covering the period March 2/3 to 13/14 for the γ-Normids, although his observing time was somewhat limited because of the waxing Moon, at first quarter on March 11. Rates were typically barely detectable (ZHRs ~ 1–3), as has been found frequently before, although his ZHR for the shower on March 13/14 was a little higher at 4 ± 2, which may have represented the maximum, predicted for 2003 March 14 (McBeath, 2003a, p. 2). With full Moon on March 18, there was little opportunity to search for the possible alternative maximum around March 17.

A final brilliant fireball for the quarter was reported directly to the Section by very few people, but generated more interest than most that were better seen from Europe. This was what became known as the Park Forest meteorite fall, named after the Chicago, Illinois, USA, suburb where several hundred L5 chondritic meteorites rained down around local midnight ($06^{\rm h}$ UT) on March 26/27, following a spectacular fireball which was seen from across five states in the Midwestern USA. Some of the recovered fragments were around 2 to 3.5 kg in weight, and the meteorites showered an area roughly 10 km long by a few kilometres wide. Given that this was across a relatively well-populated residential part of the city, and that numerous buildings, roads and cars were damaged, it is surprising, but most fortunate, that there were no reports of any injuries.

Acknowledgements

As normal, my fulsome thanks go to all those contributing data and other comments to help make this report possible.

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SPA Meteor Section Results: April-June 2003

Alastair McBeath[1]

Highlights from correspondence and data sent to the SPA Meteor Section from 2003 April to June are presented and discussed. These included: an update to the preliminary visual Lyrid results published earlier; a good set of data across the η-Aquarid maximum, indicating a peak on May 5/6 with a ZHR of 41 ± 8, and a possible radio-visual submaximum, lasting from May 9–14 in the radio data; and probable June daytime stream maxima around June 7–8 (Arietids), 10–11 (ζ-Perseids), and June 25–27 (β-Taurids). No June Boötids were detected in late month visually or by radio, confirming the initial IMO results.

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1 Introduction

Prospects for the quarter looked reasonably enticing in advance, with the Lyrid maximum partly Moon-free, a possible outburst from the π-Puppids predicted, the η-Aquarids entirely moonless at their best, plus a potential Boötid return at the end of June. However, weather conditions were often not ideal for visual watchers, and radio work was hampered by various problems, not least the start of another very bad northern hemisphere Sporadic-E (Es) season during May. Preliminary details from the April 20–26 epoch for the Lyrids and π-Puppids were published earlier (McBeath, 2003b), which results and observers' lists are not repeated again in detail here.

Table 1 shows the quarter's observing tallies.

The effects of the Es season are clear enough from the diminishing radio tallies, particularly in June, where 15 of the total of 27 datasets were largely lost to interference of one form or another, and the remainder were often severely curtailed. Radio analyses on the raw results were performed as normal, under the modified strictures described earlier, in (McBeath, 2004). Visual workers had most luck with conditions in May, while much of the effort in June was concentrated near the probable June Boötid epoch.

The radio observers included Dirk Artoos (Belgium), Belorussian Radio Observers Ivan and Ruslan Sergey, Gilberto Klar Renner (Brazil), Bob White (England), and Radio Meteor Observation Bulletin (RMOB; website: `www.rmob.org`) reporters:

> Masami Aihara (Japan), Enric Fraile Algeciras (Spain), Mike Boschat (Nova Scotia, Canada), Walter Boschin (Italy; with Diego Ganzini, Alessandro and Giuseppe Candolini), Jeff Brower (Colorado, USA), Maurice de Meyere (Belgium), Thierry Duhagon (France), Minoru Ehara (Japan), Kenji Fujito (Japan), Valter Gennaro (Italy), Ghent University (Belgium), Patrice Guérin (France), Steve Hansen (Massachussetts, USA), Kazuyoshi Kanatsu (Japan), Michael Krocil (Czech Republic), Toshihide Miyake (Japan), Naoki Moriwaki (Japan), Kazuyuki Nagao (Japan), Stan Nelson (New Mexico, USA), Hiroshi Ogawa (Japan), Sadao Okamoto (Japan), Mike Otte (Illinois, USA), TianJing Ouyang (China), Shigeo Sambe (Japan), Robert Savard (Quebec, Canada), Marcel Schneider (Luxembourg), Hironobu Shida (Japan), SKiYMET radar (Norway), Dave Swan (England), Istvan Tepliczky (Hungary), Yung Cheich (Garfield) Tsao (Taiwan, China), Takashi Usui (Japan), Bruce Young (Queensland, Australia), Ilkka Yrjölä (Finland).

The RMOB data came thanks to editor Chris Steyaert, in issues 117–120 inclusive, and 122, 2003 April to July, and September respectively.

Visual observations were made by:

> American Meteor Society observers (AMS; website: `www.amsmeteors.org`; results summarized in the AMS' journal 'Meteor Trails' 20, September 2003, provided by observer Bob Lunsford in California, USA): George Gliba (West Virginia, USA), Robert Hays (Indiana, USA), Javor Kac (Slovenia), Pierre Martin (Ontario, Canada), Paul Martsching (Iowa, USA), Bert Matous (Kansas, USA), Kim Youmans (Georgia, USA); Arbeitskreis Meteore (AKM; website: `www.meteoros.de`) watchers, observations listed in their journal Meteoros 6:7 and 6:8 (2003), provided by Ina Rendtel, in Germany if not noted: Frank Enzlein, Christoph Gerber, Daniel Grün, Sven Näther, Jürgen Rendtel (Germany and Canary Islands), Roland Winkler, Oliver Wusk (Queensland, Australia); Shelagh Godwin (England), Valentin Grigore (Romania), Alastair McBeath (England), Jonathan Shanklin (England), Enrico Stomeo (Italy).

2 April

With few exceptions, most of the visual data concentrated around the Lyrid epoch. Much of this material, and all of the radio results covering the Lyrids and π-Puppids, were discussed in depth earlier (McBeath, 2003b). Some further visual details have been received since the preliminary report was prepared, which suggested Lyrid ZHRs were around 5–10 on April 21/22, between 00^h–06^h UT, and peaked at around 18 ± 7 the next night, with mean ZHRs of 12–18 found from 23^h–02^h UT then. These findings are in line with the IMO results (Dubietis & Arlt, 2003b) certainly, although no coverage of the April 22, 22^h UT maximum was available from the SPA data, and there was no short, sharp maximum found. The earlier radio results, which also indicated little evidence for a well-defined peak, should now be considered final for this epoch in 2003.

