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Administrative

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History

Front cover photo

This $m = -6$ Aquarid was taken by Alexandru Cornu at Darmanesti-Castel, Romania on 2004 August 12 at $21^{\mathrm{h}}26^{\mathrm{m}}55^{\mathrm{s}}$ UT. The exposure lasted from $21^{\mathrm{h}}23^{\mathrm{m}}15^{\mathrm{s}}$ to $21^{\mathrm{h}}27^{\mathrm{m}}58^{\mathrm{s}}$ UT. Camera: Praktica; lens: Pentacon $f = 50$ mm, $f/1.8$; film: Konica VX400.

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 — Old stalwarts and new entrants

Chris Trayner

September sees the International Meteor Conference again, as every year — but this one is special. It is the 25th such conference to be held. The first, just called a Meteor Seminar, took place in June 1979 near Bonn. Originally held every 18 months, these meetings later grew and matured into the well-organised, annual events we have come to rely on.

To mark this anniversary, we are publishing a brief history of these conferences. The author, Paul Roggemans, has been involved with IMO and the IMC since those early days, and there can be few people better qualified to archive this history before it gets forgotten. His article is on page 115.

This September's IMC will decide on the location for the 2007 one. If your national group are interested in organising one for 2008 or after, please contact the IMO Council to enquire what will be required.

Like many similar voluntary organisations, the IMO produces two most visible products: annual meetings and a Journal (plus many other less visible but equally valuable activities). The world changes, though, and new media are coming to the fore. One which is now well established is the World-Wide Web. The IMO has had a website for years, and it has recently been re-furbished.

A recent addition to it is an area for ongoing projects. A website is well suited to relatively fast-changing information like this. For those who have not yet seen this, Luc Bastiaens' and Alastair McBeath's letter (below) gives an introduction to it.

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Letter — Improvements to the IMO website

Luc Bastiaens [1] *and Alastair McBeath*

Regular visitors to the IMO website, `www.imo.net`, will know that work has been on-going since 2005 to improve and update the site, making it easier to use and more attractive for visitors. The main facelift to the site happened last August, but minor improvements have continued since.

Much as before, the homepage still has recent news on it, and links to all the key elements about the IMO, including its history, commissions, WGN and other publications, the online 'Who is Who' listing, practical notes on the various observing techniques, and the current year's Shower Calendar in English and several other major languages. Data archives are accessible this way too, including extracts from the VMDB back to 1984, and fireball data from 1993–1996.

A significant new segment has recently been added, entitled 'Ongoing Projects'. The idea of this is to help publicise meteor-related projects, not just those run officially by the IMO, to encourage people to contribute to such existing projects or even start new ones. The homepage at `www.imo.net/projects` provides one-paragraph summaries of the projects, with links to contacts or where more information can be found. Currently, the projects include the IMO's 'Meteor Observing Handbook', the Meteor Beliefs Project and the Unified Meteor Database. Both the latter two have further information elsewhere on the IMO site. The idea is that the various notes will be updated regularly, as fresh information becomes available, provided by the project organizers.

Additional projects are needed to help keep the pages fresh and looking alive, so whether you are an amateur or a professional, if you are working on something meteoric yourself, contact Luc at `webmaster@imo.net` to claim your own spot. Please include a short description of your project (one paragraph) to go on the homepage, and optionally a more elaborate explanation that could be linked from it. You should also give an e-mail address, so anyone interested in your project can contact you.

Next time you are online, visit the IMO site, and if you have any comments or suggestions for further improvements to it, please let Luc know!

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Conferences

Proceedings of the Radio Meteor School, Oostmalle, Belgium, 2005

In 2005, for the first time, the IMO organised a specialist summer school immediately before IMC. The Proceedings have now been published. The cost is €15 including shipping. For ordering details, see the IMO website `http://www.imo.net/imo/publications` . To give a flavour of what the volume contains, outline details are printed here.

Basic elements of meteor stream theory

Oleg I. Belkovich (lecturer), Danica Pajović, and Jean-Marc Wislez (editors)

The goals and means of meteor stream observing are defined, and the basic parameters describing a meteor stream (flux density and mass index) are introduced. The Poynting-Robertson effect is explained.

The physics of meteoroid ablation and the formation of ionized meteor trails

Oleg I. Belkovich (lecturer), and Cis Verbeeck (editor)

The physics of meteoroid ablation, as well as the formation and diffusion of ionized meteor trails are described, introducing the electron line density α and initial radius r_0. The diffusion of the ionized trail is given. The characteristic height h_0 of a meteor stream is introduced.

The physics of backscattering of radio waves from ionized meteor trails

Oleg I. Belkovich (lecturer), and Jean-Marc Wislez (editor)

The distinction between the underdense and overdense reflection mechanism is introduced, and the amplitude evolution in time of the reflected signal is derived for both cases. The paper finally looks at reflections from meteors having a transitional electron line density.

Processing of radar observations 1: Sporadic background, detection threshold, radar sensitivity

Oleg I. Belkovich (lecturer), Juan Martín Semegone, Pavol Zigo, and Cis Verbeeck (editors)

A method is described in order to determine and exclude the sporadic background from radar observations, yielding the meteor shower activity. It is explained how to properly set up the threshold for meteor detection. Finally, two methods are discussed for determining the sensitivity of the radar equipment.

Processing of radar observations 2: Determination of the meteoroid flux density

Oleg I. Belkovich (lecturer), and Cis Verbeeck (editor)

Two methods are described for determining the meteoroid flux density $Q(m_0)$ of a meteor stream. In the first method, all observed stream meteors are considered, and the problem is solved by calculating the collecting area of a typical sector in the echo plane, reducing the flux density in this sector to mass m_0, and integrating over all directions in the echo plane. The second method uses the number of observed overdense meteors with an echo duration longer than 1 second.

Processing of radar observations 3: Calculation of meteoroid flux density and mass index

Oleg I. Belkovich (lecturer), Danica Pajović, and Cis Verbeeck (editors)

A practical approach is presented to calculate the mass index s and the flux density Q of a meteor stream based on radar observations. This method is illustrated with radar observations of the Geminids over several years.

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Forward scatter meteor observations

Oleg I. Belkovich (lecturer), Saša Nedeljković, and Cis Verbeeck (editors)

The principles of meteor radar observations can be applied to forward scatter observations, but lead to more difficult calculations due to the complicated geometry. This forward scatter geometry is discussed in this paper, as well as its implications for various formulas and for determining the equipment sensitivity, the meteoroid flux density and the mass index.

Meteoroid streams: Mathematical modeling and observations

Galina O. Ryabova (lecturer), and Antonio Martínez Picar (editor)

The approach to mathematical modeling of meteoroid streams is discussed, as well as how to use observations in the calibration of the model. This is illustrated by means of the Geminid meteoroid stream.

Basic radio interferometry

Michiel Brentjens

This paper treats a basic derivation of the visibility on a baseline due to a distant point source with a general spectrum.

Using EZNEC for calculating antenna characteristics

Frans Lowiessen

The use of the EZNEC software package for calculating antenna characteristics is illustrated by calculating the antenna pattern and the antenna impedance for a dipole antenna at different heights above the ground.

Meteor astronomy using a forward scatter set-up

Jean-Marc Wislez

An overview of the classical theory of the reflection of radio waves off meteor trails is given: the reflection conditions and mechanisms are discussed, and typical (t, A)-profiles of radio meteors are derived. Various configurations of the receive station(s) are proposed. The goal is to give the radio observer more insight in the possibilities, limitations and relevant parameters of forward scattering, and on how to obtain these through observations.

Meteor forward scattering at multiple frequencies

Saša Nedeljković

Meteor forward scattering is a well known method of detecting meteors using a radio telescope to receive signals from distant transmitters scattered from a meteor trail. The traditional way of performing the meteor forward scattering is to tune the receiver to some particular frequency to match a distant transmitter and wait for reflected signals. In this paper I will show how new technologies can be used to make a simpler digital radio telescope capable of analyzing broadband spectra from 0 to 250 MHz. Such spectra contain information about several reflections on a single meteor, which can be enough to calculate the meteor's kinetic parameters.

Brainstorm meeting on radio meteor data storage format

Jean-Marc Wislez

Radio meteor data storage in FITS format: METFITS

Michiel Brentjens

This paper proposes a FITS-based storage format for raw radio meteor observations. This format is suggested for storing all unprocessed measurements from forward scatter set-ups, in order to preserve the observational data for the time when decent processing methods and software are readily available. The format specification is still preliminary, and is open for discussion.

Fireballs

Canadian fireball activity from 1962 to 1989

Martin Beech [1]

The time of occurrence data for 2373 fireball events predominantly observed from across Canada and documented in the Millman Fireball Archive is studied. The cumulative number of fireballs, arranged according to solar longitude, has been constructed and is interpreted in terms of an annual fireball activity profile. We find distinct enhancements in fireball activity at the times of the α-Capricornid, Perseid, Taurid, Leonid, χ-Orionid and Geminid meteor showers. Six other peaks in the activity profile are also identified but these do not correspond to any prominent cometary meteor shower. The strongest peak in the entire activity profile falls at $\lambda_\odot = 165°$ (September 7) and we suggest that it may be related to the 'Group 3' meteorite stream identified by Halliday et al., (1990). A peak at $\lambda_\odot = 248°$ (November 30) is also tentatively identified with the 'Group 4' stream of Halliday et al. In addition we also tentatively associate a fireball peak at $\lambda_\odot = 191°$ (October 4) with the so-called HC34, H-chondrite meteorite stream identified by Wolf et al., (1995) and linked to the Peekskill meteorite fall in October of 1992.

1 Introduction

The stately grandeur of a passing fireball is an incredible sight and for a few brief moments the night becomes charged with expectation and wonder. Even the humblest tyro cannot be but inspired by the sight of a fireball, and this, with respect to our understanding of such phenomena, is of great importance. The Millman Fireball Archive (MFA) exists partly because of the efforts of a few dedicated researchers and partly because multitudes of casual observers were sufficiently inspired to report the *hautgoût* of their experiences. The earliest report card in the MFA exemplifies this latter point and relates to the midnight sighting of a simultaneous sound-producing fireball observed from the top of Mount Oscar (British Columbia) in August of 1927.

The impetus to begin a Canadian fireball archive followed from the fall of the Bruderheim meteorite in March of 1960, and the archive was initially overseen by Dr. Peter Millman for the Associate Committee on Meteorites (ACOM – now the Meteorites and Impact Advisory Committee [MIAC] to the Canadian Space Agency)[1]. The archive was most actively maintained from early 1962 through to the end of 1989, and contains some 3878 report cards relating to the observation of 2131 fireballs (Beech, 2003; Beech, 2004). The archive also contains report cards relating to a further 315 fireballs witnessed by observers in the United States. A study of the MFA fireball magnitude distribution has reveal that most were between magnitude −1 to −5 in brightness (many are simply described as 'bright' or 'very bright'); about 15% of the events were deemed to be brighter than magnitude −10 (Beech, 2004). In this communication we analyze the fireball occurrence times with the aim of investigating the annual fireball activity profile.

