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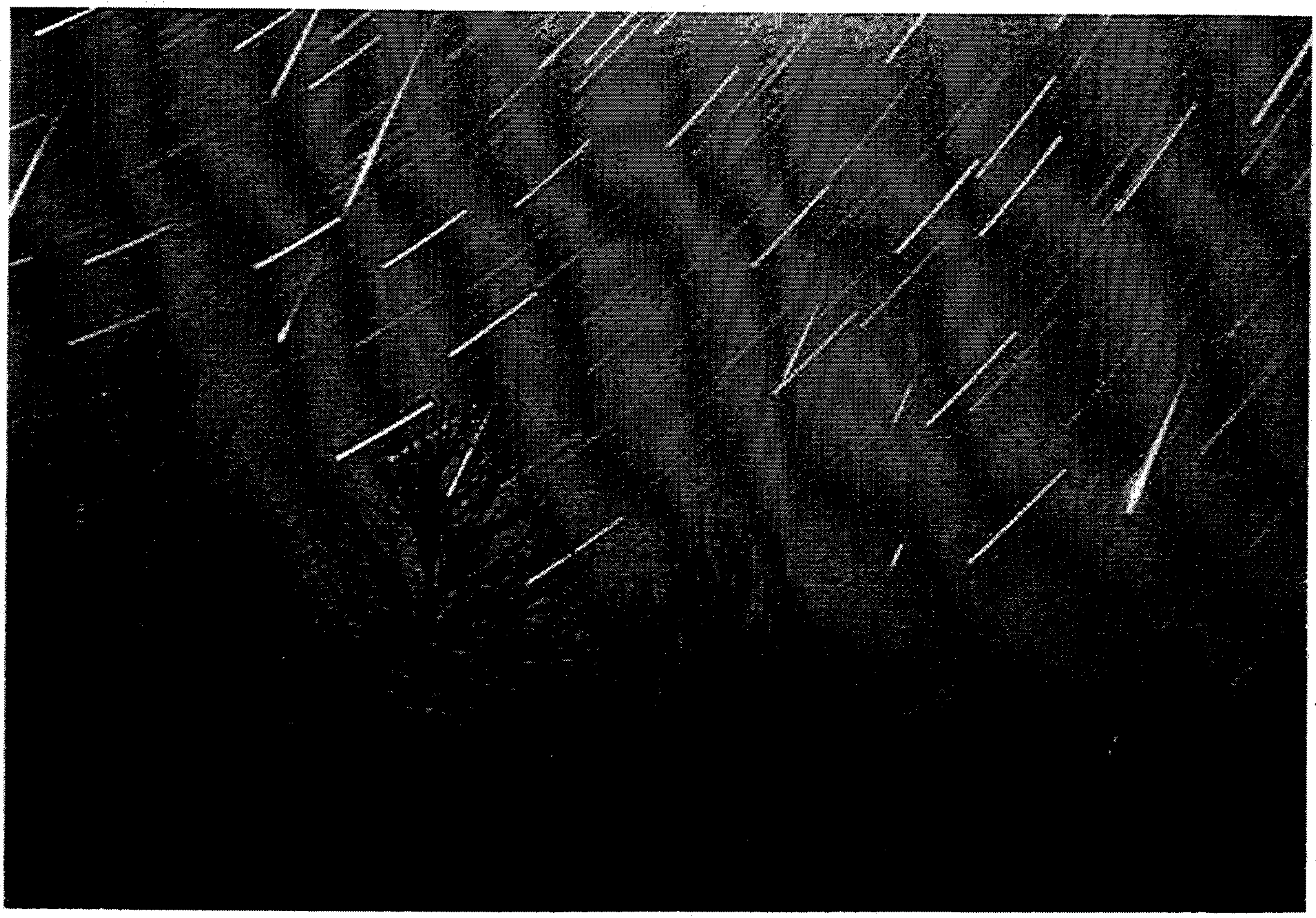

This impressive meteor photograph (the negative shows ten meteors) was taken at 5^h00^m a.m. local time in the morning of November 17, 1998 (November 16, 1998, 21^h00^m UT), from Beijing. The photographer is He Jingyang from the *Beijing Xuntian Sky Watcher Association*. The photograph was taken with a 50 mm $f/2.8$ lens on Kodak Tri-X 400 film. The exposure lasted 20 minutes.

In this issue:

- Membership/subscription renewal information
- News on the 1999 and 2000 IMCs
- Update on the Visual Meteor Database
- Hints for observing the 1999 Leonids
- Analyses of the 1998 and 1999 Perseids
- Meteoric references in Romanian poetry
- Observational results from Spain

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Useful Information

The December issue *(WGN 27:6)*

The *December issue* will be mailed around mid-December. Contributions are due on *November 26* at the latest. They should be sent to *Marc Gyssens.*

Subscriptions and ordering of publications

Volume 28 (2000) of *WGN* will contain at least 240 pages and costs 35 DEM or 17.90 EUR, including non-airmail delivery. Ordering other *IMO* publications is done in the same way as paying subscription/membership fees. More information can be found in this issue. Changes of address and complaints about not receiving *WGN* should be addressed to the Treasurer, Ina Rendtel.

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

From the Editor-in-Chief

Marc Gyssens

The combination of the total solar eclipse of August 11 and the Perseid maximum were beyond doubt the past few months' highlight for most of our readers. As it goes with total solar eclipses, some saw it and some did not...; and for the ensuing Perseid peak, I reckon the same holds. The variabilities of the weather is something a meteor observer has to live with anyway, and have not detracted observers from going out and gathering an impressive amount of data. In this issue, you can find some first conclusions on the activity of the 1999 Perseids. At the same time, we bring you a more definitive global analysis of the activity of the 1998 Perseids.

Another highlight during the past few months, was the International Meteor Conference (IMC) *in Frasso Sabino, Italy, a small town beautifully set in the Sabine Mountains, some 50 km from Rome. Roman remains in the very building where the lectures took place were impressive witnesses of the rich past of the region, and add to this nice weather and good food, and the picture is complete... This year's* IMC *was characterized by an exceptionally strong and well-filled program. I will long remember the impressive Leonid session. Both the presence of two professional meteor astronomers, Vladimir Smirnov from Odessa, Ukraine, and David Asher from Armagh, Northern Ireland, and the good response to the Support Fund the* IMO *set up to encourage participation contributed to this success. With regard to the second aspect, it is very gratifying for me and the other Council members to see that the initiative we took has such an immediate impact. Also gratifying to see were the many contacts and exchanges between meteor observers of various countries during the breaks, the meals, and the evenings. Results and experiences were exchanged and joint projects set up. The activity during the* IMC *is proof that the international meteor community (even though most participants were European) is healthy.*

A final proof of the health of the international meteor community is that a lot of groups are keen on organizing an IMC. *Choosing between the proposals for the* 2000 IMC *turned out to be very tough. After a long deliberation, the Council chose to have the next* IMC *in Pucioasa, Romania, from September 21 to 24, 2000. Every participant of this year's* IMC *is already looking forward to the next edition! So, If you missed Italy, do not miss Romania! More information, both on this year's Conference as on the next one, can be found in this issue; more detailed information and a registration form for the* 2000 IMC *will be printed in the December issue.*

As the end of the year is slowly approaching, we must ask you to renew your membership/subscription. We are pleased to announce that dues have remained unchanged compared to last year. Several members and subscribers have already taken the opportunity of their presence at the IMC *to renew. To the others, we ask not to delay your renewal unnecessarily; in this way, you are helping us in keeping our records straight! Renewal information can be found below.*

Finally, I want to share with you (again) a concern which remains amidst all the enthusiasm around the last IMC. *Up to now, the dedication of meteor observers world-wide to their endeavor, which was so obvious in Frasso Sabino, and which also follows from the* VMDB *statistics presented in this issue, does still not translate into more interest in taking up one of the several organizational tasks that have to be carried out within the* IMO. *Perhaps people are satisfied with the way things go and therefore take the services of the* IMO *for granted. However, the burden of delivering these services is currently resting on too few shoulders. So, I hope the attitude of the meteor community towards the organization aspect of the* IMO *will change soon, because this is vital to ensure the continuity of our Organization in the near future!*

Meanwhile, enjoy reading this issue, and all the best for the 1999 Leonids, for which we also present some additional information!

Renew Your IMO Membership/WGN Subscription Now!

Ina Rendtel

General information

Please help us in keeping our records straight by renewing right now. In this way, you ensure that your subscription is processed well in time before the February issue has to be sent out and you save the already overloaded *IMO* officers to have to run on and off to the post office to mail back issues. All relevant information is concisely summarized below.

International payments invariantly involve costs. Therefore, if you also wish to buy other *IMO* publications (outside back cover), it is a good idea to combine this with your renewal in one order and one payment. *New* IMO *publications* are Report 11 containing the 1998 visual observations, and the Proceedings of the 1998 and 1999 *IMCs*, the latter of which will appear shortly and can already be ordered. You can also pay your subscription for *two* years, by which you can avoid a possible increase in dues for 2001! Finally, you can **become a supporting member** by adding at least 15 DEM (7.67 EUR) or 10 USD per year to your membership.

Payment instructions

Please, send your payments to the Treasurer or one of her assistants as indicated below:

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- **All others** pay in *US Dollars* to *Robert Lunsford*, 161 Vance Street, Chula Vista, California 91910, USA.

All people insisting on paying by check should pay to Robert Lunsford in US Dollars, as indicated above. Make checks payable to Robert Lunsford, not to the IMO!

Price list

Type of subscription	2000	2000 + 2001
Regular subscription (*WGN*)	35 DEM (17.90 EUR) or 25 USD	70 DEM (35.79 EUR) or 50 USD
Combined subscription (*WGN*, *FIDAC* News, Report)	70 DEM (35.79 EUR) or 50 USD	140 DEM (71.58 EUR) or 100 USD
Also possible outside Europe:		
Regular subscription with airmail delivery	70 DEM (35.79 EUR) or 50 USD	140 DEM (71.58 EUR) or 100 USD
Combined subscription with airmail delivery for *WGN* only	110 DEM (56.24 EUR) or 80 USD	220 DEM (112.48 EUR) or 160 USD

Letters to WGN

compiled by Marc Gyssens

On possible new radiants

In *WGN* 27:1, pp. 51–52, Detlef Koschny and Joe Zender reported the discovery of a possible new radiant in Auriga. As I counted the Leonids and plotted all other meteors on November 17 and November 18, 1998, I decided to check these plots, in order to find possible Aurigids. On November 17, 1998, I observed from 5^h30^m UT to 9^h30^m UT. In this period, I plotted 36 meteors. I found 2 slow meteors radiating from the indicated area. On November 18, 1998, I observed from 7^h30^m UT to 9^h30^m UT and plotted 17 meteors. Again, I saw two meteors radiating from this area, but this time one with a medium speed and another with a slow-to-medium speed.

I have also checked the plots I have made in 1997. On November 17-18, I observed from 22^h10^m to 1^h00^m and plotted 5 meteors. One medium-speed meteor came from the possible radiant.

As the speed information is missing in the article of Detlef Koschny and Joe Zender, I cannot say which of the five mentioned meteors could be coming from this possible new radiant. My speed data indicate that I have seen maximally 2 meteors from this possible radiant. This can also be a chance alignment.

My data do not confirm the existence of a possible new radiant in Auriga, but it can well be that this radiant really exists. I was observing later in the night than Detlef Koschny and Joe Zender did. Perhaps they observed a short-lived "outburst" of this radiant, which was already past by the time I started observing. Confirmation can now only come from observers who observed around the same time as Detlef Koschny and Joe Zender (21^h40^m UT to 1^h18^m UT).

In *WGN* 27:2, pp. 1170-118, Arkadiusz Olech and Maciej Kwinta reported the discovery of a new possible radiant near β Ursae Minoris. After reading their article, I decided to check my plots to see if I could confirm the existence of the possible new shower. I counted Perseids and plotted all other meteors during the Perseid campaigns in 1991, 1993, 1994, 1996, 1997, and 1999. Checking my hundreds of plots again, I found two possible β-Ursa Minorids, one on August 18, 1993, and one on August 4, 1994. If this new possible radiant is so prominent as written in the article of Arkadiusz Olech and Maciej Kwinta, I should have seen more meteors from this shower. Therefore, I seriously doubt the existence of this new shower. Can other observers check their plots to confirm or deny the existence of this new possible shower?

Erwin van Ballegoij, August 22, 1999

The 1999 International Meteor Conference

Frasso Sabino, Italy, September 23–26, 1999

Jean-Marc Wislez

The *IMC* started on September 23, as usual on a Thursday evening. That day during the late afternoon, after having arrived from Rome where I spent a couple of days with some friends, I was drinking a beer in front of Hotel Persi and enjoying the wonderfully warm evening sun, casting its golden glow over a rolling landscape amidst the Sabine Mountains, while familiar faces started to arrive—and a few new ones, too. Enthusiasm and disappointment alternated when the list of participants, and absentees, started to get more concrete. I felt the mixed expectation of familiarity and new confrontations, a feeling that is known and appreciated by seasoned *IMC* participants.

Frasso Sabino is a village in the Sabine Mountains, which are part of the Apennines, a mountain chain running north-south over almost the entire length of the Italian peninsula. The town is located about 50 km from Rome, in the Province of Rieti, near the Via Salaria, an originally Roman road which cuts from west to east through the Apennines and links the Capital to the Adriatic Sea. Hotel Persi is situated right on the Via Salaria.

At 7 p.m., we were brought to the lecture room, which was at about one kilometer from the hotel. The lecture room was part of a building called "Grotta dei Massacci." This partly renovated structure used to be a 17th-century country palace built on top of the ruins of a Roman tomb of the 2nd century BC. From the lecture rooms, the colossal stones of these ruins were clearly visible through glass panels in the floor and doors. This, and two other Roman tombs within a few hundred meters from the conference location, made us impressively aware of the rich history of the region. At the "Grotta dei Massacci," we were welcomed by the organizing team, and the *IMC* was officially opened by Marc Gyssens on behalf of the *IMO* Council. Several Council members who usually attend *IMC*s, among them President Jürgen Rendtel, could not make it to the *IMC* this time. The opening was followed by the evening meal back at the hotel, and of course some drinking and chatting in the bar, as would be the case every night.

As always, the meals and the bar were the best places to socialize. This was especially true for the meals this year, with excellent food and wine *à volonté*. Concerning the bar, this *IMC* saw a new phenomenon: closure at 1 o'clock due to the setting of the hotel alarm. While this looked very unpleasant at first—nobody likes to break off interesting and pleasant conversations with people you cannot meet often, it brought more people to the morning lectures, and few people have turned into "zombies" during the conference.

On Friday, the first morning session saw a series of shower analysis presentations: preliminary results of the 1999 Perseids by Rainer Arlt, two lectures on possible new showers, and two on the Taurids.

The next session had another presentation on a candidate minor shower, but essentially addressed more technical means of observing meteors: meteor spectroscopy and video observations. A highlight here was certainly the lecture by Sirko Molau, in which he presented a fully automated video system that yields lists of observed and processed meteors as output! I can remember how, only 6 years ago, at the *IMC* in Puimichel, France, in 1993, he proudly showed us the first meteors he had been able to capture on video tape...

In the afternoon, professional meteor worker Vladimir Smirnov from Odessa, Ukraine, spoke about peculiarities of meteor radiation, which seemed to shed some light on why meteors are recorded so well by red-sensitive video cameras. Before and into the coffee break, there was a poster session which initiated a flourishing pool of avid discussions. I mainly talked to Juan Martin Semegone from Buenos Aires, Argentina, who is heavily involved in the building of a radio meteor receiver, a subject I am especially interested in.

It was no surprise to see a series of lectures dedicated to the Leonids, which filled the remaining part of the afternoon. Of course, the results of last year's expeditions in China and Mongolia were presented, with funny and sometimes really impressive videotapes. However, the real highlight of this "Leonid special, " and, I dare say, of the whole *IMC*, was a lecture by David Asher of Armagh Observatory, in Northern Ireland, in which he presented results from simulations of the Leonid stream, which apparently permit a prediction of Leonid activity peaks with an accuracy of up to a few minutes! Also the fireball outburst of last year was explained to be the result of a resonance phenomenon in the meteoroid orbits. Please, read the article co-authored by David in *WGN* 27:2 if you did not already do so, it is worth it! After this presentation, one could not help wondering if meteor astronomy might be on its way to become a predictable science after all. Let us first use this year's Leonids as a test case, however...

In the evening, we visited the near-by observatory of the organizing *Associazione Romana Astrofili*, situated in an old mill. The observatory's telescope is a self-made 0.37-m $f/12$ Cassegrain, and the renovated structure also contains a charming small planetarium. As could be expected, the evening was closed in the bar, with serious and less serious exchanges. Unlike at other *IMC*s, this exchange was again followed by a full 8 hours of sleep!

Some participants arrived late due to visa problems. At some point, we had almost abandoned hope that the small Yugoslav delegation would still make it to the *IMC*. It was therefore a pleasant surprise Saturday morning to see that at least som of the Yugoslavians had finally made it. Their lectures were rescheduled.

After the lectures on Saturday morning, which included a second talk by Dr. Smirnov—this time about the coefficient of meteor plasma radiation, the annual meeting of the General Assembly of the *IMC* took place. There were of course the financial reports and the activity reports of the Council Members and Commission Directors present, but what we were really looking forward to was the announcement of the Council of their decision as to where the next *IMC* would take place. We already knew Romania and Slovenia were in the running, and that both candidates had a strong proposal, so choosing would have been hard. In a Salomon's judgment, the Council members present at the *IMC* (after proper consultation of the other Council members via email and telephone) attributed the 2000 *IMC* to the Romanians, who had submitted their candidacy for the third consecutive time, but also assured the Slovenians that they would seriously reconsider their proposal next year.

Figure 1 – Group photo at Farfa Abbey.

The annual excursion took us to Farfa Abbey, a picturesque monastery lost in the mountains, and surrounded by a small village. Farfa Abbey dates back to Carolingian times, although little of that period remains. It used to be a very influential place in the region, both religiously and politically. After a guided tour through the premises, including the abbey church, we got some free time, during which we could reflect on the rich history of this place. When it was about time to leave, we witnessed the beginning of a marriage ceremony in the abbey church—apparently a very posh one. On the short way back to the hotel, we made a stop at the center of Frasso Sabino, which most of us had not yet seen, then! The old town is centered around the Sforza Cesarini Castle, located on a sharp hill top. After the castle had lost its strategic importance, houses have been erected on top of it, and even the top floor of the tower is an apartment, which became apparent when an Italian "mama" looked through the window to see what was going on below. We walked inside the fortification, which afforded us spectacular views over the surrounding area, with the Farfa River meandering deep below us, but also made us discover cosy corners with small houses decorated with flowers, which added to the medieval character of the village center. Our Italian friends pointed our attention to several particularities which would otherwise have gone by unnoticed, such as a piece of petrified wood amidst the stones that have been used to construct a gate.

