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Fireball with a terminal flare photographed by André Knöfel on July 26-27, 1992. The photograph was exposed between $21^h01^m15^s$ and $01^h17^m35^s$ UT using a fish-eye lens, $f = 35$ mm, $f/3.5$, from Langewiese in Germany. The magnitude -5 fireball appeared at $0^h14^m53^s$ UT. The trail of dots is caused by an airplane while the fainter trail is *not* a meteor.

In case of non-delivery, return postage guaranteed. Please return to:
v.u.: Marc Gyssens, Heerbaan 74, B-2530 Boechout, Belgium

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Contents

Useful Information

The June Issue *(WGN 21:3)*

The *June issue* is expected to be mailed a little later than usual, during the second week of June 1993. Because this is issue is anticipated to become fairly thick, contributions are due early, on *April 30* at the latest. They should be sent to *Marc Gyssens* (address on inside back cover).

WGN Subscription/IMO Membership 1993

The subscription rate for volume 21 (1993) is 25 DEM for six issues. Additional gifts are of course welcome. It is anticipated that volume 21 will contain over 240 pages.

Administrative Correspondence

Ordering *IMO* publications is done in the same way as paying subscription/membership fees. Complaints about not receiving *WGN* or changes of address should be sent to *Paul Roggemans.*

All addresses can be found on the inside of the back cover.

From the Editor-in-Chief

Marc Gyssens

For the new members and subscribers that have just joined us this year: this issue is a regular, "thin" issue of WGN. *The* IMO *has a policy of offering* WGN *at the lowest price possible. Therefore, we alternate regular issues with thick issues, rather than dividing the annual number of pages evenly over all issues. This helps to save on postage costs.*

There is, however, some evolution in this pattern of alternating thin and thick issues. Last year's Volume 20 comprised two thin and four thick issues, compared to three of each in previous years. This move was necessary despite the fact that starting about one and a half years ago we began printing non-article contributions in a smaller font to save on space. The reason for this evolution is that you, the reader, are continuously submitting more and more articles, a practice we do not complain about! Therefore, please keep up the good work and keep sending in your contributions! Taking into account what is already in the pipeline for the June issue, there is a good chance that that issue will not be just a thick one but an extra-thick one!

Of course, the continuous growth of WGN *also involves more work. As a result, we thought that it would be appropriate to give some instructions to authors, particularly since it has been a long time since we last did that and the journal has seen many new contributors since then. By following the instructions found below, you will save us work and at the same time speed up the processing of your article, which in turn will contribute to a timely publication schedule.*

Finally, it should be emphasized that the growth of WGN *merely reflects the growth of the* IMO *as a whole. In that respect, it should also be emphasized that the growing amount of work resulting from this requires a larger number of members prepared to make new commitments to handle the additional workload. With new Council elections having been initiated in* IMO Document 10, *which was sent to the members with the February issue, it might be a good idea to re-read the last few pages of that document to find out if the profile sketched there does not suit you! Some more information on the election procedures is given in this issue.*

Enjoy this issue!

Instructions to Authors of WGN

Marc Gyssens

1. A general advice

If you intend to write something for *WGN*, the best initial advice I can give you is to browse through previous issues of the journal for articles or notes similar to the one which you intend to write. In this way, you will get a feeling for the general style of the journal. For certain notions, tables, etc., *WGN* uses more or less standard abbreviations, symbols, layout, etc. Deviating from these undeclared "standards" causes extra editorial work to make the article conform to the style of the journal.

Although we understand and appreciate that every author has his or her own style of writing, try nevertheless to *adhere to the general style of WGN*.

In particular, authors of visual observational reports should note that the bimonthly journal does *not* publish individual raw data, unless they serve to make a point, such as a shower outburst. The reason for this policy is straightforward: those data will be published in the *WGN Observational Report Series*. Average ZHRs and magnitude distributions (provided they are significant and the observing conditions are specified), however, are welcome. The main purpose of the observational reports in the bimonthly journal is to give the readers an impression of such things as the activity seen from a shower, shortly after the event took place. Observational reports should therefore be written from that perspective. Again, writers of observational reports are advised to browse through past issues of *WGN* to get a better feeling for what is expected.

2. Submission

The continuous growth of our journal involves ever more editorial work. In order to keep the editorial workload reasonable, we appreciate receiving an electronic version of your submission as well. However, electronic submission cannot be a substitute for a hard copy, as the transfer process can sometimes scramble up formulae, tables and bits of text. In such cases we need a version on paper to sort things out.

More concretely, if you have access to electronic mail, send me a text file of your article to the e-mail address mentioned on the inside back cover. At the same time, send me one hard copy of the paper by ordinary mail, including possible illustrations. Make sure the illustrations cannot get damaged in the mail by wrapping them properly.

If you do not have access to electronic mail, then try to provide a text file on, preferably, a 3.5″, or else, a 5.25″ MS-DOS diskette. Make sure the file is pure ASCII; WP-files or files for other editors are useless to me. However, most of these editors have a command to generate an ASCII version of a document, so please make use of this option. Something you should not be worried about is the formatting of your text. The program used to make *WGN* (TEX) takes care of that. Therefore, it does not matter where you insert line breaks. Quite often, we receive files in which almost no line breaks are present. Presumably, these files are ASCII-dumps of files created with WP or similar editors that do not require you to give explicit line breaks within a same paragraph. If you edit a text for *WGN*, we suggest you explicitly insert line breaks at the end of each line of text. We do not, however, need your text to have an aligned right margin. Moreover, lines that are too long may cause errors in the transmission to the machine on which *WGN* is produced.

In the past, diskettes were often not returned to the authors. We will see to it that from now on diskettes are systematically returned to the sender as soon as all the articles on it have been published. When you use diskettes, send me the diskette, together with one paper copy, including possible illustrations. Make sure the diskette and the illustrations cannot get damaged in the mail by wrapping them properly.

If you cannot provide me with an electronic version of your article, then send me a type-written version in triplicate. Hand-written articles are permissible, but only if they are clearly legible. In particular, you should be careful when writing proper names (persons, sites, etc.). Often, we lose much time in figuring out the spelling of such names! Also, clearly indicate where accents should be placed! Hand-written articles should also be provided in triplicate. If in your country, copying facilities are limited or extremely expensive, you may send only one copy.

When I receive a submission, I first decide whether or not it qualifies for refereeing. *Only articles dealing with global analyses of observations, analyses of data obtained by professional equipment, articles of a theoretical nature, and certain review articles qualify for the refereed section.* In particular, I would like to again emphasize that the decision to have an article refereed is not a judgment on the content but on the nature of the article.

A non-refereed article is usually published in the upcoming issue, provided the deadlines indicated on the inside front cover are respected. Space limitations will sometimes defer a timely sent-in article to the next issue. Exceptionally, an additional delay is possible, if I need to consult either the author or members from the Editorial Board to clarify the article. The refereeing procedure typically takes two months, based on our initial experience. The procedure can, however, take longer if the alterations suggested by the referees require a second round of refereeing. As a rule, a refereed article is dealt with by one professional and one amateur referee. Unless the referees request otherwise, the refereeing procedure is open, in the sense that once the referee reports are in and sent to the author, the author is free to contact the referees directly to ask for clarifications if necessary.

3. Language and style

In principle, only submissions in English are acceptable. From time to time members of the Editorial Board have offered translation services, but these should be regarded as a personal favor. As an *IMO* officer, the Editor-in-Chief cannot guarantee the translation and publication of articles written in another language. Moreover authors having been offered a translation service on a personal basis must be aware that the work involved can lead to delays.

Having said this, we are well aware that a large number of *WGN* readers and authors have difficulties with the English language as it is not their first language, and there is no reason whatsoever to be ashamed of that. I see to it that every contribution by an author who is not a native English speaker is edited for language problems. In particular, starting with Volume 21, Peter Brown goes over each such article to make sure that the result does not sound awkward to native English speakers. So while no author should be embarrassed by making English errors (we take care of those), he or she should nevertheless be sure that the meaning of his or her sentences is clear. In some languages it is customary to use long and grammatically involved sentences. If these sentences are translated literally into English, their meaning often becomes ambiguous. This in turn forces me to either leave out the ambiguous passage or to contact the author for clarification, resulting in delays. As a policy, I never guess at the meaning of an ambiguous sentence! Therefore, authors who do not have mastery of the English language are advised to avoid writing sentences that are too long or too complex.

However, native English writers should also be aware of the language they use. As many of the readers are not very familiar with all the nuances of the language, they should avoid using rarely used or unnecessarily complex words. They should also avoid writing too long or too complex sentences full of idiomatic expressions, for the same purposes. In general, I would advise native English contributors to be a little more generous with commas than is customary, as punctuation can be of great help to a reader who is not that good in English in understanding the structure of a sentence.

As a guide to everyone, I would suggest you put yourself in the place of the reader when you write something. What is obvious to you may not be obvious to the reader. Also, be aware that the background of our readership is very heterogeneous. Make sure that the reader can follow your line of thinking. This means that you must arrange the paragraphs that express your thoughts in a logical order. Within a paragraph, you should ensure that the flow of thoughts is natural. The little words or phrases linking a sentence to the previous one are extremely important in this respect. However, you should make sure that these referencing words are not ambiguous. Many authors tend to use words such as "this" or "they" in a context where it is not exactly clear what these words refer to. In such cases, the references must be made more precise, e.g., "this person" or "the observers."

Finally, do not obscure the legibility of your article by throwing in too much notation. Sometimes, authors introduce symbols for no real purpose. Also, if you quote figures, make clear exactly what quantity they express. Always be clear in the units you use. As a rule, *WGN* uses metric units. Therefore, authors from countries where the imperial system is still in use are kindly asked to make the conversions themselves, being careful to properly round off.

4. Abstract

Most contributions in *WGN* require an abstract. The exceptions are calls for observation, announcements and reports of conferences and other events, book and software reviews, and communications of an organizational nature. Those contributions not requiring an abstract are published in smaller print. All other articles, including observational reports, require an abstract. The abstract should be brief and mention the main points of the article. From the abstract, a reader must be able to decide whether or not the article is of interest to him or her. Also, an abstract is useful when *WGN* articles are reviewed in other publications.

Often, articles requiring an abstract are submitted without one, forcing me to write one. Though in many cases a one-line abstract suffices, this is a time-consuming job. Provide an abstract yourself! To find out the appropriate length for your abstract, browse through old *WGN*'s looking for contributions that are comparable to yours!

5. Organization of the contribution

You may—but do not have to—divide your articles into sections. Whether or not sectioning is appropriate mainly depends on the length of the article. Generally, there will be no point in dividing a one-page article into sections. A five-page article on the other hand *must* be divided into sections to provide the reader with natural breaks within the article. The decision to use sections must be made on an article by article basis and serves to increase the readability of the article. If you intend to use sections the *entire* article must be divided into sections, including the first part. Also, sections are numbered consecutively, except for acknowledgments and references, which come at the end of the article.

Subsections are *not* used in *WGN*; if a section becomes too long, try splitting it into several sections. In exceptional cases it is permissible to divide long sections by using unnumbered headings, which will be printed in italics. For examples, we refer you again to past issues of this journal.

