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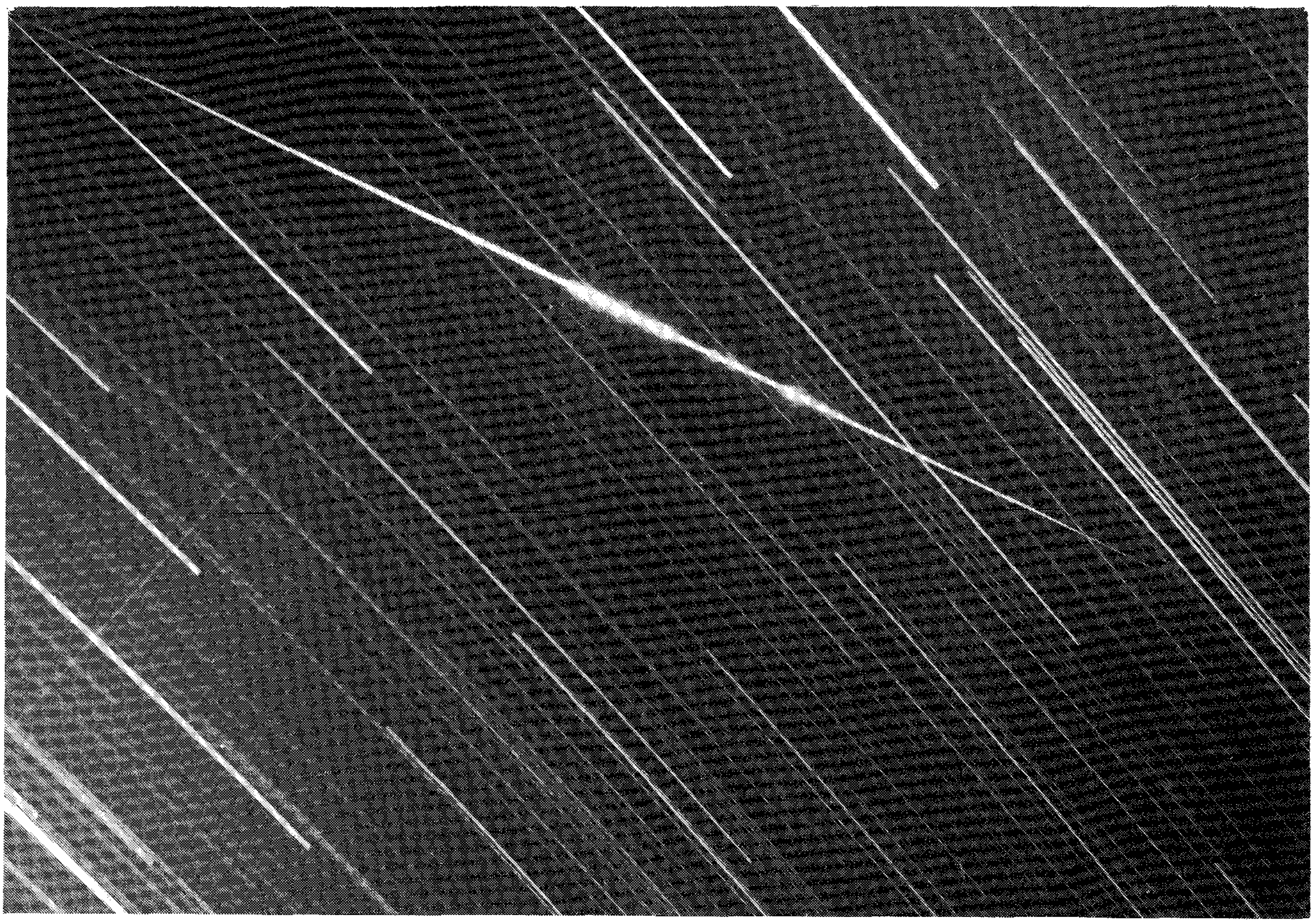

This −6 Taurid fireball was photographed in the Cancer-Hydra region from Vienne, France, by Steve Evans (BAA, UK) on November 16, 1988 at 3^h06^m UT. The photograph was exposed from 02^h33^m until 3^h35^m UT with a 75 mm $f/4.5$ lens on Kodak TMAX 400.

In this issue:

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 2, April 1989, pp. 29–84

Contents

Useful Information

The June Issue *(WGN 17:3)*

This issue will be mailed in the first week of June. Contributions for the *June issue* are due by *April 28* at the latest. They should be sent to *Marc Gyssens* or to any member of the editorial board (addresses on the inside of the back cover).

From the Editor-in-Chief

Marc Gyssens

As promised, this is an extra thick number of WGN! Thanks to the policy of publishing a thicker journal every other issue, we finally managed to work away most of the publication delay which became a real problem in the passed year. As a consequence of that publication delay, we still had a number of observing reports covering 1987. Since they were already entered in the computer and since it would not be fair towards the authors not to publish their contributions, we decided to take advantage of this thick issue to publish them all in one bunch. We apologize to the authors for not being able to publish their reports earlier, but, at the same, we can assure them that we do not expect a repetition of this problem in the near future. All reports concerning last Fall and last Winter that were in our possession at the time of this writing, can be found in this issue! It goes without saying that no more raw data reports on 1987 will be published in subsequent issues of WGN!

Founding IMO members will find in this issue a third voting bulletin, containing the candidacies for the Council and other functions within IMO, as well as a—we hope quasi-final—version of the Organization's Constitution. Meanwhile, mostly positive reactions keep coming in. We got letters from several professional meteor astronomers encouraging our efforts. Extracts will be published in the next WGN. New initiatives keep emerging. Malcolm Currie has agreed to start up a Telescopic Commission within IMO; we now also have a Radio Meteor Database and the Visual Meteor Database is gradually taking its final form. You can find out more on the next pages. Also note that the International Meteor Weekend in Hungary, where IMO's Founding Assembly is to take place, is now finally scheduled for the first weekend of October. A registration form is printed in this issue.

We do not often receive contributions on meteorites for WGN. Therefore we are glad to publish an article by Detlef Koschny dealing with the suspected Martian origin of some meteorites. For meteor photographers, we have a test on a promising film from Kodak and for the radio observers, there is an American contribution on how to distinguish meteor and aircraft reflections. Radio observers are really spoiled in this issue; a great number of reports is devoted to their work. Finally, we want to ask the reader's attention for the short note published below. It was received while this issue was already being processed and contains some hot news. Happy reading!

Meteors from 1989 DA

Christian Steyaert

Robert McNaught mentions in the *Astronomer Electronic Circular* No. 272 of March 7 that the minimum distance of 0.04 AU between the Earth and the orbit of the newly discovered asteroid 1989 DA occurred on February 23, 1989, with 1989 DA within two days of this minimum position. Meteor activity was possible throughout February and early March from a radiant with $\alpha = 5°$ and $\delta = +30°$. Meteors would be very slow with $V_\infty = 15$ km/s. Any activity would only be visible in the evenings from mid to high northern latitudes.

My own calculations, based on the orbital elements published in *Minor Planet Circular* 14360 confirm this. I found a minimum distance of 0.044 AU on February 20, 1989 with $\alpha = 8°$, $\delta = +32°$ and $V_\infty = 14$ km/s. Zenith attraction (the gravity pull of the Earth) has been included.

Contrary to several other planetoids of the Apollo type, 1989 DA has only one close approach to the Earth's orbit.

A Telescopic Commission for IMO

Malcolm J. Currie

Unfortunately, the telescopic observation of meteors has largely been limited to a few keen amateurs scattered around the world at different epochs. Only during the 1950s and early 1960s in Czechoslovakia were there large groups of observers and coordinated observations. To obtain the greatest benefit from the small numbers of observations it is vital that telescopic data are pooled. *IMO* can clearly play an important role in promoting telescopic-meteor watching, setting standards for both data acquisition and analysis, maintaining a database, and coordinating observing programs.

I have been asked to organize the telescopic commission until the first Director is elected. I have my own ideas for the telescopic program, but I do not want to impose my views unilaterally in a democratic association. There are probably many other ideas that have not occurred to me. Therefore, I should like to hear the suggestions and comments, particularly from experienced telescopic observers on how they would like to see the *IMO* Telescopic Commission develop. Discussion documents containing proposals and the rationale behind them will be circulated to the interested parties—the first is already in preparation. I hope we can iterate to concrete plans at or by the first meeting of the General Assembly near Lake Balaton in Hungary.

A Radio Meteor Database

Jeroen Van Wassenhove

At this time, there also exists a *Radio Meteor Database (RMDB)*. Presently, it contains 120 000 meteor reflections registered in four different countries. Due to the data structure, the *RMDB* uses two different formats: dBase III Plus and Lotus 1-2-3.[1]

The contents of the *RMDB* is given below:

Filename	Length	Description
RMDB1.WK1	85659 k	Denmark 1986
RMDB2.WK1	86835 k	Denmark 1987
RMDB3.WK1	4764 k	Canada
RMDB4.DBF	1063 k	Hungary 1987
RMDB5.DBF	9600 k	Belgium 1987
READ.ME	1408 k	General Inf.

At this moment, the *RMDB* is available for 200 BEF in one format: 360 k $5\frac{1}{4}''$ floppies.

When this article was written, the 1988 date are almost completely processed. So when you read this, several files will aready have been added to the *RMDB*. In the future, the *RMDB* will be expanded with more advanced functions. Of course, we will keep you informed on this further developments!

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[1] dBase III Plus is a registered trademark of Ashton-Tate and Lotus 1-2-3 is a registered trademark of Lotus Development Corporation.

More on IMO's Visual Meteor Database

Paul Roggemans

Since the introduction of this computer application was presented in *WGN* 16:6, several people made comments to the *VMDB* proposal. Some of these are relevant enough to publish. It turned out that several amateurs still do not know how to report data to enable fast input. By following the simple guidelines given below, you can save us a lot of time and help us to produce data analyses with the shortest possible delay.

First of all, you should use *IMO* observer's codes: e.g. Yukiko Nagashima should be identified as NAGYU (from Nag-Yu). The hourly rate reports should be summary reports with complete data in tabular form:

Observer-Sitecode-Date-Period (UT)-$T_{\rm eff}$-F-Lm-Showers-Spor-Total

When the effective observing time $T_{\rm eff}$ is not given, we can only assume that the observed time ran from the start until the end of the watch without any break. E.g. 7^h56^m–9^h23^m will be entered as 1.45 h. This however requires some fast calculations which are a source for potential errors and which slow down the input speed. For the same reasons, always give the effective observing time in decimal hours, *not* in (hours and) minutes.

Also, give the correction factor F and not cloud percentage or a vague description.

For the limiting magnitude, we need one value, not a comment such as "variable" or "5.0 to 5.5". If the limiting magnitude varied during the watch, just list a (weighted) mean value.

Finally, use the shower abbreviations of *IMO*. It is no problem if you observed a shower not listed in the radiant file, just identify this shower by giving its coordinates. If your shower is relevant, it will simply be added to `RADIANT.DBF`. For shower groups such as Taurids and Aquarids which represent a group of radiants in the *VMDB* it is possible to register these as totals when observers were unable to distinguish the various sub-radiants.

Very few people give magnitude distributions per night per shower per observer. This is a pity because it is just less data available to *IMO* analyzers.

To identify observing sites, we reserved series of site-codes to certain countries.

Table 1 – Reserved site-codes per country

Country	Site-Codes	Country	Site-Codes	Country	Site-Codes
Australia	12001–12999	France	14400–14999	Malta	10950–10999
Belgium	10000–10399	GDR	11000–11999	the Netherlands	10400–10899
Brazil	22501–23000	FRG	16001–16500	Norway	19000–19999
Bolivia	21001–21500	UK	13000–13899	Spain	15501–15999
Canada	21501–22000	Hungary	17000–17999	Switzerland	16501–16999
Czechoslovakia	23501–24000	Italy	13900–14399	USA	25001–26000
Denmark	22001–22500	Japan	18000–18999	USSR	24001–24999
Finland	15001–15500	Luxemburg	10900–10949	Yugoslavia	23001–23500

As you can see, practical experience forced us to switch from three- to five-digit site codes.

Several observing reports were received during the past two months. Because of the workload involved in prepare *IMO* Voting Bulletin 3, I was unable to compile a paper for this issue of *WGN*. However, this enables me to enter more data so that a more complete article can be prepared for all Fall showers. Later this year I intend to produce a first annual report for *IMO*, containing all the data we got from both *IMO* members and non-*IMO* members. The report will be generated from the *VMDB* by programs which require hardly any human effort at all. Therefore I invite all observers to submit to *IMO* all reports covering 1988 not yet sent in earlier. For people who sent in data not compatible with the *IMO* format we ask to make an effort to send us an adapted version.

International Meteor Weekend

Lake Balaton, Hungary, October 5–8, 1989

Tamas Kalmar

Registration Form

If you wish to attend the International Meteor Weekend in Hungary, during which the Founding Assembly of the International Meteor Organization will take place, please fill out this form, or a facsimile, and return it to: *MACSIT, Pf. 36, H-1387 Budapest 62, Hungary.*

First Name: ____________________ Middle Initial(s): ______ Last Name: ____________________

Mailing Address: ____

____

Phone number: ____

Accompanying person(s): ____

Do you intend to give a lecture? Yes–No

On what subject: ____

____

Do you intend to exhibit a poster? Yes–No

How much room do you need (m^2): ____

Are you an *IMO* member? Founding–Associate–No

Membership in other astronomical organizations: __________________________________

____

Date of Arrival: ____

Date of Departure: ____

Date and signature,

Observers' Notes: May–June 1989

Jeff Wood

1. Introduction

May and June sees the seasons changing from Spring to Summer in the northern hemisphere and from Fall to Winter in the southern hemisphere. Thus observing conditions tend to be more favorable in the northern hemisphere with warm clear nights than in the southern hemisphere where the temperatures approach freezing point when it is clear. Although there is only one really major shower active during this period, the η-Aquarids, there are a large number of minor streams active especially in the Scorpius-Sagittarius region that makes for good viewing. Table 1 below lists 20 of the more important showers that occur during May and June.

Table 1 – A list of some of the meteor showers to be seen in May-June 1989.

Shower	α	δ	Period	Max
α-Scorpids	246°	−23°	Mar 26–Jun 4	Several
η-Aquarids	337°	−1°	Apr 18–May 29	May 5
Corona Australids	284°	−40°	May 8–27	May 18
May Ophiuchids N	254°	−13°	Apr 25–Jun 2	May 18
May Ophiuchids S	256°	−24°	Apr 21–Jun 4	May 19
κ-Scorpids	267°	−39°	May 5–28	May 20
o-Cetids	27°	−4°	May 5–Jun 2	May 20
χ-Scorpids	247°	−13°	May 20–June 17	Jun 2
ω-Scorpids	243°	−22°	May 21–June 15	Jun 3
τ-Herculids	228°	+39°	May 19–Jun 14	Jun 3
Daytime Arietids	44°	+23°	May 29–Jun 19	Jun 7
ι-Scorpids	265°	−40°	May 30–Jun 18	Jun 8
γ-Sagittarids	272°	−28°	May 23–Jun 16	Jun 8
λ-Sagittarids	276°	−25°	Jun 5–Jul 21	Several
θ-Ophiuchids	264°	−20°	Jun 4–Jul 15	Several
June Lyrids	278°	+35°	Jun 11–21	Jun 16
June Bootids	219°	+49°	Jun 20–Jul 6?	Jun 28
τ-Cetids	24°	−12°	Jun 18–Jul 5	Jun 28
ρ-Sagittarids	293°	−17°	Jun 15–Jul 8	Jun 29
τ-Aquarids	342°	−12°	Jun 19–Jul 8	Jun 30

Table 2 – Moonlight and observing conditions in May-June 1989.

Date	k	Date	k
Friday April 28	0.59−	Friday June 2	0.05−
Friday May 5	0.01−	Friday June 9	0.29+
Friday May 12	0.44+	Friday June 16	0.89+
Friday May 19	0.97+	Friday June 23	0.85−
Friday May 26	0.73−	Friday June 30	0.13−

New Moon:	May 5, June 3, July 3
First Quarter:	May 12, Jun 11, Jul 11
Full Moon:	May 20, Jun 19, Jul 18
Last Quarter:	April 28, May 28, Jun 26

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 η-Aquarids

This fine shower is active from April 19 through to May 29 and reaches a maximum ZHR of 50 to 60 meteors per hour on May 5. The η-Aquarids have an unusual activity curve with ZHRs remaining above 35 from about May 3 to May 10. In some years, this period is even greater like in 1980 when it extended from May 2 to May 15. Another unusual feature of the η-Aquarids is a second maximum on May 8 which has been detected on at least five occasions in the last 12 years. Studies by Sekanina in the USA during the 1960s and 70s involving radio meteors showed that the η-Aquarids consisted of two sub-streams, the "proper" η-Aquarids which reached maximum around May 3–5 and the so-called Halleyids which reached maximum on May 8. Since the radiants are very close together, it is impossible to visually separate meteors belonging to these sub-streams and so naked eye results show their combined activity.

The η-Aquarids which were produced by debris from Halley's Comet are a very spectacular stream especially for southern hemisphere observers. Unfortunately, because the radiant reaches culmination during daylight hours, the η-Aquarids cannot be viewed in all their glory. Although the radiant is equatorial with a declination of $-1°$, the seasons are such that it is daylight in much of the northern hemisphere before the radiant can rise more than 20° above the horizon. The southern hemisphere is more favorably placed and the radiant is able to rise above 50° before sunrise.

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

1989 is a favorable year moon-wise to observe the η-Aquarids. *IMO* encourages observers in both hemispheres to make this stream a special target for their attention.

3. Scorpius-Sagittarius complex

This name is given to the large number of ecliptic streams that are active in the constellations of Scorpius and Sagittarius from March to July. Although many of these streams produce only a handful of meteors per night, they have been known for unusually high rates on odd occasions. The Scorpius-Sagittarids are noted for the brilliant fireballs they produce. Although their parent body is not known, various authors have connected them with Comet Lexell (1770 I) and the Apollo Asteroids Adonis and 1983 LC.

In Table 1, I have listed some 12 components of the complex. Of these, the most active are the α-Scorpids, the ω-Scorpids, the Corona Australids and the λ-Sagittarids, which in most years produce over 4 meteors per hour at maximum. Because of their long period of activity and the fact that their radiants are visible virtually the whole night, these streams are not unduly hindered by the moon. I recommend that the serious meteor observer who is looking for something to do make monitoring the Scorpius-Sagittarids a must in 1989.

4. Daytime showers

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

5. Minor northern hemisphere showers

The τ-Herculids reach maximum on June 3. Observations to date indicate the τ-Herculids produce very low rates in the order of 1 to 3 meteors per night. However, the fact several τ-Herculids have been captured on film means that those meteors that do occur must be quite bright. With a favorable moon, northern hemisphere observers are encouraged to monitor this stream in 1989.

Observations have shown that the June Lyrids produce irregular activity from year ranging from ZHRs of 1 to 10 meteors per hour. Although there is a full moon on June 19, an enhanced display of June Lyrids will not be unduly affected due to their overall brilliance if indeed one does occur. The June Lyrids are noted for being blue-white in color and having a train. The average magnitude of their 1969 display was 2.0 making them easily visible in all but the poorest of skies.

The June Bootids were produced by debris from Comet Pons-Winnecke and provided a great display on June 28, 1916. Since this time further good displays, but nowhere near as strong, were noted in 1921 and 1927. However, after the 1920s the shower produced 2 or 3 meteors per hour at best. Even though calculations show that Jupiter has perturbed the orbit of the meteors away from the Earth, another good display could come at any time like the surprise 1966 great Leonid storm. Thus observers should continue to monitor the June Bootids on a regular basis. These meteors were characteristically very slow and very faint. Observers of the 1921 and 1927 displays said that the majority of the meteors seen were magnitude +4 or fainter meaning that a dark sky is a must to detect them. A Last Quarter Moon rising after midnight in late June means that the Bootids are well placed for observations in 1989.

6. Minor southern hemisphere showers

The τ-Cetids were first observed by Jack Bennett, the discoverer of the great comet of 1970–71, during the late 1970s when rates of 5 to 10 meteors per hour were recorded. The τ-Cetids are best viewed the last couple of hours before dawn. They produce often bright, fast, blue-white meteors that frequently have a train. The τ-Cetids have some interference from a Last Quarter Moon in 1989.

The τ-Aquarids produce variable rates from year to year. At best they can reach 15 meteors per hour and at worst almost zero at maximum. With a favorable Moon, observers are encouraged to keep an eye out for these meteors. The τ-Aquarids are similar in speed to the δ-Aquarids and like their late July counterparts produce many meteors in the magnitude +2 to +4 category. Few τ-Aquarids produce trains.

7. Conclusion

Please submit all of your observations to your national or regional IMO representative. Individuals and groups are invited to send observational results to Paul Roggemans who will take care of combined analyses. We invite meteor workers to set up well defined observing projects or to propose specific observing efforts. 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!

Please mind that the **International Meteor Weekend** near Lake Balaton in Hungary will take place from **October 5 till October 8**! During that weekend, the **Founding Assembly of IMO** will be held. Interested meteor workers are kindly invited to fill out the registration form on p. 32 of this issue of *WGN* and to return it to the address indicated.

SNCs—Meteorites from Mars?

Detlef Koschny

SNC-meteorite is a term used to designate a type of meteorite that is suspected to originate from Mars. An overview is given of the arguments in favor of a Martian origin of these meteorites and possible ejection mechanisms are discussed.

1. Introduction

People interested in astronomy—and especially in meteors and meteorites—should have heard the term *SNC-meteorites*. One of the first question will be: how do I pronounce it? Well, to make life easier, just introduce another character and say "Snick-meteorites". Now, what is so special about them? They are supposed to come from Mars, the beautiful Red Planet which is between 56 and 400 million kilometers away from Earth. Why scientists think that the SNCs are from Mars, and how to got off there, will be the topic of this article.

2. What does "SNC" mean?

SNC, of course, is an abbreviation. It stands for *Shergotty, Nakhla and Chassigny*, the names of the meteorites that typify three subgroups of the SNCs. All together, they form a group of eight meteorites that are very distinct from other, "normal" meteorites. Some information on each individual meteorite is given in Table 1.

Table 1 – Some information on the eight SNC-meteorites [3]. Usually the meteorite is named after the location where it was found.

Type	Name	Location	Remarks
Shergottites	Shergotty	Shergotty, India, 1865	several stones
	Zagami	Zagami, Nigeria, 1962	
	EETA 799001	Elephant Moraine, Antarctica, 1979	mass 7.9 kg
	ALHA 77005	Allan Hills, Antarctica, 1977	
Nakhlites	Nakhla	El Nakhla el Baharia, Egypt, 1911	40 stones one stone killed a dog! total mass 40 kg
	Lafayette	Lafayette, Indiana, USA	two finds
	Governador Valaderes	Governador Valaderes, Brazil	
Chassigny	Chassigny	Chassigny, France, 1815	

3. The evidence

There are two main characteristics that make the SNCs different from other meteorites: their age and their chemical composition.

Let us first discuss the chemical composition. The age of a rock can be determined via *radiometric age determination*. Suppose that a rock formed a long time ago from crystalizing magma and that it contained uranium-238. Since ^{238}U is radioactive, it decays into other elements. A certain percentage of the atoms disintegrate every minute. After 4560 million years, the so-called "half-life" of ^{238}U, half of them will have disintegrated. The stable end products of this process are helium and lead-206. Thus, from the ratio of e.g. ^{206}Pb to ^{238}U, the age of the rock can be determined.