Back at the hotel, anticipation grew. At the last two *IMC*s, our Romanian friends had presented a program of astropoetry and some astro-plays. For most of us, these had been fascinating but somewhat strange performances, with an unclear goal. This year, we were already more accustomed to the idea, and we had been explained that, in Romania, this is one of the few ways to attract people to sciences in general and astronomy in particular. Apparently, Romania has a strong tradition of performing arts. After dinner, the *moment suprême* had come, and we returned to the "Grotta" for this year's edition. We were not disappointed! A combination of astro-poetry, astro-music, and astro-play helped us, on the one hand, to better understand the Romanian soul, but, on the other hand, was great fun, too! In one instance, Andrei Georghe, acting as the Earth in one of the plays, surprised everybody by walsing over the stage as one of the ballet-dancing hippos in tutu in Walt Disney's *Fantasia*—I still cannot figure out how he did it! Anyway, we are looking forward to more of this next year in Romania!

Figure 2 – Mihaela Triglav and Rainer Arlt working hard on figuring out the best way to analyze Taurid activity.

After the performance, our Japanese friend and faithful *IMC* participant Nagatoshi Nogami treated us on very interesting sweets from his country typical for the Moon Festival. Yes, we closed Saturday evening in the bar...

On Sunday, we got two striking examples of people working on astronomy in circumstances very unlike those in Western Europe: we learned about the astronomy popularization work in Romania, and about an effort to build a reliable radio meteor receiver in Argentina. With an event as spectacular as a total solar eclipse in Europe, on August 11, 1999, an exception was made to the "meteor-related presentations only" rule, and a few groups presented their eclipse activities and observations, illustrated by captivating video records.

Before the closure of the *IMC*, we saw promising presentations of the Romanian (2000) and Slovenian (2001) *IMC* locations, and Rainer Arlt advised us about where to go in order to have the best view on the 1999 Leonids. Once again, this *IMC* was a very unique event, totally unlike any other *IMC*—as usual, one could say.

After the IMC, I spent one more day in Rome, but this time with David Asher, Nagatoshi Nogami, and our Romanian friends. The city was a whole new experience with this international company. I could not think of a better way to close this *IMC*!

The 2000 International Meteor Conference

Pucioasa, Romania, September 21–24, 2000

communicated by Marc Gyssens

It was decided at the 1999 *IMC* to have the 2000 *International Meteor Conference* in Pucioasa, Romania, from September 21 (Thursday evening) to September 24 (Sunday noon). It will be organized by the *Romanian Society for Meteors and Astronomy* (*SARM*). Pucioasa is a spa town, located at an altitude of 400 m, about 100 km to the northwest of Bucharest, and only 23 km to the northwest of Târgovişte. There are direct trains and buses from the Bucharest airport/train station to Pucioasa, but the organizers plan to offer an additional shuttle service.

Accommodation will be provided in double rooms, and all meals will be served at the hotel restaurant, at 150 m from the conference site. The conference is organized in cooperation with the Town Authorities. The full conference fee will be 170 DEM (86.92 EUR). (Reductions for Eastern European participants are possible.)

More information and a registration form will be provided in the next issue of *WGN*. Alternatively, you may also consult the *IMO* Web pages at `http://www.imo.net`.

Fifteen Years of Collecting Observations in the Visual Meteor Database

Rainer Arlt

A summary of the present status of the *Visual Meteor Database* (*VMDB*) is given as a comprehensive data source covering the years 1984–1998. Statistical accounts are given and observers' characteristics are shown. Problems of reporting meteor observations are discussed, and hints are given to ensure a high quality of visual data.

1. What is the VMDB?

Observing meteors visually involves a number of uncertainties in the results, most notably the various characteristics of the human being carrying out the observation. A meaningful result can only be derived from a sample of data. The *Visual Meteor Database* (*VMDB*) was created by Paul Roggemans in 1988 [1] in order to collect meteor observations in a standard format in computer-readable format, that is, ready-to-use for analyses of meteor showers and sporadic meteors. The database stores information on observing periods, basically beginning and end times, effective observing time, cloud obstruction, and limiting magnitude, plus numbers of meteors per shower seen in this period. The *VMDB* does not store individual meteors. Magnitude distributions of shower meteors and sporadic meteors are usually given per night; for major showers, they are given per shorter periods.

2. Current statistics

Looking at the totals of visual meteor observations collected in the *VMDB* as given in Table 1, we find a very satisfying development. In fact, the *VMDB* is now the largest meteor database in the world containing data gathered from 1.5 million meteors. Again, the *VMDB* is not a database of meteor coordinates; it stores rate information and magnitude distributions in a ready-to-use way. Thanks to the Leonids, we passed in 1998 the 10 000-hour mark of effective observing time in a single year. The following report gives an update and additional information to the report in [2].

Table 1 – *Visual Meteor Database* (*VMDB*) grand totals for 1984–1998.

Year	T_{eff}	Meteors	Observers	Countries
1984	516^h	3 990	64	4
1985	$2\,113^h$	35 058	194	5
1986	$2\,210^h$	40 310	191	13
1987	$1\,653^h$	22 000	183	7
1988	$5\,684^h$	115 298	346	17
1989	$5\,322^h$	89 493	414	21
1990	$4\,488^h$	79 053	339	21
1991	$5\,360^h$	139 308	377	27
1992	$4\,529^h$	76 811	317	29
1993	$7\,532^h$	178 566	582	34
1994	$5\,431^h$	105 823	462	30
1995	$5\,924^h$	102 804	518	32
1996	$7\,832^h$	151 396	646	35
1997	$9\,570^h$	192 019	662	35
1998	$11\,066^h$	222 485	933	48
Total	$79\,230^h$	1 554 414		

The distribution of world-wide observing sites as used in 1998 is shown in Figure 1. Magnifications of this map for Europe, North America, and north-east Asia are given in Figures 2, 3, and 4. The more regular distribution of Japanese sites comes from a gridding which divides the country into longitude and latitude areas resulting in a finite number of observing sites ab initio. This method does not provide full accuracy for the individual observing site, but is completely sufficient for visual observing purposes. A diagram showing the observational coverage of each degree in solar longitude is shown in Figure 5. The peaks of major showers are cut for the sake of more detail in the less frequently covered periods. We find the lowest numbers of observations in early January after the Quadrantids and in early and mid-March.

A breakdown of observer numbers and total effective hours is given in Table 2 for the entire database from 1984 to 1998. This overview proves the global character of the *VMDB*, since almost 60% of the countries provided more than 100 hours of observations each, and did not just occasionally participate. The following statistics may be an interesting complement to the survey study of observers in [3].

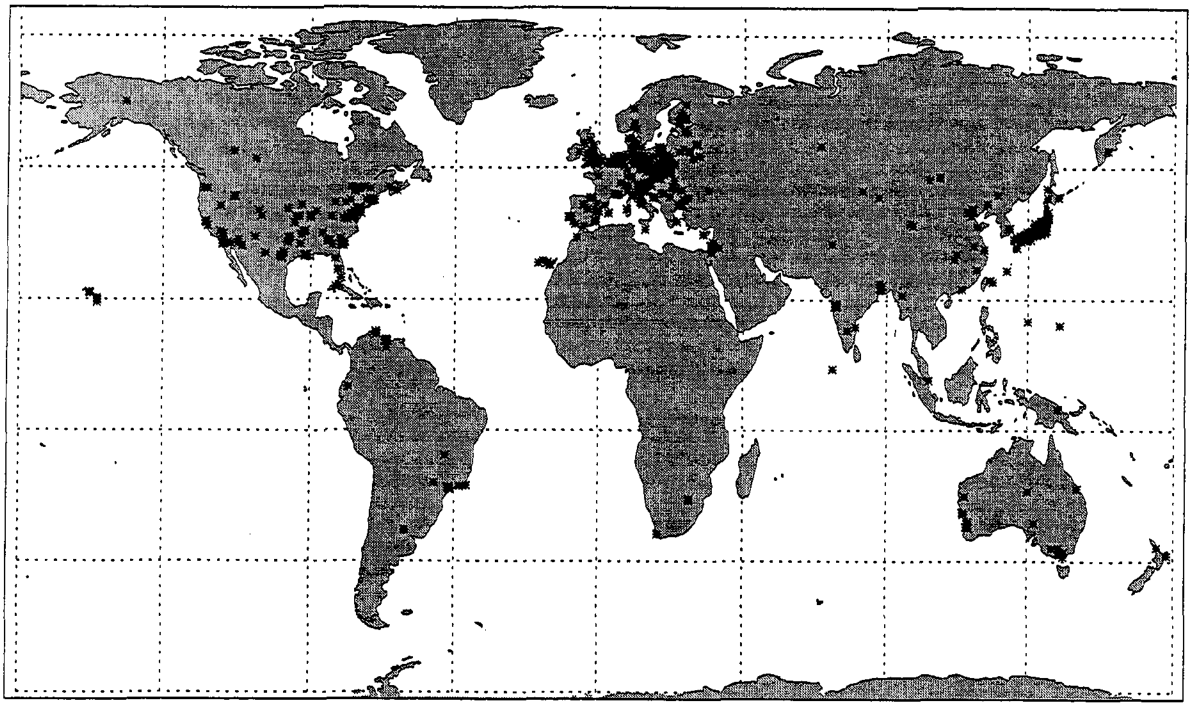

Figure 1 – Distribution of observing sites in 1998.

Table 2 – Number of observers and total effective observing time per country or region. The last column shows the number of observers per million people (country/region populations based on 1991 statistics). *Some earlier USSR observers could not be associated with the new countries anymore.

Country	Obs	$T_{\rm eff}$	Density	Country	Obs	$T_{\rm eff}$	Density
Argentina	10	$49^{\rm h}04$	0.32	Japan	376	$8\,958^{\rm h}53$	3.1
Australia	189	$3\,837^{\rm h}83$	11.8	Jordan	28	$355^{\rm h}92$	10.2
Austria	16	$130^{\rm h}80$	2.1	Kazakhstan	3	$8^{\rm h}90$	0.19
Belarus	17	$192^{\rm h}03$	1.7	Malta	43	$818^{\rm h}33$	121.1
Belgium	357	$5\,996^{\rm h}13$	36.2	Morocco	9	$7^{\rm h}76$	0.38
Bolivia	20	$74^{\rm h}87$	3.0	the Netherlands	46	$1\,866^{\rm h}40$	3.2
Brazil	17	$118^{\rm h}89$	0.12	New Zealand	12	$902^{\rm h}10$	3.6
Bulgaria	85	$2\,104^{\rm h}56$	9.5	Norway	21	$547^{\rm h}91$	5.0
Canada	45	$1\,284^{\rm h}60$	1.8	Pakistan	1	$22^{\rm h}71$	0.01
China	42	$334^{\rm h}25$	0.04	Papua N. Guinea	1	$0^{\rm h}83$	0.29
Croatia	60	$706^{\rm h}85$	13.0	Poland	98	$5\,481^{\rm h}48$	2.6
Cuba	7	$13^{\rm h}46$	0.68	Portugal	8	$66^{\rm h}24$	0.78
Czech Republic	130	$2\,073^{\rm h}60$	12.3	Romania	16	$1\,167^{\rm h}36$	0.70
Denmark	9	$741^{\rm h}42$	1.8	Saudi Arabia	1	$1^{\rm h}26$	0.09
Dominican Rep.	2	$2^{\rm h}00$	0.31	Singapore	1	$1^{\rm h}75$	0.39
Ecuador	1	$0^{\rm h}50$	0.10	Slovakia	294	$6\,770^{\rm h}19$	58.6
Estonia	10	$40^{\rm h}74$	6.6	Slovenia	75	$498^{\rm h}69$	47.3
Finland	42	$1\,420^{\rm h}89$	8.6	South Africa	10	$242^{\rm h}17$	0.30
France	12	$330^{\rm h}46$	0.22	South Korea	2	$8^{\rm h}32$	0.05
Germany	151	$10\,285^{\rm h}70$	1.9	Spain	144	$3\,852^{\rm h}74$	3.7
Gibraltar	1	$2^{\rm h}29$	32.1	Sweden	6	$7^{\rm h}47$	0.72
Hong Kong	8	$26^{\rm h}68$	1.4	Taiwan	3	$12^{\rm h}31$	0.15
Hungary	345	$5\,182^{\rm h}97$	32.5	United Kingdom	101	$2\,067^{\rm h}18$	1.8
India	21	$158^{\rm h}83$	0.03	United States	254	$8\,674^{\rm h}14$	1.0
Ireland	6	$12^{\rm h}81$	1.7	Ukraine	19	$242^{\rm h}66$	0.37
Israel	10	$80^{\rm h}09$	2.1	Venezuela	10	$32^{\rm h}96$	0.56
Italy	62	$923^{\rm h}12$	1.1	Yugoslavia	72	$1\,173^{\rm h}23$	7.7
USSR*	11	$97^{\rm h}01$	-				

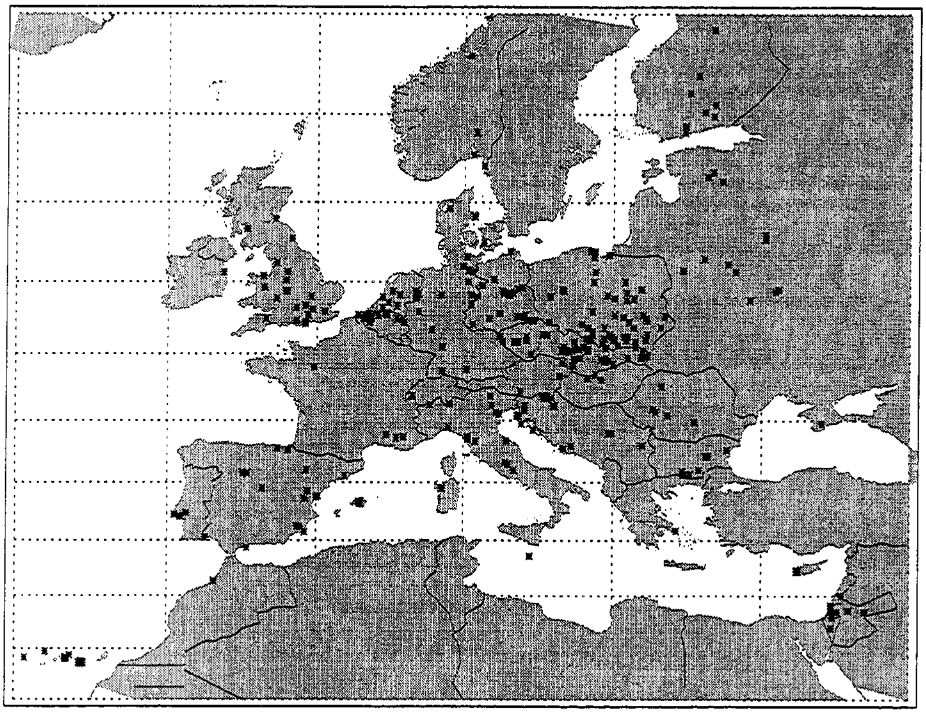

Figure 2 – European observing sites in 1998.

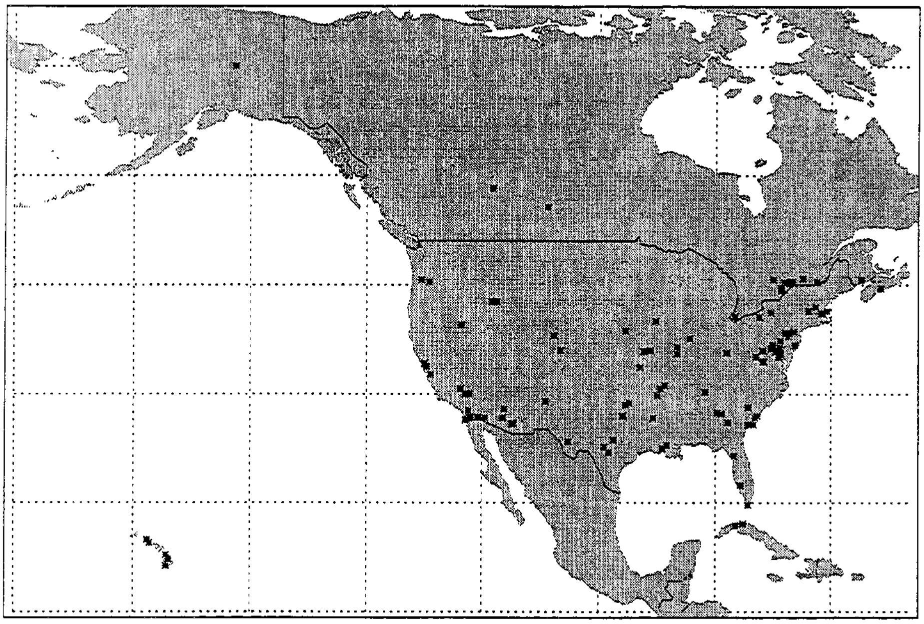

Figure 3 – North American observing sites in 1998.

How often does a meteor observer go out to log an observing session? The complete set of files was scanned, and the observing nights of each individual observer were extracted. This gives us an indication of how many observers are long-term meteor amateurs. Figure 6 shows the number of observers who watched meteors in certain numbers of nights, binned in 25-night classes. A list of the 20 most active observers as stored in the *VMDB* is given in Table 3 ranked by the number of observing nights (*left*). The last column gives the average time lapse between two observing nights in days. Quite a few observers have not contributed to the *VMDB* for many years, but have been very active recently. Table 3 also lists 20 observers reversely ranked by their average time lapse between observing nights (*right*). Here, we find a number of observers not listed in the left panel of Table 3, who use really every chance to go out and observe meteors. It should be noted, that the list contains only observers with at least 20 observations.

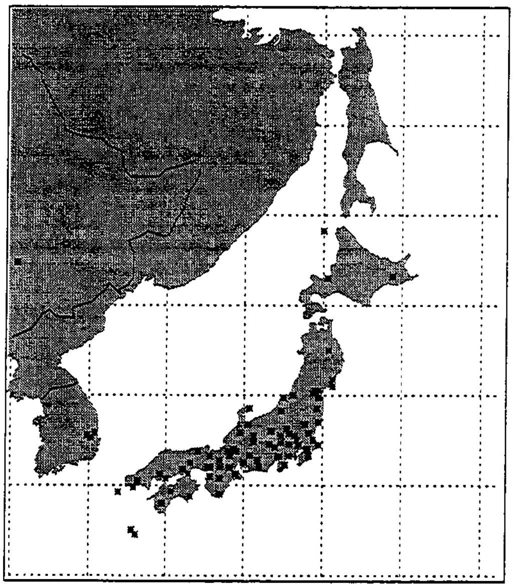

Figure 4 – Japanese and north-east Asian observing sites in 1998.