6. Figures and tables

Both figures and tables are numbered consecutively throughout the article. As an author, you cannot predict where in the text a table or figure will eventually be placed; layout considerations can force us to move a table or figure forward or backward relative to the place where it was originally intended to appear. Therefore, never refer to figures or tables with words such as "below" or "above," but use the figure or table number instead. Also note that in reference to a particular table or figure, the words "Figure" and "Table" are written with capital letters and are *never* abbreviated.

For each figure or table, a caption should be provided. This caption should briefly explain what the figure or table is about, and be as self-contained as possible. Every figure or table used must, of course, be relevant to the article as a whole and therefore be explicitly referred to in the text.

When composing a table for *WGN*, be aware of the technical restrictions. Your table should fit on a page, meaning that its width must not exceed about 17 cm. The length is no problem, as a table can run over several pages. Notice that *WGN* does not print tables in landscape mode! Also, there are certain kinds of tables, such as magnitude distributions, which are printed in a fairly standard way. Try to respect these standards, again by comparing your article to similar articles published in the past.

Figures can either be black-and-white illustrations or diagrams, or photographs.

Concerning the former, black-and-white illustrations or diagrams should be camera-ready. This means that they should not require any additional processing before publication. In particular, you should use dark black ink for a drawing and you should take great care in the lettering of your figure. If you are not good at drawing yourself, find a friend or colleague who is willing to help you! If you make a drawing or diagram by computer, please use a laser printer to produce the output. High-resolution matrix printers are acceptable provided the figure allows reduction to hide the imperfections of the printer.

Whatever device you use to produce your illustrations or diagrams, it cannot be emphasized enough that the output must be really pitch black! Grayish pens, almost finished ink cassettes, or worn ribbons will result in a poor reproduction. The same remark holds for lines that are too thin, which is sometimes the case for the gridlines of a diagram.

In general, black-and-white illustrations or diagrams should be produced in such a way that they allow reduction. Reduction of figures is often needed to save space in order to make sure that all submissions can be accommodated without needing an unreasonable number of pages. Also, reduction can be necessary for layout reasons, to fit a certain illustration on a certain page. In order to allow reduction, you must pay special attention to the lettering. If a figure cannot be reduced, it is usually because the lettering on the original is too small in size. In general, make sure there is a reasonable proportion between the size of your illustration and the size of the lettering.

Photographs can be reproduced in *WGN*, but faint details are inevitably lost. Therefore, photographs need to be of good contrast. Very dark photographs with extremely faint meteors are irreproducible. For the last year we have been scanning the photographs before making the halftones, allowing us to enhance contrast. In particular, this technique enables us to process color photographs as well and still obtaining a reasonable result. Be mindful, however, that there are limitations to what a computer can do. Make sure your photographs are of good contrast; furthermore lighter photographs reproduce better than darker ones. Notice that in the text of the article, photographs too must be referred to as figures.

7. References

In *WGN*, references are numbered according to their first appearance in the text. Please observe this convention. Introducing numbers ourselves or rearranging the numbers in an alphabetically-ordered list is time-consuming as well as a possible source for errors.

Also, *WGN* prefers full references. In the case of journal articles, this means authors, title, journal, volume (and if possible, issue), year (and if possible and appropriate) month, and page range. In the case of books, we expect authors or editors, title, publisher, place of publication, year, and if appropriate, relevant page range. In the case of conference articles, we expect authors, title, proceedings, editors, if applicable and appropriate, series and publisher, year, and page range.

Letters to WGN

compiled by Marc Gyssens

Radio reflection duration and visual magnitude

The letter of George Zay published in last year's December issue (WGN 20:6, p. 210), pointing out that visually bright meteors do not always yield long radio reflections and vice-versa, continues triggering a lot of reactions. They follow below.

I noted with interest the letter to *WGN* from George J. Zay in the December 1992 issue of *WGN*.

During 1986–1987, I frequently exchanged correspondence with Walter Scott Houston about our common experiences and interests in meteor astronomy. Walter Scott is the gentleman who writes the very excellent "Deep Sky Wonders" monthly column for *Sky and Telescope*. The exchange of materials included an article on radio meteors that appeared in the July 1958 issue of *Scientific American*. Walter Scott also sent me copies of the notes that he and Cliff Simpson (WOYUQ) had used to generate the article, as well as follow-up comments on the published article.

With regard to Mr. Zay's letter, let me quote the 5th item from Scotty's notes:

> "Our first effort at gathering problems was simply to see if we could find any correlation between the radio and visual brightness and hourly rates. We knew when we started the project that we could count meteors on the reflection furnished by the 20 Mc. signal of WWV out of Ft. Collins, but as it was not really good reception we decided to make a better system of our own.
>
> To our surprise we found absolutely no correlation between radio loudness and visual magnitude. A first magnitude meteor might barely beep the radio, and conversely, a sixth magnitude meteor might shake the speaker almost off the table. Eventually, we concluded the effect came from the polarized pattern of the Yagi, and started to look at designs for non-polarized antennas."

The rest of the item refers to the station being closed down and experimentation being discontinued because of job changes.

¿From many hours of simultaneously observing meteors and listening to them on my detection system, I have noted many instances where bright meteors produced minimal radio response, and vice versa. I have even noticed very loud signals on the radio system that lasted upwards of 30 seconds from meteors that I did not see!

I know of two other radio observers who have reported the correlation disparities between visual and radio brightness.

To complicate the matter further, I have co-observed with a friend who lives about forty miles from me. We have both monitored the same signal (67.250 Mhz), and despite our separation, we are both approximately the same distance from the signal source (270 km). We were using different receivers and different antennas—I had a five element Yagi and he had a dipole. While listening and being in contact by telephone, many of the meteors detected simultaneously had very different detection parameters, and to add more questions to the detection geometries, we both heard meteors that the other observer did not hear.

So, Mr. Zay, welcome to the wonderful realm of unknowns that bedevil any meteor observer who looks and listens at the same time.

William H. Black, K4BSN, February 9, 1993

This letter is to follow up on the visual magnitude/reflection duration correlation, which I brought up in the December 1992 issue.

Recalling some of the bright meteors I have seen simultaneously, it appears that one of the influencing factors for signal time duration is the meteors alignment in relation to the antenna's direction. That is, if the meteor is lined up with the antenna's pointed direction, you will get a somewhat longer signal than one that appeared perpendicular or just overhead. If this is so, radio durations and visual magnitude correlations are useless. I am sure there are other factors that need to be ferreted out.

In noting signal strength, that too is troublesome, at least when listening in on a commercial FM station. When listening directly or recording on a chart recorder, the problem is the same. When a meteor reflects a commercial radio signal, it is dependent upon what's being transmitted at that particular moment as to what strength I am going to record on my recorder. A transmitter of a continuous steady signal will be more meaningful here I think.

When counting meteor reflections, perhaps it would be more useful to note sheer numbers per hour rather than assign brightness values based upon duration and closeness based upon strength.

As a personal project, I have started to include on my visual meteor plotting work the meteors that did and did not make a simultaneous radio signal and the duration of the one's that did make a signal. I am actually just getting started. But this will be something I am going to do for my own curiosity. If there is anyone in *IMO* land who is interested in the data that I accumulate, please contact me. I will be happy to share what I get.

George J. Zay, February 16, 1993

I read the several comments, some more emotional than others, about the relationship between visual magnitude and echo duration with great interest. The relation $\log T = -0.182 M_v + 0.288$ was a result of a Perseid campaign at Puimichel, France, in 1986. Several meteor observers from different countries were present there, including Paul Roggemans. During several nights, I carried out simultaneous visual-radio observations. For this purpose, a circularly polarized antenna was pointed to the zenith to improve the chance of seeing the visual counterpart. In this way, 64 radio-visual meteors were gathered. With these observations, the above-stated relationship was derived as described in [1]. So, this relationship is *only* valid for this specific equipment set-up, frequency, etc.

What amazed me at the time was that, despite several unknown parameters (reflection point, velocity, etc.) and possible errors (e.g., estimated visual magnitude), this relationship seems to fit rather well. The correlation coefficient obtained was -0.83, which is not bad at all taking into account the very small sample. Of course, this might be a pure statistical coincidence, but on the other hand it is very unlikely that at the used frequency (88.30 MHz), e.g., a meteor of visual magnitude $+0.5$ will yield a reflection duration of 5 seconds.

This discussion leads us to one of the main goals of the relationship under consideration, namely the determination of the "radio limiting magnitude" of a forward scatter system. A lot of radio observers would like to know the limiting magnitude of their observing system. This method, which is certainly rough in some respects, does give them an answer.

Below I give some more references [2–5] for people who are interested in this exciting matter.

[1] J. Van Wassenhove, "The Relation between Visual Magnitude and Echo Duration", *WGN* 15:4, August 1987, pp. 116–118.

[2] V. Znojil, M. Šimek, J. Grygar, J. Hollan, "The relation between meteor optical brightness and the properties of the ionized trail", *Bull. Astron. Inst. Czechosl.* 32, 1981, pp. 1–19.

[3] B.A. Lindblad, "Combined Visual and Radar Observations of Perseid Meteors – I. Observations in 1953", *Medd. From Lunds Series I*, 189, pp. 1–98.

[4] B.A. Lindblad, "Combined Visual and Radar Observations of Perseid Meteors – II. Observations in 1955", *Medd. From Lunds Series I*, 198, pp. 1–38.

[5] B.A. Lindblad, "The Relation between Visual Magnitudes of Meteors and the Durations of Radar Echoes", *Medd. From Lunds Series II*, 138, pp. 27–39.

Jeroen Van Wassenhove, March 3, 1993

Comment by the Editor: *From all the reactions published thus far, I think nobody questions the existence of a correlation between visual magnitude and echo duration. The main point of the whole discussion is that the formula under scrutiny cannot be used naively, because* (i) *it is a based on too small a sample,* (ii) *there is a wide scatter, and* (iii) *the formula is not universally valid. The reaction by Jeroen Van Wassenhove only confirms this conclusion. Finally, caution must be taken upon considering professional work because that is based on back scatter rather than forward scatter.*

About the Upcoming Council Elections

Marc Gyssens

As I pointed out in my Editorial, the procedure for the election of a new Council has been initiated. While we welcome candidates for a Council position, we must at the same time caution prospective candidates that serving as a Councillor requires a large commitment and a lot of time. In *IMO Document 10*, sent to all members with the February issue, a profile for a Council member is sketched, based on our experiences over the past years.

If you feel that the requirements in that profile are too much for you, you would be better to refrain from being a candidate. If on the other hand you think you do satisfy the requirements and can effectively contribute to the Organization by helping in getting the massive amount of work done, your candidacy is most welcome. In that case you should send your candidacy as outlined in *IMO Document 10* to the Secretary-General. Only candidacies reaching the Secretary-General before midnight UT of May 31–June 1 will be considered; it is your responsibility to allow postal services enough time to make sure that your candidacy arrives in time.

The candidacies will be communicated to all voting members together with a voting bulletin with the June issue. Contrary to what is said in *IMO Document 10*, votes much reach the Secretary-General before midnight UT of September 14–15. The votes will then be counted and the result announced at the General Assembly at the *IMC* in Puimichel, on Friday September 24. The new Council will take office starting January 1, 1994.

