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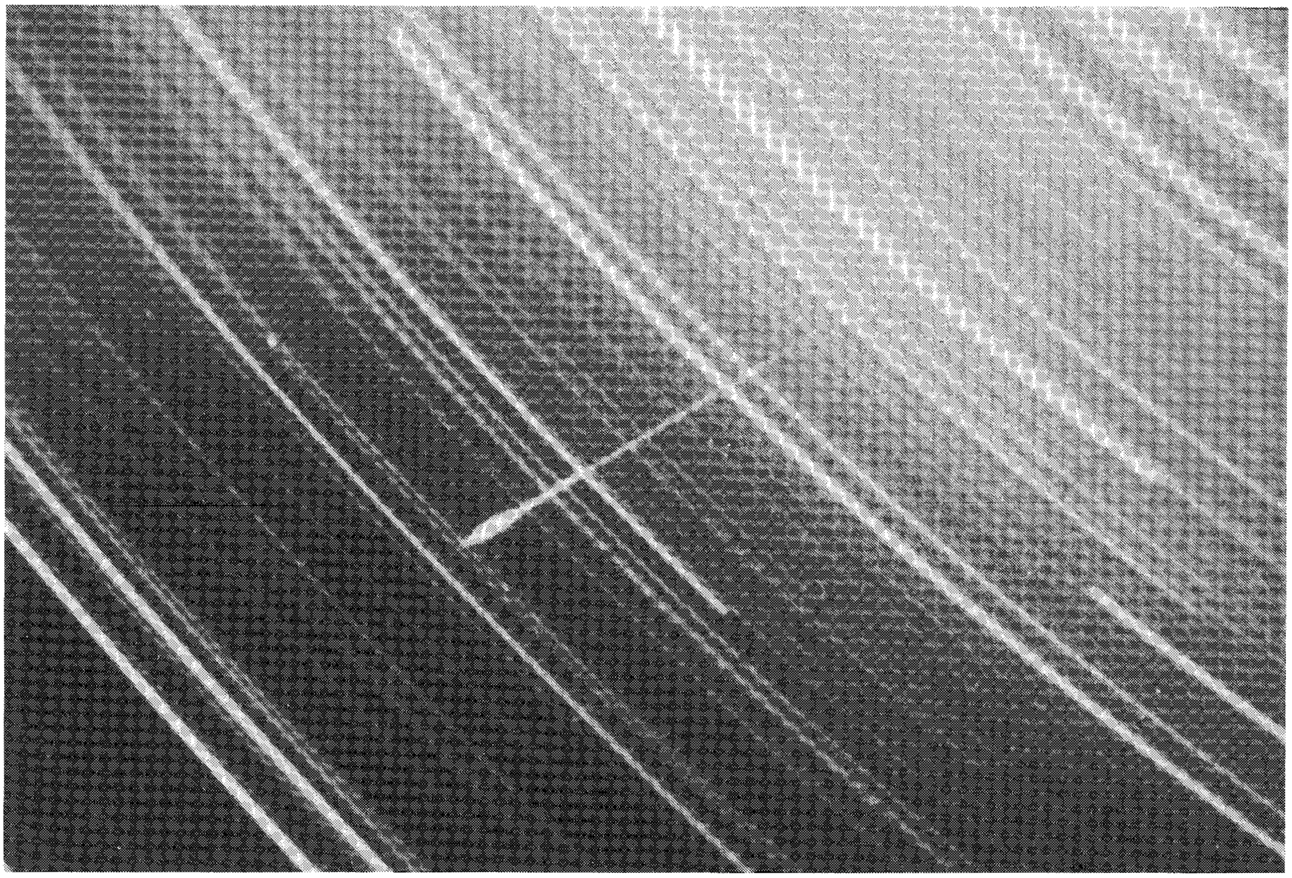
bimonthly journal of the international meteor organization



This −4 to −5 Perseid was photographed by José María Trigo Rodríguez on August 11–12, 1988, at Pico Peñarroya Valdelinares, Teruel, Spain. The photograph was exposed from 00^h08^m until 02^h45^m UT with a 24 mm $f/2.8$ Vivitar lens on a Praktica Super TL 1000 camera.

In case of non-delivery, return postage guaranteed. Please return to:
v.u.: Paul Roggemans, Pijnboomstraat 25, B-2800 Mechelen, Belgium

Afgiftekantoor: 2800 Mechelen 3

WGN, volume 17, nr 4, August 1989, pp. 113–168

Contents

Useful Information

The October Issue *(WGN 17:4)*

This issue will be mailed at the end of September. Contributions are due *September 1*. They should be sent to *Marc Gyssens* or to any member of the editorial board (addresses on the inside of the back cover).

WGN Subscription/IMO Membership 1990

All information can be found on pp. 113–114 of this issue of *WGN*.

From the Editor-in-Chief

Marc Gyssens

As you can see, this is yet another thick issue of WGN! Apart from a comprehensive report on the 1988 Perseids and a preliminary report on the 1989 Quadrantids, the main article in this issue is a professional contribution from the Soviet Union on the necessity of further international research on the 1908 Tunguska explosion. There is also news from the IMO Fireball Data Center, a Japanese article on a simultaneous photographic χ*-Orionid-fireball, and several contributions on radio work from the United States. Apart from instructions to visual observers, we also have a call for telescopic observers in this issue and Dirk Artoos asks radio observers too to check for enhanced activity in September. Of course, there are also a lot of observational reports from all over the world, so there is a lot to read!*

Meanwhile, we are entering the final stages in the founding of IMO. The founding members elected commission directors as well as a council. As far as the directors are concerned, the major change is that the Visual Commission is now directed by Ralf Koschack (address on inside of back cover). The first president of IMO will be Jürgen Rendtel and the other council members will be: Peter Brown, Malcolm Currie, Marc Gyssens, Robert Hawkes, Detlef Koschny, Masahiro Koseki, Vasilii Martynenko, Alastair McBeath, Duncan Olsson-Steel, Paul Roggemans, Ann Schroyens, Christian Steyaert, Gabor Süle, Alexandra Terentjeva, Casper Ter Kuile, Glenn Ticket and Jeff Wood. The council will assume office on October 5, the day of the Founding Assembly. The provisional administration's task will then be accomplished!

Meanwhile, IMO keeps on working. Some IMO members present at the Uppsala conference in Sweden, on which you can find more in this issue, were pleased to see that many professionals are encouraging our organization. Many useful contacts were either established or reinforced. Presently, we are working on the compilation of a comprehensive report on visual and fireball observations in 1988. This report will appear as the first volume of an observational reports series of WGN. Look out for this newcomer at the International Meteor Weekend in Hungary!

Finally, for most meteor observers, summer in the northern hemisphere is synonymous to holidays and to more time for extensive observing. We wish you plenty of good skies, and, please, do not forget to send us your observations together with a report for WGN!

IMO Contributions/WGN Subscriptions for 1990

Marc Gyssens and Ann Schroyens

In our continuing effort to keep *WGN* as inexpensive as possible, subscription rates and membership fees for 1990 have been fixed as follows:

1. *IMO*-members (airmail delivery)	400 BEF	12 USD	1500 JPY
2. non-*IMO*-members (surface mail delivery)	400 BEF	12 USD	1500 JPY
3. non-*IMO*-members (airmail delivery)	600 BEF	18 USD	2250 JPY

The last option only exists for countries outside Europe. As said, these prices are kept as low as possible. Therefore, if you can afford to give something extra, please do so! You will help us in our continuous effort to improve *WGN* and the services *IMO* can render as well as in keeping subscription rates low and thus making the information available to the widest possible audience. Also, early renewals are appreciated.

People in North America can pay through *Peter Brown*. If you pay him by postal money order, just transfer the required amount; if you pay by personal check, add another 2 USD. People in Japan can pay on the postal giro account (nagano) 8-36-445 of *Masahiro Koseki*, referring to *WGN 1990* and mentioning name and address in Roman characters. People in the UK can pay through *George Spalding*. Please contact these persons if you need further details.

All others should pay through *Ann Schroyens*, preferably by international postal money order (made payable to Ann, *not IMO*) or by Eurocheque (made payable to Ann, drawn in Belgian francs in a Belgian city (mention e.g. Brussels) and with your Eurocheque card number figuring on the back). Please avoid using bank checks, because, no matter what your bank may claim, they invariantly cause cashing expenses for us. If, for some reason, you have to pay with a bank check, you should add *at least* 300 BEF to the amounts listed above! Also, the check must then be drawn to a Belgian bank in Belgian francs, otherwise we simply cannot accept it.

Finally note that the addresses of all persons above figure on the inside of the back cover!

On the Specification of Fireball Data and Accompanying Phenomena

André Knöfel and Jürgen Rendtel

Lately, we received some valuable comments concerning the work of *IMO's Fireball Data Center (FIDAC)*. As we got the first reports on fireballs, we also would like to add some hints.

If we receive a fireball form, we can only detect obvious errors. Therefore we urgently ask to be very careful in filling out any form. If the sighting of a fireball makes further inquiries necessary, it takes a rather long time doing this from Potsdam. Therefore we argue in favor of regional or national "sub-centers". In this way, it is also possible to save a lot on postage and phone bills. In some cases, "sub-centers" already exist: for example, Jeff Wood collects fireball data published in the *NAPOMS* bulletins and Dieter Heinlein acts as a collector for the FRG. All people still working this way are asked to continue doing so and to feel responsible for passing on such data to *FIDAC*. We also like to have close contact with coordinators of photographic work since visual sightings can often be helpful in solving certain questions.

The limit of magnitude -3 was chosen to allow for corrections and for allowing comparisons with other estimates (fireball estimates are often too bright).

Despite comments of A. Terentjeva, we do not intend to change the report form. The phenomena she refers to are very rare ones indeed, and, as she points out, only very skilled observers can cope with these. All observations concerning trains are requested in the form of careful, detailed reports including information about the reliability of all data. In particular, we mention:

- There are two different types of trains produced by fireballs: *ionization trains*, the bright trains seen during night time, and *smoke or dust trains*, dark trains seen during daylight, resulting from the disintegration of the meteoroid. The latter appear at lower heights (40–60 km) than ionization trains, and are only visible when illuminated by sunlight.
- The descriptive part of the report should specify the type, drift velocity, behavior of individual (dense) parts, duration of visibilty, and diffusion velocity. Try to measure drift and diffusion velocity, or to obtain a series of photographs.
- Most careful descriptions of meteor sound phenomena are requested, since the nature of electrophonic fireballs (synchronous sound) is still unclear to date. In 1980, C.S.L. Keay [1] dealt with anomalous sounds. He asked for three groups of pertinent information, to which we add a little more:

- *meteorological:* relative humidity, temperature, wind conditions[1], barometric pressure, cloudiness;
- *environmental:* type of trees in immediate vicinity, ungrounded metal objects nearby, presence of electrical/electronic equipment;
- *personal:* hair length (unrestrained), fur or hairy clothing near ears, glasses (frame material).

Descriptive data (including measured data, photographs and drawings) must be sent in on a separate sheet accompanying the fireball form.

References

[1] C.S.L. Keay, "Audible Sounds Excited by Aurorae and Meteor Fireballs", *J. Roy. Astron. Soc. Can.* *74*, 1980, pp. 253–260..

Observation of Remarkable Trains

Christian Steyaert

Explanations for remarkable trains, observed by Gotfred Møbjerg Kristensen from Havdrup, Denmark, in the night of April 27–28, 1989, are proposed and discussed.

In the night of April 27–28, 1989, Gotfred Møbjerg Kristensen made a remarkable observation from Havdrup, Denmark. In going outside for visual meteor observations, he saw three unusual, bright trains, similar to those produced by meteors. The brightest one was seen in Lyra, the second in Draco and the third one in Bootes. A fourth one was discovered only 38 minutes after the first three ones. They were shaped in narrow streaks with brighter knots, and white-green in color.

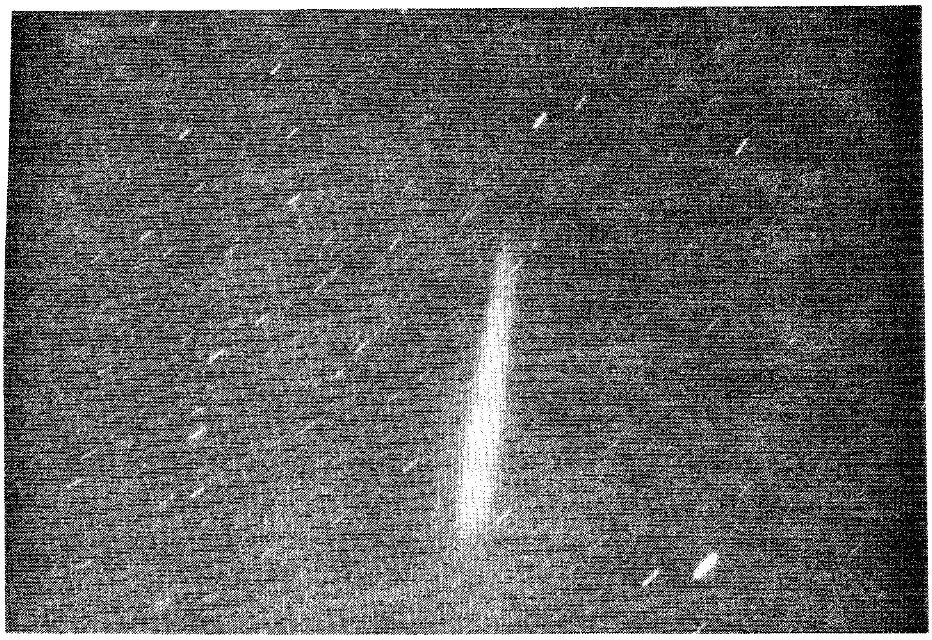


Figure 1 – Light-train in Lyra photographed on April 27–28, using a Nikon F3HP 50mm $f/1.8$ at 22^h54^m UT, with an exposure of 5 minutes. The light train appeared straight and showed bright knots of about magnitude +1.

[1] surface wind (direction and velocity) as well as wind at higher levels (some meteorological stations publish their aerological measurements or provide them on request)

They drifted slowly in the direction ENE. Gotfred took photographs with standard 50 mm objectives. Afterwards, a very weak fifth train was discovered on an all-sky exposure. All observations were made between 22^h51^m and 23^h29^m UT.

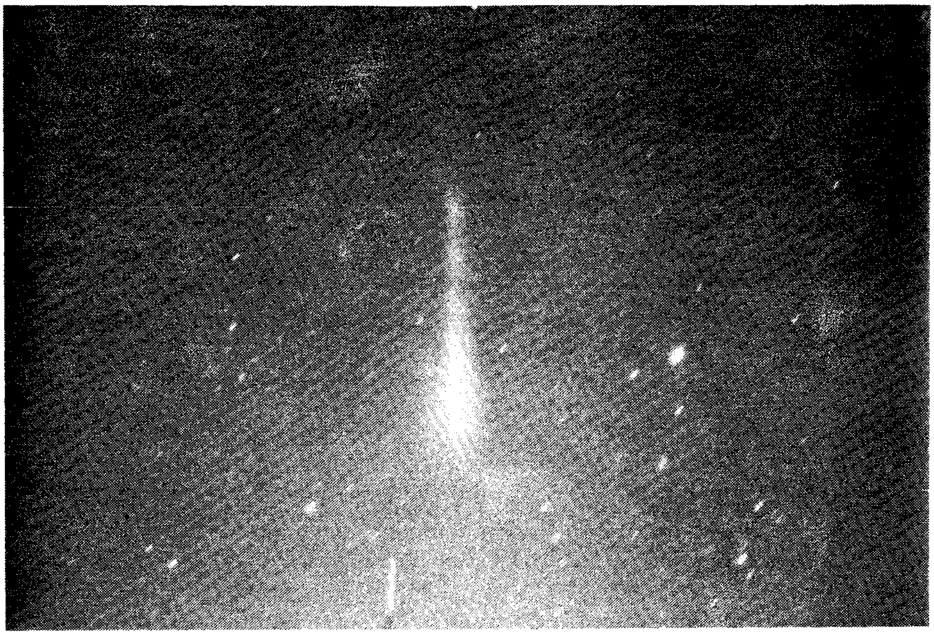


Figure 2 – The same light-train photographed around $22^h56^m \pm 2^m$ UT, using a Nikon F2, 50 mm $f/2.0$, with an exposure of 2 minutes.

When these trains are drawn on a gnomonic map, they all converge towards one point, very close to the observer's zenith. Although this point could be called the "radiant" of these trains, it is also correct to say that each of these trains were almost vertical. A few possible origins for these trains can be considered:

- *aurora:* however, aurora are much shorter living, and, most of the time, rapidly moving;
- *meteor trains:* also meteor trains tend to fade away and deform more rapidly. Several meteoroids almost appearing at the same time, or one larger fragmenting piece would have been required to produce this phenomenon;
- *optical phenomena* in the atmosphere: The fact that the trains were vertically directed might already indicate that they were caused in the lower rather than the upper atmosphere. The small noted drift might indicate that the position remained fixed in azimuth and elevation;
- *temperature inversions* can cause reflections of e.g. gas flares of refineries or similar industries. Photographs of such events exist.

At the time of this writing, the local meteorological conditions at the observing site are unknown, but are certainly required before making final conclusions. The directions of the potential light sources should also be known.

Even if this phenomenon is not related to meteors, it remains worthwhile to inform observers of the existence of displays that might be confused with meteor phenomena.

Laser beams: Paul Roggemans mentions that the description above is similar to what he saw while observing at the Haute-Provence Observatory in Southern France, where atmospheric measurements were done by laser equipment. He was close to the light source and the beam was seen very distinctly. At a larger distance only a short trail was seen, being the laser light reflected on dust or cloud layers.

Visual Observers' Notes: September–October 1989

Jeff Wood

1. Introduction

Following the excellent activity of the previous two months, observers tend to feel let down when rates return to normal during September and October. Because of this, nowhere near as much observational work has been carried out during this time even though there is a lot to see. Table 1 below gives a list of the 14 more active showers that occur in these months.

Table 1 – A list of some of the meteor showers to be seen in September–October 1989.

Shower	α	δ	Period	Max
α-Aurigids	85°	+42°	Aug 24–Sep 10	Sep 1
κ-Aquarids	338°	−5°	Sep 11–28	Sep 20
Piscids S	8°	0°	Sep 6–Oct 10	Sep 24
Piscids N	26°	+14°	Sep 25–Oct 19	Oct 12
Annual Andromedids	14°	+21°	Sep 25–Oct 25	Oct 3
October Capricornids	303°	−10°	Sep 20–Oct 14	Oct 3
σ-Orionids	86°	−3°	Sep 10–Oct 26	Oct 4
Draconids	262°	+54°	Oct 9	Oct 9
σ-Puppids	109°	−44°	Sep 28–Oct 30	?
ε-Geminids	104°	+27°	Oct 14–27	Oct 19
Orionids	95°	+16°	Oct 2–Nov 7	Oct 22
Leo Minorids	162°	+37°	Oct 22–24	Oct 24
Taurids S	51°	+14°	Sep 15–Nov 26	Nov 3
Taurids N	58°	+22°	Sep 19–Dec 1	Nov 12

Table 2 – Moonlight and observing conditions in September–October 1989.

Date	k	Date	k
Friday August 25	0.37−	Friday September 29	0.01−
Friday September 1	0.01+	Friday October 6	0.30+
Friday September 8	0.46+	Friday October 13	0.95+
Friday September 15	1.00+	Friday October 20	0.67−
Friday September 22	0.51−	Friday October 27	0.06−

New Moon:	August 31, September 29, October 29
First Quarter:	September 8, October 8, November 6
Full Moon:	September 15, October 14, November 13
Last Quarter:	August 23, September 22, October 21

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.

2. The Orionids

The Orionids are produced by the debris of comet P/Halley and are a regular meteor shower in the yearly calendar. They are active throughout the whole of October reaching a maximum on October 22 of between 15 to 30 meteors per hour. A feature of the activity curve of the Orionids is the width of the period of maximum activity which lasts on average from October 20 to 24. The Orionids are fast meteors that radiate from several centers near the star Betelgeuse. They are often yellow in color and have a train. The Orionids are not noted for producing fireballs though a few are seen each year.

3. Taurids

From September through December each year there are a number of centers of activity occurring in the constellations of Aries and Taurus. These are broadly classified into two branches called Taurids North and South respectively. Although both branches reach maximum in early November, they produce considerable activity in mid to late October. Taurid meteors are often bright blue, orange or yellow colored fireballs. Very few leave a train.

4. Minor showers

The *α-Aurigids* are a northern hemisphere shower reaching maximum on September 1. Rates are variable from year to year. The α-Aurigids are noted for producing fast moving yellow fireballs many of which have a train. With favorable Moon conditions, *IMO* would like to give this shower special attention in 1989.

A gibbous Moon interferes greatly with the *κ-Aquarids* in 1989. κ-Aquarids are slow meteors that reach maximum on September 21. At best they produce 2–3 meteors per hour.

The *Piscids* consist of two branches: a Northern Branch which reaches maximum on October 12 and a Southern Branch which reaches maximum on September 24. At best, both of these branches produce 2–3 meteors per hour. The Piscids tend to be faint meteors.

The *Annual Andromedids* reach maximum on October 3. Not much is known about the Annual Andromedids since they mostly have been observed by radio and photographic means. *IMO* urgently requires data on this shower and so requests observers to monitor it in 1989 when there are favorable Moon conditions.

The *October Capricornids* have been tentatively identified with comet P/Haneda-Campos. First observed in 1971 it has produced variable activity thereafter. At maximum on October 3, rates may range from 1 to 7 meteors per hour. With favorable Moon conditions, *IMO* urges observers to monitor the October Capricornids in 1989.

The *σ-Orionids* are a minor stream that radiates from the belt of Orion from early September to late October. They reach a broad maximum of 5 meteors per hour around October 4. σ-Orionid meteors are fast yellow-white in color and often have a train. They have favorable Moon conditions for viewing in 1989.

The *Draconids* are produced by the debris from comet P/Giacobini-Zinner and are periodic in nature. The comet's position in 1989 means that no activity is expected from this stream this year.

The *σ-Puppids* are a southern hemisphere shower occurring from September 28 through to October 30. Since data is rather scanty, we do not know for certain when the date of maximum is, but it appears to be around October 14. The σ-Puppids appear to produce variable rates ranging from 1 to 8 meteors per hour depending upon the year. They are fast meteors that are generally blue-white in color and have a train. The σ-Puppids are noted for some brilliant fireballs.

The *ε-Geminids* reach maximum on October 19 and having a radiant position and a speed similar to the Orionids are frequently confused with this shower. observations of the ε-Geminids will be badly affected by the Moon in 1989.

Finally, the *Leo Minorids* are a northern hemisphere shower that can only be seen just before sunrise. It is noted for its extremely weak visual activity.

5. Conclusions

We invite meteor workers to set up well defined observing projects or to propose specific observing efforts. Please make sure your observations reach *IMO*! Observing groups are welcome to provide us with a summary report of their observations and these will generally be published in *WGN*. We look forward to seeing the results of your observations. Clear skies and good viewing!

Telescopic Observers' Notes: August–October 1989

Malcolm J. Currie

To most northern-hemisphere observers summer is synonymous with the Perseids. Yet the good rates we observe with the naked-eye are as much due to an-above average sporadic background and the southern complex of radiants in Aquarius and Capricornus, supplemented by a number of minor showers. The Perseid shower is the best observed, and provides reliable high rates—of course, that is its attraction. However, for the same reasons I would say it holds few surprises, especially for the visual observer. That is not to say that observing the Perseids is a waste of time; you only have to remember Mark Vints's short-lived telescopic sub-radiant detected last year to disprove that [1]. My point is that if you are interested in the *science* as well as the pleasure of watching meteors, you should be concentrating on some of the other showers.

The 1989 lunar chiaroscuro particularly favors the Aquarid and Capricornid showers. They have been poorly observed in comparison with the Perseids mainly because of their low altitude at mid-northern latitudes, and hence reduced rates. There is also the difficulty faced by the naked-eye observer who must assign shower membership. The density of radiants and their movement makes this formidable even for the experienced observer. Also, for a given meteor simple occlusion by one Aqr-Cap radiant of another is the norm rather than the exception. Combining that fact with the poor orientation estimates of naked-eye observers ($\pm 4°$) forces me to answer "No" to Ralf Koschack and Jürgen Rendtel's question #2 [1]. One way forward is via telescopic observing. Plotting accuracy is more than an order-of-magnitude better than for the naked eye, and so the properties (size, motion, activity) of individual radiants may be monitored. There are no occlusions for carefully selected telescopic field centers. The Aquarids are rich in faint meteors, and so are quite well suited to telescopic work, in contrast to the Perseids.