Different elements are used as radio-active clocks, allowing cross-checking the obtained numbers. Radioactive clocks may be reset by shock or by melting. Table 2 lists the ages obtained by different dating methods (see [1] for further references).

Table 2 – Ages for SNC-meteorites, determined by different dating methods [1]. "Myr" stands for 10^6 yr, "Gyr" for 10^9 yr. Note the difference between crystalization age, shock age and cosmic ray exposure time.

Type	Rb-Sr	^{39}Ar-^{40}Ar	Sm-Nd
Shergottites	180 Myr (shock reset)	250 Myr (for one: over 1 Gyr)	1.3 Gyr (cryst. age?)
Nakhlites	1.3 Gyr	1.3 Gyr	1.3 Gyr
	(interpreted as crystalization age)		
Chassigny		1.3 Gyr	
cosmic ray exposure time: 2 to 10 Myr for all types			

When traveling through space, cosmic rays hit the meteorite and form certain nuclides like helium-3, neon-21 or argon-38. From the abundance of these nuclides, the cosmic ray exposure time can then be calculated to about 2 to 10 million years.

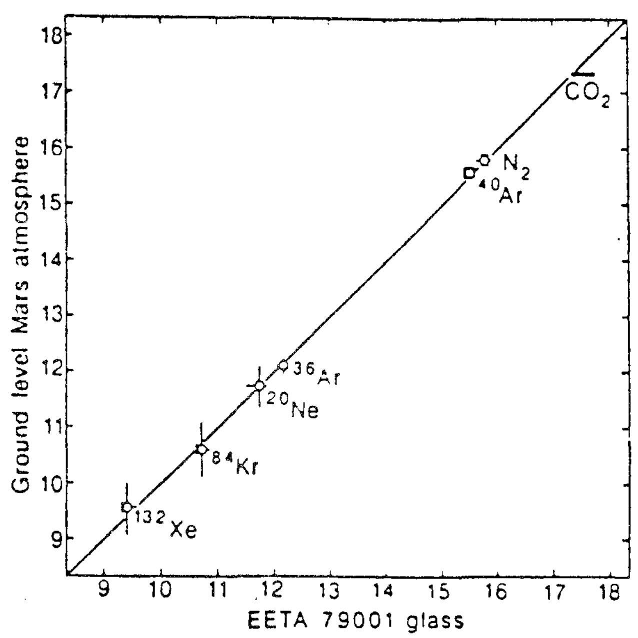

Figure 1 — Comparison of the relative abundances of various gasses trapped in EETA 79001 glass with samples of the Martian atmosphere [2]. The number of particles per cubic centimeter is shown on a log-log plot.

The major element compositions are distinct from those of other meteorites and lunar samples. Actually, they are very similar to certain terrestrial rocks, the basalts. Their texture (size, shape and arrangement of the minerals in a rock) indicates formation from a magma.

The glassy nodules embedded in the EETA 79001 rock contain a unique noble gas composition, matching closely the compositional pattern measured by the Viking spacecraft for these gasses in the Martian atmosphere (see Figure 1).

The atmosphere of Mars contains isotopically heavy nitrogen, ^{15}N, distinguishing it from all other volatile reservoirs in the solar system. An analysis of the trapped gasses in EETA 79001 also revealed very large enrichments of ^{15}N. Since the glassy nodules are absent in the other SNC-meteorites, the presence of these gasses is difficult to prove. Nevertheless, all eight meteorites are tied together through a distinctive oxygen isotope signature [2]. More information about the chemical characteristics of the SNCs can be found in [3].

4. The model

Wasson ans Wetherill concluded in 1979 that Mars was the least improbable parent body for the SNCs [4]. First quantitative evidence gave the nobel gas concentration measurements mentioned above. Combining all the information we have now, we can set up the following scenario.

The SNCs crystalized from a solidifying lava flow on Mars about 1.3×10^9 year ago. Then the material just sat there for more than one billion years, until an asteroid impacted on Mars and accelerated surface material to velocities larger than the escape velocity. The shock-reset Rb-Sr (rubidium-strontium) clocks indicate that this happened about 200 million years ago.

In order to explain the comparatively short cosmic ray exposure time of 2 to 10 million years, we assume that the ejecta consisted of larger boulders, maybe 10 to 15 meters across. Due to collisions in space, they broke up into smaller pieces, which finally hit the Earth.

Some people suggested an asteroidal origin. However, the late crystalization ages for SNC meteorites are difficult to explain with such an assumption. Current models of planetary evolution indicate that late volcanism is confined to larger bodies like planets of the large moons. The heat source for melting on asteroids was presumably the decay of short-lived radio nuclides; this mechanism could not remain active long enough to explain crystalization ages at 1.3 billion years or later.

5. The ejection process

A fairly big question—and still not quite answered—is: how were the SNCs accelerated above escape velocity (5 km/s for Mars), especially since the Nakhlites and Chassigny show no signs of having experienced high shock levels?

H.J. Melosh suggests a model that could explain the low shock levels [5]. According to his theory, the impact of a meteorite on a surface is equivalent to an underground explosion. From a theoretical "depth of burst", a spherical shock wave emanates. When the shock wave reaches the surface, it is reflected downwards as a tensile wave and interferes with the direct stress wave. This interference is such that the material near the surface does not receive the full compression of the shock wave. Since the acceleration of material off the surface depends on the pressure gradient, parts of the surface layer might be ejected to high velocity without seeing high shock levels. However, experimental analysis and numerical code simulations do not quite support this model [6,7].

A second ejection mechanism has been extensively discussed: the entrainment of planetary surface material by a high velocity vapor jet. O'Keefe and Ahrens, as well as Nyquist, show by experimental and numerical code simulations, that for oblique impacts, vapor jets can form with speeds up to three times the impact velocity [1,8]. This model too, however, has some problems: the material ejected above escape velocity has maximum sizes of only 1 meter or so, whereas the short cosmic ray exposure time asks for much larger sizes.

The amount of vapor—and with it the size of the particles accelerated above escape velocity—could be increased by postulating buried ice or bound water, that is vaporized by the primary impact. An argument against this process is that it requires a substantial regolith thickness, but the lack of brecciation in the samples indicates that they arise from undisturbed bedrock.

The most plausible ejection mechanism is the acceleration of surface material with low shock levels according to the Melosh model, maybe combined with an oblique impact. More experiments are needed to clarify the model's validity.

6. Where on Mars did they come from?

If these meteorites really come from Mars, we should be able to pinpoint their former location on the surface fairly precisely. We need a surface that formed in the geologically recent time of about 1.3×10^9 years ago. Superimposed, we should see an impact structure large enough to eject material to sufficiently high velocities.

Remote age determination on planetary surfaces can only be done counting craters, a method which lacks accurate calibration on Mars. With an age of about 1.15 to 1.60×10^9 years, the Tharsis region on Mars is the only area young enough to possibly be the origin of the SNC meteorites.

Figure 2 shows a geological sketch map from [3]. For units younger than 1.6×10^9 years, the locations of superimposed larger craters are also illustrated. These craters should be large enough to produce low-shocked ejecta according to the Melosh model.

At least two oblique impact structures are also in the Tharsis region (outside of the mapped area in Figure 2). These might have been able to produce vapor jets that drag-accelerated surface material above escape velocity.

7. Problems

The short cosmic ray exposure time can be explained by the ejection of large boulders (larger than about 20 m in size) that were fragmented later. However, the craters in the Tharsis region are only large enough to accelerate particles of about 1 to 5 m in size when applying the models discussed above.

Also, the mean transit time from Mars to the Earth was calculated by Wetherill [9] to smaller than 10 million years for a large fraction of the ejecta (35%). This led to the suggestion that the impact that shock-reset the Rb-Sr clocks 200 million years ago did only deposit the SNC parent material in an ejecta blanket, whereas the acceleration off Mars was performed by a second impact only a few million years ago. The craters of these impacts—with the right age and the right size—still have to be found.

The ejection mechanism itself is another subject that is still open to discussions. As mentioned in Section 5, the Melosh model for obtaining ejecta with low shock levels still lacks confirmation by other researchers. The acceleration via gas jets from oblique impacts yields sufficient total escaped ejecta masses for particles smaller than about 1 m in size.

In 1983, the meteorite ALHA 81005 was found in Antarctica. It was a very special meteorite: by comparison to samples brought back by the Apollo astronauts it could be proven without doubt that ALHA 81005 was from the Moon. Shortly afterwards, three more stones from the Moon were found. Since the Moon has a lower escape velocity than Mars, should we not expect a larger number of lunar meteorites?

Impacts capable of launching sizable ejecta are expected to occur at a maximum rate of about once every 400 million years on Mars and about the same or even longer time on the Moon. The long transit time between Mars and the Earth would lead to the establishment of a steady state population of potential Martian meteorites. Ejecta from the Moon, however, would arrive in spurts that are short compared to the time between two impacts. Since the lifetime of meteorites on Earth is short, this could explain the low number of lunar meteorites.

8. Conclusions

As we can see, it seems possible that the SNCs are from Mars, but their precise origin on Mars and how they got off the planet still needs more examination. Some researchers already assume that the SNCs definitely are from Mars. Traces of calciumcarbonate, calciumsulfate, magnesium and phosphorus were found in EETA 79001. These elements are important for the formation of life. Furthermore, the CO-isotope composition of the meteorite resembles that of fossile life on Earth. So, maybe, the discussion about life on Mars will now start all over again...

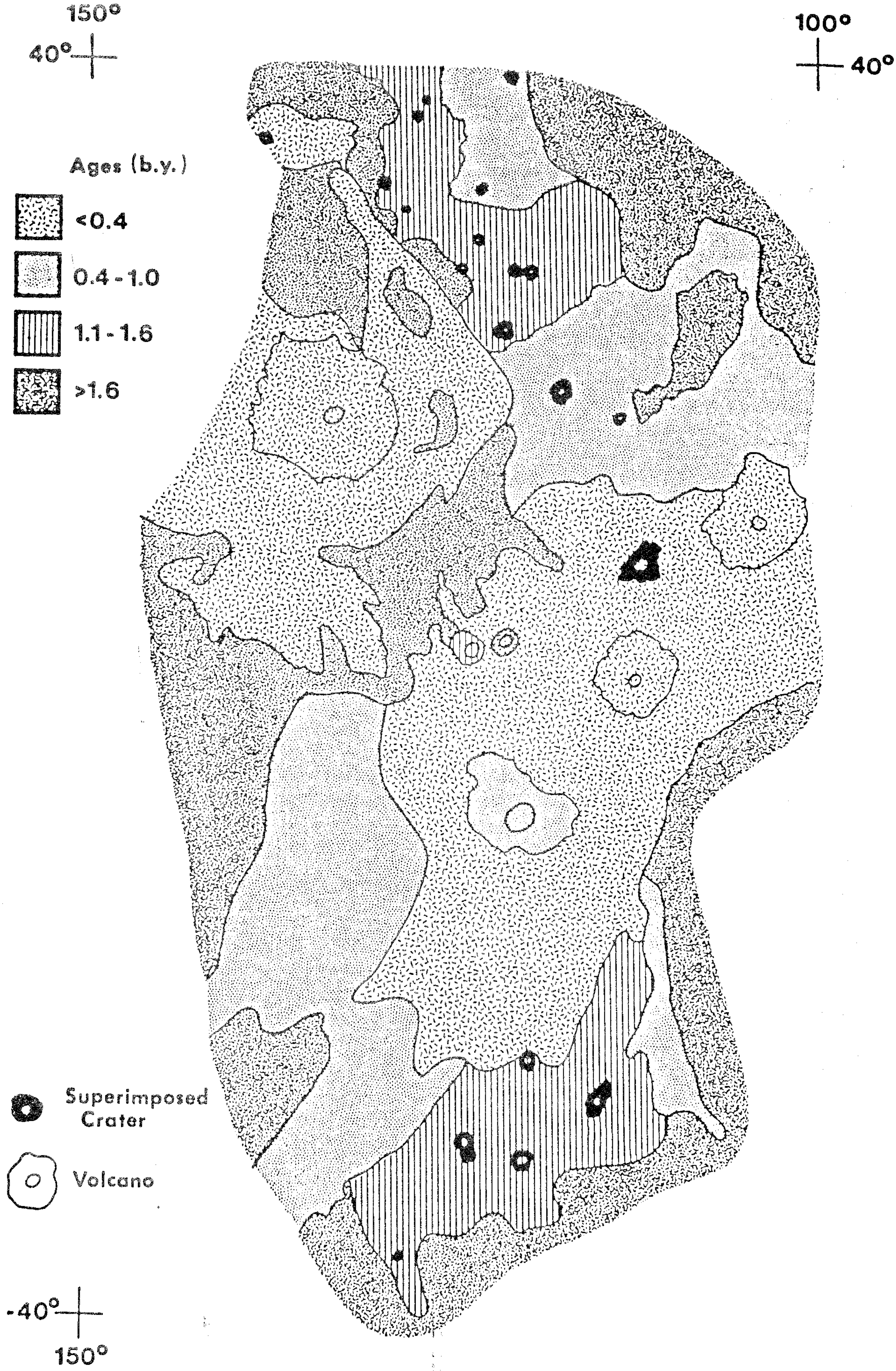

Figure 2 – Geologic map of the Tharsis region on Mars. For the areas younger than 1.6×10^9 years, superimposed craters are shown.

Acknowledgment

I wish to thank Dr. Bruce Murray from the Planetary Science Division of the California Institute of technology for having suggested this topic and for having always been helpful in answering my questions.

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Testing the New Kodak T-Max Black and White Film

Ghislain Plesier

In February 1988, a new Kodak black and white film of the T-Max series was presented to the press. The film has an Exposure Index of 3200 ISO, but exposures at 12 500 ISO were said to be possible... and even more. With an easy test, the value of this film for meteor work was determined.

As soon as the P3200 was available, two of them were bought to do a simple test. First of all, we must know what particularities of the film must be examined. For meteor photography, three major conditions have to be fulfilled: the film must be very sensitive, the contrast may be higher than for normal photography but not too high, and finally the graininess must be very low in order to have sharp definition. As you can see, these conditions seem somehow inconsistent with each other, but they happen to be the qualities of this film, according to the manufacturer.

The first film was used to find out what speed-setting gave the best results. The manufacturer gives the following possibilities: 800, 1600, 3200, 6400 and 12 500 ISO with the T-Max developer. To obtain these results, one should only change the development time (respectively 6+, 7, 9+, 11 and 12+ min. at the recommended temperature of 24° C). As a high sensitivity is needed, I used the settings from 1600 to 12 500 ISO. To obtain the most reliable result, I proceeded in the following way: a sequence of six exposures was made with exposure-times of 1, 2, 5, 10, 15 and 20 min. , respectively. Then, four negatives were omitted and the same sequence was made again until the film was completely exposed. This gave me four equivalent series, exposed on the same film, with the same camera-setup, under the same sky-conditions and of the same part of the sky. With other words, the four series were obtained under totally identical conditions. Then in the dark room the film was completely reeled off and folded into two parts with the same length. At this point, the film was cut into two parts, and each of them was again folded and cut into two equal halves. Some might already have understood that this cutting was not damaging the exposed negatives as the cutting should be (!) situated there where the four blank shots were made. The four strips could then be stored in lighttight boxes and processed *one at a time*, using the development-times mentioned above. During the processing, new developer was used for each strip in order to have comparable results and new fixing bath as the T-Max films do need a thorough fixing.

The second film was used a few days later to examine the difference between the (expensive) T-Max developer and a more common one, namely Kodak D-76. Therefore, I once again used the same technique of cutting the film, but no sequence was made this time. Instead, the first film was examined for the negative with the best density and contrast. In my case, the negative of 10 min. exposure at 3200 ISO was definitely the best. Therefore I exposed all negatives of the second film (except the four blanks ...) during 10 min. each. The first part of the film was processed with T-Max developer while the second was developed in D-76.

How were the results of all this testing? Was this "sensational" product of Kodak actually living up to the expectations that publicity gave us? The first conclusion could already be made immediately after the four sequences of the first film were put next to each other. All of the Exposure Indexes used (1600-3200-6400-12 500) had at least one of the six negatives suitable to make prints of it. A closer study clearly revealed that the contrast was surprisingly low, especially at the low ISO-values. The 1600 ISO strip could even be called greyish. This was clearly illustrated in another way: for all exposures I used a 24 mm f:2.8 wide-angle objective. This usually gave rise to a loss of light in the edges of the negatives and made it quite a problem to make prints. This effect immediately caught the attention on the films I mostly used (Tri-X or T-Max 400, pushed to 800 or 1600 ISO). But with the P3200, this effect became visible only on the 6400 and 12 500 ISO strips and even then it was not that worse; short exposures at these ISO-settings were perfect. While printing the negatives, no major problems were encountered. Paper of gradation "normal" was used and prints of 13×18 cm were made. This was the moment of truth concerning the graininess of the film. The picture of the 1600 ISO-strip revealed an astonishingly sharp image with fine star trails, a beautiful dark background and a uniform distribution of the grain. Excited by this fine image the other negatives with higher ISO-values were printed and caused me to be even more thrilled as the results became visible. The 3200-print had lost some of the dark background but was comparable to the former in quality. On the two-minutes exposure the Milky Way could be clearly distinguished. The third step was the 6400 ISO. That print was starting to have a prominent graininess but there was still no reason to be concerned as meteor prints usually are not printed on that high scale. The darkening in the corners of the photo became obvious too. Finally the 12 500 ISO was obtained. The darkening was now dominant and comparable to the results I used to obtain with Tri-X or even T-Max 400. The star trails were somewhat "swollen" as the graininess had now reached a level that was no longer acceptable for meteor photography. No accurate measurements could be performed on these images. But they could still be used for normal astrophotography if rather short exposures were used.

At this point of the test we can conclude that the T-Max P3200 film is highly recommended to the demanding meteor photographer when Exposure Indexes from 1600 to 3200 are used and development is done in T-Max developer at the times and temperatures indicated. Some personal testing to find the best combination could be useful. The only restraints are the high price of the developer and the short exposure times that must be observed as the film has some trouble with the Schwartzschild-effect. Personal experience made me conclude that for me, the following combinations were the best: 25 min. at 1600 ISO, 10 at 3200 ISO, 8 at 6400 ISO and 2 min. at 12 500 ISO. These times are strictly for my observing site and could be too high for most of the other observers as I do have a rather dark observing location. The short exposure time problem can be solved partially by using a rotating shutter. Of course under perfect skies (e.g. the South of France) exposure times can still be raised. The obstacle of the high price can be solved by reusing the developer. After developing a film, you do not have to pour the developer away; you can store it until another film must be processed. The only adjustment that should be made is that the processing time must be increased by one minute for each additional development. The developer can be used for 3 to 4 films. The test with the second film I bought was to find out if development with another product might give satisfactory results for a lower cost. The conclusion of this inquiry was even more explicit: the superior results with the T-Max developer could not be matched in any way by the D76 developer. The contrast was not too bad but the graininess was hideous and the density was too high with the latter. To conclude this test I would like to warn everybody that you might get completely different results with this film as it is still in a very experimental stadium. Even the manufacturer draws the attention to the fact that all his information concerning the film is highly dependable on personal working methods, the application you give to the film and of course the film itself. So the only thing you can do is to make some test shots for your application (in our case meteor photography) and look for the best results.

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Signal Processing Techniques for Separating Meteor Echoes from those of Aircraft

Gene Greneker

The use of a television station's video carrier to monitor meteor activity offers information about both day and night time meteor activity; specifically, the rate of entry into the Earth's ionosphere of individual meteors. When television stations located several hundred miles from the receiving station are used as signal sources, interference from aircraft can often be confused for meteor trails especially when the only criteria for detection of a meteor is an increase in the signal strength of the received signal. Aircraft interference causes bias in the collected statistics. The problem can be severe if the observer lives near a metropolitan area or if there are major airways between the observer and the signal source. The technique to be presented in this article offers a proposed method to eliminate the bias in meteor counts due to aircraft. Once identified, aircraft echoes can be removed. The proposed technique can be used with a home computer system and signal processing software. Evidence is provided to show that the technique is effective in achieving the stated goal of discriminating aircraft echoes from those of meteors.

1. Introduction

Television stations radiate high power audio and video carriers over an elevation beamwidth of less than 10°. While most of this energy is radiated toward and just below the horizon, there is a considerable energy that is radiated above the horizon. Given the curvature of the Earth, this energy illuminates an area several hundred kilometers above the Earth at ranges of 150 to 300 km from the station. When the video carrier of a low channel (2 through 6) VHF station is monitored from a receiving site located between 150 and 300 km from the station, the signal is enhanced when a meteor enters the region above the Earth between 160 and 70 km and burns as a result of frictional heating. The resulting ionized trail reflects radio waves when the electron density becomes greater than 10^{15} electrons per cubic meter. The reflective trail, made up of disassociated electrons behind the incoming meteor, forms a cylindrical shaped trail of electrons that reflects power from the video carrier downward towards the receiver resulting in an increase in signal strength at the receiver. The video signal enhancement occurs in amplitude and may last from less than a second to many seconds, depending on the number of electrons in the trail, the dispersion rate of the electrons in the trail and the carrier frequency.

Numerous articles have been published on the subject of radio meteor observations and several of these articles are offered in the reference section of this article. Given the availability of these references, the physics of the trail phenomenon will not be discussed in further detail, except to note that aircraft flying at altitudes that allow them to be "visible" to both the receiver and transmitter sites will reflect radio frequency (RF) energy that also causes an enhancement in the received energy form the illumination source. These aircraft reflections can be confused as meteors at the receiver site when only signal strength recordings are used to count the number of meteor reflections.

Since amplitude (signal strength) data can be undependable for developing meteor counts because of the aircraft data bias, analysis was conducted to determine whether frequency domain processing of the meteor and aircraft signals would allow meteor echoes to be separated from aircraft echoes. The analysis shows that frequency domain signal processing offers an advantage over amplitude methods alone. The technique is straightforward.

2. Theory of meteor trail reflectivity

The reflective region forms on the trail well behind the actual meteor itself. Constructive and destructive interference of the received signal occurs due to there being multiple reflection points along the trail. This phenomenon produces a "whistle" when a meteor (size of a grain of sand) enters and the signal is aurally monitored at the receiving site. The smaller micro-meteors sound, to the ear, like a "ping" similar to the sound heard when a slightly microphonic vacuum tube warms up. Frequency analysis of both type meteor echoes shows there is a unique frequency domain signature present in both type trail echoes. There is also a smaller frequency shift associated with the reflection from the trail as it is being blown by the tropospheric winds. This effect may last for many seconds after the entry of the meteor. There is a signal strength enhancement each time a meteor trail is observed, that can be easily confused with aircraft reflections.

3. The experiment and resulting data

The video carrier of WTVY located in Dothan, Alabama, approximately 300 km from the receiving site in Marietta, Georgia, was used as a signal source. The video carrier on 67.250 MHz, VHF channel 4, was monitored during the period $12^{h}30^{m}$ through $13^{h}00^{m}$ UT on March 20, 1987, to collect meteor and aircraft echoes. The antenna was a four element broadband VHF yagi television antenna aimed approximately 20° to the south of the bearing to WTVY. The receiver used was an FRG-9600 operated in the upper sideband mode with the bandpass set to approximately 3 kHz during the observation of both aircraft and meteors.