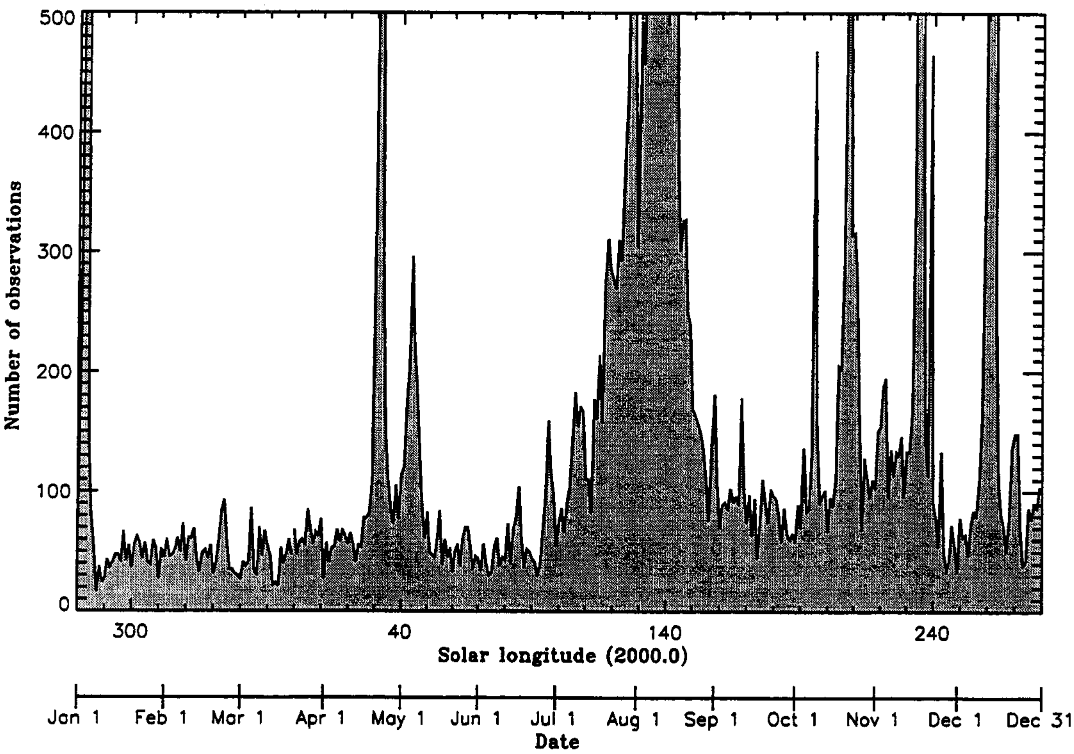

Figure 5 – Total number of observing periods per degree in solar longitude for 1984–1998.

The first column in Figure 6 for observers having less than 25 nights contains 2746 people comprising 91% of all contributors. This demonstrates that meteor observing is, first of all, a hobby. Good skills for a simple major-shower observation can be obtained in a first or second observation already, and the large number of few-time watchers is not questioning the quality. However, a substantial 34% of the observers reported only from a single night, most probably a Perseid, Leonid, or Geminid night. The contribution to the effective observing time is, of course, very low and does not exceed 3%. The contributions of few-time observers are given in Table 4.

Table 5 shows how many new observers were introduced to the database over the years. The systematic collection of meteor observation in the *VMDB* started in 1988 whence the relatively large number of "new" observers, who may have observed before as well. The perfect conditions for the 1993 Perseids attracted a substantial number of new observers and, of course, last year's Leonids again introduced a large community of amateur astronomers to meteor observing.

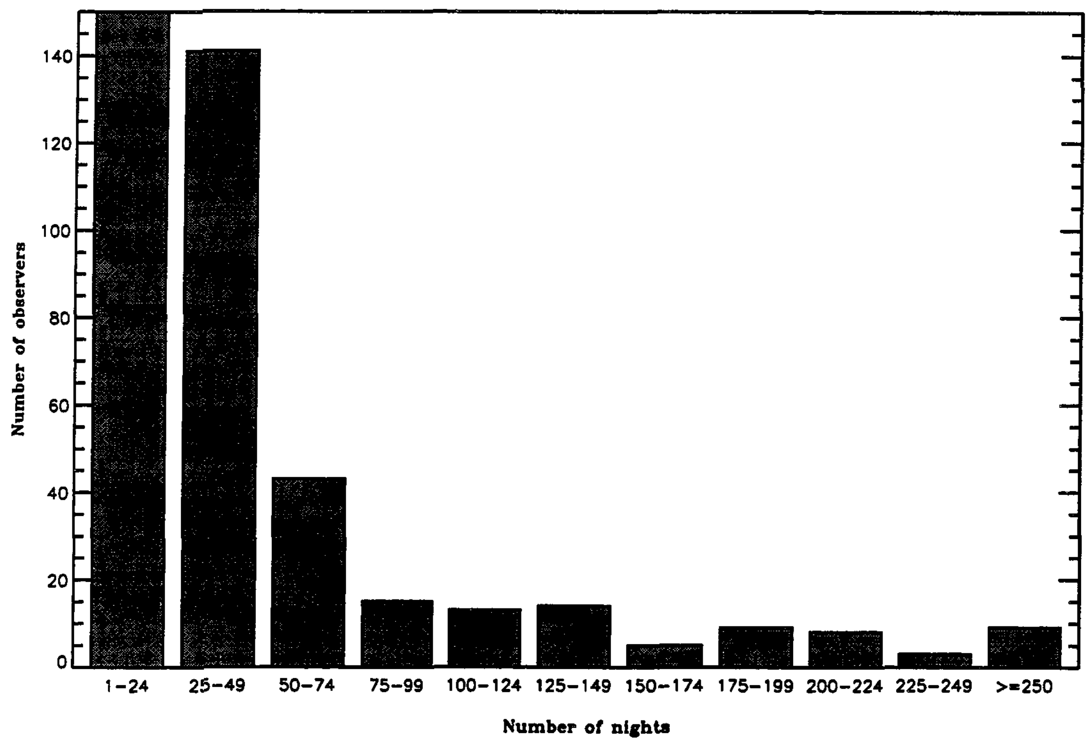

Figure 6 – Number of observers who watched for meteors in a certain number of nights. The first column includes 2746 observers with less than 25 nights.

Table 3 – Top 20 observers measured by their number of nights ("Nr") stored in the *VMDB* (*left*), respectively by the average time lapse between two observing nights ("Days") (*right*). Only observers with at least 20 nights in the *VMDB* were taken into consideration.

Top 20 by observing nights			Top 20 by time lapse between observations		
Observer and code	Nr	Days	Observer and code	Nr	Days
Jürgen Rendtel (Germany, RENJU)	791	5.0	Mitsue Sakaguchi (Japan, SAKMI)	183	3.3
Kazuhiro Osada (Japan, OSAKA)	489	6.1	Jakub Koukal (Czech Rep., KOUJA)	49	3.7
Robert Lunsford (USA, LUNRO)	428	9.1	John Gallagher (USA, GALJO)	127	3.7
G.M. Kristensen (Denmark, KRIGO)	376	5.6	Jarosław Dygos (Poland, DYGJA)	171	4.3
George Zay (USA, ZAYGE)	359	7.3	Sven Näther (Germany, NATSV)	106	4.7
Koetu Sato (Japan, SATKO)	298	8.8	Jürgen Rendtel (Germany, RENJU)	791	5.0
Katuhiko Mameta (Japan, MAMKA)	297	14.8	Tomasz Żywczak (Poland, ZYWTO)	137	5.1
Kiyoshi Izumi (Japan, IZUKI)	270	16.0	Mark Mikutis (USA, MIKMR)	22	5.4
Koen Miskotte (Netherlands, MISKO)	266	17.2	G.M. Kristensen (Denmark, KRIGO)	376	5.6
Leo Rajala (Finland, RAJLE)	241	18.9	Tomasz Fajfer (Poland, FAJTO)	179	5.9
Yasuo Yabu (Japan, YABYA)	237	18.5	Kazuhiro Osada (Japan, OSAKA)	489	6.1
Ralf Koschack (Germany, KOSRA)	235	16.7	Gracjan Maciejewski (Poland, MACGR)	92	6.1
Josep M. Trigo (Spain, TRIJO)	223	17.7	Graham Wolf (New Zealand, WOLGR)	161	6.8
Alastair McBeath (UK, MCBAL)	218	21.8	Konrad Szaruga (Poland, SZAKO)	120	7.1
André Knöfel (Germany, KNOAN)	217	17.9	George Zay (USA, ZAYGE)	359	7.3
Takema Hashimoto (Japan, HASTA)	215	20.4	Paweł Trybus (Poland, TRYPA)	67	7.7
Adam Marsh (Australia, MARAD)	211	16.9	Maciej Kwinta (Poland, KWIMA)	159	7.9
Jeff Wood (Australia, WOOJE)	210	18.7	Maciej Reszelski (Poland, RESMA)	184	8.0
Francisco Sevilla (Spain, SEVFR)	208	10.4	Pierre Martin (Canada, MARPI)	149	8.4
Richard Taibi (USA, TAIRI)	204	21.5	Koetu Sato (Japan, SATKO)	298	8.8

The "endurance" of observers is given in Table 6 showing that the majority of amateurs observe only in a single year. A substantial part of these 1760 observers is formed by 1998 Leonid watchers who are very much encouraged to take part in observations this year, too. Observers who have watched in at least three years form 31% of all observers. We find even three observers who contributed to the *VMDB* in all the 15 years. There will be more of these long-term observers once the files prior to 1988 have been updated more systematically.

Table 4 – Contributions to the effective observing time of observers with only a few observing nights.

Number of nights per observer	1	≤ 2	≤ 3	≤ 4	≤ 5	< 25
Percentage of the total T_{eff}	2.7%	5.0%	7.1%	9.4%	11.7%	35.3%

Table 5 – Distribution of observers versus their first year of reporting to the *VMDB*.

First year	Observers	First year	Observers	First year	Observers
1984	64	1989	208	1994	184
1985	167	1990	175	1995	199
1986	121	1991	165	1996	273
1987	95	1992	122	1997	253
1988	239	1993	305	1998	435

Table 6 – Distribution of observers versus the duration of their activities in years.

Duration	Observers	Duration	Observers	Duration	Observers
1	1760	6	77	11	38
2	328	7	57	12	22
3	258	8	53	13	10
4	179	9	40	14	2
5	132	10	46	15	3

Apart from the major meteor showers, the *VMDB* endeavors to store information on minor meteor showers, too. Weak-activity showers require much more care upon associating meteors with the radiants than major showers, since the relative error of a mis-classification is much larger. Plotting meteors into star charts with a careful analysis after the observation is the best way of minor-shower observing. Table 7 shows the development of the proportion of "plotting" observations over the years. The percentage shows no significant trend, probably because the number of medium-experienced observers starting to plot meteors is comparable to the number of new-comers starting with a major shower in the same year.

Table 7 – Development of observations during which meteors are plotted into star charts.

1990	1991	1992	1993	1994	1995	1996	1997	1998
$1042^{\mathrm{h}}.73$ 23%	$1272^{\mathrm{h}}.62$ 24%	$1902^{\mathrm{h}}.78$ 42%	$1570^{\mathrm{h}}.55$ 21%	$1381^{\mathrm{h}}.37$ 25%	$2267^{\mathrm{h}}.34$ 34%	$1854^{\mathrm{h}}.03$ 24%	$2716^{\mathrm{h}}.85$ 28%	$3112^{\mathrm{h}}.75$ 28%

The 1998 Leonids have attracted a variety of casual meteor observers, mostly amateur astronomers, who logged a meteor observation for the first time. Since highest activity was expected over Asian geographical longitudes, amateurs from a number of countries new to the *VMDB* contributed with reports. Therefore, I think it is helpful to summarize a few observational principles, below, for the sake of improving the quality of future reports.

3. Improvements in reporting observations

Despite the growing flux of observations, which helps us in achieving global data collecting, we should not forget to remind the contributors to sustain a high level of quality in both meteor recording and observational reports.

An item which is often neglected in observational reports is the *center of the field of view*. Indeed, meteor numbers and brightness depend on the elevation of the field of view. In many cases, the deviations will be small, but can be significant under peculiar circumstances as shown in the analysis of the 1998 Leonid shower in [4].

> *I strongly recommend to give the center of the field of view. Please give the field in degrees for both the right ascension and the declination. An accuracy of* 10° *is sufficient.*

A given field center automatically allows the study of the dependence of meteor numbers and characteristics versus radiant distance of the field. The field center also allows to judge on how difficult it was for the observer to discriminate specific meteor showers.

The *breakdown* of an observing night is often too coarse, particularly in the case of major-shower maxima. A former argument in favor of long of periods was the small significance of a few meteors, but this argument has become obsolete. Indeed, the considerable amount of data covering the same period now permits the derivation of reasonable results, since many short periods can be stacked for a reliable average.

> *The observation may be broken down into groups of 10–20 meteors per period. For the case of a major-shower maximum, this can result in 10-minute or 15-minute periods.*
>
> *Please do not forget to give the numbers of other than the major-shower meteors and sporadics for the same short periods.*
>
> *Magnitude distributions of major showers should also be broken down into several per night. A good quantity in a distribution is 20–30 meteors.*
>
> *Please use the same time marks for the magnitude breakdown as in the breakdown of observing periods. This is not a scientific requirement; it is just more convenient for the utilization of your reports.*

The *distinction between a zero-meteor shower and a shower not observed* should by all means be clear. There is an enormous difference between not considering a particular shower during observation/analysis and considering that shower but observing no meteors from it. Observers often tend to use a slash or a hyphen if they did not see meteors from a shower. This is most misleading. Sometimes, a shower which was observed but from which no meteors were seen during the entire session does not even appear in the table header!

> *Please mark exactly those showers which you considered during your observation and, in the table of periods, distinguish between "–" (not considered during that period) and "0" (considered, but no meteors seen during that period).*

Finally, you must mention the *observing method.*

> *Do not forget to mention your observing method on the form, which is "C" for "counting" (direct shower association under the sky; e.g., simple tape-recorder observation), "P" for "plotting" (meteors were plotted into star charts), and "R" (meteor positions were recorded on tape or paper using reference objects).*

Plotting meteors has two main purposes:

1. The association with meteor showers can be carried out with fairly objective methods, such as the application of standard plotting errors and speed errors for the decision upon shower membership. Plotting is therefore the recommended observing method for all minor showers. (Notice that major showers like the Perseids must be considered minor if observed outside the period around the maximum.) This means, whenever you mark "P" in your observing form, you should have carried out a shower association *after the observation* applying association criteria concerning path direction, angular speed, and meteor length.
2. Plotting allows saving the complete information on the meteors. Plotting makes the observation useful for confirming new showers at any time, since the full information of the meteors is preserved. Whenever shower association criteria have been refined, or better computer programs have been developed for a consistent shower analysis, or just a possible new shower needs to be confirmed, we can easily re-use these plotting observations.

4. Reporting by electronic mail

Whereas the printed visual observing form is widely used, the submission of data in electronic formats is far from standardized. As a general rule, the electronically delivered report should be in a similar format as the printed form (such as given at `http://www.imo.net/visual/imoform.html`). Your report should be composed of simple ASCII characters. For those of you who did not grow up with computers, but started to use them with a screen full of little pictures and buttons, I would like to emphasize, that everything you store on disk with the `Save` menu item from your business text or spread sheet software, is not ASCII. The files you create are unreadable for everybody who has not the particular version of this program. It is unreadable for everybody who has not a PC, but a Unix workstation, for example.

A PC program which is as simple as the purpose we wish to fulfil, is called NOTEPAD. It creates ASCII files, and allows you to type table-like structures by simply tabulating with blank spaces. Notepad uses a character font, which is mono-spaced, i.e., all characters have the same width. Your report may look jumbled when loading it into another program, like your mail program; just send it off, and the recipient will be happy.

I would like to give two examples of an e-mail report here, the first of which will be adequate for a straightforward major-shower observation and requires a minimum of coordinating and typing. Despite their conciseness, contributions like these are most welcome and useful. The second example is a very detailed report for all those who wish to make the maximum of visual meteor observing.

```
Date: 1998/12/13-14
Site: Potsdam (11157)
Position: 13deg 04min E, 52deg 24min N, 30m
Observer: Rainer Arlt (ARLRA)

Time (UT)  Field    Teff   F    lm     GEM    SPO
0203-0230 100 +20  0.45  1.0  6.20   C 15    C 4
0230-0248 100 +20  0.30  1.0  6.15   C 12    C 2
0417-0432 120 +30  0.25  1.0  5.80   C  8    C 1

GEM: -1(2) 0(1) +1(5) +2(8) +3(12) +4(5) +5(2)
SPO: +2(3) +3(2) +4(2)
```

The way of reporting the magnitude distributions ensures that the report is unambiguous, even if you did not manage to use a monospaced character font. The "C" indicates that the meteors were counted and associated with the shower under the sky; they were not plotted. The second example is a marginally modified report by George Zay:

```
DATE: July 14/15, 1998 BEGIN: 4h05 UT END: 7h20 UT
OBSERVER : George J. Zay, IMO code: ZAYGE
LOCATION : Long: 116 deg 37' 30'' West; Lat: 32 deg 50' 18'' North
            Descanso, CA, USA; Elev: 1019 meters, IMO code: 25052

OBSERVED SHOWERS:

SHOWER   RA   DEC.          |     SHOWER   RA   DEC.
SAG      298  -21           |     JPE      344  +16
PAU      328  -34           |     SDA      325  -19
CAP      293  -14           |     NDA      317  -10
PER      007  +53           |
-------------------------------------------------------
OBSERVING PERIODS: For Plottings, 30 sec/meteor was subtracted
from observing times & 10 sec/meteor for Non-plots.
0 = None seen;      / = shower not watched.
PERIOD(UT)  FIELD    Teff  F   LM   SAG   JPE   PAU   SDA   CAP   NDA   PER   Spor
--------------------------------------------------------------------------------
4h05-5h09   264d+13 1.00  1  5.92  P 2   / /   / /   P 0   P 0   P 0   P 0    P 3
5h09-6h15   285d+14 1.00  1  6.00  P 0   P 0   P 0   P 0   P 0   P 1   P 0    P 5
6h15-7h20   297d+09 0.98  1  6.00  P 0   P 1   P 0   P 0   P 1   P 0   P 1    P 3
--------------------------------------------------------------------------------
MAGNITUDE DISTRIBUTIONS:
SHOWER  -6  -5  -4  -3  -2  -1  0  +1  +2  +3  +4  +5  +6  TOTAL
SAG                                     1   1                 2
JPE                             1                             1
CAP                                         1                 1
NDA                                             1             1
PER                                     1                     1
SPOR                     1         1    5   1   1   2        11
-----------------------------------------------------------------
SKY OBSCURED: 0        Ki X Min              1
                       -------- = K'= 0     ------- = F = 1
                        T min                1 - K'
-----------------------------------------------------------------
DEAD TIME: 16.0 minutes (Includes camera operation time.)
BREAKS   : none
Teff     : 2.98 hours
-----------------------------------------------------------------
```

LIMITING MAGNITUDE:

TIME	STAR AREA	STAR COUNT	LM
4h05	15	8	5.8
4h05	13	12	5.9
4h35	13	13	6.0
4h35	15	8	5.8
5h09	5	8	6.0
5h09	13	13	6.0
5h40	5	8	6.0
5h40	13	13	6.0
6h15	5	8	6.0
6h15	13	14	6.0
6h45	5	8	6.0
6h45	13	14	6.0
7h20	5	8	6.0
7h20	13	13	6.0

MEAN LIMITING MAGNITUDE: 5.96

METEOR DATA

#	TIME UT	MAG	SPEED	COLOR	TRAIN SEC	SHWR	MAP #	PLOT
1	4h28	2	2	orange		spor	3	1
2	4h30	3	3	white		spor	3	1
3	4h44	2	3	white		SAG	3	1
4	4h47	1	3	white	1	spor	6	1
5	5h00	3	3	white		SAG	9	2
6	5h10	2	4	white		spor	6	1
7	5h18	5	3	white		spor	9	1
8	5h38	4	4	white		NDA	3	1
9	6h03	2	5	white	1	spor	6	1
10	6h09	4	2	white		spor	9	1
11*	6h12m46s	-2	3	orange		spor	9	2
12	6h29	2	5	white		spor	6	1
13	6h40	5	3	white		spor	9	1
14	6h44	2	5	white		spor	9	2
15	6h47	3	2	white		CAP	6	1
16	7h07	2	5	white		PER	6	1
17	7h13	0	5	white	2	JPE	9	1

7h20 ## STOP

VELOCITY SCALE:	PLOT ACCURACY:
0 = STATIONARY	1 = ACCURATE PLOT
1 = VERY SLOW	2 = NORMAL PLOT
2 = SLOW	3 = GENERALIZED AREA/DIRECTION
3 = MEDIUM	
4 = FAST	
5 = VERY FAST	

All plotting charts are postal mailed to Rainer Arlt of IMO.
* Meteor #11 was photographed. Information about it will be mailed to Juergen Rendtel.