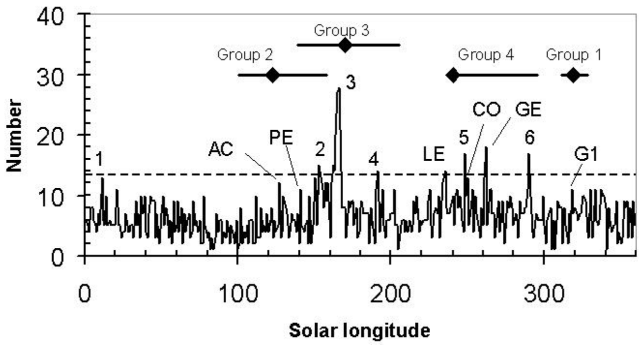

Figure 1 – Number of fireballs versus solar longitude for the MFA dataset. See the text and Table 1 for a discussion of the labeled peaks. The duration of each of the four fireball groups identified by Halliday *et al.,* (1990) are shown and the mean time of associated fireball appearance is indicated by the solid diamond shape. The dashed line indicates the two sigma level above the mean.

Time of event information is available for 2373 of the fireballs contained in the MFA records. This is less than the full complement of fireball events documented simply because in a number of cases either no complete time of day information is available, or just a year and month are recorded. For the 2373 fireballs with complete time records the UT time, day, month and year information have been used to determine a corresponding solar longitude (epoch 2000), and the resultant data set has been 'binned' in one-degree increments. The resulting data distribution is shown in Figure 1.

2 Annual fireball activity

A number of features are immediately obvious from Figure 1. Indeed, several distinct peaks are delineated and

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[1]The entire MFA data set may be accessed via the link at `http://hyperion.cc.uregina.ca/~astro/MIAC/intro.html` . In addition, a summary of fireball accounts received by MIAC in the time interval from September 1992 to March 1997, and from October 2001 to the present day can be accessed through the same web page. MS Excel files of the full MIAC fireball report forms are also available for 1999 onwards.

Table 1 – Summary of peaks identified in Figure 1. Column 1 relates to the labels shown in Figure 1. Column 2 provides some brief comments about the possible origins and/or associations for each peak. Column 3 indicates the solar longitude of the peak maximum while column 4 gives the full width half-maximum value for each identified peak. Column 5 indicates the number of meteors contained in the 'peak bin'. The average number of fireballs per 'one-degree' solar longitude bin is 6.6 ± 3.5. See text for further discussion on each peak.

Label in Figure 1	Comments and possible associations	$\lambda_\odot$ (°) of maximum	FWHM (°)	Number
1	Peace River / Revelstoke	11.0	±0.5	13
AC	Alpha Capricornid meteor shower	127.0	±0.5	12
PE	Perseid Meteor Shower	141.0	±0.5	11
2	λ Aquilid stream	154.0	±3.0	15
3	Group 3 MORP stream	165.0	±4.0	28
4	HC34 meteorite stream (Peekskill)	191.0	±2.0	14
LE	Leonid meteor shower	235.0	±1.0	14
5	Group 4 MORP stream	248.0	±3.0	17
CO	Chi Orionid meteor shower	250.0	±1.0	13
GE	Geminid meteor shower	262.0	±2.0	18
6	Group 4 MORP stream (extreme)	290.0	±2.0	17
G1	Vilna / Group 1 MORP stream	318.0	±1.0	11

a reasonably clear minimum in activity is evident at around a solar longitude of $\lambda_\odot = 95°$, close to the time of the summer solstice. The features labeled in Figure 1 are described (and briefly annotated) in Table 1. A number of annual meteor shower maxima are discernible in Figure 1, although, and surprisingly, the Perseid meteor shower at $\lambda_\odot = 141°$ is not the most prominent peak (see section 5 below). The α-Capricornid shower at $\lambda_\odot = 127°0$ is well defined, and so to are the Leonids at $\lambda_\odot = 235°0$, the χ-Orionids at $\lambda_\odot = 250\overset{\circ}{.}0$, and the Geminids at $\lambda_\odot = 262\overset{\circ}{.}0$. We also identify a number of distinct peaks and relatively strong activity in the time interval $\lambda_\odot = 220\overset{\circ}{.}0$ to $230\overset{\circ}{.}0$ corresponding to the times at which the Southern and Northern Taurids are active. Beech, Hargrove and Brown (2004) have recently discussed the variable activity of the Taurid shower as evidenced by the MFA record and several other fireball surveys. Indeed, the Taurid fireball activity appears to be modulated by a 7:2 mean motion resonance with Jupiter (Asher & Clube, 1993), resulting in enhanced Taurid activity at intervals corresponding to 3, 4 or 7 years. Beech, Hargrove & Brown (2004) found evidence for six epochs of enhanced Taurid activity in the MFA data.

All of the annual showers known to regularly produce bright fireballs appear to be represented in Figure 1. The α-Capricornid shower has a complex radiant structure, but since its initial documentation in the late 19$^{\text{th}}$ century, it has become well known for producing slow and bright fireballs. The α-Capricornid stream is commonly associated with comet 45P/Honda-Mrkos-Pajdusakova, although Hasegawa (2001) has recently argued that several additional comets and Apollo asteroids may 'feed into' the shower. Indeed, Neslušan (1999) argues for a connection between the α-Capricornid stream and comets 14P/Wolf and D/1892 T1 (Barnard 3), with the latter comet, Neslušan suggests, being a fragment from the former. Such a cometary fragmentation event (if it occurred) would no doubt place a multitude of centimeter to meter-sized fragments into the associated meteoroid stream — such objects would then be capable of producing bright fireballs if they chanced to enter the Earth's upper atmosphere.

The χ-Orionid shower is well known for producing infrequent but bright fireballs and it is generally believed to be associated with the Apollo asteroid 2201 Oljato (Babadzhanov, 1996). The χ-Orionids and Oljato have also been associated with the 'extended' Taurid complex (Babadzhanov, 2001) and may therefore have an extensive collisional as well as complex dynamical history. Interestingly, the evolutionary status of 2201 Oljato is apparently that of an extinct cometary nucleus (Lupishko & DiMartino, 1998; Babadzhanov, 2001). Indeed, the same extinct cometary nucleus status also applies to the parent body, 3200 Phaethon, of the Geminid shower — again, a shower that is well known for producing slow, bright meteors (Beech, Illingworth & Murray, 2003). We note, as well, that the Geminid shower (with a peak at $\lambda_\odot = 262\overset{\circ}{.}0$) is the most prominent of all the annual meteor showers represented in Figure 1. The Leonid meteor shower, associated with comet 55P/Tempel-Tuttle, is well known for its ability to deliver, in contrast to the Geminid and α-Capricornid showers, very swift and bright fireballs. The fireball rich Leonid storm of 1965 is clearly evident in the MFA records, and 11 Leonid fireballs are documented for the nights of November 16 and 17 in just that one year.

The sporadic background fireball rate is expected to vary by a factor of about 1.5 during the course of the year at latitude 52° (Halliday & Griffin, 1982). This background variation relates to changes in the altitude of the apex of the Earth's way, which in the Northern Hemisphere is at its highest during the autumnal months. We find that the 'background' variation in fireball activity varies according to the relationship $N = 6.0 - 2.0cos(\lambda_\odot - 95°)$, with a minimum at a time close to that of the summer solstice. In addition to the apex effect, the number of fireballs reported circa $\lambda_\odot = 90°$ would be expected to be low due to the short nighttime hours that occur at that time of the year. In broad terms, however, it would appear that the annual variation in the reported number of 'sporadic' fireballs referenced in the MFA is consistent with expectation.

3 The 'un-attached' peaks and possible meteorite streams

We identify six prominent peaks, at or above the two-sigma level of the mean, in Figure 1 that have no apparent commonality with any known and/or distinctive annual meteor showers. These particular peaks (annotated in Table 1) possibly relate to weak and/or only intermittently active showers that produce perhaps one or two fireballs every other year. This being said, the peak at $\lambda_\odot = 154°$ (August 26) may correspond to the λ-Aquilid fireball stream, which according to Gavajdova (1995) is active from August 14 to 31. Indeed, of all the potential fireball 'streams' discussed by Gavajdova, the λ-Aquilid stream is the most prominent in terms of its designated membership. Hasegawa (1993) also finds within the historical record an indication that a shower (Hasegawa's stream number 8) was, or is intermittently, active in the solar longitude interval from 150° to 153° (epoch 2000). This particular stream is identified according to a series of seven meteor shower outbursts recorded during the time interval from AD 464 to 1888. If the $\lambda_\odot = 154\overset{\circ}{.}0$ peak in Figure 1 and Hasegawa's stream number 8 are related, then a truly ancient heritage is implied with activity, at various levels of intensity, being in evidence for perhaps the past 1500 years.

The peak at $\lambda_\odot = 248°$ (November 30) may be a 'residue' associated with the storm producing, but now inactive Andromedid meteor shower, although we do note that the Andromedids were never recognized as being an especially fireball rich shower (see below, however). We note that this peak falls close to the mean time of occurrence ($\lambda_\odot = 241°$) for the Group 4 meteorite stream identified by Halliday *et al* (1990). Once again, Hasegawa (1993) also finds historical evidence to indicate that a meteor shower is active at a solar longitude of $\lambda_\odot = 248\overset{\circ}{.}1$. This stream (Hasegawa's stream number 16) is identified according to eight meteor shower outburst/storm events reported from AD 1531 to 1887. The prominent peak in Figure 1 at $\lambda_\odot = 290°$ (January 10) is also weakly evident in the study by Ahn (2003) who analyzed a set of historical Korean fireball records collected during the Koryo dynasty (AD 918 – 1392). Terentjeva and Barabanov (2004) have recently suggested, on the basis of comparing orbital parameters, that two fireball streams can be associated with the Tagish Lake meteorite that fell on January 18, 2000 (Brown, *et al*, 2000). Indeed, the meteorite, Terentjeva and Barabanov (2004) argue, can be connected with asteroid (4183) Cuno, the μ-Orionid and 60-Orionid fireball showers. Terentjeva (1990) identified the two fireball streams from a study of the MORP and PN fireball orbital data[2], and concluded that they are both active throughout the entire month of January. There is a weak (one sigma level) peak in Figure 1 at the time of the Tagish Lake meteorite fall, but we can at best suggest that the strong peak at $\lambda_\odot = 290°$ might be due to either the μ-Orionid or the 60-Orionid fireball shower, or a mixture of both.

The peak at $\lambda_\odot = 165\overset{\circ}{.}0 \pm 4°$ indicates that a preponderance of MFA fireballs were reported in the time interval from September 3 to September 11. Given the extraordinary dominance of this peak we have looked at the year-to-year variation in the fireball record during the time interval $\lambda_\odot = 161\overset{\circ}{.}0$ to $169\overset{\circ}{.}0$. We accordingly find that in only six of the twenty-seven years over which data was collected that no fireballs were reported in the specified time interval. In most years 2 to 4 fireballs are reported in the time interval, although in 1964, 1965, and 1966, some 7, 8 and 9 fireballs respectively were reported. The circumstances of 1966 September 8 seem especially remarkable, in that on that night alone five distinct fireball reports were logged from observers in Newfoundland, Quebec and Ontario, as well as from the flight crew of an Air Canada airplane commencing its landing at Winnipeg (in Manitoba). The $\lambda_\odot = 165\overset{\circ}{.}0$ peak appears to be due, therefore, to both a 'steady' annual component and to a series of apparent 'outbursts' in the mid-1960s. Rendtel & Knöfel (1989) have studied the annual variation in fireball activity as evidenced in twelve contemporary and historical catalogs. Their analysis proceeded by dividing the annual fireball counts into ten-day 'activity' bins, and our $\lambda_\odot = 165\overset{\circ}{.}0$ peak would fall within their bin numbers 25 and 26. While we do not see strong equivalent fireball activity within these specific bin numbers (i.e., through comparison with Figure 3 in (Rendtel & Knöfel, 1989)) for all of the surveys they consider, we certainly do see corresponding activity in some of them. Most notably we see enhancements in the SEAN[3] data and the early 20$^{\text{th}}$ century catalogs published by Heinrich Bornitz[3]and Torwald Køhl[3]. An activity enhancement in 'bin 26' is particularly noticeable in the SEAN fireball

[2]The Meteorite Observation and Recovery Program (MORP) was in operation from 1971 to 1985, and consisted of 12 camera stations distributed across the Prairie Provinces of Canada. The camera stations were able to monitor a sky area of some 8.3 x 10^5 km^2. The Prairie Network (PN) system of 16 wide-field cameras operated from 1964 to 1974. Situated throughout the central plains of the United States the cameras could monitor a sky area of some 1.14 x 10^6 km^2.