4. Aircraft signature analysis

Figure 1 is a voltage spectral plot of aircraft signatures that was analyzed in the frequency domain using a Hewlett Packard model 3561A Dynamic Signal Analyzer. Frequency is displayed along the X-axis of the plot. The left margin of the plot represents 0 Hz, the center of the plot represents 605 Hz and the right side of the plot represents 1210 Hz. The scale along the X-axis is linear. The video carrier frequency was offset from the zero beat so that the resulting beat note from the receiver was 642 Hz. This beat, or offset carrier frequence, is shown in Figure 1 as the 642 Hz line that runs the duration of the plot along the Y-axis.

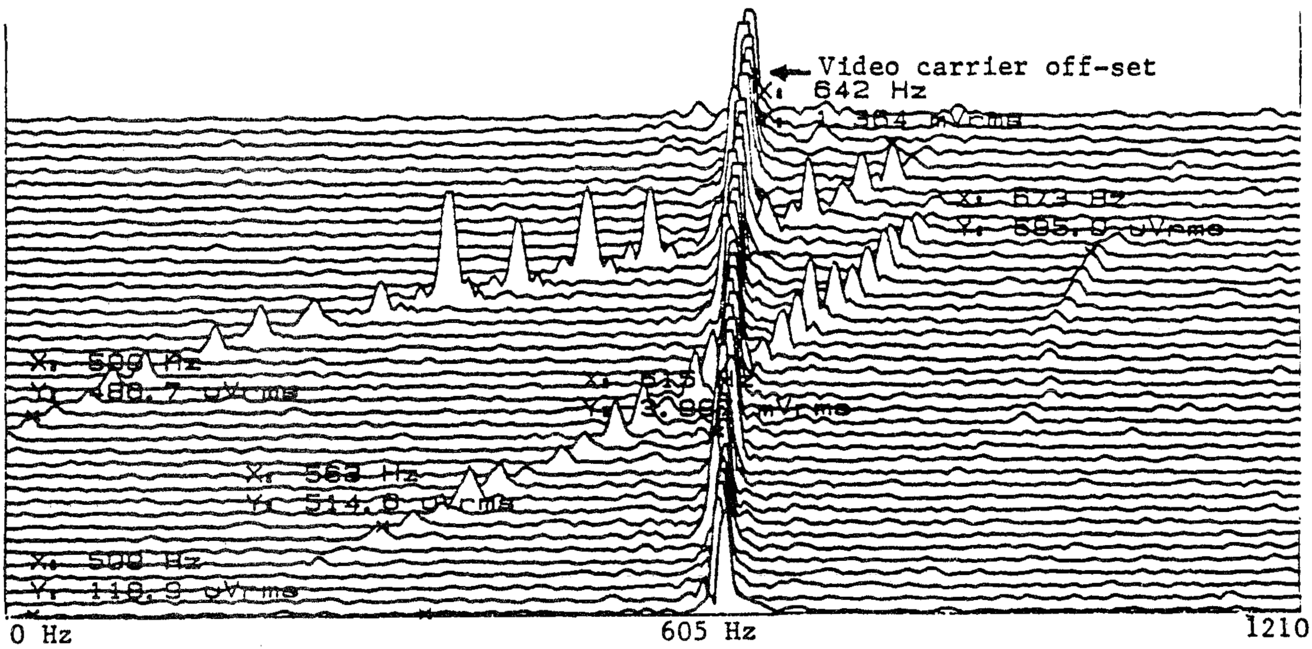

Figure 1 – Voltage spectrum of aircraft echoes. The center of the X-axis represents the frequency of 605 Hz. The video carrier frequency is 642 Hz. Increasing time is from the bottom of the "waterfall" plot to the top of the plot. The relative amplitude of the signal at any given time is inferred from the height of the "spike" in the record.

A Doppler shift is generated as the aircraft approaches and crosses the baseline between the transmitter and receiver due to constructive and destructive interference caused by the changing signal path due to the aircraft motion. The resulting Doppler shift appears in Figure 1 as successive "spikes " that change slowly in frequency with time.

The record shows that three aircraft were observed during the approximate 40 second analysis period. The first aircraft was detected when its Doppler frequency was approximately 250 Hz. This echo persisted until the Doppler frequency increased to approximately 750 Hz. The relative amplitude of the signal is indicated by the height of the 'spike" in Figure 1. The second aircraft echo that was detected starts at 10 Hz and rises to approximately 750 Hz at the time the echo goes into the noise. The second echo is, on average, a higher amplitude signal than the first. A third aircraft signature appears on the right hand side of Figure 1. It has a relatively short duration, and low average amplitude. Its frequency also increases with time.

There are several other prominent features of the aircraft signatures that appear to be characteristic of aircraft but not meteors. The aircraft signatures change in frequency in linear fashion when frequency is plotted as a function of duration in comparison to observed meteor echoes.

5. Meteor echo analysis

A very pronounced "whistler" meteor echo was recorded for analysis purpose. After the "whistler" phase, the trail echo produced a long duration low frequency Doppler shift as the trail was carried by tropospheric winds. This echo was selected for frequency spectrum analysis as this signature is typical of the echo of larger meteors.

Figure 2 shows the spectral display produced when approximately 3 seconds of the entry of the "whistler" meteor was analyzed. When this echo was recorded the visual carrier was offset from zero beat by 385 Hz. The carrier frequency of 385 Hz is marked on the plot and runs along the entire Y-axis (increasing time runs from the bottom of the plot to the top).

The meteor echo begins with a Doppler shift of 1025 Hz at the point that is marked by the X on the 12th line from the bottom of the plot. The time history of this record is not obvious

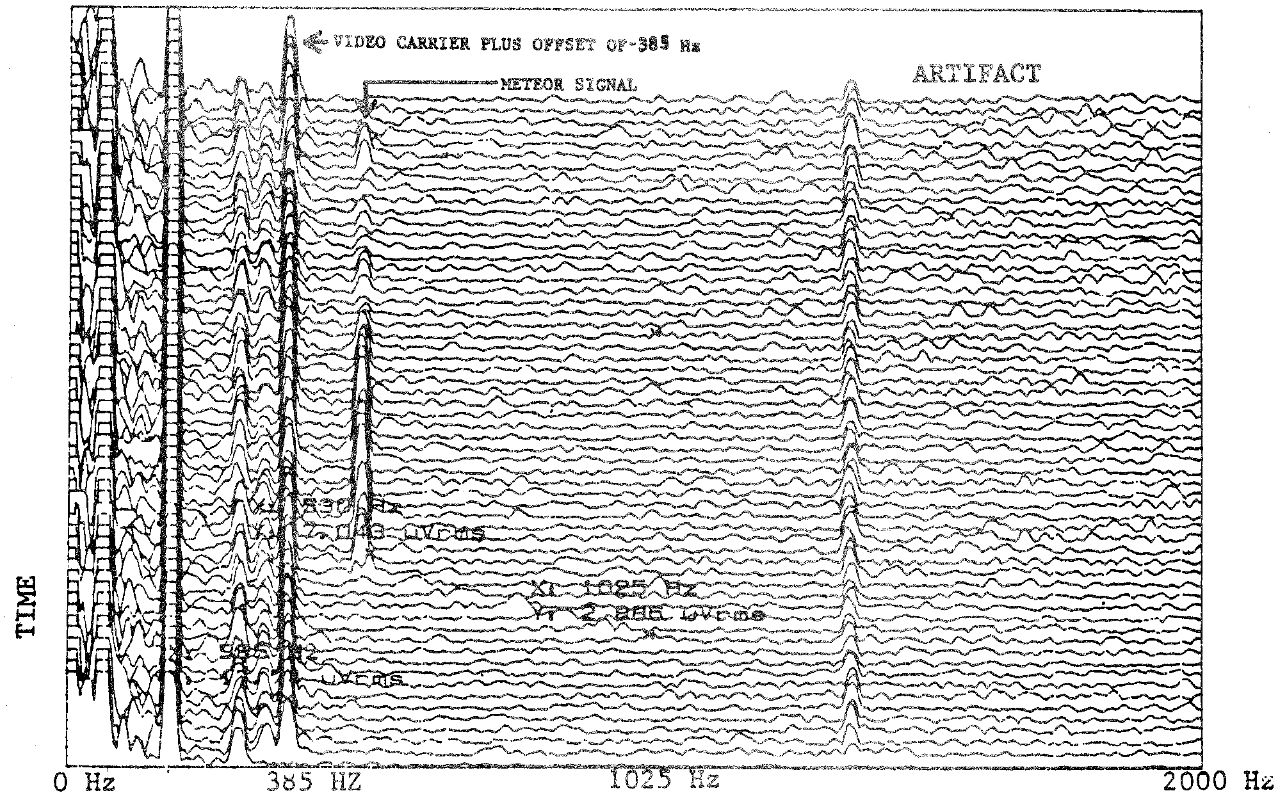

Figure 2 – "Waterfall" plot of meteor echo time history frequency spectrum signature. The plot is not scaled to show that the meteor trail was first detected in the 12th plot from the bottom. The detail that shows the frequency change as a function of time is more clearly presented in Figure 3.

in Figure 2 because of the low dynamic range of the scale. For this reason Figure 3 was generated from measured data to provide more detail on the meteor trail history using the single line expansion feature of the analyzer. Figure 3 is two plots on a single figure, and shows a detailed time history of the Doppler shift and also of the associated echo amplitude. The observed Doppler frequency is shown on the left Y-axis. This scale applies only to the frequency versus time plot. The right side of the plot shows the signal amplitude in units of microVolts, and applies only to the amplitude analysis.

The data represented along the upper X-axis represent elapsed time and the data shown along the lower X-axis is the index number of the sample. The upper plot shows that the meteor Doppler frequency decayed from a maximum of 1250 Hz to a relatively steady level of 520 Hz within approximately 500 milliseconds of initial detection. The Doppler shift then became relatively constant around the average value of 510 Hz, which is approximately 125 Hz above the carrier frequency of 385 Hz. It is thought that this fairly constant offset from the carrier frequency represents the rather constant Doppler shifts induced as the trail is being blown by the tropospheric winds.

The bottom trace represents the amplitude of the detected signal. When the meteor trail was first detected the amplitude was less than 5 microVolts. The signal increases rapidly to approximately 38 μV within 750 milliseconds, and then decays with increasing time, until approximately 3 seconds after entry when the reflectivity from the meteor's trail has dropped to a level of 3 μV.

The oscillatory effect seen in the echo is typical of meteor echoes. When the reflected power from the many points along the trail all add in electrical phase, a peak in amplitude occurs. As the trail geometry changes, the reflections become 180 electrical degrees out of phase at the receiver and signal cancellation occurs causing the deep nulls in the amplitude that are observed.

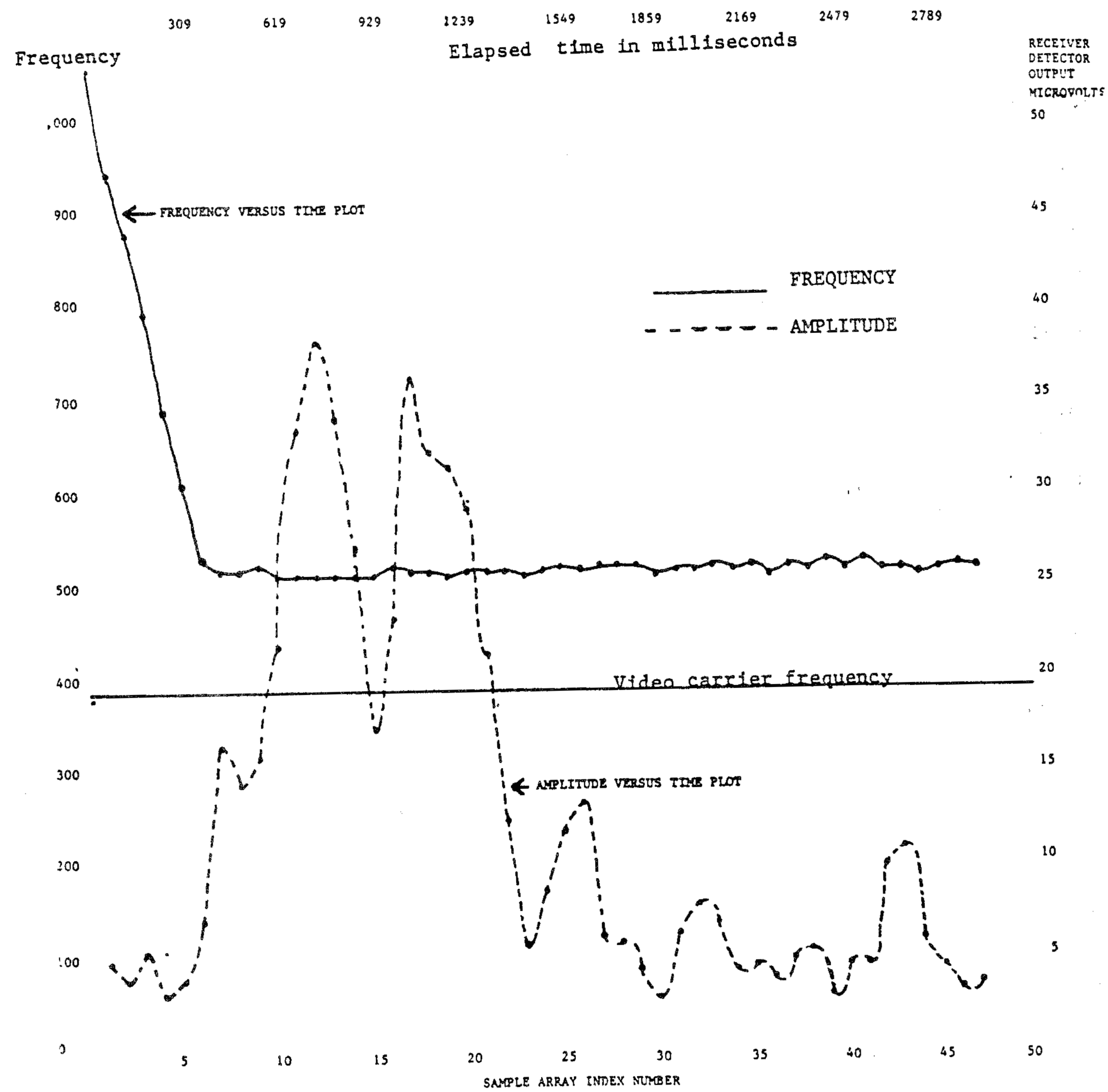

Figure 3 – A combined plot of the frequency spectrum of the meteor echo produced as a function of time and the amplitude of the return as a function of time.

6. Discrimination analysis

The spectral characteristics of the meteor echo are different from the aircraft echo. The echo from the meteor trail starts at a high frequency and decreases rapidly to a low frequency that remains relatively constant during the duration of the echo. Once formed, the trail is blown by the tropospheric winds, generating a low frequency Doppler signature. The aircraft signature, however, changes steadily in linear fashion, and is usually longer in duration than a meteor echo. The width of the spectrum is large if the echo is observed for its entire duration.

7. Automatic meteor signature recognition

It is proposed that automatic meteor discrimination could be done with a home micro processor system. A system level design for automatic meteor signature analysis and discrimination will be the topic of a future paper if sufficient interest exists. The system components required would be an antenna, receiver, notch filter, analog to digital (D/A) converter, microprocessor system and signal processing software.

The receiver would monitor the television video carrier. The audio output of the receiver would be fed directly into the notch filter tuned to the carrier beat note so that there would be no output from the filter when carrier alone is present. When a meteor or aircraft echo is received there would be output from the filter due to the Doppler shift component. After halfwave rectification, the resulting voltage would be fed to a trigger, which would change state as long as the output of the notch filter exceeded the present threshold. This voltage level would be used to signal the computer that an echo was present. The computer would next sample the data from the A/D converter that is digitizing the receiver's audio output. This process would convert the analog audio output of the receiver to a digital word each time the A/D converter sampled the audio output (the sample rate would be on the order of 2 kHz).

The digitized samples would be stored in system memory until the threshold of the trigger dropped below a preset level indicating that the meteor echo is no longer present. The microprocessor would then compute a spectrum for each 125 milliseconds of data collected using Fast Fourrier Transform (FFT) techniques. This spectral time history would then be stored and analyzed with a meteor discrimination algorithm. This algorithm would make decisions regarding echo validity on the basis of echo spectral characteristics such as length of echo, amplitude and frequency history.

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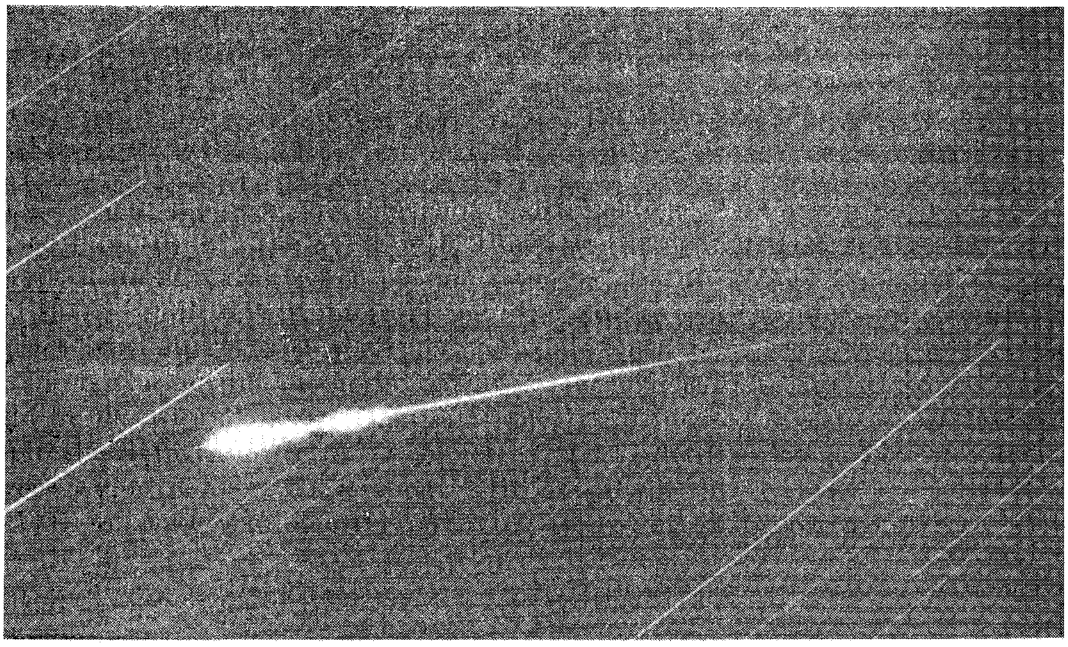
A Geminid Fireball from Yugoslavia



This picture shows a nice Geminid fireball of approximately magnitude −9, photographed by the Yugoslavian group *Amatersko Astronomsko Društvo Višnjan* in the night of December 11–12, 1988.

1988 Fall and 1989 Winter Observations

The 1988 Sextantids

Dirk Artoos

Radio observations by the author in Belgium, which are probably due to activity of the Daylight Sextantids are presented and discussed.

In a previous issue of *WGN* [1], I made a call for observations concerning an usually high radio meteor activity in the morning of September 28. A few days later, I contacted Paul Roggemans who told me that I could have heard activity from the Daylight Sextantids, the maximum of which was predicted for September 27 at 11^h UT at $\lambda_\odot = 184°$. In Table 1 and Figure 1, I present my observations. Both the numbers of meteors recorded (black blocks) and the corresponding hourly rates (lighter blocks) are given.

Table 1 – Radio observations by the author of the 1988 Daylight Sextantids

Date	Period (UT)	N	Hourly Rate
Sep 26	21^h00^m–21^h15^m	32	128
27	06^h10^m–06^h20^m	43	258
27	21^h00^m–21^h15^m	44	176
28	06^h10^m–06^h20^m	38	228
28	08^h45^m–09^h00^m	70	280
28	09^h15^m–09^h30^m	66	264
28	21^h00^m–21^h15^m	43	172
29	07^h45^m–08^h00^m	58	232
29	21^h00^m–21^h15^m	40	160

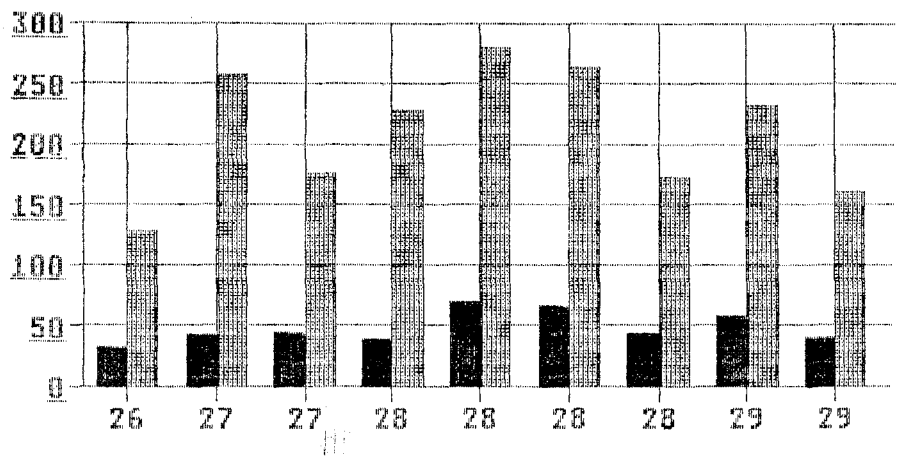


Figure 1 – Radio meteor activity observed by the author between September 26 and 29. Black blocks represent the numbers of meteors seen and lighter blocks are the corresponding hourly rates.

According to Kronk, the Daylight Sextantids are active between September 24 and October 9. The shower's maximum activity seems weak, but reached nearly 30 meteors per hour in 1957. The stream may be periodic, with an encounter with the Earth occurring every 4 to 5 years. This daylight meteor shower was discovered by A.A. Weiss in 1957 during a radio survey conducted at Adelaide (South Australia). Due to the uncertainty of the radiant position at that time, the shower was referred to as the *Sextantids-Leonids*. Weiss further noted that no trace of activity had been detected during previous radio-echo surveys. The next detection of the Sextantid stream was made in 1961 by Nilsson who operated the radio equipment at

Adelaide during September 21–29, and detected 9 members of this stream during September 24–29. Interestingly, Nilsson noted a similarity between the Sextantid orbit and the orbit of the Geminids of December. He claimed that *statistically, the difference between the Sextantid and Geminid orbits is not significant, and the former could well represent the daytime return of a branch of the latter stream after perihelion passage if the stream is wide enough.* Indeed, as Nilsson pointed out, the closest approach of the Sextantids to Earth in December is 0.34 AU, while the indicated width of the Geminid meteor stream is 0.11 AU. The width of the Sextantid and Geminid streams presented the largest problem in their being directly related, but other problems also existed. Nilsson noted that the Geminids occurred annually with consistent rates *indicating that the meteoric matter is extended uniformly along the orbit.* On the other hand, the Sextantids have only been detected in 1957 and 1961. Surveys in other years should have detected the stream, but since they did not, Nilsson suggested the shower might be periodic. The next sighting of the Sextantids came in 1969, during the second session of the Radio Meteor Project. Although the Sextantids may not be due to the same stream as the Geminids, the orbits of the two streams are close enough to consider the possibility that the origins of both streams are linked in some manner. Further observations of the Sextantids should prove of great interest!

