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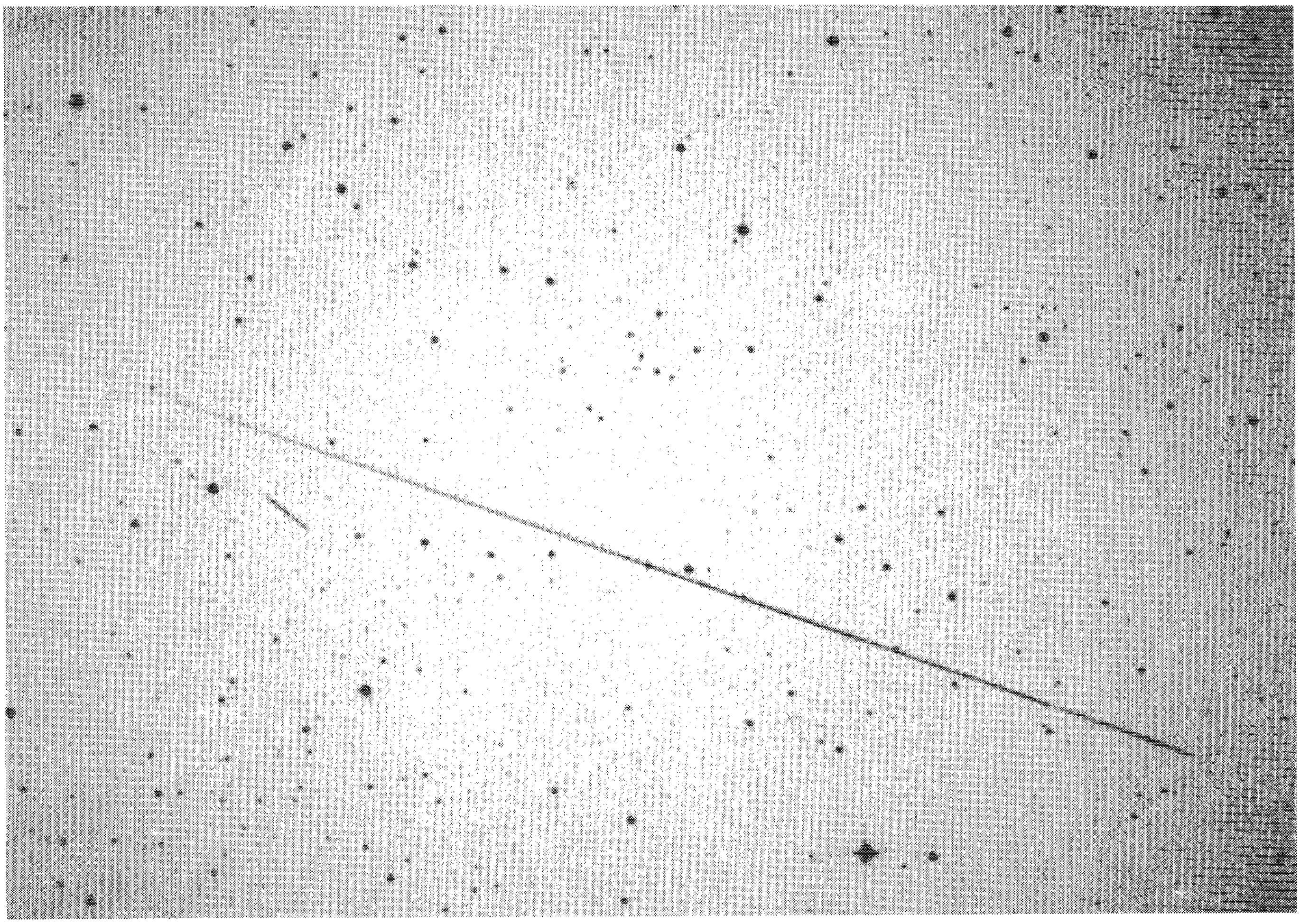

A negative of a small part of a photograph taken at around 12^h UT on April 16, 1991 with the UK Schmidt Telescope at the Anglo-Australian Observatory. Apart from the long sporadic meteor train, there is also a much shorter line due to an asteroid—3025 Higson—which moved about 200 000 km during this three-hour exposure.

In case of non-delivery, return postage guaranteed. Please return to:
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WGN, volume 19, nr 3, June 1991, pp. 79–104

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Useful Information

The August Issue *(WGN 19:4)*

The *August issue* is expected to be mailed during the second week of August, due to the printer's summer holidays. Due to the editor-in-chief's professional commitments, however, contributions are due *July 5*. They should be sent to *Marc Gyssens* or to any member of the editorial board (addresses: inside of back cover).

WGN Subscription/IMO Membership 1991

The subscription rate for volume 19 (1991) is 20 DEM for six issues. It is anticipated that volume 19 will contain over 240 pages. Subscriptions should be paid to Ina Rendtel, in DEM. However, read the note on p. 74 of the June issue. People who can only pay from a bank account must send an international bankdraft in USD payable to Peter Brown. British subscribers may also contact Alastair McBeath and Japanese subscribers may contact Masahiro Koseki. All addresses can be found on the inside of the back cover. Please make sure we retain the full amount due after deduction of bank and/or exchange charges. Please refer to p. 3 of the February issue for further details. Additional gifts are of course welcome.

Administrative Correspondence

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

From the Editor-in-Chief

Marc Gyssens

In this issue, you fill find once again a shower analysis using IMO observations from all over the world. Some of our readers may have wondered why such analyses ceased to appear in WGN for such a long time. The reason for this is that the format for visual observations adapted in Balatonföldvár in October 1989 required a thorough revision of several routines in the Visual Meteor Database (VMDB) As a consequence, a lot of additional work came on top of the already heavy workload of the author of the VMDB, causing an unavoidable delay. Fortunately, the analyzing programs are ready now, meaning that you can expect a global shower analysis in almost each issue from now on.

We believe these analyses are very important, because they constitute the major source of feed-back for the observers. Since the study of meteors is a statistical study, individual observations, even under exceptional circumstances, provide little information just by themselves. Several comparable observations combined together, however, can be of great scientific value. To see this, it suffices to read the analysis in this issue concerning the 1989 Perseids. This analysis for instance confirms the double peak found in the 1988 data, suggesting that this previously unnoticed feature bears some relationship with an unnoticed return of the Perseids' parent comet, Swift-Tuttle. However, it is definitely too early to draw conclusions; more observations are needed to see how the activity profile evolves.

Unfortunately, the 1990 Perseid observations do not allow another confirmation, since in that year, observations were hampered by bad weather almost everywhere. Therefore, I want to encourage each and every observer to cover the Perseid activity to the best of his or her ability, especially in view of the very favorable circumstances. Also, our Visual Commission director needs some additional Aquarid observations, particularly in the periods July 15–20 and August 10–20 to complete the Aquarid Project started in the summer of 1989. Moonwise, it is perfectly possible to fill up these gaps! In this spirit, I wish you all a wonderful July and a splendid August!

On the Front Cover:

A Meteor and an Asteroid

Duncan Steel, Anglo-Australian Observatory

Occasionally in taking an astronomical photograph an observer may capture an image of something that he or she was not expecting, such as a supernova or a satellite passing through the field of view. But to capture two unexpected phenomena within millimeters of each other in an exposure is really quite extraordinary.

The photo on the cover of this issue shows a magnified section of a photographic plate taken by Malcolm Hartley on April 16, 1991, using the UK Schmidt Telescope (UKST) at the Anglo-Australian Observatory (AAO). This section on the original covers a field about half a degree wide, or about 3 cm on the plate. Over a hundred images of stars, galaxies and other deep-space phenomena are apparent. On the whole plate, about 36 cm on a side, there was one meteor recorded: these turn up in about one plate in a hundred, the emulsion being very slow, and are regarded by the astronomers involved as a nuisance, like satellite trails, since it is the deep-space objects which are of interest. However, there is also a trail due to an asteroid, which moved across the plate by about 1 mm during the three hours of the exposure: the actual distance that the asteroid traveled in this time was about 200 000 km. In this negative image it is the short, dark, continuous-density straight line on the left, at about $\alpha = 11^{h}15^{m}$ and $\delta = -26°30'$. It was rather surprising to find this asteroid trail almost intersecting the meteor on the plate.

By checking the lists and orbits of all known asteroids, Robert McNaught (AAO) was able to identify this asteroid as 3025 Higson, which spends its time in the main belt in a near-circular orbit at about 3.2 AU from the Sun, but having a fairly high inclination (21°) to the plane of the Earth's orbit. By performing detailed inspections of all plates taken at the UKST we discover many new asteroids, and in particular we pay attention to those whose trails indicate them to be in unusual orbits, such as the Apollo asteroids which cross the path of the Earth and thus may hit us at some time in the future. These asteroids are also of interest since they may be extinct or dormant comets which at present or in the past have spawned meteoroid streams.

From the Visual Commission

May 1991 Status of the Visual Meteor Database

Paul Roggemans

Recently, the author and the director of the Visual Commission have completed the input of the 1990 observational reports. The analyzing programs have been worked out, tested and applied to the 1989 Perseids. Several readers have been asking for more articles with results of analyses. We fully understand that observers wish to see that useful work is done with their observational efforts. We do not wish to disappoint any observer by delaying reports or by a lack of feed-back. It is possible to work faster in the future.

The visual report format was adapted in 1989. The first version of the *Visual Meteor Database (VMDB)* was evaluated and an improved version prepared. It took several months before the new software was available to reprogram the *VMDB*. Despite the fact that *IMO* has a Computer Commission, the *VMDB* was worked out by the author within the Visual Commission, a rather time consuming job, which explains the delay to some extent. It is the task of the Computer Commission to provide programs for the different aspects of meteor work. I am aware that this is not the case, but it is impossible for me to provide programs for the different aspects of meteor work. Moreover, several people made request to get copies of these *VMDB* programs. The *VMDB*, however, is not a public program, but a program that is operated inside the Visual Commission.

It should also be noted that the input of all the reports consumed very much time. Several people send us their reports very late, as a consequence of which early analyses are not possible. Very few people used the *IMO* reports in the past, or they used them in the wrong way. The fact that many reports are not yet presented in a standard format also slows down routine input. All your data are verified for inconsistencies. One of the most common errors are incorrect totals. It seems that for meteor observers, $1+1$ does not necessarily equal 2. Several observers report radiants that were below the horizon at the time of observation, self-invented showers, or extend activity periods by several days or even weeks. Such reports must be corrected during the input. Magnitude distributions are often neglected, which is extremely regrettable. On about 18 000 hourly rate observations, we found 12 with the Sun above the horizon, indicating errors in the time conversion to UT. All these problems can be avoided provided you abide by the guidelines of the Visual Commission. Please help us, and you will enable us to publish the analyses much sooner in the future!

IMO Aquarid Project—Intermediate Report

Ralf Koschack

In 1989, visual observers were called upon to investigate the radiants of the Aquarius/Capricornus region in July and August [1]. As a large number of radiants are concentrated in a relatively small area it is difficult or even impossible to distinguish them. The observing project aims at finding out whether and for which periods the separation of the individual radiants is possible or whether certain radiants can be neglected due to their low activity. The result to be achieved is a strategy for visual observations of that radiant complex.

Observers may have wondered why no results have been published yet. The reason is twofold:

- The analysis of a major quantity of positional data requires certain tools, in this case a database the data are stored in and an analyzing routine. Both had to be elaborated and have become available in early 1991 only. The database called "PosDat" was established by a team lead by Detlef Koschny, and Rainer Arlt has programmed the analyzing routine "RADIANT".
- Each year, the Moon prevents certain periods to be covered by observing. Thus the complete activity period of the complex lasting from mid July to the end of August cannot be covered in one single year. Generally, three years are necessary to obtain a complete coverage.

In Table 1 the meteor numbers per period available by now in the required format are shown. Table 2 shows the observers who contributed observations in the requested format. It can be seen that the periods July 15–20 and August 10–20 are almost uncovered. This year, the Moon offers the possibility to improve this situation. Therefore it is the best solution to complete the coverage this summer and to make the analysis in fall rather than now. In order to present the results as soon as possible, the Visual Commission asks you to mail your observations by the end of September.

Table 1 – Meteor numbers per period available now.

Period	Number	Period	Number
Jul 15–20	26	Aug 10–15	0
20–25	154	15–20	32
25–31	384	20–25	272
Aug 01–05	737	25–31	164
05–10	372	Tot	2141

Table 2 – Contributions of individual observers to the Aquarid project.

Observer	Meteors	Observer	Meteors	Observer	Meteors
Rainer Arlt	125	Robert Lunsford	28	Petra Rendtel	47
Eva Ivanova	9	Julian Markov	25	Paul Roggemans	133
André Knöfel	21	Ina Rendtel	284	Plamen Stefanov	229
Ralf Koschack	1054	Jürgen Rendtel	167	Richard Taibi	19

It is a general problem that, except for major showers, in one single year often not enough observational data can be obtained to produce useful analyses and thus, an accumulation of data over several years becomes necessary. In such cases it will become the rule to publish short intermediate reports like this one observers can see from which and how much data were already obtained. Anyway, if you contribute observations to an observing project in the required format, these observations are stored by the Visual Commission to use them in future analyses.

Reference

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

International Meteor Conference

Potsdam/Am Schwielowsee, September 18–22, 1991

Rainer Arlt, André Knöfel, Ina and Jürgen Rendtel

Until the end of April, we received more than 30 regular registrations. Those who are not able to pay due to currency restrictions or to send pre-payments are asked to contact the organizing committee immediately. Unfortunately, the number of special regulations is limited. The rest of the registration fee is asked after arrival at the conference site. *Please note that it is not possible to stay at the conference site without registration since we book only the number of rooms requested via pre-registrations.*

Precise information about the site, the best way to get there, and the program will be given in a third circular to be sent about the end of August.

Here, we present a preliminary time schedule for the 1991 *IMC*:

- *Thursday, September 19:*
  Arrival of the participants. Dinner, informal talks, opening and introduction meeting.
- *Friday, September 20:*
  Morning: lectures; afternoon: lectures and one workshop; evening: workshops.
- *Saturday, September 21:*
  Morning: lectures and poster session; afternoon: *IMO* General Assembly and excursion; evening: workshops.
- *Sunday, September 22:*
  Morning: lectures and closing of the 1991 *IMC*; in the afternoon, we may organize sightseeing through Potsdam on request (town and famous park Sans Souci).