Who is Who Announcement

Paul Roggemans

Several *IMO* members returned the letter sent with *WGN* 21:1. If you have not done so, please send it promptly to the Secretary-General (address on inside back cover). It would indeed be a shame if the updated version of *Who is Who* should contain outdated information simply because some members failed to react. The updated *Who is Who* will be printed after the postal codes change in Germany.

Deadline for VMDB Input: May 31

Rainer Arlt

Last year, most of the visual data came in fairly regularly. Since the conditions for Perseid observations were rather poor, the 1992 files of the *Visual Meteor DataBase (VMDB)* are somewhat smaller than those of the previous year. If you still have observations not sent in, please send them as soon as possible to Rainer Arlt (address on inside back cover). As we have to produce Volume 5 of the *WGN Observational Report Series*, observations should be received by *May 31* at the latest. If you have access to e-mail you can easily send me the data to the Internet address `100114.1361@compuserve.com`. The observations should be prepared in a format that resembles the *IMO* observing report form. Completeness, however, takes precedence to the format of the submitted report.

When entering the 1992 observations, I noticed that several observers forgot to give their field of view. You may give these values in right ascension and declination with an accuracy of about 10°. Furthermore, observers often forgot to distinguish whether they *did not see* any meteors of one shower or whether they *did not watch* for that radiant. There is no shame in not having observed a shower, but please unambiguously note this. You may do that by listing the observed showers before giving the actual observation, independent of the number of meteors seen from those radiants.

Visual Meteor Database Statistics for 1991

Paul Roggemans

1. Introduction

Since statistics on visual observations were published in *WGN* 18:6 (December 1990) and *WGN* 20:1 (January 1992), it has become something of a tradition to communicate these totals to the observers. It is encouraging for observers to see that the *IMO* is making good use of their reports. All forms are entered into a database and all original documents are archived. If the *IMO* had not existed, one is left to wonder what would have happened to all the data collected and analyzed so far?

To begin with, no standards for observing and reporting would have developed. Meteor observing would still be a jumble of scattered efforts with uncomparable and to a large extent little used data. In some countries, no meteor groups would have been established, large amounts of data would have been destroyed and lost by amateurs who faded out of the hobby. Anybody willing to study a meteor stream would have been quickly discouraged when trying to obtain enough useful data. Observers would have to be content with analyses based on small data samples collected by national societies.

Fortunately, the chaos that existed in amateur meteor astronomy is now largely history. Some people, however, still deny the importance of a global organization and believe that analyzing data samples 10% the size of those used by the *IMO* provides comparable results. Generally, the available observations can only be studied successfully when all efforts are coordinated on a global scale. There is not enough data available to be divided for whatever purpose.

2. IMO totals

The tables presented here represent the amount of data received up to the end of 1992 for the period 1988 to 1991.

Table 1 – *VMDB* grand totals for 1988–1990.

	1988	1989	1990	1991
Effective time	$5685^{\rm h}$	$5322^{\rm h}$	$4487^{\rm h}$	$5227^{\rm h}$
Meteors	115 298	89 493	79 053	137 765
Observers	346	414	339	377
Countries	17	21	21	27

In Table 1, the high number of meteors reported in 1991 is mainly due to the remarkably successful Perseid and Geminid observations. There is a disturbing trend emerging, however, since the first IMO years 1988–1989. The regularity of observational coverage outside the major stream periods is getting poorer. Fewer efforts are made regularly throughout the year and this is evident in practically all groups and countries involved.

Table 2 – Total observing time and number of meteors per month.

Month	1988–1991		1991	
	$T_{\rm eff}$	N	$T_{\rm eff}$	N
January	$1124^{\rm h}.15$	15167	$199^{\rm h}.96$	1836
February	$587^{\rm h}.64$	5407	$60^{\rm h}.17$	454
March	$569^{\rm h}.07$	3925	$87^{\rm h}.58$	642
April	$1119^{\rm h}.98$	12081	$279^{\rm h}.50$	2541
May	$839^{\rm h}.69$	14093	$117^{\rm h}.23$	1121
June	$421^{\rm h}.11$	3685	$103^{\rm h}.80$	871
July	$1847^{\rm h}.37$	29490	$219^{\rm h}.72$	2282
August	$7673^{\rm h}.06$	203594	$1999^{\rm h}.20$	69494
September	$875^{\rm h}.85$	9392	$278^{\rm h}.06$	3044
October	$1677^{\rm h}.56$	23149	$303^{\rm h}.93$	3745
November	$1513^{\rm h}.35$	17068	$371^{\rm h}.43$	4249
December	$2472^{\rm h}.03$	84558	$1206^{\rm h}.04$	47486
Total	$20720^{\rm h}.86$	421609	$5226^{\rm h}.62$	137765

This means that the risk of completely missing an unexpected meteor outburst, new stream, or fireball has unfortunately become greater. We strongly recommend that amateurs use any clear night to monitor the sporadic background even just for one or two hours to make sure nothing unusual is going on in the sky! It is a very relaxing job and one that is very useful as well. If this trend continues, future meteor outbursts may happen when literally all experienced amateur meteor observers are asleep! Do not let this happen.

3. The VMDB competition

There was a time when some people described themselves as the most experienced meteor observers in the world. More often than not, they were very enthusiastic amateurs but by no means the most active observers. Since the *IMO* keeps detailed statistics, we know exactly who are the most active observers and where meteor astronomy is most productive. There is a small minority of meteor observers who still do not report to the *IMO*, but they would not greatly change the overall statistical picture. We do hope that the few individuals outside *IMO* will soon agree to share in the development of a global meteor environment by joining the *IMO* or at least submitting their observations to the Organization.

Table 3 – Total effective observing time and numbers of meteors seen per observer.

1988–1991				1991		
Nr.	Observer	T_{eff}	Met.	Nr.	T_{eff}	Met.
1	Rendtel Jürgen (RENJU)	$974^{\mathrm{h}}.69$	15472	1	$272^{\mathrm{h}}.19$	4547
2	Knöfel André (KNOAN)	$671^{\mathrm{h}}.58$	11677	7	$104^{\mathrm{h}}.40$	3019
3	Koschack Ralf (KOSRA)	$504^{\mathrm{h}}.59$	25695	3	$164^{\mathrm{h}}.48$	9237
4	Roggemans Paul (ROGPA)	$492^{\mathrm{h}}.12$	12955	5	$141^{\mathrm{h}}.72$	4616
5	Trigo José (TRIJO)	$469^{\mathrm{h}}.09$	11317	8	$102^{\mathrm{h}}.92$	3053
6	Wood Jeff (WOOJE)	$439^{\mathrm{h}}.36$	15011	12	$79^{\mathrm{h}}.08$	2584
7	Rendtel Ina (RENIN)	$368^{\mathrm{h}}.12$	13675	15	$74^{\mathrm{h}}.30$	3794
8	Arlt Rainer (ARLRA)	$346^{\mathrm{h}}.33$	8627	13	$78^{\mathrm{h}}.06$	2407
9	McBeath Alastair (MCBAL)	$338^{\mathrm{h}}.27$	3637	6	$113^{\mathrm{h}}.69$	1439
10	Marsch Adam (MARAD)	$329^{\mathrm{h}}.03$	2800	32	$34^{\mathrm{h}}.29$	398
11	Plesier Ghislain (PLEGH)	$323^{\mathrm{h}}.72$	3084	28	$36^{\mathrm{h}}.68$	802
12	Glossop Mark (GLOMA)	$307^{\mathrm{h}}.48$	7055	44	$26^{\mathrm{h}}.33$	844
13	Koch Bernhard (KOCBE)	$302^{\mathrm{h}}.69$	6820	9	$101^{\mathrm{h}}.78$	2416
14	Platt George (PLAGE)	$299^{\mathrm{h}}.32$	6907	85	$16^{\mathrm{h}}.33$	535
15	Rajala Leo (RAJLE)	$237^{\mathrm{h}}.64$	4994	16	$64^{\mathrm{h}}.32$	1529
16	Taibi Richard (TAIRI)	$225^{\mathrm{h}}.92$	1859	23	$43^{\mathrm{h}}.25$	370
17	Lunsford Robert (LUNRO)	$225^{\mathrm{h}}.15$	6681	17	$58^{\mathrm{h}}.71$	1608
18	Stapf Siegfried (STASI)	$199^{\mathrm{h}}.84$	3430	4	$142^{\mathrm{h}}.90$	2029
19	Gallagher John (GALJO)	$199^{\mathrm{h}}.65$	1063	2	$199^{\mathrm{h}}.65$	1063
20	Mameta Katuhiko (MAMKA)	$194^{\mathrm{h}}.54$	2697	11	$85^{\mathrm{h}}.82$	1419
21	Bellot Luís (BELLU)	$180^{\mathrm{h}}.59$	2255	14	$77^{\mathrm{h}}.52$	1506
22	Coroneos Martin (CORMA)	$173^{\mathrm{h}}.80$	4545	109	$11^{\mathrm{h}}.56$	359
23	Kuschnik Ralf (KUSRA)	$161^{\mathrm{h}}.53$	3103	120	$10^{\mathrm{h}}.74$	143
24	Yabu Yasuo (YABYA)	$150^{\mathrm{h}}.66$	1532	18	$55^{\mathrm{h}}.66$	859
25	Miskotte Koen (MISKO)	$147^{\mathrm{h}}.95$	2553	10	$88^{\mathrm{h}}.50$	1506
26	Winkler Roland (WINRO)	$135^{\mathrm{h}}.39$	1666	20	$45^{\mathrm{h}}.69$	604
27	Hashimoto Takema (HASTA)	$125^{\mathrm{h}}.88$	1663	29	$36^{\mathrm{h}}.55$	827
28	Tomioka Hiroyuki (TOMHI)	$123^{\mathrm{h}}.25$	1359	39	$29^{\mathrm{h}}.01$	208
29	Plesier Francis (PLEFR)	$122^{\mathrm{h}}.91$	1126			
30	Brown Peter (BROPE)	$122^{\mathrm{h}}.31$	2772	42	$26^{\mathrm{h}}.94$	627

Table 3 lists the 30 most active observers for 1988–1991. We now compare this long term activity with the results for 1991: "Nr." gives the place of the observer in the 1991 classification. For more details, we refer to the *WGN Observational Report Series*.

Table 4 lists the totals, grouped according to the country where the observers live, not where observations were made! For instance, most Belgian observations were collected in France. We also mention the year when the observations from the country concerned were communicated to the *IMO*. An asterisk indicates that only casual reports were received by the *IMO*.

Considerably fewer observations were obtained from Australia and Belgium in 1991. Very impressive progress is noted in the USA, where several very active observers have joined meteor efforts. Also Japan was very productive in 1991.

Table 4 – Total number of observers, number of meteors, and observing time per country.