1988 Fall Observations from Texas

David Swann

An overview is given of the author's observations of the Orionids, Taurids, Leonids and Geminids as well as some of the minor streams

The weather did not interfere with my observations of the Orionids and Taurids but did with the Leonids. The ground conditions were such that I did not venture out to my normal observing site for the Geminids. Instead, I observed them from my backyard. I recorded my highest one hour rate for the Orionids on October 21–22 and the Taurids on November 6–7. These two rates are my all time highs for both of these streams. Table 2 gives a summary of my hourly rates.

Table 1 – Abbreviations.

Shower	Abb.	Shower	Abb.
Orionids	O	Arietids	DA
Leonids	NL	ε-Geminids	EG
Geminids	G	Andromedids	BI

Table 2 – 1988 Fall observations from Texas by David Swann.

Date	Period (UT)	$T_{\rm eff}$	Lm	F	Tau	Other streams	Spor
Oct 09–10	05^h35^m–06^h35^m	1.00	6.4	1.00	2	3DA	6
09–10	06^h35^m–07^h35^m	1.00	6.4	1.00		2DA	3
09–10	07^h35^m–08^h35^m	1.00	6.4	1.00	3	1O	4
16–17	07^h55^m–08^h55^m	1.00	6.2	1.00		5O	4
16–17	08^h55^m–09^h55^m	1.00	6.2	1.00		3O,1DA,1EG	5
21–22	08^h55^m–09^h55^m	1.00	6.0	1.00		9O,1DA,2EG	8
21–22	09^h55^m–10^h55^m	1.00	6.0	1.00	1	17O,1EG	8

Table 2 – continued

Date	Period (UT)	T_{eff}	Lm	F	Tau	Other streams	Spor
Nov 06–07	08^h15^m–09^h15^m	1.00	6.3	1.00	8		8
06–07	09^h15^m–10^h15^m	1.00	6.2	1.00	4		7
12–13	09^h00^m–10^h00^m	1.00	6.2	1.00	2	1BI	7
12–13	10^h00^m–11^h00^m	1.00	6.2	1.00	2	2NL	14
Dec 12–13	10^h27^m–11^h27^m	1.00	5.5	1.25		31G	6

This was the first time since the 1960s that I attempted to observe the Arietids. Since the Arietid and the South Taurid radiants were close it was somewhat difficult to separate the two.

Table 3 – Global magnitude distributions of the 1988 Fall showers and of the sporadic background, as obtained by David Swann in Texas.

Shower	−3	−2	−1	0	+1	+2	+3	+4	+5	+6	Tot	$\overline{m}$
Orionids	0	0	1	0	1.5	8	11	9.5	4	0	35	3.07
Taurids	0	0	1	0	0	6.5	8	5	1.5	0	22	2.89
Arietids	0	0	0	0	1	1.5	2.5	2	0	0	7	2.78
ε-Geminids	0	1	0	0	0	1.5	1.5	0	0	0	4	1.38
Geminids	0	0	1	1.5	3	6.5	12	7	0	0	31	2.55
Sporadics	1	0	1	0.5	8.5	16	23	20	9.5	0.5	80	2.95

Of the 35 Orionids, 37% showed a train and of the 4 ε-Geminids seen, one had a train. No other showers produced trains. Of the sporadic background meteors, 14% showed a train.

It was my intention to concentrate on the Geminids for the morning of December 14. Due to heavy rain ending on December 11, the decision was made not to observe from my normal observing site. Not wanting to lose a clear night, observing was started on December 12–13. I noticed that my brighter Geminids appeared as yellow or blue-white in color.

Australian Observations in October–November 1988

Jeff Wood

An overview is given of Australian observations of the Leonids, the Taurids and the ζ-Puppids in October and November 1988.

During October and November 1988, we observed the Leonids, the Taurids and the ζ-Puppids. The following observers participated in the project:

Mark Glossop, George Platt, Martin Coroneos, Nathan Stewart, Jeff Wood, Nardia Hickson, David Stevenson, Michael Tonkin, Linda Carter, Guy Blackburn, Guy Blackman, Yukiko Nagashima, Craig Hinton, Michelle Treasure, Paul Camilleri.

The averaged observed ZHRs are shown in Table 1; magnitude distributions are given in Table 2.

Clear skies and the absence of interference from the Moon saw Australian Meteor Observers carry out an extensive observation program of the Leonid meteor stream. From the data

Table 1 – Average daily ZHRs of the 1988 Leonids, Taurids and ζ-Puppids as observed in Australia.

Date	Leonids		Taurids		ζ-Puppids	
	Nr. Obs.	ZHR	Nr. Obs.	ZHR	Nr. Obs.	ZHR
Oct 14–15			4	0.7 ± 0.9		
21–22			1	9.8		
23–24			2	6.1 0.4		
24–25			2	5.9 0.4		
30–31			5	4.5 2.5		
31–32			3	4.3 0.6		
Nov 04–05			2	4.9 ± 1.1	2	0.8 ± 0.8
09–10			20	2.8 1.1	15	0.8 0.4
10–11			17	2.6 1.3	11	1.2 0.6
11–12	7	0	8	3.7 0.8	8	1.2 0.3
12–13	10	0.4 ± 0.6	25	5.4 3.0	21	1.6 0.5
13–14	6	0.7 0.7	10	2.8 1.2	10	3.6 1.0
14–15	6	1.2 1.0	8	2.5 1.5	8	2.2 0.8
15–16	4	2.4 1.4	4	2.7 0.9	4	1.9 0.5
16–17	3	9.1 0.7	3	2.3 0.5	3	1.7 0.4
17–18	4	14.7 1.1	4	2.1 1.3	4	1.0 0.6
18–19	3	4.1 0.4	3	1.7 1.2	3	0.8 0.6
19–20	3	1.3 1.8	3	3.6 2.7	3	1.1 0.8

Table 2 – Global magnitude distributions of the 1988 Leonids, Taurids and ζ-Puppids obtained from Australian observations.

Shower	−6	−5	−4	−3	−2	−1	0	+1	+2	+3	+4	+5	+6	Tot	$\overline{m}$
Leonids	0	0	0	0	2	0	3	8	14	18	16	9	1	71	2.83
Taurids	1	0	3	1	2	6	16	34	69	91	73	26	5	327	2.65
ζ-Puppids	0	0	0	2	0	1	2	7	23	69	65	21	8	198	3.36

above, it can be inferred that maximum occurred on November 17 with a maximum ZHR of approximately 20. Of the 27 Leonids of magnitude +2 or brighter, 7.4% were green, 11.1% blue and 14.8% yellow in color. All the remainder were white. 33.8% of the Leonids seen had a train. Several of these were quite persistent with the longest lasting some 30 seconds after the meteor itself disappeared from view.

The 1988 Taurids were observed from October 14 through to November 20. Despite some interference from the Moon and the weather, they were observed on 18 nights for a total of 148 man hours of observing time by 14 observers. For the Taurids between magnitudes −3 and +5, an r-value of 2.67 was obtained. Of the 132 Taurids having a magnitude of +2 or brighter, 43.2% were yellow, 2.3% were green, 8.3% were blue, 3.8% were orange, 0.8% were red and the remainder were white in color. 3.4% of the Taurids seen had a train. All of these were of short duration.

The ζ-Puppids are a branch of the Puppid-Velid complex that occur during early to mid November each year. In 1988 as a part of our November meteor project, we decided to thoroughly monitor the activity of this stream. For the ζ-Puppids between magnitudes −1 and +5, an r-value of 3.47 was obtained. Of the 35 ζ-Puppids of magnitude +2 or brighter, 22.9% were yellow, 11.4% were blue and the remainder were white in color. 8.6% of the ζ-Puppids seen had a train. All of these were of a short duration.

JAS Observations of the 1988 Taurids and Geminids

Alastair McBeath

A summary of naked-eye visual observations by JAS Meteor Section members during the 1988 Fall and early Winter is discussed, with particular reference to the Taurid and Geminid showers. Some results for these two streams are presented.

1. Introduction

Weather conditions over Great Brittain were generally rather poor in 1988 September and October, though early November and mid-December were somewhat better. September, which often brings good, clear skies, was especially disappointing, while November proved to be less cloudy than usual, by contrast.

Twenty observers submitted data from this period, as listed below. All watches were carried out from the British Isles, except where noted.

George Ackinclose (United Arab Emirates), Roy Barclay, Neil Bone, Andy Chapman, Michael Dale, Gavin Fitzgerald, Kenneth Fraser, Shelagh Godwin, Peter Hallett, Mark Harris, Derrick Hasted, Sebastian Jay, Savvas Koushiappas (Cyprus), Richard Livingstone, Lee McDonald, Alastair McBeath, Michael O'Dwyer, Ian Rigney, Simon Wragg, Kyriacos Xylaris (Cyprus).

In total, 241.73 man-hours of naked-eye watching were performed and 1690 meteors seen.

As many of the JAS Meteor Section observers are inexperienced, little emphasis is placed on the observation of most of the annual minor showers to avoid unnecessary confusion, but some of the more prominent minor streams are covered. During the fall and early Winter session discussed in this article, the following nine streams were under scrutiny: α-Aurigids, Northern and Southern Piscids, Orionids, Northern and Southern Taurids, Leonids, Geminids and Ursids. Too few α-Aurigids, Piscids, Orionids, Leonids and Ursids were seen to permit any detailed analysis of them, but the Taurids and Geminids proved more numerous, allowing closer examination.

2. Data analyses

Analyses as delimited in [1], covering shower ZHRs, magnitude distributions and train details were carried out for both the Taurids and Geminids, and uncorrected sporadic observed rates (OHRs) were also prepared for comparison. All information used in the analyses was obtained from experienced observers, under skies with less than 20% cloud cover, although due to often hazy skies, the Lm-criterion was relaxed to cover occasions when the limiting magnitude reached +5.0 or better. Precise details for the Lm-conditions can be found in the appropriate paragraph below.

3. The Taurids

Some 186 shower members were reported between October 10–11 and December 5–6, but under the strictures given earlier, the total available for analysis was reduced to only 84. Mean limiting magnitude for this period was +5.30, the range being +5 to +6.

Table 1 – Combined mean Taurid ZHRs in 1988 from JAS Meteor Section Data

Date	ZHR	Date	ZHR
Nov 02–03	11.8 ± 5.8	Nov 04–05	14.7 ± 7.6
03–04	11.0 7.7	13–14	11.6 7.0

As few observers differentiated between the northern and southern branches of the shower, combined mean Taurid ZHRs were calculated for several nights where conditions allowed, as shown in Table 1. Lower activity (less than 2 meteors per hour) was noted on other nights with similar sky conditions both before and after the nights given in that table. The mean sporadic OHR over this time was 3.5 ± 0.9.

Table 2 gives the global magnitude distributions for the Taurid period in 1988.

Table 2 – Global magnitude distributions for the 1988 Taurids and sporadic background from JAS Meteor Section results.

Shower	-5^-	-4	-3	-2	-1	0	$+1$	$+2$	$+3$	$+4$	$+5^+$	Tot	$\overline{m}$
Taurids	1	0	3	1	15	16	12	13	17	6	0	84	0.98
Sporadics	1	1	1	4	11	13	30	59	45	15	1	181	1.75

Train results revealed that 5.9% of Taurids were trained, compared to 11.6% of sporadics at this time.

4. The Geminids

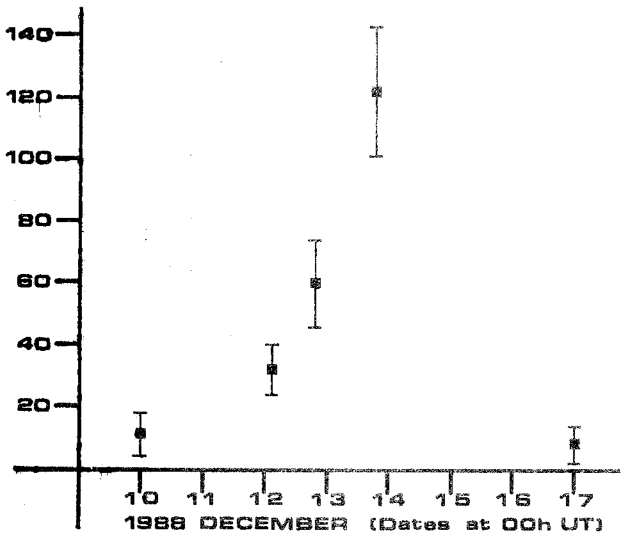


Figure 1 — ZHR graph for the 1988 Geminids observed by JAS Meteor Section Members

Between December 4–5 and December 16–17, 630 Geminids were observed, under skies with a mean limiting magnitude of +5.48 (ranging from +5.0 to +5.8). Of these, 296 were available for detailed examination, after allowing for inexperienced watchers and observing conditions.

Figure 1 shows Geminid activity for nights between December 9–10 and December 16–17. During this period, the mean sporadic OHR was 6.2 ± 0.7.

Global magnitude distributions for the Geminids and corresponding sporadics are given in Table 3.

Examining the proportions of trailed meteors indicated that 3% of Geminids and 5% of sporadics left persistent trains.

Table 3 – Global magnitude distributions for the 1988 Geminids and sporadic background from JAS Meteor Section results.

Shower	-5^-	-4	-3	-2	-1	0	$+1$	$+2$	$+3$	$+4$	$+5^+$	Tot	$\overline{m}$
Geminids	0	0	7	17	32	52	41	53	68	25	1	296	1.25
Sporadics	0	1	0	7	6	16	33	31	44	21	1	160	1.82

5. Discussion

The Taurid epoch results were affected by poor sky quality, which reduced the usefulness of the sporadic analysis particularly for that spell, but as the Taurids have rarely been so well-observed by the Section in the past few years, their data should be rather more useful for comparison with future years, despite the relatively small sample of suitable meteors. Rates at best were comparable with what Kronk [2] and Spalding [3] note in early to mid-November.

Haze was problematic for the Geminids too, but not quite to the same extent as it had been earlier. Overall, the magnitude results were comparable to those obtained in recent years by the Section at that time, although the percentages of trained meteors were a little lower than previous data might have suggested. In the past, typically about 5% and 10% of Geminids and sporadics respectively have shown trains. Haze may, perhaps, have concealed the fainter trains, which would explain the apparent discrepancy. The peak ZHR seems to have been somewhat higher than Kronk [4] or Spalding [3] suggests, and was rather more in line with the early *IMO* results published in [5].

Acknowledgments

Once again, I am indebted to the JAS observers whose continued support has made this report possible, and to whom go my most grateful thanks.

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The Coma Berenicids from Maryland: 1984–1989

Richard Taibi

An overview is given of the author's observations of the Coma Berenicids in the period 1984–1989.

Observers of the Geminids, Ursids and Quadrantids have probably been surprised by swift meteors coming from Coma Berenices. Perhaps similar in rate to the Taurids, this stream spans December 12 to January 23 [1]. They are welcome sights for the frigid northern observer in mid and late January when the sporadic rate dips and there are no prolific showers. Perhaps their serendipitous appearance helps us answer the nagging question *Why am I out here freezing when there is so little to see?* and we are able to persist an hour longer in our watch. Perhaps southern hemisphere observers, watching for meteors in their Summer, have seen some of these meteors too? It may be that a monotonous Summer evening is broken by a flash from Coma. The purpose of this article is to stimulate interest in this reliable minor shower and hopefully to amass some data about it for the *Visual Meteor Database (VMDB)*.

Bernhard Koch [2] has already begun the record with his 1988 article in *WGN*. His data are for his group's observations in December 1987,. The results of my observations suggest that the shower is long-lived. Table 1 is a list of five observing seasons from 1984 to 1989.

Taken as a totality, my data suggest that a season commences about mid December and ends in January or February of the following year. Table 1 shows that the earliest Coma Berenicid I have seen was on December 12 (1988) and the latest one on February 22 (1987). In his preliminary analysis of the 1988 Geminids, Roggemans [3] cites some Berenicid observations on December 7 and 10, thereby extending the observing season earlier into the month of December. In my data, there is a possibility of a maximum in the late 20s of December, perhaps December 27 or 28. Koch's data also support this observation.

Table 1 – Observations by the auteur in Maryland of the Coma Berenicids and the sporadic background between 1984 and 1989.

Date	Period (UT)	T_{eff}	Lm	F	Com	Spor
1984 Dec 26	07^h07^m–09^h07^m	2.00	5.5	1.00	1	16
29	08^h30^m–10^h30^m	2.00	5.0	1.33	3	10
1986 Jan 17	04^h58^m–06^h58^m	2.00	5.0	1.00	3	3
1986 Dec 28	08^h32^m–10^h25^m	1.88	5.5	1.06	5	10
31	08^h10^m–11^h00^m	2.83	5.5	1.00	1	17
1987 Jan 04	05^h30^m–09^h53^m	4.14	5.5	1.00	1	25
09	08^h35^m–10^h35^m	2.00	6.0	1.00	2	15
25	05^h44^m–06^h44^m	1.00	4.6	1.25	0	1
27	07^h00^m–09^h20^m	1.92	4.6	1.25	1	1
1987 Feb 01	07^h30^m–08^h30^m	1.00	4.5	1.43	2	2
03	08^h00^m–09^h00^m	1.00	4.7	1.25	0	5
05	08^h00^m–09^h01^m	1.02	4.8	1.11	2	1
06	08^h32^m–09^h32^m	1.00	5.0	1.11	0	1
08	08^h12^m–10^h12^m	1.90	5.5	1.00	1	9
20	03^h40^m–05^h10^m	1.50	5.7	1.00	0	1
22	05^h00^m–07^h00^m	2.00	5.2	1.00	1	9
1987 Dec 23	08^h30^m–10^h30^m	2.00	5.3	1.16	1	10
1988 Jan 12	03^h05^m–05^h05^m	2.00	5.5	1.00	1	4
24	06^h28^m–09^h25^m	1.80	6.0	1.00	1	6
1988 Dec 12	06^h55^m–08^h22^m	1.45	6.0	1.00	1	15
13	04^h59^m–06^h07^m	1.13	5.1	1.02	0	4
14	05^h00^m–08^h00^m	2.88	5.9	1.00	1	22
1989 Jan 03	08^h33^m–11^h00^m	2.45	5.3	1.00	2	12
12	07^h35^m–09^h35^m	2.00	6.0	1.00	3	14

Table 2 – Magnitude distribution of the Coma Berenicids observed by the author in Maryland between 1984 and 1989.

Magnitude	0	+1	+2	+3	+4	+5	Tot	$\overline{m}$
Number	1	2	4	10	10	6	33	+3.33

Table 2 shows the magnitude distribution for the 33 Coma Berenicids I have seen in the last four years. The shower tends towards having third and fourth magnitude members, with the mean being +3.33. Koch's mean was +3.70 because his group's sites were about one magnitude darker than my site in eastern Maryland and therefore his group saw more faint meteors than I did.

I hope this article will spark some interest in observing the Coma Berenicids each year. Your results, when sent to *IMO*, will help to better define the characteristics of this shower.

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The 1988 Geminids and Phoenicids in Australia

Jeff Wood

An overview is given of Australian observations of the 1988 Geminids and Phoenicids. The 1988 Phoenicids showed almost no activity.

The warm, clear Summer skies of December without interference from the Moon saw Australian meteor observers carry out a very extensive program to monitor the Geminid meteor stream. During four of these nights, the Phoenicid meteor stream was also observed. 24 people participated in the 1988 Geminid watch. Their names are as follows:

George Platt, Mark Glossop, Guy Blackman, Jeff Wood, Huon Chandler, Martin Sale, Matthew Clements, Shannon Powell, Paul Camilleri, Craig Hinton, Louise Cockeram, Maurice Clark, Michael Keating, John Drummond, Nicholas Harvey, Martin Coroneos, Roger Vodicka, Mark Grinceri, Andrew Camineschi, Michelle Treasure, Kim Felstead, Yukiko Nagashima, Michael Preston and Chris Dacey.

Table 1 – Average daily ZHRs of the 1988 Geminids and Phoenicids as observed in Australia.

Date	Geminids		Phoenicids	
	Nr. Obs.	ZHR	Nr. Obs.	ZHR
Dec 03–04	10	1.0 ± 1.04	8	0.7 ± 0.6
04–05	4	2.6 0.1	4	1.7 1.0
05–06	2	2.3 2.3	3	1.0 1.7
06–07	4	3.1 0.4	4	0.4 0.9
07–08	4	3.1 2.1		
08–09	1	5.3		
10–11	25	5.9 3.2		
11–12	19	12.2 6.6		
12–13	25	38.0 20.2		
13–14	26	86.0 28.9		
14–15	4	17.3 4.7		
15–16	4	5.0 3.5		
16–17	3	2.1 2.2		

Table 2 – Global magnitude distributions of the 1988 Geminids and Phoenicids obtained from Australian observations.

Shower	−5	−4	−3	−2	−1	0	+1	+2	+3	+4	+5	+6	Tot	$\overline{m}$
Geminids	1	5	4	12	41	127	259	526	538	412	186	28	2139	2.60
Phoenicids	0	0	0	0	0	0	1	3	2	5	1	0	12	3.17

The Geminid maximum occurred on December 13 around 17^h UT. For the meteors between magnitudes −3 and +5 an r-value of 2.75 was computed. Of the Geminids of magnitude +2 or brighter, 0.9% were red, 8.0% were orange, 42.5% were yellow, 2.6% were green, 4.2% were blue, 0.2% were violet and 41.6% were white. 5.3% of the Geminids seen had a train. With the exception of a 12 second train produced by a −4 yellow/green fireball on the morning of December 14, all the trains were of short duration lasting no more than 3 or 4 seconds after the meteors themselves disappeared from view.

Clearly, the 1988 display of the Phoenicids was one of the weakest on record. It would seem that this shower continues to provide erratic rates from year to year, but as yet, there does not appear to be any real regularity. We will need to continue annual monitoring to see if a regular pattern emerges. Of the 4 Phoenicids of at least magnitude +2, 3 were white and 1 yellow in color. None of the Phoenicids seen had a train.

1988 Geminids and 1989 Quadrantids in the GDR

Jürgen Rendtel

Observations of the 1988 Geminids and 1989 Quadrantids carried out by members of the *Arbeitskreis Meteore* (GDR) are described shortly. Since the Quadrantids peaked in the afternoon of January 3, we observed the decrease of the rates when the radiant descended down to 10° of altitude. Some of the typical problems connected to this situation are discussed.

Both Geminids and Quadrantids show a sharp activity peak of short duration. Although the winter nights are quite long at our latitude, one might miss the maximum. Additionally, the weather conditions are unfavorable in most years.

Therefore groups of observers prepared for observing campaigns during the night of December 13–14, 1988. Due to very strong wind (up to 70 km/h at the surface and about 100 km/h at the cloud level) no prediction of cloudiness was possible. Members of the *Arbeitskreis Meteore* were able to observe during some intervals at different sites. In contrast, the following night was clear at most locations. Results of all observation nights showing average Geminids ZHRs and sporadic HRs are given in Table 1.

Table 1 – Globalized 1988 Geminid results from the GDR. The observations marked with * suffered from clouds.