So I would like telescopic observers to concentrate on the Aquarid complex by watching in $\alpha = 19^h37^m$ and $\delta = +17\overset{\circ}{.}5$ or in $\alpha = 20^h34^m$ and $\delta = +12\overset{\circ}{.}5$, and in $\alpha = 22^h55^m$ and $\delta = +10°$, which should be suitable for the latitudes of most observers. Alternate between the two fields viewing for about half an hour at a time. This ensures that radiants can be identified and shower membership assigned during analysis. Pay special attention to plotting the meteor paths accurately.

Last year I discovered a shower of fast and faint meteors radiating from a compact radiant in the "W" of Cassiopeia [3]. Activity lasted from late August to mid-September with a peak rate of about half of the sporadic background. However, there were no confirmatory data. So, I would like observers, especially those with 10–20 cm apertures, to determine whether or not this is a regular shower. Observers at mid-northern latitudes should use the following field centers: before about 23^h30^m local solar time, watch at $\alpha = 21^h50^m$ and $\delta = +72°$ and at $\alpha = 1^h35^m$ and $\delta = +40°$; for the rest of the night, at $\alpha = 23^h12^m$ and $\delta = +74\overset{\circ}{.}5$ and at $\alpha = 2^h53^m$ and $\delta = +38\overset{\circ}{.}5$. At latitudes around $+35°$ N a different set of fields should be viewed, but again switching around 23^h30^m; the evening pair are $\alpha = 21^h50^m$ and $\delta = +72°$, and $\alpha = 23^h22^m$ and $\delta = +25°$; the late are $\alpha = 21^h50^m$ and $\delta = +72°$, and $\alpha = 3^h45^m$ and $\delta = +71°$.

Other attractions include some weak and complex activity in Cygnus throughout August and September. The exact nature is unknown, and needs monitoring over many years to see which radiants are active when. The above field centers will identify any prominent Cygnid radiant. The α-Aurigids are also known to be active at telescopic magnitudes around late August to early September. The Piscids are also rich in faint meteors. Into October the Orionid shower is deserving of telescopic coverage to map its complex radiant, but moonlight interferes this year, so I will not say any more until 1990 when conditions are ideal.

Since little is known about telescopic activity during late September and most of October, sporadic watches are also important. Weak shower activity is more prominent than with the naked eye because of the high plotting accuracy—just a handful of meteors whose paths all intersect within a degree is far more convincing that a shower is present than a vague claim by a naked-eye observer seeing the same number of meteors. Choose pairs of fields at similar declinations, but whose right ascensions are separated by about 40°, such that they have altitudes around 40–60°. Alternate between the fields in the normal way. As the sky revolves change to another pair of fields.

References

[1] M. Vints, "The Telescopic Perseid Radiant", *WGN* 17:3, June 1989, pp. 98–99.

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

[3] M.J. Currie, *BAAMS Newsletter* 30 *Telescopic Appendix*, October 1988.

September 8 and P/Brorsen-Metcalf

Dirk Artoos

The reappearance of comet P/Brorsen-Metcalf in mind, I would like to draw your attention to the possible appearance of a meteor shower connected with it.

In [1], J.D. Drummond published a list of about 240 long and short period comets, considered to be very meteoroid productive. In his list, Drummond took the 0.20 AU of P/Encke as upper limit for the distance between the Earth's orbit and the comet/meteoroid orbit. All comets coming within 0.20 AU of the ecliptic were selected from [2], including the pre- as well as the post-perihelion crossings of the Earth's orbit. It is a known fact that, with few exceptions, almost all short period comets that approached the Earth up to 0.08 AU have produced meteors.

Therefore this call for action to all visual, photographic and radio amateurs: it could be interesting to stay alert around September 8, since any special activity will emerge easily from the rather low general meteor activity in this period of the year. A theoretical radiant is to be looked for at $\alpha = 352°$ and $\delta = -7°$.

References

[1] J.D. Drummond, *Icarus* 47, 1981, pp. 500–517.

[2] B. Marsden, "Catalogue of Cometary Orbits", 1979.

A Call for Action: September 16

Dirk Artoos

This call is meant for all visual as well as radio meteor observers.

Paul Roggemans passed me some data from Wanda Simmons (USA) concerning a visual observation made by Tom Reiland (Glenshow, Pennsylvania, USA) who reported 8 meteors between 8^h30^m and 9^h15^m UT of September 16, 1988, all coming from a radiant northeast of Orion (near Gemini). September 16 is far too early for Orionids or Geminids. I confirmed Tom's observation with my own radio records of that date. I observed every morning from 5^h10^m–5^h20^m

UT at a frequency of 66.45 MHz and azimuth 275°. The results are as follows:

Table 1 – Radio observations of Dirk Artoos during mid-September of 1988. Hourly rates are uncorrected.

Date	Number	Hourly rate
Sep 12	20	120
13	28	168
14	44	264
15	37	222
16	42	252

From these results it is clear that there was some activity increase around that time, and therefore I would call for extra attention by all observers in mid-September for this sector of the sky. I suggest the reader would also check whether he still has mid-September observations of former years. If so, I would be very interested in them and would appreciate it if they would be sent to me. Of course, I would also like to hear from you if you had success this year! My address is: *Nattenhofstraat 74, B-2800 Mechelen, Belgium*

Enhanced Activity around September 27–30?

Dirk Artoos

I would like to ask all observers, radio as well as visual, to pay special attention when observing between September 27 and September 30.

From my observations of 1988, I registered 280 reflections per hour on September 28, about 9^h00^m UT (solar longitude $\lambda_\odot = 184\overset{\circ}{.}92$ (1950.0)). This means a possible maximum activity might occur this year on September 28, at 15^h UT. According to my calculations, the suspected radiants in Auriga and Sextans are very close to the horizon in Europe, but for our colleagues in Australia and other southern countries they are better situated.

Here are the data concerning the suspected radiants:

Table 1 – Radiant suspected to show enhanced activity around September 27–30.

Shower	α	δ	$\lambda_\odot$ (Max.)
Sextantids	152°	0°	$181\overset{\circ}{.}25$
δ-Aurigids	$87\overset{\circ}{.}8$	+54°	$186\overset{\circ}{.}50$

Do not be discouraged if you do not notice anything special. If you do register a higher activity, please let us know and remember to use UT only to indicate times. Good luck!

To all observers, whatever technique they use, let us know your results! Also, you are invited to write something for *WGN*. In that case, please remember that rough data are only interesting if they can be published shortly after the event to which they refer. Finally, it is likely that some spectacular fireball pictures will be shot during the months to come. If so, send a print to *WGN*; we are always short in suitable photographs for the front cover!

On the Necessity of International Investigation into the 1908 Tunguska Event

N. Vasilyev[1] *and G. Andreev*[2]

The authors discuss the necessity of developing an international program on investigating causes and after-effects of the 1908 Tunguska event. The present article concentrates on the collection and treatment of archival data, the search for the substance of the Tunguska meteorite and the study of biological after-effects. Concrete directions for research are suggested. Finally, it is argued that investigations into the Tunguska catastrophe could lead towards avoiding future confusion between Tunguska-like events and nuclear explosions, and towards international measures for preventive destruction of similar objects, heading for collision with the Earth.

1. Introduction

The Tunguska disaster of 1908, often referred to as *the fall of the Tunguska meteorite*, is the biggest cosmic phenomenon that has occurred on our planet in recorded history. Its most probable cause is a collision of the Earth with the nucleus of a small comet (possibly a fragment of Encke's comet) or with an Apollo type asteroid.

A vast amount of factual material testifying the uniqueness of the event was collected since 1926, when L.A. Kulik determined the location of the Tunguska explosion, and especially since 1958, when K.P. Florensky carried out the first post-war expedition to this region, based on field investigations, subsequent research, as well as archive studies. The main characteristics sharply distinguishing the Tunguska phenomenon from a number of other meteorite falls can be summarized as follows:

1. *The global character of the event:* although it was the most striking one, the actual explosion in the area between the Podkamennaya and Nizhnyaya Tunguskas was far from being the only episode in the complicated chain of anomalous geophysical phenomena in the summer of 1908. These phenomena began to occur some weeks before the actual disaster took place, culminated directly after the fall in the night of June 30–July 1, 1908, and gradually disappeared by the end of that summer. This chain of events involved several regions of the Earth. In summary, these events included:
   - an increased fireball activity as compared to preceding and following years (the entire summer of 1908);
   - optical anomalies of the night and twilight sky: intensification of proper emission of the night sky, unprecedented development of noctilucent clouds, bright "particolored" dawns, complicated haloes, violations of the atmospheric polarization in the form of deviations from the normal notion of the neutral points of Arago and Babinė (these anomalies began the first days of June and disappeared by the end of the summer, with a maximum on June 30–July 1);
   - disturbances of the transparency of the Earth's atmosphere connected with the circulation of dust clouds which probably consisted of aerosols (from the end of May 1908 onwards, with a maximum in California during August 1908);
   - a local magnetic storm starting three minutes after the explosion and lasting for four hours, with characteristics similar to geomagnetic disturbances after nuclear explosions in the Earth's atmosphere;
   - aurora with anomalous forms on June 30 at the counterpoint of the Earth's magnetic field (observations by Mouson in the Erebus region of Antarctica during Shakleton's expedition);

[1] Vice-chairman of the Commission of meteorites and cosmic dust of the Siberian Branch of the USSR Academy of Sciences.

[2] Consultant IAU Commission 22, Tomsk State University.

- according to some data by Park, Turkoo et al., (1981), a minimum in the ozone layer was observed for some months.

2. *The possibly complicated trajectory of the Tunguska meteorite in the Earth's atmosphere:* a significant change of the trajectory's inclination near the epicenter; probably a ricochet. (A ballistic wave wake, caused by the flight of a body on the ascending section of its path, is present in the devastated area's vectorial structure.)
3. *The "above ground" nature of the explosion:* the release of the main load of energy took place at an altitude of 5–7 km, and there are no traces of meteoritic fragments on the ground.
4. *Absence of material belonging beyond any doubt to the Tunguska meteorite in the impact region and in adjacent places.*[3] (Alleged discoveries of such material turned out to be either artifacts or cosmic dust background.) There is some evidence for the discovery of substance from the Tunguska meteorite in distant areas of the globe (Antarctica).
5. Presence in the event's epicenter of *isotope shifts* with respect to H, C and Pb.
6. Detection in the event's epicenter of an *osmium anomaly*, which was formed approximately during the first decade of this century.
7. Presence in the devastated area of a complex of *remote biological after-effects*, including accelerated growth of trees and genetic mutations.

There are some other effects probably connected with the Tunguska catastrophe, such as reversal of soil magnetization and changes in thermoluminescent properties of rocks, which have not yet been observed in falls of meteorites belonging to well-known classes.

Despite a large amount of work on the Tunguska event, both in the USSR and abroad, the following crucial issues regarding the 1908 event remain unclear to date:

- the nature of the Tunguska cosmic object, its element and isotopic composition (the cometary origin of the Tunguska meteorite is probable, but not proved);
- the mechanism of its destruction, taking into account the ricocheting of the part that survived the explosion;
- the mechanism of its geomagnetic effect and the determination of the similarities and differences with the corresponding effects of nuclear explosions;
- the mechanism for the development of the biological—including genetic—after-effects;
- the reason for the local reversal of the magnetization in the soil near the explosion's epicenter;
- the mechanism for the development of the atmospheric anomalies during the summer of 1908;
- the contribution of electromagnetic — including electrophonic — phenomena to the physical characteristics of the Tunguska event.

Solving these problems will not only enable us to determine the nature of the Tunguska meteorite, but also to fundamentally extend our knowledge about small bodies in the solar system, and the role of cosmic cataclysms in the history of the Earth and the development of its biosphere. Unfortunately, progress in the investigation of the Tunguska problem has been held up by a number of objective circumstances, the most evident of which are:

1. The global character of the event. The anomalous cosmophysical effects during the 1908 Summer have swept over the entire terrestrial globe, including the southern and western hemispheres. Consequently, we need a global approach towards their study, including a further collection of archival data.

[3] An area of 15 000 km^2 was covered by the cosmochemical survey.

2. The necessity of carrying out cosmochemical research at various points of the Globe in order to detect 1908 cosmic aerosols in stratified objects (bottom silts, shelf ices, sphagnum peats), using highly sensitive analytical methods.
3. The necessity of revealing possible after-effects of damage to the ozon layer based on analysis of biomedical statistics of the years following 1908;
4. The desirability of taking into account the data obtained in the Tunguska investigations for developing cosmic experiments to study small bodies in the solar system, in particular experiments on probing cometary nuclei with unmanned spacecrafts.

From these arguments, it is clear that we need to develop an international program for investigating the 1908 Tunguska phenomenon, the purpose of which can be formulated as follows:

to investigate the character of the cosmic object whose collision with the Earth led to a devastating event in Central Siberia in the summer of 1908, to investigate immediate and remote after-effects of this event, to determine the role of phenomena of a similar nature in the evolution of the Earth and the history of its biosphere, to define possible biosocial after-effects, and to work out a system of international measures to prevent catastrophes caused by collisions of the Earth with small bodies in the solar system.

In the following sections, we suggest some possible directions for these investigations.

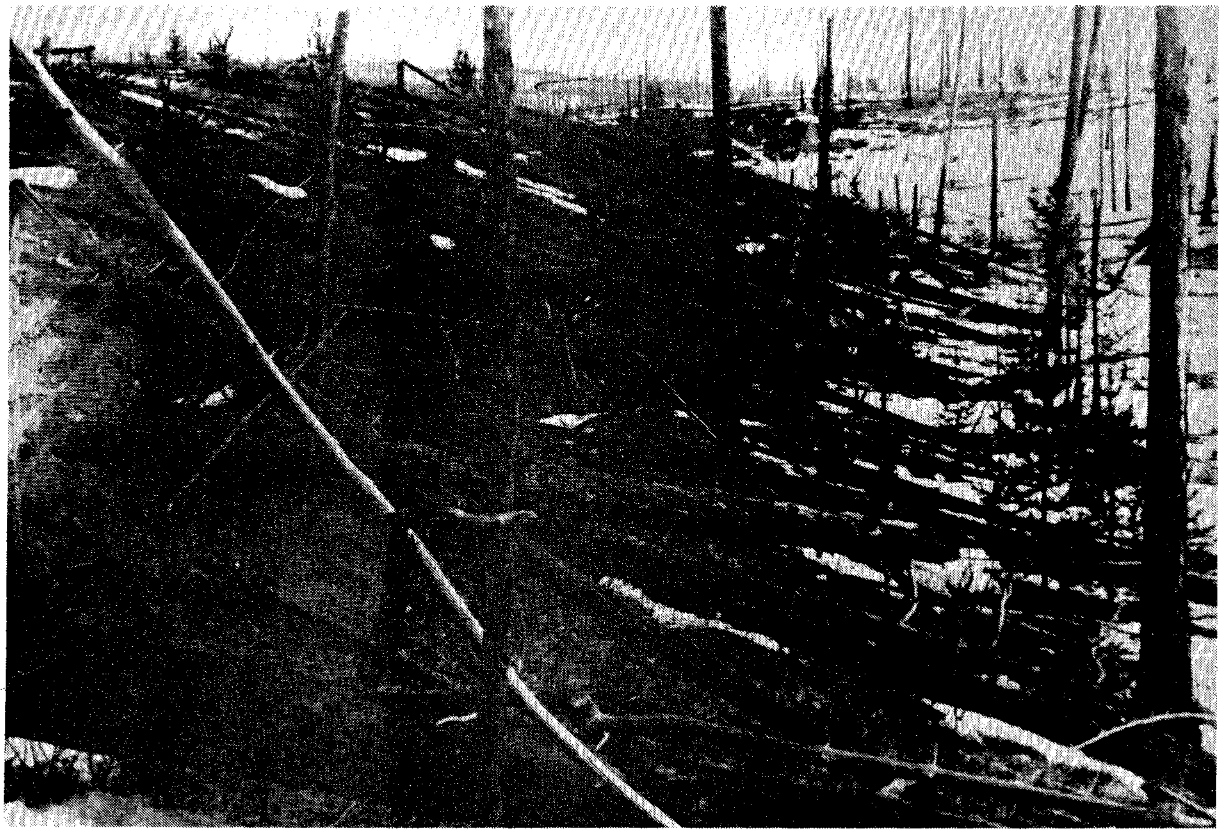


Figure 1 – A region located 8 km from the epicenter, in which all the trees were blown over.

2. Collection and treatment of archival data

The work carried out so far in this direction shows that information characterizing geophysical events in the summer of 1908 is located in two different sources:

- archives of observatories and other scientific institutions functioning in 1908;
- articles and notes in periodicals—mainly newspapers, including local ones.

Most of the information kept in archives of observatories has been collected and studied by now. Nevertheless, experience has shown (Park et al, 1981) that, even here, not all resources have been exhausted yet.

To uncover information "hidden" in periodicals, the Commission on meteorites and cosmic dust of the Siberian Branch of the USSR Academy of Sciences has asked to leading universities all over the world if they could form groups of teachers and students willing to collect and analyze relevant information in newspapers and periodicals. Previous experience with the universities in Denmark and Colombia in 1968–69 proved such a cooperation to be highly efficient. The Tomsk State University could become the center for collection and further analysis of this information. This work could be finished in 3–4 years.

A special item in this respect could be the search for the original diary entrees by Mouson who observed auroras from near the Erebus volcano at Antarctica during the Summer of 1908. There is information in Shackleton's accounts that on June 30, Mouson registered an aurora which he visually considered to be anomalous. Unfortunately, Shackleton's accounts of his expedition do not contain further details on this issue. Since the Erebus volcano is situated near the counterpoint of the Earth's magnetic field, it goes without saying that additional information on Mouson's observations would be of fundamental interest. Everything seems to indicate that the original data by Mouson are preserved in the archives of the British Royal Geographical Society in London, or, perhaps, in a scientific center in Australia.

3. Search for the substance of the Tunguska meteorite

It is necessary to search for the substance of the Tunguska meteorite, to analyze its element and isotopic compositions, and to compare these with standard cosmic material obtained from other sources.

1. Due to the global character of the Tunguska event, one may suppose that fallout of cosmic substance has occurred in several forms, each of which requires a particular approach towards its detection, collection and identification. There are some grounds to believe that a finely dispersed component of the Tunguska meteorite's substance fell out on almost the entire surface of the Earth, including the southern hemisphere. This fallout caused a lowering in the transparency of the atmosphere observed in California in August 1908. The question whether these fallouts have spread evenly over the Earth, however, remains open. Therefore it is necessary to select and analyze samples of stratified objects at various points of the globe, such as:
    - *shelf ices* of Greenland, Severnaya Zemlya, the Novosibirsk Islands, the islands of the Canadian Northwest Territories, and the Antarctic islands. Material is needed from several places in the northern and southern hemispheres, for as Ganapati's experience has showed (1984), it is extremely risky to draw conclusions based on data from one single point.
    - *sphagnum peats* vastly spread in forest-tundra and forest-steppe zones all over the northern hemisphere and also encountered in isolated spots of the southern hemisphere, like the Kerguelen islands, and probably Tasmania and Tierra del Fuego. Peculiar to sphagnum peats is their regular growth (for the given natural zone), their high adsorption ability, practically excluding the secondary redeposit of dissoluble particles, and oligotrophism (nutrition exclusively or mainly at the expense of aerosol fallouts). As a result, each peat-bed is a kind of natural "calendar" of aerosol fallouts on that particular location, which easily leads to stratification and isolation of a mineral component according to the method of Yu. A. Lvov (1971). Selection of samples of sphagnum peats in various areas of the western, eastern and southern hemispheres with later analysis of the mineral fraction using precise methods seems promising.
    - *bottom silts* in reservoirs having no outlets. They can serve as additional sites for finding 1908 aerosol fallouts in those regions of the globe in which stratified ice and sphagnum peats are absent.

    In particular, work in the following directions appears to offer good perspectives:

- checking the data on the presence of increased concentrations of osmium and other platinoids in layers of continental ice dated as of 1908 (in particular Ganapati's data about Antarctica);
- outlining an anomalous area with increased content of elements of a platinum group in 1908 layers of sphagnum peats of up-river bogs in the northern hemisphere (Siberia, Canada).

2. There are some grounds to believe that in the immediate proximity of the region of the Tunguska catastrophe, there is a zone of fallouts of more roughly dispersed cosmic material, representing the remnants of the destroyed cosmic body. If the Tunguska meteorite really had a cometary origin, then it is reasonable to assume there is a zone in which terrestrial objects have been enriched with products of melting cometary ice. Correspondingly, one may expect that in the region of the Tunguska event, the 1908 layer in stratified objects has been enriched by the element-markers of the cosmic material (platinoids, nickel, cobalt). Also, one may expect the presence of anomalies in the isotopic compositions of H, C and O. These assumptions are confirmed by work of E.M. Kolesmikov (1978–88) and M.I. Nasarov (1988). They showed that in the epicenter itself, the 1908 peat-layer has been enriched with iridium and ^{13}C, while it has impoverished in deuterium. The next task is now to determine the boundaries of the cosmochemical anomaly. Similar work has to be carried out on the supposed train of spreading of the Tunguska meteorite's substance. On the whole, the problem involves the selection of some 40 cores of sphagnum peats and their layer by layer analysis using NAA and mass-spectrometry (all in all about 800 samples). Such a task can be effectively carried out within the framework of international cooperation, using laboratories having some experience in analyzing cosmic substance.
3. Of particular interest is the comparison between the results of the cosmic substance search in the region of the epicenter and the data obtained from probing cosmic objects—first of all, comets. It is necessary to analyze the results of *Vega* and *Giotto* from this viewpoint. It would be desirable to develop experiments in the near future to probe cometary nuclei and to select cores of cometary substance for determining isotopic composition and concentration of C, H, O as well as iron, nickel, cobalt, zinc, silver, bromine, mercury, rare-earth elements and platinoids. Such analysis is interesting, since increased concentrations of the above elements, as well as isotopic shifts with respect to C, H and Pb, have been found in the peat layer from 1908 around the epicenter.

4. Investigation of biological after-effects

In the region of the epicenter of the Tunguska explosion, there is a zone of genetic anomalies in plants caused by that explosion, but which coincides neither with the region of the uprooting of trees nor with the outline of the forest fire of 1908 (V.A. Dragavtsev, G.F. Plekhanov, 1968–1980). There are grounds to assume the presence of genetic anomalies in other species of plants and animals too (for example ants, lowest mosses and various species of the soil microflora). To discover the indicated anomalies and to interpret them correctly, it is desirable to cooperate with laboratories specialized in investigating the genetics of micro-organisms and arthropods.

5. Conclusion

The uniqueness of the Tunguska phenomenon imposes a moral responsibility upon the international scientific community to carry through thorough investigations of this event. Indeed, its repetition in future times might be confused with a nuclear explosion and thus cause a nuclear conflict with all the ensuing consequences. For this reason, it is necessary to work out criteria for distinguishing high-altitude non-nuclear explosions of the Tunguska type from above ground explosions of nuclear devices. Furthermore, recommendations should be written down for the identification of similar objects heading for collision with the Earth, and, in case of emergency, for their immediate preventive destruction in space.

The Perseid Meteor Stream in 1988: A Double Maximum!

Paul Roggemans

The data obtained from 53 341 meteors observed in July and August 1988 were used to study the detailed activity profile of the Perseids. A double peak was found. A first maximum occurred at $\lambda_{\odot} = 139^{\circ}.0 \pm 0^{\circ}.1$, followed by a deep decrease in activity at $\lambda_{\odot} = 139^{\circ}.2 \pm 0^{\circ}.1$. The second maximum appears to be the main one, covering $\lambda_{\odot} = 139^{\circ}.5 \pm 0^{\circ}.2$. These features around the shower's maximum were found in 1985 too. The particle size distribution throughout the stream does not vary during its activity; only the post maximum activity mainly consists of rather smaller particles.

1. Introduction

Although the Perseids are the most popular meteor shower known among amateurs, few Perseid appearances in the past were studied in detail. National, regional and local meteor groups in the northern hemisphere mobilized all their members and collected many observing reports. Unfortunately, most of these groups' members were just occasional observers. Results of observers only working a few nights around the Perseid maximum are just bad due to a lack of experience. Despite these disadvantages, many reports covering fragments of the total activity period were published. Very few of these reports are of much use to get a reliable idea of the Perseid activity.