[3]The Scientific Event Alert Network (SEAN) bulletin was maintained and published by the Smithsonian Institution in Washington from 1975 to the end of 1990, at which point its name was changed to the Bulletin of the Global Volcanism Network. Along with information on various transient terrestrial phenomena the Bulletin carries monthly fireball reports gleaned from around the world. The data collected by Torwald Køhl amounted to some 987 personally observed fireballs witnessed between 1876 and 1925. Heinrich Bornitz collected together both contemporary and historical fireball data for the time interval 1600 to 1888. It is interesting to note that Bornitz (1900) actually argued for the existence of meteorite producing streams; he also suggested that meteorite producing bodies could reside in what we would now recognize as cometary meteoroid streams (see (Beech, 2002) for a further discussion of this particular topic).

data gathered between 1982 and 1986.

The mean time of occurrence (September 13) for the Group 3 stream identified by Halliday *et al* (1990) falls close to the $\lambda_\odot = 165\overset{\circ}{.}0$ peak. Further, Drummond (2000) suggests that that the Group 3 fireball stream may possible be related to his NEA Association number 2, which interestingly contains the transitional comet/asteroid object (4015) Wilson-Harrington. Halliday *et al* (1990) indicate that at least one of the fireballs from the Group 3 stream may have been a carbonaceous chondrite, and this would be consistent with a possible origin from a predominantly devolatized cometary nucleus. Beech & Gauer (2002) find that the probability that (4015) Wilson-Harrington might be struck by a 1-m sized meteoroid as it passes through the main belt asteroid region is of order 0.03 percent per orbit (assuming a nuclear radius of 1-km). Impacts with centimeter-sized meteoroids, however, are a certainty on time scales of order several thousands of years, for this particular cometary nucleus. As to whether such impacts can trigger cometary outbursts, and large fragment ejection events, is presently unknown (Gronkowski, 2004). In contrast to the foregoing discussion, Gustafson & Williams (1992) have suggested that the Group 3 stream may be related to Amor asteroid 3908. Indeed, they argued that Amor asteroids (3908) Nyx and (3551) Verenia may be common fragments from a larger, now disrupted parent object. Gustafson & Williams (1992) suggest that the disruption event responsible for the production of 3908 and 3551, and possible the Group 3 stream, could have occurred as recently as 24 000 years ago.

Of the four possible meteorite producing streams identified by Halliday, Blackwell & Griffin (1990) their Group 1 stream is of particular interest since it contains the Innisfree meteorite that fell in Alberta on 1977 February 6. Group 1 also contains a second MORP fireball, and suspected meteorite dropping event, that was recorded on 1980 February 6 with a near identical orbit to that of the Innisfree meteorite (Halliday, 1987). The Vilna, Alberta meteorite also fell on 1967 February 6 but it is apparently not a Group 1 member, in spite of its time of occurrence, although no good orbit exists for the parent object of this particular meteorite. The main reason for excluding Vilna from the Group 1 stream is compositional in that Vilna is an L5 olivine Hypersthene ordinary chondrite, while Innisfree is an LL5 Hypersthene ordinary chondrite. This being said, Galibina and Terent'eva (1987) have argued that a whole family of fireball producing objects exists with orbits similar to that of the Innisfree meteorite. Drummond (2000) suggests that there is a possible link between his NEA association number 4 and the Group 1 fireball stream. We do not see any evidence for a particularly strong peak in Figure 1 at $\lambda_\odot = 318\overset{\circ}{.}0$, the time of the Innisfree meteorite fall.

Dodd *et al* (1993) and Wolf *et al* (1997) have argued that an H chondrite meteorite producing stream can be distinguished from the random background of falls occurring between September and October in the time interval from 1812 to 1992. The meteorites are associated according to their fall time and the measured content of their volatile trace elements and thermal histories. This stream, designated as HC34, includes some 17 meteorite members, one of which being the well-known Peekskill meteorite (1992 October 9; Brown *et al*, 1994). Wolf *et al* (1995) provide data that indicates the HC34 stream would have been active during the interval from $\sim$ September 27 to $\sim$ October 7 at the time that the MFA fireball data was being gathered. This time interval encompasses that of the distinctive peak in Figure 1 at $\lambda_\odot = 191^\circ \pm 2^\circ$ (October 4), and we suggest that this peak may be related to the HC34 stream.

The peak in Figure 1 at $\lambda_\odot = 11\overset{\circ}{.}0$ (March 30) accommodates the approximate fall times of the Peace River and Revelstoke meteorites. These two meteorites are clearly not petrologically related, however, since the Peace River meteorite is an L6 olivine Hypersthene ordinary chondrite, while Revelstoke is a CI carbonaceous chondrite. There are no orbit determinations for either the Peace River or Revelstoke meteorites, so it is not clear if any 'commonality' (other than date of fall) should be expected between the meteorites. This being said, the peak at $\lambda_\odot = 11\overset{\circ}{.}0$ is reasonably distinct and may indicate that an intermittent fireball/meteorite producing shower is active on, or near to, March 31.

In addition to the meteorite falls discussed above, we find no distinct activity peaks at the times of the other known Canadian meteorite falls. Nor do we find any distinct peaks at the arrival times of the Lost City (1970 January 4), or the recent Park Forest (2003 March 27) meteorite fall in the United States. We further find no distinct peak in Figure 1 at the mean time ($\lambda_\odot = 123^\circ$, July 26) identified by Halliday *et al* (1990) for their Group 2 meteorite stream.

4 Discussion: meteorite streams

The possible existence of meteorite producing streams and the possibility of meteorite falls being associated with cometary meteor showers is a topic that has had a long and contentious history. The fall of the Mazapil iron meteorite in Mexico on 1885 November 28 on the night of the Andromedid meteor shower outburst, for example, has been roundly debated for well over a century. Some commentators have in the past suggested that the two events demonstrate that cometary streams can contain material capable of producing iron meteorites. Most contemporary commentators argue, however, that the two events are entirely unrelated (Beech, 2002). Indeed, the problem in establishing the existence of a meteorite-producing stream is that time of fall data alone can not guarantee a stream association. One can alternatively look to identify meteorite-producing streams by comparing the orbital parameters of known meteorite falls (Halliday, 2001). The problem with this technique, however, is that relatively few meteorites have well known pre-Earth encounter orbits. Not only this, in recent times the Príbram (1959 April 7) and Neuschwanstein (2002 April 6) meteorite falls have further confused the situation in that they have near identical orbits (Spurný *et al*, 2003) but their respective compositions indicate that they are derived from very different parent bodies. This latter 'physical' observation argues against the possibility that the two meteorites are derived from a coherent stream of meteorite producing objects. We make this statement, counter to the argument presented by Spurný *et al* (2003), on the basis that Príbram is a 'common' H5 ordinary chondrite meteorite, while Neuschwanstein is a rare EL6 enstatite chondrite meteorite. Not only are the petrological types of the meteorites very different, so too are their respective cosmic ray exposure (CRE) ages. Príbram has a CRE age of order 12 million years, while the CRE age of Neuschwanstein is some 48 million years.

Pauls & Gladman (2005) have recently studied the orbital dynamics of potential meteorite producing objects in Earth-crossing streams and find that the decoherence time scale, such that the fall times become random, is of order 10^4 to 10^5 years. Grazier & Lipschutz (2000) estimate the stream decoherence time to be of order 10^5 to 10^6 years. These results further argue against a stream association for the Neuschwanstein and Príbram meteorites given the great disparity in their CRE ages. While the numerical simulations do not rule out the possibility of there being coherent meteorite-producing streams, they do imply that the break-up events responsible for the production of the streams must have occurred in the relatively recent past. All the above being said, however, it is arguably possible (although probably unlikely) that the Neuschwanstein and Príbram meteorites are derived from a coherent meteorite-producing stream associated with the relatively recent break-up of a mega-brecciated parent asteroid.

5 Discussion: general

The many selection effects that have shaped the time distribution of fireball reports referenced within the MFA are difficult to quantify. We do not know, for example, how the weather has effected the reporting from one season to the next or from one year to the next, and neither do we know what specifically motivates people to report their sightings of fireballs — clearly, most people do not report them. All that the archive effectively provides us with, in the context of this study, is the time of a fireball event, and this by necessity must be a random sample of the true fireball time of arrival distribution. Most surprisingly to the author was the observation that the strongest peak in Figure 1 is centered at $\lambda_\odot = 165°$ (September 7) rather than at $\lambda_\odot = 141\overset{\circ}{.}0$ corresponding to the maximum of the annual Perseid meteor shower. It had been anticipated that a strong Perseid peak would be evident since it is by far the best known of the annual meteor showers, and it does produce many bright meteors and fireballs. Perhaps we are seeing in the case of the Perseids a 'desensitized reporting' selection effect. That is, since the Perseid shower is both well known and well advertised the general observer is not greatly surprised if a bright fireball is seen in early to mid-August, and correspondingly does not report the event.

For the 10-year subset of data recorded in the MFA from 1 January, 1962 to 31 December, 1971 (a total of 1249 events) the time of observation has been divided into pre and post local midnight 'bins' — ostensibly covering the time interval midnight ±6 hours. Monthly averages of the number of pre to post local midnight fireball observations have been made, and very little variation is found. The yearly averaged ratio is 2.5 ± 0.5 to 1.0. The fact that this ratio is virtually constant throughout the year suggests that there is a real 'evening' excess of fireballs rather than there simply being more 'evening' compared to 'early morning' observers. This ratio is also in good agreement with the 2.4:1 ratio of the midnight ± 6 hours recording times for meteorite falls deduced by Hughes (1981), and the 4:1 ratio for fireballs deduced by Rendtel & Knöfel (1989).

In addition to weather factors and human reporting biases, the effectiveness of any survey in sampling the actual fireball activity from one year to the next must, at some level, depend upon the survey duration and the collecting area for observations. The MFA can probably claim a good fraction (perhaps of order one third — see Beech, 2004) of the Canadian land-mass for its survey area and a definite survey time of 27 years. The SEAN data (see note 2) can in principle claim global coverage (although in reality it is probably far from this), but the survey time considered in the article by Rendtel & Knöfel (1989) amounted to just 4 years. At face value the global land-mass area is some 15.5 times greater than that of Canada alone, and consequently (in the ideal case) the SEAN area times time survey product is potentially of order 2.4 times greater than that achieved by the MFA. The area times time survey product for the MFA, however, is some 7 times greater than that achieved by the MORP (see note 3) camera systems (assuming a 1/3 reduction in the Canadian land-mass area for the potential MFA reporting populace). The MFA area times time survey product is, in addition, some 6 times greater than that achieved by the PN camera systems. Again, in the ideal case, an individual observer, such as Torwald Køhl (see note 2) who collected data for 47 years, the area times time product is some 35 times smaller than that of the MFA (assuming an individual can monitor something like 50 000 km^2 of sky at any one instant). It would appear, therefore, all things being equal, if one is looking to identify week and/or time varying fireball showers then surveys such as the MFA are arguable better able to reveal them than the past surveys conducted by individual observers and by dedicated camera systems.