Date	Period (UT)	Gem	ZHR	Spor	HR
Dec 07–08*	$8^{h}.20$	13	3.1 ± 1.1	63	12 ± 2
08–09	$0^{h}.91$	3	5.4 4.0	11	15 5
09–10	$4^{h}.14$	6	7.9 3.3	23	10 3
12–13*	$0^{h}.67$	7	29 13	3	9 6
13– *	$0^{h}.14$	6	102 49	1	11 14
13– *	$2^{h}.90$	78	53 14	29	13 3
–14	$4^{h}.80$	141	49 13	45	9.3 1.3
14–	$18^{h}.19$	50	10 ± 7	140	9.5 ± 2.4
–15	$10^{h}.76$	34	4.5 ± 3.5	135	15 ± 3
15–16	$10^{h}.18$	9	1.9 ± 1.3	114	15 ± 4

On January 2, 1989, clouds moved northwards. In the morning of January 3, most southern parts of our country were cloudless allowing Quadrantid observations. During this time, a steadily increasing ZHR was noticed. Except for the northernmost districts, it was clear the next night, when the maximum was expected.

The most brilliant Quadrantid was seen by Ina Rendtel around sunset (about −5 to −6). Therefore, the Potsdam observers were alerted. However, the highest rates obviously occurred before 16^{h} UT. During this night, we recorded a decrease in ZHR from about 50 in the early evening to less than 10 in the morning of January 4. This decrease in rates is clearly illustrated by Table 2.

Table 1 – Selected 1989 Quadrantid observations from the GDR. Observer codes refer to the *Visual Meteor Database (VMDB)*. For each observations, the altitude of the radiant (h) is mentioned. ZHRs are calculated taking into account zenith attraction of the radiant.

Date	Time (UT)	Obs	T_{eff}	Lm	h	Qua	ZHR	Spor	HR
Dec 31–32	19^h15^m	RENJU	$3^h\!.45$	6.25	14°	2	2.5	29	11
Jan 02–03	22^h30^m	BADPI	$1^h\!.00$	6.40	16°	7	26	18	20
02–03	23^h30^m	BADPI	$1^h\!.00$	6.43	21°	9	25	8	9
02–03	00^h30^m	BADPI	$1^h\!.00$	6.58	27°	15	30	17	16
02–03	01^h30^m	BADPI	$1^h\!.00$	6.67	34°	16	25	18	15
02–03	02^h17^m	BADPI	$0^h\!.58$	6.77	40°	10	22	9	13
02–03	02^h35^m	KOSRA	$0^h\!.78$	7.07	42°	27	32	22	15
02–03	03^h30^m	KOSRA	$0^h\!.90$	7.06	51°	33	31	13	8
02–03	04^h30^m	KOSRA	$0^h\!.95$	6.89	60°	48	43	18	12
02–03	05^h22^m	KOSRA	$0^h\!.68$	6.85	68°	30	36	12	12
Jan 03–04	16^h45^m	RENIN	$0^h\!.83$	6.08	18°	10	50	2	3.8
03–04	16^h45^m	ARLRA	$0^h\!.66$	6.13	18°	5	30	2	4.6
03–04	16^h45^m	RENJU	$0^h\!.98$	6.16	18°	11	44	6	8.9
03–04	17^h04^m	KOSRA	$0^h\!.72$	7.00	15°	10	35	11	8.8
03–04	17^h30^m	KNOAN	$1^h\!.30$	6.34	15°	17	52	9	8.2
03–04	17^h45^m	ARLRA	$0^h\!.50$	6.13	14°	2	20	2	6.0
03–04	17^h45^m	RENJU	$0^h\!.98$	6.18	14°	10	48	3	4.4
03–04	18^h00^m	KOSRA	$0^h\!.95$	6.98	12°	7	22	20	12
03–04	18^h30^m	KNOAN	$0^h\!.98$	6.34	12°	9	43	8	9.7
03–04	19^h00^m	KOSRA	$0^h\!.70$	6.99	10°	3	15	8	6.7
03–04	19^h04^m	HERGU	$2^h\!.01$	6.34	10°	5	14	23	14
03–04	19^h07^m	RENJU	$1^h\!.23$	6.20	12°	4	18	4	4.5
03–04	19^h07^m	ARLRA	$1^h\!.75$	6.27	12°	4	12	9	6.6
03–04	19^h07^m	RENIN	$1^h\!.40$	6.27	12°	5	19	5	4.6
03–04	19^h59^m	SPEUL	$2^h\!.08$	6.18	10°	7	21	16	11
03–04	21^h33^m	RENIN	$0^h\!.60$	6.23	14°	2	15	4	9.0
03–04	21^h48^m	KOSRA	$1^h\!.42$	6.67	14°	11	22	12	7.3
03–04	22^h16^m	SPEUL	$2^h\!.00$	6.19	15°	8	17	20	14
03–04	23^h02^m	KNOAN	$2^h\!.28$	6.28	20°	6	8.3	21	12
03–04	23^h58^m	RENJU	$1^h\!.50$	6.20	26°	7	13	6	5.6
03–04	23^h58^m	ARLRA	$1^h\!.40$	6.36	26°	9	16	3	3.3
03–04	01^h28^m	RENJU	$1^h\!.44$	6.16	36°	6	8.9	8	8.1
03–04	01^h28^m	ARLRA	$0^h\!.78$	6.31	36°	3	3.7	2	3.2
03–04	01^h48^m	KOSRA	$1^h\!.42$	6.59	38°	9	9.8	13	8.7
03–04	05^h16^m	KOSRA	$1^h\!.12$	6.12	68°	6	7.6	7	9.5
Jan 04–05	18^h51^m	SPEUL	$1^h\!.25$	5.86	10°	1	6.1	7	12

There were some more observers active than mentioned in Table 2. However, the particular conditions of the Quadrantid shower were not taken into account by all of them. Around 19^h30^m, the radiant descends to a minimum altitude of about 10° at our latitudes. Consequently, only few Quadrantids can be seen and the correct shower association requires the knowledge of their angular velocity and trail length in function of their distance from the radiant and their altitude. Therefore, it is necessary to observe very carefully and to look into the direction of the radiant. The influence of all these effects rapidly decreases after midnight (local time). Observational data of the evening period have to be checked very strictly.

If the altitude of the radiant is less than 10°, ZHRs should better be omitted from further analysis because of the uncertainties involved.

The 1989 Quadrantids from Maryland

Richard Taibi

An overview is given of the author's observations in Maryland of the 1989 Quadrantids.

Peter Millman [1] predicted that the 1989 Quadrantid maximum would occur on January 3 at 10^h UT. Based on this prediction, eastern North America was favored for good rates since the radiant would be highest just before morning twilight. The weather forecast for the morning of maximum was fog and thickening clouds for my site east of Washington, D.C. I decided to take a chance and awaken anyway. I was rewarded by the sight of departing clouds. Throughout the observing session, the fog diminished and the clouds did not reappear. Tables 1 and 2 show my observing results.

Table 1 – Observations of the 1989 Quadrantids, Coma Berenicids and the sporadic background by the author from McKendree, Maryland.

Date	Period (UT)	T_{eff}	Lm	F	Qua	Com	Spor
Jan 03	08^h33^m–09^h00^m	0.45	5.50	1.00	10	1	0
03	09^h00^m–10^h00^m	1.00	5.35	1.00	10	0	5
03	10^h00^m–11^h00^m	1.00	5.20	1.00	18	1	7

Table 2 – Magnitude distributions of the 1989 Quadrantids observed by the author.

Date	Period (UT)	−3	−2	−1	0	+1	+2	+3	+4	+5	Tot	$\overline{m}$
Jan 3	08^h33^m–09^h00^m	0	0	1	1	0	1	2	4	1	10	2.80
3	09^h00^m–10^h00^m	0	1	0	1	0	3	3	2	0	10	2.10
3	10^h00^m–11^h00^m	1	1	1	3	1	4	2	4	1	18	1.67

The data in Table 1 suggest that the Quadrantid rate was increasing towards 11^h UT when astronomical twilight began. This trend of rising rates is consistent with Dr. Millman's 10^h UT prediction for the maximum.

Another indication that maximum was being approached are the mean magnitude data in Table 2. The mean Quadrantid magnitudes increase as the observing periods reach 11^h00^m UT when the mean was +1.67. The *Handbook for Visual Meteor Observations* [2] suggests examining magnitude data as a way to ascertain the Quadrantid's peak rate period because previous observations showed that pre-maximum shower meteors are dimmer than meteors appearing at maximum. Astronomical twilight prevented further data collection which might have revealed whether the brightness maximum had indeed occurred. I look forward to reading other observer's data to see if a mean brightening trend continued after 11^h UT or not. Western North American and Hawaiian data may show when the rate and mean magnitude peaks occurred.

I am also interested to learn if there was any Quadrantid fireball seen after the maximum. In 1987, I saw a Quadrantid fireball about seven hours after predicted maximum.

No color was noted in most (65.8%) Quads; 26.3% were blue-white, 5.3% were yellow-white and 2.6% were blue. Only the three brightest Quadrantids produced trains, which is 7.9% of the total.

References

[1] Calendar Notes, *Sky and Telescope*, January 1989, p. 74.

[2] Roggemans P. (ed.), "Handbook for Visual Meteor Observations", IMO, 1987, p. 63.

Belgian Radio Observations of the 1989 Quadrantids

Cis Verbeeck

The results of the 1989 Quadrantid radio observations of *Urania*, the Public Observatory of Antwerp (Belgium), are discussed. 5291 meteor reflections observed by 19 people in $46^{h}.5$ made it possible to analyze the activity profile of the shower. It is argued that a sharp (radio) maximum occurred on January 3 around 4^{h} UT.

Urania, the Public Observatory of Antwerp, has a radio equipment with a Yagi-antenna since August 1988. The antenna is pointed to the radio station Koszalin in Poland, at 66.17 MHz. In December 1988, a project was planned to monitor the 1989 Quadrantid activity.

On January 2, at 15^{h} UT, we started to observe the Quadrantids. 19 observers stayed at the Observatory until the evening of January 4. We were able to follow the shower continuously from the beginning till January 4 at 5^{h} UT. Then we had to take a break, but observations were resumed at 8^{h} UT. Another break followed between $12^{h}30^{m}$ and 14^{h} UT, after which observations went on until 18^{h} UT. We had then observed for $46^{h}.5$.

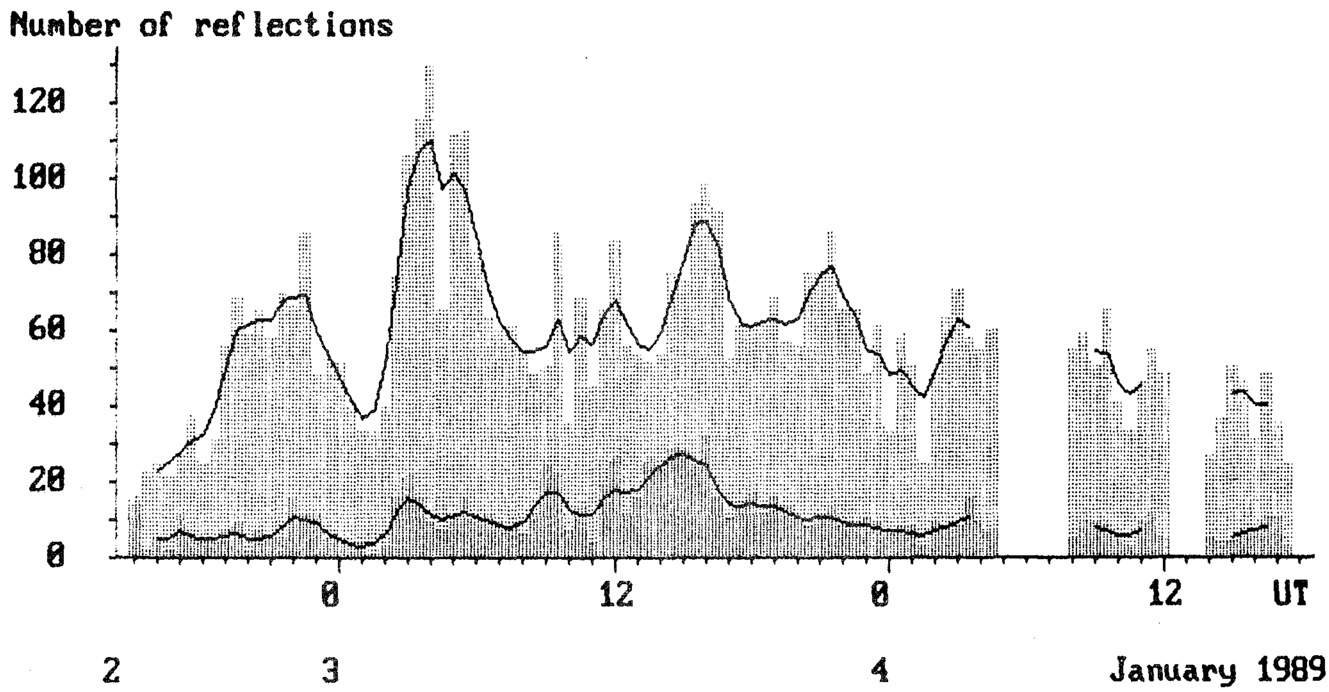


Figure 1 – Belgian radio observations of the 1989 Quadrantids

In Figure 1, the number of meteors is shown as a function of time. The upper curve represents the total number of meteors per interval of $0^{h}.5$, whereas the lower curve shows, for the same interval, the number of meteors with a duration of at least 2 seconds. There was a clear maximum around January 3 at 4^{h} UT. Still, there are a lot of prominent submaxima. Especially the peak around January 3 at 16^{h} UT could be considered as another possible maximum for the Quadrantids, since the lower curve then reaches its absolute maximum. These curves however do not represent the real number of meteors that appeared. The antenna catches more meteors as the radiant approaches the direction perpendicular to the antenna.

Table 1 gives effectivity numbers: the higher the number, the more favorable the relation antenna-radiant. If no number is given, the direction antenna-radiant is very unfavorable. If we take the effectivity numbers into account, the peak of January 3 at 4^{h} UT is undeniable a maximum. 129 reflections were heard in half an hour while the effectivity number was almost

Table 1 – Effectivity numbers for the configuration antenna-radiant.

UT	0^h	1^h	2^h	3^h	4^h	5^h	6^h	7^h	8^h	9^h	10^h	11^h	12^h	13^h	14^h	15^h	16^h	17^h	18^h	19^h	20^h	21^h	22^h	23^h
Eff. Nr.	4	3	2	1	1	1	2	1		2	4	6	7	8	8	8	7	6	5	4	4	4	4	4

as low as possible: 1. The submaximum of January 3 at 16^h UT (106 reflections in $0^h.5$) can easily be explained as a result of the favorable configuration of the antenna with respect to the radiant. Moreover, this submaximum is relatively smooth, while the 4^h peak is very sharp and lasted only for some three to four hours. This sharp maximum is typical for the Quadrantids.

Another argument in favor for our claim is the low number of meteor reflections around January 4 at 4^h UT (54 in $0^h.5$), proving that high rates around 4^h UT are unusual. When we started observing on January 2 around 16^h UT, rates were very low (less than 30 reflections per half hour), though the effectivity of the antenna is high at that time. From this, I conclude that the real Quadrantid activity was still very low then.

If these conclusions are right, there was only little activity before maximum, which suddenly announced itself on January 3 around 2^h UT, and lasted till 6^h, with a peak between 4^h and 4^h30^m. After maximum, however, activity decreased quite slowly. Some submaxima were generated by geometric factors, but no new activity outburst occurred.

The 1988 Perseids from Hungary

István Tepliczky

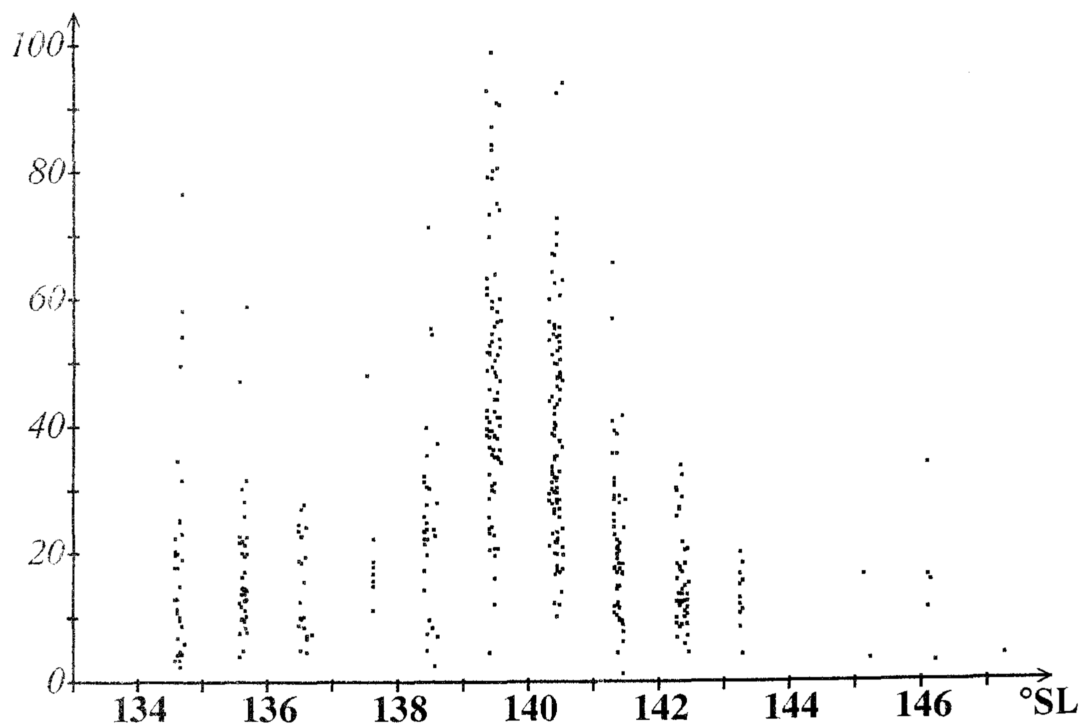


Figure 1 – Graphical representation of the 1988 Perseid activity as registered by the Hungarian Meteor and Fireball Observing Network (MMTÉH).

As most readers do know, the number of contributions for WGN increased enormously in 1988, causing a considerable delay in the publication of some reports. We finally managed to cope with this delay by editing a really thick issue, such as the present one, twice or three times a year. As a last consequence of this delay, we still have some unpublished contributions on observations in 1987. We take advantage of this thick issue to finally publish them, and, at the same time, apologize to the authors for the long delay. However, it goes without saying that no more raw data on 1987 will be published in subsequent issues! (ed.)

Some Final 1987 Observations

Spring 1987 Sporadic Radio Meteor Activity

Jeroen Van Wassenhove

Radio observations of the sporadic activity were carried out during the months January, February and March 1987. No abnormally high activity was reported.

Some Belgian observers listened to the sporadic activity during the months January, February and March 1987. Their results are presented in Table 1. One observer, Luc Gobin, listened intensively form January 16 till 18. His results are shown in Figure 1. Due to the diurnal variation, sporadic activity in the morning is three times higher than in the evening. This fact should be kept in mind when reducing data of meteor showers.

Table 1 – Belgian radio observations of the meteor activity in early 1987. Observations were carried out Maurice De Meyere (MD, St.-Martens-Latem), Luc Gobin (LG, Mechelen), Christian Steyaert (CS, Bottelare) and Jeroen Van Wassenhove (JV, Nazareth).

Date	Obs	Period (UT)	ν (MHz)	N
Jan 16	MD	05^h00^m–06^h00^m	72.11	27
31	CS	19^h09^m–20^h09^m	91.30	3
Feb 01	CS	12^h23^m–12^h53^m	88.40	3
07	CS	20^h00^m–21^h00^m	91.20	4
07	JV	20^h00^m–20^h15^m	91.10	4
07	JV	20^h20^m–21^h00^m	91.10	8
14	CS	19^h17^m–20^h17^m	91.10	16
15	CS	13^h00^m–14^h00^m	91.10	4
22	LG	10^h00^m–10^h30^m	66.17	43
28	CS	19^h30^m–20^h30^m	91.10	5
Mar 01	CS	10^h00^m–10^h45^m	91.10	1
01	CS	10^h45^m–10^h50^m	88.40	2
03	LG	19^h30^m–20^h30^m	66.17	43
04	LG	19^h30^m–20^h30^m	66.17	67
05	LG	19^h30^m–20^h30^m	66.17	52
07	CS	19^h30^m–20^h00^m	88.40	0
07	CS	20^h00^m–20^h30^m	88.40	2
21	CS	21^h15^m–22^h15^m	91.10	11
28	JV	19^h40^m–20^h32^m	88.40	7

As usual, all counts are uncorrected.

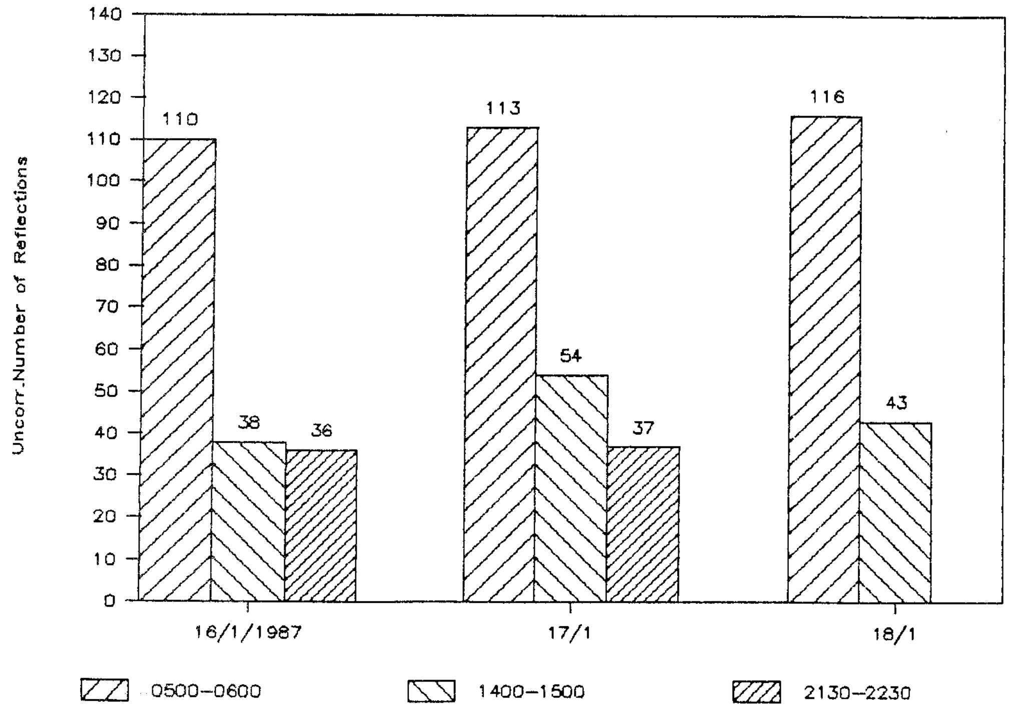


Figure 1 – Radio observations of the sporadic activity from January 16 till 18, 1987 by Luc Gobin (Mechelen) at 66.17 MHz.

A large amount of data was received from the Danish observer Gotfred Møbjerg Kristensen. He listened at least five hours a day! Figure 2 shows the average daily number of reflections he registered during February and March.