All participants are asked to send in further contributions and suggestions for the program. As you can see from this tentative time schedule, we want to increase the effectiveness of poster presentation since in this way, more people can show aspects of their work. Additionally, their is more opportunity for mutual contacts. We would like to encourage you to present posters, but, please, inform us in advance so that we can accommodate all posters!

Furthermore, we intend to organize workshops for participants having different levels of experience in observing and in analyzing data, as was decided at the 1990 *IMC*.

It has already become an established tradition to publish proceedings of the *IMC*s where you can find details of the lectures you may have missed. Of course, we want to continue this tradition. In order to reduce the time lapse between the *IMC* and the appearance of the proceedings, we urge all contributors to bring camera-ready manuscripts with them to the *IMC*. Alternatively, you may bring these as an ASCII file on an IBM-compatible $3\frac{1}{2}''$ or $5\frac{1}{4}''$ diskette. In this case, also bring a hard copy of the text in order to avoid misunderstandings during the processing of your diskette.

For all those who did not yet register: we allow pre-registrations until the end of July 1991. This deadline is a very hard one, since at that time we have to decide on the number of room reservations. Registrations arriving in Potsdam past the deadline can no longer be included in our planning! Since we assume you do not want to miss the 1991 IMC, we recommend you to register as soon as possible!

As a reminder: pre-payments of 100 DEM should be transferred either to the postal giro account 547234-107 at Postgiroamt Berlin (bank code 100 100 10 must be mentioned) or to the bank account 133213 at the Volksbank Potsdam (bank code 160 921 34).

In case of any questions, please contact the organizing committee: *Rainer Arlt, André Knöfel, Ina and Jürgen Rendtel, AK Meteore, PSF 37, D-O-1570 Potsdam, Germany.*

New Earth-Grazing Asteroids

Christian Steyaert

New Earth-grazers keep being discovered photographically. From now onwards, we will give the closest approaches to the Earth's orbit in a tabular form.

Table 1 – Closest approaches of new Earth-grazing asteroids.

Name	$\lambda_\odot$ (2000.0)	Date	Shortest distance (AU)	V_∞ (km/s)	α (1950.0)	δ (1950.0)
1991 DG	9°.30	Mar 30.39	0.03915	15.6	160°.8	−29°.1
	127°.52	Jul 31.09	0.17343	15.1	143°.3	+28°.7
1991 GO	212°.35	Oct 26.16	0.02198	21.8	32°.0	−02°.8
	15°.58	Apr 05.75	0.02853	21.8	10°.4	+20°.0
1991 JR	66°.41	May 28.10	0.04451	13.1	226°.8	+42°.4
1991 JW	238°.92	Nov 21.64	0.02076	12.6	217°.4	−73°.2
	69°.30	May 30.82	0.06126	12.5	267°.5	+22°.1

The November 21 approach of 1991 JW indicates that possible meteor streams associated with low inclination asteroids can have radiants far from the ecliptic. For those who want to make calculations themselves, or compare orbits, the following elements and their reference will be useful. (On the IAU Circulars, elements for 1950.0 are still given).

Table 2 – Orbital elements of Earth-grazing asteroids.

Name	IAU Circ	Date (1991)	T (1991)	e	q (AU)	a (AU)	ω	Ω	i
1991 DG	5197	Feb 25	May 22	0.374040	0.905770	1.447009	63°.40200	179°.4590	11°.45100
1991 GO	5242	Apr 17	Feb 17	0.655580	0.664520	1.929389	88°.52900	24°.3560	9°.58700
1991 JR	5264	May 13	Jun 16	0.261590	1.039150	1.407281	206°.87100	59°.5720	10°.15400
1991 JW	5266	May 13	Sep 17	0.118080	0.915300	1.037849	301°.84400	53°.5240	8°.69100

Visual Observers' Notes: July–August 1991

Marc Gyssens and Jeff Wood

1. Introduction

The period July–August is the most consistently rich period for meteor rates of the whole year. On a dark night an observer can expect to see over 20 meteors per hour for much of this time. During the last few days of July and around August 12 with the maxima of the major showers the South δ-Aquarids and the Perseids respectively, the total number of meteors exceeds 50 per hour and rates much higher than this are not uncommon at these times. With all this activity then, meteor workers are encouraged to get out and observe the many showers that occur. Table 1 below lists the more important showers that occur during July and August.

Table 1 – A list of some of the meteor showers to be seen in July–August 1991.

Shower	Activity	Max	Radiant			Drift		V_∞	r	ZHR
			α	δ	Diam.	$\Delta\alpha$	$\Delta\delta$			
Pegasids	Jul 07–Jul 11	Jul 09	340°	+15°	5°	+0°.8	+0°.2	70	3.0	8
Phoenicids (Jul)	Jun 24–Jul 18	Jul 11	21°	−43°	7°	+1°.0	+0°.2	47	3.0	
Piscis Austrinids	Jul 09–Aug 17	Jul 28	341°	−30°	5°	+1°.0	+0°.2	35	3.2	
α-Capricornids	Jul 03–Aug 25	Jul 29	Table 3		8°			23	2.5	8
δ-Aquarids S	Jul 08–Aug 19	Jul 28	Table 3		5°			41	3.2	20
δ-Aquarids N	Jul 15–Aug 25	Aug 12	Table 3		5°			42	3.4	5
ι-Aquarids S	Jul 15–Aug 25	Aug 04	Table 3		5°			34	2.9	3
ι-Aquarids N	Aug 11–Sep 20	Aug 20	Table 3		5°			31	3.2	3
Perseids	Jul 17–Aug 24	Aug 12	Table 3		5°			59	2.6	95
κ-Cygnids	Aug 03–Aug 31	Aug 18	286°	+59°	6°			25	3.0	5
π-Eridanids	Aug 20–Sep 05	Aug 28	52°	−15°	6°	+0°.8	+0°.2	59	2.8	
α-Aurigids	Aug 24–Sep 05	Sep 01	84°	+42°	5°	+1°.1	0°.0	66	2.5	15
Piscids S	Aug 15–Oct 14	Sep 24	8°	00°	8°	+0°.9	+0°.2	26	3.0	3

Table 2 – Moonlight and observing conditions in July–August 1991.

Date	k	Date	k
Friday June 28	0.99−	Friday August 2	0.66−
Friday July 5	0.51−	Friday August 9	0.02−
Friday July 12	0.00+	Friday August 16	0.38+
Friday July 19	0.54+	Friday August 23	0.95+
Friday July 26	0.99+	Friday August 30	0.79−

New Moon:	July 11, August 10, September 8
First Quarter:	June 19, July 18, August 17
Full Moon:	June 27, July 26, August 25
Last Quarter:	July 5, August 3, September 1

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.

For more details on the showers to be observed, we refer to the *IMO 1991 Meteor Shower Calendar*. Here we highlight the Perseids and the Aquarid/Capricornid complex.

2. The Perseids

This shower is active from July 17 to August 24 and reaches a maximum ZHR of about 95 on August 12. In view of the very favorable observing conditions (New Moon on August 10), we urge observers to do a special effort for this shower. The analysis of the 1989 Perseids to be found elsewhere in this issue indicates that some features discovered in the 1988 data reappear. Unfortunately, poor weather almost everywhere mid-August 1990 and an uncooperative Moon resulted in few data on the 1990 Perseids (only about 3000 meteors), so little can be said about that year. Therefore, we hope that 1991 will give sufficient data to make a meaningful comparison with 1988 and 1989.

A list of radiant positions throughout the activity period can be found in Table 3. Due to their high inclination, the Perseids are best seen in the Northern Hemisphere.

Table 3 – Radiant positions for the α-Capricornids, the δ-Aquarids South and North, the ι-Aquarids South and North, and the Perseids.

Date	α-Cap		δ-Aqr S		δ-Aqr N		ι-Aqr S		ι-Aqr N		Per	
	α	δ	α	δ	α	δ	α	δ	α	δ	α	δ
Jul 05	290°	−14°	321°	−21°								
15	296°	−13°	329°	−19°	311°	−11°	310°	−19°			12°	+43°
25	303°	−11°	337°	−17°	321°	−09°	321°	−17°			24°	+49°
Aug 05	312°	−09°	345°	−15°	332°	−06°	335°	−15°			37°	+55°
15	318°	−06°	353°	−13°	342°	−04°	346°	−13°	322°	−06°	50°	+59°
25	324°	−04°			352°	−02°	356°	−11°	332°	−06°	63°	+61°
Sep 05									343°	−04°		
15									353°	−02°		

3. Aquarids/Capricornids

This rather complex group of showers were subject to intense scrutiny during 1989 and 1990. As can be read elsewhere in this issue, we still need more data to make an analysis. Especially, the periods July 15–20 and August 10–20 remain virtually uncovered up to date. Taking into account the phases of the Moon, it should be possible to fill up these gaps in 1991.

The visual observing program requires a good observational experience and an observing site south of 45° N. Looking at Table 3, it is obvious that the observer has to look at a point between the radiants of the δ-Aquarids N and the ι-Aquarids S in order to distinguish meteors of these southern showers. This will be quite impossible for observers situated north of 45° N. Observations of this program should start only if the radiants have a sufficient altitude. If possible, two observers should look into the same field simultaneously. This could allow estimates of the accuracy of the data.

Only meteors possibly radiating from the Aquarius/Capricornus-region should be plotted. It is necessary to consider the direction, trail length and angular velocity. All other meteors are counted only. Any Aquarids or Capricornids appearing outside the map's field are also counted after careful association to the radiants given in Table 3.

In doing so, we are able to calculate ZHRs based on the tabulated radiant positions, and to analyze the radiant position using the plotted meteor trails only. We want to draw the attention to the relationship between the angular velocity of shower meteors, the altitude of their beginning point h_b and the distance D between their end point and their radiant. This criterion is as important as the alignment and the trail length and has to be used carefully in the case of countings. The maps with scale factor $R = 75$ mm that are still often used, are unfavorable for exact plottings of short trails in the vicinity of the radiants. The relevant map of the *Atlas Brno* ($R = 160$ mm) is suitable for our purposes. We ask you to use only this map.

Table 4 – Angular velocity (°/s) for the Aquarids as a function of the altitude of the meteor's beginning point h_b and the distance D between the end point and the radiant.

	ι-Aquarids (N+S)					δ-Aquarids (N+S)				
	$h_b = 10°$	20°	40°	60°	90°	10°	20°	40°	60°	90°
$D = 5°$	0.3	0.6	1.1	1.4	1.7	0.4	0.7	1.4	1.8	2.1
10°	0.6	1.1	2.1	2.9	3.3	0.7	1.4	2.7	3.6	4.2
20°	1.1	2.2	4.2	5.6	6.5	1.4	2.8	5.3	7.2	8.3
40°	2.1	4.2	7.9	11	12	2.7	5.3	10	14	16
60°	2.9	5.6	11	14	17	3.6	7.2	14	18	21
90°	3.3	6.5	12	17	19	4.2	8.3	16	21	24

Table 5 – Idem for the α-Capricornids.

	$h_b = 10°$	20°	40°	60°	90°
$D = 5°$	0.2	0.4	0.8	1.1	1.3
10°	0.4	0.9	1.6	2.2	2.5
20°	0.9	1.7	3.2	4.3	4.9
40°	1.6	3.2	5.9	8.0	9.3
60°	2.2	4.3	8.0	11	13
90°	2.5	4.9	9.3	13	14

Your reports must include for each date:

1. copies of your maps with the meteors plotted on them (X and Y coordinates should be measured with respect to the frame of the map), and
2. a report using the *IMO* Visual Observing Forms.

The shower association should be done at the desk using all criteria, including path length, position w.r.t. the radiant and angular velocity. For more details, we refer to [1].

Reference

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

Telescopic Observers' Notes: July–August 1991

Malcolm J. Currie

For the first time in three years I have received no observations for the first third of the year, therefore, regrettably, these notes cannot include any quick-look analyses.

1. Forthcoming events

During the late 1950's the richest telescopic shower of the year—some three times the sporadic background at maximum—was well observed from Czechoslovakia during the period July 11–20. Strong activity was recorded in 1969 and 1971; the shower was seen a decade later, though it was not so prolific; however, recently the *α-Lyrids* seem to have vanished or provided a much-weaker flux. Whether this is a permanent change or due to a periodic shower is unknown, therefore watches should be made during this period each year. Certainly, it is unusual for a telescopic shower to furnish such high rates, suggesting a concentrated clump of material in the stream. In 1989 and 1990, observations by Mark Vints, Martin Debattista, Antoine Grima, and Godfrey Baldacchino show activity around 0.1 of the sporadic background from a radiant at $\alpha = 281°$ and $\delta = +44.^\circ5$, diameter 2°. This is some six degrees north of the radiant observed for the α-Lyrids in 1958 by Martynenko, and by Crimean astronomers a decade later. The meteors were fast, consistent with them being α-Lyrids.

The *o-Draconids* are also active telescopically, but rates are low around 0.1–0.2 of the sporadic background. Activity was stronger in 1989 than 1990.

The *Phoenicid* shower has shown little or no activity visually, yet is an exceptional shower when observed by radar-echo techniques. This implies that it is a good candidate for telescopic investigation. Radar results reveal a sharp maximum around July 14. 1991 offers an excellent opportunity for telescopic observers in the Southern Hemisphere to investigate the properties of this shower.

The ecliptic complex in Capricornus, Aquarius and Piscis Austrinus begins to radiate meteors during the July New-Moon period. We already have good observations spanning the fortnight around $\lambda = 126°$. In 1991, there is an opportunity to study *Cap/Aqr/PsA* behavior before and after this period. The telescopic observer does not have to prejudge the source of a meteor. Radiants will be determined in the analysis stage. Choose field centers separated by about 30° around $\delta = +10°$ from $\alpha = 240$–$30°$.

The main event of this period is the *Perseid* shower. Conditions are very favorable around the time of maximum. Whilest the visual watchers will be interested to see whether the activity curve shows a bimodal maximum, I hope that some of you will not be allured by high visual rates, and will attempt telescopic watches to search for multiple radiants, and perhaps to correlate these with variations in rates. Several sub-centers have been noticed over the years, many via telescopic observation, most recently by Mark Vints in 1988 [1]. See [2] for more details. There are radiants well south of the main radiant area too; the furthest being the β-Perseids at $\delta = +40^\circ$. Your data will form part of an analysis Petr Pravec is undertaking from several years' Perseid telescopic data. Watches should go on a week beyond the visual maximum. Low-power binoculars are best as the Perseids are proportionally deficient in faint meteors. Suggested field centers: $\alpha = 01^h15^m$, $\delta = +38^\circ$ and $\alpha = 23^h12^m$, $\delta = +74^\circ$ before 2^h local time; $\alpha = 02^h53^m$, $\delta = +38^\circ$ and $\alpha = 04^h50^m$, $\delta = +66^\circ$ after 2^h local time ($\beta > 20^\circ$ N). Telescopic watches during the Perseids offer an increased opportunity to view a bright meteor close at hand. If you have not witnessed a meteor train form, and then decay due to high-velocity winds in the upper atmosphere, then you have not lived!