To cover 1988, *IMO* collected data from the most experienced observers in the northern hemisphere. In addition, *IMO* got several reports from new observers. Observations were accepted when they were done according to *IMO*'s standards and complete reports were submitted. Several reports were refused because these minimum conditions were not met. The final usable data represents 53 341 meteors, 32 041 of which were Perseids and 16 990 were sporadics. The remainder consists of Aquarids, α-Capricornids, κ-Cygnids and a few other minor showers. All observations covering July 1–August 31, 1988 were taken into account. The 157 contributing observers were:

Peter Aneca (ANEPE), Tomi Anttila (ANTTO), Rainer Arlt (ARLRA), Pierre Bader (BADPI), Petra Baldauf (BALPE), Sandro Baroni (BARSA), Dirk Bernaerts (BERDI), Lieve Bresseleers (BRELI), Peter Brown (BROPE), Lucia Bruning (BRULU), Miguel Camarasa (CAMMI), Dominique Caris (CARDO), Oscar Cervera García (CEROS), Sven Claeys (CLASV), Koen Clement (CLEKO), Sabine Clement (CLESA), Pascal Cornelis (CORPS), Luigi D'Argliano (D'ALU), Tim Daniels (DANTI), Bart de Pontieu (DE BA), Carl De Pooter (DE CA), Frederic De Cock (DE FR), Jurgen De Herdt (DE JU), Marc De Lignie (DE MA), Patrick De Pauw (DE PA), Jan De Bie (DE-BJA), Bernard De Grootte (DEGBE), Stefano Del Dotto (DELST), Kris Deman (DEMKR), Kurt Dequick (DEQKU), Anne De Weert (DEWAN), Jean Deweerdt (DEWJE), Patrick Dewispelaere (DEWPA), José Vicente Díaz Martinez (DIAJO), Filip Dierckx (DIEFI), Ivo Dielen (DIEIV), Maurizio Eltri (ELTMA), Raúl Fernández (FERRA), Kai Gaarder (GAAKA), Irina Gaus (GAUIR), Koen Geukens (GEUKO), Hans Goertz (GOEHA), Peter Goris (GORPE), Roberto Gorelli (GORRO), Marc Gyssens (GYSMA), Gabi Haderer (HADGA), Roar Hanoa (HANRO), Teemu Hankamäki (HANTE), Takema Hashimoto (HASTA), Roberto Haver (HAVRO), Lars Trygve Heen (HEELA), Bernd Heinrich (HEIBE), Trond Erik Hillestad (HILTR), Casper Jans (JANCA), Klaas Jobse (JOBKL), Kurt Jonckheere (JONKU), Chizuyo Kawamura (KAWCH), Norihito Kawamuro (KAW-NO), Timo Kinnunen (KINTI), Becky Kirkwood (KIRBE), John Kirkwood (KIRJO), Robert Kirkwood (KIRRO), André Knöfel (KNOAN), Bernhard Koch (KOCBE), Detlef Koschny (KOSDE), Ralf Koschack (KOSRA), Ralf Kuschnik (KUSRA), Patrick Laenen (LAEPA), Alberto Latini (LATAL), Dirk Laurent (LAUDI), Kris Lavrijsen (LAVKR), Stefan Lobet (LOBST), Robert Lunsford (LUN-RO), Hannu Määttänen (MAAHA), Katsuhiko Mameta (MAMKA), Ann Martaux (MARAN), Mario Lučic (MARLU), Massino Martini (MARMA), Alastair McBeath (MCBAL), Norman McLeod (MCLNO), H. Mizoguchi (MIZHI), Antonio Juan Montesimos (MONAN), Dina Moro (MORDI), Andrés Rafael Paños Moya (MOYAN), Kristiaan Neyts (NEYKR), Michael Nolle (NOLMI), Kurt Osaer (OSAKU), Pekka Parviainen (PARPE), Dirk Pauwels (PAUDI), François Plesier (PLEFO), Francis Plesier (PLEFR), Ghislain Plesier (PLEGH), Giacomo Poleschi (POLGI), Edoardo Radice (RADED), Stefano Raffaelli (RAFST), Leo Rajala (RAJLE), Andreas Rendtel (RENAN), Ina Rendtel (RENIN), Jürgen Rendtel (RENJU), Paul Roggemans (ROGPA), Wim Rogiest (ROGWI), Maarten Roos (ROOMA), Christiaan Rutges (RUTCH), Kotaro Sakuma (SAKKO), Napoleone Scarpa (SCANA), Ann Schroyens (SCHAN), Daan Schroyens (SCHDA), René Scurbecq (SCURE), Holger Seipelt (SEIHO), Yasuo Shiba (SHIYA), Steve Sillis (SILST), Karl Simmons (SIMKA), Wanda Simmons (SIMWA), Wendy Simmons (SIMWE), Olaf Skjæraasen (SKJOL), Lieven Smits (SMILI), Paul Smits (SMIPA), George Spalding (SPAGE), Peter Spanyi (SPAPE), Ulrich Sperberg (SPEUL), Enrico Stomeo (STOEN), Stefano Stomeo (STOST), Stefan Ströbele (STRST), Dominique Suys (SUYDO), Magne Svanemsli (SVAMA), David Swann (SWADA), Richard Sweetsir (SWERI), Richard Taibi (TAIRI), Yuko Takeuchi (TAKYU), Emmanuel Thienpont (THIEM), Glenn Ticket (TICGL), Emiliano Trizio (TRIEM), José Trigo Rodríguez (TRIJO), Anik Vanhuysse (VANAN), Didier Van Hellemont (VANDI), Filip Van Gorp (VANFI), Frank Van Reeth (VANFK), Griet Van de Steene (VANGR), Hendrik Vandenbruaene (VANHE), Jan Vandenbruaene (VANJN), Jonas Vanreusel (VANJO), Karin Van Genegen (VANKA), Marc Van den Broeck (VANMK), Mireille Vanheerentals (VANMR), Peter Van den Eijnde (VANPE), Pierre Van Mechelen (VANPI), Tom Van De Vreken (VANTM), Tonny Vanmunster (VANTO), Ward Van Nuffelen (VANWA), Cis Verbeeck (VERCI), Ivo Verlaeckt (VERIO), Ivo Verstraelen (VERIV), Sam Vereecke (VERSA), Wim Vinken (VINWI), Jean-Marc Wislez (WISJE), Nikolai Wünsche (WUNNI), Yasuo Yabu (YABYA).

2. The activity profile

The observations were analyzed in the Visual Meteor Database, according to the method described in [1]. In total, 1824 ZHRs were computed. Of course, 157 observers working around the world will not turn up all with the same results. A very big scatter on the individual results is to be expected. This would be a problem if not enough reports were available, as the results would then become statistical insignificant.

Figure 1 shows the results of the 1824 points; an enormous scatter shows up as some observations were done under poor circumstances, yielding too large uncertainties on the correction factors used in ZHR-calculations. Some observers report limiting magnitudes, cloud percentages and time intervals that are really very poorly determined; at least these reports give very different results. Obviously some of the complete reports are still of a poor quality. There are no objective criteria to refuse reports, just because the results do not fit the general picture. Only in the past few years, combined reports covering global observing efforts became possible. It will be the first challenge for the Visual Commission of *IMO* to investigate the treatment of global observational data, their reliability and methods to overcome the incorporation of bad observing reports in the analyses.

From Figure 1, it can also be seen how dangerous it is to draw conclusions when not enough observations are available. By taking one point each hour, it is easily seen that another hourly rate profile emerges depending upon which points are chosen. A ZHR is indeed only an estimate of the shower's activity and not some absolute quantity linked to the stream. In order to obtain the most likely approximation of the activity profile from an unbiased set of estimates, one can average all the estimates available per time period. The number of estimates must be of statistical significance; three or four estimates are insufficient. Well-organized and skilled national, regional or local observing groups may get about 20 independent observations for a one hour interval, but their night-time span limits their coverage to 20 up to maximum 40% of the total duration of the shower. *IMO* is the only organization with the necessary world-wide observational support that can guarantee continuous coverage of meteor stream activity: for some observing intervals during the 1988 Perseids, no less than 150 reports are available! The observing intervals around 0^h UT are very crowded; they correspond to the European observing window. We hope that the blanc hour periods arising from too few observers in America, the Far East and the Pacific will be filled up soon for future showers!

Figure 1 tells very little about the Perseid activity: according to some observers, activity was very high, while many reported low ZHRs, too. At maximum, ZHRs range from a spectacular 280 down to only 20! While the former observers must have thought that the 1988 Perseids

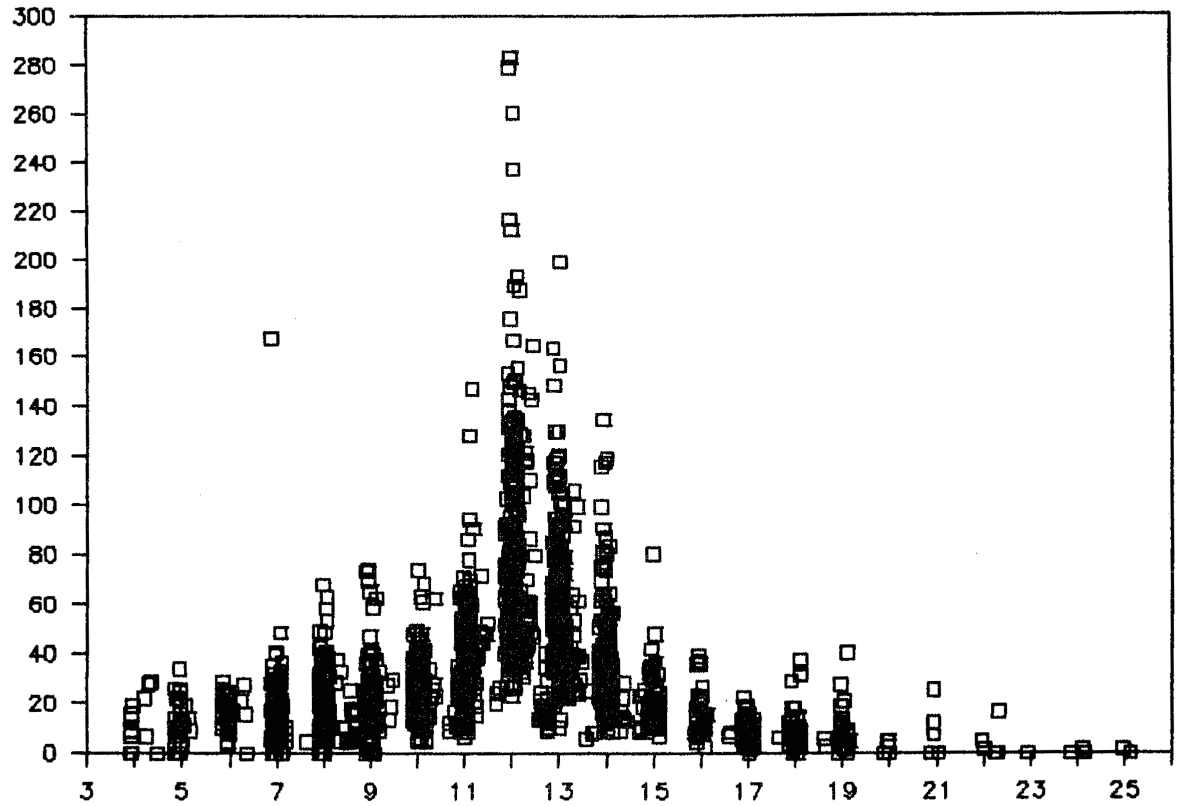


Figure 1 – Individual ZHRs obtained world-wide for the Perseids in August 1988.

were exceptionally rich, the latter ones must have seen the biggest disappointment in their life! The true maximum activity, of course, is far from both extremes.

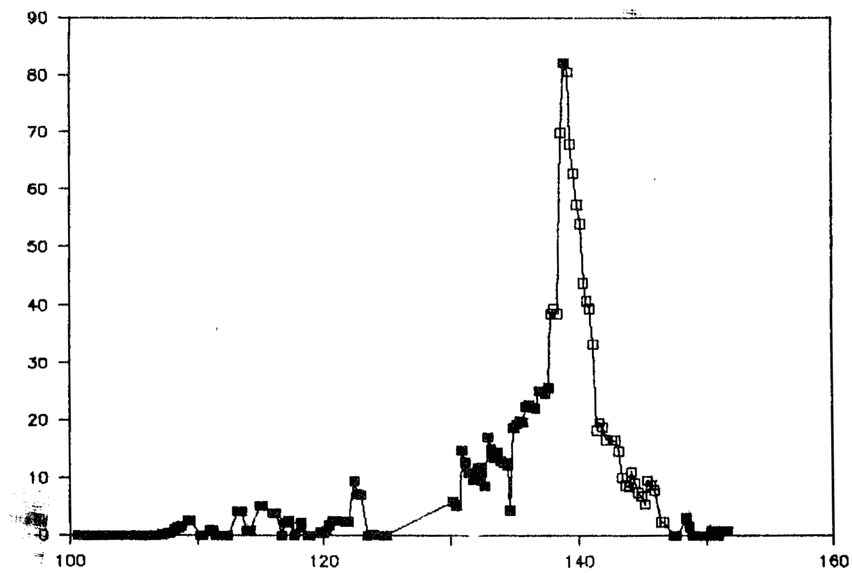


Figure 2 – Averaged ZHR curve of the 1988 Perseids as a function of solar longitude (1950.0) (12 hour periods).

In order to obtain an averaged curve, we computed average ZHRs for 12 hour periods, using a step of 6 hours. These averaged ZHRs are presented in Figure 2. We attempted to reduce the standard deviation by excluding ZHRs obtained under too poor circumstances. ZHRs were only considered when the ratio (ZHR/number of Perseids observed) did not exceed 5, i.e. when the total correction factor did not exceed 5.

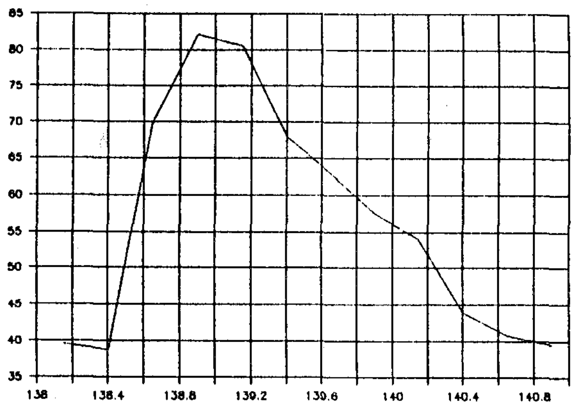


Figure 3 — Averaged ZHR curve of the 1988 Perseid maximum as a function of solar longitude (1950.0) (12 hour Perseids).

The error bars, representing the standard deviations, were omitted to make the graph more readable. Perseids are non-existing in early July to show up very scarcely only in mid-July. Some nights at the end of July did not produce any Perseids at all to the eyes of some observers. Moonlight prevented observing at the end of July and Perseid activity was picked up around August 3. Rates were about 10, but at $\lambda_\odot = 134.^\circ8$, several observers recorded remarkably low rates during a five hour period. From $\lambda_\odot = 135^\circ$ onwards rates got up from 20 to 30 at $\lambda_\odot = 138.^\circ0$. For the maximum activity we enlarged the corresponding area in Figure 2; the result is shown in Figure 3. From $\lambda_\odot = 138.^\circ4$, rates increased very steeply from 38 to 80 at $\lambda_\odot = 138.^\circ9$. The curve then levels around maximum values of about 83 ± 2 for a short while, but starts to decrease slowly from $\lambda_\odot = 139.^\circ2$. It takes two days for the Perseid activity to return to the level of 38 meteors an hour, while the corresponding increase took only half a day. From Figure 3, we infer that the maximum occurred $0.^\circ6$ earlier in solar longitude than in 1985 [2], when Japan and Europe got the main peak around $\lambda_\odot = 139.^\circ6$. In 1986 [3], the author had very little American data available and no Japanese ones. As a consequence, the detailed hourly rate profile showed many blanc intervals that year. Distinct high rates were then reported for the period $\lambda_\odot = 139.^\circ33$ to $\lambda_\odot = 139.^\circ57$, coinciding with the second maximum observed in 1988, as will be shown later. Lindblad [4] reports the Perseid maximum at $\lambda_\odot = 139.^\circ39$.

The averaging period of 12 hours is pretty long and it smoothes away all short duration variations in activity. Therefore we computed a more detailed picture of the Perseid activity profile, averaging ZHRs over 6 hour intervals, with a step of 1 hour (Figure 4).

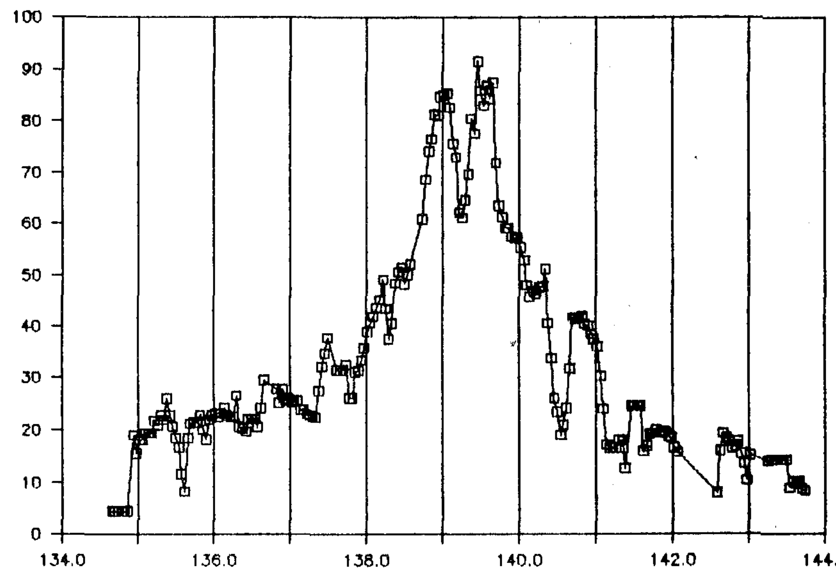


Figure 4 – Detailed picture of the 1988 Perseid activity profile as a function of solar longitude (1950.0) (6 hour periods).

Figure 4 describes in detail the activity profile of the 1988 Perseids. The curve starts with a dip at $\lambda_\odot = 134.^\circ8$ when several observers reported no Perseids at all!

As for Figure 3, we enlarged the area of Figure 4 showing maximum activity (Figure 5). Figure 5 clearly reveals a double maximum!

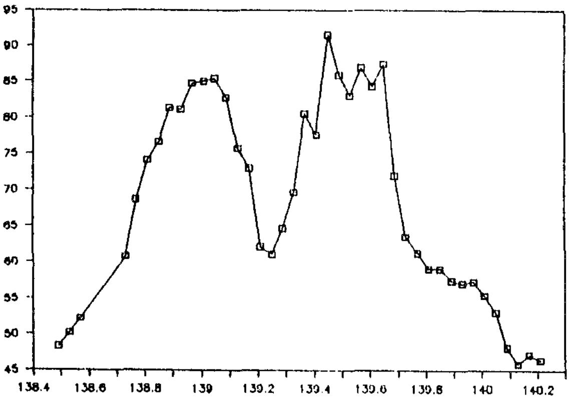


Figure 5 — Averaged ZHR curve of the 1988 Perseid maximum as a function of solar longitude (1950.0) (6 hour periods).

A first one occurs at about $\lambda_\odot = 139.^\circ0$. It was spotted by European observers in the hours around August 12, 0^h UT, when the zenith distance of the radiant kept observed rates at less impressive values. Rates then started to decline, so that little advance in effective rates was experienced in Europe when the radiant climbed higher in the sky in the final hours of that night. American observers in Florida got very low rates when they started observing. At $\lambda_\odot = 139.^\circ25$, Perseid activity reached only 75% of the level which was produced 6 hours earlier! The individual observers all get consistent, low ZHRs, except for one observer, whose ZHRs were systematically higher (higher perception?). The second maximum which is the main one, appeared at $\lambda_\odot = 139.^\circ44$ with a ZHR of 90. It was enjoyed by American observers in their morning sky, and provided high rates with a radiant high up in the sky.

As observed in Japan, rates remain high for some hours until $\lambda_\odot = 139.^\circ7$. They then quickly decline in a couple of hours to 60 Perseids per hour at $\lambda_\odot = 139.^\circ8$. From then on, activity decreases steadily and a frequency of 20 meteors per hour is reached at $\lambda_\odot = 142^\circ$. The dip at $\lambda_\odot = 141.^\circ2$ is only present in a small number of American observations.

Table 1 presents ZHRs averaged over 8 hour intervals with a step of 6 hours, as to obtain results similar to those published in [5]. Here, this interval proves to be too long. Details are smoothed away, although the two maxima are still noticeable at $\lambda_\odot = 138.^\circ9$ and $\lambda_\odot = 139.^\circ4$. Table 1 also gives an idea of the spreading on the averaged ZHRs and the number of data points taken into consideration. The other results were represented in graphs to save space.

Table 1 – ZHR-values for the 1988 Perseids and corresponding sporadic HR-values, averaged over 8 hour intervals with a step of 6 hours.

Date	$\lambda_\odot$	Obs	Per	ZHR		Spor	HR	
Aug 03.84	131.°15	17	147	12.7 ±	7.7	396	18.0 ±	13.6
04.10	131.°40	1	7	9.1	19.1	10	18.6	18.6
04.37	131.°65	1	0	0		0	0	
04.62	131.°90	1	0	0		0	0	
04.89	132.°15	19	230	11.3	9.5	386	11.7	6.3
05.14	132.°40	4	10	11.3	6.7	13	13.6	5.2
05.93	133.°15	29	469	15.0	6.3	599	12.9	9.2
06.18	133.°40	3	26	20.0	6.3	14	10.9	5.0
06.45	133.°65	2	4	7.9	11.2	6	18.8	3.0
06.97	134.°15	78	445	12.8	9.5	522	12.8	7.9
07.23	134.°40	12	24	6.8	6.4	38	11.5	10.4
07.51	134.°65	1	3	4.4	4.4	4	4.0	4.0
07.76	134.°90	9	77	17.4	13.0	61	7.4	3.8
08.02	135.°15	92	987	19.3	12.2	772	10.4	5.6
08.28	135.°40	6	75	20.7	13.8	51	9.2	5.7
08.54	135.°65	11	77	18.9	14.9	59	4.9	3.1
08.80	135.°90	29	420	23.2	14.9	407	7.5	4.4
09.06	136.°15	59	1369	24.0	15.2	825	9.6	5.9
09.33	136.°40	4	69	22.1	7.5	43	9.4	1.5
09.58	136.°65	2	39	24.1	7.7	18	8.8	1.5
09.84	136.°90	43	600	25.7	10.3	495	9.9	3.2
10.10	137.°15	72	969	24.3	11.1	511	9.9	6.3
10.36	137.°40	9	113	27.5	14.3	70	11.0	8.2

Table 1 – continued.