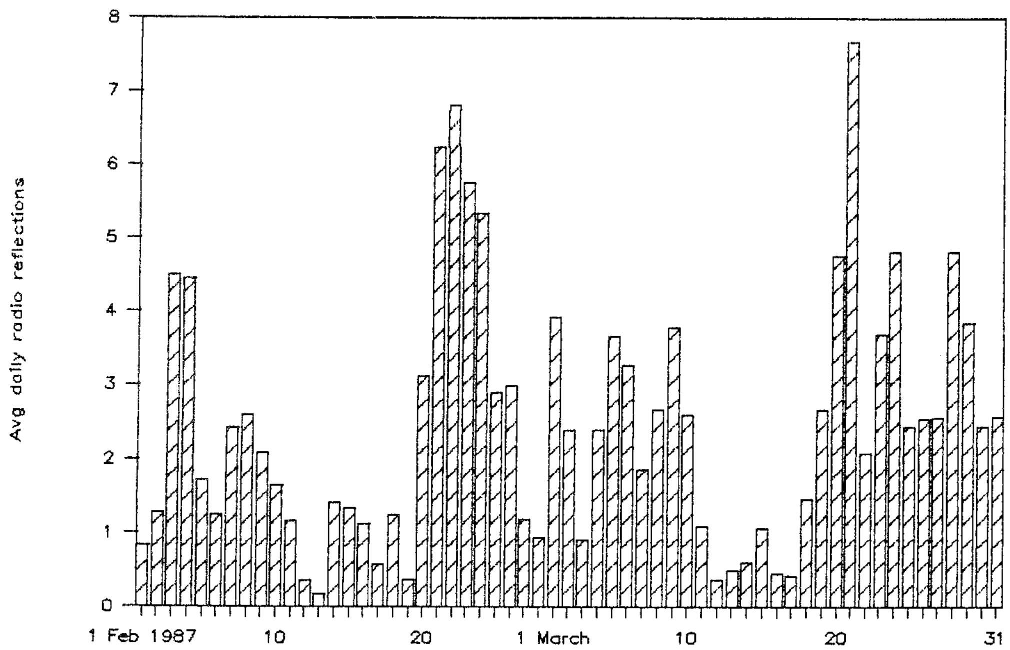


Figure 2 – Radio observations of the sporadic activity during February and March 1987 by G.M Kristensen (Havdrup) at 100.6 MHz.

Concluding, we may say that sporadic meteor activity during January, February and March 1987 was low. No abnormally high activity was reported during these months. Finally, the author wishes to thank the observers for their efforts.

Radio Observations of the 1987 η-Aquarids

Jeroen Van Wassenhove

An overview is given of Belgian and Danish radio observations of the 1987 η-Aquarids.

In Belgium, two observers listened to the 1987 η-Aquarids: Maurice De Meyere (St.-Martens-Latem) at 72.10 MHz, and Luc Gobin (Mechelen) at 66.17 MHz.

The results of both persons are shown below.

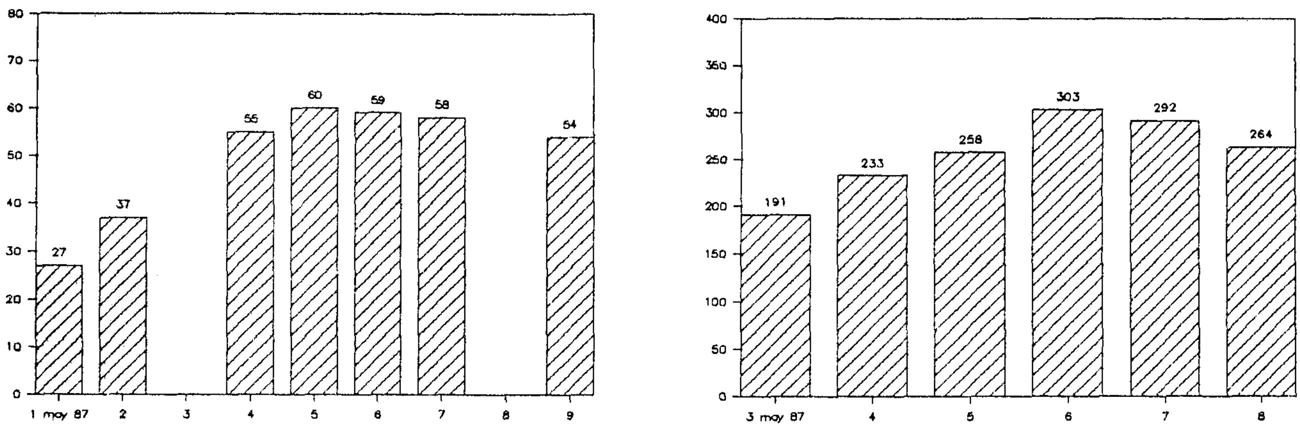


Figure 1 – Radio observations of the 1987 η-Aquarids by M. De Meyere at 72.10 MHz between 6^h00^m and 7^h00^m UT (left) and by L. Gobin at 66.17 MHz between 4^h00^m and 5^h00^m UT (right).

On May 3, Maurice De Meyere could not observe properly due to a thunderstorm and sporadic-E conditions.

Table 1 – Number of echo durations of at least two seconds

Date (May)	1	2	3	4	5	6	7	8	9
M. De Meyere	1	4		2	4	3	5		4
L. Gobin			16	22	23	18	27	18	

In Denmark, Gotfred Møbjerg Kristensen (Havdrup) listened during several days at 100.60 MHz. His results are presented in Table 2.

Table 2 – η-Aquarid radio observations by G.M. Kristensen in May 1987 from Havdrup at a frequency of 100.60 MHz. Observing periods are given in UT.

Date	03^h00^m–04^h00^m	04^h00^m–05^h00^m	05^h00^m–06^h00^m	06^h00^m–07^h00^m
May 4		12	27	
5				36
6	34	36	43	
7	24		30	24

All times are in UT, and all counts are uncorrected.

Clearly, now spectacular activity was recorded.

Radio Observations in Fall 1987

Jeroen Van Wassenhove

An overview is given of radio observations of the Draconids, Orionids, Taurids, Leonids, Geminids and Ursids from Belgium, Denmark, Hungary and Canada.

1. The Draconids or Giacobinids

Having the high Giacobinid meteor activity of 1985 in mind, several people carried out observations around October 8. Luc Gobin (Belgium) listened from October 4 till October 12 on 66.17 MHz during two periods: 4^h45^m–5^h45^m and 20^h00^m–21^h00^m UT. His results are shown in Figure 1. The average for the first period amounts to 158 ± 20 meteor reflections, and for the second to 86 ± 6 meteor reflections.

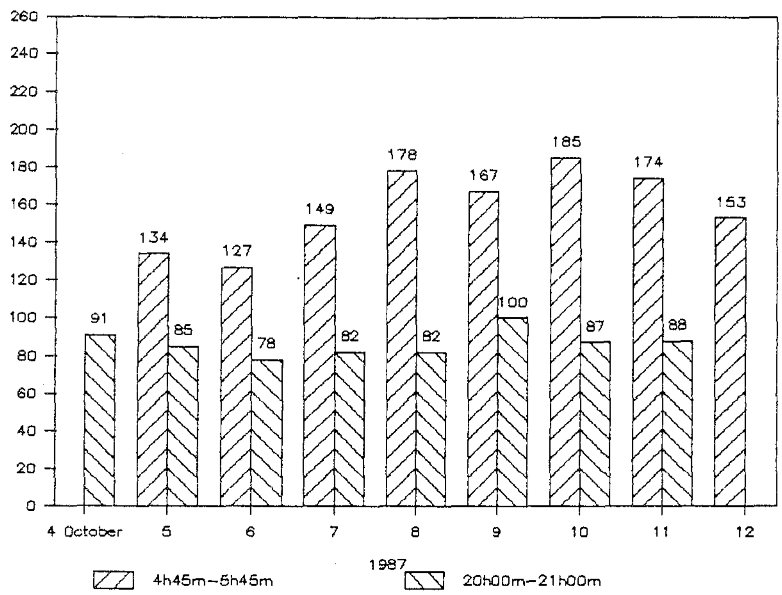


Figure 1 – 1987 Giacobinid radio observations by Luc Gobin (Belgium) at 66.17 MHz.

Maurice De Meyere (Belgium) listened between 09^h00^m and 10^h00^m on 66.17 MHz. His observations are presented in Table 1. On average, 46.5 ± 13.9 meteor reflections were observed.

Table 1 – 1987 Giacobinid radio counts (uncorrected) by Maurice De Meyere (Belgium).

Date	N	Date	N
Oct 6	42	Oct 8	66
7	45	9	33

Dirk Artoos (Belgium) observed from 8^h30^m to 9^h00^m at 88.30 MHz in Carcassonne, France. His results are as follows:

Table 2 – 1987 Giacobinid radio counts (uncorrected) by Dirk Artoos (Belgium).

Date	N	Date	N
Oct 7	4	Oct 10	2
8	5	11	6
9	4	12	4

On average, Dirk Artoos heard 4.2 ± 1.3 reflections.

Gotfred Møbjerg Kristensen (Denmark) observed around October 8, but on irregular periods. This is also the case for Christian Steyaert (Belgium). Therefore, these observations could not be included in this analysis.

The first two observers have an increase in meteor activity on October 8. However, if one looks to the averages and the corresponding error bars, it is very doubtful that this increase is caused by the Giacobinids. If one looks to the observations of Luc Gobin, one notices that on October 10 (period 4^h45^m–5^h45^m UT), he registered more meteor reflections then on October 8. On October 11, too, he reports a rather high value: 174 reflections. Furthermore, during the second period on October 8, Luc Gobin did not report an increase. The observations of Dirk Artoos do not show any increase of meteor activity at all. Having all this in mind and also the fact that the Giacobinids are active during a very short time (some hours), we may safely conclude that they did not show any significant activity.

2. The Orionids

Three Belgian observers carried out radio observations of this annual shower. The observations of Luc Gobin are shown in Figure 3. Christian Steyaert listened between 20^h00^m and 21^h00^m UT on October 23 and heard 10 meteor reflections.

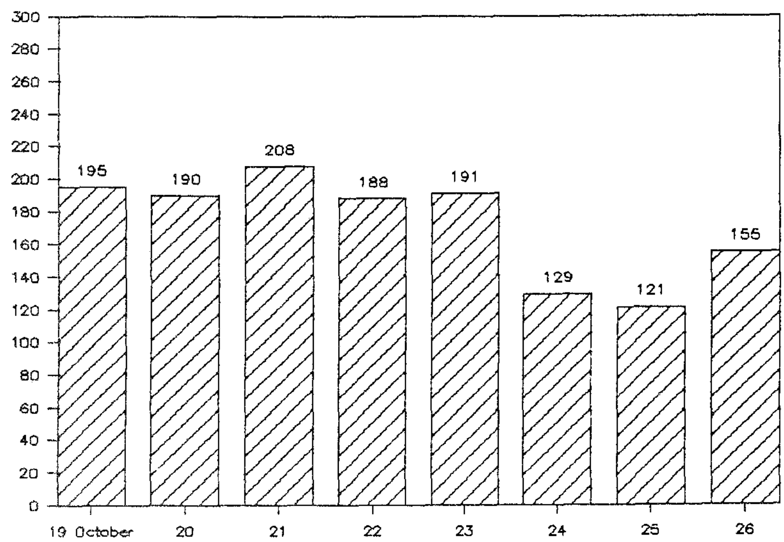


Figure 2 – 1987 Orionid observations by Luc Gobin at 66.17 MHz between 4^h45^m and 5^h45^m UT.

The observations of Gotfred M. Kristensen (Denmark) are presented in Table 3.

Table 3 – 1987 Orionid radio observations by G.M. Kristensen at 100.60 MHz. Observing periods are given in UT.

Date	21^h00^m–22^h00^m	22^h00^m–23^h00^m
Oct 18	7	3
19	3	3
20	4	5
21	3	5
22	15	11
23	8	10
24	8	

On average, G.M. Kristensen heard 6.8 ± 4.2 meteors in the first period and 6.2 ± 3.4 in the second.

On October 23, Istvàn Tepliczky and Istvàn Csòti (Hungary) heard 56 meteor reflections between 22^h14^m and 00^h14^m UT. They listened on 94.70MHz.

The activity of the Orionids 1987 can be considered as normal. The Orionids do not show a "real" peak as e.g. the Perseids do; only a moderately increased activity is noticed.

3. The Taurids

In the beginning of November, the Taurids appear, with a vague maximum around November 3. The observations of Luc Gobin are presented in Table 4.

Table 4 – 1987 Taurid radio counts (uncorrected) by Luc Gobin (Belgium) between 21^h00^m and 22^h00^m UT at 66.17 MHz.

Date	N	Date	N
Oct 31	99	Nov 03	107
Nov 01	102	04	131
02	103	05	101

On average, he registered 107.1 ± 11.9 reflections.

Peter Brown (Canada) listened on 90.0Mhz with a 5-elements Yagi antenna.

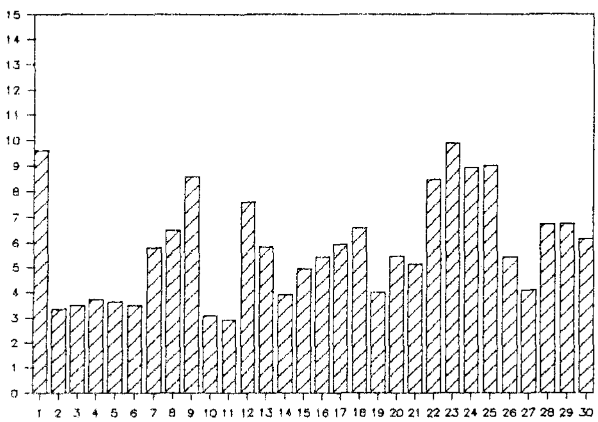
Table 5 – 1987 Taurid observations by Peter Brown at 90.0 MHz.

Date	Period (UT)	N	Date	Period (UT)	N
Nov 1	20^h00^m–21^h00^m	10	Nov 7	04^h00^m–05^h00^m	8
2	04^h00^m–05^h00^m	30	8	03^h00^m–04^h00^m	12
3	04^h00^m–05^h00^m	16	8	04^h00^m–05^h00^m	13
5	04^h35^m–05^h04^m	12			

On average, Peter Brown registered 14.4 ± 7.2 reflections.

Dirk Artoos also listened in this period but during too irregular intervals, so that his observations are not suited for this analysis.

The observations of G.M. Kristensen are shown in Figure 3. Again, as for the Orionids there is no "real" maximum, only a rather moderately increased fluctuating activity.



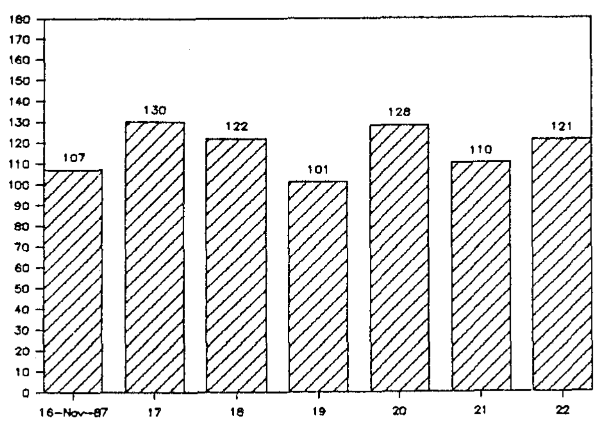


Figure 3 – Radio observations in November 1987 by G.M. Kristensen at 100.60 MHz (left) and 1987 Leonid radio observations by Maurice De Meyere at 66.17 MHz between 7^h55^m and 8^h55^m UT (right).

4. The Leonids

Radio observations of this meteor shower were carried out by Maurice De Meyere (Figure 3), who noticed on average 117 ± 11 reflections, by Luc Gobin (Table 6), who reported on average 159 ± 28 meteors and by G.M. Kristensen (Figure 3).

Table 6 – 1987 Leonid radio counts (uncorrected) by Luc Gobin (Belgium) between 4^h44^m and 5^h44^m UT at 66.17 MHz.

Date	N	Date	N
Nov 15	126	Nov 18	150
16	149	Nov 19	170
17	202		

Both observers have an increase in meteor activity on the same day, namely November 17. The increase of Luc Gobin (202) is very striking. The increase of M. De Meyere is not that big. This means that there were Leonids, but very faint ones as G.M. Kristensen did not notice anything significant on that date (his equipment is not that sensitive).

5. The Geminids

The following people carried out radio observations of the Geminids: Luc Gobin, Maurice De Meyere, Dirk Artoos (Belgium), Gotfred Møbjerg Kristensen (Denmark), István Csóti, István Tepliczky, Szilard Teichner (Hungary) and Peter Brown (Canada). Dirk Artoos listened during too irregular times. The observations of the other persons are presented in the corresponding figures and tables.

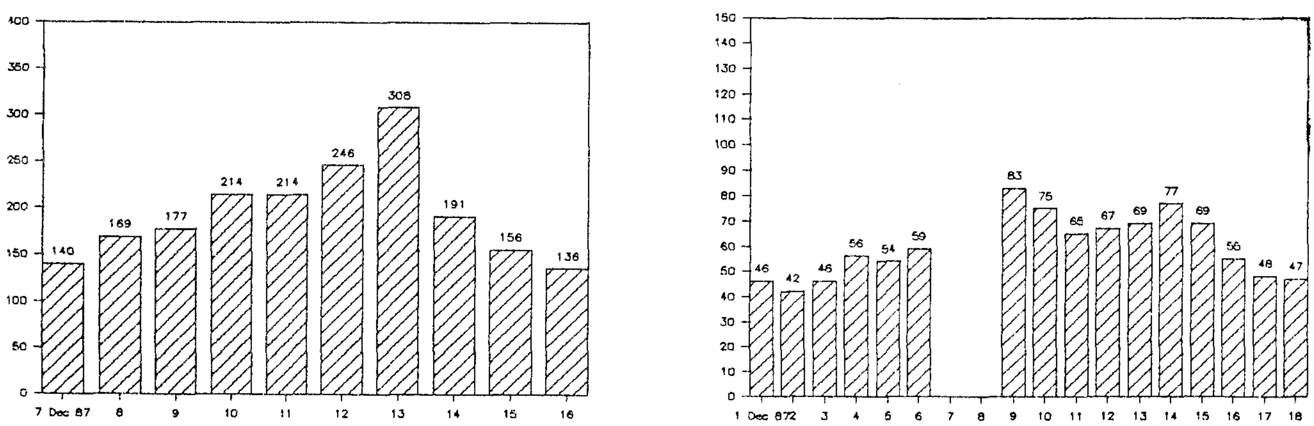


Figure 4 – 1987 Geminid observations by Luc Gobin at 66.17 MHz between 21^h00^m and 22^h00^m UT (left) and by Maurice De Meyere at 66.17 MHz between 8^h00^m and 9^h00^m UT (right).

Table 7 – 1987 Geminid radio counts (uncorrected) by G.M. Kristensen (Denmark) at 100.60 MHz between 4^h00^m and 5^h00^m UT.

Date	N	Date	N
Dec 12	18	Dec 14	64
13	29	15	44

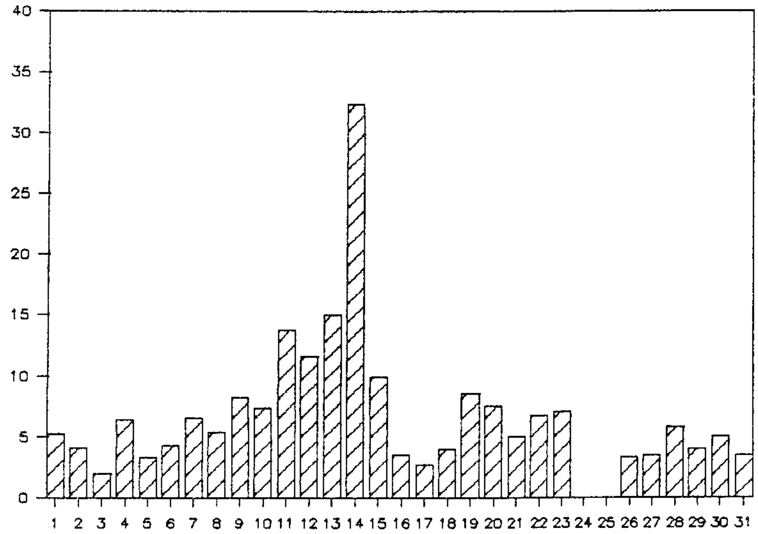


Figure 5 – Radio observations in December 1987 by G.M. Kristensen at 100.60 MHz.

Table 8 – Hungarian radio observations of the 1987 Geminids.

Date	Observer	Period (UT)	N
Dec 13	S. Teichner	12^h35^m–12^h55^m	12
13	S. Teichner	17^h25^m–18^h25^m	38
13	I. Csòti	17^h35^m–18^h35^m	57
13	I. Csòti	21^h10^m–21^h40^m	36
Dec 14	S. Teichner	15^h00^m–16^h00^m	28
14	S. Teichner	17^h27^m–17^h45^m	29
14	S. Teichner	18^h39^m–20^h39^m	48
14	I. Tepliczky	21^h40^m–22^h10^m	108
14	I. Tepliczky	22^h25^m–22^h55^m	138
14	I. Tepliczky	23^h10^m–23^h40^m	161
Dec 15	I. Tepliczky	07^h05^m–07^h35^m	21
15	I. Tepliczky	08^h00^m–08^h30^m	39
15	S. Teichner	19^h25^m–19^h55^m	21
15	I. Csòti	21^h35^m–22^h05^m	43

Table 9 – 1987 Geminid observations by Peter Brown at 90.0 MHz.

Date	Period (UT)	N	Date	Period (UT)	N
Dec 3	4^h00^m–5^h00^m	14	Dec 10	04^h00^m–05^h00^m	18
4	4^h00^m–5^h00^m	14	11	04^h00^m–05^h00^m	18
5	4^h00^m–5^h00^m	9	12	04^h00^m–05^h00^m	16
6	4^h00^m–5^h00^m	7	13	04^h30^m–05^h00^m	31
7	4^h00^m–5^h00^m	8	15	04^h00^m–05^h00^m	40
8	4^h25^m–5^h25^m	10	16	04^h00^m–05^h00^m	21
9	4^h00^m–5^h00^m	7	17	04^h00^m–05^h00^m	6

With the data of Luc Gobin, we were able to make a classification of the echo-durations. The echo-durations lasting at least 2 seconds were counted for each day and the percentage they represented was calculated. The result is shown in Figure 6. Notice that Figure 6 deals with percentages , *not* numbers of meteor reflections. The average percentage of long echo-durations amounts to $9.2 \pm 4.8\%$.