Country	1988–1991			1991		
	Obs	N	$T_{\rm eff}$	Obs	N	$T_{\rm eff}$
Germany (1988)	55	119778	$5048^{\rm h}.03$	38	38057	$1358^{\rm h}.45$
Australia (1988)	145	57577	$2771^{\rm h}.67$	28	6750	$247^{\rm h}.79$
Belgium (1988)	117	39766	$2034^{\rm h}.89$	41	11847	$368^{\rm h}.72$
Japan (1989)	90	31708	$1954^{\rm h}.66$	63	16518	$724^{\rm h}.13$
Hungary (*)	154	27430	$1775^{\rm h}.96$	10	3539	$88^{\rm h}.29$
United States (1988)	72	25299	$1528^{\rm h}.90$	45	8108	$565^{\rm h}.27$
Spain (1988)	41	28704	$1429^{\rm h}.00$	25	10991	$404^{\rm h}.91$
United Kingdom (1988)	6	8652	$544^{\rm h}.42$	4	4112	$174^{\rm h}.23$
Malta (*)	27	6828	$476^{\rm h}.71$			
Finland (1988)	23	9337	$473^{\rm h}.64$	12	4019	$158^{\rm h}.26$
the Netherlands (1988)	13	9238	$422^{\rm h}.73$	8	4592	$220^{\rm h}.35$
Bulgaria (1990)	23	8851	$340^{\rm h}.55$	21	8384	$257^{\rm h}.28$
Italy (1988)	40	7476	$294^{\rm h}.40$	11	1469	$53^{\rm h}.04$
Norway (1988)	13	9470	$262^{\rm h}.74$	5	3126	$61^{\rm h}.10$
Croatia (1989)	23	5197	$224^{\rm h}.40$	3	1231	$61^{\rm h}.98$
Canada (1988)	8	5892	$221^{\rm h}.33$	7	3318	$89^{\rm h}.42$
France (1988)	7	2752	$212^{\rm h}.51$	3	1266	$47^{\rm h}.54$
Ukraine (*)	8	7243	$185^{\rm h}.10$	7	5157	$124^{\rm h}.44$
Yugoslavia (1990)	13	2457	$107^{\rm h}.62$	13	2090	$94^{\rm h}.74$
Rumania (1990)	3	1047	$73^{\rm h}.21$	1	779	$27^{\rm h}.46$
Brazil (*)	8	1595	$65^{\rm h}.09$			
Czechoslovakia (1989)	10	990	$58^{\rm h}.18$	8	145	$11^{\rm h}.30$
New Zealand (1988)	8	1020	$57^{\rm h}.67$	5	315	$13^{\rm h}.63$
China (1989)	8	1070	$49^{\rm h}.15$	5	608	$20^{\rm h}.71$
Bolivia (*)	6	306	$26^{\rm h}.60$			
Denmark (1991)	1	308	$26^{\rm h}.12$	1	308	$26^{\rm h}.12$
Slovenia (1990)	10	976	$23^{\rm h}.23$	10	934	$17^{\rm h}.67$
Hong Kong (*)	2	167	$10^{\rm h}.00$			
Taiwan (*)	2	343	$8^{\rm h}.00$			
Venezuela (1991)	1	61	$7^{\rm h}.41$	1	61	$7^{\rm h}.41$
Ireland (*)	1	30	$4^{\rm h}.56$			
Korea (1991)	1	35	$1^{\rm h}.43$	1	35	$1^{\rm h}.43$
Poland (1991)	1	6	$0^{\rm h}.95$	1	6	$0^{\rm h}.95$
Total	940	421609	$20720^{\rm h}.86$	377	137765	$5226^{\rm h}.62$

A surprising result is the total number of meteors reported on a global scale in these four years. For the overall majority of meteor streams, very few meteors were reported. The problems associated with identifying minor streams is reflected in these totals (Table 5). In some observers' circles, very lax methods enable the observers to associate with any meteor a member of one minor stream or another. To make matters worse, questionable lists of meteor radiants are still being used. Some observers cannot perceive a single meteor from a well-established minor stream radiant, but report meteors from radiants nobody else can detect. It should be clear that there are still a lot of unscientific beliefs involved!

For some streams where two or more components exist, some reports give no distinction between the different branches of the streams. In these cases the totals for all components should be added. For instance for the Taurids, the totals under `TAU`, `STA`, and `NTA` should be added, yielding $2074 + 2652 + 2288 = 7014$ Taurids.

Table 5 only contains those showers for which meteors were reported in 1991.

4. Conclusion

Starting with the 1992 observations, the *VMDB* has been successfully taken over by Rainer Arlt. When the *IMO* was created, the handling of large quantities of visual observations was my personal priority, a challenge which had existed for many years. Indeed, the *VMDB* has become a reality and one of the most important achievements of the *IMO*. It is a guarantee to all observers that their efforts will never be lost. All data is kept in different places on different computers and all data is printed and spread among many libraries. The chances that all the copies could be destroyed is vanishingly remote. Maintaining the *VMDB* is a very demanding job. I would like to thank Rainer for his efforts to take over this job from me. Please send all your reports to Rainer in as short a time as possible after the observation is made.

Table 5 – Total number of meteors observed per shower.

Shower	1988–1991	1991	Shower	1988–1991	1991
φ-Bootids (FBO)	39	6	Aquarids (AQU)	3413	255
α-Scorpids (ASC)	749	58	Giacobinids (GIA)	135	72
δ-Aurigids (DAU)	510	461	κ-Cygnids (KCG)	5696	1169
α-Bootids (ABO)	328	52	Perseids (PER)	114249	43966
μ-Virginids (MVI)	112	1	Orionids (ORI)	4593	540
σ-Leonids (SLE)	20	1	Phoenicids (Jul) (PHE)	196	17
Puppid/Velids (VEL)	209	30	χ-Scorpids (CSC)	30	5
Andromedids (Ann) (AND)	173	23	Coma Berenicids (COM)	1759	924
Taurids (TAU)	2074	269	Aurigids (AUR)	584	49
Ophiuchids N (NOP)	20	4	Lyrids (Jun) (JLY)	236	87
σ-Orionids (SOR)	186	84	Leo Minorids (LMI)	2	2
χ-Orionids N (ORN)	487	198	Pegasids (Jul) (JPE)	67	67
γ-Sagittarids (GSA)	11	3	χ-Orionids S (ORS)	295	123
ζ-Puppids (ZPU)	336	9	Ursids (URS)	170	63
Leonids (LEO)	1618	605	Phoenicids (Dec) (PHO)	24	5
Scorpio/Sagittarids (SAG)	145	125	Piscids S (SPI)	547	203
α-Cygnids (ACG)	1746	2	α-Carinids (ACN)	34	3
ι-Aquarids N (NIA)	655	228	δ-Aquarids S (SDA)	5472	831
α-Canis Majorids (ACM)	40	2	κ-Aquarids (KAQ)	65	25
α-Centaurids (ACE)	225	29	ε-Geminids (EGE)	404	85
δ-Aquarids (DAQ)	481	120	ε-Eridanids (EER)	56	1
Capricornids (Oct) (OCC)	53	24	δ-Cancrids (DCA)	338	90
α-Capricornids (CAP)	4921	679	Lyrids (LYR)	1591	473
o-Centaurids (OCE)	164	14	θ-Ophiuchids (TOP)	116	18
π-Eridanids (ERI)	40	14	δ-Draconids (DDR)	78	3
ω-Scorpids (OSC)	19	7	ι-Aquarids S (SIA)	1028	352
Quadrantids (QUA)	5144	440	Taurids N (NTA)	2288	667
τ-Herculids (THE)	41	9	χ-Orionids (XOR)	276	276
Geminids (GEM)	52799	32354	Piscids N (NPI)	118	8
η-Aquarids (ETA)	5117	211	o-Draconids (ODR)	340	1
α-Aurigids (AAU)	94	1	ω-Canis Majorids (OCM)	19	5
α-Monocerotids (AMO)	55	13	Piscids Austrinids (PAU)	402	44
σ-Hydrids (HYD)	1193	692	δ-Aquarids N (NDA)	3587	820
Taurids S (STA)	2652	637	λ-Sagittarids (LSA)	296	15
α-Virginids (AVB)	123	1	β-Corona Australids (CAU)	28	5
Pegasids (Nov) (PEG)	44	3	Virginids (VIR)	1053	198
θ-Centaurids (TCE)	149	5	α-Crucids (ACR)	87	31
Monocerotids (MON)	974	569	Other showers (DIV)		982
δ-Leonids (DLE)	208	21	Sporadics (SPO)	175088	47266

The 1993 IMO International Meteor Conference

Puimichel, France, September 23–26

Paul Roggemans

As of early March, 50 people from 15 countries had registered for the 1993 IMC, though some still need to confirm their participation. The limit of available places has been solved by the Puimichel staff: we still have 15 places free in some houses we can rent near the conference site. We received several requests for financial support from some participants, but for the places that are still free, we must charge a small supplement of 150 FRF for the entire *IMC* per person. This is what we must pay to the owners of the houses, which do not belong to the Observatory. People who stay from September 18 to 23 can stay at the observers' residence for the exceptional price of 150 FRF per day (normally 240 FRF), an option we strongly recommend. To save on expenses, only one circular will be mailed near the end of July containing all the final information. We will also keep you informed through *WGN*. If you have not yet made your reservations, please contact the organizer. Do not miss this opportunity to meet your friends from so many different locations!

The Blue Arcs of the Retina

Alastair McBeath

During my continuing researches into meteor colors, and human color vision in general in recent months, I have come across a phenomenon which may be of interest to nocturnal visual observers in particular. This concerns the blue arcs of the retina, which can best be noted by a simple experiment during dark-adaptation, preferably while still indoors.

The experiment requires a room which once all artificial lights are extinguished will be completely dark, a willing observer with normal color vision, and a dim red torch, such as would be used for recording visual observations outdoors at night. To see the blue arcs, turn out the room lights and switch on the red torch. Turn the torch until only a thin sliver of red light can still be seen, and look slightly away from the light. A faint bluish-white arc should flash in the field of vision when this is done.

The reasons why this occurs are not properly understood, although the shape of the arcs is very close to that of nerve fibers within the retina. Bioluminescence of these nerves has been shown by experiment to play no real part in generating the arcs, however, and no other mechanism has yet been definitely identified. A good, brief review of the topic is [1].

Reference

[1] J.D. Moreland, "On demonstrating the blue arcs phenomenon", *Vision Research* 8, 1968, pp. 99–107.

Visual Observers' Notes: May and June 1992

Jeff Wood

The months of May and June contrast greatly between the northern and the southern hemispheres. In the northern hemisphere there are few showers active and hence overall meteor rates tend to be low. In the southern hemisphere there are quite a few showers to be seen. This together with the ecliptic being high overhead ensures that good rates are seen.

Table 1 lists some of the meteor showers to be seen in May and June 1992. Table 2 shows moonlight and observing conditions. The illuminated part of the Moon is always given for 0^h UT on the date indicated. The dates of the phases of the Moon are also given in UT. Note that the activity period data for the June Bootids and the o-Cetids are uncertain.

The Visual Commission of the *IMO* although requiring data on all streams realizes practical considerations like work, study, family, Moon and weather prevent people from observing regularly on a day by day basis throughout most of the year. With this in mind, it has been decided to encourage everyone who has time to observe to concentrate on a couple of showers per month rather than the whole lot. This means we should be able to get a good set of data on these few rather than sparse data on many showers. The showers chosen for special investigation for the months of May and June are the Scorpio-Sagittarid showers, the η-Aquarids, the June Bootids, and the "Daytime" showers in Cetus and Aries.

Table 1 – A list of the meteor showers to be seen in May–June 1993.