Date	$\lambda_{\odot}$	Obs	Per	ZHR	Spor	HR
Aug 10.63	137°65	2	17	31.5 ± 13.2	19	9.5 ± 2.1
10.88	137°90	88	1555	33.4 15.4	985	10.9 6.0
11.14	138°15	90	2232	43.3 22.0	796	11.8 6.1
11.40	138°40	9	288	48.5 9.5	73	8.9 4.8
11.93	138°90	150	7040	81.1 36.5	1582	11.1 7.5
12.19	139°15	94	4563	79.7 39.8	971	13.0 9.1
12.45	139°40	20	949	80.4 38.7	161	10.1 7.3
12.70	139°65	23	934	73.4 28.3	387	9.5 8.2
12.97	139°90	162	5017	57.0 23.0	1624	11.0 6.3
13.22	140°15	31	771	46.3 22.2	228	9.3 5.7
13.49	140°40	9	270	40.6 25.9	62	6.0 4.5
13.75	140°65	21	509	36.3 18.7	391	10.0 4.0
14.01	140°90	113	2723	39.9 18.4	1219	12.3 6.0
14.28	141°15	7	101	16.6 6.5	41	5.1 2.8
14.53	141°40	3	22	20.5 7.6	35	14.3 8.8
14.78	141°65	22	268	20.5 9.3	356	10.9 6.1
15.04	141°90	52	820	19.6 8.5	740	10.7 5.4
15.83	142°65	18	163	18.9 11.4	157	10.2 6.0
16.09	142°90	22	253	16.8 8.7	225	9.9 5.3
16.61	143°40	2	7	14.4 0.5	11	6.8 6.9
16.87	143°65	24	121	8.7 5.8	237	8.6 5.1
17.13	143°90	17	121	6.8 3.7	281	13.6 5.5
17.66	144°40	1	3	11.1 11.1	8	12.8 12.8
17.91	144°65	43	199	7.6 5.4	436	8.9 5.3
18.17	144°90	15	71	6.6 4.3	118	9.1 4.3
18.68	145°40	2	3	5.4 3.7	10	5.3 3.0
18.95	145°65	17	69	9.2 7.7	105	9.6 6.5
19.20	145°90	6	25	5.1 3.4	43	8.4 4.5
19.99	146°65	5	8	2.3 2.2	46	11.6 4.7
20.77	147°40	1	0	0.0 0.0	3	12.9 12.9
21.02	147°65	2	0	0.0 0.0	4	12.9 0.0
21.81	148°40	1	3	4.7 4.7	7	8.3 8.3
22.06	148°5	2	5	3.0 2.4	25	8.4 0.1
22.32	148°90	2	0	0.0 0.0	9	10.8 1.7
22.85	149°40	1	0	0.0 0.0	3	23.6 23.6
23.89	150°40	1	0	0.0 0.0	1	6.3 6.3
24.14	150°65	2	1	0.8 1.1	8	6.4 3.2
24.93	151°40	1	3	1.5 1.5	19	7.2 7.2
25.18	151°65	1	0	0.0 0.0	9	15.6 15.6

In general, a double maximum can be the result of different perceptions. Therefore, Figure 6 shows the result of a more rigorous approach. 754 ZHRs, derived between $\lambda_{\odot} = 137^\circ$ and $\lambda_{\odot} = 140^\circ$, were averaged over the short interval of 2 hours every hour. Only individual observations with the ratio (ZHR/observed rate) not exceeding 3 were included. This way, only observational data obtained under good circumstances with a reasonable radiant elevation were considered. The black dots are not perception corrected whereas the open dots are perception corrected, using the sporadic activity as a calibration factor. For the perception corrected ZHR, the dip separating both maxima becomes even more distinct!

Exactly the same details were found in 1985 [6]. Then, a first maximum occurred at $\lambda_{\odot} = 139\overset{\circ}{.}0$. This was followed by a period of low activity around $\lambda_{\odot} = 139\overset{\circ}{.}3$ after which the main maximum occurred over Europe between $\lambda_{\odot} = 139\overset{\circ}{.}4$ and $\lambda_{\odot} = 139\overset{\circ}{.}7$. In 1985 however, this phenomenon was not immediately interpreted as a real feature.

It was attributed to the assumed influence of the zenith distance correction (zenith exponent $\varepsilon = 1.0$). Later on, it turned out that the zenith distance correction could not explain the variation in activity [6]. It now turns out that the 1985 features are not spurious ones but real density variations that are clearly confirmed by the 1988 data: the Perseid maximum consists of two distinct maxima, about half a day apart. These density variations suggest a hollow, toroidal shape for the core of the stream. The 1985 and 1988 series being the two only global observing efforts available for this stream support this theory. It may also explain the large discrepancies in the global appreciation of the stream's activity, arising among observers expecting a single maximum.

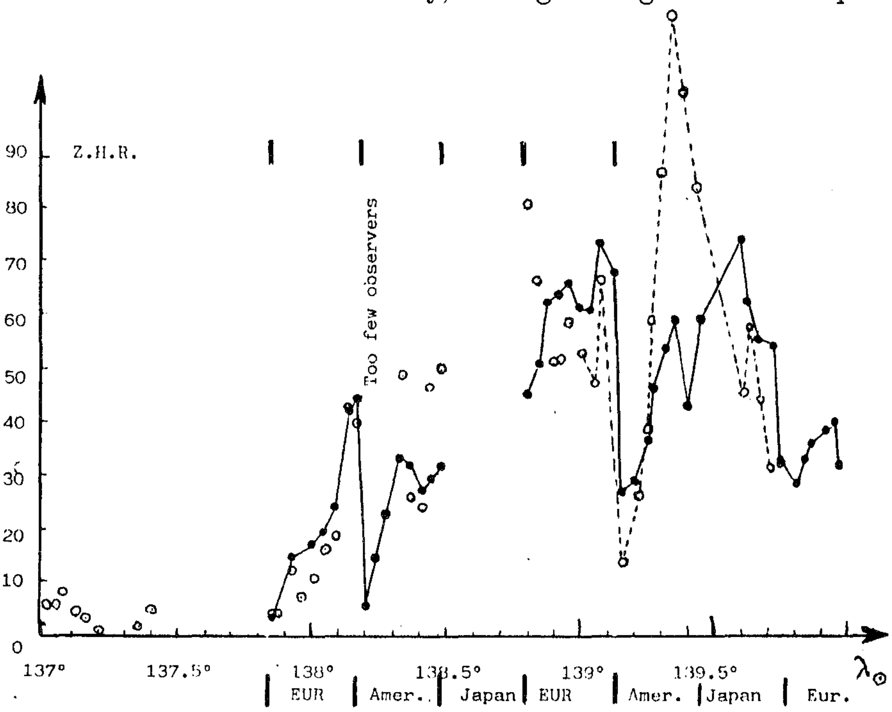


Figure 6 – Averaged ZHR curve of the 1988 Perseid maximum using only high quality observations (2 hour periods).

In 1989, European observers will get the Japanese advantages of 1988, unfortunately with some disturbing moonlight. Europeans will see the steep increase in rates at their morning sky of August 12. Americans will get the unfortunate position Europe had in 1988. Rates will be disappointing with the radiant high in the sky at $\lambda_\odot = 139.^\circ 2$ (local morning of August 12). Japanese observers should see rates increasing steeply after a start with poor rates until midnight, in their early morning sky of August 13. The main maximum starts most favorably in Japan (local morning of August 13) and lasts for 6 hours until midnight in the European sky. The rising of the radiant will then compensate for the decline in activity, as most of the maximum will pass by with a rather low radiant elevation and with moonlight.

3. Magnitude data

Figure 7 shows the variation in limiting magnitude corrected mean brightness for the sporadics (black dots) and the Perseids (open dots). No significant variations can be found except that the proportion of faint Perseids increases sharply after August 16, as in 1986 [8]. Figure 8 is similar to Figure 7, but shows the population index r instead of the mean magnitude $\overline{m}$. The scatter is quite large, the only conclusion being possible is that smaller particles are encountered after the maximum activity. It should be noted that the total Perseid distribution yield a very high r-value far above the literature value of 2.4. It is higher than the value of 2.5 used for ZHR computations. The sporadics yield an r-value about 3 as was assumed in the HR computation. The use of a higher r-value would not change the general features appearing in the ZHR profile as most observations were done in very good sky and are not very sensitive to errors on the assumed r-value. Finally, Table 2 gives daily global magnitude distributions for the 1988 Perseids and the sporadic background.

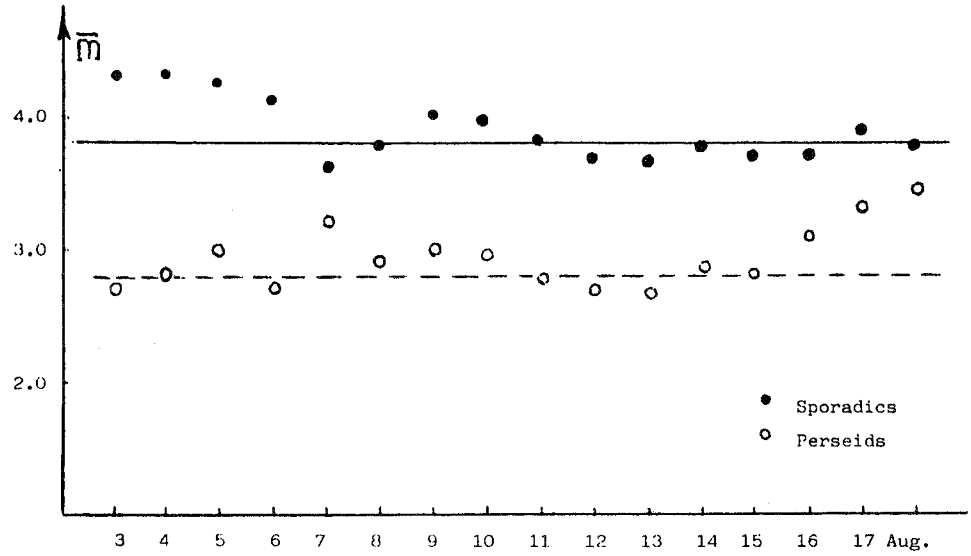


Figure 7 – Corrected mean magnitudes for the 1988 Perseids (open dots) and the sporadic background (black dots).

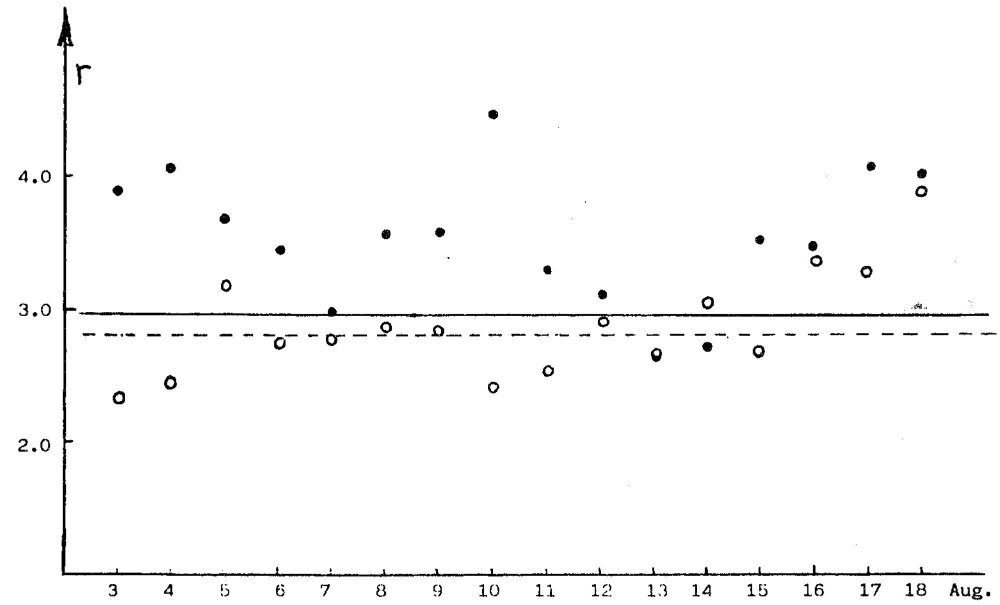


Figure 8 – Daily r-values for the 1988 Perseids (open dots) and the sporadic background (black dots).

Table 2 – Global magnitude distributions of the 1988 Perseids and the sporadic background.

Date	Sh	Lm	−6	−5	−4	−3	−2	−1	0	+1	+2	+3	+4	+5	+6	+7	Tot	$\overline{m}$
Aug 03	P	6.40	0	0	0	0	0	0	2.5	6	6	2	6	3.5	1	0	27	2.65
03	S	6.62	0	0	0	0	0	0	3.5	7.5	8	16	41	55.5	29.5	6	167	4.38
04	P	6.47	0	0	0	0	1.5	9.5	9	12.5	21.5	38.5	33.5	16	7	0	149	2.78
04	S	6.56	0	0	0	0	0	2	5.5	11	31.5	57.5	63	113.5	92	15	391	4.40
05	P	6.49	0	0	0	0	0.5	3.5	13.5	23.5	51	41	51.5	40	7.5	0	232	3.00
05	S	6.39	0	0	0	0	0.5	3	5.5	15	29	56.5	86	105.5	67.5	9.5	378	4.18
06	P	6.46	0	0	1	1	2.5	6	35	65.5	100	107	69	67	10.5	0.5	466	2.67
06	S	6.54	0	0	0	1	0	4.5	14.5	13	56	96	123	152	112.5	24.5	597	4.19

Table 2 – continued.

Date	Sh	Lm	−6	−5	−4	−3	−2	−1	0	+1	+2	+3	+4	+5	+6	+7	Tot	$\overline{m}$
Aug 07	P	5.67	0	0.5	5.5	0.5	10	22.5	35.5	68	89.5	128.5	106.5	48	7	0	522	2.44
07	S	5.67	0	0	2.5	1.5	6	19	33	58.5	76	132	125.5	80	13	0	548	2.81
08	P	6.10	0	0	2	5.5	12	29.5	69	134.5	231	235	189.5	98	16	0	1022	2.51
08	S	6.28	0	0	0	0	1.5	7.5	21.5	47.5	92.5	165	185	159.5	59	9	748	3.57
09	P	6.36	0	0	0	5.5	21.5	48.5	74.5	181	321	377	351	224	64.5	6.5	1676	2.87
09	S	6.57	0	0	0	2	1	6	4.5	38.5	119.5	203.5	267	271	191	39	1143	4.13
10	P	6.26	2	2	1	2	11	30.5	60	122	219	273	225.5	148.5	14.5	0	1113	2.72
10	S	6.37	1	0	0	0	0	1	2.5	30.5	67	136	172.5	146	59	9.5	625	3.85
11	P	6.31	1.5	3.5	10.5	11	34	93.5	212	381	648	735.5	564	306.5	87	12	3100	2.58
11	S	6.52	0	0	1	1	3.5	12.5	35.5	65	164	281.5	332.5	306.5	196	41	1440	3.85
12	P	6.09	1	4	20	51	158.5	356.5	687.5	1300	1762	1911	1403	712	169.5	7.5	8543	2.33
12	S	6.25	0	1	0	0.5	9.5	18.5	41.5	111.5	225	395	382	351.5	130	20	1687	3.50
13	P	6.22	0	3	13	21	69	192.5	394	715.5	1139	1273	900.5	406.5	81	1.5	5209	2.40
13	S	6.36	1	0.5	3.5	2	5.5	9.5	31.5	98.5	224	334	429	325.5	114	18.5	1597	3.54
14	P	6.38	0	0	1	9.5	26.5	80.5	158	408.5	674.5	693	596.5	333.5	104	15.5	3103	2.73
14	S	6.50	0	1.5	1.5	0	4	13	26.5	63	171.5	315.5	388	312	172	41.5	1510	3.81
15	P	6.48	0	0	0	2	14.5	26	50	96	207	233	216.5	88.5	36.5	7	977	2.79
15	S	6.66	0	0	0	1	1	7	17	39	121	185	243	237.5	139	15.5	1006	3.90
16	P	6.38	0	0	0	0	0.5	4	23.5	28.5	59.5	70.5	80	48.5	10	0	325	3.00
16	S	6.39	0	0	0	0	0	3	6	18.5	34.5	71.5	85	72	20	0.5	311	3.61
17	P	6.38	0	0	0	0	0	2	7	19.5	37.5	64.5	51	35	10.5	1	228	3.22
17	S	6.44	0	0	0	0	0	1	8.5	15.5	51.5	98.5	122.5	118.5	47	4	467	3.87
18	P	6.48	0	0	0	0	0	0.5	6	13	34	54.5	65.5	40.5	6	3	223	3.43
18	S	6.52	0	0	0	0	0	1.5	7	15.5	57.5	109	127	117	44	5.5	484	3.83
19	P	6.20	0	0	0	0	0	1.5	6	4	13	25.5	18	6	1	0	75	2.84
19	S	6.22	0	0	0	0	0	0	4	11	16	28	27.5	17.5	1	0	105	3.15
20	P	6.23	0	0	0	0	0	0	0	1	5	1.5	1.5	0	0	0	9	2.39
20	S	6.23	0	0	0	0	0	0	0	2	11.5	12	11	3.5	0	0	40	3.06
21	P	5.65	0	0	0	0	0	0	0	0	0	1.5	2.5	1	0	0	5	3.90
21	S	5.65	0	0	0	0	0	1	0	0	0	4	3	6	0	0	14	3.79
25	P	6.58	0	0	1	0	0	1	4	5	15	22	12	5	0	0	65	2.60
25	S	6.58	0	0	0	0	0	1	0	3	14	10	20	11	0	0	59	3.31
Tot	P	6.23	4.5	13	55	110	363	914	1877	3608	5651	6315	4961	2636	634.5	54.5	27202	2.53
Tot	S	6.41	2	3	8.5	9	34.5	112	276	681	1590	2733	3252	2975	1494	261.5	13433	3.76

4. Conclusions

Looking at the activity profile, we can consider different explanations. Some of them, however, are unlikely.

First, we may safely exclude purely observational effects, since other periods or nights and other streams do not seem to suffer from such effects. All observers used the same method and we may assume that they report consistent data. Next, correction factors might be insufficient to compute the genuine activity of the stream. Therefore, in 1985, a zenith exponent $\varepsilon = 1.5$ was used instead of the usual $\varepsilon = 1.0$ [6]. Although this made disappear some minor fluctuations, new ones emerged and the general shape of the activity profile remained. Only using data obtained under semi-ideal circumstances (e.g. cloudless skies with limiting magnitude above 6.0) does not change anything either.

Another possible explanation is that all or most of the observers active during the dip in between the two maxima have low perceptions. Although this is true for some of them, many of the observers otherwise obtain "normal" rates; why should they all have "fallen asleep" during the same period, both in Europe and North America? Moreover, if observers were less perceptive during the dip, they should also have seen fewer sporadic meteors than usual, and this was not the case. An attempt to correct for perception by relating all rates to the sporadic background made the dip even more prominent.

It seems that the only explanation that makes sense is that the Perseid activity around $\lambda_\odot = 139\overset{\circ}{.}2 \pm 0.1$ (1950.0) was just lower than shortly before or after this period. Looking at some independent individual reports only confirms this thesis.

Czechoslovak observers [9] concluded that the Perseid activity appeared to be lower than in previous years. This is consistent with the author's experience in Southern France where no break-through occurred in the shower activity during the morning of August 12. Preparing his observational report, Jürgen Rendtel [10] wrote: *According to this data set [Bulgaria], there seems to be a (local) maximum of Perseid-ZHRs around* 0^h *UT on August 12. All observers except one found a relative maximum in their independent series...* All this fits very well into the general activity profile presented here: good activity was occurring when the radiant was still low in the European sky. When the radiant got higher, activity declined, and, as a consequence, rates did not improve as much as one would have expected right before the predicted maximum. Activity in the final morning hours were really disappointing to many European observers, as ZHRs were then lower than in the evening.

Dennis di Cicco [11] was rather confused with widely varying opinions on the shower's quality. The major differences in his reports can be easily explained when the double maximum profile is true. Dennis di Cicco refers to the reports of Richard Sweetsir who wrote he was kind of disappointed with the rates in Florida. Karl and Wanda Simmons, also from Florida, got their best ZHR of 42 at August 12, 9^h UT: pretty low. Other observers mentioned in [11] on the other hand report very good rates, but all of them refer to local morning hours of August 12 (10^h–12^h UT), when Florida observers had to cease watching because of day break. The results of di Cicco were confusing for those expecting a single maximum; however, they are fully explained by the double maximum profile presented in this paper.

The Perseids are *not* declining in strength. The low meteor counts reported mainly by United States' East Coast observers can be fully accounted for by a combination of lower activity in between both maxima and the low radiant elevation.

Jones [7] found that hollow meteor streams result from planetary perturbations. He worked with the Geminid meteor stream, for which the only impulsive gravitational perturbations are due to close encounters with the Earth, Venus and Mercury. The highly inclined, eccentric Perseid meteor stream is mainly perturbed by the small mass of the Earth at its annual transit. Both observed maxima are almost 0.009 AU apart in space; in between, particles are less densely packed. If the Perseid core is hollow with maximum particle concentrations on the surface of a torus-like shape along the main orbit, there is of course no reason to assume that the Earth transits through the center, so the actual diameter may even be larger than 0.009 AU.

Finally the question may be asked why a double peak has never been reported earlier, except for 1985 and 1988. Jenniskens [12] wrote in his conclusions for 1988 that the activity was almost the same as in 1983, 1985 and 1986, He even claims that the Perseids are so stable that they are more reliable for determining perception factors than the poorly defined sporadic background.[1] The conclusions of Jenniskens clearly show that local groups covering only a short fraction of each day cannot by themselves detect features in the activity profile that are separated by less than a day. Also, combining data from several years may tend to smoothing away some features as they may show slight variations each year, both in form as in time of occurrence. Only a world-wide effort to follow the stream's activity continuously can yield reliable conclusions.

A numerical integration of Perseid orbits to verify which cross section will emerge will be most helpful. It is well-known [13] that the Perseid stream consists of two superimposed components, one of which is a flat, long lasting branch consisting of strongly perturbed particles indicating the aging process is already going on for several thousands of years. The formation of a hollow toroidal core responsible for the main maxima is more likely the result of short term, less dispersive perturbations.

[1] His database consists of 6496 meteors 55% of which have also been analyzed in this article.

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An Update on the 1989 Quadrantids

Paul Roggemans

A preliminary activity profile of the 1989 Quadrantids in presented, which is mainly based on European and American observations.

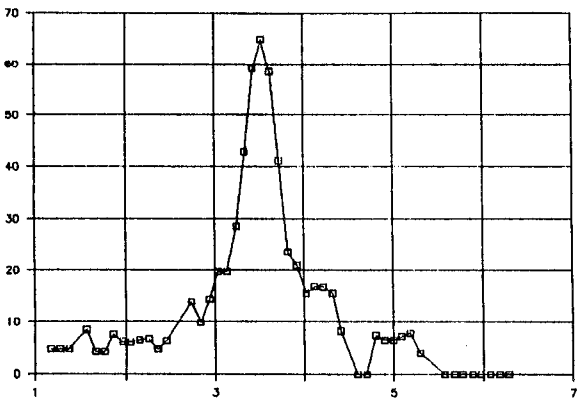

Figure 1 — ZHR profile of the 1989 Quadrantids.

A very good and complete picture has been obtained for the Quadrantid activity profile. Figure 1 shows that the maximum was reached shortly after 12^{h} UT on January 3. American observers got closest to it in their local morning hours, when the radiant was high in the sky. Unfortunately no Japanese observational report became available so far. The time intervals between the last American morning observations and the first European evening observations is not covered and it is possible that even higher rates were seen from Japan. The best rates in Europe were noticed in the morning of January 3. In the evening of that day, the radiant was close to the European horizon, and observed rates rather low. *IMO* looks forward to receiving still some more data, especially from North Pacific observing sites.

A χ-Orionid Fireball over Japan

Yasuo Shiba, Seiko Nishioka and Katsuhito Ohtsuka

The result of orbital calculations of a fireball photographed over Japan on December 10, 1988, are presented. This fireball was a member of the χ-Orionids.

A fireball (no. YS8801) of magnitude -7 was photographed simultaneously from two stations in the Tokai District on December 10, 1988, at $18^h30^m25^s$ UT, by using 35 mm-fireball-cameras with wide angle lenses. The fireball extinguished with eight final flares, a feature not found among Geminid meteors.