In conclusion, the arrival times of MFA fireball events have been studied in terms of their equivalent solar longitudes. We find that those cometary meteor showers well known for generating bright meteors and fireballs (e.g., the Perseids, χ-Orionids, Leonids and Geminids) are all represented in the cumulative solar longitude plot (Figure 1). We also find a number of distinct, yet unattached to any known cometary stream, peaks in the cumulative solar longitude plot. Several of these latter peaks may relate to asteroidal streams capable of producing the occasional meteorite fall.

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Radio meteors

Technical study of a radio system for meteor stream observation at OAN

Antonio Martínez Picar [1] *and Franklin Ulises Martínez Quevedo* [2]

The astrophysics of interplanetary matter has progressed significantly over recent years. The efforts mainly focus on the development of automatic systems that allow observation, recording, standardization and analysis of the solar system phenomena such as meteor activity. Observations of meteor showers using radio methods have the advantage of allowing uninterrupted recording of their activity, without having to consider the atmospheric variables and the diurnal schedule.

Positive experiences of the work in Venezuela show the technical feasibility and scientific potential of this kind of system, as well as the necessity of their permanent installation. This paper show the results of a series of physical measurements, theoretical considerations and technical criteria in order to determine the conditions for the successful installation and utilization of an automatic system for meteor observation using the forward-scatter method at the National Astronomical Observatory (OAN).

1 Introduction

Radiometeor observations can be performed continuously, without being influenced by the atmospheric variables and limited sky fields that restrain optical observations. With this it is possible to detect larger samples in space and time.

The first test of this type of system setup in Venezuela, carried out in June–August 2002, demonstrated the technical feasibility and scientific potential of this kind of system as well as the necessity of its permanent operation (Martínez Picar, 2003).

Following the main objective of defining necessary basic aspects for SARECOM development, two previous studies were carried out at this stage. The first sought to select the physical location for the equipment. The next tried to obtain a short list of candidates for the final choice of the most appropriate transmitter.

2 Field work

A set of measurements was carried out directly at the OAN facilities, which is located close to 'Llano del Hato' town, Mérida State (March of 2006). A brief description of the work is given next.

2.1 Receiver location

In order to complete the setup of SARECOM, it is necessary to have technical staff available to operate the equipment, and the facilities most also comply with the following requirements:

- Easy access to the equipment.
- Available power supply.
- Protection against adverse climatic conditions.

After reviewing the available sites at OAN it became clear that all the structures (all domes for astronomical instruments, the museum's headquarters and the observer's residence) are good candidates to harbor the equipment.

Considering the fact that it might be necessary to mount a tower for the receiving antenna, it is convenient to have a roof adequate to support the structure. On the other hand, taking into account that similar systems already exist in the residence of the OAN (e.g. a meteorological station), it was concluded that the residence building is the best place to locate the system, since it provides protection against the harmful effects of the elements (rain, low temperatures, direct exposure to the solar radiation, etc.), electric power and easy access to the equipment by the observatory technical personnel.

2.2 Spectrum availability checkup

A total of 58 spectrum measurements were conducted in two open sites inside the OAN's boundaries which were chosen according to the probability of SARECOM installation. These sites were located in the adjacent external region to the residence (West wing) and the area in front of the Stock Telescope's dome (Schmidt camera). The open areas were chosen because the indoors causes a typical attenuation of the electromagnetic radiation of about 15 dB.

The measurement equipment consisted of a portable spectrum analyzer (Anritsu 3 GHz, model Site Master 332B), a wideband helical monopole antenna (acting like a probe) and a support which held the equipment far from ground. Figure 2 shows the spectrum analyzer carrying out the measurements.

For each location the measurements were conducted in *Max. Hold* mode, which enabled the evaluation of all the maximum power values of the spectrum present at each location. Ten sweeps were carried out in the range of frequencies below 500 MHz and three for the rest of the spectrum. This allowed enough sampling in time to

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IMO bibcode WGN-344-martinezpicar-radiometer
NASA-ADS bibcode 2006JIMO...34..111M

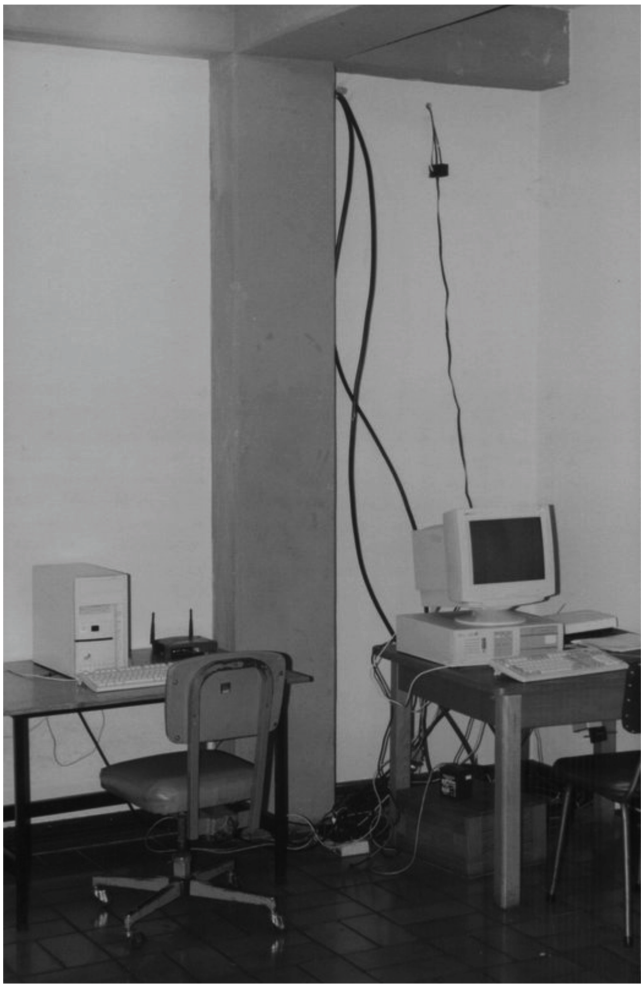

Figure 1 – The residence of OAN. Left: residence's roof at OAN. Right: indoor room suitable for SARECOM installation.

Table 1 – Denomination and characteristics of the frequency sweeps.

Denomination	Range (MHz)	No. of sweeps
PA1	0.1 – 50	10
PA2	50 – 90	10
PA3	90 – 150	10
PA4	150 – 300	10
PA5	300 – 500	10
PA6	500 – 1000	3
PA7	1000 – 3000	3

estimate reception of signals of variable intensity and bandwidth.

To obtain the most detailed readings, the measurements were carried out with minimum resolution bandwidth (RBW = 10 kHz) and minimum video bandwidth (VBW = 3 kHz) that the equipment allows. On the other hand, the range of frequencies covered by the analyzer (0.1 to 3000 MHz) was divided with the purpose of obtaining detailed readings in the range. Table 1 shows the measurement characteristics specific to each part of the spectrum.

Also, to prevent free reading of undesirable electromagnetic sources, we made sure that no cellular phones or other equipment emitting radio frequencies in the distance of at least 2 m from the sensor were present at each measurement location.

3 Results

Figure 3 depicts the combination of the readings obtained for all the frequency sweeps by the spectrum analyzer, shown in the Table 1. The received power is shown in dBm (decibels relative to 1 mW).

This graph shows high pollution in the band between 0.1 MHz and 200 MHz. Most of the broadcasting services allowed in the country (CONATEL, 2001) operate in this part of the spectrum. The values centered around 800 MHz stand out as well; these correspond to the bands of frequency assigned to services of cellular telephony; 1450 and 1830 MHz for wireless fixed telephony, and 2400 MHz used by the wireless local area network (WLAN) service, standarized by IEEE 802.11b/g protocol (Crow et al., 1997) recently installed at the OAN.

For the purposes of the SARECOM installation project, the range of frequencies is restricted to the low part of VHF (50 – 90 MHz), as presented in Figure 4 showing this portion of the spectrum. The presence of open television signals for the channels 2, 4, 5 and 6 (luminance, chrominance and audio carriers) is also clearly visible. In this figure we can see that the range of frequencies between 61 and 63 MHz is free of signals. Considering that the frequency of the luminance subcarrier for TV channel 3 corresponds to 61.25 MHz,

Figure 2 – The equipment during the measurements.

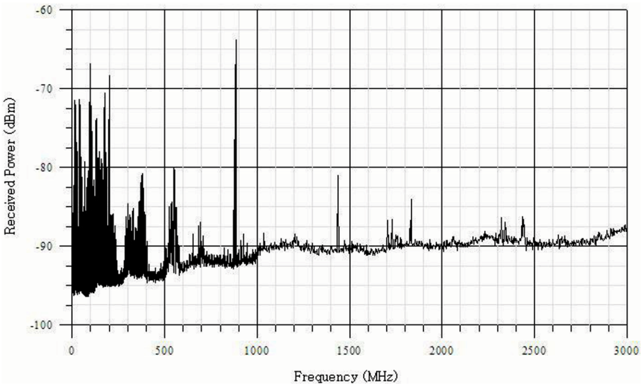

Figure 3 – Composition of data obtained by the spectrum analyzer in the OAN.

it is obvious that the continuous signal coming from broadcasting transmitters operating in this frequency is not received above the noise level at the OAN.

In Venezuela some commercial TV broadcasters operate on channel 3. Their transmitters are located in the areas of Barquisimeto, Coro, Guarico, Pto. La Cruz and San Cristóbal (TVRADIOWORLD, 2006).

To illustrate this fact more clearly, Figure 5 shows a detail of the spectrum obtained for the portion of the spectrum assigned to the TV channel 3 specifically.

The received power of a signal reflected from a low density meteor trail can be estimated using Eqn. 1 (McKinley, 1961):

$$P_\mathrm{R} = \frac{P_\mathrm{T} G_\mathrm{T} G_\mathrm{R} \lambda^3 r_\mathrm{e}^2 \alpha^2 \sin^2\gamma}{32\pi^2 R_\mathrm{T} R_\mathrm{R} (R_\mathrm{T}+R_\mathrm{R})(1-\sin^2\phi\cos^2\beta)} e^{-\frac{8\pi^2 r_0^2}{\lambda^2 \sec^2\phi}} \tag{1}$$

where: P_R is the received power,
P_T is the transmitted power,
G_T is the gain of the transmitting antenna,
G_R is the gain of the receiving antenna,
λ is the wave longitude,
r_e is the electron radius,
α is the linear density of electrons in the trail,
γ is the angle between the electric vector of the incident wave and the line of sight of the receiver,
R_T is the transmitter-reflection point distance,
R_R is the receiver-reflection point distance,
ϕ is the half angle of forward-scatter,
β is the angle between the meteor and the propagation plane, and
r_0 is the initial radius of the meteoric trail.

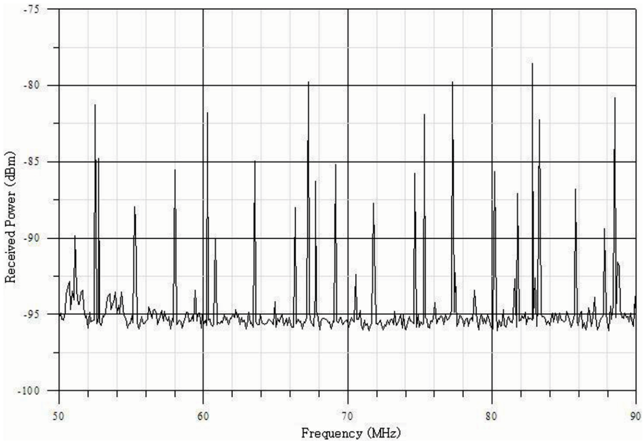

Figure 4 – Power spectrum corresponding to frequencies assigned to open TV service (VHF's low range) obtained at the OAN.