Two showers could not be analyzed reasonably in the first period, since their radiants were below or near the horizon. They are clearly distinguished from "none observed." The July Pegasids and the Perseids are actually not active according to the *IMO Shower Calendar*—a fuzziness of the activity limits of a few days is allowed though.

The development of clear instructions—mainly with programmers of meteor software in mind—on how a standard output of an observing report should look like are planned for the near future.

5. Availability of the VMDB

The data are published in the annual *WGN Observational Report Series*; the 1999 issue containing the 1998 observational data contains 288 pages [5]. The database is also available in the form of ASCII text files at the Internet home page of the *IMO*: `http://www.imo.net/visual/vmdb.html`. The data are freely available, provided (*i*) they are used for scientific and/or educational purposes, and (*ii*) articles in which these data are used contain appropriate reference to the *VMDB* archives in their publications, either in the form of *a citation of this article* or a citation of the specific *WGN Observational Report Series* volume (see, e.g., [5]).

6. Other visual meteor archives

A positional meteor database PosDat was created in 1991 [6]. The main purpose was to make available a compact database with visual, telescopic, photographic, and video meteor positions. The general information about the observations was reduced to a minimum necessary for radiant searches.

A much more comprehensive system for visual meteor observations has been developed by Rattei and Richter [7]. The VisDat system was created to simplify and standardize the observer's input and analysis of a meteor observation. It thus saves nearly the full information of the field log in a database, including meteor positions. The actual database format is a superset of the PosDat structure. The big advantage is the objective shower association according to standard criteria reducing the uncertainties to the plotting and speed errors during the observation.

Acknowledgments

Personally and on behalf of analysts of the data, I would like to express my gratitude to all the observers who contributed to the *VMDB*. I would like to specially thank Jürgen Rendtel and Luis Bellot Rubio for their help in typing in observations from Germany and Spain. I felt all the work is worth being done, encouraged by the enthusiasm of amateur astronomers. I would also like to thank professional astronomers who realized this archive and its output is not just an amateurs playground, but a substantial source of scientific material, gathered by amateurs. The combination of professional and amateur work makes astronomy such a world-wide fascinating field.

References

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[2] R. Arlt, "The Present Visual Meteor Database", *WGN* 23, 1995, pp. 4–5.

[3] G. Baldacchino, "Observing the Meteor Observer. A Global Survey of Meteor Observers", *WGN* 24, 1996, pp. 187–200.

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[5] R. Arlt, *WGN Observational Report Series* 11, 1999, pp. 1–288.

[6] D. Koschny, "PosDat—The Positional Meteor Database of the IMO", *WGN* 20, 1992, pp. 136-139.

[7] J. Richter, "VisDat: A Database System for Visual Meteor Observations", *WGN* 27, 1999, pp. 2–4.

Hints for Visual 1999 Leonid Observations

Rainer Arlt

1. The prediction

Summarizing the predictions in short, we expect a strong, narrow outburst of Leonids in November 1999. Since the behavior of the 1998 Leonids and that of many previous years and epochs can be reconstructed with particle models in impressive agreement with the observations, the prediction following from the same models are thought to be quite accurate, too (see, e.g., [1,2] for such models). According to [3], a to-the-minute prediction is possible for November 18, 2^h08^m UT. This is the time of passing the closest dust trail which was ejected by the parent Comet 55P/Tempel-Tuttle in 1899. Meteoroids from other epochs will add to this picture, but strongest activity is expected for this time with no larger deviation than one hour according to the fully independent study in [2]. The maximum ZHR is supposed to be of the order of 1000, but half or twice this value is easily possible, since the prediction of rates is most difficult. Maximum visible rates under a magnitude +6.5 sky will range from almost 15 meteors per minute as seen from the Near East to about 5 meteors per minute on the Canary Islands where the radiant is significantly lower.

2. The observation

In case of very high rates, you will run into problems of noting shower and magnitude information for each meteor. First, drop the shower information from your log. The contamination by sporadic meteors will be negligible, whereas the magnitude information is most essential for understanding the Leonid meteoroid stream. Try to report **magnitudes for each meteor as long as possible**. Your notes, whether on tape or on paper, will just be a sequence of numbers—the magnitudes—plus regular time marks (see below).

As it is highly probable that the main activity will be caused by particles recently ejected from the comet (1899 is only three revolutions ago), we expect a lot of faint meteors in the shower. An abundance of meteors might reduce the attention of the observer to the nicely bright meteors (which will be numerous, even though the population index may be high). Please **keep up your vigilance** even if the show suggests you to just "sit back."

Limiting magnitude estimates will be difficult during an outburst. At least, you should obtain a limiting magnitude estimate shortly before and a limiting magnitude shortly after the outburst. If the conditions change during extraordinary activity, you may note relative measures like "Lm reduces by 0.1" simply according to your impression. Another possibility is a short break in your observation for **limiting magnitude determination**. This is certainly the more accurate way, though we will lose a minute or two in recording meteors, which is not considered to be a dramatic loss.

3. The observing report

If a strong Leonid outburst materializes, we will experience very quick changes in the visible rate of meteors. The information of the activity profile should not be smeared out by choosing observing periods that are too long. Be sure to have enough time marks in your notes. If the rate reaches 3 meteors a minute or more, you can talk on your tape-recorder in real time, that is, without stopping the device. You are then free to make observing periods of down to a minute duration after your observation. Since the recording and replay speed may not be exactly the same, you should speak a few time marks (say every 10 minutes) onto your tape for calibration.

A perfect observing report will list **short periods with less than 10 meteors each**. If the ZHR goes beyond 1000, it might be possible that you will report periods shorter than a minute. In a similar way, magnitude distributions should contain about 20 meteors, seen in a period of possibly as short as two minutes (if you manage to speak magnitudes for all meteors on the tape). Remember that your individual count for such short periods may not look significant, but the combination of many of these periods reported by many observers at the same time, will yield precise values for the shower's population index and activity in high temporal resolution.

Please, do not forget to give the main **direction of your field of view**, which is necessary to reduce meteor numbers to actual spatial number densities of meteoroids in the stream, or to flux densities. Field centers should not be chosen below 50° elevation.

Remember that the **cloud cover factor refers to the field of view** only, not to the entire sky, since we wish to correct only the individual observer's rate, not that of the entire sky. The typical field of view in which 98% of the meteors are seen has a diameter of roughly 100°. If clouds appear behind you or near the horizon, not affecting your field, you should not give an obstruction correction in the observing report.

We will be grateful if you send your reports to the *IMO Visual Commission, c/o Rainer Arlt, Friedenstraße 5, D-14109 Berlin, Germany*, or by electronic mail to `arlt@compuserve.com` (avoiding possible system overload at the *IMO* server).

4. References

[1] D. Asher, M.E. Bailey, V.V. Emel'yanenko, "Resonant meteoroids from Comet Tempel-Tuttle in 1333: the cause of the unexpected Leonid outburst in 1998", *Mon. Not. R. Astr. Soc.* 304, 1999, pp. L53–L56.

[2] P. Brown, *Ph.D. Thesis*, Univ. of Western Ontario, London, 1999.

[3] R. McNaught, D. Asher, "Leonid Dust Trails and Meteor Storms", *WGN* 27, 1999, pp. 85–102.

Call for photographs and reports

Of course, you should make it a priority to send your observations to Rainer Arlt and/or other relevant commission directors as quickly as possible after the observations so that we can make a reliable first assessment of the Leonid activity shortly after the event.

Since we anticipate a lot of people will set up expeditions of some sort and also try to photograph the Leonids, we call upon you to send your most spectacular pictures to WGN—they may be selected for the front cover—and to make a report of your observations for your fellow meteor workers to read in this journal!

Marc Gyssens, Ed.

Ongoing Meteor Work

Global Analysis of the 1998 Perseid Meteor Shower

Rainer Arlt

Despite the Full Moon near the 1998 maximum of the Perseids, 19 171 Perseids were recorded by 420 observers. The strong Perseid peak, which has been observed since 1988, was most probably located at $\lambda_\odot = 139^{\circ}.75 \pm 0^{\circ}.03$ (August 12, $15^{\rm h}40^{\rm m}$ UT) with a maximum ZHR of 110 ± 20. Systematic errors in the peak ZHR cannot be ruled out due to the strong interference of the Full Moon. The traditional Perseid maximum was observed at $\lambda_\odot = 140^{\circ}.10 \pm 0^{\circ}.02$ (August 13, $0^{\rm h}25^{\rm m}$ UT) with ZHR = 74 ± 3. The particle fluxes corresponding with both peaks were 0.032 ± 0.005 km^{-2}h^{-1} and 0.020 ± 0.003 km^{-2}h^{-1}, respectively. These numbers convert to 150 ± 23 and 93 ± 13 particles per 10^9 km^3. An additional enhancement of activity at $\lambda_\odot = 140^{\circ}.35$ (August 13, $6^{\rm h}40^{\rm m}$ UT) as observed in 1997 was also found in the 1998 data with the same position and activity level.

1. Observational records

Last year, when a near-Full Moon interfered with the Perseid maximum, many observers must have wondered, "is this only because of the poor limiting magnitude or is the activity really low?" The large number of observations involved in this analysis suggests that the activity level of the traditional maximum is not extraordinarily low, and neither is the particle population in the stream. The amount of data gathered for the 1998 Perseids is indeed quite substantial—a total of 19 171 Perseids was recorded in $3476^{\rm h}.05$ observing hours by 420 observers from 27 countries. I would like to thank all observers for their efforts and patience despite the poor conditions:

Sana'a Abdo (ABDSA, $14^{\rm h}.55$), Zaid Abdullah (ABDZA, $3^{\rm h}.55$), Velibor Adzic (ADZVE, $26^{\rm h}.17$), Iyad Ahmad (AHMIY, $4^{\rm h}.50$), Juan Carlos Alcázar (ALCJU, $4^{\rm h}.47$), Ziad Al-Khatieb (ALKZI, $14^{\rm h}.16$), Ahmad Al-Niamat (ALNAH, $9^{\rm h}.50$), Ibrahim Al-Sabban (ALSIB, $6^{\rm h}.25$), José Alvarellos (ALVJO, $2^{\rm h}.13$), Jaroslav Ambroz (AMBJA, $6^{\rm h}.15$), Marcel Andrejko (ANDMR, $2^{\rm h}.50$), Rainer Arlt (ARLRA, $13^{\rm h}.23$), Timofey Avilich (AVITI, $3^{\rm h}.20$), Ivo Babarovič (BABIV, $2^{\rm h}.90$), Branislav Baca (BACBR, $9^{\rm h}.59$), Paolo Bachini (BACPA, $2^{\rm h}.58$), Anton Badac (BADAN, $0^{\rm h}.55$), Pierre Bader (BADPI, $1^{\rm h}.90$), Lars Bakmann (BAKLA, $2^{\rm h}.60$), Igor Baluk (BALIG, $2^{\rm h}.56$), Ladislav Balint (BALLA, $2^{\rm h}.52$), Ana Bankovic (BANAN, $11^{\rm h}.12$), Geert Barentsen (BARGE, $7^{\rm h}.54$), Michal Bares (BARMC, $9^{\rm h}.33$), Luc Bastiaens (BASLU, $5^{\rm h}.90$), Wienik Beirinckx (BEIWI, $2^{\rm h}.49$), Pavel Belov (BELPA, $5^{\rm h}.30$), Pavol Belcak (BELPV, $8^{\rm h}.22$), Orlando Benítez Sanchez (BENOR, $33^{\rm h}.87$), Rastislav Beres (BERRA, $1^{\rm h}.83$), Nikola Biliskov (BILNI, $12^{\rm h}.72$), Tina Bizjak (BIZTI, $1^{\rm h}.00$), Franky Blanckaert (BLAFR, $1^{\rm h}.00$), Miroslav Blaho (BLAMI, $11^{\rm h}.79$), Eva Bojurova (BOJEV, $23^{\rm h}.09$), Franziska Böttcher (BOTFR, $3^{\rm h}.45$), Derek Brake (BRADE, $1^{\rm h}.40$), Emil Brezina (BREEM, $0^{\rm h}.55$), Lieve Bresseleers (BRELI, $2^{\rm h}.34$), Paweł Brewczak (BREPA, $17^{\rm h}.02$), Michal Broncek (BROMC, $4^{\rm h}.54$), Milan Capik (CAPMI, $1^{\rm h}.50$), Jens J. Carlsen (CARJE, $5^{\rm h}.64$), Roman Cecil (CECRO, $3^{\rm h}.81$), Milan Cekic (CEKMI, $18^{\rm h}.01$), Milan Cernak (CERMI, $1^{\rm h}.00$), Aleš Cesen (CESAL, $7^{\rm h}.31$), Decho Chakarov (CHADE, $15^{\rm h}.30$), Gaetan Chevalier (CHEGA, $3^{\rm h}.43$), Sylwia Chełmoniak (CHESY, $1^{\rm h}.50$), Marek Chrastina (CHRMA, $5^{\rm h}.16$), Peter Čirip (CIRPE, $15^{\rm h}.92$), Koen Clement (CLEKO, $3^{\rm h}.03$), Thomas Cook (COOTH, $2^{\rm h}.00$), Jana Cyprichova (CYPJA, $3^{\rm h}.35$), Bartosz Dąbrowski (DABBA, $2^{\rm h}.00$), Hani Dalee (DALHA, $6^{\rm h}.96$), Luigi d'Argliano (DARLU, $2^{\rm h}.33$), Miroslava Darakchieva (DARMI, $6^{\rm h}.61$), Goedele Deconinck (DECGO, $8^{\rm h}.98$), Denis Dermadi (DERDE, $16^{\rm h}.48$), Peter Detterline (DETPE, $16^{\rm h}.41$), Didier Dielen (DIEDI, $7^{\rm h}.67$), Lukas Diko (DIKLU, $14^{\rm h}.62$), Elena Dimovski (DIMEL, $1^{\rm h}.66$), Virgilio Dionisi (DIOVI, $1^{\rm h}.00$), Ivan Donik (DONIV, $9^{\rm h}.97$), Radek Drlik (DRLRA, $11^{\rm h}.25$), Waldemar Drozdowski (DROWA, $2^{\rm h}.30$), Sergey Dubrowsky (DUBSE, $5^{\rm h}.39$), Milan Dujava (DUJMI, $12^{\rm h}.11$), Ewa Dygos (DYGEW, $5^{\rm h}.66$), Jarosław Dygos (DYGJA, $89^{\rm h}.70$), Oliver Dzafic (DZAOL, $4^{\rm h}.39$), Marcin Dżuła (DZUMA, $3^{\rm h}.92$), Esvet Emurlova (EMUES, $4^{\rm h}.68$), Bert Everaert (EVEBE, $12^{\rm h}.44$), Emmanuel Fabel (FABEM, $2^{\rm h}.65$), Ramón Fabré (FABRA, $2^{\rm h}.90$), Tomasz Fajfer (FAJTO, $14^{\rm h}.00$), Marian Fenovcik (FENMA, $7^{\rm h}.21$), Marko Fenik (FENMR, $11^{\rm h}.49$), Daniel Ferdinandy (FERDN, $13^{\rm h}.78$), Milan Ferdinandy (FERMI, $2^{\rm h}.83$), Karolina Fialova (FIAKA, $5^{\rm h}.25$), Karol Fietkiewicz (FIEKA, $1^{\rm h}.75$), Anneleen Fransen (FRAAN, $5^{\rm h}.49$), Nobuyuki Fukuda (FUKNO, $0^{\rm h}.50$), Michael Funke (FUNMI, $5^{\rm h}.70$), Marko Gacesa (GACMA, $8^{\rm h}.85$), Marcin Gajos (GAJMR, $18^{\rm h}.63$), Vladimir Gajdos (GAJVL, $13^{\rm h}.49$), Cezary Gałan (GALCE, $12^{\rm h}.27$), Svetlana Gavrishina (GAVSV, $5^{\rm h}.68$), Lucia Gecelovska (GECLU, $1^{\rm h}.42$), Robert Gehlhaar (GEHRO, $3^{\rm h}.58$), Christoph Gerber (GERCH, $2^{\rm h}.00$), Jaroslav Gerboš (GERJA, $6^{\rm h}.13$), Ivanka Getsova (GETIV, $13^{\rm h}.76$), Maarten Gillis (GILMA, $5^{\rm h}.25$), George W. Gliba (GLIGE, $2^{\rm h}.00$), Shelagh Godwin (GODSH, $2^{\rm h}.75$), Ivan Goethals (GOEIV, $6^{\rm h}.03$), Roberto Gorelli (GORRO, $1^{\rm h}.00$), Lew Gramer (GRALE, $5^{\rm h}.02$), Robin Gray (GRARO, $2^{\rm h}.58$), Valentin Grigore (GRIVA, $5^{\rm h}.79$), Matthias Growe (GROMA, $1^{\rm h}.02$), José Luis Guixeras Romero (GUIJO, $2^{\rm h}.23$), Andrej Guliš (GULAN, $3^{\rm h}.00$), Pavol Habuda (HABPA, $12^{\rm h}.61$), Cathy Hall (HALCA,

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(MATMH, 0^h37), Alastair McBeath (MCBAL, 3^h67), Lukas Merey (MERLU, 1^h42), Jana Micikova (MICJA, 5^h10), Ivica Mihaljevic (MIHIV, 16^h29), Pavel Mikulka (MIKPA, 12^h50), Roman Mikusinec (MIKRO, 4^h22), Ana Milovanovic (MILAA, 3^h44), Ana Milosavljevic (MILAB, 4^h25), Larue Miller (MILLA, 0^h50), Koen Miskotte (MISKO, 19^h61), Rossitsa Miteva (MITRO, 6^h92), Miroslav Mocak (MOCMI, 6^h22), Jarmo Moilanen (MOIJA, 2^h70), Sirko Molau (MOLSI, 3^h78), Ivelina Momcheva (MOMIV, 16^h92), Sigehiro Mori (MORSI, 0^h75), Denisa Mullerova (MULDE, 1^h00), Krzysztof Mularczyk (MULKR, 9^h91), Miguel Angel Muñecas (MUNMI, 1^h10), Jaroslav Murin (MURJA, 13^h78), Minoru Muraki (MURMI, 6^h73), Sven Näther (NATSV, 23^h88), Robert Necela (NECRO, 1^h40), Jovan Nedeljkovic (NEDJO, 12^h55), John Newton (NEWJO, 4^h00), Kevin Nicasi (NICKE, 5^h27), Dalibor Nikolic (NIKDA, 14^h50), Mirko Nitschke (NITMI, 7^h03), Matus Novak (NOVMA, 3^h40), Daniel Očenáš (OCEDA, 5^h75), Mohammad Odeh (ODEMO, 4^h81), Ibrahim Odwan (ODWIB, 9^h95), Teemu Öhman (OHMTE, 4^h40), Kazuhiro Okishio (OKIKA, 0^h75), Arkadiusz Olech (OLEAR, 29^h35), Jan Ondrus (ONDJA, 12^h14), Peter Onufrak (ONUPE, 2^h85), Artyom E. 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The observers came from the following countries, ensuring good coverage of the activity:

Australia, Belarus, Belgium, Bulgaria, Canada, China, Croatia, Czech Republic, Denmark, Estonia, Finland, Germany, Hungary, Israel, Italy, Japan, Jordan, the Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, United Kingdom, United States, and Yugoslavia.