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Table 1. Visual, video and radio hours' totals, visual and video meteor numbers recorded (with a partial breakdown of visual types), per month. Eleven of the video trails were Lyrids.

Month	Visual						Video		Radio
	Hours	LYR	ETA	VIR	SAG	Meteors	Hours	Meteors	Hours
April	41^{h}	64	0	11	2	204	5^{h}	21	$10\,134^{\mathrm{h}}$
May	$88^{\mathrm{h}}.2$	—	215	—	94	778	—	—	$8\,522^{\mathrm{h}}$
June	$66^{\mathrm{h}}.7$	—	—	—	47	404	—	—	$4\,445^{\mathrm{h}}$

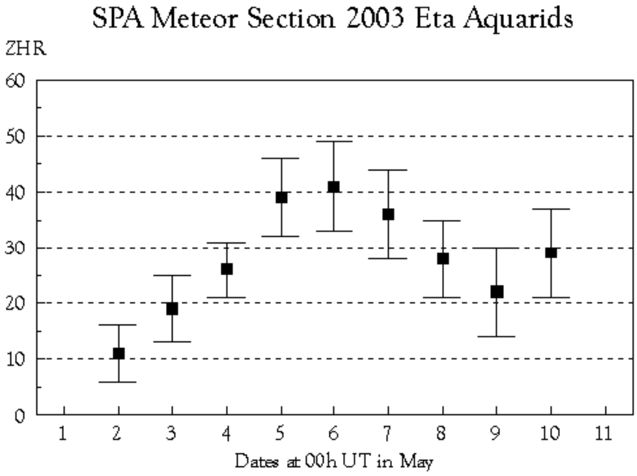

Figure 1 – Mean η-Aquarid ZHRs from early May 2003. Each datapoint is an average value computed from whatever ZHRs were available per date, usually obtained between roughly 03^{h} to 11^{h} UT. ZHRs were calculated using an assumed $r = 2.4$, for observations made where the LM was +5.5 or better, cloud cover was less than 15%, and the radiant elevation was at least 15°, with standard error bars appended.

3 May

A useful set of visual results was received from across the expected η-Aquarid maximum in early May, as illustrated by Figure 1. Although this ZHR graph is somewhat simplified, the overall trends in the data are very similar to those found in the preliminary IMO report issued on IMO-News (Dubietis & Arlt, 2003a), although the mean SPAMS datapoints for May 5–7 inclusive were slightly higher than the IMO values. Although there was relatively little difference in activity on these three dates, the peak in both sets was achieved on May 5/6, in these results with a ZHR of 41 ± 8 centred on a mean time of $06^{\mathrm{h}}20^{\mathrm{m}}$ UT. This was close to the predicted peak, around $11^{\mathrm{h}}30^{\mathrm{m}}$ UT on May 6 (McBeath, 2003a, pp. 6–7), especially as the η-Aquarids often exhibit this relatively gently-arching activity pattern over their main maximum.

Figure 2 gives four radio graphs from the early May period for contrast with the visual results. There was little clear consensus between the various available radio datasets as to when the main η-Aquarid maximum might have occurred. Both May 6/7 and 7/8 produced about equal numbers of results in favour of either night giving the stronger rates. Interestingly, both dates were after the visual maximum was found. Whether this implies a different meteoroid population then is unknown, as too few people provided magnitude distribution data to allow that element to be examined for the η-Aquarids this year. As Figures 2c and d suggest, there was often little difference in activity for several days over or near the shower's anticipated best. Not all systems favoured the May 6/8 period as producing the higher activity either.

Another curious aspect was the rise in rates in both the visual, and a significant number of the radio, graphs on May 9/10. There are no visual data available after this date unfortunately, and quite a number of the radio datasets were increasingly incomplete after this time too. However, the surviving radio observations which showed a fresh peak here, suggested elevated rates persisted until about May 13 or 14. The 2003 May 9–14 period is equivalent to $\lambda_\odot$ (eq. 2000.0) $\sim 48°$–$53°$, which tallies with the peaks found in the Forward Scatter Meteor Year analyses (McBeath, 2001) from the latter stages of the η-Aquarid maximum spell (ending around $\lambda_\odot = 50°$), and around $sol = 52°$–$53°$. It is likely this is one of the variable submaxima seen with both the Orionids and η-Aquarids from time to time, making a somewhat stronger return this year, possibly made more obvious because the normal maximum period rates were relatively low. If the increased visual ZHRs in Figure 1 are accurate, this is probably the first confirmation that the radio peaks around this period previously may indeed have been due to the η-Aquarids. The moderate η-Aquarid ZHRs, even at their best, were in line with the proposed twelve-year cycle findings of Dubietis (2003), which indicated η-Aquarid rates should be slowly rising from their latest trough in 2001–2002.

4 June

There were two main meteoric periods to highlight during June, for the daytime streams early in the month, and the potential June Boötid outburst later. As expected, the proposed June Lyrid epoch in mid-month fell prey to the full Moon, and no visual results were presented from then.

As commented in the Introduction, Es caused difficulties for many radio observers by June, so much so that only eight out of the twenty-six radio operators active during the month were able to provide sufficient useful coverage over the anticipated daytime shower peaks of the Arietids and ζ-Perseids, to be properly analysed. As five of those datasets were from Japan,