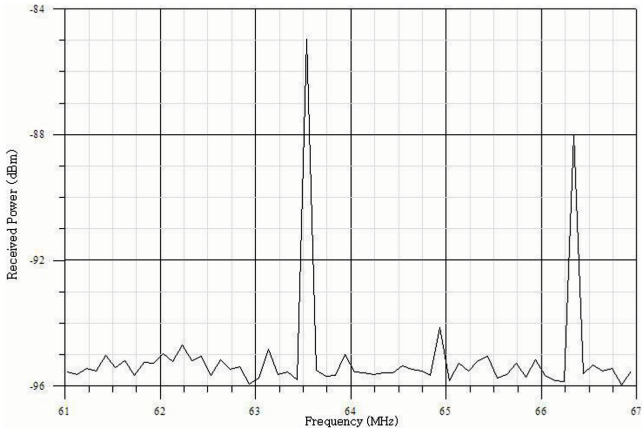

Figure 5 – Power spectrum in frequencies assigned to TV channel 3 obtained from OAN.

Table 2 shows the results for the received power using the broadcasting stations operating on channel 3 in Venezuela. The calculation of P_R was carried out assuming the use of a dipole antenna at the transmitter (gain $G_\mathrm{T} = 2.16$ dBi), a 4-element yagi antenna with 9.47 dBi of gain for the reception antenna (Martínez Picar, 2003) and some assumptions made about the geometry of the phenomenon ($\gamma = 90°$and $\beta = 45°$).

A comparison of the values in Table 2 with the levels registered in the Figure 5 shows that the received power P_R for all the transmitters considered is higher than the noise level for the frequency corresponding to the video carrier for channel 3.

It is evident from Figure 7 that the signal of three of the channel 3 transmitters can be 'swept' from the OAN

Table 2 – Transmitter candidates and estimated reception powers.

Location (Town/City, State)	P_{T} (dBm)	Distances to OAN (km)	Φ (°)	P_{R} (dBm)
Barquisimeto, Edo. Lara	84.77	132	33	−64.45
Guarico, Edo. Lara	83.22	88	24	−65.15
San Cristóbal, Edo. Táchira	80.79	124	32	−68.27
Coro, Edo. Falcon	80.45	186	43	−70.05
Pto. La Cruz, Edo. Anzoátegui	80.33	420	64	−75.98

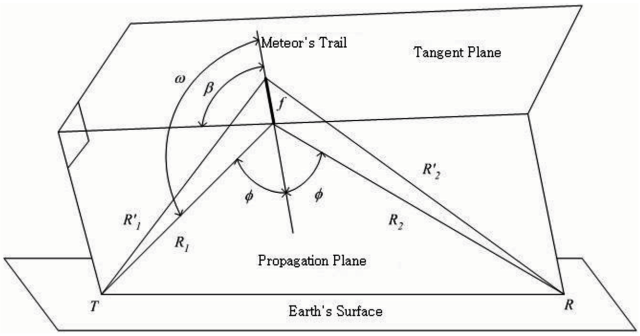

Figure 6 – Geometry of the forward-scatter involved in the calculation of half-longitude of the first Fresnel zone (f).

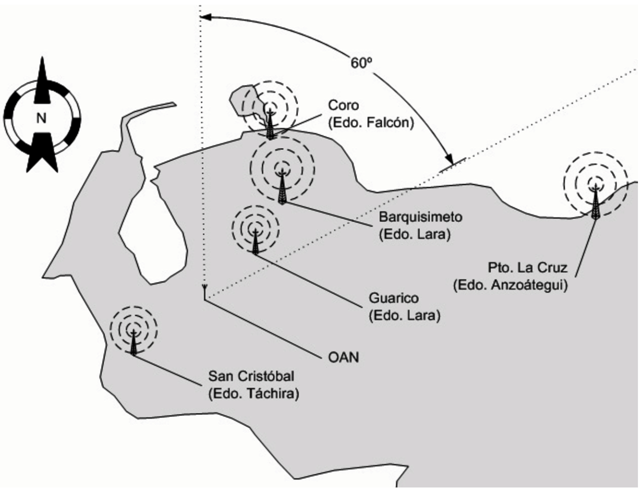

Figure 7 – Diagram with the location of the channel 3 transmitters and the OAN.

simultaneously using an antenna with a 60° main lobe width. This considerably increases the probability that the necessary geometric conditions for the detection of meteors using the forward-scatter method are met.

4 Conclusions

The results obtained complete the first phase of the project — the installation and initiation of a system for permanent radio registration of meteoric activity located at the OAN. These results enable us to establish the input parameters for the next phase of the project, regarding mainly the design of the receiving equipment (antenna type, orientation and radio receiver).

Specifically, from the results obtained in this work we may conclude the following:

- The frequency of 61.25 MHz, corresponding to luminance signal carrier (or video signal) assigned to the TV channel 3 in NTSC[1], is available for the establishment of the system, since it doesn't have interfering signals, neither the direct reception of any broadcasting signal.
- An antenna of 60° main lobe width and 9.47 dBi gain (Martínez Picar, 2003) is appropriate to cover three TV transmitters simultaneously for recording meteors using the forward-scatter technique.
- The OAN's residence facilities offer the appropriate physical plant to harbor the selected equipment as well as the necessary technical personnel to operate the system.

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[1]Referring to television broadcast signal modulation standard published by the *National Television Standards Committee* system, adopted in Venezuela.

History

The 25th International Meteor Conference

Paul Roggemans [1]

Since the founding of the International Meteor Organization, the International Meteor Conferences guaranteed the vital personal contacts between its members. In recent years IMCs were sometimes assumed to have started with IMO. However, the IMCs grew out of a much older initiative, the Meteor Seminars that started in 1979, later also called International Meteor Weekends. These events played a crucial role in the making of the IMO. The 2006 IMC in Roden, the Netherlands later this year is in fact a jubilee edition as it is the 25th edition since the very beginning in 1979!

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1 Introduction

At an IMC the many unfamiliar names get faces of human persons who become friends encouraging each other's creativity to explore meteor astronomy. The atmosphere at these IMCs is a kind of irresistible magic. But how did it all start? The lectures are in general of a very professional quality and the proceedings provide very valuable references, but has it always been this way? On the occasion of the 25th IMC, it is worthwhile to look back at the very beginning of this initiative.

Few people remain from those who were involved at the very early years of the IMCs. Recent editions of the IMC give a feeling of comfort as if future IMCs can be taken for granted. However, many obstructions and difficulties had to be overcome to achieve the current quality of organizational standards, lectures and proceedings. Before the early editions of IMCs get completely forgotten, it seems to make sense to describe the origin and the history of the IMC and to compare some statistics of the past 24 editions.

2 How it started

The first Meteor Seminar took place in June 1979 near Bonn. The initiative was taken by amateur astronomers from Bonn in West Germany, some of whom participated in a meteor group of the IAYC. They wanted to meet each other again some time after the camp to look at results of projects started at the camp. The first Meteor Seminär involved some other interested persons and took place in June 1979 at Königswinter, Germany. The first organizers were Bernhard Schmitz and Hans Joachim Becker. The announcement of this first meeting described its aims:

Es ist dies das erste Zusammentreffen auf dieser Ebene und wird von der AG Meteore Bonn veranstaltet. Erwartet werden auch ausländische Gäste. Dort könnte die Diskussion um eine gesamteuropäische Z'arbeit ein Tagesordnungpunkt sein… (3 November 1978 letter from Bernhard Schmitz.)

Proceedings were prepared afterwards and another meeting planned for 1980. This meeting finally took place in November 1980 in Pullach near Munich, Germany, organized by Hans-Georg Schmidt. Most participants of the 1979 meeting took part again, joined by other participants from Germany, Belgium, Austria and Switzerland. Lectures were given in German, the participation fee was about €30 and the event started with informal presentations Friday evening, with Saturday as main lecture day, including a professional guest speaker. Sunday morning was reserved for discussion about the coordination of amateur meteor work. The meeting ended after dinner Sunday noon. Proceedings were planned but failed to materialize due to a lack of time. The intention to have a third Meteor Seminar in 1981 failed. The lack of continuity in amateur meteor work almost meant the end of the initiative. Most 1979–1980 participants quit meteor work for various reasons after 1980.

Through correspondence, Paul Roggemans and Hans-Georg Schmidt decided that a third meeting should be planned. The name changed to 'International Meteor Weekend' and the meeting was organized in Belgium in February 1982. Most of the participants of 1979–1980 were no longer interested, no more than four people from the Munich area in Germany, four Dutch amateurs from Denekamp and only four Belgians registered; on Saturday some more Belgian meteor observers attended the meeting as visitors. At that time very few amateurs were used to travelling far, staying overnight for amateur meetings. In 1982 the initiative survived, involving the Dutch amateurs for the first time. The circumstances at that time made it impossible to compile Proceedings.

The Dutch participants exported the idea of such Meteor Weekend to the Netherlands where they took care of the next IMW in May 1983 in Denekamp, the Netherlands. At that time it was a problem to get amateurs motivated to present a lecture. Most amateurs struggled a lot with presentations in English, another aspect to learn: how to give a lecture and this in English? It is most remarkable that the initiative was kept alive in the years 1982–1983. After 1980 it was the intense correspondence by letters that served to motivate some amateurs to have the International Meteor Weekends.

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In 1983 Hans Georg Schmidt of the Munich team agreed to take care of a next International Meteor Weekend in Southern Germany. The search for a good location led to the Bruder Klausheim in Violau near Augsburg. This facility was under construction in 1984. The IMW became the very first and thus opening activity of this perfect conference center in February 1985. The number of participants was higher, the quality of the lectures had improved, organizational experience was gained. In 1985 the first efforts were made to get participants from East European countries to the IMW, but the Iron Curtain proved to be too solid yet. The main concern was continuity as the first five editions depended on initiatives of individuals. Proposals to work towards more formal cooperation between the different meteor observing groups failed to convince a majority of the IMW participants.

3 The 1986-edition: a breakthrough

Meanwhile international amateur cooperation intensified through other processes. Many amateurs spent most successful observing weeks in Southern France and such international observing efforts became very popular. An intense exchange of observing reports happened via WGN which became popular as an international circular for meteor observers. In the mid 1980s the IMW became the place for observers and WGN-subscribers to meet each other personally. For the first time the International Meteor Weekend 1986 was announced one year in advance with plenty of publicity in journals. The first IMWs had certainly suffered from a lack of publicity and attention. For instance no written report can be found anywhere of the 1983 edition. The 1986 IMW was a very ambitious edition with a very carefully prepared discussion forum. In WGN (Vol.14, 1986, pp.134–136) we read a summary of the topics on the program:

- International co-operation between amateurs and professional meteor workers, contacts, information, ...
- Universal method of rate correction, which corrections to be used?
- To improve the worldwide instruction of amateur meteor observers: edition of a 'Handbook for amateur meteor observers' and an international circular for meteor workers.
- The edition of a bibliography on meteor literature.
- Future meetings, an international meteor observing camp, the foundation of a permanent meteor observatory in the South-East of France at Puimichel ...