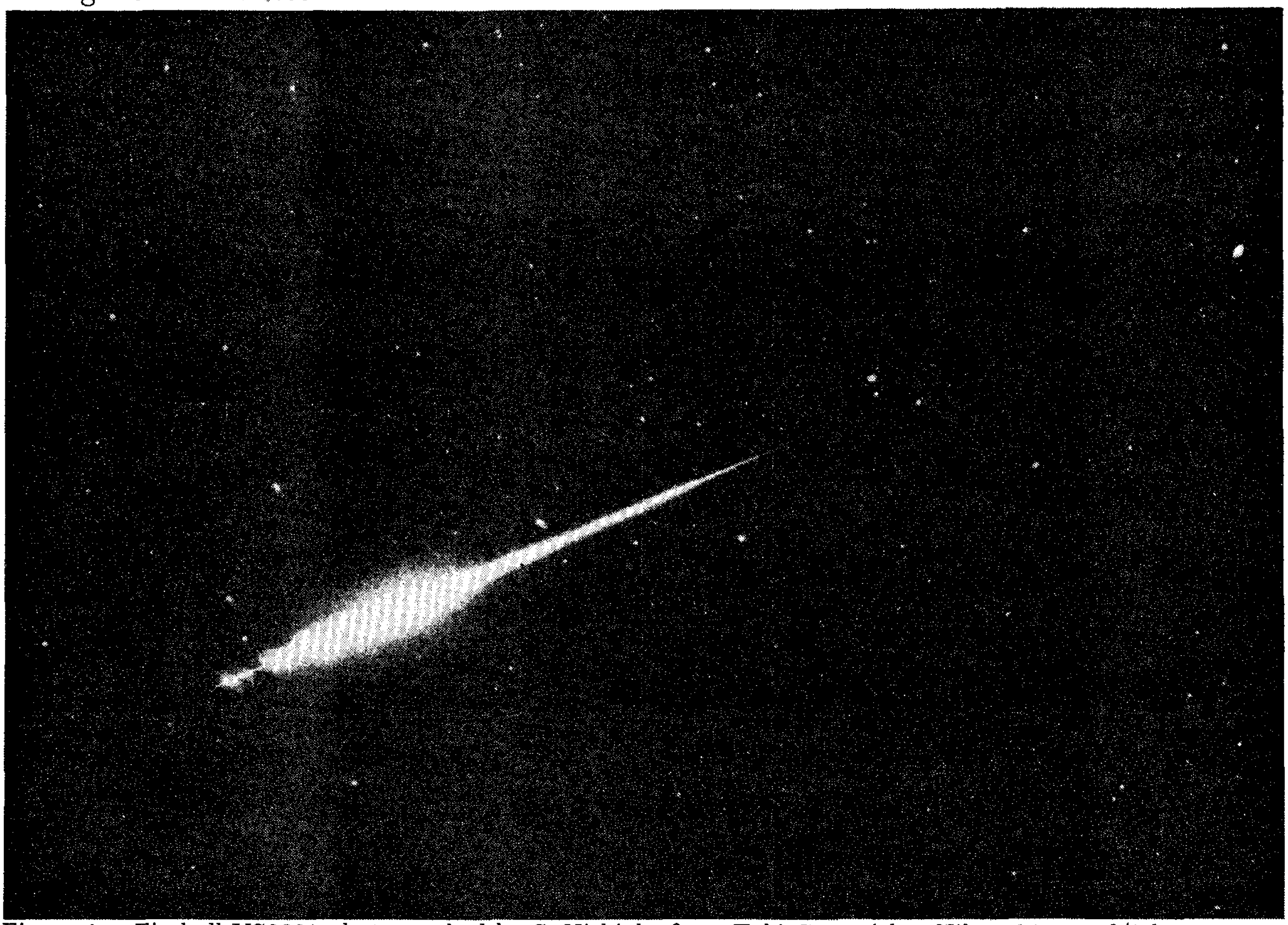

Figure 1 – Fireball YS8801 photographed by S. Nishioka from Taki-Gun with a Nikon 24 mm $f/2$ lens.

Observations and measurements were done by Shiba[1] and Nishioka, and orbital calculations were by Ohtsuka. The results of the trajectory and orbital elements are shown in Tables 1 and 2, below.

Table 1 – Results of trajectory and calculations of meteor no. YS8801 (1950.0).

Time of appearance	1988 Dec 10.77112 UT
Solar longitude	$\lambda_\odot = 258^\circ\!.45$
Apparent radiant position	$\alpha = 82^\circ\!.8 \pm 2^\circ\!.5$ $\delta = +18^\circ\!.0 \pm 0^\circ\!.8$
Corrected radiant position	$\alpha = 79^\circ\!.5$ $\delta = +16^\circ\!.3$
Begin	$\lambda = 136^\circ 58'\!.6$ E $\phi = 33^\circ 27'\!.2$ N $h = 99$ km
End	$\lambda = 137^\circ 22'\!.9$ E $\phi = 33^\circ 29'\!.1$ N $h = 65$ km
Geocentric velocity	21.9 km/s
Heliocentric velocity	37.0 km/s

[1] *We also received the photograph by Y. Shiba, taken from Okazaki-City. Unfortunately, we could not print it due to low contrast.* (Ed.)

Table 2 – Orbital elements (1950.0).

ω	91°
Ω	78°.45
i	5°
e	0.72
q (AU)	0.564
a (AU)	2.0
V_∞	24.2 ± 1.7 km/s

The results indicate that the fireball is a member of the Southern χ-Orionid meteor shower. This shower is probably associated with asteroid 2201 Oljato [1,2,3]. Meteor observers should try to collect more data on the χ-Orionids in order to shed more light on this relationship.

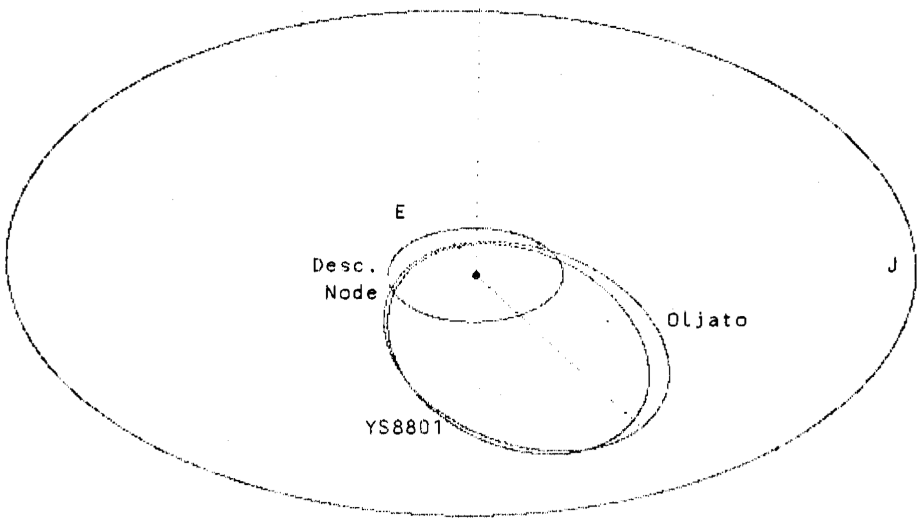

Figure 2 – Orbits of fireball YS8801 and asteroid 2201 Oljato.

References

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Erratum: Monocerotids and Mellish

Mr. Ohtsuka was so kind to point our attention to several printing errors in the tables in his article "The December Monocerotids and P/Mellish" on pages 93–96 of the previous issue of WGN. The errors occurred in the reference numbers for the various meteors and in the dates in Table 1 on p. 93. Especially this last error is very confusing. Therefore, we give the correct table below.

In the continuation of Table 1 on p. 94 and in Table 3 on p. 95, the numbers before the dash in the reference numbers of the meteors should be removed as in Table 1 on p. 93. We invite our readers to apply these corrections to the article of Mr. Othsuka. We apologize to the author for these unfortunate mistakes due to some errors that occurred during proofreading. We will try

harder to avoid similar mishaps in the future! (Ed.)

Table 1 – Photographic December Monocerotid meteors (Eq. 1950.0). Appropriate references are given after the reference number. Data marked with * were remeasured and recomputed.

Ref. Nr.	Date (UT)	$\lambda_\odot$	α	δ	m	V_g	$\sin Q$	$\cos Z$	V_∞	H_b	H_e
9412 [9]	1953 Dec 07.38	255°0	94°	+12°	0.4	44.2		0.92	45.4	95.7	
12564 [8]	1958 Dec 10.20	257°5	99°44	+08°14		42.56	0.704	0.534	44.30	105.8	90.9
9475 [10,11]	1953 Dec 10.52	258°1	101°60	+07°67	1.0			0.555	43.9	105.2	94.4
62* [13]	1977 Dec 10.72	258°2	100°23	+07°93		42.5	0.780	0.852	43.8	101.2	83.5
64* [13]	1977 Dec 11.56	259°0	100°78	+07°66	0.5	41.2	0.553	0.698	42.9	101.3	86.2
9557 [9]	1953 Dec 12.40	260°1	102°	+09°	−0.7	41.6		0.89	42.9	103.5	
2313 [1]	1950 Dec 13.20	260°6	102°6	+08°4	−1.2	42.7	0.120	0.553	44.4	107.9	88.9
552 [12]	1972 Dec 12.87	260°7	102°63	+08°22		41.34	0.451	0.662	42.99	103.0	86.3
TN16 [14]	1985 Dec 13.64	261°1	102°22	+08°02	−1.2	41.9	0.943	0.877	43.4	99.6	82.5
72 [13]	1977 Dec 13.71	261°2	101°6	+07°4	−1.0	39.1			(40.6)	100.0	91.0
73 [13]	1977 Dec 13.71	261°2	102°4	+06°1		40.5			(42.0)	100.0	77.6
75 [13]	1977 Dec 13.75	261°2	103°8	+07°9		43.4			(44.8)	100.8	85.1
9660 [8]	1956 Dec 13.43	261°3	105°35	+08°97		35.21	0.028	0.833	36.75	95.4	92.9
2405 [1]	1950 Dec 15.29	262°7	103°5	+08°1	−1.4	42.1	0.119	0.843	43.7	96.0	80.3
6040 [9]	1952 Dec 17.37	265°4	106°	+11°	−0.7	41.9		0.93	43.3	107.5	
Mean	Dec 12–13	260°2	102°0	+08°3		41.6			43.2	101.9	86.6
S.D.		2°4	1°1	1°2		1.8			1.7	3.8	4.7
1917 I	Dec 14–15	262°6	103°4	+08°6		41.4					

A Visual/Radio meteor Observing Interface

William H. Black

Meteor studies are carried out in the amateur community by a very large number of visual observers and a very small number of radio observers. The two groups have one commonality, competence, but technically and socially, they are worlds apart. This paper describes an impromptu observing session at the 52nd Annual Stellafane Convention where radio and visual meteor detections were observed simultaneously. The results strongly suggest that the scientific value of meteor data could be greatly enhanced by the merger of these two observing modes.

1. Introduction

I have been actively involved in radio meteor detection development/research for the past 10 years. By far, the most successful system developed to date is a receiver system that monitors a long radio path between my station and the video i.f. of TV Channel 4. I currently have two such systems, a 192 mile path to Dothan, Alabama, and a 224 mile path to Nashville, Tennessee. A third path is being built to research the feasibility of defining meteor trajectories, a critical parameter in separating shower members from sporadic meteors.

A sensitive radio system will produce hourly counts continuously. The data it produces can be overwhelming in terms of quantity, while at the same time being extremely difficult to define qualitatively. Parameters such as color, trajectory, magnitude, end points, fragmentation, cannot be accurately measured by radio, whereas the radio system can do the one critical thing that visual observers cannot do: count meteors continuously.

One more thing needs to be mentioned. Radio pathing involves high gain, highly directional antennas which limit the area of the sky that the system "sees". This means that the "sky volume" in which most of the meteor detections occur is primarily at the center of the path. This is an oversimplification of the detection geometry, but it may partially explain why, prior to going to Stellafane, I have never seen and heard a meteor simultaneously.

2. Observing

I decided to take one of my systems to Stellafane to determine whether or not portability is a viable option, and to exploit any latent interest in radio meteor work there might be among the convention attendees. Portability proved to be highly successful, and the system attracted a great deal of interest. The portable system is diagramed in Figure 1.

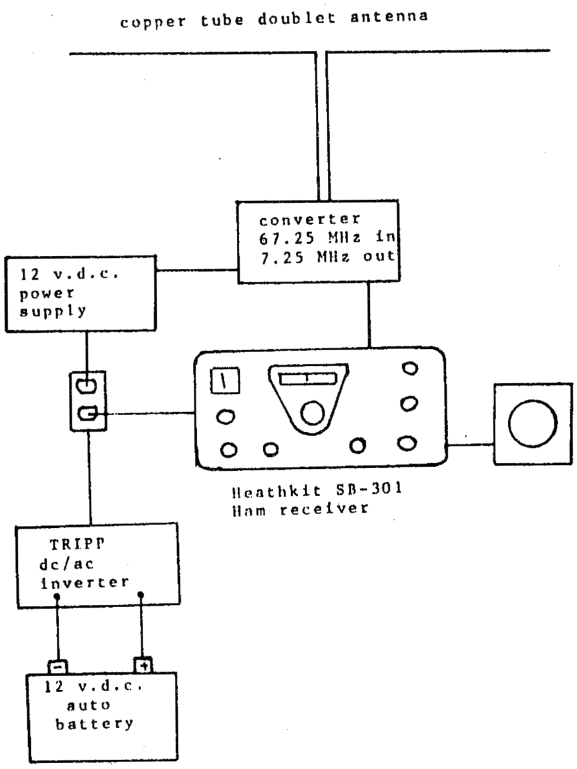

Figure 1 – A portable radio meteor detection system

Friday night the Vermont sky was beautifully clear, and the Perseids were coming at a rate of about one every three minutes. I set up the receiver system next to my camper, while telling some members of the Cape Cod Astronomical Society who were seated nearby what I was trying to demonstrate. They were enjoying the shower display, so circumstances were just right for some correlative observing.

We did not keep track of the time, or the number count, but every meteor that was seen was also heard! Also, there seemed to be a direct relationship between visual magnitude and audio response. I was planning to put the system on display the next day, so to limit current drain on the battery, the session was terminated after about a half hour of observing.

3. Evaluation

At this point in time, I do not know whether what happened was a unique set of lucky circumstances, or whether portable radio/visual observing can be done anywhere on a clear night. By using a dipole antenna instead of a Yagi, the radio system was "seeing" the same local sky as the visual observers. This is probably the most important factor that allowed this coincident observing session to happen, and will greatly simplify design considerations for portable systems.

Another uncertainty is where the radio frequency energy that was illuminating the Vermont sky is coming from. Television stations radiate enormous amounts of power on all channels and for Channel 4, some station in New England that uses a video i.f. sub-carrier on 67.240 MHz was too strong to be used, but when I switched to 67.250 MHz, there was almost no television signal carrier: just perfect sky illumination and lots of meteors.

For each VHF TV channel, there are three possible video i.f. frequencies: Channel 4 stations are assigned either 67.250 MHz or one of the offset frequencies of 67.240 or 67.260 MHz. This means nothing to the casual TV viewer, but it is a great asset to using these frequencies for radio meteor work: if one station is too strong, select a more remote station by changing to another frequency. Since returning home from Stellafane, I am redesigning a portable system that can monitor Channels 3 and 4. I am certain it will work well, but I regret that I cannot bring that Vermont night sky to Atlanta! However, with four good showers in the next five months and winter skies not too far off, many hours of correlative observing are being planned.

4. Future

To my knowledge, this is the first time ever that such a perfect correlation of radio and visual events has ever been demonstrated. It may also be the first time that a radio detection system has been run as a portable unit. It is most unfortunate that such good luck befell such an unprepared observer. On the other hand, one of the most exciting possibilities in amateur meteor astronomy may be nearer to reality.

Picture this scenario. An astronomy club, maybe yours, decides to develop a profile of the Perseid Meteor Shower. The group has experienced visual observers and recently completed a portable radio unit. The radio unit has dipole antennas for TV Channels 3 and 5, because there is a local Channel 4. The portable unit has a Yaesu FRG-9600 receiver, powered by an dc/ac converter from an automobile battery. In addition to the portable unit, one member has set up a similar station at his home: the receiver output goes through an A/D converter into a PC, which is programmed to accumulate counts and print the counts every six hours. The observing plan is to make a 96 hour run, to cover two days before and two days after the shower peak.

The home station is started and will, virtually unattended, collect meteor counts continuously over the 96 hour period. That capability is old hat: the real excitement mounts after nightfall on the second night (the first night was cloudy). Skies have cleared, the beautiful crescent of the moon just past new has set and as midnight approaches, the number of meteors has perceptively increased. Here is where it comes all together. All kinds of new and interesting correlations are now possible. What does a meteor that fragments sounds like? Is there any relation between color and sound? How do trajectories relate to sound? For meteors with persistent trails, which lasts longer, the sight or the sound? Is magnitude/sound linear?

A broken layer of thin clouds moves in between 3^h and 4^h a.m. local time. The brighter meteors can still be seen, the radio signals are unaffected: a good time to develop some feel for correlations during periods of degraded visibility.

After the observing period is over, the database is vastly more valuable than if it had been derived from one input mode. Although not without it's faults and shortcomings, you can now monitor *every* meteor shower: day and night, rain or shine, you can collect data. Who will be the first to discover a new meteor shower using such a capability?

I would like to correspond with any individuals or groups who are interested in developing a radio/visual interface. If you need specific information about radio monitoring, send me a large self-addressed stamped envelope. My address is: *William H. Black, 1493 Sugar Maple Court, Lilburn, Georgia 30247, USA.*

Lake Lucerne Radio Meteor Observatory

William Black

The Lake Lucerne Radio Meteor Observatory is an amateur radio astronomy facility currently specializing in radio meteor research and data collection. The observatory and this publication are dedicated to the belief that the progressive amateur astronomer can produce worthwhile contributions to radio meteor science. The observatory, while operational, is still mainly in a developmental phase. The ultimate goal is a facility that is capable of producing creditable meteor data continuously. Producing data continuously is relatively simple, but the strictest definition of "creditable meteor data", discussed in the article, is by far the most challenging problem facing any amateur involved in the meteor science.

1. Introduction

Many amateurs name their observatories. Names can relate to memorable people, geographic locations, functional descriptions, fictional characters, acronyms, etc. I chose the Lake Lucerne Radio Meteor Observatory because I live in the Lake Lucerne area of Lilburn, Georgia, and the observatory currently is devoted entirely to radio meteor research and data acquisition. In the past few years, several amateurs have made very significant contributions to radio meteor science, and the competency of these amateurs are an integral part of the accomplishments and future planning at the LLRMO.

2. Facilities

The LLRMO currently has two fully computerized radio detection paths. The north-south path uses the video i.f. carrier of television channel 4 in Dothan, Alabama, on a frequency of 67.250 MHz. The path length is approximately 300 km. The east-west path is approximately 600 km, and originates from television channel 3 in Memphis, Tennessee on a video i.f. carrier frequency of 61.240 MHz.

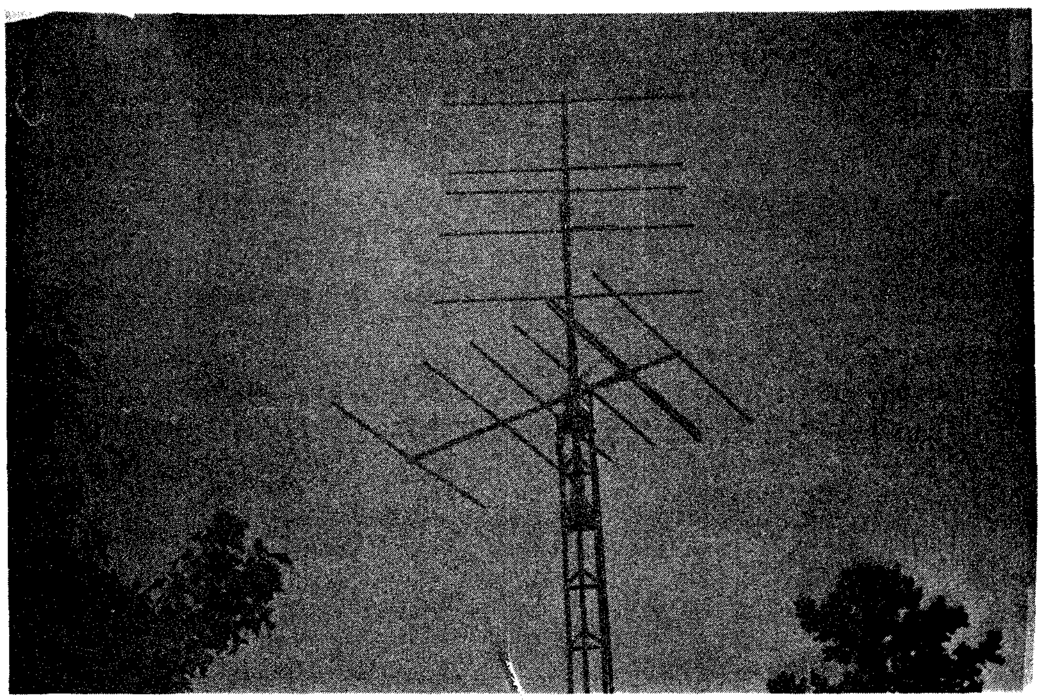

Figure 1 – Antennas used in the Lake Lucerne Radio Meteor Observatory.

The antennas used on these frequencies are illustrated in Figure 1. The top antenna is a commercial beam for channel 4, whereas the bottom antenna is a homebrew Yagi for channel 3. Another Yagi is under construction for a third path, and a dipole antenna is available for radio/visual correlation studies.

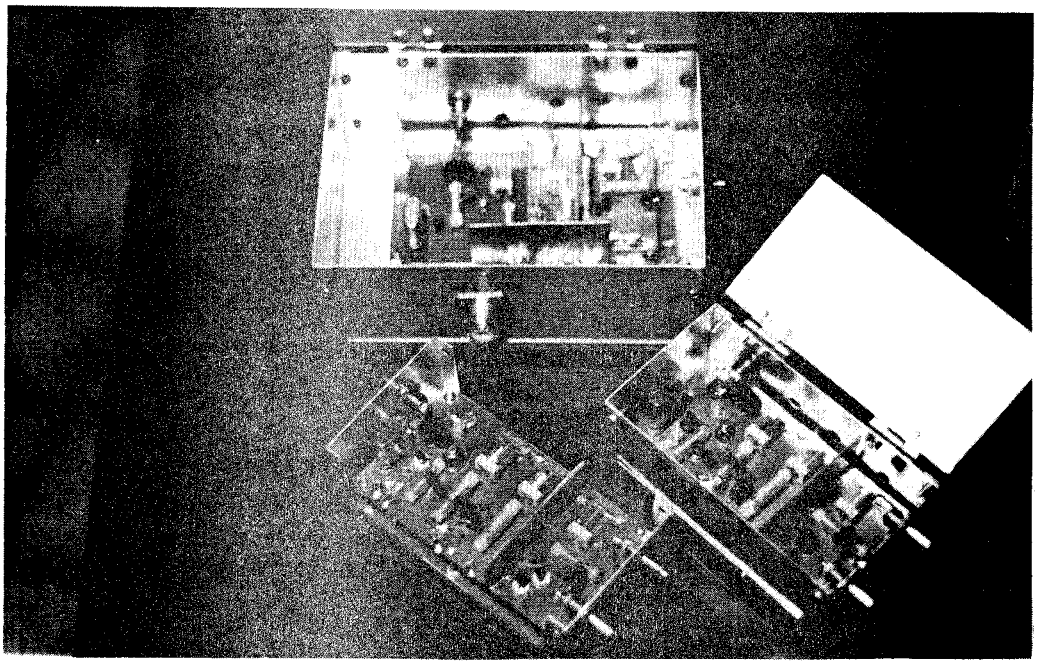

Figure 2 – Converters to with the two path antennas of Figure 1 are connected.

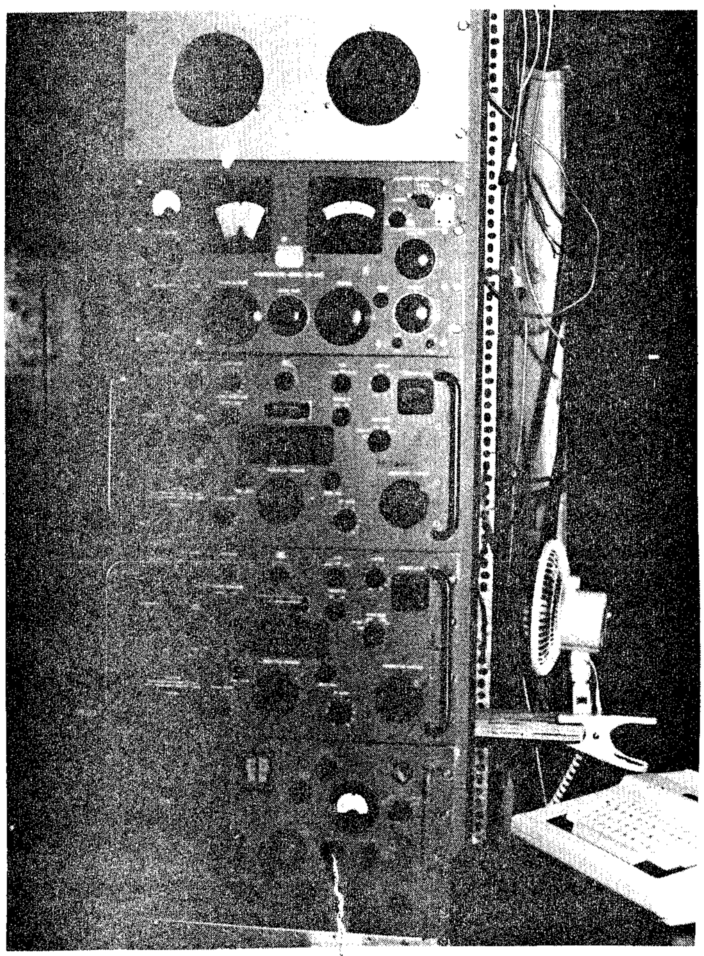

Figure 3 – The converters' output to the two Collins R390A receivers

The two path antennas are coaxially connected to the converters illustrated in Figure 2. The largest converter outputs on 10.7 MHz, but the other two converters were modified to output on 7.250 MHz, making them usable with any ham type receiver. The converters were modified from the Swenson-Franke design in the November 1979 *Sky and Telescope*.