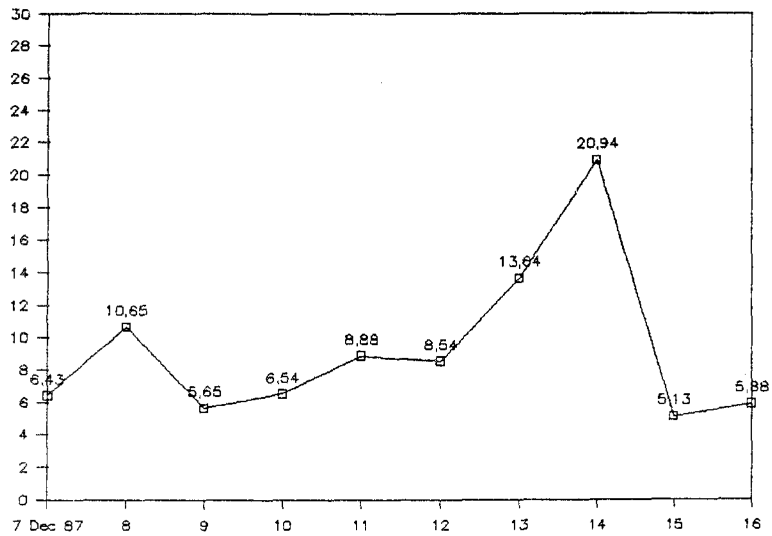


Figure 6 – Percentage of echo-durations lasting longer than 2 seconds, as calculated from 1987 Geminid radio observations by Luc Gobin at 66.17 MHz from 21^h00^m to 22^h00^m UT.

L. Gobin has his highest activity on December 13 (308), G.M. Kristensen, S. Teichner and I. Tepliczky on December 14. The observations of M. De Meyere are a bit mysterious. He reports the highest activity on December 9. No other observer confirms this. The time of maximum was calculated for L. Gobin and G.M. Kristensen. This gives us December 13, $16^h.1 \pm 1^h.8$ UT for L. Gobin and December 14, $9^h.3 \pm 2^h.9$ UT for G.M. Kristensen.

The difference between the calculated maxima is too large to make any reasonable conclusion. The only conclusion one can make is that the Geminid maximum occurred around December 14th. This is also indicated by the increase in long echo-durations on December 14 (20.94%) for L. Gobin. It is remarkable that this increase does not coincide with his highest count the day before.

Maybe visual work can give us more information?

6. Ursids

Observations of this meteor shower were carried out by D. Artoos, P. Brown, L. Gobin and G.M. Kristensen. The first two observers listened at irregular intervals. The results of the latter two are presented in the following tables.

Table 10 – 1987 Ursid radio counts (uncorrected) by Luc Gobin (Belgium) between 4^h55^m and 5^h55^m UT at 66.17 MHz.

Date	N	Date	N
Dec 21	156	Dec 25	180
22	192	26	179
23	221	27	175
24	237		

On average, Luc Gobin counted 191 ± 28 reflections.

Table 11 – 1987 Ursid radio observations by G.M. Kristensen in May 1987 from Havdrup at a frequency of 100.60 MHz. Observing periods are given in UT.

Date	20^h00^m–21^h00^m	21^h00^m–22^h00^m
Dec 20	6	5
21	11	10
22	14	14
23	8	8
24	7	8
25	18	8

L. Gobin and G.M. Kristensen have both an increase of meteor activity around December 22, which is most probably caused by rather faint Ursids. So we may conclude that the Ursids 1987 did not show an unusually high activity.

1987 Radio Observations in Denmark

Gotfred Møbjerg Kristensen

An overview is given of the radio observations of the author in Denmark during 1987. Two very long meteor reflections were heard on November 22–23.

In 1987, I observed 4495 hours and registered 35 605 meteor reflections. I listened minimum six hours a day, except for December 24–25, when I could not listen due to the E-layer. Figure 1 shows the average daily hourly rate plotted for each day. The maximum daily hourly rate plotted for each day is presented in Figure 2. Both figures agree very well with the activity profiles of minor and major meteor showers.

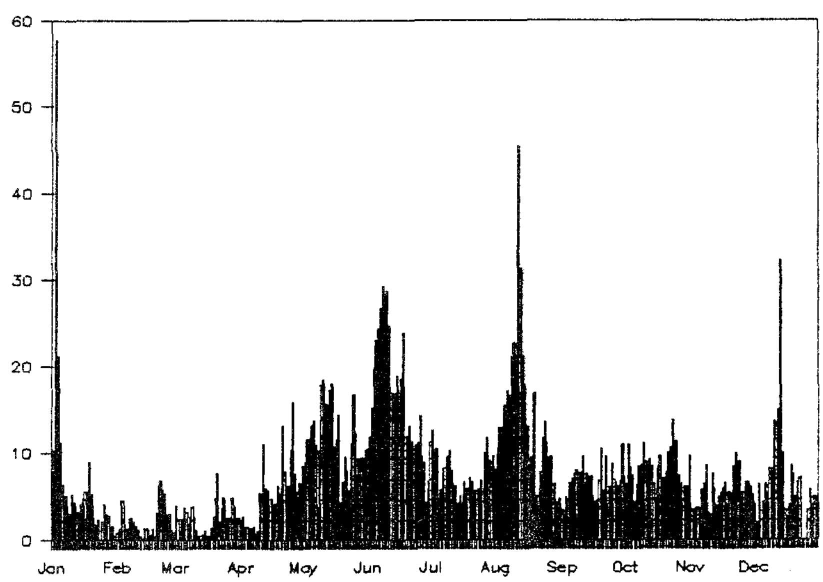


Figure 1 – Average daily hourly rate of radio reflections in 1987 as observed by G.M. Kristensen in Denmark at 100.6 MHz.

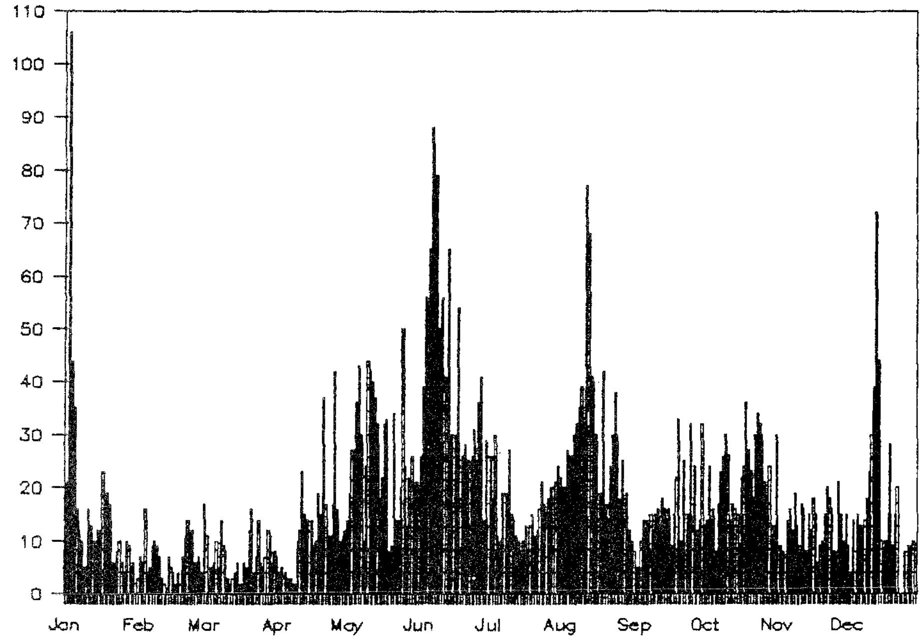


Figure 2 – Maximum daily hourly rate of radio reflections in 1987 as observed by G.M. Kristensen in Denmark at 100.6 MHz.

On the night of November 22–23, 1987, I heard two very long meteor reflections. The first one started at $22^h37^m58^s$ UT and lasted for 153 seconds. The second came 33 minutes later, at $23^h11^m42^s$ UT with a duration of 107 seconds. If someone has seen or heard one of those meteors, please contact me!

Belgian Visual Observations in Fall 1987

Glenn Ticket

An overview is given of Belgian observations of the 1987 Orionids, ε-Geminids and Taurids.

This article deals with the results obtained from visual observations carried out mainly in Belgium in the months of September, October and November 1987. The Orionids, ε-Geminids and Taurids were distinguished from the sporadic background. In total, 6 observers monitored the skies during 70.3 hours:

Ghislain Plesier (PLEGH), Paul Roggemans (ROGPA), René Scurbecq (SCURE), Octaaf Steen (STEOC), Glenn Ticket (TICGL), Pierre Vingerhoets (VINPI).

In 1987, the month of September knew favorable observing conditions in Belgium. Unfortunately only 2 observers made use of this situation. On September 24, the first Taurids were reported. The number of Taurids, however, was very low, so that a reliable ZHR could not be obtained.

In October more observers were active. Some observations were carried out in the Haute-Provence, Southern France, though these were severely hampered by bad weather. In total 57 ε-Geminids were reported, but most of these were likely Orionids. The largest part of these meteors were reported by one observer, whose number of Orionids was to low. These meteors were furthermore equally bright as the Orionids. The ZHR values of the Orionids were calculated without taking into account these ε-Geminids. Therefore the values in Table 1 might be too low.

Table 1 – ZHR-values for the 1987 Orionids and corresponding HR-values as obtained from Belgian observations.

Date	$\lambda_\odot$	Nr. Obs	Ori	ZHR	Spor	HR
Oct 17.89	203°.45	1	0	0	7	9.6 ± 9.6
17.99	203°.55	6	25	9.1 ± 8.4	56	13.7 3.4
18.09	203°.65	8	30	8.4 7.3	60	11.5 4.8
18.19	203°.75	3	5	4.3 4.1	11	6.6 1.4
18.89	204°.45	3	1	1.2 2.1	28	14.2 1.5
18.99	204°.55	6	8	4.0 3.5	44	12.4 4.0
19.09	204°.65	5	20	8.1 4.4	32	10.8 8.7
19.19	204°.75	2	13	10.2 7.6	16	11.1 15.6
19.90	205°.45	1	3	6.8 6.8	6	5.1 5.1
20.00	205°.55	3	21	10.6 6.5	28	8.0 6.2
20.10	205°.65	2	18	12.6 7.8	22	9.4 8.0
22.92	208°.45	2	5	8.4 5.2	17	11.8 6.9
23.02	208°.55	4	25	13.1 6.6	24	8.9 6.6
23.12	208°.65	2	20	17.9 3.9	7	6.0 7.1
23.82	209°.35	2	0	0	17	7.3 1.8
23.92	209°.45	4	13	7.9 12.4	40	9.3 3.3
24.02	209°.55	2	13	15.8 14.5	23	11.2 3.8
24.93	210°.45	2	2	2.2 0.1	20	11.6 2.8
25.03	210°.55	4	4	2.0 0.6	29	8.4 4.3
25.12	210°.65	2	2	1.8 0.9	9	5.1 2.0
25.83	211°.35	1	2	5.6 5.6	14	12.3 12.3
25.93	211°.45	2	3	4.6 1.4	17	8.9 4.7
26.03	211°.55	3	15	7.6 3.5	24	9.7 5.0
26.13	211°.65	3	20	9.6 0.4	25	9.7 5.0
26.23	211°.75	1	6	9.7 9.7	4	5.6 5.6

The only days which were without observations are October 20 and 21. Most likely maximum occurred during one of these nights, since the highest rates are obtained in the morning of October 23 while rates are rather low for a maximum.

Another shower of interest in that period is the Taurid shower. The ZHR values were calculated using the radiant position of the Southern branch. The average ZHR values are listed in the table below.

Table 2 – ZHR-values for the 1987 Taurids and corresponding HR-values as obtained from Belgian observations.

Date	$\lambda_\odot$	Nr. Obs	Tau	ZHR	Spor	HR
Oct 16.94	202°.50	2	0	0	22	12.3 ± 4.3
17.04	202°.60	2	0	0	22	12.3 4.3
17.85	203°.40	2	5	8.6 ± 7.8	11	8.3 1.9
17.95	203°.50	5	11	6.3 5.4	33	10.0 2.8
18.05	203°.60	8	20	5.7 5.5	59	11.5 4.8
18.15	203°.70	6	15	5.6 6.1	42	11.0 5.5
18.25	203°.80	1	1	1.9 1.9	5	8.1 8.1
18.85	204°.40	2	0	0 0	17	13.7 1.6
18.95	204°.50	5	1	0.5 1.0	44	16.8 4.7
19.05	204°.60	6	4	1.4 1.7	34	12.0 8.7
19.15	204°.70	4	3	1.5 2.0	23	9.3 9.3
19.25	204°.80	1	0	0	16	22.1 22.1
19.96	205°.50	3	3	1.1 2.0	28	8.0 6.2

Table 2 – continued

Date	$\lambda_{\odot}$	Nr. Obs	Tau	ZHR	Spor	HR
20.06	205°60	3	3	1.1 2.0	28	8.0 6.2
22.88	208°40	1	3	6.6 6.6	12	16.7 16.7
22.98	208°50	4	12	5.7 2.6	24	8.9 6.6
23.08	208°60	3	9	5.4 3.1	12	6.4 5.1
23.88	209°40	4	10	4.0 3.4	40	9.3 3.3
23.98	209°50	4	10	4.0 3.4	40	9.3 3.3
24.88	210°40	1	2	2.8 2.8	13	13.6 13.6
24.98	210°50	3	5	2.9 1.3	22	9.0 5.0
25.08	210°60	3	5	2.8 1.4	16	6.6 3.0
25.18	210°70	1	2	2.3 2.3	7	6.5 6.5
25.89	211°40	2	8	6.6 2.5	17	8.9 4.7
25.99	211°50	3	13	6.0 2.0	27	8.7 3.4
26.09	211°60	3	6	2.2 2.5	25	9.7 5.0
26.18	211°70	2	1	0.9 1.3	15	10.4 6.9
Nov 16.93	233°50	2	7	5.8 ± 2.3	7	5.0 ± 3.5
17.03	233°60	2	7	5.8 ± 2.3	7	5.0 ± 3.5

As one can see only few observations were carried out in November. Both maxima of the Taurid stream were missed. The Taurid activity never got above the sporadic background activity which seems to have an average HR value of approximately 10.

In the following table, one can find magnitude distributions of the observed showers and sporadic meteors and the resulting population index.

Table 3 – Magnitude distributions and r-value of the 1987 Orionids, ε-Geminids and Taurids and of the sporadic background, as obtained from Belgian observations.

Shower	−3	−2	−1	0	+1	+2	+3	+4	+5	+6	Tot	$\overline{m}$	Lm	r	Cor
Orionids	0	2	1	8.5	14	22.5	40.5	39	17	0.5	145	2.89	6.13	2.94	0.997
ε-Geminids	0	0	2	3.5	4.5	8	12	13.5	9.5	4	57	3.16	6.18	2.82	0.990
Taurids	1	0	2	4	9.5	19.5	25.5	27	10.5	2	98	2.99	6.07	3.05	0.998
Sporadics	0	0.5	4.5	15.5	23	64	122	156.5	79.5	11.5	477	3.36	6.08	4.08	0.994

As one can see, the r-value of the ε-Geminids is comparable to that of the Orionids, confirming that a lot of meteors, reported to belong to the second shower, are actually Orionids. The r-value of the Orionid shower agrees very well with the literature value. The r-value of the Taurids is a different story. Perhaps this is due to the fact that most observations took place in the beginning of the period of Taurid activity? The r-value of the sporadic meteors is also very high.

1987 Observations from Florida

Norman W. McLeod III

An overview is given of the 1987 observations of the author in Florida.

For 1987, I had 37 nights, $89^{h}21^{m}$ of observing time and 1761 meteors, a surprising amount considering the unending terrible weather which has continued since mid-1986. El Niño was definitely present for 1986–87 with mostly cloudy weather for two years.

My 1987 Lyrid observations were already presented in [1]. Looking back to May, I was nosed out of the U.S. η-Aquarid record by Robert Lunsford—he had a 32 the day before I had my 31. May 6 or 7 seems to be the best η-Aqaurid date at present.

Some good weather for a change occurred during the δ-Aquarids. July 29–30 since 1976 has had a single hour that exceeds 50 meteors total. In 1987 it was local daylight hour 2–3 with 52 total; but the δ-Aquarids South did not help much. The δ-Aquarids North gave the best show ever with 10, and the early Perseids were also strong with 11. I thought the δ-Aquarids South did somewhat less than usual in 1987. α-Capricornids continued to be dull; up to 1976, I considered them to be a major shower, but no more. I have not seen many α-Capricornids in recent years. Perseid maximum was cloudy, but no big loss there.

The first early October cool weather in several years came down for the Draconids. I visited my parents in the North Carolina mountains where casual watching up for the predicted ε-Geminid storm did not even produce a meteor. Arriving back in Florida, it was looking great for the Orionids. I thought we had it made for the entire Orionid epoch, but I dreamed too soon. Most nights I would go out, then have clouds not move in, but form right over my head. It was exasperating to finish with only two good Orionid nights in an important year. I did see good back to back Orionid hours of 35 and 32 on October 20–21, so the slightly enhanced rates I started getting in 1985 are still there.

An Orionid paper authored by George Spalding indicates that no one else has seen any increase in the Orionids. There are two rationales for my high rates. The Orionids being the faintest shower (tied with δ-Aquarids) mandates excellent skies to see more than a handful. Every observer excels on a particular shower due to magnitude perception—mine happens to be good on the faint side. Through the 1970s I was used to consistent top Orionid rates of 25–28, then a slump occurred in 1979–82, when I did not exceed 20. Recovery to normal occurred in 1984, then a move to new heights in 1985 with record hours of 29, 31 and 40. The first two are admittedly marginal. Then in 1987 I had the pair of good rates. No claim that Halley caused the increase can be advanced. The Orionids might go through these variations several times during one revolution. I hope to be observing enough years to see another fall and rise.

The November Leonids were the poorest I have seen. They were almost absent. The best I got was 5, although I missed November 17–18, maximum date is shifting later rapidly. A very fortunate weather break occurred for the Geminids. I got the two best nights with clouds and fog holding off until moonrise. An inexperienced observer with me at maximum, saw 125/hour total, about twice my perception. December 14–15 was one of the most delightful nights I have ever experienced—dark and balmy—except the tape recorder failed me almost completely. Recalling by impression, this night had Geminid rates to about 30, far better than the same dismal night in 1985. Being half a day closer to the peak made quite a difference. The Geminids overall performed exactly as I expected.

Below, the observational data are given. The author gave his data in local time, but did not mention when he switched from Eastern Daylight Saving Time (EDT) to Eastern Standard Time (EST). We assumed that all observations from October 29–30 and afterwards were given in EST. In order to avoid ambiguities that may cause misinterpretations, we urge all observers to report their observations in UT, no matter where they live. (ed.)

Table 1 – Shower abbreviations.

Abb.	Shower	Abb.	Shower	Abb.	Shower
E	η-Aquarids	K	κ-Cygnids	DE	δ-Aurigids
MV	μ-Virginids	PA	Piscis Austrinids	SA	Andromedids S
AS	α-Scorpids	U	υ-Pegasids	NA	Andromedids N

Table 1 – continued

Abb.	Shower	Abb.	Shower	Abb.	Shower
A	δ-Aquarids S	ER	Eridanids	NL	Leonids
AN	δ-Aquarids S	AB	α-β-Perseids	G	Geminids
C	α-Capricornids	T	Taurids S	M	Monocerotids
IS	ι-Aquarids S	TN	Taurids N	SH	σ-Hydrids
IN	ι-Aquarids N	PS	Piscids S	DA	δ-Arietids
P	Perseids	O	Orionids	LD	December Leonids
AC	α-Cygnids	EG	ε-Geminids		

Table 2 – 1987 Observations from Florida by the author.

Date	Period (UT)	T_{eff}	Lm	F	Streams	Spor
Apr 26–27	07^h38^m–08^h26^m	0.80	7.3	1.00		5
26–27	08^h38^m–09^h26^m	1.00	7.3	1.00	1E	11
28–29	07^h36^m–08^h36^m	1.00	7.3	1.00	2E	7
29–30	06^h42^m–07^h26^m	0.77	7.3	1.00	2MV,1AS	5
29–30	07^h26^m–08^h26^m	1.00	7.3	1.00	1E,1AS	8
29–30	08^h26^m–09^h26^m	1.00	7.3	1.00	6E,1MV,3AS	8
30–31	08^h27^m–09^h27^m	1.00	7.3	1.00	6E,2AS	11
May 02–03	06^h26^m–07^h26^m	1.00	7.3	1.00	1MV,1AS	6
02–03	07^h26^m–08^h26^m	1.00	7.3	1.00	1AS	4
02–03	08^h26^m–09^h26^m	1.00	7.3	1.00	9E,2MV	12
03–04	09^h27^m–10^h27^m	1.00	6.5	1.00	2MV	4
03–04	08^h27^m–09^h27^m	1.00	6.5	1.00	11E	5
04–05	07^h23^m–08^h24^m	1.00	7.2	1.00	1E,1MV,1AS	13
05–06	07^h25^m–08^h25^m	1.00	7.3	1.00	8E,1AS	5
05–06	08^h25^m–09^h25^m	1.00	7.4	1.09	19E,1AS	7
06–07	07^h59^m–08^h26^m	0.45	6.5	1.00	5E	3
06–07	08^h26^m–09^h26^m	1.00	7.0	1.00	31E	5
07–08	08^h26^m–09^h26^m	1.00	7.0	1.00	16E,1MV,1AS	6
08–09	08^h26^m–09^h26^m	1.00	6.0	1.00	4E	7
Jul 28–29	05^h31^m–06^h26^m	0.92	6.5	1.00	1A,1AN,1C,1IS,1IN,1PA	8
28–29	06^h26^m–07^h26^m	1.00	6.5	1.00	3A,3AN,4C,2IS,1IN	8
28–29	07^h26^m–08^h26^m	1.00	7.0	1.25	3P,1AN,1C,1IN,1PA	9
28–29	08^h26^m–09^h26^m	1.00	7.2	1.00	6A,1AN,2AC,1K	16
29–30	06^h26^m–07^h26^m	1.00	7.4	1.00	11P,5A,10AN,3C,4IS,3IS	16
29–30	07^h26^m–08^h26^m	1.00	7.4	1.00	9P,6A,1AN,1IS,1IS,1U,1ER	20
29–30	08^h26^m–09^h26^m	1.00	7.4	1.00	7P,10A,2AN,2C,1AS	15
30–31	06^h55^m–07^h26^m	0.52	6.5	1.00	3P,2A,1C	7
30–31	07^h55^m–08^h26^m	1.00	7.0	1.00	10P,1IS,1IN	6
30–31	08^h55^m–09^h26^m	1.00	7.2	1.00	6P,2A,1AN,1C,2PA	10
30–31	09^h26^m–09^h42^m	0.27	7.0	1.00	4P,4A,1AN,2C	9
Aug 01–02	06^h55^m–07^h26^m	0.63	7.2	1.00	3P,2A,1C	7
01–02	07^h26^m–08^h26^m	1.00	7.2	1.00	1P,5A,4AN,1AC,1U	5
01–02	08^h26^m–09^h26^m	1.00	7.2	1.00	9P,2AN,1C	9
02–03	06^h42^m–07^h26^m	0.73	7.2	1.00	4P,3A,2AN,2C,1IN,1PA	8
02–03	07^h26^m–08^h26^m	1.00	7.2	1.00	8P,4A,2AN,1AC	13
02–03	08^h26^m–09^h26^m	1.00	7.2	1.00	6P,1A,2AN	8
03–04	06^h36^m–07^h26^m	0.83	7.2	1.00	3P,6A,2AN,2IN	16
03–04	07^h26^m–08^h26^m	1.00	7.2	1.00	8P,6A,2AN,3C,2PA	6
03–04	08^h26^m–09^h26^m	1.00	7.2	1.00	7P,5A,4AN,2C,1IN	13