The *α-Ursa Majorid* shower offers moderate telescopic rates, though these are reduced because the radiant attains a low altitude. It is active during August 10–25 and a maximum on August 14. There have been few reports during the last two decades.

There are several minor showers present during July and August, many radiating from Cygnus, the best-known being the *κ-Cygnids*. Visually it is hard to disentangle the showers from the sporadic meteors. Whilest not easy even for telescopic analysis, I think it and video techniques offer the best chance to ascertain which are the true radiants and which are spurious. Already in the last two years a handful of probable radiants have been detected. Obviously, confirmatory data are desirable. Despite being famous for fireballs the *κ-Cygnids* also have many faint meteors. We do not have clear activity periods, radiant positions and motions for these radiants. Field centers away from north-west Cygnus are advisable, as it becomes hard to "see the wood for the trees" if you watch amongst the radiants. Centers for the Perseid and southern complex should reveal the presence of other showers.

References

[1] M. Vints, "A New Telescopic Perseid Subradiant?", *WGN* 16:5, October 1988, p. 171.

[2] G.W. Kronk, "Meteor Showers: a Descriptive Catalog", Enslow, Hillside, NJ, 1988, pp. 165–166.

Possible Activity from 1990 MF?

Dirk Artoos

The asteroid 1990 MF is perhaps a candidate for meteor production in July. According to [1], the approach of the asteroid with the Earth's orbit occurs on July 8, with a possible radiant at $\alpha = 248^\circ$ and $\delta = -22^\circ\!.5$. It might be a nighttime performance in the summer sky, located on the border of Ophiuchus and Scorpius. The second approach in September is closer but possible activity occurs during daytime. For radio observers, the observability function for the July approach is shown in Table 1. Good luck!

Table 1 – Observability function for a four-element antenna elevated at 45° for each hour of the day (local time), four cardinal directions and four latitudes. For the calculations a transmitter distance of 1000 km and a transmitter power of 30 kW were assumed.

Lat.	Dir.	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
+50	S	55	19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	58	89	100	100	86
+50	W	68	29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	36	70	91	100	99	89
+50	N	58	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	23	61	92	100	100	89
+50	E	68	32	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	33	70	91	100	99	89
+35	S	81	50	14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	16	52	83	100	99	100	98
+35	W	82	60	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	25	67	84	96	100	99	93
+35	N	77	43	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14	45	80	97	99	100	95
+35	E	83	65	21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	24	62	84	94	100	100	95
00	S	100	89	59	21	0	0	0	0	0	0	0	0	0	0	0	0	23	62	90	99	79	27	33	84
00	W	71	75	62	23	0	0	0	0	0	0	0	0	0	0	0	0	30	69	90	100	87	79	69	68
00	N	84	71	46	16	0	0	0	0	0	0	0	0	0	0	0	0	18	48	72	85	100	97	97	100
00	E	100	90	66	26	0	0	0	0	0	0	0	0	0	0	0	0	28	64	75	71	68	71	80	88
−35	S	99	91	73	48	19	0	0	0	0	0	0	0	0	0	0	21	50	75	92	100	92	99	100	94
−35	W	45	66	72	60	25	0	0	0	0	0	0	0	0	0	0	29	64	81	80	100	97	58	36	32
−35	N	100	95	77	50	20	0	0	0	0	0	0	0	0	0	0	22	52	78	96	100	76	14	20	81
−35	E	100	87	81	62	26	0	0	0	0	0	0	0	0	0	0	28	61	71	63	42	32	38	62	98

Reference

[1] C. Steyaert, "New Earth-Grazing Asteroids", *WGN* 18:5, October 1990, p. 186.

The 1989 Perseid Meteor Stream

Ralf Koschack and Paul Roggemans

In 1989, saw in total 49 111 Perseids during 1949 effective observing hours, representing 1584 observing intervals. Of these, 1231 intervals, in which 22 632 Perseids were seen, were selected for further analysis. For these observations, only 11 896 Perseids were reported in magnitude distributions, for which population indices r were computed. The computed r-values were used to calculate a perception-corrected ZHR profile. From the ZHR profile and the r profiles, spatial number densities were derived according to [3]. Comparing the activity profile with 1988 [8], the most prominent feature that reappears is a double maximum with a first peak at $\lambda_{\odot} = 139^{\circ}\!.6$ and a second stronger peak at $\lambda_{\odot} = 140^{\circ}\!.0$ (2000.0). Since this feature was not noticed in the 60's and 70's, the suggestion is raised that the peak at $\lambda_{\odot} = 139^{\circ}\!.6$ might possibly have been caused by an injection of new cometary material from the unnoticed perihelion passage of comet Swift-Tuttle around 1980–1981.

1. Introduction

The observability of the Perseids in 1989 was severely hampered by the Moon. Full Moon on August 17 made observing impossible after August 14. As announced in the Observers' Notes [1], the maximum could be observed using the last few hours of the night when the moon had disappeared. Such situation is not very favorable for a detailed analysis, because of the limited number of hours that can be observed from every longitude. Overall, the weather has not been too bad for most observers and, despite the poor expectations, *IMO* managed to collect a most reasonable amount of data.

In the period between July 25 and August 24, 1584 observing intervals were reported, representing 1949 effective observing hours in which 49 111 meteors were seen. The average limiting magnitude was 6.15. After omission of data that were not usable for the Perseid analysis, 1231 observing periods remained during which 22 632 Perseids were seen.

We particularly chose the Perseids for an extensive analysis in order to refresh the motivation of our observers who should cover the 1991 return of this shower to the very best of their abilities. The 1991 Perseids are perfect moonwise and *IMO* now has more observers than in 1989. Also, more people learned to work with the *IMO* standard observing method. We do expect a lot of the data for 1991!

2. The derivation of the population index r

In order to know the exact correction needed to compensate the limiting magnitude, we need to know the population index. To compute the population index, it is necessary that observers report magnitude distributions for every night separately. The form format presented in [2] should be used by observers around the world. Unfortunately, until recently, few amateurs were aware of this important aspect in visual work. As a consequence, we were forced to to assume a constant r-value in most instances. That r-value was then taken from the literature or from the few magnitude distributions that were available. However, the r-value is not necessarily constant; it may vary throughout the stream as the composition of the stream varies from one region to the other. *IMO* has been emphasizing the importance of this aspect for some time now, and in 1989, this has finally resulted in enough magnitude data to obtain an r-value profile of the Perseids.

The current *VMDB* stores magnitude distributions per 24 hour period. Significant variations in r can be resolved only over several days. The *VMDB* will be modified for the timing of the magnitude data, so that the resolution of the r-profile becomes comparable to that of the ZHR-profile.

The program we used can be described as follows [3].

First of all, the true cumulative numbers of meteors $\Phi(m)$ were computed for every magnitude distribution $N(m)$ with a limiting magnitude of at least 5.0. The probabilities of perception $p(m)$ used for this were obtained in [3]. In each $\Phi(m)$-distribution containing at least 25 meteors, the brightest magnitude class $m_{\max}$ with $\Phi(m_{\max}) \geq 3$ was located. For $m_{\min}$, the class of $(\mathrm{lm} - 2)$ was chosen. (Fainter magnitude classes were not taken into account, the reason being that the perception correction $p(m)$ is in many cases rather uncertain for the faintest two magnitude classes.) Next, the interval from $m_{\min}$ to $m_{\max}$ was considered and the following procedure was applied:

1. If the range from $m_{\min}$ to $m_{\max}$ did not contain at least five classes, no calculations were made.
2. If the range from $m_{\min}$ to $m_{\max}$ did contain at least five classes, the r-value was computed with a linear regression of the form $\log \Phi(m) = am + b$ using the least-squares method, the population index finally resulting from $r = 10^a$.
3. If the correlation coefficient was less than 0.98, the r-value for the range from $m_{\min}$ to $m_{\max}$ was rejected.
4. Next, for each value of m in the range between $m_{\min}$ and $m_{\max}$, the value v given by:

   $$v = m \log(r) + \log \Phi(0) - \log \Phi(m)$$

   was computed. If for one value of m, $|v|$ (distance to the regression line) was larger than 0.15, the entire distribution $\Phi(m)$ under consideration (rather than merely the range under consideration) was excluded from the analysis.

The above procedure was then repeated for each magnitude range obtained from the former by leaving out the brightest class until only 5 magnitude classes were left. Hence, in general, more than one r-value was computed for the same cumulative distribution $\Phi(m)$. E.g., if three magnitude class ranges fulfilled all the conditions of the procedure, then three r-values were found for that magnitude distribution. The r-value with the best correlation coefficient is finally accepted as the most reliable r for that magnitude distribution.

After a first run through all available data, a number of distributions had been eliminated, because they failed the v-criterion. Some other distributions, however, remained unused, either because for no magnitude range a correlation coefficient of at least 0.98 was reached, or because they did not have enough meteors in them. A recycling procedure then took together per date interval all these unused distributions for which the limiting magnitude was between 7.0 and 7.5. As soon as these new distributions were composed, the computational procedure described was applied to them, yielding some more r-values.

In case there were still unused distributions, the recycling procedure was rerun for all unused distributions with limiting magnitude 6.5 or better; this recycling continued with decremental steps of 0.5 in the limiting magnitude, down to $\mathrm{lm} = 5.0$.

The result was a file with many reliable, independent r-values per date interval. These values were averaged per date and the standard deviation σ was computed. The error margin representing the 68% confidence interval was computed using:

$$\Delta r = \sigma / \sqrt{n}$$

with n the number of r-estimates used in the interval.

The results of these calculations are shown in Figure 1 and Table 1. Each date interval used was 24 hours long and centered around 0^{h} UT, e.g., date August 1 means that the r-value was obtained from individual r-values of the period July 31 at 12^{h} UT to August 1 at 12^{h} UT. A higher resolution would be favorable, especially around the maximum. Unfortunately, only a few non-European observers reported useful magnitude distributions. As a consequence, each 24^{h}, one r-value was derived only when European observers were active.

The variation in the r-value seems to be real as the profile is not just scattered: there is always a steady increase/decrease over at least three days. It would be most interesting to investigate these variations in more detail. For this purpose, we urgently need magnitude distributions in the required format (see [2]) from observers around the world. When all observers would follow this advice, a sliding averaging procedure like for the ZHR profile could be attempted to obtain a smoothed r-profile. The r-values for the 1989 Perseids were used in the ZHR and the number density computations. Values between two dates were interpolated.

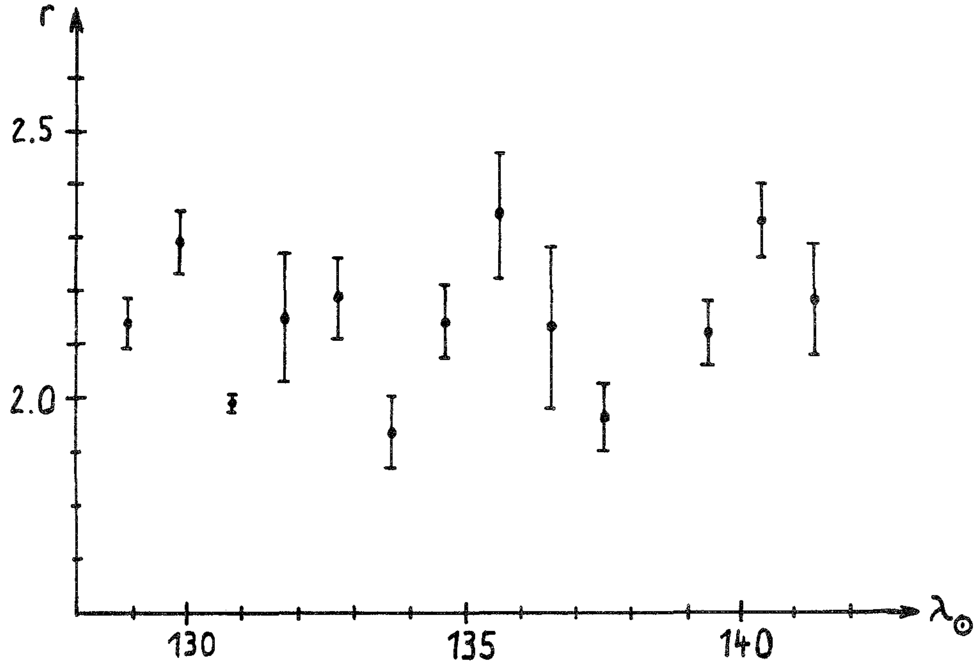

Figure 1 – Profile of the population index for the 1989 Perseids. Error margins correspond to 68% confidence intervals. Solar longitudes refer to the equinox 2000.0.

Table 1 – The r-profile for the 1989 Perseids. The mass distribution index s was obtained from $s = 1 + 2.3 \log r$. The number of individual r-values to average as well as the total number of meteors used are given. Error margins correspond to 68% confidence intervals.

Date	$\lambda_{\odot}$ (2000.0)	r-values	Meteors	$\overline{\mathrm{lm}}$	r	s
Aug 01	128°89	5	230	6.75	2.14 ± 0.05	1.76
02	129°85	4	211	6.78	2.25 ± 0.06	1.81
03	130°80	3	130	6.82	1.99 ± 0.02	1.69
04	131°76	7	361	6.67	2.15 ± 0.12	1.77
05	132°74	8	435	6.55	2.19 ± 0.08	1.78
06	133°68	7	483	6.84	1.93 ± 0.07	1.66
07	134°64	11	635	6.69	2.14 ± 0.07	1.76
08	135°59	8	578	6.67	2.34 ± 0.12	1.85
09	136°55	9	565	6.57	2.13 ± 0.15	1.75
10	137°51	15	544	6.27	1.96 ± 0.07	1.67
12	139°43	18	1293	6.03	2.12 ± 0.07	1.75
13	140°39	45	5673	6.20	2.33 ± 0.07	1.85
14	141°35	14	758	6.46	2.18 ± 0.10	1.78
Tot		154	11896			

3. Computation of the ZHRs

In total, 1231 ZHRs could be computed as described in [4]. The only new aspect is a refined correction for the zenith distance. For the correction for the geometrical conditions, the zenith attraction was also taken into account:

$$C_z = \frac{1}{\theta_e - \theta_b} \int_{\theta_b}^{\theta_e} Z d\theta$$

with:

$$Z = \left(\frac{\sqrt{V_\infty^2 + 125}}{\sqrt{V_\infty^2 + 125} + V_\infty \sin h_R - V_\infty} \right)^\gamma$$

where h_R is the elevation of the geocentric radiant and V_∞ is expressed in km/s. For the zenith exponent γ, the value 1 was taken. Only observations with a limiting magnitude of at least 5.0 and a cloud correction factor F of at most 1.2 were considered. Observing intervals that were too short were also ignored and the radiant had to be at least 20° above the horizon.