The lunar interference with the most interesting part of the activity period regrettably reduces the value of this impressive number of reports. On the other hand, as we can conclude about the 1998 Perseid activity level, we recognize that, given a considerable number of reports collected from all around the world, fairly accurate results can be obtained from Full-Moon shower maxima. The following analysis is a comprehensive update on the first graphs shown in [1].

2. The population index

In a first attempt, we applied the general method of deriving individual population indices for each observer and averaging these into bins of variable size. The smaller number of observations and the smaller numbers of Perseids therein required slightly more liberal criteria for the computation of population indices than we usually apply, such as (*i*) at least 5 consecutive magnitude classes should be filled with at least 1 meteor, (*ii*) the magnitude distribution should contain at least 15 meteors, and (*iii*) the faintest magnitude class should be at least 1.5 magnitudes from the limiting magnitude. These criteria selected 227 records out of 1327 magnitude distributions. After the computation of individual population indices, all records with a correlation coefficient of less than 0.98 were removed, which were 19 out of 227 records. Figure 1 shows the profile of average population indices. The profile hardly provides convincing results, since the averages are based on very few (even though meaningful) individual r-values.

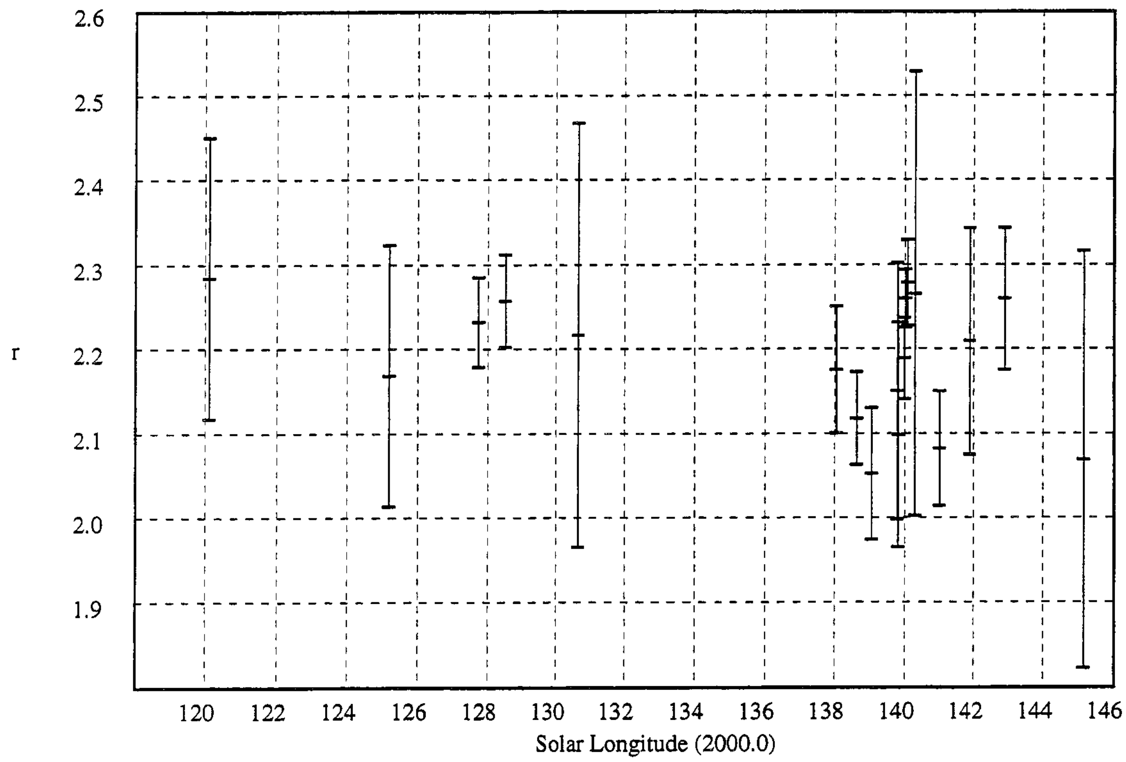

Figure 1 – Population index profile as computed from averaged population indices

An alternative method avoids the computation of individual r-values and the omission of so many records due to the above criteria which require the individual r-value to be meaningful. Magnitude distributions of several observations are "stacked" instead. The actual meteor magnitudes do not help in this respect, since the probability to detect a meteor of a given magnitude depends on the observer's limiting magnitude. We do not average the magnitudes which give little information on the r-value, but the *magnitude distance from the limiting magnitude*. The average distance is an unambiguous function of the population index. The function has been kindly derived and supplied by Janko Richter [2].

Figure 2 shows the population index profile as computed according to the second method. Much more records are included in this profile, since the individual observations need not fulfill criteria of meaningfulness, but rather add to each other. Numerical simulations delivered the population index errors given in Figure 2. We will provide full detail of the analysis method in a future article in *WGN*.

The strong increase of r near $\lambda_\odot = 135°$ is supposed to be due to the near Full Moon. The r-maximum may have revealed a typical observing error here: observers may tend to estimate magnitudes comparing the meteors with memories instead of real stars. That is, a meteor which is "as faint as that" is estimated to be +5 "as usual," but it is not taken into account that, now, under a sky with a significantly decreased limiting magnitude, a meteor "as faint as that" will have another, brighter magnitude. This observational behavior would result in an r-value that is too high.

A profile of the average limiting magnitudes belonging to the population indices of Figure 2 is given in Figure 3. The minimum near Full Moon is a clear indication of the relative poorness of results at least between solar longitudes $\lambda_\odot = 133°$ and $\lambda_\odot = 139°$. After $\lambda_\odot = 139°$, the larger number of observations provides fairly accurate r-values despite the Moon. Actually, the limiting magnitude does not influence the computation of the population index (as long as the true magnitude distribution is a power law), but the observer faces unusual conditions, and even experienced observers might record systematically erroneous data.

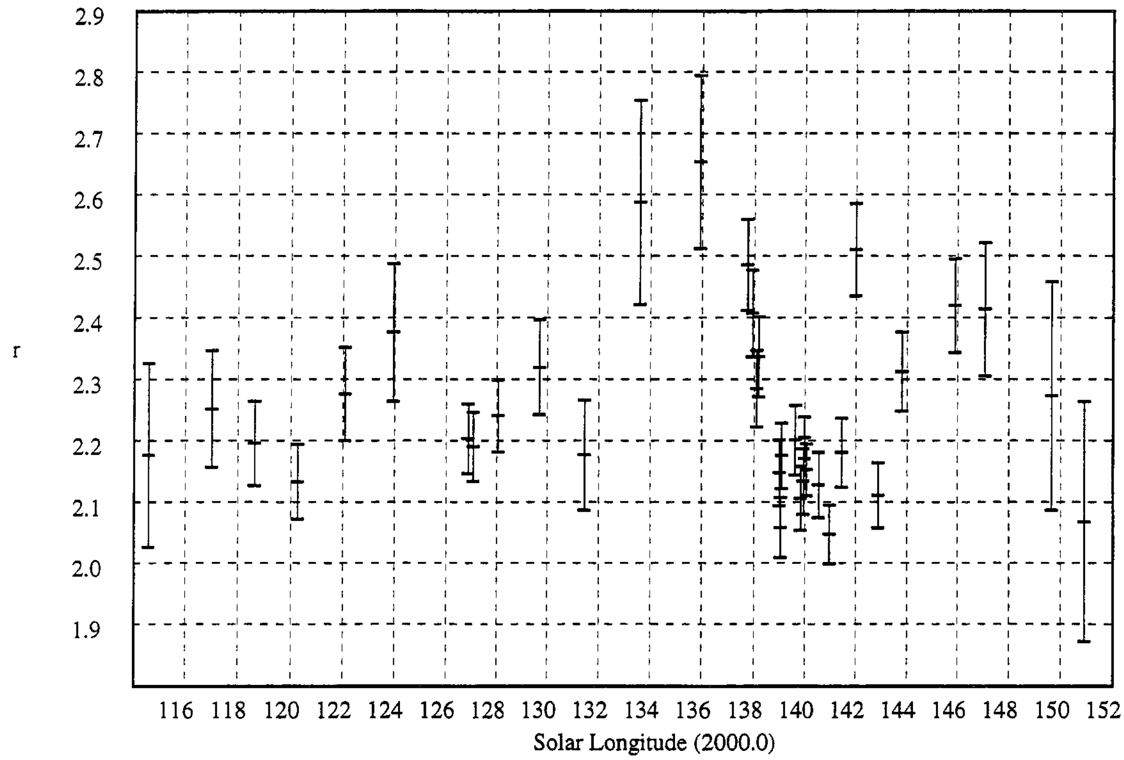

Figure 2 – Population index profile as computed from the average magnitude distance from the limiting magnitude.

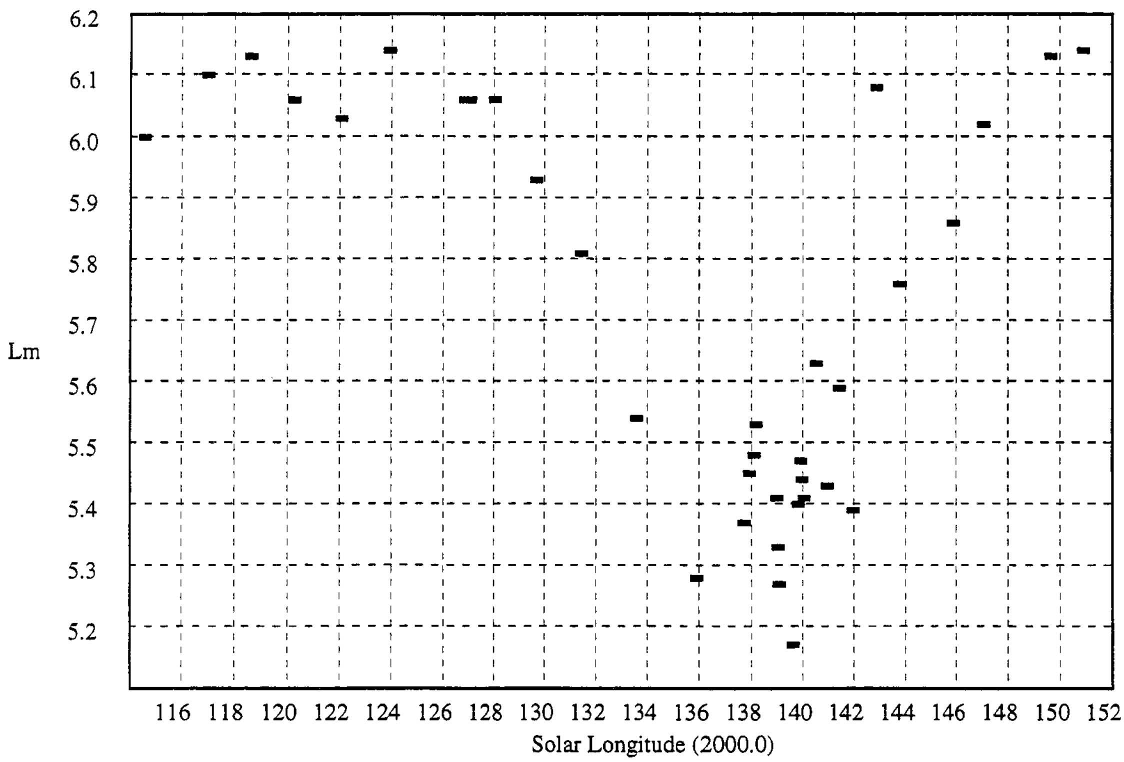

Figure 3 – Limiting magnitude profile showing the influence of the Full Moon shortly before the Perseid maximum in 1998.

Comparing this feature with previous analyses, we find a slightly enhanced population index in 1997 with $r = 2.28$ near $\lambda_\odot = 134.^\circ5$ and a decreasing population index after $\lambda_\odot = 135.^\circ5$ in 1994; the profile is not covered before this date in that year, and the 1996 analysis only starts with $\lambda_\odot = 137.^\circ6$. We may thus conclude that there is weak support for the enhanced-r feature in the Full-Moon period.

A general feature of the 1998 Perseid profile, apart from the r-peak near $\lambda_\odot = 135^\circ$, is the relatively high level of r, though the amplitude of the variations is the same as in other years (0.5). The details of the population index profile of Figure 2 for the days near the maximum are given in Figure 4. The population index never goes below 2.0, whereas Perseid maxima in previous years always showed a clear minimum reaching $r = 1.8$. The minimum is actually found at $\lambda = 141^\circ$ (August 13, 23^h UT) with $r = 2.05 \pm 0.05$.

We found the same value at that time for the 1997 Perseids [3] being also a local minimum. In fact, also the analyses of the 1994 and 1996 Perseids [4,5] show the same population index, though no minimum at all.

It is not possible to conclude about distinct small-scale features; not even the "new" Perseid activity peak coincides with a clear dip in the population index anywhere between $\lambda_\odot = 139.^\circ5$ and $\lambda_\odot = 140.^\circ0$.

The population indices are computed with an adaptive window width which changes according to the number of meteors available. The data points between solar longitudes $\lambda_\odot = 137.^\circ5$ and $\lambda_\odot = 141.^\circ5$ reached the required number of 1000 meteors. Additional criteria for the adaptive window algorithm are a maximum window width which is 4° of solar longitude for this profile (shifted by 2°, see the left part of Figure 2) and a minimum step which is $0.^\circ1$ in solar longitude in the profile shown in Figures 2 and 4.

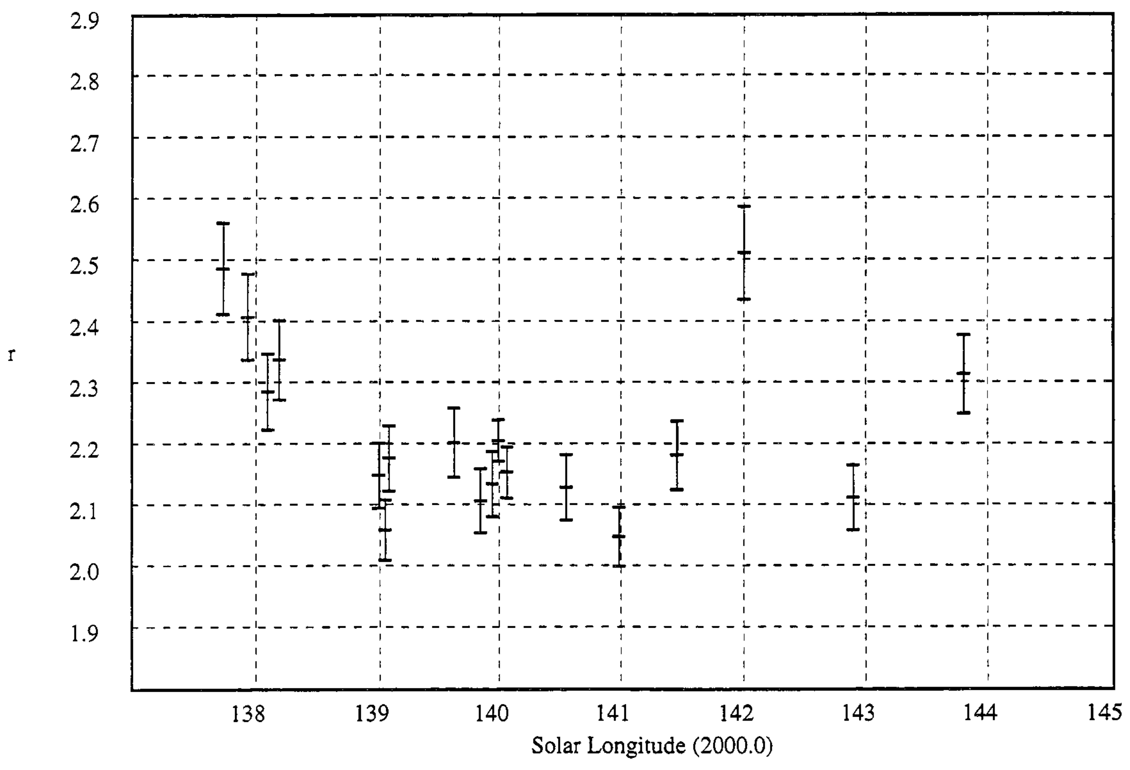

Figure 4 – Details of the population index profile near and after the maximum.

3. The ZHR profile

Using the population index profile given in Figure 2, we computed the activity profile by

$$\overline{\mathrm{ZHR}} = \left(1 + \sum_i n^{(i)}\right) \Big/ \sum_i \frac{T_{\mathrm{eff}}^{(i)}}{C^{(i)}}$$

with

$$C^{(i)} = r^{6.5-\mathrm{Lm}^{(i)}}\, F^{(i)} / \sin h_{\mathrm{R}}^{(i)},$$

where $\mathrm{Lm}^{(i)}$ are the stellar limiting magnitudes, $F^{(i)}$ the correction factors for field-of-view obstructions, and $T_{\mathrm{eff}}^{(i)}$ the effective observing times of the individual observing periods. The factor $\sin h_{\mathrm{R}}^{(i)}$ is basically the geometric correction for the radiant elevation h_{R}, here computed as the numeric average over the observing period, which is more precise than the sine of the radiant elevation of the middle of the period.