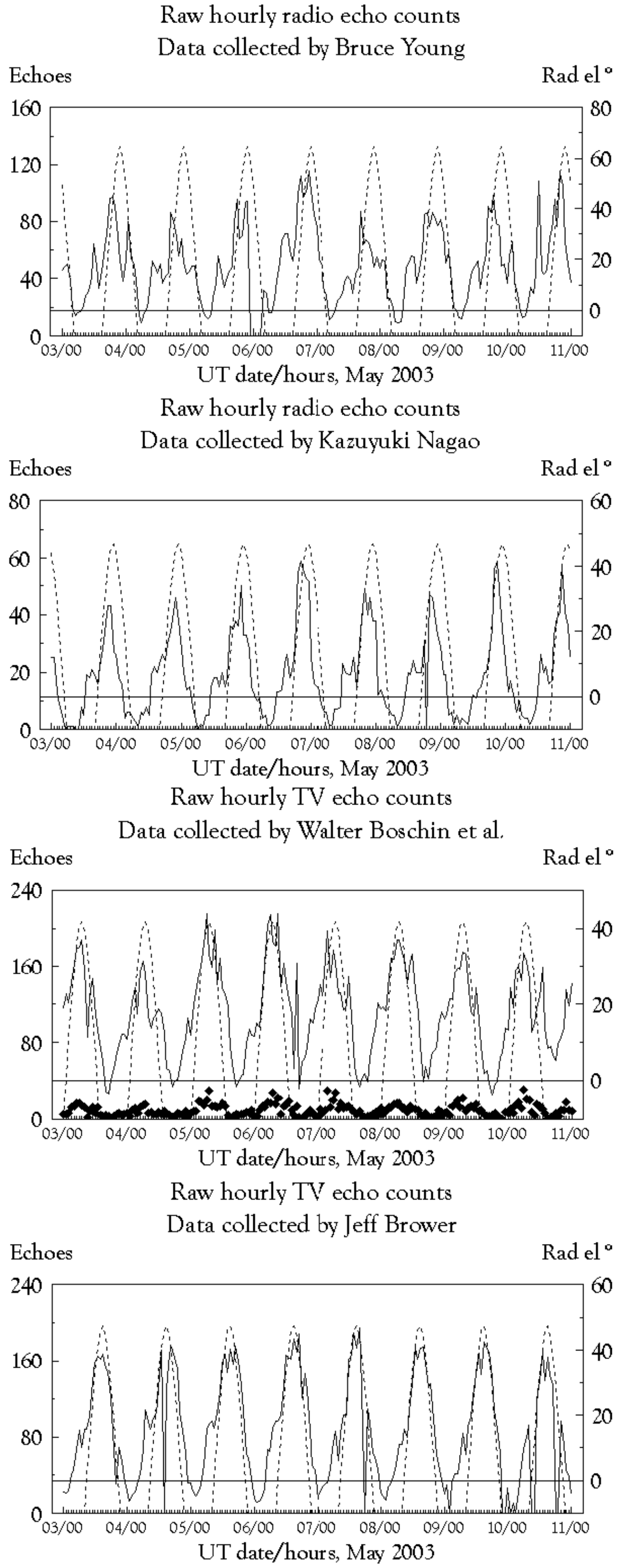

Figure 2 – Four sample raw radio or TV meteor echo count graphs, over the expected 2003η-Aquarid maximum. Echo count lines are the irregular ones, keyed to the left-hand y-axes. The daily-symmetrical lines, keyed to the right-hand y-axes, show the η-Aquarid radiant elevation for each site. The graphs help show how the shower was radio-viewed from different parts of the world: a) Australia (Bruce Young); b) Japan (Kazuyuki Nagao); c) Europe (Walter Boschin et al; the diamond datapoints near the x-axis show long-duration echo numbers, D > 1s, again keyed to the left-hand y-axis); and d) North America (Jeff Brower). Drops to zero in the echo count lines normally indicate times when interference prevented accurate data collection.

global coverage was extremely poor, thus it is unsurprising that testing for the two main shower peaks has proven tricky. Examining the surviving data suggested a weak consensus for June 7/8 and 10/11 to have produced the more likely maxima. The first was close to the expected Arietid peak, though the second was around a day late for the ζ-Perseids' maximum (McBeath, 2003a, p. 5) but, as noted in the IMO Shower Calendar, both maxima have frequently been detected up to a day late in recent years. This June's radio results more generally indicated that various days between June 6/7 and 10/11 might have produced similar activity, this blending again quite a common problem in daytime meteor investigations recently.

IMO preliminary visual results (Arlt, 2003) revealed effectively nonexistent June Boötid activity later in the month, on June 25–27. SPAMS observations, comprising a subset of the IMO ones, naturally concurred with this. Despite only seven surviving radio reports throughout the expected daylight β-Taurid/June Boötid epoch, there was no obvious signature relating to the Boötid radiant's best visibility from any of the sites (in Japan, northern Europe and South America). The β-Taurids gave a general mild enhancement between June 25 and 27, without an especially clear specific maximum signature, roughly as normal. There was no good evidence for the peak to have fallen as late as predicted, around June 28 (McBeath, 2003a, p. 20).

In previous years, when checking for potential Taurid Complex 'swarm' returns, it has been hinted that unusual noctilucent cloud occurrence might reveal some enhanced activity due to the ζ-Perseids or β-Taurids (McBeath, 2000). Consequently, the list of such sightings compiled by Tom McEwan, probably the most comprehensive northern hemisphere listing available, was examined again this year (available at: `www.nlcnet.co.uk`). Although no Taurid 'swarm' event was due in 2003, it is still useful to use such a year as calibration. No unusual noctilucent cloud events were apparent, although the number of sightings overall was rather sizeable again. This may simply have resulted from a larger and more active observer population as a whole, but there are also signs that the total display numbers of such clouds have been remarkably consistently high for much of the past decade, in contrast to the more obviously cyclical trends found in the past. Why this should be so remains unknown.

Acknowledgements

I am delighted to express again my grateful thanks to all the contributing observers and correspondents from this quarter. I must especially thank Tom McEwan, not only for providing regular comments and updates on his noctilucent cloud listing throughout the season and beyond, and for providing a hard copy of the finalised listing in late 2003, but also for his helpful discussion of various points relating to the clouds and their modern occurrence patterns.

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TV Observation of the 2004 June Boötid Meteors

Sadao Okamoto [1], *Masayoshi Ueda, Yasunori Fujiwara and Satoshi Uehara*

Predictions were given by several researchers that the maximum of the June Boötids might be on 2004 June 23. We obtained three June Boötid meteors from TV cameras simultaneously at double stations. The radiant points and heliocentric orbits of these meteors suggest that they belong to Comet 7P/Pons-Winnecke.