The results were stored in a file for the computation of the perception coefficients.

4. Computation of the perception coefficients

The ZHR values were computed using a sliding mean as described in [5]. New in the analyzing procedure is that the step length and the averaging window can be varied during the averaging procedure. It is known that the Perseid profile is stable until August 6. Until that date, an averaging window of 1° was used advancing 0.°5 per step. The window was left at 1° but the step reduced to 0.°25 from August 6 to 10. The solar longitude interval between 138° to 142° contains the maximum and is therefore the most interesting. For this interval, a window 0.°25 wide was moved 0.°1 at each step. The averaged ZHR values then produced a smooth ZHR profile. This preliminary result is then used by the operator to obtain the rough shape of the ZHR-profile and, in function of this picture, to determine the final averaging intervals with their most optimal widths and step lengths.

The averaging procedure in then repeated with the adjusted window widths and step lengths. Until $\lambda_\odot = 133.°4$, a window of 2° with a step of 0.°5 was taken. From $\lambda_\odot = 133.°4$ to $\lambda_\odot = 138.°0$, the values 1° and 0.°25 were taken, respectively. From $\lambda_\odot = 138.°0$ to $\lambda_\odot = 141.°5$ the window width became 0.°25 and the step length 0.°1. Finally, from $\lambda_\odot = 141.°5$ to $\lambda_\odot = 142.°5$, ZHRs were averaged over 0.°5 every 0.°2. No later data were available because of moonlight.

Once the average ZHR is known for a certain time lapse, it is possible to compare the individual observers' ZHRs to the average ZHR and thus to calculate the perception coefficient. The method we used is described in [6]. The average ZHR can be written as:

$$\text{ZHR}_{\text{avg}} = \frac{\sum_i N_i}{\sum_i (1/C_i)}$$

with N_i the number of meteors seen and C_i the correction to compute ZHR_i. We then compute:

$$P_i = \frac{\text{ZHR}_i}{\text{ZHR}_{\text{avg}}}$$

The quantity P_i compares the perception of an observer to the average perception for a certain r-value. As shown in [3], a difference in perception can in general be described by shifting the perception function over a quantity Δlm, implying that a difference in perception de facto comes down to a difference in limiting magnitude. From:

$$P_i = r^{\Delta \text{lm}_i}$$

we find:

$$\Delta \text{lm}_i = \frac{\log \text{ZHR}_i - \log \text{ZHR}_{\text{avg}}}{\log r}$$

The P_i- and Δlm_i-values were then averaged per observer. The Δlm_i differing by more than 0.6 of a magnitude from the average were omitted and then the remaining values were averaged again. The results can be seen in Table 2. Positive Δlm's indicate that perception was higher than average.

Table 2 – Perception data derived from the 1989 Perseid observations.

Observer	Obs.	Δlm
Almasi Csaba (ALMCS) (Hung.)	12	+0.26
Aneca Peter (ANEPE) (Belg.)	11	+0.24
Antalicz Peter (ANTPE) (Hung.)	5	+0.04
Arlt Rainer (ARLRA) (Germ.)	44	+0.34
Asztalos Zoltan (ASZZO) (Hung.)	16	−1.11
Balazs Antal (BALNN) (Hung.)	5	−0.55
Baldauf Petra (BALPE) (Germ.)	22	+0.16
Balko Zsolt (BALZS) (Hung.)	5	−0.07
Barankai Jozsef (BARJO) (Hung.)	21	−1.13
Bardacs Laszlo (BARLA) (Hung.)	5	−0.06
Bellot Luis (BELLU) (Spain)	2	−0.08
Benner Lance (BENLA) (USA)	12	+0.18
Bensing Paul (BENPA) (Neth.)	10	−0.34
Bernaerts Dirk (BERDI) (Belg.)	4	+0.36
Bogdan Tamas (BOGTA) (Hung.)	3	−1.67
Borsiczky Emese (BOREM) (Hung.)	13	−0.34
Brcic Vanja (BRCVA) (Yugo.)	6	+0.31
Brown Peter (BROPE) (Can.)	59	−0.10
Brozovic Marina (BROMA) (Yugo.)	29	−0.02
Butkai Attila (BUTAT) (Hung.)	5	−1.00
Camarasa Miguel (CAMMI) (Spain)	41	+0.22
Canepari Franco (CANFR) (Italy)	2	−0.38
Carbonari Adolfo (CARAD) (Italy)	8	−1.41
Chan C.L. (CHACL) (H.K.)	7	−0.75
Cioffi Herbert (CIOHE) (Italy)	3	−0.97
Clemmens Mario (CLEMO) (Belg.)	11	+0.65
Cotar Uros (COTUR) (Yugo.)	6	−0.24
D'Argliano Luigi (D'ALU) (Italy)	4	−0.25
Danica Durovic (DANDU) (Yugo.)	16	−0.35
Daniels Tim (DANTI) (Belg.)	3	−0.44
Danko Csaba (DANCS) (Hung.)	5	+0.08
De Clerck Albert (DE AL) (Belg.)	3	+0.08
De Cock Frederic (DE FR) (Belg.)	4	−0.31
De Herdt Jurgen (DE JU) (Belg.)	4	+0.73
De Pontieu Bart (DE BA) (Belg.)	16	−0.19
De Pooter Carl (DE CA) (Belg.)	3	−0.77
Depoorter Werner (DEPWE) (Belg.)	3	+0.63
Dequick Kurt (DEQKU) (Belg.)	2	−0.37
Deslijpere Tommy (DESTO) (Belg.)	6	+0.19
Dionisi Massimo (DIOMA) (Italy)	2	−0.44
Dunai Rezso (DUNRE) (Hung.)	14	+0.07
Dzydovic Nena (DZYNE) (Yugo.)	7	+0.38
Egger Roland (EGGRO) (Germ.)	13	+0.28
Eltri Maurizio (ELTMA) (Italy)	3	−0.47
Farkas Csaba (FARCS) (Hung.)	5	−0.38
Fekete Janos (FEKJA) (Hung.)	33	+0.14
Feldmann J.-Bapt. (FELJE) (France)	2	−0.71
Fernandez Raul (FERRA) (Spain)	11	−0.06
Fodor Antal (FODAN) (Hung.)	5	−0.93
Gaarder Kai (GAAKA) (Norw.)	27	+0.51
Galic Jelena (GALJE) (Yugo.)	17	+0.02
Giovanardi Stefano (GIOST) (Italy)	3	−0.39
Goran Prendzou (GORPR) (Yugo.)	9	−0.03
Gorelli Roberto (GORRO) (Italy)	2	−0.69
Grishchenyuk A.I. (GRIAI) (USSR)	17	+0.33
Grubits Laszlo (GRULA) (Hung.)	11	−1.03
Haas Robert (HAARO) (Neth.)	4	+0.10
Haderer Gabi (HADGA) (Germ.)	10	+1.218
Hajnal Eva (HAJEV) (Hung.)	8	−0.59
Halmi Gabor (HALGA) (Hung.)	3	+0.96

Observer	Obs.	Δlm
Hankamäki Teemu (HANTE) (Finl.)	2	+0.48
Hashimoto Takema (HASTA) (Jap.)	10	+0.25
Havassy Dora (HAVDO) (Hung.)	16	−0.15
Haver Roberto (HAVRO) (Italy)	6	−0.91
Heen Lars T. (HEELA) (Norw.)	42	+0.51
Heri Tamas (HERTA) (Hung).	12	−1.31
Hillestad Trond E. (HILTR) (Norw.)	6	−0.42
Ivashchenko W.Y. (IVAWY) (USSR)	28	−0.17
Izumi Kiyoshi (IZUKI) (Jap.)	3	+0.59
Jaaskelainen Petri (JAAPE) (Finl.)	2	−0.77
Jonckheere Kurt (JONKU) (Belg.)	15	−0.69
Jones Jeffrey (JONJE) (USA)	7	−0.02
Joo Istvan (JOOIS) (Hung.)	5	+0.12
Kawamura Junji (KAWJY) (Jap.)	2	−0.02
Kegli Zoltan (KEGZO) (Hung.)	12	−1.15
Kiss Oszkar (KISOS) (Hung.)	9	−1.99
Knöfel André (KNOAN) (Germ.)	52	+0.07
Koch Bernhard (KOCBE) (Germ.)	9	−0.07
Kocsis Laszlo (KOCLA) (Hung.)	3	+0.55
Konya Andras (KONAN) (Hung.)	12	−0.82
Koschack Ralf (KOSRA) (Germ.)	55	0.00
Koschny Detlef (KOSDE) (Germ.)	6	+0.62
Kovacs Sandor (KOVSA) (Hung.)	27	+0.32
Kovacs Zsolt (KOVZS) (Hung.)	6	−1.70
Kudor Gyongyver (KUDGY) (Hung.)	7	−1.34
Kuschnik Ralf (KUSRA) (Germ.)	49	+0.17
Latini Alberto (LATAL) (Italy)	4	−0.35
Laurent Dirk (LAUDI) (Belg.)	13	−0.15
Lavrijsen Kris (LAVKR) (Belg.)	4	−0.36
Lengyel Katalin (LENKA) (Hung.)	12	−1.06
Levina A.S. (LEVAN) (USSR)	31	−0.07
Lucic Mario (MARLU) (Germ.)	2	−0.76
Lukic Vladimir (LUKVL) (Yugo.)	17	−0.15
Lunsford Robert (LUNRO) (USA)	29	+0.08
Maattanen Hannu (MAAHA) (Finl.)	3	+0.08
Maeda Kouji (MAEKO) (Jap.)	7	+0.68
Mameta Katsuhiko (MAMKA) (Jap.)	18	+0.10
Mantovani Marco (MANMA) (Italy)	3	−0.3
Martini Massino (MARMA) (Italy)	5	−0.96
Mattch Angelo (MATAN) (Yugo.)	6	−0.17
McBeath Alastair (MCBAL) (UK)	12	−0.55
McLeod Norman (MCLNO) (USA)	5	−0.46
Meuleman Wouter (MEUWO) (Belg.)	28	+0.31
Milojevic Stasa (MILST) (Yugo.)	20	+0.06
Miskotte Koen (MISKO) (Neth.)	13	−0.04
Monok Gabor (MONGA) (Hung.)	8	−0.84
Mori Gabor (MORGA) (Hung.)	10	−1.94
Morrow Michael (MORMI) (USA)	3	−1.03
Nagy Attila (NAGTT) (Hung.)	4	−2.43
Nagy Istvan (NAGIS) (Hung.)	5	−0.14
Nagy Rezso (NAGRE) (Hung.)	11	−0.75
Neuwirth Csaba (NEUCS) (Hung.)	8	−0.18
Nikolic Predrag (NIKPR) (Yugo.)	14	+0.17
Nishioka Seiko (NISSE) (Jap.)	13	−0.29
Noze K. (NOSKU) (Jap.)	8	−1.61
Nyerges Gyula (NYEGY) (Hung.)	3	+0.60
Onodera A. (ONOAK) (Jap.)	2	+0.74
Orlik Ivan P. (ORLIV) (Hung.)	14	−0.81
Orloaca Valentina (ORLVA) (Yugo.)	12	+0.07
Paturi Petriina (PATPE) (Finl.)	3	+0.60

Table 2 – continued.