The sixth edition was an absolute breakthrough: 50 participants of the teams from Germany, Belgium and the Netherlands but also representatives from five other countries. The projects around the comet Halley return triggered new interest from the professional astronomer community for more cooperation with amateurs. The IAU Commission 22 saw in the IMW a good communication channel to get in contact with amateur meteor workers and sent two representatives: Dr. I. Williams and Dr. B.A. Lindblad. It became obvious that amateurs had to create a channel to communicate with one voice to professional meteor researchers. Moreover professional astronomers have no time or interest to sort out all kinds of incomparable observing and reporting methods which made amateur work often quite useless. At the IMW the IAU representatives witnessed the ongoing process of discussion to define a standard visual observing method as well as standard reporting formats. The sixth IMW was a historic and decisive step towards the formation of IMO.

The 1986 IMW got plenty of attention in the meteor publications as well as the next editions of 1988 and 1989. The success of future IMCs depended on the publicity and attention given to the event — a golden piece of advice to future organizers: do not neglect the necessity of making publicity for each IMC!

4 IMW became IMC when the IMO was founded

Having in mind several frustrations due to the 'International Halley Watch', a big fiasco for meteors, the ever failing comparison of data due to different methods, the uncertainty due to the absence of a well organized framework, etc. ... had convinced many amateurs of the necessity of an international organization for meteor studies. Endless discussions at previous IMWs learned that each time again that the regular long-term meteor workers wanted to get something like IMO, but the opposition against the idea came from local amateurs who most of all never came to a meeting more than once or twice. Since the first debate on how to coordinate meteor observing, discussions were twisted into polemic disagreements by amateurs who were opposed against any form of agreement of standardization. Time has proven that the opposition came from people who mostly had a short-lived interest in meteors.

At the 1986 IMW, participants agreed to have the next edition about one and a half year later in the Netherlands, with Casper ter Kuile and his group as organizers. Meanwhile the 1986 IMW organizers had worked out all plans necessary to officially start with IMO. The 1988 IMW was organized with a lot of enthusiasm by Casper ter Kuile and his group of Buurse. The 1988 IMW was very well organized and an ultimate occasion for discussion about IMO. As at previous IMWs, the opposition came from local amateurs who were opposed against a formal IMO-structure. But a vast majority, many of who were unable to be present at the 1988 IMW, decided in favor and the IMO was established with 1 May 1988 as official birthday.

From 1988 onwards the 'International Meteor Weekend' occasionally happened to be called 'International Meteor Conference' which became its official name since 1990. The edition of 1989 was the first IMC organized by the Hungarian amateurs as local organizing committee together with the provisional IMO administration.

The 1989 IMC hosted the IMO founding general assembly. Some significant changes were introduced to the concept in 1989. The meeting was extended by one day, from Thursday till Sunday instead of Friday till Sunday. Also from then on IMWs or IMCs would be planned annually. Another new aspect was the Saturday afternoon excursion, providing time for a relaxed social contact between people. The fall of the Iron Curtain that had split Europe since 1945 coincided with the foundation of IMO and the first IMC in Eastern Europe. Meteor work was much more popular and better developed in Eastern Europe than in Western countries. The overall majority of East European meteor workers welcomed the birth of IMO with much enthusiasm.

5 The role of IMO in the IMCs

In 1990 the IMC took place at the same site as in 1985: the Bruder Klausheim in Violau near Augsburg. For those who were present at both events, it was obvious that the meteor observers community had made tremendous progress. For a very last time some protest was expressed against IMO, that became the main organizational structure to assure future IMCs. It was pointed out that the IMO should guarantee continuity, help local organizing committees, or organize the event in case no local organizers would volunteer for the job. In this sense IMO has a useful role to play while 'All meteor workers are a big family, whether someone is a member of IMO or not, everybody will always be welcome at the IMC to share in friendship the common interest in meteors'. This explains why no IMO membership is required for IMC participation, contrary to many other astronomical societies. Most societies limit access to their meetings to 'members-only'. IMO on the contrary wants to create an optimal co-operation environment where everyone is welcome.

The 1991 IMC got less intense publicity and the effect was reflected in a much lower participation. The necessity of publicity should not be underestimated by future organizers. In 1992 another experiment took place: the 1992 IMC was linked to a professional symposium on Meteors in Slovakia. It was a success with many professional astronomers and amateurs participating in each others' meetings. The concept was repeated in 1998 and may be repeated in 2007. In 1993 the proposal of having an IMC in England didn't work out. Then the IMO itself had to plan a last-minute alternative event that took place in Puimichel, France, in order to maintain the annual frequency of the happening. After 1993 the IMO Council got every year proposals from candidate IMC organizers, sometimes a choice has to be made out of several proposals for a same year. It happens that candidate IMC organizers overlook organizational aspects or commitments, risking the 1993 situation to be repeated. The role of the IMO Council in selecting IMC proposals as well as in verifying the organizational qualities, proved to be a necessity.

The four days proved to be more worth the effort and costs of traveling than the three-days events of before 1989. Also the annual frequency of one IMC a year proved to be better than a frequency of one IMC every 18 months. While the first IMCs relied almost completely on the personal correspondence between organizers, today the contacts are kept more between the participants themselves. This may explain why more people became loyal annual IMC participants and create together the typical but indescribable atmosphere that characterizes the IMC.

Since the very beginning of these meetings discussion forums were organized to deal with questions of standardizing observing and reporting methods. Once the IMO was founded, these discussions were continued in workshops most of which were very unproductive. As a consequence workshops ended in borderless discussions without results. Workshops became unpopular and the time was used for free expression and social contacts.

6 Some statistics about the IMCs

In the past 24 years many hundreds of people participated at one or more IMCs. Participants came from 35 different countries: Argentina, Australia, Austria, Belarus, Belgium, Bulgaria, Canada, China, Croatia, Czech Republic, Denmark, France, Germany, Hungary, Ireland, Italy, Japan, Jordan, Macedonia, Malta, Netherlands, Norway, Poland, Romania, Russia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Tajikistan, U.K., Ukraine, U.S.A., Venezuela and Yugoslavia. In total 1343 registrations were recorded which is an average of 56 per year, recent years being well above this average. Since 1979 about 500 presentations were given at IMCs, most of which were worked out as papers in the Proceedings, accumulating a total volume of over 2300 printed pages.

IMCs were always low budget events: the fee was as low as about €25 in 1986 for three days, including Proceedings. The most expensive IMC so far was Frasso Sabino in Italy in 1999 with €120 which is due to annual inflation still 12% more expensive than the €120 of the 2005 IMC. With 95 participants, the IMC 2000 in Romania had the largest number of participants ever. The IMC 2005 had the largest number of countries represented (20) as well as the largest number of presentations (59). With 194 pages the Proceedings of the 2003 IMC were the most voluminous so far.

The following overview with some data of all 25 IMCs covering the period 1979–2006 has been derived from correspondence, proceedings and WGN.

1. **1979 Königswinter (Bonn)** — Germany, 8–10 June, 18 participants from 2 countries, 9 presentations and Proceedings of 24 pages, fee €33.
2. **1980 Pullach (Munich)** — Germany, 21–23 November, 31 participants from 4 countries, 10 presentations but Proceedings were never completed, fee €31.
3. **1982 Hasselt** — Belgium, 26–28 February, 12 participants from 3 countries, about 10 presentations, no Proceedings attempted, fee €32.

4. **1983 Brecklenkamp** — Netherlands, 13–15 May, 23 participants from 3 countries and about 10 presentations, no Proceedings, fee €41.
5. **1985 Violau (Augsburg)** — Germany, 22–24 February, 37 participants from 4 countries, 10 presentations no Proceedings, fee €35.
6. **1986 Hingene** — Belgium, 3–5 October, 50 participants from 8 countries, 16 presentations and Proceedings of 80 pages, fee €25.
7. **1988 Oldenzaal** — Netherlands, 25–27 March, 65 participants from 9 countries, 17 presentations and Proceedings of 84 pages, fee €32.
8. **1989 Balatonföldvár** — Hungary, 5–8 October, 66 participants from 11 countries, 20 presentations and Proceedings of 103 pages, fee €90.
9. **1990 Violau (Augsburg)** — Germany, 6–9 September, 58 participants from 13 countries, 19 presentations and Proceedings of 64 pages (15 papers, 2 posters, 17 lectures), fee €70.
10. **1991 Potsdam** — Germany, 19–22 September, 36 participants from 6 countries, 22 presentations and Proceedings of 90 pages (20 papers, 10 posters, 12 lectures), fee €90.
11. **1992 Smolenice** — Slovakia, 2–5 July, 71 participants from 17 countries, 20 presentations and Proceedings of 93 pages (18 papers, 0 posters, 20 lectures), fee €75.
12. **1993 Puimichel** — France, 23–26 September, 55 participants from 16 countries, 31 presentations and Proceedings of 113 pages (31 papers, 9 posters, 22 lectures), fee €90.
13. **1994 Belogradchik** — Bulgaria, 22–25 September, 57 participants from 8 countries, 15 presentations and Proceedings of 89 pages (15 papers, ? posters, 12 lectures), fee €85.
14. **1995 Brandenburg** — Germany, 14–17 September, 45 participants from 11 countries, 20 presentations and Proceedings of 133 pages (20 papers, ? posters, 17 lectures), fee €95.
15. **1996 Apeldoorn** — Netherlands, 19–22 September, 61 participants from 12 countries, 25 presentations and Proceedings of 143 pages (25 papers, ? posters, 22 lectures), fee €98.
16. **1997 Petnica** — Yugoslavia, 25–28 September, 69 participants from 11 countries, 16 presentations and Proceedings of 109 pages (16 papers, ? posters, 15 lectures), fee €70.
17. **1998 Stará Lesná** — Slovakia, 20–23 August, 64 participants from 14 countries, 21 presentations and Proceedings of 117 pages (19 papers, ? posters, 21 lectures), fee €85.
18. **1999 Frasso Sabino** — Italy, 23–26 September, 56 participants from 13 countries, 26 presentations and Proceedings of 156 pages (21 papers, ? posters, 26 lectures), fee €120.
19. **2000 Pucioasa** — Romania, 21–24 September, 95 participants from 14 countries, 44 presentations and Proceedings of 132 pages (27 papers, 14 posters, 30 lectures), fee €87.
20. **2001 Cerkno** — Slovenia, 20–23 September, 69 participants from 19 countries, 32 presentations and Proceedings of 109 pages (19 papers, 7 posters, 25 lectures), fee €102.
21. **2002 Frombork** — Poland, 26–29 September, 64 participants from 15 countries, 28 presentations and Proceedings of 175 pages (28 papers, ? posters, 26 lectures), fee €100.
22. **2003 Bollmannsruh** — Germany, 19–21 September, 79 participants from 15 countries, 29 presentations and Proceedings of 194 pages, fee €115.
23. **2004 Varna** — Bulgaria, 23–26 September, 73 participants from 17 countries, 20 presentations and Proceedings of 115 pages, fee €100.
24. **2005 Oostmalle** — Belgium, 15–18 September, 91 participants from 20 countries, 59 presentations and Proceedings of 195 pages (29 papers, 18 posters, 41 lectures), fee €120.
25. **2006 Roden** — Netherlands (14-17 September).

7 Future perspectives

Several disciplines in amateur astronomy were much better organized than meteor observing. With IMO, amateur meteor work got a global working structure, with WGN a worldwide referenced journal and with the IMC its annual opportunity to meet colleague meteor observers in person. The 25th edition as jubilee IMC is extra motivating for those who participated in the early years to join again to recall the unique IMC experience.