Table 2 – continued

Date	Period (UT)	$T_{\rm eff}$	Lm	F	Streams	Spor
Aug 04–05	06^h32^m–07^h26^m	0.90	7.0	1.00	7P,4A,1IS,1U	3
04–05	07^h26^m–08^h26^m	1.00	7.1	1.00	10P,5A,4AN,1C,1ER	5
04–05	08^h26^m–09^h26^m	1.00	7.0	1.00	2P,2A,1AN,1AP	10
24–25	06^h28^m–07^h27^m	0.98	7.0	1.00	1P,2AN,1C,1IN	14
24–25	07^h27^m–08^h27^m	1.00	7.0	1.00	1P,1AN,1C	11
24–25	08^h27^m–09^h27^m	1.00	7.2	1.00	1AN,1C	18
25–26	07^h31m–08^h27^m	0.93	7.0	1.00	1P,1K	10
25–26	08^h27m–09^h27^m	0.93	7.0	1.00		12
27–28	06^h27m–07^h27^m	1.00	7.0	1.00	1C,1U	12
27–28	07^h27m–08^h27^m	1.00	7.0	1.00		18
27–28	08^h27m–09^h27^m	1.00	6.8	1.00	1C	12
29–30	07^h53m–08^h26^m	0.55	7.3	1.00	1C,1K	10
29–30	08^h26m–09^h26^m	1.00	7.3	1.00		15
Sep 17–18	06^h27m–07^h27^m	1.00	7.0	1.00		7
17–18	07^h27m–08^h27^m	1.00	6.5	1.00	1TN	8
19–20	07^h27m–08^h27^m	1.00	6.5	1.00	1T,1PS	16
19–20	08^h27m–09^h27^m	1.00	6.5	1.00		12
Oct 16–17	05^h54m–06^h26^m	0.53	6.8	1.00	4O,2T	4
16–17	06^h2m–07^h26^m	0.53	6.8	1.00	4O,3T,1EG	7
19–20	07^h04m–07^h26^m	0.36	7.3	1.00	5O	0
19–20	07^h26m–08^h26^m	1.00	7.3	1.00	20O,4T	6
19–20	08^h26m–08^h59^m	0.55	7.0	1.00	8O,2T,1DE	1
20–21	07^h02m–07^h26^m	0.40	6.8	1.00	6O,1T,1TN	4
20–21	07^h26m–08^h26^m	1.00	6.8	1.00	14O,3T,2TN,1SA	1
20–21	08^h26m–09^h26^m	1.00	6.8	1.00	35O,6T,1TN	7
21–22	09^h26m–10^h26^m	1.00	7.0	1.00	32O,2T	13
24–25	08^h07m–09^h04^m	0.95	7.2	1.00	6O,1T	7
29–30	07^h41m–08^h26^m	0.75	7.2	1.00	4O,3T,2TN	4
29–30	08^h41m–09^h26^m	1.00	7.2	1.00	8O,1T,1TN	8
Nov 15–16	08^h30m–09^h27^m	0.95	6.2	1.00	3NL,1TN	8
15–16	09^h27m–09^h57^m	0.50	6.2	1.00	1NL	2
16–17	07^h29m–08^h26^m	0.95	7.3	1.00	1NL,1T,1TN	8
16–17	08^h26m–09^h14^m	0.80	6.0	1.00	5NL	4
23–24	08^h08m–09^h50^m	1.70	7.4	1.00	2NL,4T,2TN,1NA	12
Dec 13–14	03^h26m–04^h26^m	1.00	7.3	1.00	67G,2T,2SH	5
13–14	04^h26m–05^h26^m	1.00	7.3	1.00	55G,1TN,2M,1SA,2LD	3
13–14	05^h26m–06^h26^m	1.00	7.0	1.00	65G,1T,1LD	1

Table 3 – Global magnitude distributions.

Shower	−3	−2	−1	0	+1	+2	+3	+4	+5	+6	Tot	$\overline{m}$
η-Aquarids	0	0	1	5	17	17	17	23	18	2	100	2.95
δ-Aquarids	0	0	0	5	9	18	23	42	33	13	143	3.67
Orionids	0	2	3	7	10	37	27	25	21	13	145	3.04
Taurids	0	0	0	2	4	12	8	11	8	2	47	3.15
Geminids	2	2	7	27	25	43	28	41	31	17	223	2.67

References

[1] N.W. McLeod III, "The Lyrids 1987 in Florida", *WGN* 16 : 4, August 1987, pp. 122–123.

1988 Spring Observations

Early 1988 Minor Showers in Australia

Jeff Wood

An overview is given of Australian observations of the α-Crucids, the α-Centaurids and the o-Centaurids in January and February 1988.

Unusually poor weather in January and February 1989 prevented Australian observers from carrying out an extensive monitoring program for the α-Crucids, the α-Centaurids and the o-Centaurids. The maximum of the first stream was even missed. The following people took part in the project:

Louise Cockeram, Nicholas Harvey, Jeff Wood, Darren Ferdinando, Michael Taylor, Craig Hinton and Michelle Treasure.

Average ZHRs are listed in Table 1.

Table 1 – Average daily ZHRs of the 1988 α-Crucids, α-Centaurids and 0-Centaurids as observed in Australia.

	α-Crucids		α-Centaurids		o-Centaurids	
Date	Nr. Obs.	ZHR	Nr. Obs.	ZHR	Nr. Obs.	ZHR
Jan 15–16	4	2.9 ± 1.7				
17–18	6	1.9 0.8				
19–20	2	1.0 1.0				
21–22	6	1.5 0.6				
23–24	3	0				
Feb 08–09			6	7.6 ± 3.1	6	1.2 ± 0.7
11–12			9	2.0 1.2	9	2.1 0.8
12–13			7	1.4 1.0	7	1.8 1.4

Table 2 contains the magnitude data.

Table 2 – Global magnitude distributions of the 1988 α-Crucids, α-Centaurids and o-Centaurids obtained from Australian observations.

Shower	−4	−3	−2	−1	0	+1	+2	+3	+4	+5	Tot	$\overline{m}$
α-Crucids	0	0	0	1	0	2	6	14	10	5	38	3.16
α-Centaurids	0	1	2	1	4	11	13	19	16	5	72	2.43
o-Centaurids	1	0	0	1	2	7	12	12	15	4	54	2.63

Of the 9 α-Crucids of magnitude +2 or brighter, one was yellow and the remainder were white in color. 7.9% of the Crucids seen had a train.

Of the α-Centaurids of at least magnitude +2, 12.5% were orange, 50.0% were yellow, 3.1% were green and 34.4% were white. 27.8% of the α-Centaurids seen had a train. All of these were of short duration lasting less than 5 seconds.

Of the o-Centaurids of magnitude +2 or brighter, 4.3% were orange, 43.5% were yellow, 4.3% were green and the remainder were white in color. 24.1% of the o-Centaurids seen had a train. With the exception of a magnitude −4 yellow-green meteor seen on February 12–13 which had a train lasting 25 seconds, all the remainder had trains lasting 5 seconds or less.

The 1988 Lyrids in Spain

José María Trigo Rodríguez

The Lyrids are active during a period of about ten days in April. In 1988, they were observed in an extensive observing campaign conducted by the Spanish Meteor Society.

1. Introduction

For some years now, members of our Society have studied this and other Spring-time streams. Generally they are not widely observed, even though their activity can become rather important.

Due to the very different observing conditions in 1987 and 1988, our observing programs differed as well. In 1987 the Moon made it impossible to observe on any nights but the final ones, so that we only saw the rear-guard members of the stream. On April 26, 1987, we had a ZHR of only 3. These circumstances also made it very difficult to accurately pinpoint the radiant's position in the sky, and this was made even more difficult by a relatively high sporadic activity. In the end we succeeded at positioning it at $\alpha = 275°$ and $\delta = +37°$. These values were derived from the results of three observers: Antonio Francisco Marìn, Raúl Fernández Sayalero and myself.

A special phenomenon during one of these nights was the simultaneous appearance of two meteors, probably coming from the radiant since they slightly diverged. Due to the bad weather and observing conditions in 1987, the results for that year are somewhat confused and confusing. Generally we can conclude that the level of activity was normal; this means ZHRs somewhere between 10 and 15.

The 1988 Lyrid appearance occurred under much better circumstances, with perfect skies and a limiting magnitude of 6.6. Some funny anecdotes add to our astronomical adventures, like a sudden downpour the night after maximum. It surprised us as we were observing on a mountain top, and we were obliged to hurry down to find some shelter, where we waited for several hours hoping it would soon stop.

During almost the entire period of activity we had the occasion to study the Lyrids and also some other streams like the α-Bootids, the φ-Bootids, the μ-Virginids, the α-Scorpids, the o-Leonids, etc. In this way, general activity varied much from one day to another: on April 21–22, the night of maximum, 30 meteors were observed by the author, with a limiting magnitude of 5.0; yet ZHR amounted to only 10 the day after.

2. The 1988 Lyrid campaign

Here are some results for the Lyrid activity as well as for the other streams, as they were observed by the following members of the Society:

> José María Trigo (TRIJO), José Vicente Díaz (DIAJO), Oscar Cervera Garcìa (GAROS), Vicente Soldevilla Perez (PERVI), Antonio Francisco Marin (MARAN) and Andrés Rafael Paños (PANAN).

The observing was done on 9 different nights between April 3 and April 24, totaling 36 hours. 197 meteors were registered, among which 54 Lyrids, 14 α-Bootids, 8 φ-Bootids and 2 μ-Virginids. We are actually further studying the α-Bootids whose activity cannot be ignored. In turn, the μ-Virginids appeared less active than in 1987, when José Francisco Sacenón recorded a ZHR of 10 (April 25–26, 1987). The φ-Bootids were also rather active in 1988.

The observational results are listed in Tables 1 and 2.

Table 1 – Abbreviations.

Shower	Abb.	Shower	Abb.
α-Bootids	AB	δ-Draconids	DD
φ-Bootids	FB	μ-Virginids	MV
o-Leonids	OL	α-Virginids C	VC
θ-Librids	TL	κ-Serpentids	KS
α-Capricornids A	AA	α-Scorpids	AS

Table 2 – Observations of the 1988 Lyrids and the sporadic background from Spain by José Trigo-Campoy Rodriguez).

Date	Obs	Period (UT)	T_{eff}	Lm	F	Per	Minor streams	Spor
Apr 03–04	PANAN	23^h15^m–23^h45^m	0.50	4.3	1.00	0		0
04–05	DIAJO	22^h22^m–22^h53^m	0.52	4.5	1.00	0		1
06–07	GAROS	21^h00^m–22^h00^m	1.00	5.5	1.00	0	1TL	2
06–07	GAROS	22^h30^m–23^h21^m	0.85	5.7	1.00	0		0
06–07	TRIJO	22^h47^m–23^h49^m	1.03	4.9	1.00	0	1OL	2
06–07	DIAJO	21^h04^m–22^h02^m	0.97	5.5	1.00	0	1OL	0
06–07	DIAJO	22^h30^m–23^h21^m	0.85	5.7	1.00	0		2
07–08	TRIJO	20^h00^m–20^h45^m	0.75	5.0	1.00	0		2
07–08	TRIJO	01^h30^m–02^h30^m	1.00	5.0	1.00	0	1KS,2TL	0
07–08	PANAN	01^h30^m–02^h30^m	1.00	5.0	1.00	0	1KS	0
19–20	TRIJO	03^h33^m–04^h33^m	1.00	5.1	1.00	1	1AB	1
20–21	PERVI	23^h40^m–03^h32^m	0.87	4.2	1.00	4		3
21–22	TRIJO	01^h40^m–03^h40^m	2.00	5.0	1.00	14		1
22–23	TRIJO	22^h24^m–22^h55^m	0.52	5.6	1.00	0	1MV	1
22–23	TRIJO	00^h11^m–02^h05^m	0.90	6.5	1.00	8	1AB,1FB,1VC, 1MV,1AS	9
22–23	TRIJO	02^h14^m–03^h06^m	0.87	6.4	1.00	7	1FB	8
22–23	PERVI	02^h00^m–03^h40^m	1.67	6.3	1.00	4	1DD,1AB	7
22–23	DIAJO	01^h32^m–03^h32^m	2.00	5.9	1.00	2	1AB	9
23–24	TRIJO	01^h05^m–02^h57^m	1.87	6.2	1.00	4	1DD,4AB,2FB,1OL	22
23–24	GAROS	22^h00^m–23^h30^m	1.50	5.5	1.00	1	1AB,1FB	2
23–24	GAROS	00^h12^m–03^h10^m	2.97	5.9	1.00	5	1FB	6
23–24	DIAJO	21^h58^m–03^h10^m	5.20	5.9	1.00	2	4AB,1FB,1AA	13
23–24	MARAN	01^h58^m–03^h00^m	1.03	6.0	1.00	2	1AB,2FB	6

Table 3 – Global magnitude distributions of the 1988 Lyrids, α-Bootids and φ-Bootids obtained from Spanish observations.

Shower	−6	−5	−4	−3	−2	−1	0	+1	+2	+3	+4	+5	+6	Tot	$\overline{m}$
Lyrids	1	0	1	1	2	2	6	9	6	8	10	8	2	56	2.10
α-Bootids	0	0	0	0	0	0	1	3	2	1	3	3	0	13	2.69
φ-Bootids	0	0	0	0	0	0	1	1	1	3	2	0	0	8	2.50

The sporadic activity was generally high, with 5 to 10 meteors per hour. Their mean magnitude amounted to +3.4.

Dirk Artoos mentioned an **unusual radio meteor activity in the morning of January 22, 1988.** This observation was confirmed by Gotfred Møbjerg Kristensen.

Belgian Visual Observations in Spring 1988

Glenn Ticket

This article deals with results from Belgian visual observations conducted in February and April of 1988. The δ-Leonids and Lyrids were covered.

Very few observations were carried out in Belgium in the first half of 1988. This article presents the results of these observations. The following persons submitted observations:

> Sabine Clement (CLESA), Carl De Pooter (DE CA), Ivo Dielen (DIEIV), Francis Plesier (PLEFR), Ghislain Plesier (PLEGH), René Scurbecq (SCURE), Lieven Smits (SMILI), Jonas Vanreusel (VANJO), Ivo Verlaeckt (VERIO).

Only 2 people were able to observe in February. The HR and ZHR values can be found in Table 1. The shower which was observed is the δ-Leonid shower, which is a minor stream. It is visible from February 3 until March 19 and reaches its maximum on February 26 according to [1].

Table 1 – ZHR-values for the 1988 δ-Leonids and corresponding HR-values as obtained from Belgian observations.

Date	$\lambda_\odot$	Obs	δ-Leo	ZHR	Spor	HR
Feb 15.85	325°85	PLEGH	2	8.3 ± 5.9	4	6.2 3.1
15.90	325°89	PLEGH	1	2.9 2.9	4	6.2 3.1
15.92	325°91	PLEFR	2	8.0 5.6	9	24.5 8.2
15.94	325°93	PLEGH	0	0	2	3.1 2.2
16.88	326°88	PLEGH	0	0	3	2.3 1.3
16.94	326°94	PLEGH	2	4.1 2.9	2	2.8 2.0
16.97	326°97	PLEFR	2	4.3 3.0	8	14.3 5.1
17.01	327°02	PLEGH	0	0	3	2.9 1.7
17.05	327°05	PLEFR	0	0	5	8.5 3.8

One should however not pay too much attention to the ZHR-values in Table 1, since they are never based on more than 2 meteors. It is however interesting to compare the number of δ-Leonids and the number of sporadics. As one can see, the latter dominate: 9 shower members and 40 sporadics were reported in nearly 11.5 hours of observing time.

In 1988, the weather was not very cooperative for observing the Lyrid activity. Some observers however did manage to watch this shower the day after maximum. In the following table, one can find the resulting ZHR and HR values from their observations.

Table 2 – ZHR-values for the 1988 Lyrids and corresponding HR-values as obtained from Belgian observations.

Date	$\lambda_\odot$	Obs	Lyr	ZHR	Spor	HR
Apr 23.00	32°52	CLESA	4	11.4 ± 5.7	1	2.4 ± 2.4
23.00	32°52	DE CA	3	8.6 5.0	2	4.8 3.4
23.00	32°52	DIEIV	1	2.9 2.9	4	9.4 4.7
23.00	32°52	SMILI	2	5.7 4.0	2	4.7 3.3
23.00	32°52	VANJO	2	5.7 4.0	2	4.7 3.3
23.00	32°52	VERIO	4	11.5 5.7	4	9.6 4.8
23.04	32°57	CLESA	5	10.0 4.5	7	13.6 5.1
23.04	32°56	DIEIV	3	7.3 4.2	7	16.4 6.2

Table 2 – continued

Date	$\lambda_\odot$	Obs	Lyr	ZHR	Spor	HR
23.04	32°56	SMILI	3	6.8 4.0	12	26.3 7.6
23.04	32°56	VANJO	3	8.0 4.6	4	10.1 5.1
23.09	32°61	DIEIV	2	3.6 2.5	9	16.9 5.6
23.09	32°61	SMILI	4	7.4 3.7	7	13.8 5.2
23.09	32°61	VANJO	4	7.1 3.5	10	18.7 5.9
23.10	32°62	CLESA	4	9.0 4.5	10	24.1 7.6
23.14	32°66	SCURE	0	0.0 0.0	4	17.6 8.8

The ZHR of the Lyrid shower never gets much higher than 10, which is to be expected since this shower has a very sharp maximum. The error on the ZHR values is rather large since these are always based on few meteors. In total, 44 Lyrids and 85 sporadics were reported in nearly 16 hours of observing. In the next table one can find the magnitude distribution of these meteors and the resulting population indices.

Table 3 – Magnitude distributions and r-value of the 1988 Lyrids as obtained from Belgian observations.

Shower	−2	−1	0	+1	+2	+3	+4	+5	Tot	$\overline{m}$	Lm	r	Cor
Lyrids	0.5	5	3	3.5	10	9	11.5	1.5	44	2.23	5.7	2.77	0.982
Sporadics	0	4	3.5	9	24.5	23.5	16	4.5	85	2.48	5.7	3.04	0.997

The r-value of 2.77 corresponds very well to the literature value of 2.88 [1].

References

[1] Roggemans P. (ed.), "Handbook for Visual Meteor Observations", 1987.

The Meteor Library

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- *M. Fulle, "Meteoroids from 1973 XII", Astron. Astrophys. 201, pp. 161–168.*

Photographic meteor data from four red-sensitive plates of comet Kohoutek 1973 XII, studied by Sekanina and Miller in 1976, are used as input to the inverse approach to the Finson-Probstein method. The results of this application are the time-dependent size distribution and its time-average, the dust mass and number loss rates and the dust ejection velocity from the inner coma. The fragmentation processes of large dust released at a regular rate, already observed in other comets, are confirmed. From these results the mass of meteoroids injected by 1973 XIII into bound orbits is computed. The value of about 10^{12} g is obtained, in agreement with 1957 III and 1962 III, quite far from the about 10^{14} g supplied by 1970 II.

- *D.O. Steel, W.G. Elford, "The True Height Distribution and Flux of Radar Meteors", Proc. 10th Europ. Reg. Astron. Meeting of the IAU, Prague, 1987, vol. 2, Interplanetary Matter (Z. Ceplecha, P. Pecina, eds.), Publ. Astron. Inst. Czechosl. 67, pp. 193–198.*

When compared to satellite detector measurements of dust particles of mass $< 10^{-6}$ g and optical meteor observations for mass $> 10^{-2}$ g, the flux of the interstitial radar meteors is discrepant: the radars render fluxes which seem too small by a factor of about 20–30. This has usually been explained as being due to the majority of the flux being held in low-velocity meteors which produce little ionization and hence have limited radar detectabilities. In this paper, an alternative hypothesis is proposed: that the discrepancy is due to wavelength-dependent effects, implying that conventional meteor radars ($f > 20$ MHz) only detect the lower-altitude underdense meteors. To test this the authors have determined the height distribution of radar meteors at 2 and 6 MHz, at which frequencies the echo ceilings are much heigher than the 100–150 km limits of VHF radars. The authors find that the distributions peak at about 105 km, fully 10 km above the peaks of the VHF radars, with many meteors occurring to at least 140 km altitude. Additional observations using the powerful Jindalee radar in central Australia confirm these results, and show that the cumulative flux of particles of mass $> 10^{-6}$ g is about 9×10^{-8} m^{2}s^{-1}; this is consistent with the satellite data and is over an order of magnitude larger than derived in previous radar meteor experiments.

- *A.G. Duffy, R.L. Hawkes "Television Observations of the 1984 Orionid Shower", Mon. Not. R. astr. Soc. 234, 1988, pp. 634–654.*

Absolute magnitudes, photometric masses, trajectory information and light curves are presented for a sample of 17 meteors from the 1984 Orionid shower. These meteors, with mean absolute television magnitude of +4.8, are observed to have mean beginning, maximum luminosity and ending heights of 111.3, 107.6 and 103.2 km respectively. The mean vertical trail length (for points 1.0 magnitude fainter than maximum luminosity) is 6.9 km. Although the point of maximum luminosity is on average only slightly skewed towards the ending of the light trail, considerable variation from meteor to meteor is observed. This suggests variation in either physical structure or chemical composition from one Orionid meteoroid to another. The radiant ($\alpha = 94^\circ\!.2$ and $\delta = +15^\circ\!.4$ at $\lambda_\odot = 207^\circ\!.$) is in quite good agreement with earlier visual and radar observations, as is the observed flux. From combining the authors' flux results with other data it is found that the cumulative zenithal flux of particles with masses greater dan m (expressed in g) can be represented by $\Theta = 2.2 \times 10^{-19} m^{-0.75}\mathrm{cm}^{-2}\mathrm{s}^{-1}$. We conclude from the height, vertical trail length and light curve data that there is no compelling evidence to suggest that the Orionid meteoroids are significantly different in physical structure from other shower meteoroids (such as the Perseids) or from the sporadic complex of faint meteoroids as a whole.

- *B.A. McIntosh, J. Jones "The Halley Comet Meteor Stream: Numerical Modeling of its Dynamic Evolution", Mon. Not. R. astr. Soc. 235, 1988, pp. 673–693.*

The ribbon-like model proposed by McIntosh and Hajdjuk for the structure of the Halley meteor stream explained many of the features of the η-Aquarid and Orionid meteor showers. This model is here verified quantitatively by numerically integrating the orbital motion of up to 500 test particles over several millennia. Perturbations by the major planets, the effect of radiation pressure and Poynting-Robertson drag, are all taken into account. The stream cross-section becomes highly elongated in only a few thousand years. Concentrations in the particle distribution are apparent for larger particles. Meteors now seen in the Orionid shower were injected into the stream earlier than a few thousand years ago whereas in the η-Aquarid shower we see particles released more recently.

- *L.M.G. Poole, D.G. Roux, "The Meteor Radiant Mapping with an All-Sky Radar", Mon. Not. R. astr. Soc. 236, 1989, pp. 645–652.*

Contour maps of meteor radiant activity distributions in the vicinity of known shower radiants have been produced from data obtained with the all-sky meteor radar recently established at Grahamstown, South Africa. The distributions were derived using a simple geometric procedure based on the property of specular reflection from meteor trains. The use of antennas with good sky coverage has resulted in maps which are relatively free of the astigmatic distortion that can arise from system anisotropy. There is some degradation due to a spurious background activity produced by the mapping procedure, but this does not seriously affect the reconstruction of prominent radiant features. It is concluded that accurate recovery of arbitrary radiant distributions from single-station radar data should be possible.

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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)

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