Observer	Obs.	Δlm	Observer	Obs.	Δlm
Pevec Alan (PEVAL) (Yugo.)	6	−0.06	Szente Sandor (SZESA) (Hung.)	12	−0.95
Phyllis Eide (PHYEI) (USA)	7	−0.44	Sziffer Andras (SZIFF) (Hung.)	3	−1.12
Plesier Francis (PLEFR) (France)	14	−0.51	Taibi Richard (TAIRI) (USA)	2	−1.93
Plesier Ghislain (PLEGH) (Belg.)	47	−1.17	Takada J. (TAKJY) (Jap.)	10	+0.27
Posztobanyi Kalman (POSKA) (Hung.)	9	−0.12	Teichner Szilard (TEISZ) (Hung.)	4	−0.55
Prohaszka Szaniszlo (PROSZ) (Hung.)	12	+0.03	Thomas Scott (THOSC) (Belg.)	5	−0.22
Raffaelli Stefano (RAFST) (Italy)	2	−0.41	Ticket Glenn (TICGL) (Belg.)	16	+0.08
Rajala Leo (RAJLE) (Finl.)	3	+0.58	Tiszinger Istvan (TISIS) (Hung.)	3	−0.26
Ramberg Pentti (RAMPE) (Finl.)	2	−0.19	Tokes Andras (TOKAN) (Hung.)	7	−0.20
Rendtel Ina (RENIN) (Germ.)	52	+0.11	Toldi Anita (TOLAN) (Hung.)	5	+0.03
Rendtel Jürgen (RENJU) (Germ.)	44	−0.04	Tombol Tamas (TOMBT) (Hung.)	16	−1.60
Rizzi Martino (RIZMA) (Italy)	5	−0.51	Tomioka Hiroyuki (TOMHI) (Jap.)	3	−1.97
Roggemans Paul (ROGPA) (Belg.)	16	−0.19	Trajkovic Miroslav (TRAMI) (Yugo.)	15	−0.71
Sagodi Ibolya (SAGIB) (Hung.)	8	−1.20	Trigo R. José (TRIJO) (Spain)	60	+0.37
Sakuma Kotaro (SAKKO) (Jap.)	4	−0.36	Uehara S. (UEHSA) (Jap.)	12	−0.08
Sarneczky Krisztian (SARKR) (Hung.)	3	−0.78	Uyama Yoshiaki (UYAYO) (Jap.)	10	+0.36
Saskor Ivan (SASIV) (Yugo.)	3	−0.80	Van Biesen Johan (VABJO) (Belg.)	4	+0.31
Sato T. (SATTA) (Jap.)	36	+0.33	Van de Vreken Tom (VANTM) (Belg.)	7	+0.42
Scarpa Napoleone (SCANA) (Italy)	4	−1.20	Van den Eede Tom (VADTO) (Belg.)	3	+0.13
Scharff Patric (SCHPA) (Germ.)	18	−1.08	Van Genegen Karin (VANKA) (Belg.)	3	−0.47
Schroyens Daan (SCHDA) (UK)	13	−0.23	Van Ginderen Johan (VANJH) (Belg.)	3	−1.27
Scott Thomas (SCOTH) (Belg.)	4	+0.28	Van Mechelen Pierre (VANPI) (Belg.)	4	+0.44
Sears Kathleen (SEAKA) (USA)	2	+0.23	Vandenbruaene Jan (VANJN) (Belg.)	27	+0.03
Sears Paul N. (SEAPA) (USA)	4	−0.20	Vandenbruaene Hendrik (VANHE) (Belg.)	4	+0.64
Seipelt Holger (SEIHO) (Germ.)	22	−0.72	Vanheerentals Mireille (VANMR) (Belg.)	12	−0.58
Serneels Sally (SERSA) (Belg.)	7	−0.81	Ver Ferenc (VERFE) (Hung.)	5	+0.12
Simmons Karl (SIMKA) (USA)	3	−0.48	Verbeeck Cis (VERCI) (Belg.)	4	−2.18
Simmons Stephen (SIMST) (USA)	3	−0.58	Vereecke Sam (VERSA) (Belg.)	15	+0.68
Sirovica Drago (SIRDR) (Yugo.)	24	−0.45	Verstraelen Ivo (VERIV) (Belg.)	7	−0.50
Smits Bert (SMIBE) (Belg.)	3	+0.09	Vician Zoltan (VICZO) (Hung.)	19	+0.36
Spalding George (SPAGE) (UK)	10	−0.06	Villa Mirco (VILMI) (Italy)	23	+0.78
Sperberg Ulrich (SPEUL) (Germ.)	21	−0.85	Vingerhoets Pierre (VINPI) (Belg.)	7	−0.38
Spötter Detlef (SPODE) (Germ.)	9	+0.20	Viragos Peter (VIRPE) (Hung.)	5	+0.08
Stapf Siegfried (STASI) (Germ.)	2	−0.47	White Noel (WHINO) (UK)	2	−0.04
Stomeo Enrico (STOEN) (Italy)	5	−0.12	Wieszt Krisztian (WIEKR) (Hung.)	9	0.00
Stomeo Stefano (STOST) (Italy)	5	−0.09	Winkler Roland (WINRO) (Germ.)	3	−3.07
Ströbele Stefan (STRST) (Germ.)	4	−0.40	Wislez Jean-Marc (WISJE) (Belg.)	7	+0.09
Sukhov D.G. (SUKDG) (USSR)	27	−0.11	Wunsche Nikolai (WUNNI) (Germ.)	2	+0.41
Suzuki Y. (SUZMA) (Jap.)	7	+0.59	Yabu Yasuo (YABYA) (Jap.)	12	+0.03
Swann David (SWADA) (USA)	15	−0.62	Zalezsak Tamas (ZALTA) (Hung.)	3	−1.40
Szabados Peter (SZAPE) (Hung.)	11	−1.61	Zhulue Chen (ZHUCH) (H.K.)	10	−0.95
Szabo Jozsef (SZABJ) (Hung.)	3	−1.73	Zivaljevic Natasa (ZIVNA) (Yugo.)	8	+0.30
Szauer Agoston (SZAAG) (Hungary)	3	−0.64	Zsohar Viktor (ZSOVI) (Hung.)	8	−1.63

Table 2 mentions all observers who contributed data that could be used in this analysis.

The individual ZHRs (ZHR_i) were then corrected for perception with:

$$\mathrm{ZHR}_i^{\mathrm{corr}} = \mathrm{ZHR}_i \times r^{-\Delta \mathrm{lm}}$$

Then the averaging procedure described above was repeated for the perception-corrected ZHRs. The error margins were computed according to [7] and represent 68% confidence intervals.

The results are shown in Figure 2.

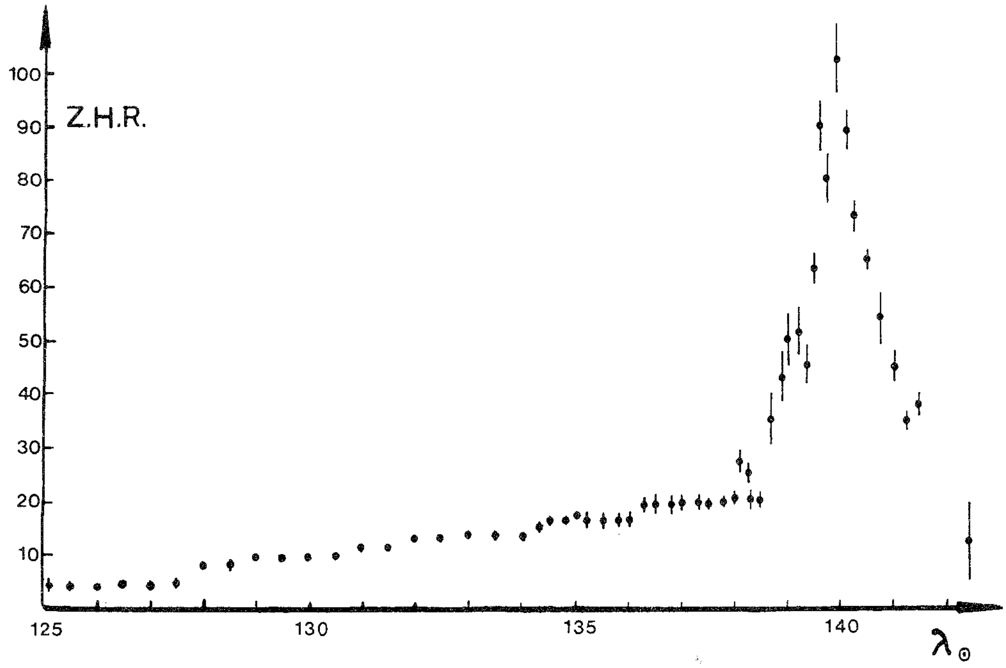

Figure 2 – Mean ZHR profile for the 1989 Perseids, from perception-corrected ZHRs using a sliding mean. Solar longitudes refer to the equinox 2000.0.

5. Spatial number densities

The computation of spatial number densities was carried out according to [3], the only difference being that for the calibration of the ZHRs to the perception of the standard observers (ARLRA, KNOAN,KOSRA,RENJU, RENIN), the $\Delta \mathrm{lm}_i$ were used instead of the perception coefficients P_i. The average $\Delta \mathrm{lm}_{\mathrm{st}}$ for the standard observers was found to be $+0.10 \pm 0.07$. Thus in all formulae given in [3], the factor k_{avg} has to be replaced by $r^{\Delta \mathrm{lm}_{\mathrm{st}}}$. The result of the computation is shown in Figure 3.

The error margins on $\rho_{6.5}$ represent the 68% confidence intervals, taking into account the uncertainties resulting from the conversion of the ZHRs to the $\rho_{6.5}$ (for the details, see [3]).

What does $\rho_{6.5}$ represent? It gives the number of particles causing meteors of absolute magnitude at least +6.5 within each 10^9 km^3 (this is a cube with edges of 1000 km). If you look at Figure 3, the numbers of particles concerned is quite small.

Apart from giving a good impression as to how thin particles are spread out over large volumes, $\rho_{6.5}$ is also a more objective measure for the shower's activity than the ZHR. The ZHR is affected by several quantities, more in particular by the perception properties of the human eye: if the population index increases, one will miss a large fraction of the meteors actually occurring since the percentage of faint meteors increases, and these are more easily missed. This means that at a constant spatial number density $\rho_{6.5}$ the ZHR decreases as the population index increases, and vice-versa. The stronger the population index varies, the more the $\rho_{6.5}$ profile will differ from the ZHR profile. Since in the present analysis the variations of r are moderate, this effect is not so obvious here.

However, if you look at the "shoulders" occurring before and after the double peak of the maximum ($\lambda_\odot^1 = 139\overset{\circ}{.}0$, $\lambda_\odot^2 = 140\overset{\circ}{.}4$, eq. 2000.0), you see in Figures 4 and 5 that the left shoulder is more pronounced compared to the right one in the ZHR profile than in the $\rho_{6.5}$ profile. This is caused by the fact that r at the time of left shoulder was smaller than at the time of the right shoulder, resulting in a higher ZHR for the same number density.

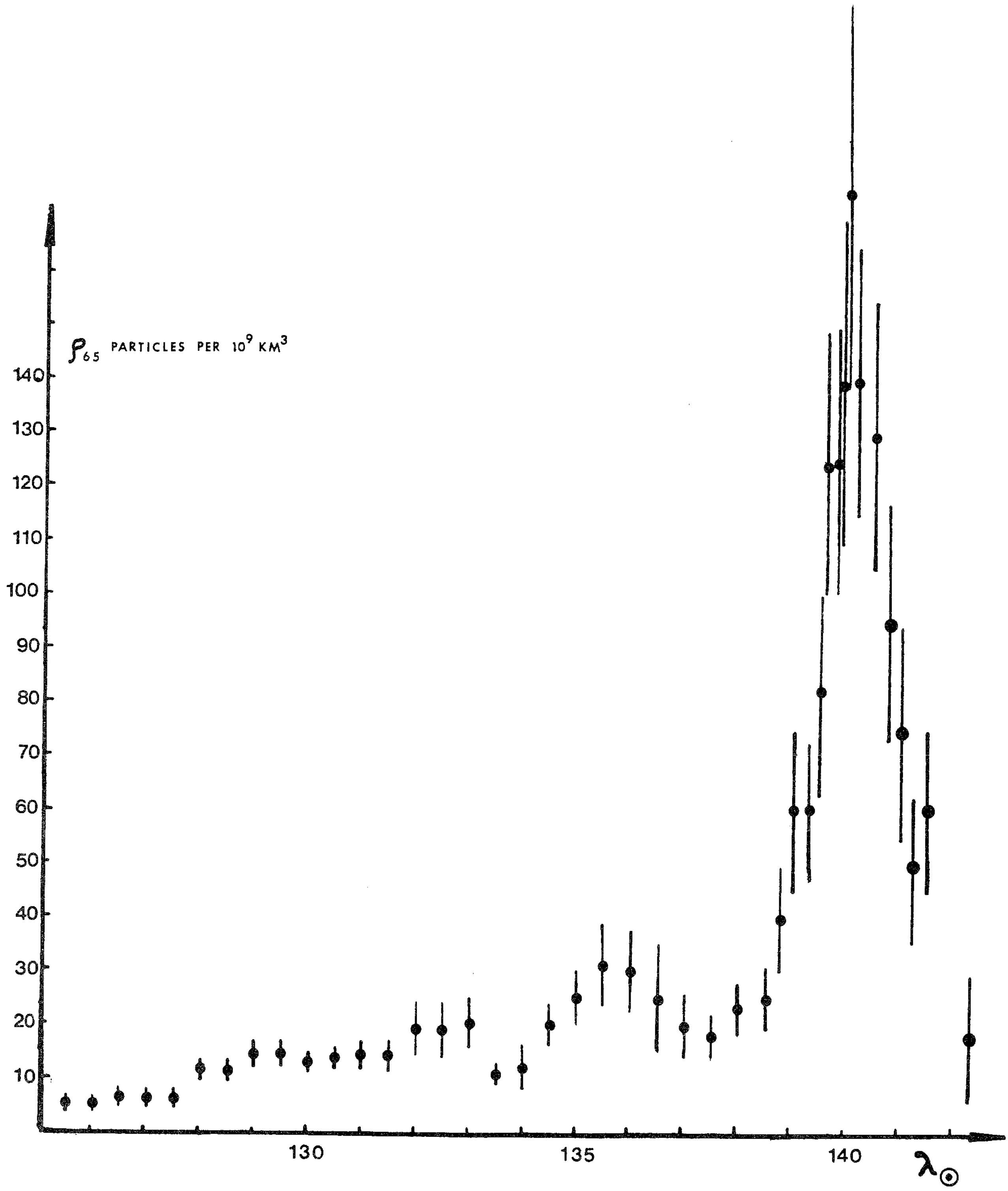

Figure 3 – The spatial number density $\rho_{6.5}$ for the 1989 Perseids as determined between $\lambda_\odot = 125°$ and $\lambda_\odot = 142°$.

But why do we refer to absolute magnitude 6.5 rather than to a certain mass? The conversion $\rho_{6.5}$ to $\rho(M > 10^{-3}$ g), i.e., number of particles with masses greater than 1 mg within 10^9 km^3, was done using the equations in [3]. The result is very sensitive for uncertainties in both the coefficients used in the equations and in the population index. Therefore, $\rho(M > 10^{-3}$ g) is considered to be a very rough estimate only that provides an impression of how different streams compare to each other. All numerical results were summarized in Table 3.

In that comparison, cometary streams with high V_∞ turn out to be quite sparse, despite their high ZHR. The reader can compare these results with, e.g., [8].