The converters' output to the two Collins R390A receivers is illustrated in Figure 3. The rack contains four military surplus receivers. The top receiver is a Hammerlund SP600X, used to monitor WWV. Beneath it is the receiver for the Memphis-Lilburn path. The next receiver down is for the Dothan-Lilburn path. The bottom receiver can be used as a backup if either of the primary receivers are lost during a run. Still another receiver, a Heathkit SB301, is available, and will be used when the third path becomes operational.

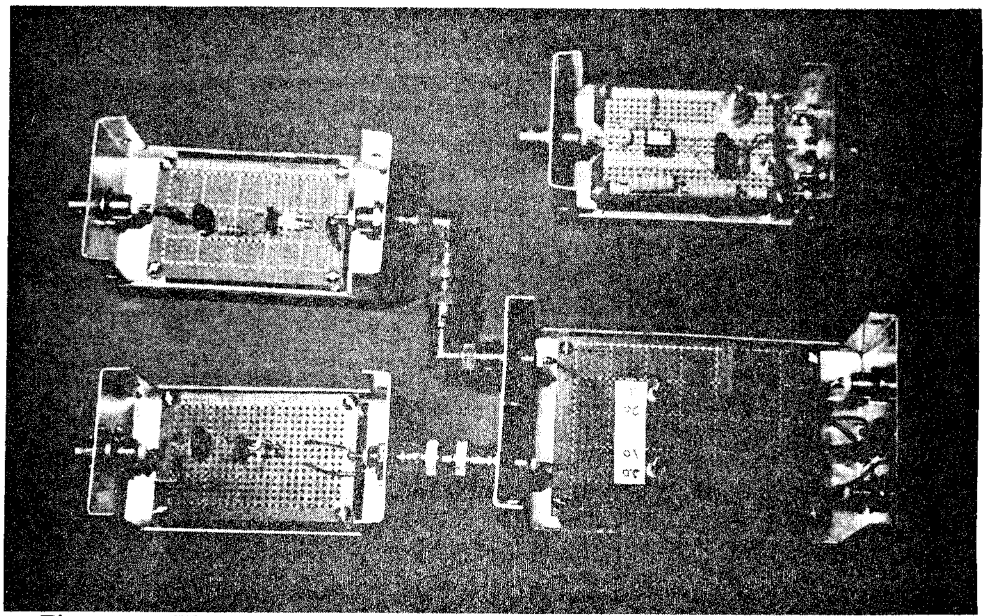

Figure 4 – The receivers' output to the d.c. operational amplifiers.

The receivers' output to the d.c. operational amplifiers is illustrated in Figure 4. The top unit is a single 741C, the bottom unit is a pair of 741Cs, driving separate LED/CdS detectors.

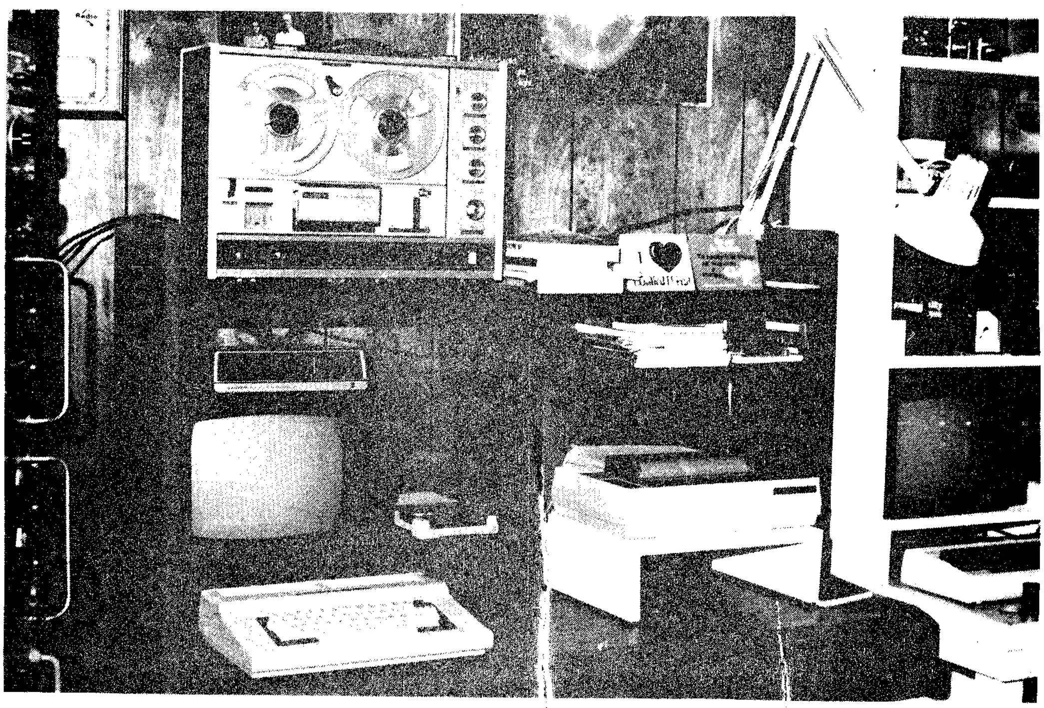

Figure 5 – Radio Shack TRS80=Color Computer 2 with DMP-130A printer.

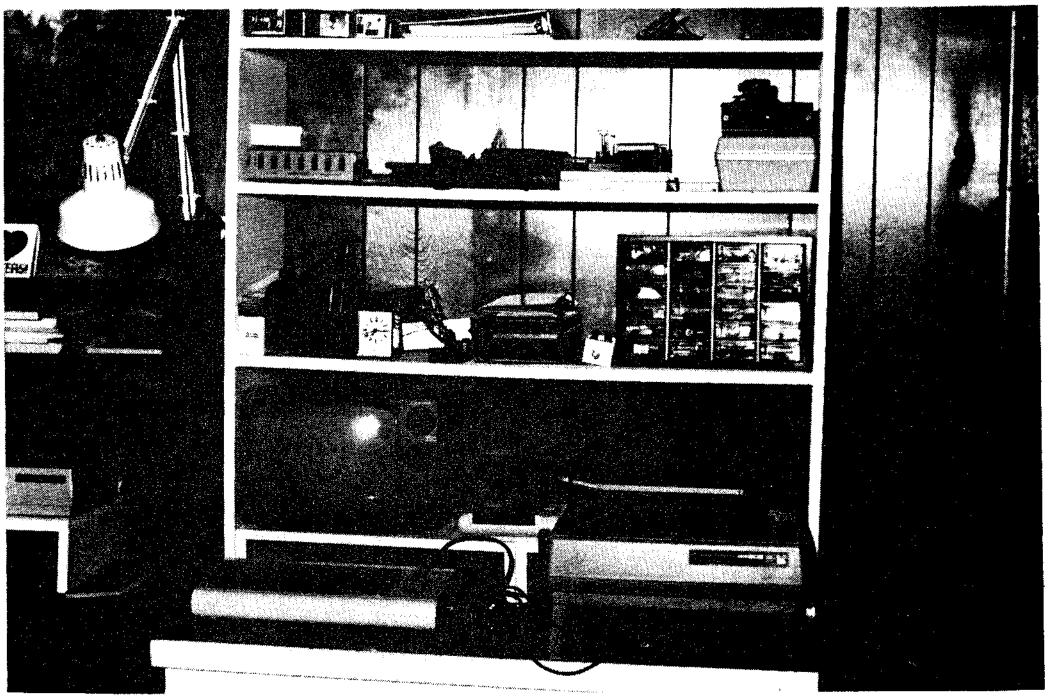

Figure 6 – Commodore VIC-20 computer with MPS-802 printer.

The detected meteor signals are counted and accumulated by the computers shown in Figures 5 and 6. Figure 5 shows a Radio Shack TRS80-Color Computer 2 with a DMP-130A printer and Figure 6 shows a Commodore VIC-20 computer with a MPS-802 printer. Both computers use 49 USD black-white televisions as monitors. A Commodore 64 will be in place by the end of February. When used for data input, the TRS80 Color Computer 2 joystick ports function as A/D converters. The game port on the VIC-20 is accessed through the LED/CdS detectors. The current configuration of operating equipment is shown in Figure 7.

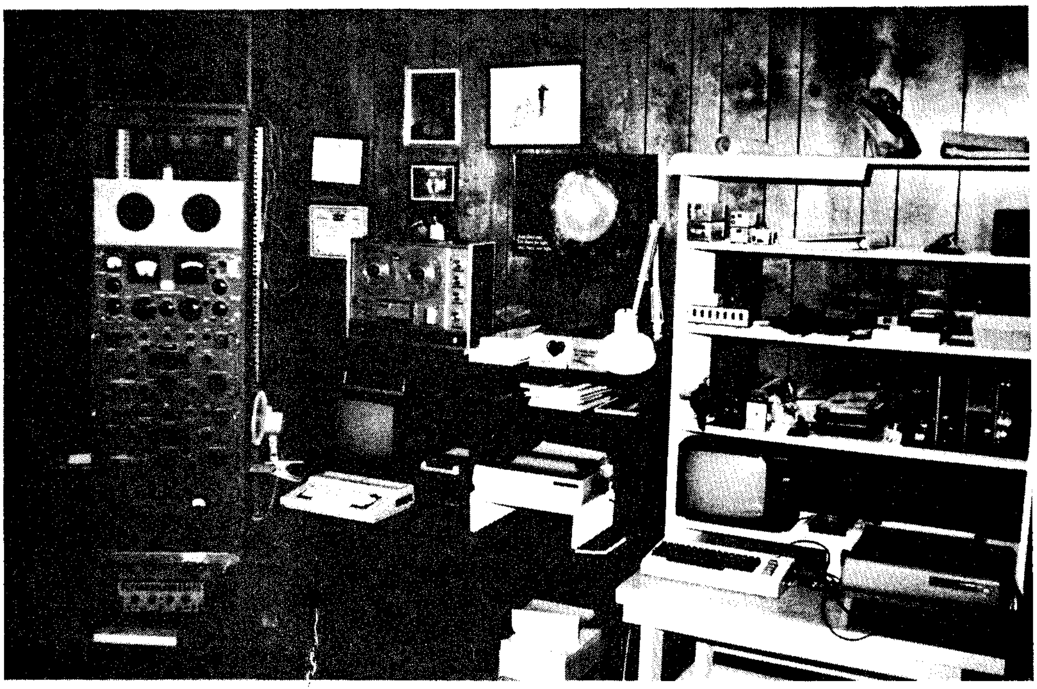

Figure 7 – Current configuration of operating equipment.

3. Current programming

The LLRMO is capable of producing single path data. Now that the east-west path is operational, continuous shower and/or sporadic monitoring on two paths simultaneously is possible. If present planning stays on schedule, a fully computerized three path capability will be operational in time for the April Lyrids. The extension of a single to a multipath capability is simply adding new hardware and facilities, but the extension of data interpretation is not quite that simple. To my knowledge; three forward scatter paths terminating at a single point and operating simultaneously has never been attempted, so a great amount of run time for sporadic and shower periods will be required to accumulate definitive data, most especially for the shower periods.

February and March are good months for systems development, with meteor activity at an annual low. At the present time, all of my resources are being directed towards the completion of a fully computerized three path detection system to be operational by mid-April, 1989.

4. Future Programming

It is one thing to plan things, and quite another thing to actually do them, which is why my most profound and expensive plans are in future planning. To date, everything planned has been accomplished, but this is because I have built progress around manageable time blocks, low expenditures of money, and most particularly, simplistic approaches to the physics and computer software so intrinsic to radio meteor science. Reality will probably force me to stay with the manageable time blocks, but this same reality will also force me to press ahead with the hardware, software, and technology upgrades that indicate two greater expenditures—money and mental.

Specifically, my present detection systems are built on state-of-the-art converters, but the receivers are almost antiques, and the computers are almost inexpensive toys. The upgrades to new receivers will probably include considering something like the Yaesu FRG-9600 - three of them - somewhere between 1500 and 2000 USD. Another possibility is to stay with the converters and get newer ham type receivers.

As for the computers, the transition to high speed, memory and storage intensive PCs is an absolute must—right now I am working with RAM and cassette storage only. The upgrade must also include accurate A/D converters as input devices, with the computer systems having high-speed online data acquisition and reduction capabilities.

Why build a three path detection system? Why must it have such expensive receivers and computers if configurations in use now can produce shower profiles and sporadic counts? In order to answer this question, we have to note two facts:

- radio detection methods cannot distinguish shower meteors from sporadics, and
- shower and sporadic counts are somewhat qualitative because each detection cannot absolutely be identified as a meteor.

Both of these can be done quite accurately by the visual observer, but the visual observer is limited to fair weather night sky.

This disparity in observing techniques has defined the future research programming at the LLRMO. Can a three path radio detection system using high speed computers with a common time base, define a meteor trajectory while tracking a shower radiant, and say with a high degree of certainty that the meteor is or is not shower related? To further complicate the system's integrity, can it be certain that it detected a meteor and not a piece of space junk, or something other than a meteor? The construction of such a system will require quality, precision components, and some very sophisticated computer algorithms. Add to this another goal: a system that can produce meteor data continuously, even if the system experiences a local power failure.

As things proceed at the LLRMO, I welcome any help, support, advice, parallel efforts etc. from any source. I know from recent contact with the newly formed *International Meteor Organization* that there is much quality knowledge and data to build on, and that there are many competent amateurs involved in meteor research. The chances of developing and implementing radio detection systems that can accurately monitor meteor activity continuously may yet prove to be an insurmountable long shot, but it is certainly a very challenging and worthwhile venture for the amateur who feels compelled to try something different.

5. Conclusions

The reader experienced in radio meteor work will see this article as "old hat", and that is exactly what it is. There is really nothing here that has not been done by others.

Any amateur who has strayed into any aspect of radio astronomy has already found out the meaning of ingenuity, trial and error, creativity, frustration, homebrew, etc. The pretty pictures here do not begin to tell the endless hours of trial and error and construction that somehow became a working reality, and I say without reservation that many other amateurs will attest to that statement. There is something very unique about the things that can be done with this observatory, but there is nothing unique about building it—too many amateurs have persevered and succeeded with similar efforts, and I am most appreciative of the help I have had from some of them.

In today's world there are easier approaches to building a radio meteor observatory—one can start with a commercial receiver and antenna, set the "Off/On" switch to "On", the receive frequency to an appropriate frequency, and there are the meteors. They are there all the time—all you have to do is listen. It is almost as easy as buying a Celestron or Meade and becoming an instant amateur. For those interested in becoming involved in radio meteor work, you do not have to go through all the technical hassles I have been through, but I know of no ways around the cost considerations.

Hungarian Radio Observations of the 1988 Ursids[1]

István Tepliczky

An account is given of Hungarian radio observations of the 1988 Ursids. It is concluded that the Ursids form a sharp stream, beginning at $\lambda_\odot = 270\overset{\circ}{.}40$ and lasting for about 5.5 hours with an activity of about 3 to 4 times above the sporadic background.

Last year our visual observations of the Ursids were hampered by moonlight. Since the activity of this stream produced an intensive maximum in 1986, we decided to use the same method of observation for the Ursids as we did for the April Lyrids. For 27 hours, eight persons listened to FM meteor echoes:

Rezső Dunai, Kálmán Kéri, Zoltán Nagy, Gyula Nyerges, István Tepliczky,
Tamás Tóth, László Vámosi, Krisztián Wieszt.

Usually one person observed in 30-minute intervals. The instrument used was a Moderato 1025A receiver (4 μV sensitivity in FM), the frequency we listened on was 94.7 MHz, the antenna was a single dipole with an east-west directed sensitivity maximum.

We started our observations in the morning of December 21. That day and the next, a small, well-characterized maximum was observed in the morning hours, possibly caused by a long duration daytime stream. The intensive meteor activity started on December 22 about 1^h00^m UT. The activity raised itself 3 to 4 times above the sporadic level. Maximum was observed

[1] *All solar longitudes in this article refer to 1988.* (Ed.)

between 2^h30^m and 2^h45^m UT ($\lambda_\odot = 270\overset{\circ}{.}47$). Then the activity gradually decreased again with small fluctuations. It ended suddenly at 6^h30^m UT.

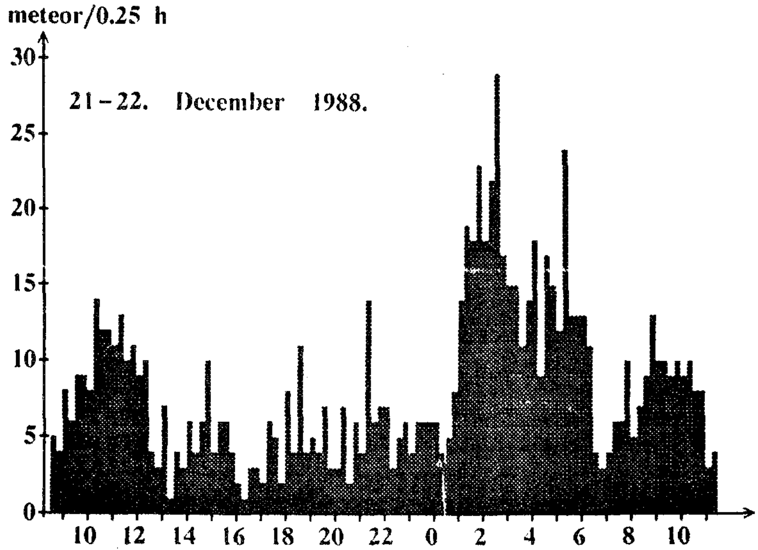

Figure 1 – Radio activity of the 1988 Ursids as observed in Hungary.

The Ursids form a sharp stream. Their activity was spread over 5.5 hours, beginning at $\lambda_\odot = 270\overset{\circ}{.}40$. To check this, we did a meteor count the next two mornings, but then only average activity was detected. We think our observing method is effective for meteor streams of short duration.

Just recently, we received a report from Spain confirming the high Ursid activity in 1986, which was registered in Norway and elsewhere. Although the article arrived very late, we judged that its contents justifies a brief summary. (Ed.)

The 1986 Ursids from Spain

José Trigo M. Rodríguez

During routine observations near Valencia, Spain, on December 22, 1986, an unexpectedly intense Ursid activity was registered.

I started my meteor watch at 19^h05^m UT. In the beginning no unusual activity was seen, which can be partly explained by the low elevation of the radiant. Yet at $19^h33^m46^s$, a -5 Ursid appeared in Aquarius, making me and my companion, Julio Marco Gonzalez, a little restless. At first impression, the fireball looked sporadic to us, but when half an hour later the activity had already spectacularly increased, we reckoned that we were witnessing an unusual event and that the fireball was undoubtedly connected with it. From about 21^h30^m UT, we were confronted with a really high activity, registering 10 meteors in about half an hour. Our major setback that night remained our unpreparedness against the biting cold, so we had to stop observing at 21^h53^m. All in all, 22 Ursids were seen during 2.37 hours of observing, with a limiting magnitude around 5.3 and an average radiant altitude of 25°.

The following night we went observing from the same site, but we did not see any activity from the radiant and so did not conduct a continuous observing session. In 1987 we did prepare another Ursid observation campaign, but the activity remained below the predictions, and not more than ZHR 10 was achieved, although the night of December 21–22 we were not able to observe continuously because of Murphy's law.

FM Variations On Diurnal Sinusoidal Patterns of Meteor Echoes

Thomas R. Manley

From April 26 through May 13, 1988, 24 hour meteor counts were made for the η-Aquarids with narrow FM. On these observations, FM variations on diurnal sinusoidal patterns of meteor echoes were examined.

1. Introduction

The η-Aquarid meteor shower was monitored from Sebring, Florida. 24 hour observations were recorded from April 26, 1988 through May 13, 1988. The total number of meteor counts per hour was made with narrow FM (as used in amateur radio) mostly on Channel 4. Narrow FM discriminates against lightning and the AM signal given off by the C 64 computer.

The greatest positive anomaly from the basic diurnal sinusoidal pattern (attenuation of 10 to 15 decibels at roughly 0^h UT) was observed when the radiant was between the horizon and the local meridian. Sebring receives meteor echoes from Jacksonville and Miami. The anomalous pattern had to come from Miami because the radiant is in the southern sky in the constellation Aquarius. When the radiant passed the local meridian, the potential path of the meteor echoes became more and more indirect and less distinct in the total meteor count.

Only meteors with a sharp rise (several tenths of a second) and usually a more gradual decay were counted in the total. Occasionally, channels 3 and 5 were substituted for channel 4 when E-layer clouds refracted channel 4 too strongly for echoes to be heard. Sometimes E-layer clouds refract sounds from various places that disrupt the recording of echoes. If only a portion of an hour was recorded, then the total count value was recorded with the appropriate multiplication factor.

2. Equipment used

The AR-2002, made by AOR, Ltd., Tokyo, Japan is a communications receiver and was used for all the observations. The receiver is quite stable and did not drift off frequency. The TV channel frequencies that allowed reception of meteor-echoes were programmed into the scanner: 55.25, 61.24, 67.24, 77.24 and 83.265 MHz for channels 2 through 6. AM and narrow band FM were put into the scanner for these frequencies so that the receiving conditions for all 5 channels could be quickly ascertained. Also, the sound tracts for these channels were programmed into the scanner. This allowed occasional identification of the stations and their cities. If the sound tract was low in volume or not present, sometimes a large amount of noise from E-cloud refraction obliterated the recording of echoes.

A small, high quality strip chart recorder was used in the recording of echoes. It requires some external wiring, and, also, the two pieces of plastic that hold the 2″ roll of paper have to be broken out with a pair of pliers before a complete roll of paper can be used without the recorder stopping from sticking in the plastic holders. Additionally, a band saw must be used to cut 2.25″ wide paper down to 2.00″ because no 2.00″ wide paper is easily available commercially. However, the surplus recorder is cheap, high quality and fully worth the price paid for it.

I took the input from an external speaker, which I have buried in the ground about 2.5 feet deep so that I do not have to listen to loud noise. An old FM recorder was attached to the circuit so that I could listen to the noise with earphones that have adjustable volume. An equalizer can also be switched into the circuit so that the different audio frequencies can be observed.

Nearly all the TV filters that Radio Shack sells were placed in line with two 20 decibel attenuators. All meteor echoes were recorded with 20 decibels of attenuation. This helps to eliminate interference from local FM and AM stations. The antenna is a Radio Shack V-185 for VHF-FM and it is 15 feet above the ground. The antenna was aimed at about N40E during all the observations. No antenna amplifier was used.

3. Practical considerations

The diurnal (daily) sinusoidal pattern of meteor echoes has its maximum near the start of the day at about 7^h a.m. local time and its minimum at about 7^h p.m. In the eastern United States, the maximum is at about 12^h UT while the minimum is around 0^h UT. When the hourly rates of meteor echoes are started at 0^h UT, the basic daily pattern approximates that of a normal curve. Ultimately, this data will have to be analyzed by statistical methods. However, this paper will deal only with the obvious variations from the roughly sinusoidal diurnal pattern of meteor echoes. Possibly, some of the nuts and bolts of radio meteor detection need to be worked out before powerful statistical analysis is used.

Narrow FM (as used in ham radio) was chosen as the method of recording meteor echoes. The only sound associated with the echoes is a swish or a diminution of static. Both these sounds indicate signal enhancement. FM is superior to various AM methods because it discriminates against the very rapid lightning strikes and other AM extraneous signals like the AM signal coming from an adjacent radio station or from a C 64 computer sitting on the table. Additionally, recording echoes at 20 decibels of attenuation also helps discriminate against local interference from FM stations.

Sporadic E-layer signals can obliterate the recording of meteor echoes at any time. However, they appear to occur mainly during the evening and early morning hours. If an E-layer cloud lies to the north of my station and obliterates my results with strong modulation, I sometimes can still receive echoes from a station to the west. If a portion of an hour is lost due to E-layer clouds, then the count is made by appropriate extrapolation of the existing data. If an entire hour of data was missing, it is missing in the bar graph.