Shower	Activity	Maximum		Radiant			Drift		V_∞	r	ZHR
		Date	$\lambda_\odot$	α	δ	Diam.	$\Delta\alpha$	$\Delta\delta$			
η-Aquarids	Apr 19–May 28	May 03	43°1	336°	−02°	4°	+0°9	+0°4	66	2.7	50
α-Scorpids	Mar 26–May 12	May 03	43°4	240°	−27°	5°	+0°9	−0°1	35	2.5	10
Ophiuchids N	Apr 25–May 31	May 10	49°7	249°	−14°	5°	+0°9	−0°1	30	2.9	
β-Corona Australids	Apr 23–May 30	May 15	54°7	284°	−40°	5°	+0°9	−0°1	45	3.1	
κ-Scorpids	May 04–May 27	May 19	58°9	267°	−39°	5°	+0°9	0°0	45	2.8	
Ophiuchids S	May 13–May 26	May 20	59°8	258°	−24°	5°	+0°9	−0°1	30	2.9	
o-Cetids	May 05–Jun 02	May 20	59°3	28°	−04°				36	3.0	
γ-Sagittarids	May 22–Jun 13	Jun 06	76°1	272°	−28°	6°	+0°9	0°0	29	2.9	
Arietids	May 22–Jul 02	Jun 07	76°7	44°	+24°	3°	+0°5	+0°4	37		
θ-Ophiuchids	Jun 04–Jul 15	Jun 13	82°4	267°	−20°	5°	+0°9	0°0	27	2.8	
Lyrids (Jun)	Jun 11–Jun 21	Jun 16	85°2	278°	+35°	5°	+0°8	0°0	31	3.0	5
Bootids (Jun)	Jun 26–Jun 30	Jun 28	96°3	219°	+49°	8°			14	3.0	2
λ-Sagittarids	Jun 05–Jul 25	Jul 01	99°6	276°	−25°	6°	+0°9	0°0	23	2.6	

Table 2 – Moonlight and observing conditions in May–June 1993.

Date	k	Date	k
Friday April 30	0.55+	Friday June 04	1.00+
Friday May 07	0.99–	Friday June 11	0.62–
Friday May 14	0.45–	Friday June 18	0.05–
Friday May 21	0.00–	Friday June 25	0.28+
Friday May 28	0.41+	Friday July 02	0.96+

New Moon:	May 21, June 20, July 19
First Quarter:	April 29, May 28, June 26
Full Moon:	May 6, June 4, July 3
Last Quarter:	May 13, June 12, July 11

1. Scorpio-Sagittarids

The Scorpio-Sagittarids encompass a number of streams that occur in the constellations of Scorpius and Sagittarius during the months of March, April, May, June and July. Named by Dr. C. Hoffmeister during the 1930s, these ecliptic streams are thought to have originated from Comet Lexell (1770 II). The Scorpio-Sagittarid showers are noted for greatly varying rates. At times, they are virtually not active while on other occasions, ZHRs of around 10 have been recorded. The Scorpio-Sagittarid showers are noted for bright colored fireballs and the occasional meteor that produces a persistent train.

As mentioned previously, the Scorpio-Sagittarids consist of a number of sub-streams. The major components whose details are described in Table 1 are the α-Scorpids, Northern and Southern Ophiuchids, β-Corona Australids, κ-Scorpids, γ-Sagittarids, θ-Ophiuchids, and λ-Sagittarids. Since Scorpio-Sagittarid meteors have velocities similar to those of the majority of sporadic meteors, great care needs to be taken in identifying them. Observers should be facing the radiant area and plot all meteors seen.

2. η-Aquarids

This fine shower is active from April 19 through to May 28 and reaches a maximum ZHR of 50 to 60 meteors per hour on May 3. The η-Aquarids have an unusual activity curve with ZHRs remaining above 35 from about May 3 to May 10. In some years, this period is even greater such as in 1980 when it extended from May 2 to May 15. Another unusual feature of the η-Aquarids is a second maximum on May 8 which has been detected on at least five occasions in the last 12 years. Studies by Sekanina in the USA during the 1960s and 70s involving radio meteors showed that the η-Aquarids consisted of two sub-streams, the "proper" η-Aquarids which reached maximum around May 5 and the so-called Halleyids, which reached maximum on May 8. Since the radiants are very close together, it is impossible to visually separate meteors belonging to these sub-streams, and so naked-eye results show their combined activity.

The η-Aquarids, which where produced by debris from Halley's Comet, are a very spectacular stream especially for southern hemisphere observers. Unfortunately, because the radiant reaches culmination during daylight hours, the η-Aquarids cannot be viewed in all their glory. Although the radiant is equatorial with a declination of $-2°$, the seasons are such that is daylight in much of the northern hemisphere before the radiant can rise more than $20°$ above the horizon. The southern hemisphere is more favorably placed, and the radiant is able to rise above $50°$ before sunrise.

The η-Aquarids are best viewed the last couple of hours before sunrise, approximately 3^h45^m to 5^h45^m am local time. They are characteristically fast, yellow in color, and have a train. It is not unusual for these trains to be very persistent, lasting more than 30 seconds. The η-Aquarids produce many brilliant fireballs, the best on record being a magnitude -9 green meteor seen during their 1980 display. This meteor also had a yellow-green train that lasted for some 5 minutes after the meteor itself disappeared from view.

In 1993, the maximum of the η-Aquarids is heavily affected by the Moon. Observers are encouraged to observe this shower pre and post maximum.

3. Daytime showers

Since the southern hemisphere is approaching the winter solstice, the long night mean that the radiants of several of the major daytime streams can rise substantially above the horizon before daylight. The two best candidates for viewing are the May o-Cetids and the June Arietids. Past observations of these streams indicate that during the last hour of darkness before dawn visual rates can rise up to 5 meteors per hour. Both the o-Cetids and the Arietids produce fast blue-white colored meteors which often have a train. Intending observers should look as close to the radiant area as possible and plot all possible shower meteors seen.

4. Theoretical radiant of comet 1983 VII

The orbit of the long-period comet 1983 VII approaches the Earth at a minimum distance of 0.003 AU on May 12, yielding a theoretical radiant at $\alpha = 289°$ and $\delta = +44°$ with $V_\infty = 45.4$ km/s. This radiant is well situated for observers in the northern hemisphere. The geocentric velocity as well as the very close approach of the Comet's orbit leave a chance that there will be a detectable shower.

The actual radiant position may differ somewhat from the predicted one. To determine it, plot all meteors possibly radiating from an area of about 15° radius around the predicted radiant, fill out a list as for the Aquarid project [1] and send it to the Visual Commission. Using *PosDat* and *Radiant*, it will be investigated whether there is a radiant and where.

For plotting, the *Gnomonic Atlas Brno 2000.0* is recommended. The field of view should be centered at a distance of about 10° to 30° from the predicted radiant. For observations the time from around May 10 until May 20 is recommended.

5. June Bootids

The June Bootids were produced by the debris of Comet Pons-Winnecke (1915 III) and appeared as a new shower in 1916. For several years they produced high ZHRs of up to 100, but in recent years the shower has mostly been absent, though on rare occasions low rates of 1–2 meteors per hour have been recorded. The last of these were in the late 1960s and early 1970s.

The June Bootids are expected to be active around June 28. They have a visual radiant diameter of approximately 8° and are extremely slow-moving. Although there are some bright meteors, observations of the shower indicate that it is unusually rich in fainter members.

In 1993, there is little interference from the Moon. Observers should begin the watch from June 24 and continue until June 30. All meteors seen should be plotted and great care taken to identify possible shower members.

References

[1] R. Koschack, J. Rendtel, "Aquarid Project 1989", *WGN* 17:3, 1989, pp. 90–92.

Telescopic Observers' Notes: May and June 1993

Malcolm J. Currie

For many, twilight becomes a major restriction on the length and quality of their observations. Public examinations also restrict the number of watches made, and so our knowledge of telescopic activity at this time of year is scant.

Moonlight interferes with the η-Aquarids, so the most prominent and favorable telescopic shower of the period is the *θ-Herculids* of late May. You will not find this shower in the *IMO* list yet. It was first noticed telescopically by Mark Vints during a sporadic watch in 1990, and subsequently observed by myself in 1992. The shower was known to the *Nippon Meteor Society*, who had recorded it by radio and by some visual observers, and had found an association with Comet IRAS-Araki-Alcock.

Following my request for additional data in these notes a year ago, Ralf Koschack kindly provided an analysis from his visual data for May 29-30, 1992. During a $1^{\rm h}82$ watch under excellent skies (limiting magnitude of 7.2), Ralf recorded six possible θ-Herculids. Five of these had an average magnitude of 5.7, the other was of magnitude −1. This supports my suggestion that this shower is rich in faint meteors, and so is best observed by radio or telescopic means. Ralf was also able to estimate the heliocentric velocity as (40 ± 10) km/s from his angular-speed estimates.

We know that the shower has a compact radiant of about 1° in diameter near maximum, and can give telescopic rates similar to the sporadic background. What we do not know is its duration, radiant motion, and size through the activity period, and population index. Also the fact that radiant positions seen by Mark Vints and myself were displaced by 5°, although $\Delta\lambda_\odot$ was only $0\overset{\circ}{.}5$, needs explanation. Thus I would urge telescopic observers to go out any clear night between May 25 and June 2 and collect more data for this shower. The radiant is approximately at $\alpha = 270°$ and $\delta = +37°$. Choose at least two field centers about 10°–20° from the radiant such that when traced back the meteor paths intersect at greater than 45°, and ideally at right angles. Alternate regularly between the fields. The first-quarter Moon sets around midnight at the shower maximum, which also occurs at a weekend.

This time of year is best known for weak activity from ecliptic complexes stretching from Libra through Ophiuchus to Sagittarius. Most have a high proportion of faint meteors—rates over half the sporadic background are possible; and they all have moderate speed making them amenable to telescopic study. It is important to plot the paths and estimate the angular speed of the meteors as carefully as possible so we can separate the various components, even with low numbers of meteors. The southern declinations of these showers strongly favors observers south of 30° N. I suggest that observers select at least three field centers about 20° north or south of the ecliptic (the latter is only for those in the southern hemisphere) separated by 15°–25°; the right ascensions of the fields should be chosen to span those of the activity centers, moving eastward with the calendar in order to follow the activity. See the *1993 Meteor Shower Calendar* for details of the various radiants and their motions. This arrangement simultaneously permits us to discriminate the real radiants from the artifacts, and to find "new" minor showers with radiants away from the ecliptic.

From Britain, the *Ophiuchids* give *observed* rates up to a third of the sporadic background during May. For Australasian and South American observers where the radiant attains a high elevation, this shower could well produce rates higher than the sporadic background. Therefore in telescopic terms this is a major shower, and warrants detailed study. Moving into June, the ecliptic radiants are in Scorpius and Sagittarius. There are few telescopic data on *Scorpio-Sagittarid* showers. Once again there is ample opportunity for rewarding observations for those fortunate to reside south of the equator. One obvious aim is to delineate the various constituent branches and to determine their activity periods. Only careful plotting enables this to be achieved, because of the proximity of the sub-centers.