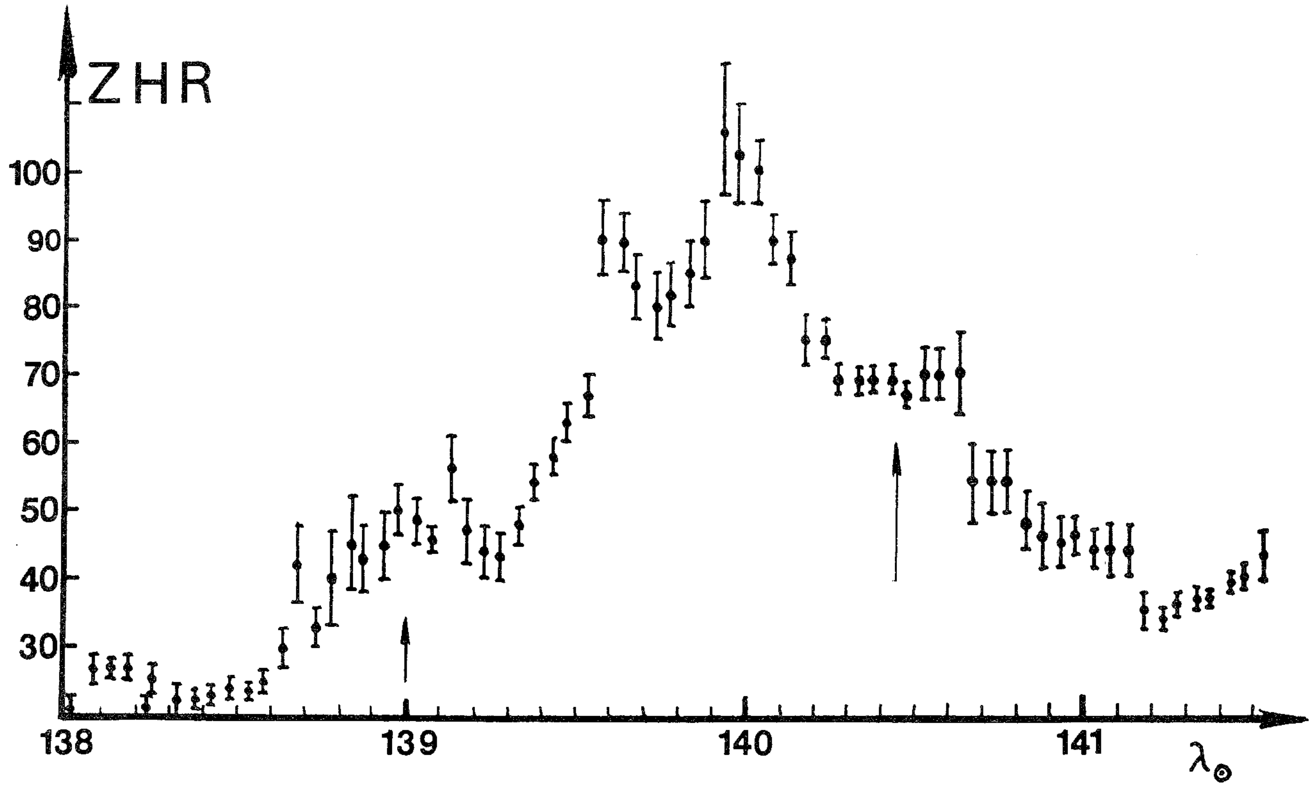

Figure 4 – Detail of the ZHR profile at the time of the maximum. The main maximum is double with the first peak at $\lambda_\odot = 139^\circ\!.6$ and the second and stronger peak at about $140^\circ\!.0$ (2000.0).

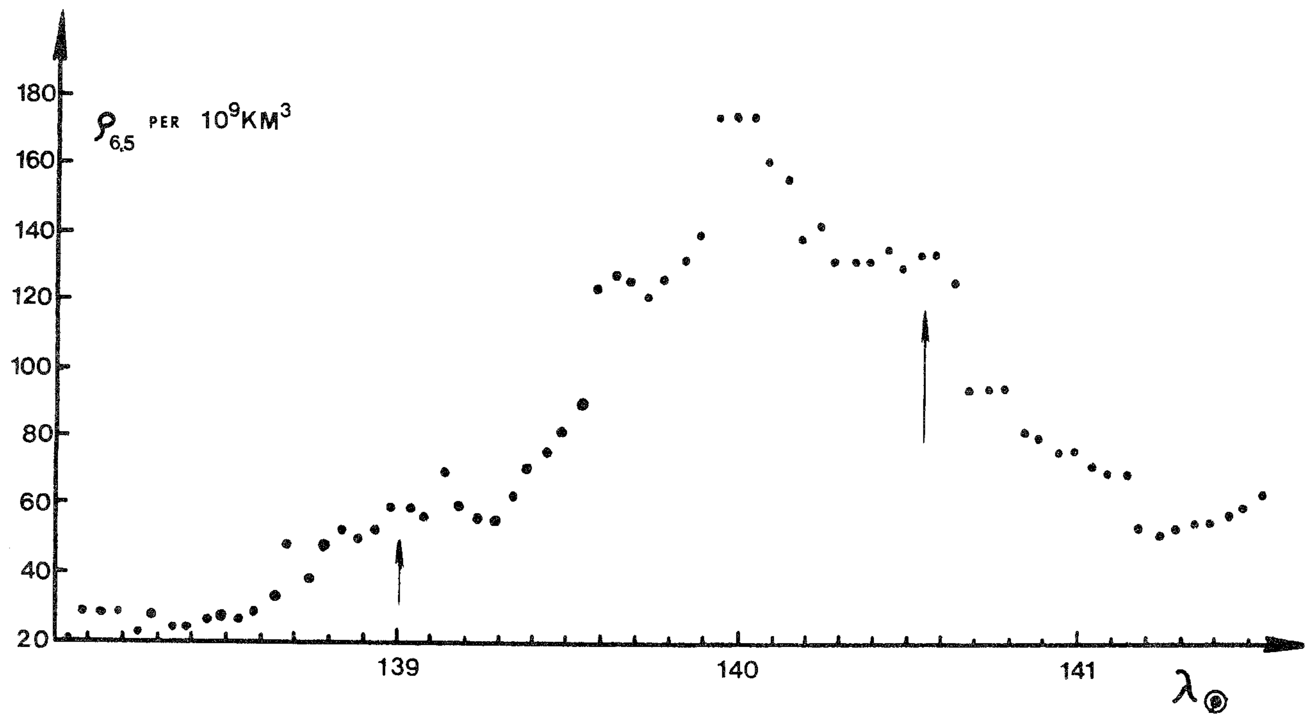

Figure 5 – Detail of the $\rho_{6.5}$ profile at the time of the maximum. The same solar longitude scale was used as in Figure 4.

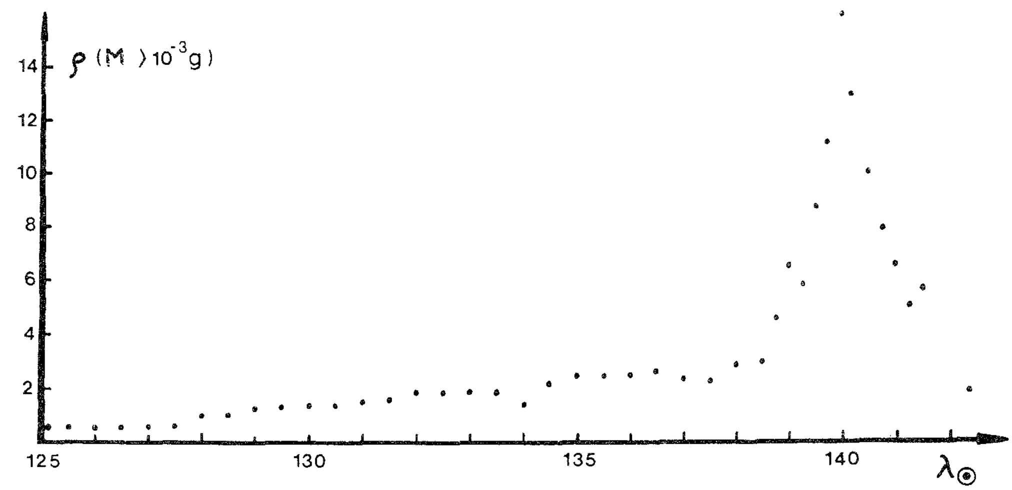

Figure 6 – $\rho(M > 10^{-3}$ g) for the 1989 Perseids derived from observations between $\lambda_\odot = 125°$ and $\lambda_\odot = 142°$ (2000.0).

Table 3 – Numeric values for r, ZHR, $\rho_{6.5}$ and $\rho_M = \rho(M > 10^{-3}$ g) for the Perseids in July and August 1989.

Day	$\lambda_\odot$ (2000.0)	r	Obs	Met	$\overline{\mathrm{lm}}$	ZHR	$\rho_{6.5}$	ρ_M
27.94	125°01	2.14 ± 0.05	12	23	6.06	3.7 ± 1.2	5.1 ± 1.9	0.5
28.44	125°51	2.14 ± 0.05	17	29	6.00	3.5 ± 1.0	4.8 ± 1.6	0.5
28.94	126°01	2.14 ± 0.05	20	34	5.97	3.6 ± 1.0	5.0 ± 1.6	0.5
29.46	126°51	2.14 ± 0.05	17	29	5.80	4.2 ± 1.3	5.8 ± 2.1	0.6
29.99	127°01	2.14 ± 0.05	20	39	6.05	4.1 ± 1.0	5.6 ± 1.7	0.6
30.53	127°51	2.14 ± 0.05	17	38	6.12	4.3 ± 1.0	5.9 ± 1.7	0.6
31.04	128°01	2.14 ± 0.05	46	326	6.50	8.0 ± 0.7	11.0 ± 2.1	1.1
31.57	128°51	2.14 ± 0.05	44	322	6.51	8.0 ± 0.7	11.0 ± 2.1	1.1
01.07	129°01	2.19 ± 0.06	70	651	6.57	9.0 ± 0.6	13.7 ± 2.6	1.3
01.62	129°51	2.19 ± 0.06	69	648	6.57	9.2 ± 0.6	14.0 ± 2.6	1.3
02.16	130°01	2.15 ± 0.04	68	576	6.55	9.5 ± 0.6	13.3 ± 2.2	1.3
02.66	130°51	2.15 ± 0.05	73	602	6.52	9.6 ± 0.6	13.5 ± 2.4	1.3
03.19	131°01	2.09 ± 0.08	67	664	6.52	11.3 ± 0.5	14.0 ± 3.1	1.5
03.69	131°51	2.09 ± 0.08	70	688	6.54	11.2 ± 0.5	13.8 ± 3.0	1.5
04.21	132°01	2.17 ± 0.10	95	1081	6.41	13.1 ± 0.6	19.1 ± 4.7	1.8
04.74	132°51	2.17 ± 0.10	94	1088	6.43	13.0 ± 0.6	19.0 ± 4.6	1.8
05.26	133°01	2.18 ± 0.08	64	673	6.32	13.4 ± 0.9	20.0 ± 4.4	1.9
05.78	133°51	2.18 ± 0.08	60	647	6.30	13.6 ± 0.9	20.3 ± 4.4	1.9
05.86	133°54	1.94 ± 0.07	79	819	6.22	12.8 ± 0.7	11.0 ± 2.6	1.5
06.11	133°79	1.94 ± 0.07	80	820	6.21	12.7 ± 0.7	10.9 ± 2.6	1.5
06.30	134°01	2.09 ± 0.07	5	35	6.56	9.5 ± 2.0	11.7 ± 3.4	1.2
06.36	134°04	1.95 ± 0.07	88	835	6.17	12.3 ± 0.7	10.9 ± 2.6	1.4
06.62	134°29	2.12 ± 0.07	54	696	6.44	15.4 ± 0.9	20.3 ± 4.2	2.1
06.88	134°54	2.13 ± 0.07	50	686	6.45	15.8 ± 0.9	21.3 ± 4.3	2.1
07.15	134°79	2.13 ± 0.07	49	685	6.46	15.9 ± 0.9	21.4 ± 4.3	2.1
07.40	135°04	2.19 ± 0.08	75	937	6.43	16.9 ± 1.0	25.7 ± 5.5	2.4
07.67	135°29	2.33 ± 0.12	79	779	6.18	15.7 ± 1.3	30.8 ± 8.3	2.3
07.94	135°54	2.33 ± 0.12	79	781	6.18	15.9 ± 1.4	31.2 ± 8.4	2.4
08.19	135°79	2.33 ± 0.12	81	793	6.18	15.9 ± 1.3	31.2 ± 8.4	2.4
08.45	136°04	2.27 ± 0.13	72	793	6.21	16.5 ± 1.2	29.1 ± 8.4	2.4
08.71	136°29	2.14 ± 0.15	44	658	6.39	19.1 ± 1.3	26.3 ± 9.0	2.6
08.98	136°54	2.13 ± 0.15	45	673	6.37	19.2 ± 2.1	25.8 ± 9.3	2.6
09.23	136°79	2.13 ± 0.15	44	664	6.38	19.1 ± 2.1	25.7 ± 9.2	2.6
09.49	137°04	2.02 ± 0.10	65	1023	6.24	19.0 ± 1.5	20.0 ± 5.8	2.4
09.75	137°29	1.97 ± 0.07	75	1098	6.03	19.4 ± 1.3	18.0 ± 4.3	2.3
10.02	137°54	1.97 ± 0.07	73	1077	6.04	19.3 ± 1.0	18.0 ± 4.2	2.3
10.27	137°79	1.97 ± 0.07	72	1074	6.04	19.4 ± 1.0	18.0 ± 4.2	2.3
10.53	138°04	1.97 ± 0.07	26	448	5.96	20.6 ± 1.6	19.2 ± 4.7	2.4
10.60	138°09	2.02 ± 0.07	8	77	5.90	26.9 ± 2.1	28.3 ± 6.7	3.3
10.65	138°14	2.02 ± 0.07	9	91	5.90	26.6 ± 1.8	28.0 ± 6.6	3.3

Table 3 – continued.