So far all IMC's took place in Europe, with participants from other continents. Let the 25th edition be an excellent occasion for our overseas friends to join the IMC in even greater number than ever before, enjoying the magic IMC-spirit, perhaps inspiring for a first overseas IMC!

Meteor Beliefs Project: Belarussian meteor folk-beliefs

Tsimafei Avilin[1]

Folk-beliefs from Belarus are given and discussed, concerning the supposed divinatory properties of meteors, often relating to birth and death, and the powers thought resident in meteorites.

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1 Introduction

Some Belarussian meteor and meteorite folk-beliefs are presented, drawn from an analysis of different folklore and ethnographic sources from the 19th and 20th centuries, as well as the author's own field researches more recently (2005 summer). The latter findings are shown by the citations to specific people in precise locations below. One peculiarity of Belarussian culture is the presence of Baltic and Slavonic traits, resulting from the shared borders with the Baltic states of Latvia and Lithuania, and the Slavonic countries of Poland, Russia and Ukraine, over a long period. Unless stated, all translations into English here were by the author.

2 Belarussian meteor folk-beliefs

The meteor phenomenon is colloquially called a 'falling star' (Avilin, in press), a 'fiery zmej' (Pietkiewicz, 1938, p. 11), a 'fiery vuzh' or a 'scorching vuzh' ('vuzh' means 'grass-snake': Nenadavets et al., 2003, p. 240; Lyaukou, 1992, p. 33). Such terms can be regionally-based in Belarus, e.g. a zmej is the typical name for meteor in the Palesse region, though the Belarussians, like many others of the east European peoples, frequently referred to very bright meteors or fireballs generally as zmeys[1]. Some people held that if the star fell fast, it was just an ordinary shooting star, but if it fell fitfully, by leaps [perhaps meaning if it flared or fragmented], then it was a zmej (Ushakov, 1896, pp. 404–405).

Sometimes a meteor was called a *znichka*, or people would say 'so a tale has gone', and a number of beliefs include the idea that stars are either the souls of the dead watching the living, or the souls of the living themselves. For instance:

- they are the souls of unbaptised children shining from the sky for their parents;
- they are candles lit by the angels every evening;
- they are candles lit by the angels when a child is born;
- they are angels, which are considered to be sinless children;
- they are the houses of angels (when the stars shine at night, it is sometimes said that the angels have opened their windows);
- they are fires that have been lit by the Lord.

Possibly, some of these beliefs are connected because of a mental analogy between fire and a newborn baby, which recurs in some Slavic myths, and hence also with a meteor (Karski, 2001, p. 312). Stars are associated with fire too, which would naturally translate to the concept of a fiery meteor as well: 'A star falls down — the Lord lit the fire and then put it out' (M. T. Pribylskaya in Staraselle village, Shklov district, Magilev region, Belarus, collected by N. Andreenko).

A 'falling star' thus may show both the birth and death of a man: 'his star is falling, and his soul is flying to the next world (or to the Lord)' (Anonymous, 2003, pp. 191 & 194); 'if a star is falling down in the sky, then a man is dying, and if one is flying upwards, then a man is born' (Shtejner & Novak, 2002, p. 251); 'if a star is falling, then a new man is appearing (or is born)' (Anonymous, 2003, p. 191); 'when a man dies, his star falls from the sky, because the angels put it out' (Serzhputouski, 1930, p. 6). A Belarussian song runs:

> 'A uchora z vyachora nyadouga gulyala,
> Nyadouga gulyala — mne vestachka upala,
> Mne vestachka upala — svekarka umirae'

(Ragovich, 1988, p. 149)

> 'Went for a walk yesterday, not long,
> Not long walked — tidings fell for me,
> Tidings fell for me — father-in-law died'

There are other beliefs that the meteor falling represents 'the soul of an unbaptised child' (Romanov, 1912, p. 290), or that 'an unbaptised child is falling to earth' (Sbornik, 1903, p. 147), therefore it is necessary to cross oneself (Moszynski, 1928, p. 156), to pray (Sbornik, loc. cit.), or to give the soul a name (Romanov, loc. cit.), saying: 'If a boy then Adam, if a girl then Eve' (Moszynski, loc. cit.); or 'If a panna then Ganna, if a pan then Ivan' (Kryviczki et al., 1987, p. 165)[2].

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[1]See also the Meteor Beliefs Project 'Meteor-Dragons Special' articles in WGN 31:6 (2003; pp. 189–198) for more comments on this draconic creature and other meteor beliefs in Serbian, Bulgarian and Russian folklore — Project Co-ordinators.

[2]*Pan* and *Panna* are something like 'Master' and 'Miss' in English, titles used for young children. Frequently, a young boy will be called 'pan' (hence 'pan Ivan', or 'pan Tsima', etc.), and a young girl will be called 'panna' (so 'panna Maryja', 'panna Olga', 'panna Ganna', etc.). This form also has a close relation to the Polish language, where these words are still used now. The terms came into the Belarussian language from Poland, because Belarus long bordered Poland, and from the 16th to the 18th centuries, the two countries were united as Re'ch Paspalita. Moreover a rich man was called 'pan' too, and 'panna' was his wife. Parents called their children in Belarus pan and panna, because they hoped their children would grow up to be rich, or that they would become very handsome and smart, like pan the rich man.

Figure 1 – Ruchnik, traditional strips of cloth sometimes called folk towels, were often ornamented with traditional symbols. The two above are symbols of a child.

There is a similar belief that a falling star is the unbaptised soul of the deceased flying to hell. In order to save the soul one should make the sign of the cross towards it and say swiftly: 'In the name of the Lord and his Son give you name: if pan then Yan, if panna then Ganna' (Anonymous, 2004, p. 196). This recurs in the Grubeshowskij uezd of Ukraine, where it is considered that these unbaptised children cry at the time of their falling, and that a name should be given to the 'falling child' in accordance with the sex of the observer (Chubinskij, 1872, p. 16). This kind of 'baptismal naming' seems to be a type of widely-used formula intended to calm the unbaptised soul.

Another belief is that a falling star is an angel: 'The old people say that these are god's angels flying to the people, but we that are sinners can't see them' (Kasa, 1907, p. 3). The Russians too believe that a falling star is an angel, flying to collect a dead soul, and that during its flight it refuses no request, so one may make a wish before the star goes out (Dal', 1880, p. 87). This is one possible explanation for the tradition of wishing on a falling star: 'Star is falling — make your wish' (L. V. Chusheva Oreshkovichi village, Berezino district, Minsk region, Belarus, collected by N. Andreenko); 'The quicker the star flies, the quicker the wish will be granted' (collected by M. Zhukava in Azyaryshcha village, Vitebsk district, Vitebsk region).

A meteor's appearance sometimes showed that the dead man, to whom the star was believed to belong, had not reached paradise, and instead had come back to the Earth to correct his own wrong acts (Anonymous, 2003, p. 192): 'An unbaptised soul is not let into paradise. It flies from Chyscza (purgatory)' (V. V. Kosach in Kalenkishki village, Braslav district, Vitebsk region, Belarus); 'A sinner enters hell' (Ja. K. Varnel in Yodlavichy village, Braslav district, Vitebsk region, Belarus); 'The Lord threw a sinful soul from the sky' (A. M. Petrashkevich in Krasnaselcy village, Braslav district, Vitebsk region, Belarus); 'An unbaptised soul goes roaming, waiting to be united with the Lord' (S. Byalus in Opsa village, Braslav district, Vitebsk region, Belarus), 'The falling star is the sinful soul who goes from the gates of paradise to hell' (collected by A. Kisyalevich from Verkhnedvinsk city, Vitebsk region). Again the protective of crossing one's self might be invoked: 'A star is falling — you should cross' (A. E. Lesun in Smorki village, Barysau district, Minsk region, Belarus, collected by N. Andreenko). There are comparable Russian folk-beliefs.

In a mythological context, the meteor as a human soul is thought to be one of the stages of the soul's journey after death. Accordingly in some Belarussian, and also Lithuanian, beliefs, a human soul after death turned into a bird and flew along the *Ptushynaya Daroga* (literally 'The Bird's Road'; the Milky Way) to purgatory (most likely *Sito*, literally 'The Sieve', the place where righteous and sinful souls would be sifted from one another; astronomically the Pleiades in Taurus). Then after this separation, the sinful souls would take the form of meteors, and fall back to Earth. At Yule, some say the souls of unbaptised children are allowed to leave Hell for a while to have fun (Zelenin, 1916, p. 483).

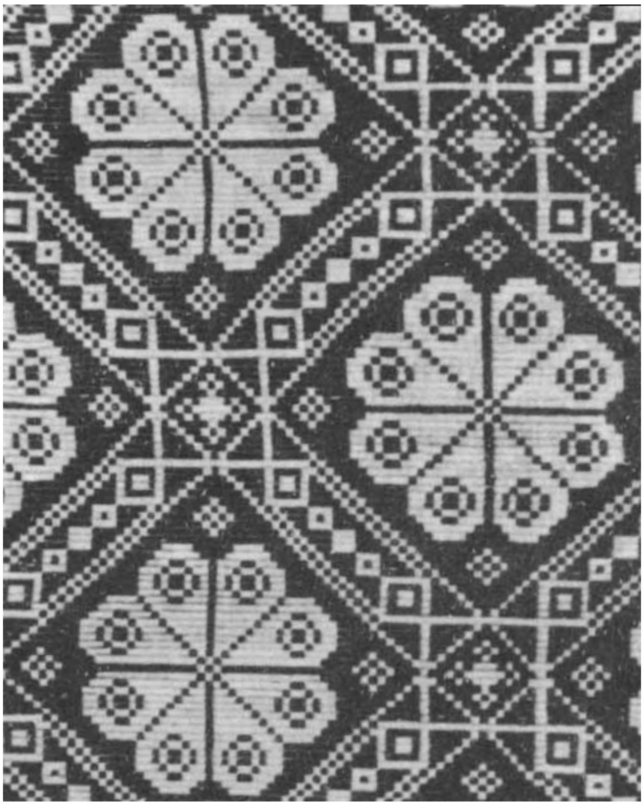

Figure 2 – This Ruchnik shows the symbol for a human soul.

A midwife was thought able to determine the fate of a newborn infant and the passing of childbirth from the character of a meteor's fall (its speed, direction, etc.): 'A midwife delivered and ran out to look: which star rolled down, which its track, how it fell — such she determined the fate' (Anonymous, 2003, p. 182). Meteors were also used to determine the mental quality and righteousness of someone just deceased.

Divinations about meteors and death:

If the meteor flew fast and straight — the death was imminent, most likely this man was killed (Anonymous, 2003, p. 192);

If it flew not too fast — the death was hard, this man was ill for a long time (ibid);

If it flew slantwards — this man died a natural death (ibid).

Divinations about meteors and the passing of childbirth:

If you see the star long, childbirth will be hard, and the girl will be wracked with pain (ibid);

If the star flew fast, the girl will give birth easily, without any troubles (ibid);

If the star fell at the time of childbirth, the child may die (N. V. Nalivaika in Pamoshcha village, Myadel' district, Minsk region, Belarus).

Divinations about meteors and the righteousness of the deceased:

If the star fell straight, the man was kind, honest, fair; his life was the same, without slyness (Anonymous, 2003, pp. 211–212);

If the star fell crookedly, the man had lived a bad or poor life (ibid);

If the star fell in the sky for a long time, and didn't dim right away, the kind man is dead, it is his soul that flies and shines (op. cit., p. 221);

If the star fell fast, the sinful, wicked man is dead (ibid).