Only meteor echoes with a rapid rise (several tenths of a second) in signal enhancement and a slower decay pattern were recorded. This helps eliminate the slower rising signal enhancement of aircraft and sporadic E layer signals from being counted. The minimum graphing speed of the recorder that can be used for this is about 3 feet per hour.

4. Data analysis

The following six bar graphs are representative of the eighteen days on which continuous 24 hour recordings of echoes were made. The April 27 graph shows an anomalous high from about 16^h to 19^h UT. I do not know what meteor shower this is from because it does not seem to fit any of the known ones.

Notice the anomaly in the May 4 graph from about 9^h to 11^h UT. Also, the total counts of meteor echoes has increased from those on April 27. This anomaly is due to the η-Aquarid meteor shower. On May 7, the anomaly is extended from 9^h to 13^h UT, with even higher total counts. The η-Aquarid shower showed its maximum anomaly for four hours until the radiant approximately reached the local meridian. After the radiant reached the local meridian, the paths of meteor refractions became increasingly indirect. These longer distance paths were not recorded as often as the shorter more direct paths when the radiant was east of the local meridian.

The bar graph on May 13 shows that the η-Aquarid meteor shower has subsided. However, there is still an interesting anomaly from 17^h to 20^h UT. I do not know whether this anomaly is a part of the diurnal cycle or due to an unknown meteor shower.

Acknowledgments

Many thanks to Bob's *Radio Observer* which initiated my interest in meteor detection by radio. Dr. David Meisel and Bill Black gave me valuable information which helped me conceptualize the whats and wheres of this method of meteor detection.

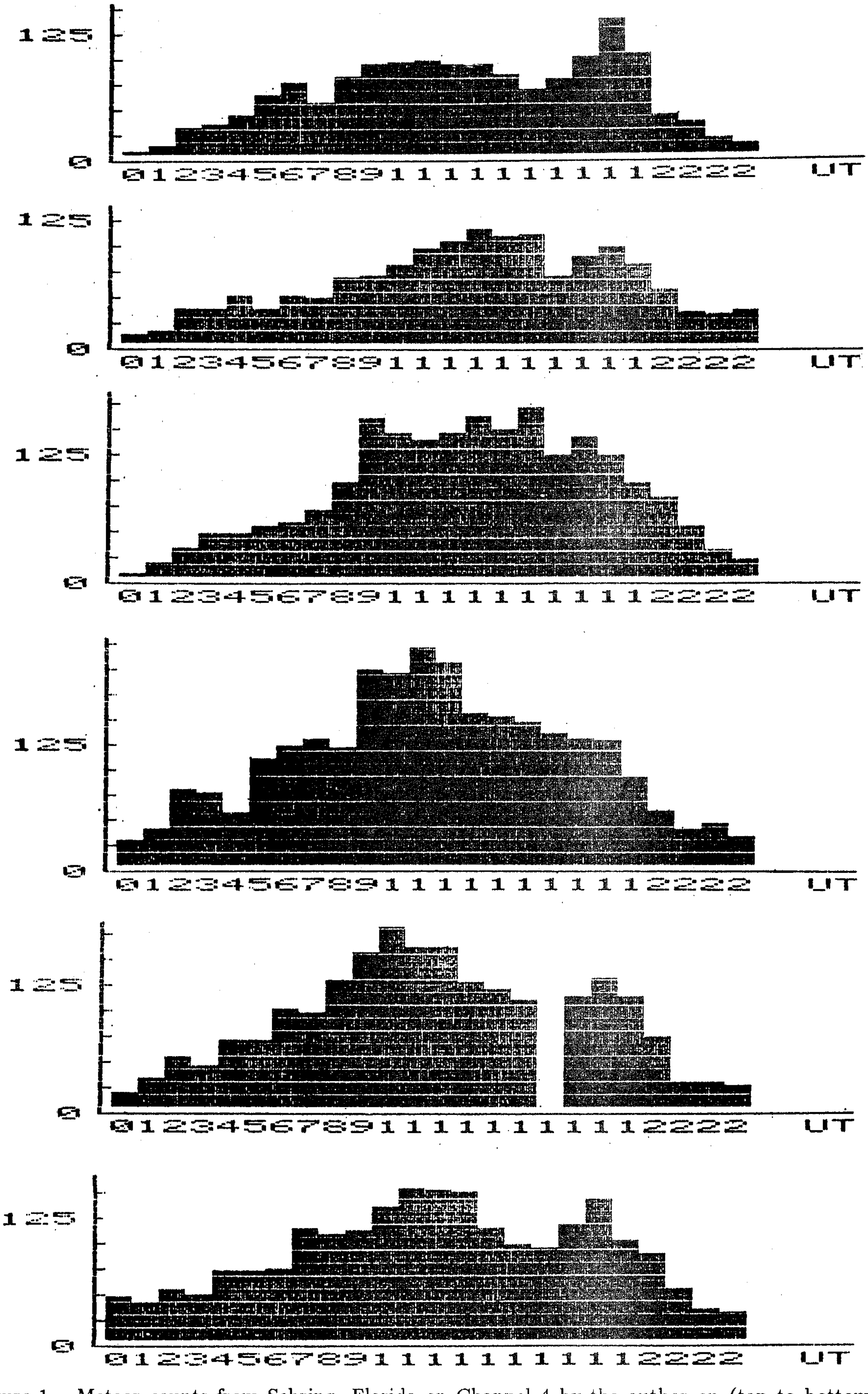

Figure 1 – Meteor counts from Sebring, Florida on Channel 4 by the author on (top to bottom) April 27, May 1, May 4, May 7, May 10 and May 13.

The 1988 η-Aquarids

The 1988 η-Aquarids in Southern Brazil

Gilberto Klar Renner

An overview is given of the observations of the 1988 η-Aquarids in Southern Brazil.

1. Introduction

The following observers of Porto Alegre (Southern Brazil) observed the η-Aquarids in 1988 during only five nights:

> Darlan Morais (DM), Gilberto Klar Renner (GKR), Luís Antônio da Silva Machado (LASM), Luiz Antônio Reck de Araújo (LARA), Luiz Augusto Leitão da Silva (LALS), Onofre Dácio Dalávia (ODD).

The following observing sites were used:

Table 1 – Observing sites used for the 1988 η-Aquarid watch in Southern Brazil.

Loc	Observing site	λ	ϕ
1	Canoas	51°10′ W	29°55′ S
2	Porto Alegre	51°11′ W	30°05′ S
3	Porto Alegre	51°10′ W	30°03′ S
4	Imbé	50°08′ W	29°48′ S

The observational data are in Table 1.

All participants with exception of Onofre Dácio Dalávia used a tape recorder for collecting the meteor data. This observer, as can be seen in this and other papers [2,3], has a very high perception compared to other observers of our group. Six observers estimated meteor magnitudes, but only five of them recorded color and train. Contrary to other years [1,2,3], our team observed the η-Aquarids in 1988 until May 22. As can be seen, this shower still shows a little activity then [4,6].

The author and Luís Antônio da Silva Machado once more observed meteors appearing in the vicinity of the radiant with approximate coordinates $\alpha = 332°$ and $\delta = 0°$, next to the o-Aquarids radiant ($\alpha = 330°$ and $\delta = -2°$). This minor stream is listed in the BMS Radiant Catalogue as number 241, where it is stated that the stream is active from April 29 to May 11 [5]. Since 1985, the author has seen six short meteors in that area. The first was seen on May 1, a point meteor. The second appeared on May 2 of the same year and another on May 8. A short meteor was also recorded on May 3, 1987, and in 1988, on May 5, two short meteors appeared almost simultaneously in opposite directions (northward and southward). They were seen by two observers and, in the opinion of the author, they were slower than η-Aquarids. We hope to obtain more observational data on this issue in 1989.

2. Results

In Table 2, we present the data obtained during the η-Aquarids observations in 1988. The brightest η-Aquarid appeared on May 5, and was estimated as -4 by Luiz Antônio Reck de

Araújo.

Table 2 – Brazilian observations of the 1988 η-Aquarids

Date (UT)	$\lambda_\odot$	Obs	Loc	T_{eff}	Lm	F	η – Aqr	Spor
May 04.34	44°08	ODD	1	0.82	5.3	1.00	19	44
05.31	45°02	DM	2	0.83	5.2	1.33	9	4
05.36	45°07	DM	2	0.75	5.2	1.00	11	2
05.31	45°02	GKR	2	0.83	5.2	1.33	6	3
05.36	45°07	GKR	2	0.75	5.1	1.00	8	5
05.31	45°02	LASM	2	0.83	5.2	1.33	10	4
05.36	45°07	LASM	2	0.75	5.0	1.00	11	5
05.31	45°02	LARA	3	1.00	5.3	1.25	4	4
05.31	45°02	LARA	3	1.00	5.3	1.25	4	4
05.36	45°07	LARA	3	0.75	5.3	1.00	12	3
May 18.31	57°58	ODD	1	0.90	5.6	1.00	6	28
May 21.29	60°45	DM	4	1.00	5.4	1.00	7	3
21.29	60°45	LALS	4	1.00	5.1	1.00	6	4
May 22.34	61°46	DM	4	1.50	6.0	1.00	6	10
22.34	61°46	LALS	4	1.50	6.0	1.00	2	7

Table 3 lists overall magnitude distributions for the 1988 η-Aquarids and the sporadic background.

Table 3 – Global magnitude distributions of the 1988 η-Aquarids and the sporadic background in Southern Brazil.

Magnitude	−4	−3	−2	−1	0	+1	+2	+3	+4	+5	Tot	$\overline{m}$
η-Aquarids	1	0	4	4	5	17	29	38	19	1	118	2.15
Sporadics	0	1	1	0	6	9	14	38	56	1	126	2.98

A total of 52 η-Aquarid meteors were estimated on color by five observers. Of these, 65.4% were yellow, 26.9% were white, 3.9% were orange, 1.9% were red and 1.9% were blue.

3. Conclusions

Once more, most of the η-Aquarids of magnitude +2 or brighter were yellow. Similar results were obtained on other occasions [2,3]. The author believes that the low limiting magnitude during the observations in 1988 increased the percentage of meteors with train. In 1988, 48% of all shower meteors showed a train. The decrease of the average magnitude of η-Aquarids and sporadic meteors compared to the 1987 η-Aquarid watch [3] could have the same origin.

References

[1] G.K. Renner, "The 1985 η-Aquarids", *WGN* 13:6, 1985, p. 206.

[2] G.K. Renner, "The η-Aquarids in 1986", *WGN* 15:3, 1987, p. 95–96.

[3] G.K. Renner, "The η-Aquarids 1987 in Brazil", *WGN* 16:2, 1988, p. 39–40.

[4] J. Wood, "Observers' Notes: March-April 1989", *WGN* 17:1, 1989, p. 6–7.

[5] R.A. Mackenzie, "BMS Radiant Catalogue", 1981, p. 15,38.

[6] S.S. Mims, "A Catalogue of Meteor Radiants", p. 2,5.

The 1988 η-Aquarids in Australia

Jeff Wood

An overview is given of the observations of the 1988 η-Aquarids in Australia.

This year, once again saw Australian meteor observers carry out extensive observations of the η-Aquarids meteor stream. The 1988 η-Aquarids began on April 19–20 and concluded around May 15–16. Overall, 15 nights were covered for a total of 79 man hours of observing time. This was in spite of frequent cloudy weather and the influence of the Moon. Ten people took part. They were as follows:

> Jeff Wood, Darren Ferdinando, George Platt, John Liew, Martin Coroneos, Guy Blackman, Gary Docking, Maurice Clark, Mark Glossop, Andrew Caminenchi.

Table 1 – ZHR-values for the 1988 η-Aquarids observed in Australia.

Date	ZHR	Nr. Obs.
Apr 19–20	1.2 ± 0.7	4
20–21	1.5 ± 1.7	7
21–22	1.1 ± 0.8	3
22–23	1.3 ± 0.8	10
26–27	6.5 ± 0.1	2
30–31	15.0 ± 1.2	2
May 03–04	39.9 ± 9.3	4
04–05	68.4 ± 11.0	7
05–06	57.6 ± 7.7	5
06–07	55.2 ± 9.6	5
07–08	41.6 ± 10.1	12
08–09	55.2 ± 11.1	8
10–11	28.9 ± 1.1	3
11–12	19.7 ± 2.9	3
15–16	7.5 ± 0.7	2

The above results show a double maximum for the 1988 η-Aquarids, respectively on May 4–5 and May 8–9.

Table 2 – Magnitude distribution of the 1988 η-Aquarids in Australia.

Magnitude	−4	−3	−2	−1	0	+1	+2	+3	+4	+5	+6	Tot	$\overline{m}$
Number	4	5	11	26	58	122	167	142	118	27	2	682	2.09

These values were obtained for observations that were mostly made in limiting magnitude 5.4 to 5.8 skies. The average magnitude for limiting magnitude 6.5 skies is therefore around 2.8 to 3.0. Of the 393 η-Aquarids of at least −2, 58.5% were white, 31.0% were yellow, 4.8% were orange, 2.5% were blue, 1.5% were red, 1.3% were green and 0.3% were violet in color. 31.4% of all the η-Aquarids seen had a train. All of these were of short duration, the longest lasting just 8 seconds.

Erratum: José Trigo let us know that on p. 204, first lines, of *WGN* 16:6, December 1988, the 47 meteors of +6 refer to the *entire night*.

Observational Results

The ε-Perseids in 1987 and 1988

José M. Trigo Rodríguez

During the first two weeks of September, a radiant is active which has really been studied very little and which is located near the star ε Persei. Observing this radiant requires complete dedication for several nights, yet between September 7 and 9 there appear many stream members—which may prove that a maximum activity exists during those days. In 1987 members of the Spanish Meteor Society organized an intensive watch, although the Moon hampered observing conditions and definitive results. In 1988, weather and Moon were more favorable, but fewer observers watched.

1. Introduction

There exist only a few references to this radiant, yet its activity is mentioned in the works of W.F. Denning. Observations now span a century exactly, being first published in May 1890 [1]. Results obtained are as follows.

Table 1 – Observational data from the previous century on the existence of the ε-Perseids.

Date	Year	α	δ	ε-Per	Other dates
Sep 3	1885	62°	+37°	7	
5	1877–85	60°	+35°	5	Sep 4
6	1880	61°	+36°	4	Sep 2
7	1886	62°	+36°	6	Aug 28
8	1885	62°	+37°	4	Sep 9–10

By the look of it a radiant in this position existed in those days. Many years have gone by since Denning made his observations, so the appearance of these meteors might indicate the stream is still existing today—and this is what this article claims.

The last few years only few observations of this radiant were put on record, even though the American Meteor Society has included it in its catalog of radiants. Today, the circular *Meteor News* locates its position around the time of maximum at $\alpha = 63°$ and $\delta = +37°$. We think the origin and real activity of this radiant should be studies profoundly—a thing we are trying to do by basing ourselves on observations which cover the past 3 years.

In coming years, we hope we will be able to exactly determine the period of activity, and—as we already stated—this can only be realized by continuous dedication and enough observations so as to exclude the possibility of interpretation errors.

2. Analysis of the observations

We tried to identify the ε-Perseids very conscientiously, in order to avoid the grave consequences the inclusion of the high sporadic activity would have on the ZHR calculations. The method applied by the author over several weeks is explained below and has been used for all observations made in 1988 under excellent conditions. Those of 1987 were also taken into account, but on their own they did not for certain reveal the exact nature of the radiant—possibly because of poor observing conditions and/or a lower radiant activity.

Shuffling around the results of a large number of meteors coming from exactly $\alpha = 60° \pm 1°$ and $\delta = +37° \pm 1°$ (like the 41 registered in 1988, of which 36 in 3 nights) we had to discard the possibility of coincidence, in the sporadic appearances as well as in possible identification errors made by the observer. Nonetheless, and in order to increase the value of the results, the task of classification became complex and all possible methods of radiant detection were unified here.

To begin with, any meteor deviating more than 2° from the assigned radiant diameter was automatically disqualified. Secondly their length and distance from the radiant was carefully studied, while looking for any type of symmetry in the distribution of the meteors in the night sky—a method always applied while studying medium active radiants. We also looked for meteors in areas near the radiant in the hope of seeing short trail or stationary meteors, but of the first only a few showed up and the author observed a quasi stationary meteor on September 6, 1987.

We also wanted to interrelate the meteors of this stream by different methods: simultaneity, characteristics and—as stated before—by the distribution of the meteors of this stream. The results of all this turned out very favorable, since the ε-Perseids appeared in small time intervals, sometimes shooting one after the other in twin appearances. Also the probability with which a sporadic might be confused with a shower member was studied, but in the end we realized this probability was of only small importance.

The meteors not typically coming from the radiant were discarded, as well as those that did not have the right speed. This last feature is interesting because all stream members were characterized by a high velocity, just not matching that of the August Perseids. Perhaps we arrived at a speed value of 50 km/s, assuming that mistakes in such deductions, while based on visual observations, are of no importance.

With respect to simultaneity, the results appear interesting and clear, since in 1988 J.V. Diaz and the author individually registered a large number of members that appeared within very small time intervals. And this is of special importance because we do not need any further observations to study this phenomenon.

In consequence of all of the above, we think it is necessary to pay detailed attention to the ZHR and characteristics of these meteors, in the hope that in the coming years the activity of the radiant will not get drowned in the large sporadic background which is characteristic for that time of year. We also think our work, which has been laborious, will be useful, if only to distinguish activity between radiants and radiants from sporadics. Technical details are mentioned in [2]

3. General results of the 1987 and 1988 campaigns

Participants in these campaigns were:

Oscar Cervera, José V. Díaz, Raúl Fernández, António Fco. Marín, Rosario Moyano, Andrés R. Paños, Vicente Soldevila, José M. Trigo.

In Table 1, we list ε-Perseid counts and corresponding ZHRs for 1987 and 1988:

Table 2 – Observations in 1987 and 1988 of the ε-Perseids from Spain.

Date (UT)	Obs	T_{eff}	Lm	ε-Per	ZHR
1987 Aug 31–32	4	31.50	5.6	2	0.25 ± 0.10
1987 Sep 01–02	2	13.92	5.9	4	0.6 0.3
02–03	3	7.30	4.5	0	0
05–06	4	14.50	5.0	1	0.35 0.35
06–07	3	6.45	4.2	1	1.6 1.6
07–08	5	13.07	4.0	0	0
08–09	2	7.50	4.0	1	1.7 1.7
09–10	2	2.57	5.0	0	0
11–12	4	20.27	4.2	0	0
12–13	4	7.25	4.8	0	0
13–14	4	9.17	5.5	2	0.6 0.4

Table 2 – continued.

Date (UT)	Obs	T_{eff}	Lm	ε-Per	ZHR
1988 Sep 03–04	2	3.17	5.85	2	1.9 ± 1.3
04–05	1	2.20	6.1	0	0
05–06	2	11.70	5.8	8	2.2 0.8
06–07	1	0.43	6.0	0	0
07–08	2	14.73	5.75	15	3.4 0.9
08–09	2	9.72	5.9	15	4.5 1.2
14–15	1	1.21	6.0	1	2.2 2.2
19–20	1	1.00	5.6	0	0

Although most hours were achieved in 1987 (133.15 of the total 177.30) the results of 1988 are more interesting, due to excellent limiting magnitudes. We also give the results concerning magnitudes. Please bear in mind that the 1987 observations were plagued by bad atmospheric conditions and Moon, which renders the mean magnitude rather bright.

Table 3 – Global magnitude distributions for the 1987 and 1988 ε-Perseids as seen from Spain.

Magnitude	−2	−1	0	+1	+2	+3	+4	+5	Tot	$\overline{m}$
1987	0	2	3	2	1	3	2	0	13	1.47
1988	2	1	1	5	4	15	9	4	41	2.66

In 1987, 1 meteor and in 1988, 7 meteors showed a train. From the magnitude distribution of 1988, we get the value r of the stream's population index, which was used in the calculation of the ZHRs mentioned above. This value amounts to 2.6.

References

[1] W.F. Denning, "Catalogue of 918 radiant points of shooting stars observed at Bristol", *MNRAS*, 1890, pp. 410–465.

[2] A.C.B. Lovell, "Meteor Astronomy", Clarendon Press, Oxford, 1954.

The October Capricornids Observed in Spain

José M. Trigo Rodríguez

This article refers to observations of the October Capricornids made by members of the Spanish Meteor Society between 1985 and 1988. Despite the high number of observations, the number of meteors remains low, which indicates a very poor activity level for this stream (not exceeding a ZHR of 1).

1. Introduction

Except in 1972, the activity period of this stream has always remained within specific time limits. That the stream did stay active for nearly 20 years since its first appearance in 1971 has been confirmed by the Australian observers who discovered it. We think the Australian NAPOMS-members merit great praise because they have covered the activity of this radiant closely during all those years, and their work has permitted us to get acquainted with the structure of the stream.

One of the greater successes in our field of astronomy occurred a couple of years ago when the relationship between the October Capricornids and comet P/Haneda-Campos was established. But this connection should still be studied in greater detail in the coming years if we really want to be certain.

In this modest article we would like to contribute a little to the general knowledge about this stream, and we hope that in coming years the atmosphere will cooperate a little better in this month of October, when clouded skies usually predominate and often result in very heavy thunderstorms (known as "cold drops") and immense floods.

On the other hand we would like to accentuate the fact that the observational results which are presented here are based on very general studies of the entire sky, which implicates that some meteors might have been missed. These mistakes can be partly excused by the large quantity of observations made in one day, and this in turn reduces the doubt-factor. In any case, this year we hope to organize an intensive campaign, with the aim of getting respectable results, visually as well as photographically.

2. Method of analysis

In the beginning of September there are some active radiants located near the radiant of the October Capricornids, (e.g. the α-Capricornid radiant whose meteors resemble those of our Capricornids, although they come from a radiant at a distance of 15° in right ascension and stop their activity just before the October Capricornids start).

Though the number of registered meteors for this period is much smaller, we looked for possible stream-members after September 15, with a clear location of the radiant near the position indicated for those days by Jeff Wood [1], halfway between λ and η Aquilae. On the other hand the number of registered meteors is too low to be completely certain of the date at which the activity starts. In any case it would be highly interesting to keep it in mind in the coming years.

We can speak of "activity" with some certainty from September 20 onwards, and the majority of meteors from this radiant was recorded during the remainder of the month. This can be partly explained by the fact that in the beginning of October only few observers watched and not many observations were reported until the appearance of the October Draconids.

3. Results

All of the above remarks become apparent in the table below, which shows the mean activity of the radiant as derived from our observations.

Table 1 – Observations between 1985 and 1988 of the October Capricornids from Spain.

Date (UT)	Obs	O-Cap	ZHR
Sep 14–15	5	1?	0.1
15–16	3	0	0
16–17	5	0	0
17–18	6	1	0.1
18–19	5	2	0.1
19–20	2	0	0
20–21	2	1	0.4

Table 1 – continued.

Date (UT)	Obs	O-Cap	ZHR
Sep 21–22	4	0	0
22–23	3	1	0.4
23–24	3	0	0
24–25	4	0	0
25–26	1	0	0
26–27	5	2	0.3
27–28	4	2	1.6
29–30	1	0	0
Oct 02–03	1	0	0
03–04	1	0	0
05–06	2	0	0
06–07	3	0	0
07–08	2	0	0
08–09	10	1	1.1
10–11	1	0	0
11–12	2	0	0
12–13	1	0	0
13–14	1	0	0
15–16	2	0	0
16–17	3	0	0
17–18	3	1?	0.2
18–19	1	0	0

Another factor which may have influenced these results is the low elevation of the radiant as viewed from Spain: it can only be observed for a few hours after nightfall. This greatly diminishes the possibility of catching its meteors in an already unattractive region of the sky.

Insofar as we were able to verify, only a poor 12 October Capricornids were registered, in spite of more than 100 observations in the active period of the stream. During the 4 years the following persons took part in the observations:

Luís R. Bellot, Javier Casamitjana, Oscar Cervera, José V. Díaz, José C. Escrivá, Raùl Fernández, Antonio Francisco, Juan Hernández, José L. Martín, David Martínez, Rosario Moyano, Andrés R. Paños, Vicente Soldevila, José M. Trigo.

Insofar as magnitudes are concerned, we refer to the table below for a magnitude distribution, although with such a small number of meteor this subject can hardly be considered representative.

Table 2 – Global magnitude distributions for the October Capricornids as seen from Spain between 1985 and 1988.