Day	$\lambda_\odot$ (2000.0)	r	Obs	Met	$\overline{\mathrm{lm}}$	ZHR	$\rho_{6.5}$	ρ_M
10.70	138°19	2.02 ± 0.07	9	91	5.90	26.6 ± 1.8	28.0 ± 6.6	3.3
10.76	138°24	2.02 ± 0.07	13	101	5.88	21.0 ± 1.5	22.1 ± 5.2	2.6
10.81	138°29	2.03 ± 0.07	33	295	5.77	25.5 ± 2.6	27.5 ± 6.8	3.2
10.85	138°34	2.03 ± 0.07	52	457	5.78	22.5 ± 2.1	24.3 ± 5.9	2.8
10.91	138°39	2.04 ± 0.07	77	706	5.78	21.8 ± 1.7	24.1 ± 5.7	2.8
10.96	138°44	2.04 ± 0.07	94	980	5.78	23.2 ± 1.5	25.6 ± 6.0	2.9
11.01	138°49	2.04 ± 0.07	91	1023	5.79	24.4 ± 1.5	26.9 ± 6.3	3.1
11.07	138°54	2.04 ± 0.07	69	812	5.81	23.5 ± 1.5	25.9 ± 6.0	3.0
11.12	138°59	2.04 ± 0.07	45	600	5.81	25.2 ± 1.9	27.8 ± 6.6	3.2
11.16	138°64	2.04 ± 0.07	19	337	5.82	30.3 ± 2.6	33.4 ± 8.0	3.8
11.22	138°69	2.06 ± 0.07	3	83	6.36	42.1 ± 5.9	48.7 ± 12.1	5.4
11.29	138°74	2.07 ± 0.07	2	40	6.45	32.8 ± 2.4	38.8 ± 8.3	4.2
11.34	138°79	2.07 ± 0.07	3	76	6.40	40.2 ± 6.8	47.5 ± 12.6	5.2
11.39	138°84	2.07 ± 0.07	4	106	6.34	44.8 ± 7.2	53.0 ± 13.8	5.8
11.44	138°89	2.07 ± 0.07	6	135	6.13	43.1 ± 5.0	50.9 ± 12.2	5.6
11.49	138°94	2.07 ± 0.07	5	115	6.05	45.0 ± 5.6	53.2 ± 13.1	5.8
11.54	138°99	2.08 ± 0.07	4	95	5.93	49.6 ± 4.1	56.0 ± 13.8	6.5
11.59	139°04	2.08 ± 0.07	5	88	5.66	48.5 ± 3.7	58.6 ± 13.7	6.3
11.63	139°09	2.09 ± 0.07	7	107	5.55	46.0 ± 2.3	56.8 ± 13.0	6.0
11.70	139°14	2.10 ± 0.07	6	126	5.67	56.2 ± 5.2	71.0 ± 16.8	7.4
11.75	139°19	2.10 ± 0.07	9	142	5.74	47.1 ± 5.1	59.5 ± 14.4	6.2
11.80	139°24	2.11 ± 0.07	19	325	6.06	44.0 ± 4.4	56.8 ± 13.0	5.9
11.85	139°29	2.11 ± 0.07	27	555	5.99	43.5 ± 4.2	56.1 ± 12.9	5.8
11.90	139°34	2.12 ± 0.07	46	1302	6.03	47.6 ± 3.1	62.7 ± 13.6	6.4
11.95	139°39	2.12 ± 0.07	54	1793	6.06	54.1 ± 3.0	71.3 ± 15.2	7.2
12.01	139°44	2.12 ± 0.07	55	1971	6.06	57.5 ± 2.9	75.8 ± 16.1	7.7
12.06	139°49	2.12 ± 0.07	47	1962	6.04	62.8 ± 3.2	82.8 ± 17.6	8.4
12.10	139°54	2.13 ± 0.07	37	1703	6.08	67.3 ± 3.5	90.6 ± 19.1	9.1
12.16	139°59	2.14 ± 0.07	18	974	6.11	90.2 ± 5.5	124.0 ± 26.2	12.2
12.21	139°64	2.16 ± 0.07	12	599	6.27	89.3 ± 5.4	127.8 ± 26.3	12.3
12.26	139°69	2.19 ± 0.07	16	900	6.42	83.2 ± 5.0	126.4 ± 25.2	11.6
12.32	139°74	2.19 ± 0.07	15	821	6.45	79.9 ± 5.5	121.4 ± 24.5	11.2
12.37	139°79	2.20 ± 0.07	16	903	6.45	81.7 ± 5.0	126.6 ± 25.1	11.5
12.42	139°84	2.20 ± 0.07	16	939	6.37	85.5 ± 5.4	132.5 ± 26.6	12.0
12.47	139°89	2.20 ± 0.07	13	775	6.30	89.9 ± 5.8	139.3 ± 28.2	12.6
12.53	139°94	2.23 ± 0.07	9	375	5.78	106.3 ± 9.6	174.4 ± 38.5	15.2
12.58	139°99	2.25 ± 0.07	13	450	5.66	102.5 ± 7.4	174.5 ± 37.6	14.8
12.63	140°04	2.26 ± 0.07	21	687	5.64	100.4 ± 5.2	174.1 ± 36.4	14.6
12.69	140°09	2.28 ± 0.07	26	811	5.77	90.0 ± 3.9	161.7 ± 32.8	13.2
12.74	140°14	2.28 ± 0.07	30	890	5.82	86.9 ± 3.9	156.2 ± 31.6	12.7
12.79	140°19	2.29 ± 0.07	42	1227	6.03	75.4 ± 3.8	137.9 ± 27.3	11.1
12.84	140°24	2.31 ± 0.07	102	3153	6.06	75.7 ± 3.3	143.4 ± 27.9	11.2
12.88	140°29	2.32 ± 0.07	174	5672	6.11	68.5 ± 2.5	132.0 ± 25.3	10.2
12.94	140°34	2.32 ± 0.07	205	7540	6.14	68.7 ± 2.2	132.4 ± 25.2	10.2
12.99	140°39	2.32 ± 0.07	215	8103	6.14	68.7 ± 2.2	132.4 ± 25.2	10.2
13.04	140°44	2.33 ± 0.07	201	7796	6.13	69.3 ± 2.3	135.9 ± 25.8	10.4
13.09	140°49	2.33 ± 0.07	136	5700	6.16	66.7 ± 2.4	130.8 ± 24.9	10.0
13.14	140°54	2.32 ± 0.08	55	2862	6.19	69.7 ± 3.8	134.3 ± 27.8	10.4
13.20	140°59	2.32 ± 0.08	16	767	6.19	69.7 ± 7.0	134.3 ± 30.0	10.4
13.25	140°64	2.29 ± 0.08	4	190	6.24	69.2 ± 6.1	126.6 ± 27.7	10.2
13.31	140°69	2.27 ± 0.09	5	160	6.25	53.3 ± 6.5	94.1 ± 23.3	7.8
13.36	140°74	2.27 ± 0.09	6	197	6.24	53.8 ± 5.2	95.0 ± 22.5	7.8
13.41	140°79	2.27 ± 0.09	6	197	6.24	53.8 ± 5.2	95.0 ± 22.5	7.8
13.46	140°84	2.26 ± 0.09	10	282	5.83	47.7 ± 4.5	82.7 ± 20.6	6.9
13.52	140°89	2.26 ± 0.09	8	217	5.72	46.1 ± 5.5	79.9 ± 21.0	6.7
13.57	140°94	2.25 ± 0.09	7	158	5.44	45.1 ± 3.9	76.8 ± 19.9	6.5
13.62	140°99	2.24 ± 0.09	11	220	5.56	45.7 ± 3.2	76.4 ± 19.2	6.6
13.67	141°04	2.23 ± 0.10	16	324	5.76	43.9 ± 3.2	72.0 ± 19.1	6.3
13.73	141°09	2.22 ± 0.10	13	247	6.02	44.0 ± 3.9	70.8 ± 18.5	6.3
13.78	141°14	2.22 ± 0.10	13	247	6.02	44.0 ± 3.9	70.8 ± 18.5	6.3

Table 3 – continued.

Day	$\lambda_\odot$ (2000.0)	r	Obs	Met	$\overline{\text{lm}}$	ZHR	$\rho_{6.5}$	ρ_M
13.83	141°19	2.20 ± 0.10	21	363	5.86	35.0 ± 2.4	54.2 ± 14.3	4.9
13.88	141°24	2.19 ± 0.10	29	567	5.92	34.2 ± 1.9	52.0 ± 13.6	4.8
13.93	141°29	2.18 ± 0.10	44	1018	6.12	36.2 ± 1.7	53.9 ± 13.7	5.0
13.99	141°34	2.18 ± 0.10	49	1145	6.11	37.1 ± 1.5	55.3 ± 14.0	5.2
14.04	141°39	2.18 ± 0.10	50	1176	6.11	37.4 ± 1.4	55.7 ± 14.0	5.2
14.08	141°44	2.18 ± 0.10	40	1024	6.20	39.3 ± 1.6	58.6 ± 14.6	5.5
14.14	141°49	2.18 ± 0.10	27	721	6.28	40.3 ± 1.9	60.0 ± 14.8	5.6
14.19	141°54	2.18 ± 0.10	7	166	6.03	43.5 ± 3.8	64.8 ± 17.3	6.1
15.03	142°34	2.18 ± 0.10	3	21	5.97	12.5 ± 7.5	18.6 ± 12.1	1.7

6. Conclusion

The analysis of the 1989 Perseids resulted in a very detailed picture of the stream cross section visited by our planet in 1989. The maximal ZHR can be considered normal. The double peak found in the 1988 analysis [9] reappeared in the 1989 analysis. Moreover, the 1989 Perseid data were analyzed with a much more refined technique and the shapes of the resulting profiles are much more detailed and clearer.

It has been suggested that the double maximum we found in 1988 was an artifact as it was not noticed before. As far as reliable profiles exist for past years, it was not noticed in the 60's or 70 's. However, it was found in other analyses that include data of the 80's. [10]. We should be careful to only compare comparable activity profiles, but if it is true that a double peak with the first maximum at $\lambda_\odot = 139°6$ (2000.0) appeared only in recent history—and this now looks very much to be the case—this could point to a new "young" stream near the old core of the Perseids.

A new, young stream within the Perseids is very well possible assuming that the parent comet Swift-Tuttle passed its perihelion unnoticed around 1980–1981, an assumption that has already been made much earlier to explain the exceptionally strong Perseid return of 1980. More support to this hypothesis was added by John Russell [11] who found a couple of Perseids, photographed in 1980, that are typical examples of material recently released from their nearby parent comet.

It is absolutely necessary to look again at the Perseid observations of the past 15 years and to follow the activity profile year after year to see how this evolves in time.

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Fireballs and Meteorites

Very Bright Fireball

Czechoslovakia, May 7, 1991, $23^h03^m58^s$ UT

P. Spurný, J. Borovicka and Z. Ceplecha, Ondřejov Observatory

A very bright fireball of −18 maximum absolute magnitude, closely resembling the Pribram fireball, was photographed over Czechoslovakia on May 7, $23^h03^m58^s$ UT.

A very bright fireball of −18 maximum absolute magnitude was photographed by three Czech stations of the European Network. The fireball traveled a 83-km luminous trajectory in 5.2 seconds and terminated its light at the extremely low height of 16 km, well below the maximum deceleration point, which coincides with the maximum brightness.

At Ondřejov Observatory, two spectral records with dispersion from 67 to 22 Å/mm and containing many hundreds of lines in the region from 3600 to 6700 Å were also obtained.

The following data are based on all available records measured by J. Keclikova and should be close to final values (except for photometric data).

Table 1 – Trajectory data.

	Beginning	Maximum light	Terminal
Velocity (km/s)	21.086	12.7	2
Height (km)	97.723	25.6	16.046
Latitude (° N)	49.6529	49.76	49.7717
Longitude (° E)	14.6411	14.61	14.6031
Abs. magnitude	− 3.5	−18.5	0.0
Photom. mass (10^3 kg)	15	2	(0.01)
Z R (°)	9.40		9.52

Fireball type: I (type II not excluded)
Average ablation coefficient: 0.006 s^2/km^2

Multiple meteorite falls are quite certain.

Spectral records point to a stony meteorite. The strongest radiators are:

atomic: iron, magnesium, calcium, sodium, manganese, chromium, titanium;
ionized: calcium, silicon; and
molecular: iron oxide, aluminum oxide.

The second portion of the fireball trajectory exhibits many fragments (more than six fragments separated at three gross-fragmentation points). The mass of the main body should be in the range from 10 to 2 kg. The second fragment has almost the same mass as the main body.

The impact area of the biggest two fragments is west of "Benešov u Prahy", as shown in Table 2.

Smaller fragments could also be recovered in the direction to the southeast from the computed impact area. Most of the impact area is covered by forests. Thus the favorable circumstances of an almost vertical fireball trajectory and only mild stratospheric and tropospheric winds are somewhat hindered by an unfavorable countryside. All activities connected with the searches for meteorites are organized by the Ondřejov Observatory of the Astronomical Institute of the Czechoslovak Academy of Sciences.

Table 2 – Impact area.

Latitude	Longitude
49.°7718 N	14.°6176 E
49.°7774 N	14.°6102 E
49.°7831 N	14.°6057 E
49.°7836 N	14.°6112 E
49.°7798 N	14.°6180 E
49.°7765 N	14.°6250 E

Table 3 – Radiant data.

Radiant (1950.0)	Observed	Geocentric	Heliocentric
α (°)	228.02	227.02	
δ (°)	+ 40.57	+ 39.85	
λ (°)			152.20
β (°)			+ 22.89
Initial velocity (km/s)	21.086	17.896	37.320

Table 4 – Orbital data.

Orbit (1950.0)	
a	2.428 AU
e	0.6192
q	0.9246 AU
Q	3.932 AU
ω	218.°65
Ω	46.°3145
i	23.°70

This fireball resembles closely the Pribram fireball, the first photographically documented meteorite fall.

The Glatton Meteorite

Jonathan Shanklin

The impact of a small meteorite is described that took place in Glatton, Cambridgeshire, England on Sunday, May 5, 1991, at 11^h30^m UT.

On Sunday, May 5, 1991, at 11^h30^m UT a small meteorite landed in the back garden of Mr. Arthur Pettifor of Glatton, Cambridgeshire, England. (Glatton is a small village about 15 km SSW of Perterborough.)

Mr. Pettifor is an 80 year old retired civil servant who used to work for the Ministry of Agriculture in East Anglia. He was planting out a bed of onions when he heard a whistling, whining noise, rather like a bomb falling, followed by a thump. Looking up he saw one of a screening hedge of conifers (cypresses), about 6 meters high, moving about. Behind the conifers is a low hedge of hawthorn and noticing some damaged branches, he spotted a small stone at the bottom of the hedge. Picking it up he found that it was lukewarm to the touch.

He contacted Anglia TV, who contacted David Dewhurst at the Institute of Astronomy, who contacted Howard Miles of the British Astronomical Association (BAA). As I live relatively nearby and Howard lives in Cornwall, he asked me to go to Glatton and investigate further.

I traveled up to Glatton on Sunday, May 12, and when I arrived found Robert Hutchison of the Natural History Museum and Colin Pillinger of the Open University were already there. They were inspecting the meteorite which is about 100 mm × 60 mm × 60 mm with a roughly conical leading surface and weighs 767 grams. It is covered with a thin (about 0.3 mm) matt brown fusion crust and has some poorly developed regmaglypts, about 10 mm across, on the trailing surface, the leading surface being smooth. Some larger brownish lumps, 5 mm or less across, possibly of nickel-iron, can be seen raised above the fusion crust.

Quite a number of people had handled it and someone had dropped it, flaking off a small piece of fusion crust and cracking one corner of the stone (about 20 mm × 20 mm). Inspecting the area of broken fusion crust with a hand lens (left over from my days of Part-1 geology, Bob Hutchison did not even have one) revealed a grey-white matrix with rounded chondrules 0.5 mm in diameter and small flecks of nickel-iron. Another corner, about 20 mm×20 mm, was obviously broken off in flight as it is covered with traces of a secondary fusion crust, perhaps showing a few crystals of olivine. It seems unlikely that this fragment will be recovered or that there are any other stones associated with the fall. Indeed, if it had landed only 20 meters further south, it might never have been found.