The addition of one "meteor" in the $\overline{\mathrm{ZHR}}$ formula results from small-number statistics: A rate $\bar{R}$ is the expected value of a whole distribution of possible events R which can produce a visible meteor number n. According to Poissonian statistics,

$$\bar{R} = \int_0^\infty p(R)\, R\, dR = \frac{1}{n!} \int_0^\infty R^{n+1}\, \mathrm{e}^{-R}\, dR = n + 1.$$

The effect is only relevant in case of small meteor numbers. Again, more details will follow in a paper on the analysis method in a future issue of *WGN*.

A clear maximum in Figure 5 can be associated with the "new" activity peak of the Perseids as detected in 1988 for the first time, though it can hardly be called "new" after more than 10 years. This peak has shown remarkable activity levels above 200 in 1991–1994. The highest value of the 1998 Perseids reaches ZHR $= 191 \pm 17$ at $\lambda_\odot = 139.^\circ 75$ (August 12, $15^{\mathrm{h}}40^{\mathrm{m}}$ UT). Only three observing periods constitute this value. Systematic observers' characteristics are not averaged out in such a small sample, and the true uncertainty is larger than the statistical error bar. Using more liberal selection criteria, in particular omitting the usual selection of observation with a total correction $C > 5$, provides us with a sample which is about twice as large.

There is a chance to reduce systematic errors of individual observers if we check sporadic rates. The average sporadic rate in the period $\lambda_\odot = 139.^\circ 9$–$140.^\circ 16$ is $\overline{\mathrm{HR}} = 16.7$, which agrees well with the typical values between 10 and 15, given the fact that a considerable number of observers do not discriminate other, minor showers from the sporadics. The average sporadic rate of $\lambda_\odot = 139.^\circ 6$–$139.^\circ 9$, mostly covered by Japanese observations, is $\overline{\mathrm{HR}} = 34$. Sporadic rates above 50, even reaching 100 can be found in reports from long-term meteor observers. The problem with observations from the same range in geographical longitude emerged already in the 1997 Leonid analysis in [7] where average sporadic rates climbed up to 75. I would like to encourage meteor observers to critically check their observations to make sure they make sense.

It is not wise to directly re-scale the ZHR with the same factor by which the HR is too high/too low. Sporadic rates comprise more faint meteors than the Perseids, and an unsuitably estimated limiting magnitude will affect sporadics and Perseids differently. Hence, the correction should be expressed in a change in limiting magnitude. We tried to solved the problem of overestimated rates by correcting all Perseid ZHRs in the period $\lambda_\odot = 139.^\circ 6$–$139.^\circ 9$ with

$$\mathrm{ZHR}_{\mathrm{corr}} = r^{-\log(\mathrm{HR}/16.7)/\log 3}\, \mathrm{ZHR}$$

where $\log 3$ stands for the approximate population index of sporadic meteors and r is the Perseids' population index at the time of the observation. The average ZHRs resulting from this correction are shaded in Figure 5. Peak time and peak activity level differ from the first, uncorrected attempt. If we want to conclude about time and ZHR of the maximum, we suggest to adopt a combination of both profiles, and a value of ZHR $= 110 \pm 20$ at $\lambda_\odot = 139.^\circ 75 \pm 0.^\circ 03$ appears suitable.

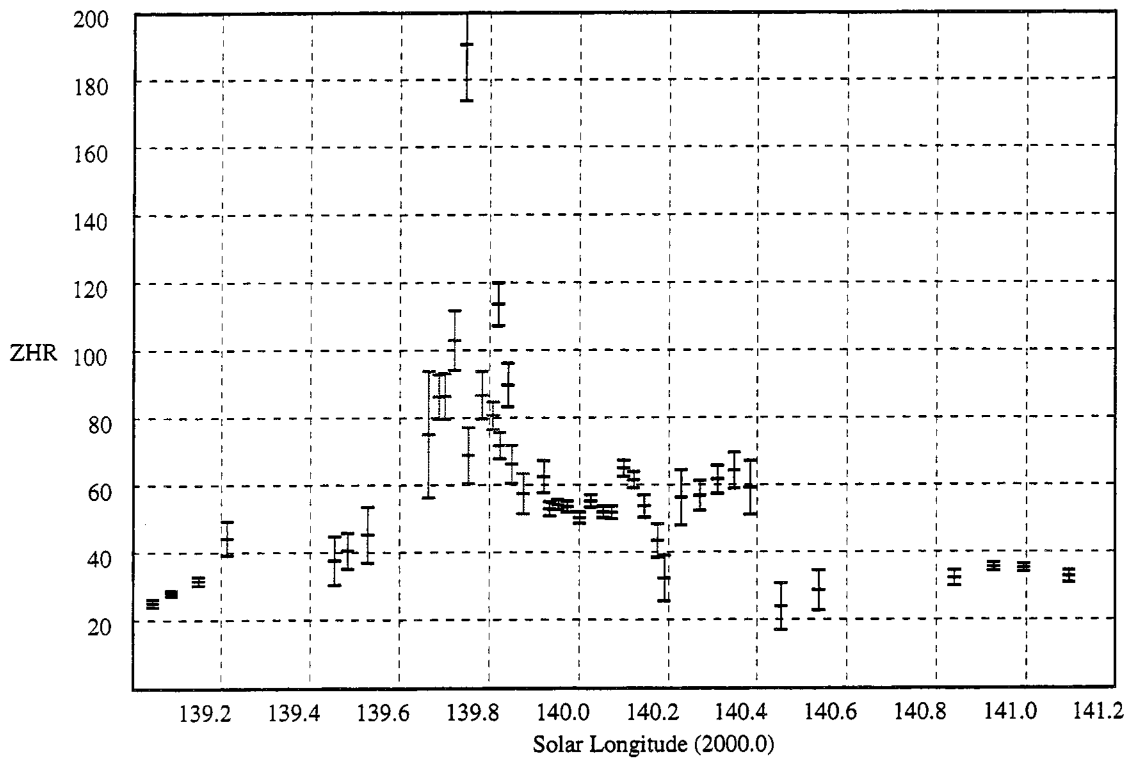

Figure 5 – ZHR profile of the 1998 Perseids for the days near the activity maxima.

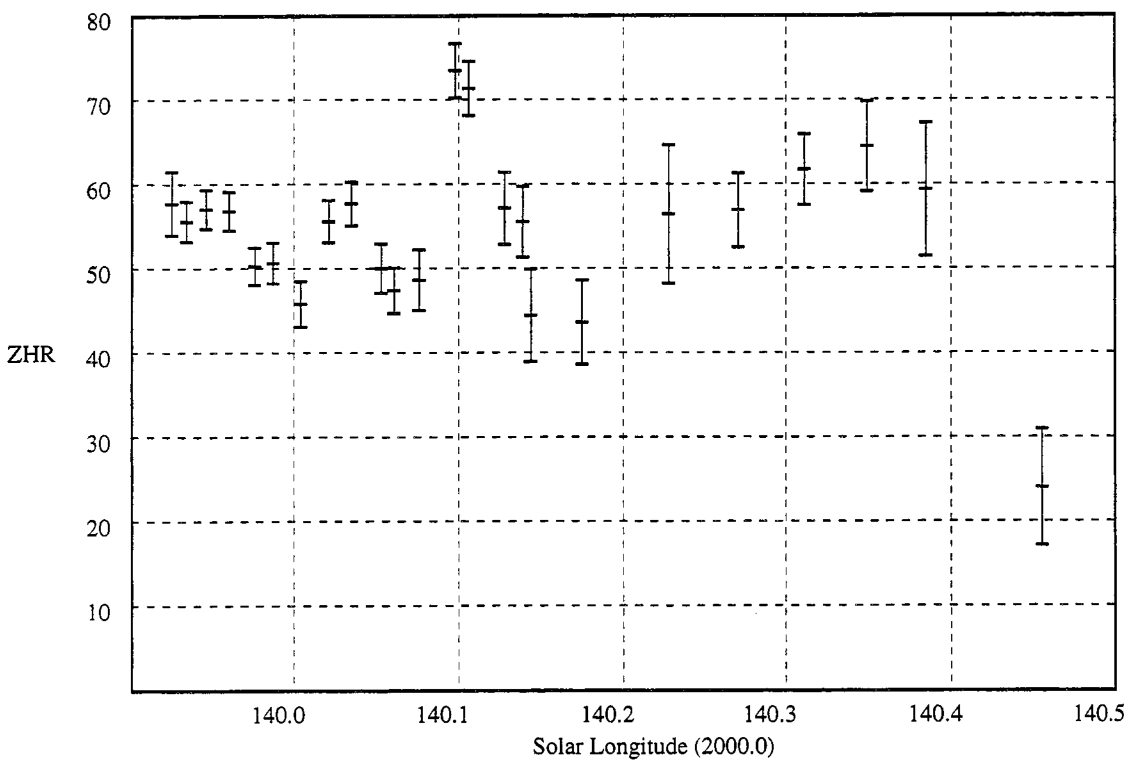

Figure 6 – Details of the ZHR profile near the traditional maximum.

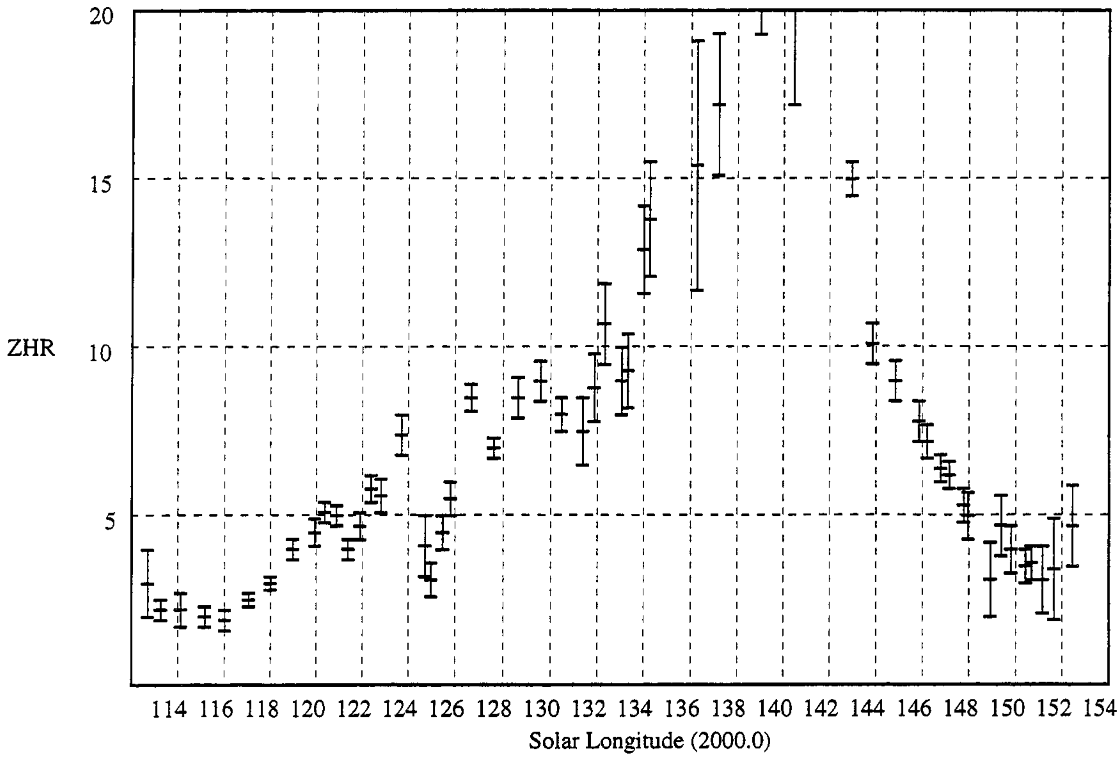

Figure 7 – Lower part of the ZHR-profile of the 1998 Perseids showing variations before and after the maximum.

The traditional maximum of the Perseids is barely pronounced in the ZHR-profile—no value reaches typical ZHRs of near 100 in 1998. A closer look at the period $\lambda_\odot = 139.^\circ9$–$140.^\circ5$ is shown in Figure 6. This graph applied a smaller bin size than the profile in Figure 5. Between $\lambda_\odot = 139.^\circ9$ and $\lambda_\odot = 140.^\circ15$, a window width of $0.^\circ030$ shifted by $0.^\circ015$ was used. The maximum falls at $\lambda_\odot = 140.^\circ10 \pm 0.^\circ01$ (August 13, 0^h25^m UT) with ZHR $= 74 \pm 3$. This maximum is not very distinct; in fact, we observed a plateau of activity between $\lambda_\odot = 139.^\circ9$ and $\lambda_\odot = 140.^\circ4$ with a ZHR-level of 50–60.

Another feature appears to have re-occurred in 1998 after it was observed in 1997: a third maximum in the ZHR a few hours after the traditional one. The agreement is perfect, despite the relatively poor coverage of the specific period in 1998; the maximum time is $\lambda_\odot = 140.^\circ35 \pm 0.^\circ03$ (August 13, 6^h40^m UT) in both years, the ZHR reaches 68 ± 5 in 1997 and 65 ± 5 in 1998.

4. Early activity period

The New Moon end July allowed a perfect coverage of the shower's activity far from its maximum. Figure 7 shows the ZHRs of the entire activity period up to a level of 20. The most striking feature is the clear activity dip at $\lambda_\odot \approx 125^\circ$ (July 28). The lowest value comprises fewer observing periods than the surrounding ZHRs, but still is an average of 22 periods. There is no consistent tendency in previous years, but we find structures in the otherwise gradually increasing ZHR-profile particularly in the period from $\lambda_\odot = 125^\circ$ to $\lambda_\odot = 130^\circ$:

- 1995: activity dip at $\lambda_\odot = 129^\circ$ [8];
- 1996: activity dip at $\lambda_\odot = 130^\circ$ [9];
- 1997: activity dip at $\lambda_\odot = 125^\circ$ [3] and activity peak at $\lambda_\odot = 130^\circ$ [10];
- 1998: activity dip at $\lambda_\odot = 125^\circ$ (this study) and activity peak at $\lambda_\odot = 130^\circ$ [11].

Are these structures a significant feature in the Perseid meteoroid stream emerging as a result of the evolution of the particle orbits? We find a comprehensive particle simulation in [12], giving a distribution of descending nodes of the Perseid particles near the orbit of the Earth.

The "activity level" of 0.8 % of the maximum nodal density is entered by the Earth on July 9, and left on August 15. This is not exactly what we typically find from observations, but the skewness of the profile is very well reconstructed. Yet, there is a short period of 3 to 4 days in the theoretical distribution near August 1 ($\lambda_\odot = 129°$), when the Earth passes an area with lower nodal density. Before this dip, there is a significant peak of nodal density on July 27 ($\lambda_\odot = 124°$), whereas the rest of the distribution consists of more gradual slopes towards and after the maximum. If the various structures observed in the visual ZHR profiles between 125° and 130° express these density fluctuations in the nodal distribution, they constitute an excellent validation for the particle simulations.

5. Particle flux profile

The actual particle numbers moving through a square kilometer per hour are shown in Figures 8, 9, and 10, similar to the ZHR profiles in Figures 5, 6, and 7. These quantities represent the density of particles in the meteoroid stream causing meteors brighter than magnitude +6.5. One should divide the ordinate values by the encounter velocity of 59 km/s × 3600 s/h to obtain the number of particles in 1 km^3, i.e., a flux of 0.02 $km^{-2}h^{-1}$ corresponds to about one particle in ten million km^3.

The peak flux density of 0.055 ± 0.009 $km^{-2}h^{-1}$ (corresponding to a number density of 260 ± 40 particles per 10^9 km^3) is significantly higher than that of 1996 and 1997. The bad influence of the bright Moon cannot be ruled out, which might have caused an underestimated limiting magnitude which will result in both an overestimated ZHR *and* an r-value that is too high, which sensitively controls the flux. This explanation, however, contrasts with the good agreement of the traditional-maximum flux of 0.020 ± 0.003 $km^{-2}h^{-1}$ (93 ± 13 particles per 10^9 km^3) with previous years. If we apply the reduced ZHR-profile as plotted in gray in Figure 5, we arrive at a flux density of 0.032 ± 0.005 $km^{-2}h^{-1}$ (150 ± 23 particles per 10^9 km^3) for the young Perseid maximum.

Table 1 – Details of the ZHR-profile near the maxima.