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1 Introduction

The maximum of the June Boötid meteors in 2004 was predicted to be on June 23 (Sato 2004, Shanov & Dubrovsky 2004). For our reference, M. Sato (2005) provided a summary of his prediction as follows:

Date	2004 June 23, $12^{h}30^{m}$ – $13^{h}45^{m}$ UT
Solar longitude	$92\overset{\circ}{.}31$ – $92\overset{\circ}{.}36$ (J2000)
Radiant Point	$\alpha = 222\overset{\circ}{.}4$, $\delta = +46\overset{\circ}{.}7$ (J2000)
V_G	14.1 km/s

In Japan, bad weather prevented our observations except on the night of June 23/24. Our observation sites and the TV cameras are listed in Table 1. We used personal computers with software called UFOCapture to detect moving objects in images recorded by TV cameras (Molau et al. 2005).

All cameras have a 1/2-inch CCD, with minimum luminosity 0.001 lx and

Focal length	Focal ratio	Field of view
f=6 mm	$f/0.8$	$56° \times 43°$
f=8 mm	$f/1.4$	$42° \times 33°$

2 Observations

We obtained thirty-three images of June Boötid meteors between $10^{h}30^{m}$ and $19^{h}00^{m}$ UT, and fortunately we succeeded in obtaining three June Boötid meteors simultaneously at two stations. The results of all three meteors are presented in Tables 2 and 3.

3 Light curves

Light curves of the meteors are presented in Figure 1. It is found that the maximum magnitudes of the three meteors were observed at heights between 80 and 83 km. These heights seem to depend on the speed of the meteor. For example, the mean height of the maximum brightness of the Leonids in 2001 was about 108 km (Ueda 2004).

4 Conclusion

Observational orbital data of the meteor M04117 may be slightly different from the those of the other two meteors, when compared to the predictions mentioned above. However, it is concluded that these three meteors all belong to the June Boötids associated with Periodic Comet 7P/Pons-Winnecke.

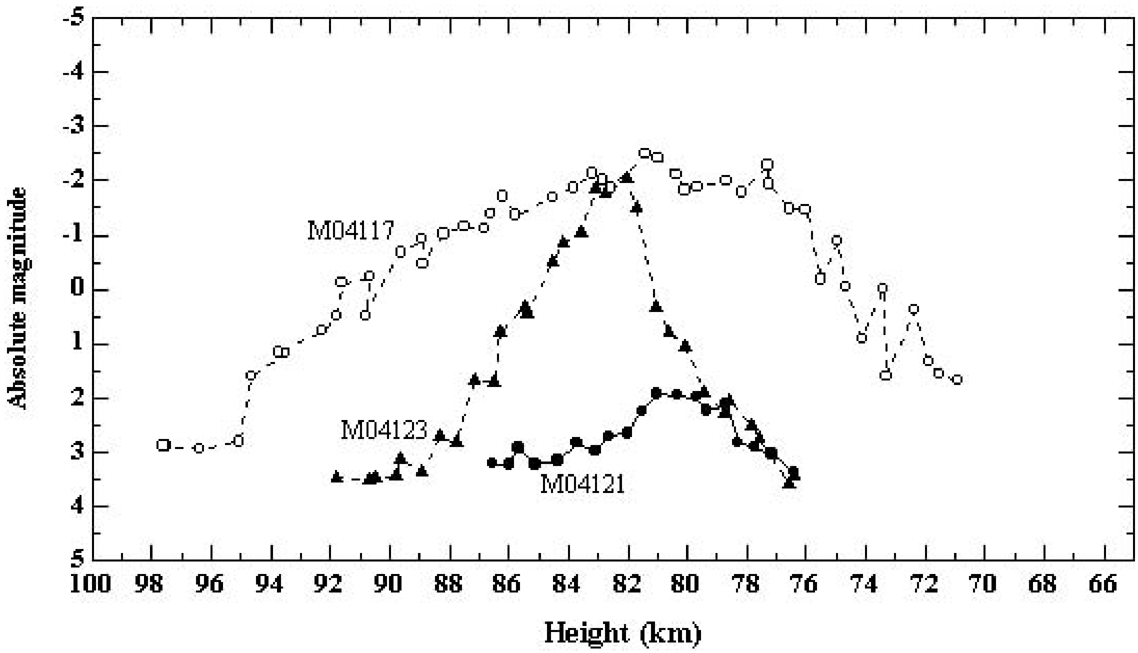

Figure 1 – The meteor light curves.

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NASA-ADS bibcode 2005JIMO...33..105O

Table 1 – Observing locations and lenses.

Observer	Id.	Location	Longitude	Latitude	Height	Lens	Limit Mag.
M. Ueda	U	Osaka	E135°634	N34°538	45 m	f=6 mm	+4
S. Okamoto	O	Aichi	E137°024	N35°121	30 m	f=6 mm	+3.5
S. Uehara	UE	Osaka	E135°539	N34°745	6 m	f=6 mm	+3.5
Y. Fujiwara	F	Osaka	E135°484	N34°735	0 m	f=8 mm	+4.2

Table 2 – Radiant point and other results.

Meteor Number		M04121	M04117	M04123
Date (2004 June 23, UT)		11h21m41s	12h07m01s	13h48m26s
Observers		U, O	U, UE	U, F
Q *		58°8	12°6	16°7
Apparent Radiant	α	224°0 ± 1°8	228°4 ± 3°3	228°8 ± 3°8
(J2000.0)	δ	+45°5 ± 0°9	+44°7 ± 1°3	+46°8 ± 2°1
v_i (km/s)		17.4 ± 3.3	20.6±8.7	17.5±2.5
V_G (km/s)		13.3	17.4	13.7
Abs. Mag.		1.9	−2.5	−2.0
Log (mass, g)		−0.66	1.02	0.60
H_{beg} (km)		86.5	97.5	91.8
H_{max} (km)		81.0	81.4	82.0
H_{end} (km)		76.4±0.2	70.9±0.6	76.4±0.6
$F = (H_{beg} - H_{max})/(H_{beg} - H_{end})$		0.579	0.575	0.633

* Q is the angle between the apparent great circles of motion as seen from the two stations.

Table 3 – Heliocentric Orbit of meteors.