Magnitude	−2	−1	0	+1	+2	+3	+4	Tot	$\overline{m}$
Number	1	0	1	2	5	1	2	12	1.75

Two meteors showed a train. Peculiar characteristics other than low to very low velocity are very wide ionization trains, some of them being "nebulous" (as described by the author) and with clear colors: bright yellow, white and blue.

References

[1] J.C. Wood, "The October Capricornid Meteor Stream", *WGN* 16:6, December 1988, pp. 191–194..

[2] J.C. Wood, "Southern hemisphere Meteor List", *NAPOMS Observers Guide*, 1982.

The 1988 Leo Minorids

José M. Trigo Rodríguez

Spanish observations of the 1988 Leo Minorids are presented and discussed.

1. Introduction

Determining the period in which this stream is active is a complicated job because Leo Minorid activity is hard to detect and its meteors are very faint. We can only conquer these difficulties by studying the stream continuously for several nights in a row—a method we have tried to apply and which resulted in this article. The observing sessions were held in Spain and Bolivia, but in Bolivia, no Leo Minorids at all were registered.

The stream's activity seems to coincide with the dates mentioned by Paul Roggemans [1]: the first Leo Minorid was seen on October 22 and the last one disappeared in the morning of October 23. The majority clearly appeared about 1 hour before dawn, a moment coinciding with the culmination of the radiant.

The campaign was interrupted earlier than foreseen; therefore the radiant's activity on October 24 could not be confirmed, since none of the participants were able to observe. In our eyes this stream deserves special attention in the coming years.

2. Results

As you can see in the table of observations, the campaign was held from October 20 to October 23, by the following observers:

> Luís R. Bellot, Javier Caballero, Oscar Cervera García, José Vicente Díaz, Antonio Fco. Marín, Andrés Rafael Paños, Antonio Román Reche, José M. Trigo.

During those three nights, 23.4 hours were spent observing. Only 5 Leo Minorids were registered, together with 333 others, among which 148 Orionids. Though the number of 5 Leo Minorids is really very small, it is not because of inadequate observing on our part but perhaps because of the very low ZHR that we did not see more of them. We think in 1989 and 1990 we should prepare a large scale campaign within *IMO* to study this stream, and then we can further study this new radiant.

Approximately the number of Leo Minorids individually appearing in the course of one night give a result of 2 or 3 at the time of maximum—an activity which I call symbolic. To conclude this article, we show a table depicting the mean activity of the radiant. They include the 4 observations which give supporting evidence of its existence. All other observations deny this very existence, but they have been included in the mean ZHR calculations.

Table 1 – Mean ZHRs of the 1988 Leo Minorids

Date	$\lambda_\odot$	Obs	LMi	ZHR
Oct 21–22	208°6	2	1	1.2 ± 1.2
22–23	209°4	3	1	0.6 0.6
22–23	209°5	1	3	1.3 1.3

The average magnitude was 3.10. One of the five Leo Minorids showed a train.

References

[1] P. Roggemans, ed., "*IMO* Handbook for Visual Meteor Observations", Sky Publishing Co., Cambridge, Mass., 1989.

Fall 1988 Results from Maryland

Richard Taibi

An overview is given of the author's 1988 observations of the Orionids, Taurids and Geminids and of minor showers active during the same period.

Table 2 shows the results of 22 hours of observation in late 1988. Although the Orionid and Leonid maxima were clouded out, fireballs seen during the Taurid and Geminid shower compensated for the obscured celestial fireworks in October and November.

Table 1 – Shower abbreviations.

Abb.	Shower	Abb.	Shower
O	Orionids	EG	ε-Geminids
T	Taurids	DA	δ-Arietids
M	Monocerotids	SH	σ-Hydrids
G	Geminids	CB	Coma Berenicids
XO	χ-Orionids		

Table 2 – Fall 1988 observations from Maryland by the author.

Date	Period (UT)	$T_{\rm eff}$	Lm	F	Streams	Spor
Oct 08	06^h48^m–07^h58^m	1.17	5.5	1.00	2O,1DA	5
10	07^h04^m–09^h08^m	2.07	5.4	1.09	1O,1T,2EG	6
16	07^h15^m–08^h15^m	1.00	5.4	1.11	4O	2
16	08^h22^m–09^h22^m	1.00	5.4	1.01	1O,2EG	5
20	06^h07^m–07^h07^m	1.00	5.7	1.00	5O,2T	6
20	07^h13^m–08^h25^m	1.20	6.0	1.22	9O,3T	7
23	09^h12^m–10^h12^m	1.00	5.1	1.09	3O,1T	6
Nov 08	04^h50^m–06^h30^m	1.67	5.8	1.11	2T	4
10	04^h35^m–06^h30^m	1.92	5.2	1.00	4T	10
12	04^h29^m–06^h30^m	1.98	5.6	1.00	8T	17
14	04^h30^m–07^h00^m	2.50	5.8	1.00	6T	14
Dec 12	06^h55^m–08^h22^m	1.45	6.0	1.00	17G,2M,3SH,2XO,1CB	15
13	04^h59^m–06^h07^m	1.13	5.1	1.00	37G,4XO	4
14	05^h00^m–06^h50^m	1.83	6.0	1.00	47G,1SH,1CB	15
14	06^h57^m–08^h00^m	1.05	5.5	1.00	21G,1SH	9

All observations listed above were conducted from McKendree, Maryland, $\lambda = 76°38'12''$ W, $\varphi = 38°46'50''$ N and $h = 36$ m. Table 3 shows global magnitude distributions for major showers.

Table 3 – Global magnitude distributions for the 1988 Orionids, Taurids and Geminids as seen by the author in Maryland.

Shower	−7	−6	−5	−4	−3	−2	−1	0	+1	+2	+3	+4	+5	Tot	$\overline{m}$
Orionids	0	0	0	0	0	0	0	0	4	8	8	5	0	25	2.56
Taurids	0	2	2	0	0	0	1	3	0	3	8	1	1	21	0.76
Geminids	1	0	1	0	1	2	4	10	23	25	28	19	8	122	2.05

Only 15% of the Orionids had a persistent train and only 4% showed color (2% yellow and 2% blue). The Taurid results include 4 fireballs. Skies during the Taurid shower were about as clear and dark as they get in the Washington DC area. Even though dimmer Taurids were possible to see, they were generally quite bright, resulting in a mean Taurid magnitude of +0.76. The four fireballs (and one other Taurid) were greenish-white to make up 25% of the Taurid total. Yellow and blue Taurids each claimed 10% and one yellow-white Taurid represented 5% of Taurids seen. No attempt was made to determine whether meteors came from the North or South Taurid radiants. The two Geminid fireballs were blue and stunning. Geminid colors were blue (2.5% of total), blue-white (6.6%), yellow (3.3%) and yellow-white (1.6%). Only 5.7% of Geminids left a persistent train.

Early 1989 Observations from Maryland and Florida

Richard Taibi

An overview is given of the author's 1989 observations of the Coma Berenicids, δ-Leonids, Lyrids and η-Aquarids.

The weather has been generally cooperative for meteor observations in early 1989. This brief article presents the highlights of my observations sofar. Table 3 shows that 1989 got off to a good start with the Quadrantids. A previous article [1] described this observation session. The February 12 session's yield of 3 Coma Berenicids add support to the contention [2] that this minor shower persists into mid-February. The five Coma Berenicids seen had an average magnitude of +3.80.

Table 1 – Observing sites for the early 1989 observations by Richard Taibi from Maryland and Florida.

Location	Abb.	λ	φ	h
McKendree, MD	MK	76°38′12″ W	38°46′50″ N	36 m
Camp Springs, MD	CS	76°54′12″ W	38°47′37″ N	73 m
Callahan, FL	CA	81°53′ W	30°33′ N	
Middleburg, FL	MI	81°54′ W	30°04′ N	

Favorable weather (if not a favorable moon) permitted a better-than-usual monitoring of the Lyrids this year. I was surprised to see a −2 Lyrid on April 12 and no fewer than five Lyrids at maximum, despite the nearly full moon. The average Lyrid magnitude was +1.13 and 7 of the 8 Lyrids seen were of magnitude +1 or brighter. Considering there was a bright moon, the surprise for me was the *number* of bright meteors. Last year, I only saw one faint Lyrid in four hours of observation on April 20, one day before maximum.

The hope of seeing many η-Aquarids prompted me to drive 3600 km (round trip) to Florida. The moonless sky at maximum and the more southerly latitude beckoned me with what seemed a certainty of good rates. Unfortunately, clouds were a problem on May 1, 4 and 5.

Table 2 – Shower abbreviations.

Abb.	Shower	Abb.	Shower
Q	Quadrantids	CB	Coma Berenicids
DL	δ-Leonids	L	Lyrids
E	η-Aquarids		

Table 3 – Early 1989 Observations from Maryland and Florida by the author.

Date	Loc	Period (UT)	T_{eff}	Lm	F	Streams	Spor
Jan 03	MK	08^h33^m–11^h00^m	2.45	5.3	1.00	38Q,2CB	12
Feb 12	MK	07^h35^m–09^h35^m	2.00	6.0	1.00	3CB,2DL	14
Apr 02	MK	08^h06^m–09^h47^m	1.68	4.8	1.15		11
12	MK	07^h02^m–08^h32^m	1.50	5.6	1.50	1L	7
17	MK	07^h30^m–09^h00^m	1.50	5.3	1.50	2L	5
22	CS	06^h30^m–08^h10^m	1.66	4.8	1.00	5L	3
23	CS	07^h30^m–08^h24^m	0.90	4.9	1.00		1
May 02	CA	07^h34^m–09^h06^m	1.53	6.0	1.00	3E	7
03	CA	06^h51^m–09^h33^m	2.70	5.9	1.00	6E	15
05	MI	08^h31^m–09^h45^m	1.03	5.4	1.00	9E	8

Fatigue and ill health prevented observations on May 6 and 7. Observed rates on May 2, 3 and 5 (Table 3) seemed rather modest. Perhaps 1989 was not a bountiful year for η-Aquarids. Table 4 shows that no η-Aquarid surpassed magnitude 0.

Table 4 – Global magnitude distribution for the 1989 η-Aquarids seen by the author in Florida.

Magnitude	0	+1	+2	+3	+4	+5	Tot	$\overline{m}$
Number	2	2	7	1	5	1	18	2.44

28% of the η-Aquarids had a persistent train. No color was noted in any of the shower's members this year.

References

[1] R. Taibi, "The 1989 Quadrantids from Maryland", *WGN* 17:2, April 1989, p. 60.

[2] R. Taibi, "The Coma Berenicids from Maryland: 1984–1989", *WGN* 17:2, April 1989, pp. 55–56.

1989 Spring Observations from Alberta, Canada

Peter Brown

An overview is given of the author's visual observations from Alberta, Canada, during the period February–May 1989.

Observing over these four months has been characterized by bright aurora and cloud. The aurora has been particularly bad, interfering with all sessions and destroying several other attempts to observe.

The main push for this period was a one week η-Aquarid camp planned for a dark Southern Alberta observing site, Little Fish Lake Provincial Park. While a full eight nights was put aside for observing, cloudy weather and aurora destroyed most of the campaign. In fact, only two nights turned out to be clear and relatively aurora free, April 30 and May 1. The former session had dark skies and only mild auroral interference later in the evening, but the group had just driven over 750 km in some 10 hours and was in no real shape for serious work. I did manage to observe over a three hour period on this night, but my tape recorder gave out and I was forced to find other means of recording. Between this and my excessive fatigue, no particularly high rates were recorded.

The next evening turned out to be spectacularly dark and clear. I observed right through until morning twilight prevented further serious observations. In the last hour with twilight rapidly advancing I also caught two bright η-Aquarids, the only ones of the entire week! I have never seen the η-Aquarids before due to the high latitudes of the sites I work from, but these two meteors made me contemplate future trips to much more southerly locales. Both meteors were bright yellow and both left trains. The speed and brilliance of the meteors reminded me of Perseids. Also on this evening a number of minor showers were noted to be active. While the σ-Leonids and the α-Scorpids produced a few events, the ϕ-Bootids seemed to be the most active radiant, with rates of about 1 meteor per hour. The Bootids are hard to mistake for sporadic background because of their low geocentric velocities and fairly low angular speeds. Conversely the lone Lyrid which was noted is likely to be a sporadic lineup.

The only other night observing could be undertaken in this period was on February 10–11. Even this evening was marred with scattered cloud and an auroral display. In spite of this I forged ahead and managed to catch one full hour of observing before clouds completely destroyed the night.

The past few years have seen the emergence of the aurora as a particularly harmful element for meteors observing from northern Alberta. The situation has become almost impossible now as every evening is punctuated with the bright green stuff, usually in active bright forms. The purpose of the trip to southern Alberta was to put some distance between me and the aurora for a change. Unfortunately solar activity has picked up to such an extent that even from the southern part of Canada, the aurora is destroying observing. One evening at Little Fish, the aurora almost touched the southern horizon spelling bad news for our American counterparts. As solar activity continues to rise I suspect the number of meteor observers in Canada will fall and the lack of dark sky is likely to deter amateurs from other fields in this country.

Observations were done at Maqua Lake (ML, $\lambda = 111°16'$ W, $\varphi = 56°23'$ N), and at Little Fish Lake (LF, $\lambda = 112°16'$ W, $\varphi = 51°22'$ N).

Table 1 – Shower abbreviations.

Abb.	Shower	Abb.	Shower
MV	μ-Virginids	FB	φ-Bootids
L	Lyrids	SL	σ-Leonids
E	η-Aquarids	AS	α-Scorpids

Table 2 – Spring 1989 Observations from Alberta, Canada by the author.

Date	Loc	Period (UT)	T_{eff}	Lm	F	Streams	Spor
Feb 11	ML	08^h05^m–09^h05^m	0.62	5.5	1.50		2
Apr 30	LF	05^h40^m–06^h40^m	0.83	6.3	1.00	1MV	5
30	LF	06^h40^m–07^h40^m	0.75	6.4	1.00		1
30	LF	07^h40^m–08^h40^m	0.50	6.2	1.00		3
May 01	LF	05^h00^m–06^h00^m	0.98	6.2	1.00	1FB	6
01	LF	06^h00^m–07^h00^m	0.98	6.3	1.00	1L,1FB,1SL	4
01	LF	07^h00^m–08^h00^m	0.96	6.3	1.00	1FB,1AS	7
01	LF	08^h00^m–09^h00^m	0.98	6.2	1.00	1FB,1AS	8
01	LF	09^h00^m–10^h00^m	0.73	6.1	1.00	2E	1

Asteroids, Comets, Meteors III: An Impression

Uppsala, Sweden, June 12–16, 1989

Trond Erik Hillestad and Paul Roggemans

The Uppsala Astronomical Observatory in Sweden organized a first conference on minor bodies in the Solar System in 1983. This very successful initiative was repeated in 1986. Several meteor scientists participated at both meetings. A third edition of this interesting conference took place from June 12 to 16, 1989, and several contributions dealing with meteors were presented.

Since the very beginning, *IMO* worked towards a closer cooperation between amateur and professional meteor astronomers. The International Astronomical Union is in favor of amateur-professional cooperation. A declaration was made in Baltimore, Mld., USA, last year to encourage all efforts in this area. As an immediate consequence, *IMO* invited professional meteor astronomers to join, and several have indeed done so. The meeting in Uppsala was a good occasion to meet several professional, both *IMO* members and non-*IMO* members and, in particular, to improve contacts with the latter. The ACM III was attended by four amateur *IMO* members: Evelyne Blomme (France), Trond Erik Hillestad (Norway), Masahiro Koseki (Japan) and Paul Roggemans (Belgium). Two Dutch non-*IMO* amateurs were also present: Marc de Lignie and Peter Jenniskens.

The first activity of the conference was a welcome reception at the observatory on Sunday evening June 11. There, we had a first meeting with several well-known meteor workers. The following morning at 8^h20^m, the conference was officially opened by Prof. Bengt Gustafsson. Ten minutes laters, lectures started, which were organized in sessions of one and a half hour, with one invited lecture of 30 minutes and four contributed lectures of 15 minutes each. The session chairmen were very strict on the schedule. By the end of the lecture time, a bell was rung to warn the speaker that he had to conclude; if the lecturer tried to pass over his time, he was simply interrupted. It is worth mentioning this for amateurs organizing meetings should have the program schedule respected, too.

Each day at ten o'clock, a half hour coffee break separated both morning sessions. During the afternoon, there was a similar program, except when workshops were held. Rather than recalling the various lectures in the report, we refer the interested reader to the proceedings of this meeting to be published later this year. In this article, we will review the many contacts with meteor workers and the discussion points raised at the workshop on meteor astronomy, which were both very important to *IMO*.

It turned out that *WGN* and *IMO* are very well-known among professional meteor astronomers, who are very impressed by the organization's activities. Especially Bertil Lindblad (Lund) is a very important promotor for *IMO* and amateur work. Alexandra Terentjeva is also very much in favor of *IMO*. She is particularly interested in fireball data and the activity of minor meteor showers. We strongly encourage interested *IMO* members to write to her for determining specific projects.

Contacts with the Czechoslovak meteor workers are also very important. Several people from Bratislava and Ondřejov were present: Stohl, Hajduk, Pecina and Kapisiensky promised to support *WGN* and *IMO*. Vladimir Znojil wrote us that he will promote the visual observing method of *IMO* (as described in the *IMO Handbook for Visual Meteor Observations* and report Czechoslovak visual ata to the *Visual Meteor Database (VMDB)*. Duncan Olsson-Steel (Adelaide) is a theoretician with special interest in the structure and the modeling of meteor streams. He also encourages amateurs to make simulations of meteor stream evolution. He will run a simulation of the Perseid and Geminid streams, which may include observational data. I.P. Williams gave a cordial support to *IMO* and David Hughes made several very positive comments on amateur work. G. Andreev (Tomsk) is willing to work within *IMO* and extends an a Tunguska investigation.[1] Bel'Kovich from Kazan strongly supports *IMO* and promised his support. In particular, Babadzhanov encouraged efforts for flux determination. Very positive comments came from Brian Marsden who agrees to publish confirmed shower outbursts in the IAU telegrams. Polish astronomers promised to publish a call for meteor observers in a Polish journal.

The originally planned workshop 12, "Dust Bands. Their relations to Meteor Streams, Asteroids and Comets", organized by S.F. Dermott was cancelled because the organizer was absent. Several other workshops were programmed, but none of them were really dedicated to meteor streams. From the informal contacts with other *IMO* members such as Masahiro Koseki, Alexandra Terentjeva and Duncan Olsson-Steel, the Czechoslovakian and Soviet meteor workers, and Bertil Lindblad, it was decided to have an informal meeting for meteor workers, for which we got a room in the observatory. Iwan Williams proposed to try to replace the cancelled workshop 12 with the planned informal meeting. This was accepted, and finally we got no less than 50 participants. Discussion leader was Iwan Williams.

Stohl opened the discussion with the proposal to study the extended Taurid activity, a project which is a very attractive target for *IMO* amateurs... Olsson-Steel stated that science is trying to understand the relationship between the minor bodies, their physical and dynamical properties by analyses and computational work. He said that very few meteor scientists are active in western countries, and that about 10 new young researchers should be encouraged to specialize in this field. Lindblad stressed that currently no permanent radar observing programs exists, and that almost all major professional observing efforts were closed down in the western hemisphere. Any unexpected activity would pass by unexpectedly unless amateurs would be able to register such an event. Babadzhanov called upon all his professional colleagues to give *IMO* their full support and all help it might need. Williams questioned whether or not *IMO* would be prepared to give confidential information about the reliability of its observers. The answer was that *IMO* will not protect unreliable observers and is prepared to give the information if professional analyses would require that. Williams stated that professional meteor workers should keep up with amateur literature. Roggemans informed the audience that worldwide news and results from amateurs are published in *IMO*'s main journal *WGN*, which is covered by *Astronomy and Astrophysics Abstracts*. He also stressed that amateurs from currency controlled countries should be able to participate at professional meetings. Williams replied that such amateurs should not hesitate to contact the organizers of such meetings to obtain a registration free of charge.

The quality of amateur work was further discussed as often professional researchers were disappointed by the unreliable nature of amateur work. It was recalled that the *International Halley Watch* amateur meteor observations contained many useless data. *IMO* can avoid such problems and disappointments by promoting its standardized observing instructions towards all amateur workers. Finally, some suggestions for future meteor work were made. Hughes proposed to study the sporadic activity for the presence of hidden minor showers. Orbital elements have to be improved and amateurs are encouraged to determine more orbital data. It is also important to determine the variation in time of meteor stream structures. Soviet scientists stressed the need for good flux determinations and studies of mass distributions. Getman called for efforts to study fireballs and their break-ups. Roggemans pointed out the need of literature studies to find historical records of past meteor outbursts.

At present, there is a **vacancy** for the directorship of the **Photographic Commission**. This is really a pitty, in view of the importance of photographic work. Moreover, the *PMDB* contains a vast amount of data (e.g. meteor orbits) waiting for further analysis. People feeling they can help *IMO* in this regard are cordially invited to contact us!

[1] *See elsewhere in this issue.* (Ed.)

Meteor Reunion in Vught, the Netherlands

Urijan Poerink

The NVWS Meteor Section wishes us to inform our readers that its fifth reunion of meteor workers will be held in Vught (North Brabant) on Saturday, September 23. Such reunions have been a regular activity on the agenda since 1985, respectively in Vught, Leiden, Muiderberg and Heesch. This time Vught will again be host.

From $10^{\rm h}$ on everyone wishing to attend will be welcomed at cafe-restaurant "Modern", Marktveld 8, situated in the very center of the town.

The first part of the program will consist of a practical seminar on measuring meteor photographs, especially those of recent observing sessions like that of the 1989 Perseids. So please bring along your pictures and negatives and the necessary data relating to them!

After lunch, which will be taken in group, several members will concisely present their other observing results, observing methods (visual, photographic or radio) or the use of computers and other material in the field of meteor observing.

We expect the reunion to close around $17^{\rm h}$. People who are interested are asked to pay 17.50 NLG (for the lunch) to Urijan Poerink, treasurer of the NVWS Meteor Section in Vught (giro account 4466085). On receiving your subscription he will then send you a more detailed program for the day. In case you are interested in giving a speech yourself, please contact Felix Bettonvil at Mozartsingel 21, NL-5216 GA 's-Hertogenbosch (telephone number +31(73)133 783).

Book Review

Masahiro Koseki

- *V.A. Bronshten, "Meteors, Meteorites, Meteoroids" (in Russian), Nauka, Moscow, 1987.*

The author of this book is part of the Meteorite Research Center in Moscow. He is a professional in the field of meteor physics and wrote "Physics of Meteor Flight in the Earth's Atmosphere", published by Reidel.

The present book covers everything from meteor observations over meteoroid physics and the history of the Solar System to impact craters. It is best suited for readers interested in meteoroid physics and the evolution of the Solar System.

It also contains a unique description concerning "electrophonic fireballs" and the Tunguska event. An electrophonic fireball is accompanied by anomalous sounds resembling rustling, hissing or whistling. West European observers in general do not report such phenomena, but many Japanese, as well as Russian and other observers did witness them. Bronshten et al. recently published a "Catalogue of Electrophonic Fireballs", including 349 cases of electrophonic phenomena. We amateurs should pay attention to such anomalous sounds, whenever a bright meteor appears.

As to the Tunguska event, Bronshten as well as several other Soviet researchers are opposed to the thesis of Sekanina, i.e. he believes that the core of small comet caused this mysterious event. This book is a must for amateurs interested in the Tunguska explosion.

The International Meteor Organization

Don't miss it!

International Meteor Weekend 1989

Lake Balaton, Hungary, October 5–8, 1989

A registration form can be found in this issue of *WGN*. Accomodation will be provided in a hotel, 10 minutes from Lake Balaton (two or four bed rooms, shower, etc.). The participation fee will be about 180 DEM (West-German Marks). More information in this issue of *WGN*!

The Founding Assembly of the *International Meteor Organization* will be held at this conference. *IMO* responsibles may find it useful to have some technical workshops during the days preceding the conference, which can be arranged within a stay of a week or so in Hungary.

Bibliographic Catalogue of Meteors (1794–1987)

compiled by Paul Roggemans

243 pages with — for 45 astronomical periodicals — references to all contributions dealing with meteor work in general, and details of the contents of over 60 books on meteor science.

This comprehensive guide to over 8000 publications on meteorics, serves as a key index to the meteor library of the author, which can be consulted by *WGN* readers.

Order this book by paying 400 BEF to Ann Schroyens, post paid (airmail rates are given in *WGN 16:1*, p. 2).