$\lambda_\odot$ (2000.0)	ZHR	PER	Periods	$\lambda_\odot$ (2000.0)	ZHR	PER	Periods
139.°047	25.3 ± 1.1	496	60	140.°098	73.5 ± 3.2	515	21
139.°089	28.1 ± 0.9	1012	106	140.°106	71.4 ± 3.2	505	20
139.°149	31.8 ± 1.3	593	51	140.°128	57.2 ± 4.3	173	13
139.°213	44.5 ± 5.1	75	5	140.°139	55.6 ± 4.2	177	13
139.°454	(37.9 ± 7.2)	27	3	140.°144	44.5 ± 5.5	64	5
139.°484	40.8 ± 5.4	56	5	140.°175	43.7 ± 5.0	76	6
139.°529	(45.5 ± 8.3)	29	2	140.°228	56.5 ± 8.2	46	3
139.°746	(190.6 ± 16.6)	131	3	140.°271	57.0 ± 4.4	166	9
139.°819	113.8 ± 6.3	328	13	140.°311	61.8 ± 4.2	215	11
139.°841	90.0 ± 6.4	197	10	140.°349	64.5 ± 5.3	150	7
139.°920	62.6 ± 4.7	178	15	140.°385	59.4 ± 7.9	55	2
139.°925	57.8 ± 3.8	231	18	140.°455	24.1 ± 6.9	11	2
139.°934	55.7 ± 2.4	525	42	140.°538	28.9 ± 5.9	23	3
139.°946	57.1 ± 2.3	622	49	140.°840	32.5 ± 2.3	191	19
139.°960	56.9 ± 2.3	618	46	140.°927	35.9 ± 1.2	829	78
139.°976	50.4 ± 2.2	547	41	140.°994	35.5 ± 1.1	956	88
139.°987	50.8 ± 2.4	443	37	141.°097	33.0 ± 1.8	334	30
140.°004	45.9 ± 2.7	284	30	141.°221	39.9 ± 7.4	28	2
140.°021	55.7 ± 2.5	477	37	141.°926	24.5 ± 0.9	742	89
140.°035	57.8 ± 2.6	478	37	141.°934	24.3 ± 0.9	742	90
140.°053	50.1 ± 2.9	290	27	142.°945	15.0 ± 0.5	1105	163
140.°061	47.5 ± 2.7	301	30	143.°843	10.1 ± 0.6	305	74
140.°076	48.7 ± 3.6	184	18				

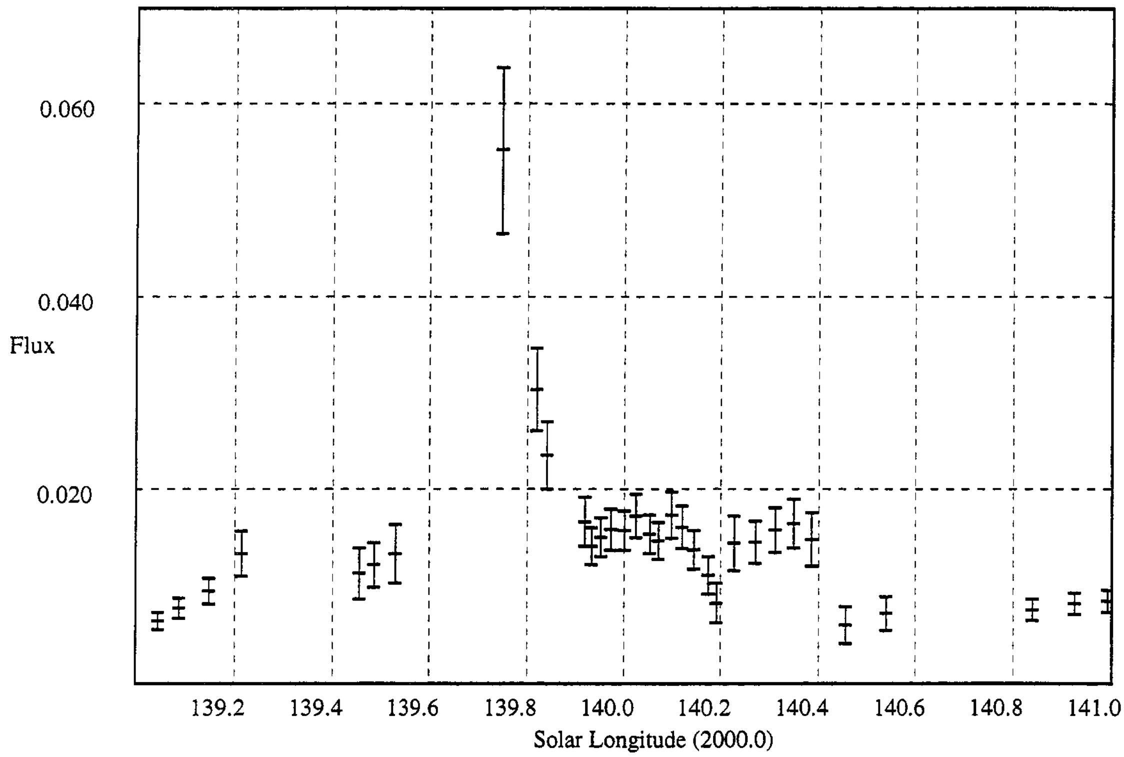

Figure 8 – Particle flux profile of the 1998 Perseids near the "new" maximum. Values are given in units of particles per square kilometer and hour and refer to the number of particles causing meteors brighter than magnitude +6.5.

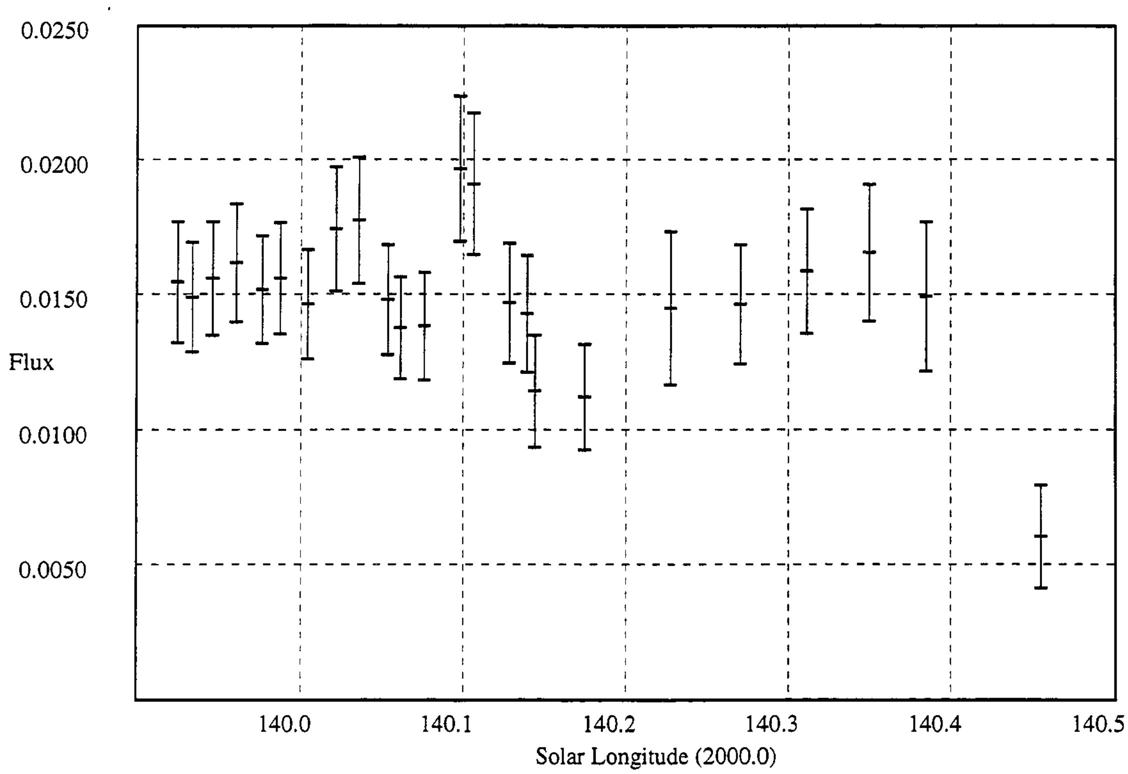

Figure 9 – Flux profile of the 1998 Perseids near the traditional maximum.

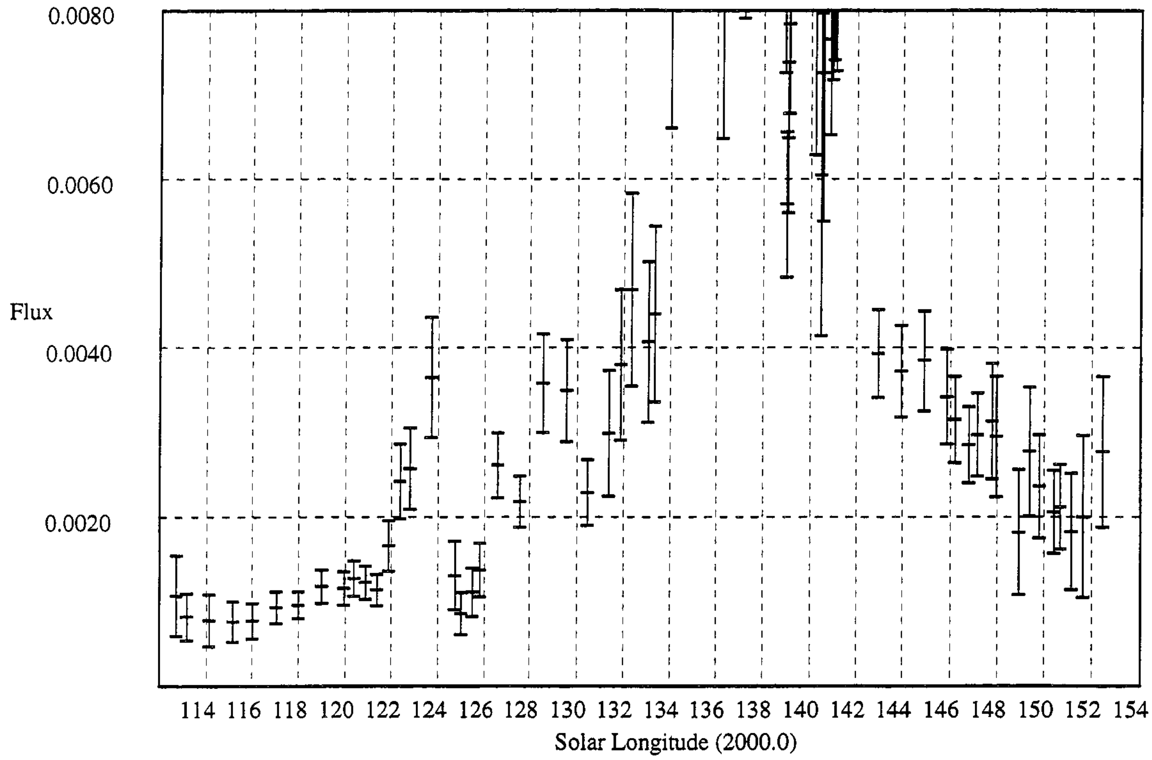

Figure 10 – Lower part of the particle flux profile of the 1998 Perseids.

Table 2 – Summary of Perseid peak data for the period 1988 to 1999, taken from [6], [3], [5], and [13] plus this study. A near-Full Moon interfered with the 1990, 1992, and 1995 results and these should be considered as rough estimates only. The same holds for 1998, in particular the outburst peak near $\lambda_\odot = 139.^\circ75$. Values for 1999 are preliminary, taken from elsewhere in this issue. The particle number density is given in units of particles per 10^9 km^3 causing meteors brighter than +6.5.

Year	$\lambda_\odot$ (outburst)	r	ZHR	$\varrho_{6.5}$	$\lambda_\odot$ (max)	r	ZHR	$\varrho_{6.5}$
1988	$139.^\circ78 \pm 0.^\circ03$	2.0	86 ± 4	97 ± 16	$140.^\circ08 \pm 0.^\circ04$	2.1	106 ± 22	94 ± 14
1989	$139.^\circ56 \pm 0.^\circ03$	2.1	102 ± 10	127 ± 23	$139.^\circ80 \pm 0.^\circ09$	2.1	94 ± 6	120 ± 20
1990	$139.^\circ55 \pm 0.^\circ05$	1.8	75 ± 10	45 ± 35	$140.^\circ54 \pm 0.^\circ2$	2.1	81 ± 61	66 ± 5
1991	$139.^\circ55 \pm 0.^\circ03$	2.2	284 ± 63	494 ± 150	$139.^\circ94 \pm 0.^\circ04$	2.1	97 ± 2	124 ± 20
1992	$139.^\circ48 \pm 0.^\circ02$	(2.1)	220 ± 22	257 ± 60	$140.^\circ13 \pm 0.^\circ2$	2.0	84 ± 34	96 ± 15
1993	$139.^\circ53 \pm 0.^\circ01$	2.0	264 ± 17	242 ± 62	$139.^\circ91 \pm 0.^\circ04$	1.9	98 ± 5	79 ± 34
1994	$139.^\circ59 \pm 0.^\circ01$	1.8	238 ± 17	151 ± 28	$139.^\circ84 \pm 0.^\circ04$	1.9	86 ± 2	69 ± 12
1995	$139.^\circ62 \pm 0.^\circ05$	(2.2)	171 ± 30	290 ± 90	$139.^\circ90 \pm 0.^\circ15$	2.1	65 ± 20	95 ± 20
1996	$139.^\circ66 \pm 0.^\circ03$	2.0	121 ± 17	114 ± 24	$140.^\circ08 \pm 0.^\circ04$	1.7	85 ± 10	76 ± 20
1997	$139.^\circ71 \pm 0.^\circ01$	1.8	137 ± 5	89 ± 19	$140.^\circ03 \pm 0.^\circ03$	1.9	94 ± 2	80 ± 28
1998	$139.^\circ75 \pm 0.^\circ03$	2.1	(110 ± 20)	150 ± 23	$140.^\circ10 \pm 0.^\circ02$	2.2	74 ± 3	93 ± 13
1999	$139.^\circ80 \pm 0.^\circ01$	2.1	104 ± 4	–	$139.^\circ90 \pm 0.^\circ02$	2.3	87 ± 6	–

6. Conclusions

The development of position and activity level of the two main Perseid peaks over the last 11 years is shown in Table 2. The clear migration of solar longitude suggests a convergence with the traditional maximum within two or three years. The nice linear progression of the first maximum allows us to predict a peak time for the 2000 "outburst" component at $\lambda_\odot = 139.^\circ845 \pm 0.^\circ005$ (August 12, 2000, $6^h25^m \pm 10$ min UT) with a maximum ZHR of the order of 100. The particle-integrating model in [14] also suggests similar activity of the young maximum to 1999 and 1998.

The comprehensive particle models in [15] suggest persistent activity from the first maximum with a depression near 2001 or 2002 and a revival in 2004–2006. Peak times were predicted for 1997 ($\lambda_\odot = 139\overset{\circ}{.}68 \pm 0\overset{\circ}{.}04$), 1998 ($\lambda_\odot = 139\overset{\circ}{.}73 \pm 0\overset{\circ}{.}05$), and 1999 ($\lambda_\odot = 139\overset{\circ}{.}76 \pm 0\overset{\circ}{.}05$) which well agree within the error margins with the observed times given in Table 2. It is also concluded that the enormous amount of data gathered in the *Visual Meteor Database* allows the detection of more small-scale features than the double-maximum of the Perseids. It will be a challenge for particle simulating computer codes to reproduce the entire observed variability of the shower. We are looking forward to the global analysis of the 1999 Perseid meteor shower whose maximum perfectly coincided with New Moon. A comprehensive comparison of activity profiles (possibly also from prior to 1988) with the expectedly large 1999 data set will be due.

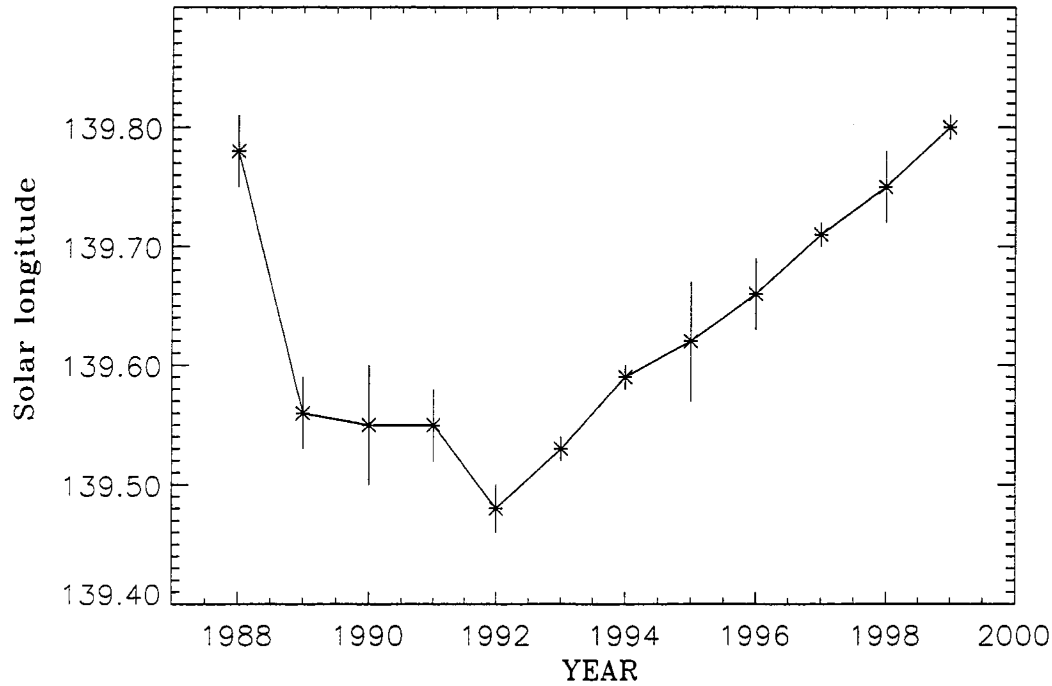

Figure 11 – Evolution of the time of maximum of the outburst component of the Perseids over the last 12 years taken from Table 2. Solar longitudes refer to eq. J2000.0.

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First Results of the 1999 Perseid Meteor Shower

Jürgen Rendtel and Rainer Arlt

A preliminary analysis of the 1999 Perseids based on 17 552 shower meteors seen by 174 observers in 1297 hours is presented. A clear activity peak at $\lambda_\odot = 139^\circ\!.80 \pm 0^\circ\!.01$ (August 12, 1999, $23^{\mathrm{h}}05^{\mathrm{m}}$ UT) with ZHR $= 104 \pm 4$ is associated with the early maximum of the Perseids connected with the return of Comet 109P/Swift-Tuttle. The minimum of the population index occurs 45 minutes after this peak with $r = 1.82 \pm 0.05$. The actual peak coincides with a local r-maximum of 2.10 ± 0.07. The traditional maximum is barely visible in this first ZHR graph; a slight but not significant increase after the early peak was noted at $\lambda_\odot = 139^\circ\!.9 \pm 0^\circ\!.02$ (August 13, 1999, $1^{\mathrm{h}}35^{\mathrm{m}}$ UT) with ZHR $= 87 \pm 6$. Similar to the returns in 1997 and 1998, we found an enhancement of activity after the traditional maximum, this year at $\lambda_\odot = 140^\circ\!.45^{+0^\circ\!.06}_{-0^\circ\!.20}$ reaching ZHR $= 80 \pm 4$.

1. Overview

The Perseids continue to attract the attention of many observers worldwide. Rate data is available for many years, and especially the activity features noted since 1988 added to the continuous observational effort. In 1999 the maximum period of the Perseid was shortly after New Moon, making it an optimal return. Furthermore, the New Moon of August 11 was a total solar eclipse for many populated areas in Europe and Asia, adding to the attention for astronomical topics. Many observers combined their efforts to follow both the eclipse and the Perseids. So the *Visual Commission* of the *IMO* received a huge amount of data already in August and early September. Hence, this first analysis contains almost as many meteor data as the complete analysis of the 1998 Perseids. The full set of observations will be analyzed in the beginning of next year.