Meteor Number		M04121	M04117	M04123
Date (2004,UT)		June 23.47339	June 23.50487	June 23.57530
Solar Longitude (2000)		92°268	92°298	92°365
Corrected Radiant	α	222°7 ± 2°0	226°6 ± 3°8	222°9 ± 4°4
	δ	+47°0 ± 1°1	+45°5 ± 1°4	+47°2 ± 2°5
V_G (km/s)		13.3	17.4	13.7
q (AU)		1.015	1.011	1.015
e		0.640	0.899	0.659
a (AU)		2.81	10.02	2.98
ω		185°61	188°26	185°50
Ω (2000.0)		92.268	92°298	92°365
i		17°53	21°54	17°95
Period (years)		4.7	31.7	5.1

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History

Meteor Beliefs Project: meteoric verse from three Romanian poets

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

A selection of short verses relating to meteors from three of the greatest Romanian poets, Vasile Alecsandri, Mihai Eminescu and Lucian Blaga, is presented, additional to material on each given previously.

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1 Introduction

Although we have published meteorically-relevant material from the three great Romanian poets Vasile Alecsandri, Mihai Eminescu and Lucian Blaga before, this is the first time they have featured under the Meteor Beliefs Project banner. Here, we have given some additional short verses from each, further to the material discussed earlier. We shall briefly recap those earlier references before proceeding to the fresh texts.

Works by Vasile Alecsandri (1819–1890), laureate of the Latinity Prize for 1881 in France, were discussed at the IMCs in 1997 (Gheorghe & McBeath, 1998), 1998 (Gheorghe, 1999) and 2000 (Gheorghe & Scurtu, 2001).

The Romanian national poet Mihai Eminescu's (1850–1889) poem Luceafărul we discussed in detail in WGN (McBeath & Gheorghe, 1999b), while much of his other meteoric verse was covered by (Gheorghe, 1999).

Lucian Blaga (1895–1961) was a poet, philosopher and playwright, probably the greatest personality in Romanian poetry during the 20th century, being shortlisted for the Nobel Prize for Literature in 1956. He loved the cosmos, and his meteor poem 'Celestial Touch' was featured in (Gheorghe, 1999).

In presenting the texts here, we have employed a free translation which does not preserve the rhyme or rhythm of the original, in order to give as clear an impression as possible. In doing so, we believe that this is the first time much of this material has been translated from Romanian into English.

2 Vasile Alecsandri

Parts of four meteoric poems are noted here, composed by Alecsandri in his early years, all taken from (Alecsandri, 1970). The first is from 'Doina', originally published in 1844. A doina is a traditional Romanian sorrowful poem, with rhythm and rhyme, and sometimes set to music. Alecsandri described it as 'the most living expression of the Romanian soul, including feelings of pain and love'. In essence, Alecsandri's poem 'Doina' is an appeal to fight for Romanian independence from the Ottoman Empire. The poet would like to have magic powers and strong allies, as in the following verse:

If I would have about me seven brothers
Brave like me
And riding dragons!

Obviously, this is a suggestion of a supernatural flight, but with celestially powerful overtones, since dragons are often closely associated with, or are physically believed to be, meteors in Romanian thought and folklore.

The second of Alecsandri's poems chosen this time was also inspired by Romanian folklore, and is entitled 'Lacramioare', literally 'Little Tears', though this is actually a common name for the plant Lily of the Valley (*Convallaria majalis*). The poem was first published in 1847 in the magazine Bucovina. In Alecsandri's vision, the lacramioare/Lily of the Valley plant symbolizes a terrestrial continuation of angels' tears shed in the heavens, and it became intermediary between the images of meteors and of his beloved woman.

There are no flowers in the world
With such sweet perfume, or sweet name
As you, small *lacramioare*!

You are tears of angels
Fallen from heaven on earth,
When their pure souls
Fly among the swinging stars
Weeping loving laments.

You are white and frail
Like the sweetheart of my life!

The tiny white, bell-shaped flowers of the low-growing Lily of the Valley do look a little like both meteors and tears, when in bloom in May and June, and they give off a wonderful fragrance too, as Alecsandri noted. One of their common English names is 'Our Lady's Tears', from the Christian Virgin Mary, which fits to this vision of angelic tears as well. Another British tale involves Saint Leonard, often associated with medieval leper hospitals, but unusually here said to have fought a mighty dragon, a fire-drake, for three days in St Leonard's Forest, Sussex. Although ultimately victorious, he was badly wounded in the encounter, and it was said afterwards that where his blood had been shed, there patches of Lily of the Valley grew (Dyer, 1994, p 14). Simpson (2001, pp. 54–55) has additional details on this local legend (including, on pp. 124–125, news that St Leonard may not have been entirely successful, as a pamphlet published in 1614 described a 3 m dragon, apparently sprouting wings, that had been

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seen in the Forest). As discussed in the Meteor Beliefs Project before — see WGN **31:6** (2003) — dragons and fire-drakes have long been linked to meteors in British and other European traditions.

The third Alecsandri item is from 'Steluta', 'Little Star', first published in 1853. It is a poetic remembrance of his sweetheart Elena Negruzzi, who had died shortly before. Alecsandri compared this tragedy with the passing of meteors:

> Pleasures of love, charming pleasures!
> Feelings! Great dreams of a wonderful future!
> You disappeared suddenly just like the travelling stars
> Which leave a deeper darkness after them.

Our final selection is from 'Bosphor', composed by Alecsandri after a trip to Istanbul. It was first published in 1853. The straits of the Bosphorus, seen by the poet as the frontier between *the shores of proud Europe and Asia*, inspired him to describe the scene including meteors:

> We could see above the moist field
> Only sparks and lightnings of silver flame
> Which, winding through the water, floated and rejected each other ...
> Or uncounted dolphins which, jumping from the sea
> And moving their backs in luminous froth,
> Sank one after the other in waves, following the stars.

3 Mihai Eminescu

In an earlier article elsewhere (McBeath & Gheorghe, 1999a), we commented on some aspects of dragonlore in Eminescu's poem, 'The Girl in the Golden Garden'. Of relevance here, we included the following translated quotation regarding a zmeu, a, sometimes meteoric, dragon-man in Romanian tradition, who became a fireball in order to meet a beautiful princess he had fallen in love with:

> Born from the sun, from the air, from the snow,
> Because of this love he became a star
> Falling from heaven to her great vestibule
> And changed into a luminous young man.

Another meteoric section which was not included in our earlier article runs:

> ...The *zmeu*
> Collects on his way
> Pleasant smiles from a thousand stars
> Flying like snow...

The end of this poem also seems to represent a meteor shower, as the zmeu weeps:

> ...tears fell towards the sea, furrowing immensity
> Like great beautiful pearls.