Inspecting the damage to the hawthorn hedge I estimate that the meteorite came in from within 10° of due North, coming down at an angle of 65°–70°. This is slightly inconsistent with the movement of the conifer, so it may have had its direction changed slightly. I could see no damage to the conifer, though this is hardly surprising given the type of tree. It made a small, elliptical pit 200 mm × 100 mm and 30 mm deep, and also made a small gash in a root at the base of the hedge.

The meteorite is currently undergoing investigation at the Natural History Museum. Bob Hutchison has identified it as an L6 (olivine-hypersthene) chondrite (which is exactly what my field identification was—Bob had made it an H6!). It has 23% iron, of which 5% is nickel-iron metal, the remainder of the iron being mainly in stony minerals. The main minerals present are olivine (24.5%) and pyroxine. Preliminary studies of the aluminum-26 abundance indicate a space age of about 2 million years and that the original meteoroid was less than a meter in diameter.

Mr. Pettifor is planing to exhibit the meteorite at the local church fete on June 29 to raise money for the repair of a pillar at the base of the tower which is crumbling. Interestingly, (for those that know of one of my other hobbies), he used to ring the four bells at the church. He was rather fed up with being pestered by the press, some of whom had apparently been quite rude and will be glad of some peace and quiet. I think he was quite grateful that I was able to answer a lot of his questions on where the meteorite had come from and what it all meant as no-one else seemed to have done this.

John Mason and Howard Miles would appreciate further information from anyone in Northern England who may have seen or heard anything, though given the weather conditions (totally overcast) and the likely ground track, this is unlikely.

Following an item in the *Daily Telegraph* which said that this was the first meteorite to land in England since the Barwell meteorite of 1965, Howard Miles had a phone call from someone in Devon who said that a meteorite had come through his house window in 1968. This had apparently been taken to Exeter University who positively identified it as a meteorite, but expressed no interest whatsoever. Howard is waiting for further information.

A Pre- and Post-Perseid Radio Increase

Dirk Artoos

In 1990, the author registered increased meteor activity on August 8 and after August 17.

In 1990, I did my Perseid radio observations between August 6 and 22, always from 9^h00^m till 9^h40^m UT (see Figure 1).

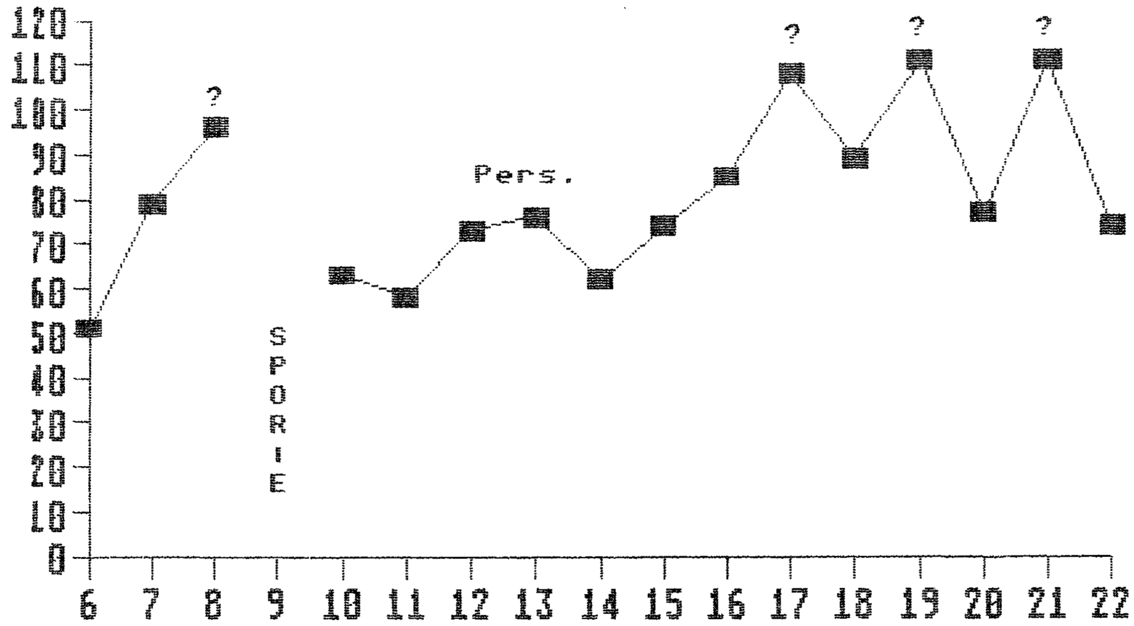

Figure 1 – Radio counts by the author from Mechelen between August 6 and 22, 1990, from 9^h00^m till 9^h40^m UT, at 66.45 MHz with an antenna elevation of 40° and azimuth of 275°.

As you can see, there was a high peak of reflections on August 8, and also a few days after the maximum of the radiant. Also, a normal drop was present after August 12, but activity rises again on August 17.

Possibly, this increase was caused by the κ-Cygnids (maximum on August 18), but the observing conditions for this shower were poor: a radiant elevation of only 20°. The ι-Aquarids (maximum on August 20) could not have been responsible for the increase, since their radiant was well below the horizon at the time of the observation (−34°).

Was this increase a late outburst of the Perseids? Or was it something else? Therefore, I would like to ask you to keep observing after the Perseid maximum to see whether or not this increase in confirmed. If possible, observe around 15^h30^m UT.

Results about a Mysterious Radiant on January 22–23

Dirk Artoos

The author discusses 1991 radio observations related to a suspected minor shower around January 22–23.

A few fellow amateurs have observed during the period in January 1991 mentioned in the title. My personal radio results are given in Figure 1.

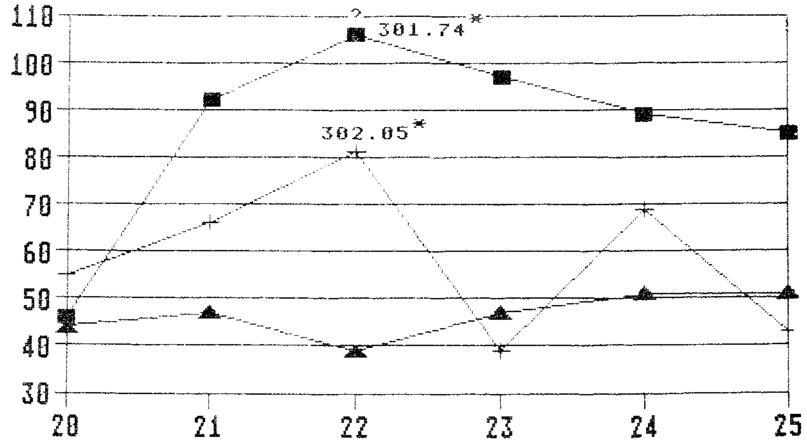

Figure 1 – Radio observations in January 1991 by Dirk Artoos, from 3^h30^m to 4^h05^m UT (squares), from 10^h45^m to 11^h20^m UT (plusses), and from 21^h30^m to 22^h00^m UT (triangles). The author listened at 66.45 MHz with an antenna elevation of 40° and azimuth of 275°. (*: solar longitude equinox 2000.0.)

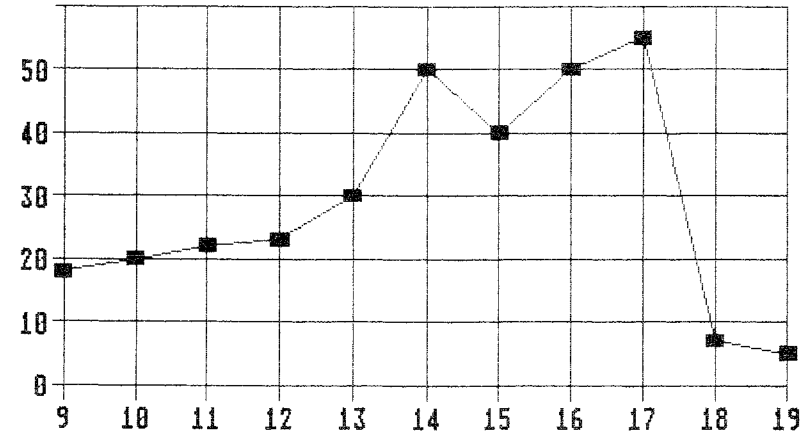

Figure 2 – Radio counts by Norihito Kawamura in January 1991.

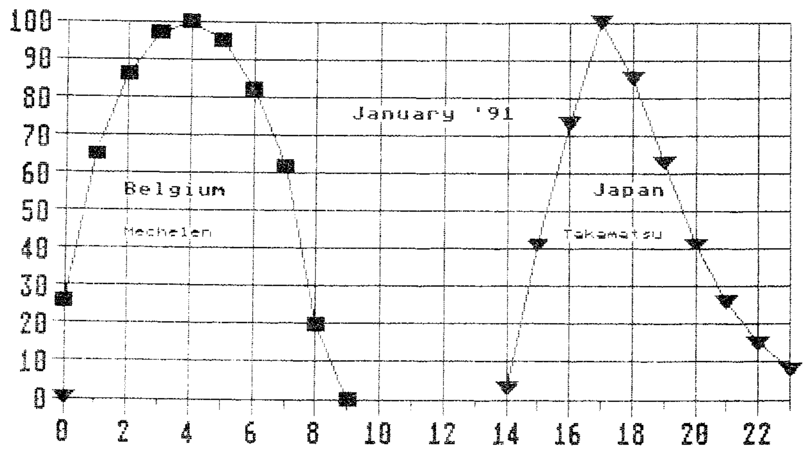

Figure 3 – Observability function for a radiant near γ Corvi, computed for Norihito Kawamura in Japan (parameters: azimuth: 270°; elevation: 90°; power: 44 kW; distance tr.-rec: 500 km) and for Dirk Artoos in Belgium (same parameters: 275°; 40°; 30 kW; 807 km).

As you can see, I have observed in three different time intervals. In the early morning (3^h30^m to 4^h05^m UT) the results were best, while at noon, the number of reflections was down, and in the evening, there was no higher activity at all. So I can conclude for my case that the "mysterious" radiant is high in the sky in the early morning hours (UT), going down late noon and being gone in the evening.

Figure 2 shows the results of Norihito Kawamura (Japan). The highest peak here was observed around 17^h UT on January 22. These data can be useful to pinpoint the possible position of the radiant, although premature conclusion should be avoided. Personally, I am thinking of a radiant in Corvus; this is perhaps the most likely solution (Figure 3).

This hypothesis is also sustained by my observations in 1990 (Figure 4).

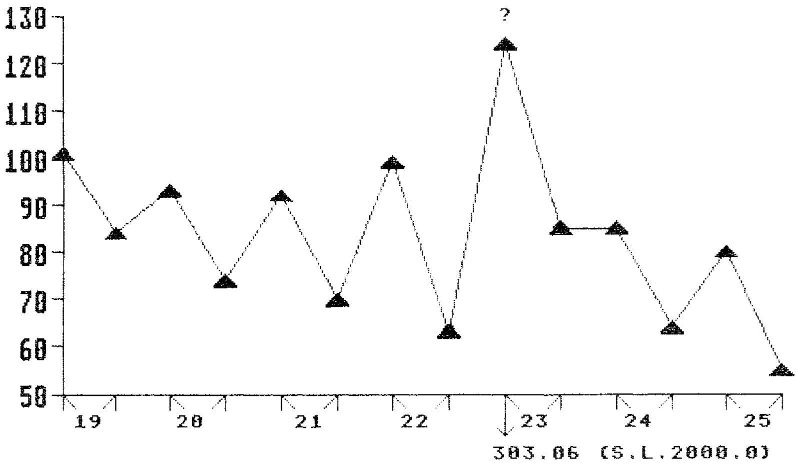

Figure 4 – Radio observations of the author in January 1990 between 4^h30^m and 5^h10^m UT and between 9^h00^m and 9^h40^m UT. (Same equipment parameters as in Figure 1.)

Observations by Richard Taibi in the USA (visual and with binoculars) in the cold winter skies showed no positive result. Malcolm Currie (UK) wrote me that the provisional telescopic results of January were negative as well.

Personally, I am convinced there is a real activity going on (since this is already the third time that I observe this phenomenon). Maybe this activity can only be perceived using radio. Some questions remain: Is there any connection with γ-Corvid activity? Could there be an asteroid involved [1]? Or does someone have a better solution or proposal?

Reference

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From the editor-in-chief

Unfortunately, a lot of other observational results had to be postponed to the August issue. We judged that we had to give priority to the IMO analysis of the 1989 Perseids, firstly because it is already some time ago that a comparable analysis has appeared in WGN, secondly because of the importance of some of the findings in this analysis, and thirdly to motivate our observers for an extensive coverage of the 1991 Perseids.

Since similar analyses will now be published frequently, space problems in WGN might re-occur. Therefore, we decided to publish purely informative articles (i.e., the articles that have no archival value and that are therefore not abstracted) in smaller print, saving us at least two pages per issue!

Anyhow, we promise that all contributions presently in the queue will be published in the August issue! (Ed.)

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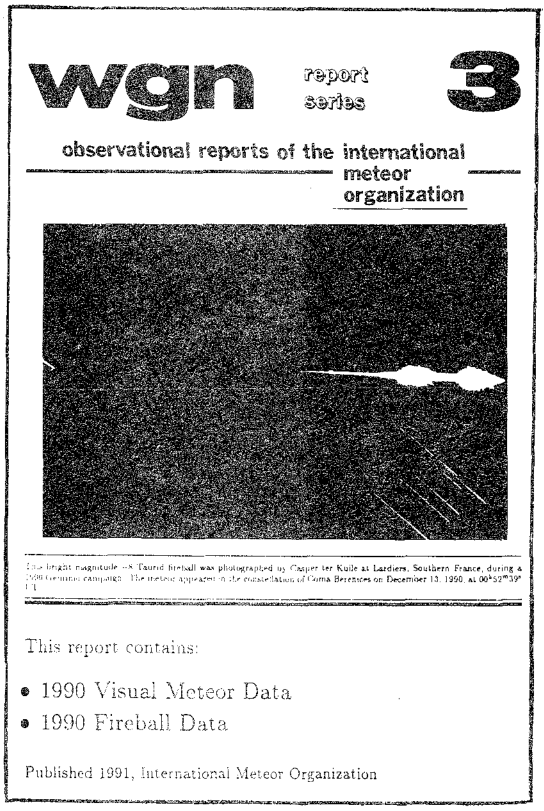

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