There are two showers that have waned from earlier prominence, but are worth being alert for. In mid-June, the *Lyrids* are something of an enigma. Discovered in 1966 and well observed by the *British Astronomical Association* in 1969, but since the mid-1970s there have been few Lyrid meteors seen. The reason for this is unknown, but it may be because the shower is strongly clumped and is only seen for a few years periodically—something like the Leonids, but much weaker. Given the absence of moonlight it is worth checking for Lyrid meteors, particularly during June 15–16. If you suspect activity, please change field centers from the ecliptic region to near the Lyrid radiant. So have a few suitable charts prepared. Although the Moon will interfere, in late June look out for weak activity of the *June Bootids*. Perturbations of the Pons-Winnecke stream by Jupiter has resulted in the Earth only intersecting the stream's periphery. However, the shower is rich in faint meteors.

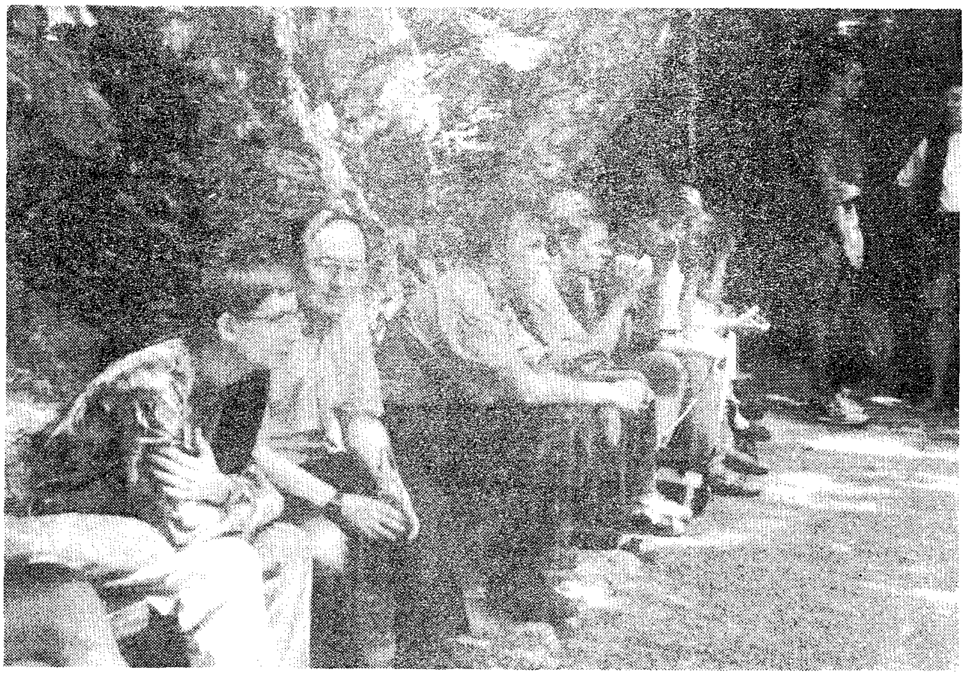

Figure 1 – Waiting to enter the Driny Cave during the excursion at the last *IMC*. From left to right, we can distinguish Rainer Arlt, Marc Gyssens, Mirko Nitschke, Sirko Molau, and Bernhard Koch. In the background we see Marc de Lignie talking to Paul Roggemans.

Ongoing Meteor Work

The Makings of Meteor Astronomy: Part III

Martin Beech, University of Western Ontario

From the Classical era to the late 18th century, a time span of nearly 2000 years, the predominant idea concerning the origin of the shooting stars and fireballs was that outlined by Aristotle in his *Meteorologica*.

1. Meteorologica: Aristotle's master plan

As we explained last time, Aristotle outlined his plans on the origins of the various transient phenomena, both terrestrial and atmospheric, in his *Meteorologica*. Aristotle reasoned in the *Meteorologica*, which was written circa 357 B.C., that objects such as shooting stars must occur in the upper atmosphere, and below the first celestial sphere.

Aristotle argued that the heat from the Sun produced exhalations, or vapors from the Earth's surface. These exhalations, Aristotle further reasoned, had an innate tendency to find their place, or sphere, in the sublunary region (i.e., in the region below the first celestial sphere occupied by the Moon) according to their hot/cold, dry/moist "qualities." The hot and dry exhalations were attributed with a tendency to rise to the very top of the atmosphere, while the cold and moist exhalations had a tendency that kept them nearer the ground.

Having outlined the idea that the Earth produced different kinds of vapors, and that these vapors had a tendency to become stratified in the atmosphere according to their "qualities," Aristotle was able to "explain" all the transient, or corruptible, phenomena. Aristotle's *Meteorologica* is essentially a compendium of the various meteorological phenomena, i.e., rain, wind, snow, earth-quakes, shooting stars, lightning, etc, and their causative vapors.

The vapors that produced the shooting stars were considered by Aristotle to be the hottest and driest of vapors. Their tendency, he argued, was that they should rise to the very top of the atmosphere. Having gathered in the upper regions, meteors (used in the modern sense of the word) were occasionally produced by the ignition of small pockets of vapor. Interestingly, Aristotle reasoned that there were several different types of meteors, the various meteors being classified according to their appearance and according to the disposition and quantity of vapor involved in the ignition. Aristotle believed that there were three meteor groups. The important difference between each meteor group was the manner in which the ignition proceeded. Aristotle explained [1]:

> *Now when the inflammable material is longer than it is broad it sometimes throws off sparks as it burns. These are called goats* (caprae). *When no sparks are given off it is called a torch* (faces). *But if the whole length of the exhalation is scattered in small parts and in many directions and in breadth and depth alike, we see what are called shooting stars* (stellae trajicentes).

In modern terms we would probably call Aristotle's "torches" either bright sporadic, or bright shower meteors. Aristotle's "goats" would correspond to fragmenting fireballs, while "shooting stars" retain their ancient form.

Why Aristotle used the term "goat" for bright fragmenting meteors is not clear. The word "capra" has the same origin as capricious, which is typically taken to mean something that leaps around erratically (like a goat). Perhaps Aristotle used the term in an attempt to convey something of the unpredictable nature of bright fireballs.

2. The strangle hold

While many attempts were made, no Classical school of thought was able to squash the Aristotilean doctrine of meteor origins. No doubt many reasons can be found for this, but probably the most important one was that no one really cared: shooting stars were lesser night time phenomena, and Aristotle's ideas were compelling.

When Seneca (3 B.C.–65 A.D.) discussed the shooting stars in his monumental *Naturales Quaestiones* [2], he deviated only slightly from Aristotle. Interestingly, he first chides Aristotle in his use of the term "goat" for fragmenting fireballs. Seneca writes that if an explanation for the term "goat" is required then some one should *first explain to me why some meteors are not called "kids."* Clearly Seneca can find no meaning in Aristotle's terminology. Seneca continues, however, that

> *fires of this sort come into existence because the atmosphere undergoes severe friction when there has been a tilting of it to one side and there is no yielding, only struggle. From this vexation are produced fiery shapes, the so-called Boards, Balls, Torches, and Blazes. When the air is more lightly shocked and has less friction, so to speak, smaller streams of light are discharged, and the flying stars trail their tresses.*

Writing more than a thousand years after Aristotle's death, the Arab astronomer/philosopher Jabir ibn Hayyan (721 A.D.–813 A.D.) explained that the shooting stars were produced by the ignition of air which had risen into the atmosphere upon being heated by the Sun [3]. Clearly Aristotle's influence still held strong at this time. In spite of their many other astronomical interests, it appears that the Arabic astronomers were not overly concerned with the study of shooting stars. There was some interest, however, in recording the appearance of meteor storms and bright fireballs. This interest followed upon the belief that the birth and the first revelation of the Prophet Mohammed were presaged by spectacular meteor showers [3].

The Aristotilean strangle hold on matters meteorological held throughout the Middle Ages. In Europe, however, Aristotle's writings had been woven into, or corrupted to agree with, religious doctrine. In this way the "scientific" explanations of Aristotle were made consistent with biblical and ecclesiastical teachings. In his lecture series concerning the events of Genesis, Henry of Langenstein (circa 1325–1397) presented an unabridged account of Aristotle's meteorological theory [4]. Meteorology, as defined by Henry, was that subject which dealt with the movement of elements from one sphere to another and the phenomena that resulted as a consequence of that movement. Since meteorology was the subject of Henry's lecture concerning the third day of creation, we note the amusing (in modern terms) consequence that God created the potential for shooting stars before he created the actual stars, which were the work of his fourth day.

3. The grip weakens

The first signs that Aristotle's hold on ideas concerning shooting stars might be weakening can be found from the thirteenth century onwards. The change is a subtle one, however, and while the idea that shooting stars were produced by ignited vapors still held, the possibility of finding meteoric residue was raised for the first time. The vapors were no longer considered to burn simply as fire, but were reasoned to burn and transmute the elements involved in the combustion. Explicit reference is given to this phenomena by William Caxton, for example, in his encyclopedia *The Mirror of the World*, which was published in 1480. Caxton notes that if one can locate the ground path of a shooting star then it is possible to find either an ash or gelatinous residue along its length [5,6]. We shall pick up on this theme again next time.

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No Evidence of Change in Ionospherical Radio Emission at 1.25–10.6 KHz during and after Meteor Flight

Željko Andreić, Lučano Beg, and Korado Korlević

On December 13, 1992, a team of Croat observers tried to determine whether or not meteors cause ionospheric radio emission at very low frequencies. No evidence for such a correlation was found.

1. Introduction

On the night of October 23, 1992, during observations of the Orionid meteor shower, we tried to see if evidence of radio emission at very low frequencies exists [1]. The working group had five persons, four of them observing visually and one observing the needle of the chart recorder and writing on the chart the data of the visual observations. Our first radio observation was meaningless due to strong interference by nearby thunderstorms (distances from 40 to 100 km) and the instability of the receiving equipment. After that observation, the electronic equipment was rebuilt, and we started new observations on the night of December 11. The activity of Geminids was low, and we saw that the observing site was to close to an inhabited area causing strong radio noise. Finally, on the night of December 13, 1992, everything was set to see whether meteors emit VLF radio waves.

2. Radio receiving and recording system

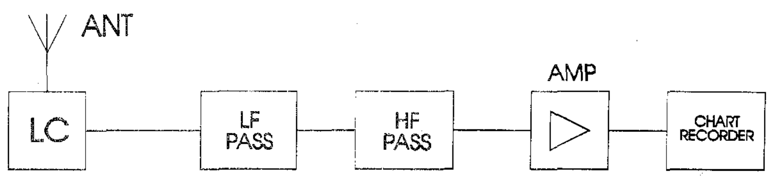

Figure 1 – Block scheme of the receiving equipment.