The whiteness implied by the 'pearls' simile seems to reflect back to Alecsandri's Lily of the Valley meteoric tears too.

Moving on to other texts we have not examined before, we found three poems from Eminescu in a compilation concerning visions of the cosmos in Romanian poetry (Dima, 1982). The first is 'The Story of the Magician Travelling Among the Stars', where the hero of the tale passes among moving stars, which seem rather like meteors: *The stars brightened reverently, moving aside for him to pass.*

Next, we have 'Life's Star', in which our quote is derived from the tradition that every human has a star in the sky, that falls when the person dies, though here on a more suicidal note:

> O, beloved star among the stars,
> Sacred golden eye trembling among the clouds,
> Be merciful and extinguish my days,
> Come down, oh, come down.

The third quotation is from 'When the Sea', which indicates a folkloric connection between meteors and meteorites, that also includes the pearly lustre again:

> On the bottom of the furious sea
> ...
> A star changed into a stone shines like a pearl,
> It is the lover of a pale star,
> ...
> It is the lover fallen from the stars...

Our final piece is from (Eminescu, 1969), in a poem with no name discovered only after Eminescu's death. In this, a young girl calls on celestial bodies to witness that she is still a virgin:

> Swear, sun,
> Swear, travelling stars,
> For I am a clean maiden.

'Travelling stars' might refer to the naked-eye planets, after the Greek for 'wandering stars', but this term in Romanian often seems to refer to meteors instead, as more clearly indicated in our third piece from Vasile Alecsandri in Section 2 above.

4 Lucian Blaga

Lucian Blaga's 'Together with the Great Blind', first published in 1921 (Blaga, 1921), is the last poem discussed here as containing meteoric verse. The poem describes a fabulous walk with the supreme prophet and god of the ancient Dacians, the people who inhabited modern Romania's territory during the days of the Roman Empire. This figure, who may have been based on a living original, later deified, was named Zamolxis (there are other variant spellings found in the literature), who became blind towards the end of his terrestrial existence. From this belief, the name 'the Great Blind' is derived. It is rather a quiet trip: the Great Blind *keeps silent, because he is afraid of words./*

He keeps silent, because every word of his becomes a deed. Suddenly, a meteoric apparition enlivens the atmosphere:

> Why was he startled?
> Father Blind, there is nothing around us.
> Only up there, a star has left the sky
> With a golden tear.

Certainly, this is one of the most beautiful images of a meteor in Romanian literature.

5 Conclusion

With all the references to tears in these quotations, and from the general tenor of several of the poems more generally, there is a distinctive melancholy which pervades much of the Romanian poetry we have examined over the years in relation to meteors. That does not detract from its power, or the beauty of its imagery, but seems appropriate, considering the ephemeral nature of meteors, so often used as a simile for the brevity of human life itself.

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Some apparatuses of meteor astronomy from the pre-electronic epoch

Miloš Weber [1]

This paper is a brief review of the optic-mechanical apparatus used in meteor astronomy before radio and optic-electronic techniques.

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1 Introduction

The progress of every branch of the science depends on the progress of the apparatus, which multiplies the ability of the human senses and which increases the objectivity of the observations and explanation of natural phenomena.

Meteor astronomy began to use some apparatuses only in the second half of the 19th century. Some examples of the design and use of diverse apparatuses, especially of their first use, are described in the following sections. As this review describes the development of apparatuses, the observational results are mentioned only to characterise the effectiveness of those, and therefore the references are limited to this aim. The examples of the Czech and Slovak republics are unknown as a consequence of the language barrier of their publications. This communication follows the one about the meteoroscope (Hoffmeister, 1937; McBeath, 2004).

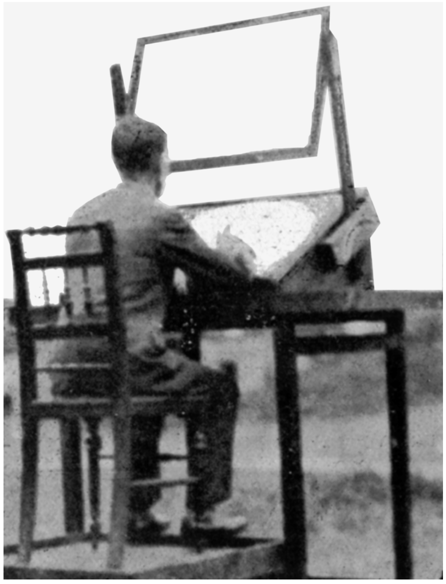

Figure 1 – Plotting through the mirror according to J. Svoboda. (From Říše hvězd X (1929), p.142.)

2 Apparatus for naked-eye observations

One function of apparatuses should be to increase the objectivity of the observations. Prof. J. Svoboda observed meteors through a mirror, as the transfer of the observed train from the mirror to the map was more accurate than from the sky. The maps were reversed to match the image in the mirror (Figure 1). This device was used in the years 1929–1938. E. Öpik used a wire rectangular reticle during the Arizona expedition in the years 1931 and 1932. The observers noted the position of the meteor train on this reticle in rectangular coordinates (Shapley et al., 1932). This method of observation was used also during the Byrd Antarctic campaign of 1933 with a wire polar reticle (Figure 2). This method was not used later even in the modified form of J. Štěpánek, who produced an optical net projected into the observer's eye. The main cause was the necessity of observing with one eye.

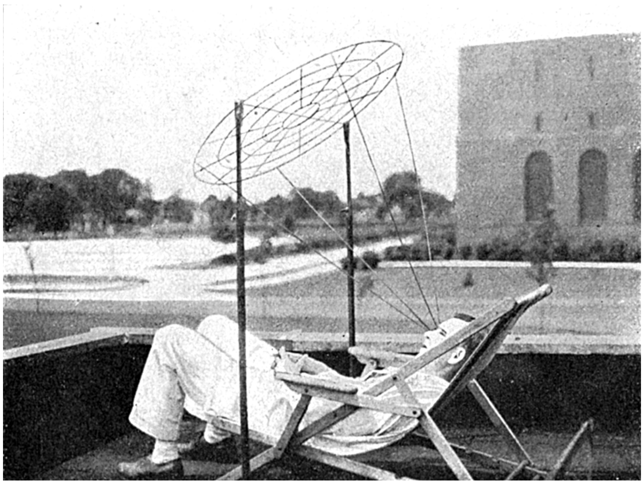

Figure 2 – Wire reticle with the polar coordinates. Used in Byrd's campaign 1933. (Říše hvězd XV,P.72)