Divinations about meteors and the coming harvest:

If the star flares — that is for a good harvest, but if the star falls and a stone falls to the earth — that is for a bad harvest (V. M. Shestak in Jarutichy village, Slonim district, Grodno region, Belarus).

Moreover, the coming weather could also be determined by the appearance of meteors. For example, 'If a star flies — tomorrow will be thundery,' or 'the Lord will give rain' (N. V. Nalivaika in Pamoshcha village, Myadel' district, Minsk region, Belarus); 'The first star falls — Maladzik is beginning' (Anonymous, 2003, p. 250). *Maladzik* is the crescent Moon before first quarter, which is said to forecast weather changes, especially for rain. Many Slavs believe that a falling star foreshadows wind. Such divinations were given only at the appropriate time, of course.

About fireballs, it was said that: 'A falling star is the Devil, the zmej, who carries gold or silver for some rich man (or a witch (Romanov, 1912, p. 290)), or flies to a wizard. The star falls over his house' (Romanov, 1911, p. 64). People looked for wizards and witches where the zmej fell to pieces (Romanov, 1912, p. 290). In some regions of Belarus the zmej, and hence the fireball, was called *khut* or *kut* (Grynblat & Gurski, 2005, p. 170), which combined the mythological forms of a house-spirit (Figure 3) and the fiery zmej. There is an interesting description of the khut and its habits in this source too (ibid):

Figure 3 – This Ruchnik shows the symbol for a house spirit.

'The khut is very willing to help with the housekeeping for people who shelter it. It carries riches home, the sheaves from other [farmers'] fields to the barn, or gold from mysterious treasures. Sometimes one might see it in the sky in the evening; if it flew fiery and red, carrying gold; if dark and black [i.e. there was no fireball seen in the sky], carrying corn and sheaves. But one must respect it [i.e. the khut], and give it tasty food. Its favourite food is fried eggs. The mistress of the house would carry fried eggs to a hill, and call:

'Khut, khut, come here! I will give you fried eggs!'

Then it would come and eat. And it would carry everything [i.e. the food dishes] home. The khut lives on the hill, and it flies there from nobody knows where. It may turn into anything, e.g. a log, an old wheel, an old stump.'[3]

A fireball was said at times to forebode some ill-fortune, including the death of a man (Romanov, 1912, p. 290): 'If a fiery zmej flies and scatters sparks from its tail, there will be some misfortune' (Pietkiewicz, 1938, p. 282); 'The star falls, if on the sea for good, if on people for bad' (A. A. Krumplevskaya in Opsa village, Braslav district, Vitebsk region, Belarus). There was a popular belief that one should not look for falling stars on the 5th of February because that would foreshadow a death soon after (Katovich & Kruk, 2004, p. 75). A similar prohibition applies in Russia, but on March 5 (February 20 Old Style). A bad sign lies on the soul of a man who has seen a falling star; it forebodes him, or someone from his family, an unavoidable death (Sakharov, 1849, p. 43). In the Tula district of Russia, there was a belief that on the Christening evening, January 18, (January 5 Old Style) wherever the zmej appeared he would find death (op. cit., p. 31). A large meteor shower was considered a bad sign. It showed that war was being waged somewhere, or that the year would be rich in one kind of grain only, but that not all would survive to see it because it would be preceded by

[3] Perhaps the khut flying 'dark and black' meant like a black cloud. This can be compared with the meteor-zmej or khut variant, the *tsmok*: 'When the tsmok carries gold, he is clear and fiery, and when rye he flies as a black cloud or turns navy blue' (Afanas'ev, 2002, p. 532). The 'everything' it might carry back to the home farm could be physical objects such as money, milk or bread, but could also include things like making a cornfield fruitful, or cows 'wealthy' in milk (ibid.). The khut might live behind the stove instead of on a hill (op. cit., p. 511) — T Avilin.

There is nothing in the description of the khut flying 'dark and black' to suggest the Belarussians thought of it as a 'dark meteor' (on which little-known phenomenon, see most recently 'Dark Meteor Database: News from 1998–2001', A. McBeath, WGN 29:1/2, 2001, pp. 13–14). Another alternative might have been a bat or a bird flying over, and thus appearing dark against the clear night sky — Project Coordinators.

a terrible high mortality (Anonymous, 2004, pp. 195-196).

A fire was said likely to happen in the village or town the zmej flew over (Afanas'ev, 2002, p. 511). The peasants would put milk out in the yard to appease it, or else it would burn down the house. A fire the zmej started could be extinguished only with milk, not water, which would only make the fire burn stronger (Maksimov, 1903, p. 292). The Belarussians believe that one should respect a falling star and not laugh at it, otherwise it will burn his house (Lyaukou, 1992, p. 33). It is likely this belief can be explained as the Belarussians greatly honour fire, and the zmej-meteor is closely linked with fire. For example, if someone defiles a fire by spitting in it, it is said to blight that person with the *vognik* disease, a rash on the mouth and neck (Karski, 2001, p. 152).

The Belarussian tsmok might fly into a house at night through a chimney, there turning into a handsome young man. Any young woman who fell in love with him would soon become ill and die (Anonymous, 2004, pp. 188-189). Such a creature might even suck milk from the breasts of their victim. The chosen woman would grow weaker day by day, and finally die (Afanas'ev, 2002, p. 530). Sometimes the affected girl was thought to be evil, or a witch (Dal', 1880, p. 27). The birth of an ugly, abnormal, weak or dead baby could be explained as a result of an event like this too (Maksimov, 1903, p. 307). Girls beloved of the zmej could not escape their fate.

3 Meteorites and thunder-stones

These 'stones from the sky' (or stones believed to have fallen from the sky, not always the same thing as true meteorites) caused strong anxiety, as they were thought to be harbingers of coming retribution from the heavens. But they could also be used as protective talismans (along with other stones with holes through them, whether natural or human-bored), for example slung round the neck of a cow, when one acted oddly, and chased after the bulls (Berman, 1873, p. 36).

The spear-tip-shaped fossils called belemnites were believed to have fallen from the sky in Belarus[4], where they were called 'Pyarunova's arrows' (from *pjarun*, 'thunder'), 'thunder arrows' or 'devil's fingers' (Lyaukou, 1992, p. 21). The storm god Perun was said to attack zmejs with such arrows. This god's powers and activities were subsumed by Saint Ilya when Christianity displaced paganism, so more modernly it would be said about thunder and lightning that St. Ilya is riding in his fiery chariot over the sky, striking at the Devil with his arrows, while the Devil tries to hide among the people. In folk-belief these fossils have curative properties, and also can be used to ward off thunder. Stone-age axes and other stone weapons also belonged, in Belarussian belief, to Perun, and had the same names as the fossils (Kirkor, 1882, pp. 267–268). In the 17th century they were commonly names 'Perun-stones' (Afanas'ev, A. N., p. 532)[4].

Generally under Belarussian folk belief, almost every strange stone more than a few centimetres in size can be referred to as a star fallen from the sky. In the Palesse region such a 'star' or 'meteorite' was broken into pieces, ground into powder, and used with water as the best magic for curing wounds (Lyaukou, 1992, p. 33). Other folk beliefs state that a stone from the sky was once an evil force that contended with the Lord, and that he, in fury, damned it, turned it into stone, and cast it down to the Earth (ibid.).

There is what seems to be an observation of a fireball, or perhaps a meteorite fall, in the folktale 'Kaval' Bagatyr' ('Blacksmith Hero'):

Suddenly they saw that a very big and bright star appeared in the sky.

'Maybe this is the soul of my child,' the blacksmith's wife thought.

The star rolled down the sky just as she thought about it: it rolled nearer and nearer, and grew. And already it burned over the village like a hayrick. People were frightened and the star cracked in pieces and went out over the village; only sparks fell to earth. One of the sparks fell onto the blacksmith's wife's legs and it was a red-hot stone.

(Serzhputouski, 1911, p. 11)

This description is analogous to those linked to genuine meteorite falls, such as those of 1892 September 22, at Zabroddze in Stolbtsy district (Lyaukou, 1992, p. 33), and 1965 June 5 at Tschorny Bor in Bychov district (op. cit., p. 37).

The fall of a stone into a garden forecast a poor harvest, and misfortune for its master, but as often in folklore, the opposite opinion also existed: 'If stones fell in the garden, something would happen to its owner', though that might mean, 'it would bring happiness to the house' or 'there is a buried treasure in this place' (L. V. Chusheva in Oreshkovichi village, Berezino district, Minsk region, Belarus, collected by N. Andreenko).

Some different Belarussian legends about stones may also be related to meteorites directly, or perhaps have a common mythological origin, for example the legend about a stone situated in the Polack district which was connected to the tsmok: *The tsmok flew with gold and silver to sinners. Suddenly the sky split open and the tsmok fell* [to the ground] *and turned into stone, and its treasures appeared in the ground beneath the stone.* (Anonymous, 2004, p. 20).

4 Conclusion

Belarussian folk-beliefs in meteors reveal links with other east European folklore, as can be seen from the discussion here. One might say with certainty that such beliefs appeared before the 18th century on the basis of the investigated material, and probably originated in greater antiquity. Christianity made its contribution

[4]As also in Britain and elsewhere — cf 'Stones from Heaven: Some Meteoric Fossil Folklore', A. McBeath, WGN 25:3, 1997, pp. 128–130 — Project Coordinators.

in changing the nature of earlier beliefs too. Moreover contemporary ethnographic expeditions will allow the recovery of more details about the still-extant meteor beliefs, and hopefully find new ones.

Some additional comments about the heavenly zmej include that the Belarussians called the constellation Draco 'Zmej' (Avilin, 2005, p. 104) or 'Tsmok', and sometimes a rainbow was called tsmok too, while the Ukrainians called the Milky Way 'zmej'. The Belarussians called a comet 'Kaneta', 'Metla' (a broom), 'Zora z khvostom' (the star with a tail), 'Krest' (a cross), or said that it was an old, great, terrible witch on a broom (Avilin, in press).

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Meteor Beliefs Project: A note on the Belarussian meteor folklore article

Alastair McBeath

Earlier in this issue, you will find the now customary Meteor Beliefs Project article, a detailed examination of meteor beliefs from folklore in Belarussia, kindly contributed by guest author Tsimafei (Tsima) Avilin. Aside from his work on such material from Belarussia, Tsima has provided some additional notes on similar matters from Russia and some of the Baltic States, which should appear in a future issue. As he will probably be unfamiliar to most IMO members, the following paragraph contains some brief biographical notes about him.

Tsima Avilin is a student at the Nuclear Physics and Electronics Department of Belarus State University in Minsk. He works there chiefly with neural networks, cluster analyses, regressions and other mathematical methods useful for classification and prediction. His recent work has included non-invasive methods for the determination of blood glucose levels. Astronomically, he became interested in variable star studies in 1995, but since 2003, he has moved on to collecting and publishing material on Belarussian astronomical folklore, conducting his inaugural expedition to collect folkbeliefs at first-hand in the summer of 2005. Some of his early discoveries are presented in his article here. He has recently set up the Belarussian Astronomy Project, to help collect more folklore from the region, and has other research trips planned concerning the astronomical folklore and early astronomical activities in Belarus. He hopes to have an article published on the surviving old Belarussian constellation lore in the near future.

As always, the Meteor Beliefs Project's coordinators welcome fresh input from anyone with information to share. You can find out the kind of material we are interested in, and what to send us, by re-reading the initial article in WGN **31:2** for April 2003, or visit the new webpage at `www.imo.net/projects/beliefs`. We look forward to hearing from you!

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