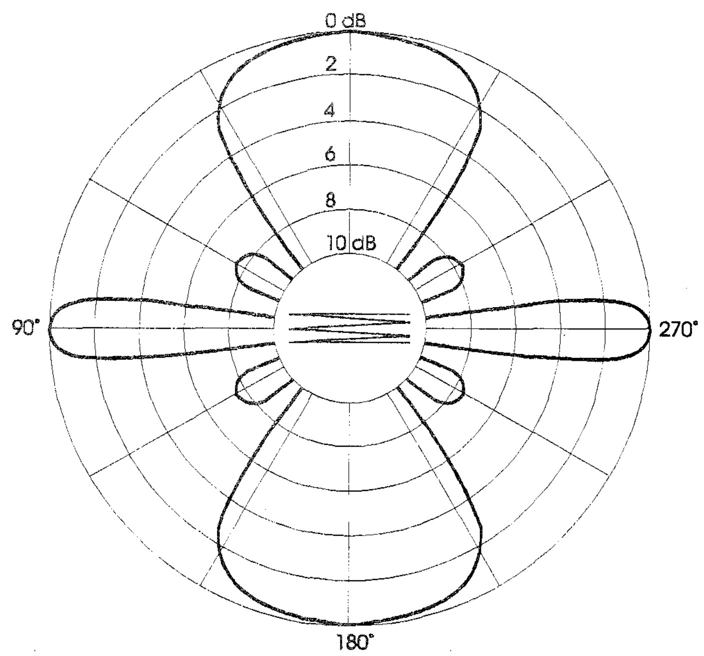

Figure 2 – Antenna sensitivity diagram.

The antenna of our receiving system was a loop antenna measuring 1×1 meter on a wooden frame made of 800 m (200 windings) of 0.5 mm insulated wire. The antenna was tuned with a capacitor to a resonance frequency of 10 KHz.

The antenna was placed 60 cm above the ground and parallel to it. The frequency response of the receiver was controlled by two filters cutting the frequencies lower than 1.25 KHz and higher than 10.6 KHz.

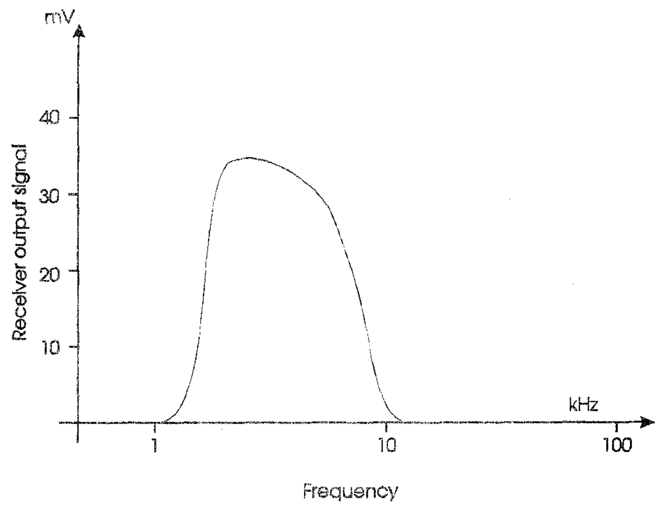

Figure 3 – Frequency response of the antenna-receiver combination at input signal 2 mV.

The signal from the antenna was amplified and transmitted to a Hewlett-Packard model 17503 A, 7127 A chart recorder, which has a sensitivity of 2 mV full scale, which is 0.9 mV in the middle of the observed spectra.

3. Visual observations

The observations during the night of December 13, 1993, were made at an isolated location two kilometers from the nearest village and three kilometers from the nearest street light.

The conditions for visual observations were fairly good taking into account the presence of moonlight. The limiting magnitude was 5.1 during the observing period (20^h15^m to 21^h45^m UT), for all four visual observers. During the observation, no distinction between Geminids and sporadics was made.

The magnitude distribution of the observed meteors was as shown in Table 1.

Table 1 – Magnitude distribution of the observed meteors.

Magnitude	−3	−2	−1	0	+1	+2	+3	+4	+5	Tot
Number	4	5	2	3.5	12.5	13	14.5	3.5	0.5	59

The combined HR for all observers and all meteors seen was 134 ± 18. Note that we recorded many very bright meteors, at all zenith distances.

4. Radio observations

The ionospheric emissions during the period from 20^h15^m to 21^h45^m UT on December 13, 1993, were very stable with slow changes in intensity. No thunderstorm and no uncontrollable noise were present. The only sources of noise were an electric blanket and walkman loudspeakers that one of observers started to hear, but these were immediately switched off.

Not one visual sighting was followed by a simultaneous increase of ionospheric activity. In the previous observations, we suspected to have some postponed radio emission, but no such delayed emission was observed this time. During the observing period, the intensity of ionospheric emission fluctuated noticeably but with no evident correlation of cumulative increase after some clusters of meteors.

5. Conclusion

The unsuccessful search for suspected emission in very favorable conditions indicates to us that no correlation exists between the flight of a meteor and ionospheric emission at frequencies and sensitivity levels that we monitored. If radio emission at very low frequencies exists during and after meteor flight in the ionosphere, the intensity of such event is below the sensitivity of our equipment (0.9 mV) or is masked by ionospheric noise, or the maximum of the emitted energy is situated at different frequencies than the ones we monitored [2].

References

[1] G.J. Drobnock, "Radio Waves from a Meteor?", *Sky* 83, March 1992, pp. 329–330.

[2] Giorgio Bressan, "Perseidi nelle onde radio", *l'Astronomia* 128, January 1993. p. 3 *(in Italian).*

Comment by the Editor: Over the last year, Peter Brown has been doing similar work together with Jim Jones and Martin Beach. The following is his comment on the above article: The maximum gain for a loop antenna (which is essentially an inductor) is in the *plane* of the loop. In the previous paper, the authors oriented the loop parallel to the ground and thus there is little chance they would have any appreciable gain in the direction of visible meteors except those that occur near the horizon, in which case any VLF signal must travel much further than meteors occurring higher up in the sky. In addition, if the system is working near the threshold of the natural ionospheric noise there should be many obvious signals from whistlers; it is not clear if the authors did detect such signals. Additionally, the mechanism which might lead to VLF emission in meteors is not at all understood—it is possible that only a small number of meteors are involved. Therefore it would seem that many nights of observing would be required to place any meaningful limit on the VLF emissions.

Interview Series

Dr. I. Hasegawa

Jürgen Rendtel

The purpose of this series of interviews made with distinguished meteor astronomers is to give another perspective on the work undertaken by professional meteor workers and provide a more personal contact between professional and amateur meteor workers. This interview was conducted on July 6, 1992, at Smolenice, Slovakia, after the *International Meteor Conference*. Dr. Hasegawa is associated with the *Nippon Meteor Society (NMS)*. His current reasearch interests include historical records of meteoric events.

Question: Where were you born and educated? Did you go to a special school and have you always been particularly interested in astronomy?

Answer: I was born on January 23, 1928, in Nishinomiya, situated between Osaka and Kobe. I had some difficulties with my health after the Second World War and so could not enter the university. After recovering my health, I was trained at the Astronomy Department of the Kyoto University. I became an assistant there. I started calculating for Dr. Joa Ueta, after whom an asteroid has been named. I made many reductions of occultations of stars by the Moon. I also dealt with predictions of occultations of stars by the Moon, as well as by planets. I calculated the occultation of two stars by Jupiter in 1952 and analyzed the observations.

Q: What were your first steps toward meteor work?

A: As for meteors, I observed the Geminids in 1943. At that time I was at a middle school, during the war. After the end of the war I became a teacher at a middle school, and so I taught my pupils how to observe meteors.

Q: You mention the Geminid observations in 1943. Was it your own idea to go out and observe this shower, or was there someone who initiated this interest or was it part of a program?

A: I became a member of the *Oriental Astronomical Society (OAA)* when I was 12 years old. I was told how to observe meteors by Mr. K. Komaki, who was the first President of the *Nippon Meteor Society (NMS)*. He was my teacher for meteor observing. Only later did I become the assistant of Professor Ueta and then I made the reductions of occultations. At this time I also calculated the orbit of comets. The first cometary orbit I determined was the orbit of Comet 1953 *a*. At this time I started a correspondence with Dr. Ľubor Kresák from Bratislava, Slovakia, and we became friends. He visited Japan in 1979. I also met him several times at IAU General Assemblies. In 1976, I received a Doctor of Sciences degree from the University of Kyoto.

Q: What was the topic of your thesis?

A: Its title was "The Distribution of Aphelion Points of Long-Period Comets." It was published in the *Publications of the Astronomical Society of Japan*.

Q: How did you become interested in the history of meteors? What attracted your attention to the old records of meteor showers?

A: About 40 years ago, Mr. Susumo Himoto showed me his notes on Chinese records of meteor showers. It was my first encounter with the field of the history of the sciences.

Q: Have you yourself searched in old documents and archives for notes concerning certain showers?

A: At first, Mr. Himoto translated the original texts into the Japanese language, and published an archive. He edited an encyclopedia about the history of China.

Q: From which countries did you get the most old records of meteor observations?

A: First of all from China, but also from Japan and Korea.

Q: How is it possible for you to study these old notes which are perhaps more than thousand years old and written with characters not in use any more?

A: In these records the same kind of Chinese characters are used which are used in Japan now. So I can understand the meaning of the old records which are written with old Chinese characters.

Q: Is it not difficult to determine the exact date of an event described in such an old record?

A: There was an exact calendar in use. The date is mentioned in these sources precisely.

Q: Do the given descriptions allow further conclusions, for instance to which shower meteors of a reported event could belong? Is there any information about the direction of the "falling stars" mentioned in old records, which were not meant explicitly to be part of the scientific note for the event?

A: The people described the direction of the meteors they had seen. For example, it is written that meteors flew from north to south. Therefore we may identify meteor streams according to the solar longitude of the observation. This is the only criterion for the identification of a meteor stream in the ancient records.

Q: How many people deal with such historical investigations concerning meteors? Are there students working with you on this topic?

A: For younger people in Japan it is rather difficult to understand the old Chinese characters. I was taught to read the old Chinese literature during my middle school activities. Unfortunately they did not teach us the English language. At that time English was the language of the enemy.

Q: Do you expect some other sources still to be discovered, or are all major archives already known?

A: About 3 or 4 years ago, Peking Observatory compiled and published the most complete ancient historical records of astronomical phenomena. And there were some more records found in China. Dr. Shaucung compiled the local records in 1966. I suppose there are no other unknown records in China. In Japan, about 50 years ago, the astronomical records from Japan were corrected and published. Records from before 1600 had to be re-dated and corrected. Findings from "modern historic records," i.e., from the period after 1600, are not yet published.

Q: Did you try to find confirmation of certain meteor showers from sources found in other parts of the world, perhaps from Arabic or European sources?

A: I was able to use the "Cometographia" compiled by Hevelius of Poland and Pingré of France. Recently also Italian and other European sources were published by Dall'Olmo. But I do not have Arabic records yet. I asked Dr. Babadzhanov of Dushanbe in Tadjikistan to find and translate Arabic records into the English language. I have already compared many of the comet and meteor records made in Europe and China as well as in Korea and Japan. I compared catalogs of naked-eye comets using the above mentioned "Cometographia" and other oriental records. The work on a catalog of meteor showers has just been finished. Probably it will be published in the Proceedings of the Symposium held here in Smolenice this week. Now we undertake an analysis of records of individual meteors. We have at hand about 6000 notes regarding individual meteors observed in China and Japan. Some of these are fainter meteors, but mainly they are bright and can be regarded as fireballs. Often there are also sound phenomena described. But it is very difficult for us to determine precise data like radiant points.

Q: Is there a particular meteor shower which can be traced back in history for a very long period with some certainty?

A: The most obvious shower we can find a long activity time for is the Lyrids in April. I think it is very old, and we detect signs of it in the oldest records in the world.