Another group of apparatuses were artificial meteors. These were designed to work as training devices and simultaneously gave the possibility of determining the observer's errors. J. Svoboda performed this research for a long time (Svoboda, 1935, 1936, 1939). His artificial meteor was designed as a line of filament bulbs behind a slit with opal glass, fixed on an arm turning around a peg on a vertical rod. The lamps were switched on and off gradually which created an illusion of a flying point. The peg controlled the radiant of the artificial meteor. The choice of filament bulb switched on varied the distance from the radiant. The duration of the meteor was registered by a chronograph with an accuracy of 0.02 s. Behind the meteor were filament bulbs as imitation stars. The observer plotted the position of the artificial meteor and after the observation he switched a filament bulb to the time imitating the duration of the meteor. This method checked not only the accuracy of plotting but also the estimation of meteor duration. The work of Svoboda was followed by Z. Horák (1937). J. Hoppe (1935) investigated observing errors in the Zeiss Planetarium. On a similar principle, J. Němec and M. Weber (1945) designed and realised

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an artificial meteor in amateur conditions. It simulated the real circumstances of observation as much as possible. The observer saw a section of the firmament at natural scale. The images of stars were projected on a white wall 6.5 m × 4 m, before which the eye of the observer was at a distance of 4 m. The field of view was 80° × 37°. The projected slide had dimensions 130 mm × 180 mm and was photographed from a gnomonic atlas at the necessary enlargement. The illusion of a flying point was created by a second projector using the principle of two slits. The slide of meteor trains was fitted with a changeable curtain containing one slit for the selected meteor train. Before the meteor train slit was a rotating disc with a slit in the form of Archimedes spiral. The light shining through the point of intersection of both slits was projected on the wall with the images of stars. After the projection of any group of meteors, the rotating disc and the changeable curtain were removed. All trains should be plotted on the map and compared with the plotting of the observers. The illusion was very natural, but systematic observations were not possible. With the end of the war Czech universities were reopened and the group of observers dispersed to finish their studies and begin their careers.

The second problem of visual observations is the recording of the duration of the meteor. F. Nušl founded a way to solve this problem (Guth, 1932). He designed a precessing mirror. The axis perpendicular to the centre of the mirror circumscribed the surface of a cone but the mirror did not rotate. The stars were observed as circles in the centre of the field of view and as ellipses at the border. Meteors were observed as cycloids resulting from the linear motion of the meteor and the circular motion of the mirror. The mirror had 10 precessions per second, so each loop of the cycloid represented a duration of 0.1^{s}. Öpik used this principle (Shapley et al, 1932) on the Arizona meteor expedition of 1931–1932. The motion of the mirror was the same but the mechanism was different. During two years of Arizona expeditions they observed 22 000 meteors. From 1 436 well observed meteors of these Öpik deduced that 66% of sporadic meteors moved with hyperbolic velocities (Öpik, 1934, 1935). This result was later negated by other visual, photographic and radar observations. Therefore the method of the precessing mirror was doubted. It must be remarked that during the Arizona expedition C.C. Lampland used the precessing mirror for telescopic observations and his mechanism was similar to the Nušl's one. J. Němec and M. Weber (1946) designed and realised a modification of the precessing mirror. It was difficult to count the number of cycloid loops generated by meteors of longer duration. They produced a mechanism which showed each fifth loop with twice the amplitude (Figure 3). The apparatus was tested, the function was perfect, but the observers group dispersed as mentioned before.

3 Apparatus for telescopic observations

The first record of the observation of a meteor in a telescope is dated 1795. On June 28, Schroeder saw a meteor in the 20-inch reflector (Chambers, 1889; Astapowitsch, 1958). The following observations were also in astronomical telescopes, partly by chance, partly by intention. For example, in 1839 Mason saw a total of 50 telescopic meteors (TM), Schmidt during 1844–1851 a total of 156 TM of m=7–11. In 1854, Winnecke first observed the TM in a 3-inch comet finder with a field of 3° and registered 105 TM in 32 evenings. In 1883, Brooks observed with a 9-inch reflector with a comet eye-piece. In the years 1879–1885, V. Šafařík observed TM at Prague with the 6.5-inch refractor, magnification 32×, field 54′ and with the 1.5-inch finder. On 1880 August 30, he saw 50–100 TM during six hours (Šafařík, 1886). In 1896, Denning observed 635 TM during 727 hours at Bristol with the 10-inch refractor. Öpik conducted the first systematic observation in 1921 from Moscow with a comet finder. Astapowitsch observed TM from 1930 April 20 to 22 with comet finders from two stations and obtained the path for three TM. From the 1930s the number of TM observations grew. The typical apparatus used was a binocular with greater field of view and aperture ratio and low magnifying power i.e. field glass usually of the type of 'trieder'. The great SOMET binocular is very successful: $2 \times D = 100$ mm, $f/4.5$, magnification 25×, field of view $3\overset{\circ}{.}6$. An example of the use of this apparatus is the paper (Kresáková & Kresák, 1955).

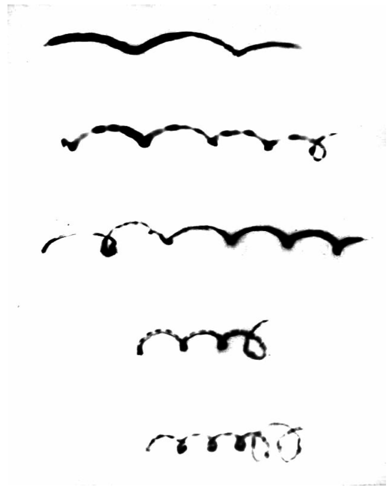

Figure 3 – Meteors (artificial) observed as cycloids in the precessing mirror with variable amplitude. Each fifth loop has a greater amplitude. The velocity of the luminous flying point diminishes downwards. (Říše hvězd XXVII, p.109.)

4 Photography

Photography is the first objective method of meteor observation and at the same time the most accurate. The first photograph of a meteor was obtained by L. Weinek, director of the Prague observatory, on 1885 November 27 during the great meteor rain of Andromedids, with a lens of $f = 240$ mm, $f/5.6$ (Weinek, 1886). The number of photographs obtained grew slowly (Guth, 1954). The lenses had a small aperture ratio and the photographic plates low sensitivity. W. L. Elkin constructed a great meteor astrograph (Figure 4) (Scheiner, 1897), and later in 1893 he realised the first rotating shutter for the accurate measurement of velocity (Elkin, 1899,

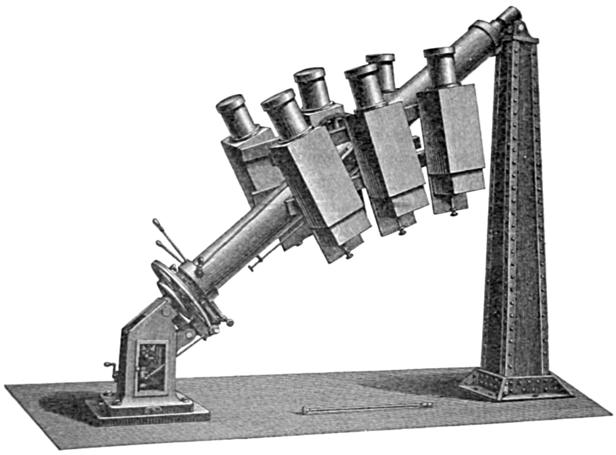

Figure 4 – Elkin's equatorial for the meteor photography. The polar axis is 12 foot long.

1900). He also photographed from two observing sites. Photography made the derivations of atmospheric paths and of heliocentric orbits more precise. For a long time only the brightest and slowest meteors were recorded. But gradually the lenses and the sensitivity and quality of the photographic materials were improved. One of top optics was the Super-Schmidt camera used first in 1951 (Plavec, 1956). The diameter of lens was 400 mm, mirror 590 mm, focal length 200 mm, aperture ratio $f/0.66$. It registered meteors with a limiting magnitude of 4. Today commercial lenses of small cameras reach the same aperture ratio. Progress continued by design of fish-eye lenses allied with organised regional nets of all-sky cameras. The pioneer in all-sky photography was V. Guth who proposed the use of convex mirrors in 1936 (Plavec, 1956). This idea was implemented. Finally, convex mirrors were replaced by fish-eye lenses such as the Distagon in 1969.

5 Meteor spectroscopy

5.1 Visual spectroscopy

The pioneer of meteor spectroscopy was Prof. A.S. Herschel. In 1863 he designed a direct-vision, binocular, visual meteor spectroscope (Figure 5), which was constructed by the optician John Browning. The field of view was about 20° and the stellar spectra were almost a degree long. A number of these meteor spectroscopes were distributed to various observers. Herschel recored the first meteor spectrum on 1864 January 18. In the years 1866–1880 Herschel, Browning, von Konkoly, Secchi and others obtained 300–400 meteor spectra. Many variations of the direct-vision spectroscopes were used: with objective and eye-piece (Konkoly, 1883), with cylindrical concave lens (Browning, 1868). Browning constructed for example a vestpocket spectroscope, Konkoly and others independently other variations. Konkoly first used a refractor with a stellar spectroscope for observing the persistent trains of meteors. The observers modelled meteors with rockets, with burning bunches of material and with balls shot by Roman candles loaded with known elements (Na, Sr, Ca, Mg, Fe, Cu) and tested the observed spectra. They were well

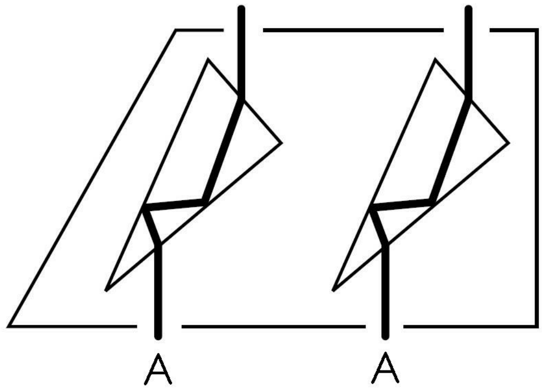

Figure 5 – The Herschel-Browning meteor spectroscope. A = entrance pupil. (From Intellectual observer 10, p.38.)

equipped with laboratory sources of spectra for comparison. In the period of visual observing of meteor spectra Rowland produced the first gratings, but they were not suitable for visual spectroscopy.

5.2 Photographic spectroscopy

Pickering obtained the first meteor spectrum in 1897 by chance on a Harvard objective prism plate. This astrograph had $D = 230$ mm, $f = 1150$ mm with a 5° prism (Millman, 1980). The first spectrum that occurred on a program of meteor spectroscopy was obtained by S. Blajko at the Moscow observatory in 1904. Blajko obtained a total of three meteor spectra. In the years 1897 to 1932, nine meteor spectra were recorded, of which five were by chance on spectrographs and four on small cameras. Meteor spectroscopy was improved by using objective gratings, usually with 600 lines/mm. With such a camera, Ceplecha (1971) obtained a spectrum with over 1000 separate features in a single spectrum on a lens $f = 360$ mm, $f/4.5$. Spectrographs for UV and for IR in the range 310 nm to 900 nm were constructed and also fast emulsions became available. Harvey (Millman, 1980) employed a battery of fast Maksutov cameras with aperture ratios $f/1.0$ and $f/1.3$ in a systematic program of meteor spectroscopy.

A special problem is the spectroscopy of meteor trains. Konokly performed the first visual observation in 1873. Nasyrov obtained the first photographic spectrum in 1965 at Aschabad. A special photographic spectroscope for the photography of meteor trains spectra was developed and constructed by P. Zimnikoval (1994a, 1994b).

It has two objectives with prisms oriented in directions differing by 90° and one objective for a nonspectral image, a recording of the time of the exposure, and it is very easy to aim. This apparatus was developed in two variants, a first 1985 and a second in 1989. D. Očenáš obtained the first meteor train spectrum with this apparatus, and further spectra followed. After three years of theoretical preparation the obtained spectra of meteor trains were evaluated and published (Rajchl et al, 1993, 1995; Borovička et al, 1996).

6 Conclusion

Radio methods, CCD cameras, video cameras with intensifiers and home cinema for artificial meteors have gradually replaced these old techniques. Only photographic methods are used currently.

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