Q: You already mentioned that you worked together with Ľubor Kresák on comets. Did you closely work together with other scientists?

A: I did research work together with Dr. Sitarski of Poland. There were also close contacts with Dr. Marsden. Mr. Syuichi Nakano was one of my students. Actually I do not have students on astronomy, but there are many friends, amateur astronomers in Japan, who are active in the field of meteor astronomy as well as in the field of cometary observations. I have written some books about comets as well. The main part of these texts deals with the determination of cometary orbits. These books are written in the Japanese language.

Q: When you started your work including the calculation of orbits, there were no computers available...

A: The work was done on paper, with the help of 7-digit-logarithms and hand-driven calculating machines. I was witness to all the steps of the development of computer techniques. About 30 years ago, computers were imported to Japan from America. I was very busy in the field of developing software. I taught programming techniques to young people. I always regarded teaching as a very important component of my work once I decided to work in astronomy, mainly on comets. So meteor work is not my main field. The amount of work on comets is larger and more difficult than meteor work, I think.

Q: In the beginning you mentioned being a member of the OAA *society. How did the* Nippon Meteor Society (NMS) *develop?*

A: The *NMS* is one section of the *OAA*. Today, there are about 300 members. Of these there are some 50 active observers. Visual and photographic observations are very popular among these observers. But there are also many people dealing with radio work.

Q: Could you please tell us a little about your future plans? Perhaps you have some new ideas from colleagues you met here in Smolenice?

A: I certainly will continue the survey of the 6000 individual meteor records of China and Japan mentioned earlier. And I wish to find short period comets in the old records. I have calculated some orbits of comets using older records of cometary observations made in China, Korea and Japan. These orbital elements are also included in Marsden's "Catalogue of Cometary Orbits."

Q: How can you find the positions of comets from the descriptions given in old records? How did the ancient observers give the positions of comets?

A: The Chinese astronomers had many small constellations. So I can derive the position of comets between these constellations. Sometimes they measured the positions of comets between stars in some astronomical coordinate system which is quite similar to the equatorial coordinate system we use today. Since there are a lot of records, it allows the identification of comets from these sources.

Q: Some years ago, Halley's Comet was very popular. It can be traced back for several centuries. Is there another comet which also can be followed over such a long period?

A: I hope to find Comet P/Encke, which is currently a short-period comet, over a very long time interval in the ancient records. It must have been a much brighter comet in the past. P/Encke is the most promising object to trace in old records, although its period is very short. But it re-occurs rather often. Dr. Sitarski predicted the perihelion times of P/Encke for some hundred years back. The perturbations which change the orbit of a comet must be considered when following a comet over long periods of time, like some thousand years.

Q: Which was the most surprising astronomical event, the most impressive astronomical phenomenon, you observed during your life?

A: This is a difficult question. One of the most impressive events I saw, was the great shower of the Draconids in 1985. And comet Bennett in 1970 was one of the brightest comets of this century, I suppose. The first comet I observed was Comet Cunningham in 1940.

Fireballs and Meteorites

Exploding Fireball over the Emilia Region Italy, January 19, 1993, $0^h33^m20^s$ UT

Korado Korlević

In [1], a preliminary account was given on a fireball event that took place over Northern Italy and Istria (Croatia) in the early morning hours of January 19. Much of the initial information concerning this event proved to be inaccurate. A correct account of what happened is given here.

On the night of January 18-19, 1993, at $0^h33^m20^s \pm 15^s$ UT, many people from Northern Italy, Switzerland, Slovenia and Croatia witnessed a very bright flash in the sky. The intensity of the flash was so great that 160 km from the epicenter it was possible to see the flash through the holes in the Venetian wooden windows, while reading a book near a the light bulb. At 700 km distance at Ondřejov Observatory, the flash was also seen in the south-southwest. Some eyewitnesses saw the fireball entering the atmosphere over the Adriatic sea from an azimuth of $310° \pm 15°$ (SE-NW), with an inclination lower than 20°, crossing the Italian region of Marche, and exploding very deep in the atmosphere over the Italian region of Emilia, between the cities of Bologna, Faenza, and Lugo. The possible errors for the parameters of flight are large because it was very difficult to find the azimuth and inclination of the flight from the confusion among eyewitnesses' data.

During the flight, the fireball resembled a burning sphere with a very short flame for a tail and a much wider trail. The magnitude during the first part of the flight was at least −13. The brightness then increased, leading to the terminal flash. All eyewitnesses agree that suddenly the fireball then became so bright that it illuminated a large portion of Northern Italy as during daytime. During the flash, the light intensity varied but had two distinct peaks. The color was arc-lamp blue and on the end orange, red, and green. The duration of the flash was at least one second, but the majority of the eyewitnesses mentioned 1.5 s or even several seconds. Because the flash occurred near a cloud layer, the latter was intensely illuminated, and distant observers described the effect as baffles or horizontal jets.

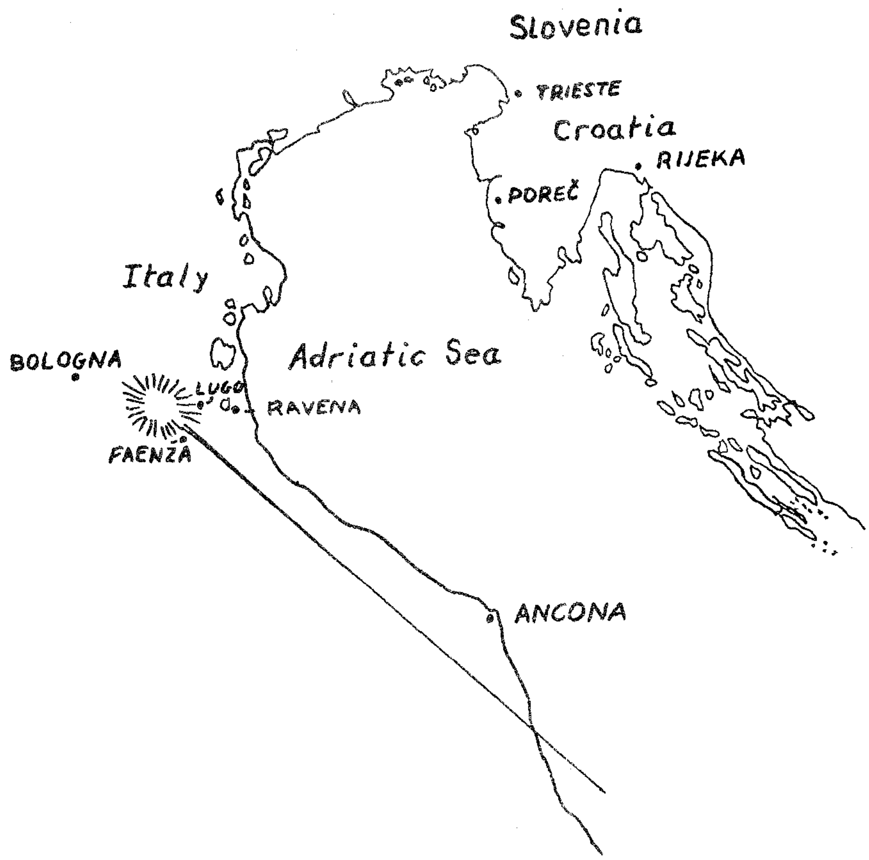

Figure 1 – Trajectory of the fireball.

Some 80 seconds after the flash in the region of Emilia a low frequency roaring, like thunder, was heard. The sound was very deep and strong. For twenty seconds the windows, and in the city of Faenza also the walls, vibrated. From non-official data, a change in intensity of the Earth's magnetic field was recorded in central Italy from 0^h56^m to 1^h00^m UT.

By misfortune, the direction of flight of the body was out of the region that is monitored by the European Fireball Network.

By pure coincidence, at the same time in the village of Kosinozici, on the Istrian peninsula near the city of Poreč, one house was set on fire for reasons that had nothing to do with the fireball. Some eyewitnesses connected the flash in the sky to the beginning of the fire, and from that coincidence a newspaper and TV story resulted that connected the fireball to the burning house.

From the descriptions of 20 eyewitnesses, by measuring azimuths and altitudes from the sites from which the fireball was seen, by the observed luminosity of the flash compared to the nearby bed light, and by connecting the data to fireballs seen in the past, it is possible to reconstruct the event [2,3]:

From the data it appears that a meteoroid composed of silicates (group I) of mass greater than 50 tons entered the Earth's atmosphere with velocity greater than 20 km/s. Penetrating deeply into the atmosphere, the aerodynamic pressure on the front part of the body increased. At a height of 20–25 km the pressure on the surface reached the breaking strength of the body. The mass started to break and crumble. The particles produced during this crumbling in the front part of the body diverged by pressure from the air and were pushed towards the rear of the body. Such small particles have no chance of surviving at that velocity so deep in the atmosphere. The last part of the event ended in some hundredths of a second, and in the place of the advancing bolide was a shining globe of plasma.

Most of the kinetic energy was transformed into light, possibly in the order of kilotons. At peak luminosity, the globe irradiated from 1 to 5×10^{13} W. Because of the great height and the rarefied atmosphere found there, the shock wave produced was in part reflected and refracted in the denser part of the atmosphere. Below, in the region of Emilia, the shock wave arrived as a deep roaring and was heard for twenty seconds, shaking windows and house walls.

The event is very remarkable [4], and it is a pity that for such a bright event occurring over a densely inhabited region so little precise information exists [5]. Though the data presented here are the best available as of yet, the error margins are very wide. Among the relatively few documented cases of collisions with bodies of such a great mass, this is one more event in which the body of the group I meteoroid was completely destroyed by aerodynamic pressure. This event is one more confirmation that during the Earth's collision with a small body which retains a high velocity deep into the atmosphere, the body is destroyed, leaving no geological consequences [2,3].

At present, the search for possible downfall of condensed meteoritic material from the plasma globe in the order of micrometers is in progress in the region of the epicenter [6]. The possibility of obtaining more detailed data exists if some of the satellites used for early warning of missile attacks, and having infrared radiometers, registered the emitted infrared radiation of the fireball [7].

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[5] Ceplecha Z., "Meteors Depend on Meteoroids", *Proceedings of the International Meteor Conference*, Violau, Germany, 1990, pp. 13-21.

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[7] Jacchia L.G., "A Meteorite that Missed the Earth", *Sky and Telescope* 48:1, July 1974, pp. 4–9.

Errata

compiled by Marc Gyssens

- In "Perseid Meteor Activity in 1992" by Dr. Milos Šimek, *WGN* 21:1, February 1993, pp 13–18, three confusing errors were not timely detected. On p. 14, 3rd but last line, the solar longitude should read as 138°70 rather than 139°70. Similarly, on p. 17, the solar longitudes on the 3rd and 4th but last lines of Section 3 should read as 138°7 and 138°8 rather than 139°7 and 139°8, respectively.
- In "Meteor Observations in New Zealand: 1991 and 1992" by Graham Wolf, *WGN* 20:6, December 1992, pp. 251–252, it was stated on p. 252 by the author that New Zealand radar meteor researcher Professor Ellyett's first name was "Bill." It should have read instead "Cliff." This arose from faulty information from an New Zealand colleague of the author. An apology is extended to Professor Ellyett for this error.

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