The 174 observers from 25 countries reported data on 17 552 Perseids registered in 1297 hours. We acknowledge the prompt reports and give a full listing of the observing times in the following table:

Nada Abanda (ABANA, $2^{\mathrm{h}}67$), Rainer Arlt (ARLRA, $28^{\mathrm{h}}49$), Emad Ashi (ASHEM, $2^{\mathrm{h}}17$), Jure Atanackov (ATAJU, $44^{\mathrm{h}}88$), Juan Alberto Aveledo (AVEJU, $1^{\mathrm{h}}90$), Obel Baez (BAEOB, $1^{\mathrm{h}}88$), Lars Bakmann (BAKLA, $1^{\mathrm{h}}90$), Luc Bastiaens (BASLU, $7^{\mathrm{h}}32$), Ray Berg (BERRY, $1^{\mathrm{h}}08$), Stefan Berkmüller (BERST, $1^{\mathrm{h}}24$), Martin Bily (BILMA, $1^{\mathrm{h}}42$), Nikola Biliskov (BILNI, $0^{\mathrm{h}}84$), Louis S. Binder (BINLO, $1^{\mathrm{h}}66$), Polona Bizjak (BIZPO, $5^{\mathrm{h}}61$), Tina Bizjak (BIZTI, $2^{\mathrm{h}}92$), Zhou Bo (BO ZH, $6^{\mathrm{h}}65$), Lukas Bolz (BOLLU, $5^{\mathrm{h}}67$), Michael Boschat (BOSMI, $2^{\mathrm{h}}00$), Jay Brausch (BRAJA, $9^{\mathrm{h}}00$), Lieve Bresseleers (BRELI, $3^{\mathrm{h}}00$), Gregor Bunčič (BUNGR, $5^{\mathrm{h}}59$), Paco Catalá (CATPA, $2^{\mathrm{h}}68$), Carlos M. Celestrin Campa (CELCA, $6^{\mathrm{h}}32$), Jakub Cerny (CERJA, $2^{\mathrm{h}}28$), Stephanie Chircop (CHIST, $1^{\mathrm{h}}73$), Andrej Cimermanovic (CIMAN, $8^{\mathrm{h}}12$), Stefano Crivello (CRIST, $5^{\mathrm{h}}58$), Tom Crute (CRUTO, $2^{\mathrm{h}}00$), Goedele Deconinck (DECGO, $2^{\mathrm{h}}34$), Denis Dermadi (DERDE, $10^{\mathrm{h}}17$), Vincent Desmarais (DESVI, $2^{\mathrm{h}}89$), Asdai Díaz Rodriguez (DIAAS, $5^{\mathrm{h}}71$), Tomas Dvořak (DVOTO, $12^{\mathrm{h}}00$), Vit Dvořak (DVOVI, $5^{\mathrm{h}}67$), Tonis Eenmae (EENTO, $1^{\mathrm{h}}83$), Khalid Eid (EIDKH, $3^{\mathrm{h}}17$), Shlomi Eini (EINSH, $2^{\mathrm{h}}27$), Bert Everaert (EVEBE, $2^{\mathrm{h}}34$), Tomasz Fajfer (FAJTO, $4^{\mathrm{h}}00$), Klaus Farrugia (FARKL, $2^{\mathrm{h}}18$), Yasunori Fujiwara (FUJYA, $1^{\mathrm{h}}67$), Keiiti Fukui (FUKKE, $0^{\mathrm{h}}97$), Nobuyuki Fukuda (FUKNO, $1^{\mathrm{h}}97$), Adrian Galea (GALAD, $0^{\mathrm{h}}85$), Martin Galea (GALMR, $12^{\mathrm{h}}14$), Rafael Gamez (GAMRA, $1^{\mathrm{h}}88$), Franco Gatt (GATFR, $0^{\mathrm{h}}94$), Maarten Gillis (GILMA, $2^{\mathrm{h}}13$), Danaja Glavisic (GLADA, $11^{\mathrm{h}}00$), George W. Gliba (GLIGE, $1^{\mathrm{h}}00$), Shelagh Godwin (GODSH, $7^{\mathrm{h}}48$), Vered Grindberg (GRIVE, $2^{\mathrm{h}}64$), Matthias Growe (GROMA, $6^{\mathrm{h}}92$), Monica de la Guardia (GUAMO, $2^{\mathrm{h}}20$), Michal Haltuf (HALMI, $8^{\mathrm{h}}91$), Wayne T. Hally (HALWA, $10^{\mathrm{h}}66$), Jung Han-Sub (HANJU, $5^{\mathrm{h}}83$), Takema Hashimoto (HASTA, $4^{\mathrm{h}}25$), Roberto Haver (HAVRO, $21^{\mathrm{h}}31$), Jingyang He (HE JI, $1^{\mathrm{h}}15$), Sinica Hrvatin (HRVSI, $6^{\mathrm{h}}67$), Sun Huaiming (HUASN, $5^{\mathrm{h}}69$), Su Hua (HUASU, $2^{\mathrm{h}}17$), Goran Ilič (ILIGO, $7^{\mathrm{h}}97$), Helle Jaaniste (JAAHE, $1^{\mathrm{h}}00$), Jaak Jaaniste (JAAJA, $0^{\mathrm{h}}67$), Jan Dušan (JANDU, $8^{\mathrm{h}}98$), Carl Johannink (JOHCA, $9^{\mathrm{h}}86$), Javor Kac (KACJA, $38^{\mathrm{h}}05$), Richard Kacerek (KACRI, $5^{\mathrm{h}}83$), Dmitry Kalayda (KALDU, $11^{\mathrm{h}}38$), Vaclav Kalas (KALVA, $4^{\mathrm{h}}57$), Nobuya Kikuchi (KIKNO, $0^{\mathrm{h}}50$), Kevin Kilkenny (KILKE, $1^{\mathrm{h}}86$), Atusi Kisanuki (KISAU, $1^{\mathrm{h}}35$), Kristina Klemencic (KLEKR, $8^{\mathrm{h}}57$), André Knöfel (KNOAN, $37^{\mathrm{h}}65$), Wakaba Kobayashi (KOBWA, $1^{\mathrm{h}}75$), Jakub Koukal (KOUJA, $90^{\mathrm{h}}69$), Ales Kratochvil (KRAAL, $1^{\mathrm{h}}33$), Zoran Kraljevic (KRAZO, $1^{\mathrm{h}}28$), Marija Krmelič (KRMMA, $6^{\mathrm{h}}61$), Maris Kuperjanov (KUPMA, $3^{\mathrm{h}}00$), Karimu Kuragaki (KURKA, $1^{\mathrm{h}}75$), Ralf Kuschnik (KUSRA, $31^{\mathrm{h}}59$), Xue Lai (LAIXU, $2^{\mathrm{h}}00$), Marco Langbroek (LANMA, $2^{\mathrm{h}}16$), Guy Lefèvre (LEFGU, $1^{\mathrm{h}}48$), Adrian Lelyen (LELAD, $2^{\mathrm{h}}84$), Anna S. Levina (LEVAN, $3^{\mathrm{h}}90$), Simon Levin (LEVSI, $12^{\mathrm{h}}16$), Robert Lunsford (LUNRO, $15^{\mathrm{h}}70$), Hartwig Luthen (LUTHA, $1^{\mathrm{h}}23$), Irena Maček (MACIR, $2^{\mathrm{h}}57$), Sona Machatkova (MACSO, $1^{\mathrm{h}}00$), Katuhiko Mameta (MAMKA, $7^{\mathrm{h}}02$), Amarilis Martinez (MARAM, $1^{\mathrm{h}}91$), Pierre Martin (MARPI, $22^{\mathrm{h}}59$), Antonio Martinez (MARTI, $2^{\mathrm{h}}05$), Tony Markham (MARTO, $2^{\mathrm{h}}00$), Alas-

tair McBeath (MCBAL, $10^{h}.83$), Mark Mikutis (MIKMR, $6^{h}.00$), Larue Miller (MILLA, $1^{h}.50$), Tijana Milevoj (MILTI, $11^{h}.63$), Koen Miskotte (MISKO, $3^{h}.37$), Darren Mizzi (MIZDA, $9^{h}.37$), Sirko Molau (MOLSI, $43^{h}.21$), Francisco Munoz (MUNFR, $2^{h}.17$), Sven Näther (NATSV, $21^{h}.30$), Hiroshi Ogawa (OGAHI, $2^{h}.00$), Jens O. Olesen (OLEJE, $1^{h}.00$), Elke Ortmanns (ORTEL, $2^{h}.33$), José Ortega (ORTJO, $3^{h}.00$), Kazuhiro Osada (OSAKA, $3^{h}.35$), Eric Palmer (PALER, $7^{h}.52$), Gregg Pasterick (PASGR, $5^{h}.43$), Cedric Peinado (PEICE, $11^{h}.56$), Juan Perez (PERJU, $2^{h}.52$), Radame Perez (PERRA, $3^{h}.77$), Suyin Perret-Gentil (PERSU, $1^{h}.50$), Vicent Peris (PERVI, $2^{h}.99$), Natasa Petelin (PETNA, $15^{h}.43$), Jose F. Ponce (PONJE, $0^{h}.30$), Gregor Požek (POZGR, $6^{h}.95$), Rui Qi (QI RU, $4^{h}.40$), Javier Ramirez Asa (RAMJA, $7^{h}.44$), Ina Rendtel (RENIN, $29^{h}.30$), Jürgen Rendtel (RENJU, $45^{h}.25$), Maciej Reszelski (RESMA, $3^{h}.95$), Janko Richter (RICJA, $3^{h}.12$), Mileny Roche Lamas (ROCMI, $1^{h}.44$), Marion Rudolph (RUDMA, $20^{h}.43$), Ja'far Sabah (SABJA, $0^{h}.78$), Mitsue Sakaguchi (SAKMI, $2^{h}.83$), René Scurbecq (SCURE, $5^{h}.13$), Harald Seifert (SEIHA, $4^{h}.53$), Mario Scheel (SELMA, $2^{h}.29$), Miguel Serra Martin (SERMI, $2^{h}.93$), Maria Shihadeh (SHIMR, $1^{h}.93$), Yasuo Shiba (SIBYA, $2^{h}.59$), Hiroyuki Sioi (SIOHI, $1^{h}.47$), Andrzej Skoczewski (SKOAN, $1^{h}.84$), Jiři Srba (SRBJI, $2^{h}.70$), Enrico Stomeo (STOEN, $3^{h}.87$), Kazuhiro Sumie (SUMKA, $15^{h}.92$), Masafumi Suzuki (SUZMA, $1^{h}.48$), Pavel Svozil (SVOPA, $2^{h}.81$), Kazumi Terakubo (TERKA, $0^{h}.50$), Maja Tomic (TOMMJ, $1^{h}.07$), Luis Tornes (TORLU, $1^{h}.90$), Gabrijela Triglav (TRIGA, $7^{h}.14$), Mihaela Triglav (TRIMI, $3^{h}.05$), Satosi Uehara (UEHSA, $6^{h}.64$), Erwin van Ballegoy (VANER, $2^{h}.27$), Koen van Gorp (VANKE, $7^{h}.39$), Vishnu Vardhan (VARVI, $3^{h}.37$), Ly Vastrik (VASLY, $1^{h}.25$), Keith Vella (VELKE, $1^{h}.75$), Cis Verbeeck (VERCI, $1^{h}.02$), Jan Verbert (VERJN, $2^{h}.34$), Rita Verhoef (VERRI, $3^{h}.58$), Suzana Veren (VERSU, $8^{h}.67$), Song Wanfang (WANSO, $2^{h}.88$), Milos Weber (WEBMI, $5^{h}.47$), Nikolai Wünsche (WUNNI, $0^{h}.75$), Oliver Wusk (WUSOL, $71^{h}.02$), Kim S. Youmans (YOUKI, $36^{h}.36$), Ilkka Yrjölä (YRJIL, $3^{h}.83$), Jure Zakrajsek (ZAKJU, $19^{h}.70$), Joseph Zammit (ZAMJO, $15^{h}.54$), George Zay (ZAYGE, $7^{h}.00$), Ju Zhao (ZHAJU, $4^{h}.23$), Xiaojin Zhu (ZHUXI, $1^{h}.65$), Vladimír Znojil (ZNOVL, $2^{h}.20$).

The geographical distribution of the observers was very suitable for the analysis, as they effectively covered all longitudes. Hence the data set has no significant gaps during the most interesting period. The observers listed above come from 25 countries:

Belgium, Canada, China, Croatia, Cuba, Czech Republic, Denmark, Estonia, Finland, France, Germany, India, Israel, Italy, Japan, Jordan, Korea, Malta, the Netherlands, Poland, Slovenia, Spain, United Kingdom, United States, and Venezuela.

While the time around the maximum is well covered, the moonlight interfered with all observations of end July. Therefore, we concentrate on the near-maximum period in this preliminary report.

2. Population index and activity

Although the number of magnitude distributions containing many shower meteors is much larger than in 1998, we also used the procedures for the computation of the population index r which were briefly described in [1].

Figure 1 shows the r-profile for the entire activity period between July 13 ($\lambda_\odot = 110°$) and August 24 ($\lambda_\odot = 150°$). The smaller error bars indicate that the amount of magnitude data is very large around the rate maximum. The gap around $\lambda_\odot = 126°$ is a result of the Full-Moon period. Furthermore, it is obvious that major variations in r happen between $\lambda_\odot = 134°$ and $\lambda_\odot = 142°$.

The large number of magnitude data allows to achieve a high temporal resolution in the population index profile between $\lambda_\odot = 139^{\circ}.5$ and $\lambda_\odot = 140^{\circ}.3$ (August 12, $15^{h}35^{m}$ UT and August 13, $11^{h}30^{m}$ UT, respectively; all following dates are rounded in 5-minute steps) shown in Figure 2. The most obvious features are two distinct minima in the value of r, at $\lambda_\odot = 139^{\circ}.83 \pm 0^{\circ}.01$ (August 12, $23^{h}50^{m}$ UT) with $r = 1.82 \pm 0.05$ and $\lambda_\odot = 140^{\circ}.15 \pm 0^{\circ}.04$ (August 13, $7^{h}50^{m}$ UT) with $r = 1.87 \pm 0.05$. Before and after this period, as well as between the minima, the population index r shows a value of 2.0 or higher. We will interpret the shape of the r-profile together with the activity profile later.

Using the profile of r discussed above, we calculated the ZHRs. The general profile (Figure 3) shows just the graph known from many previous returns. However, the 1999 observations allow to follow the rates at both ends when the ZHRs are at the detection limit.

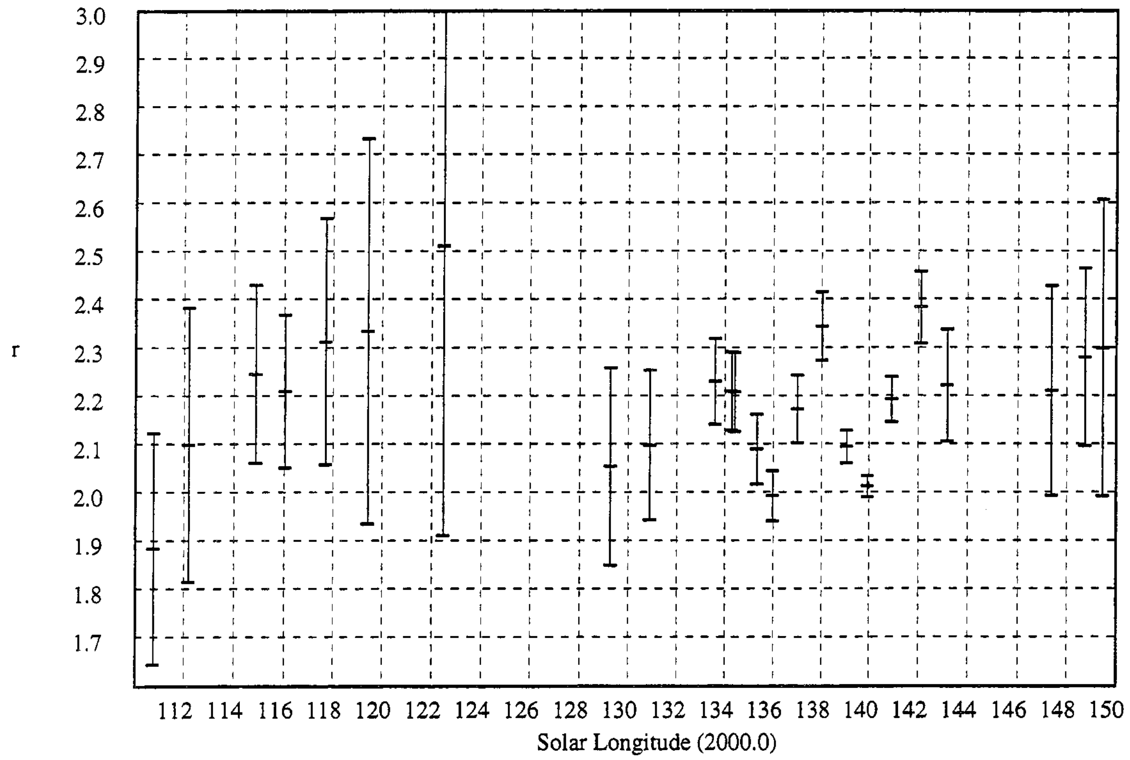

Figure 1 – Coarse population-index profile over the entire activity period of the 1999 Perseids. A profile with full temporal resolution is shown in Figure 2.

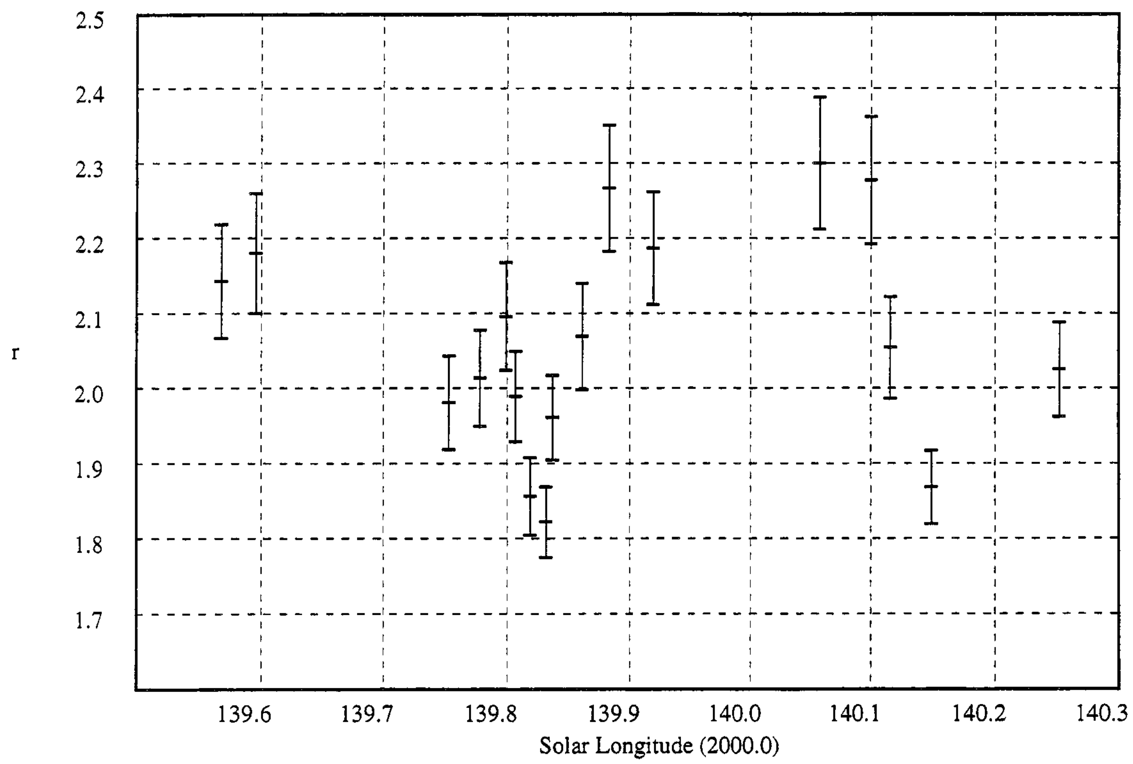

Figure 2 – Fully resolved profile of the population index of the 1999 Perseids. The rate maximum coincides with the local r-maximum at $\lambda_\odot = 139^\circ\!.80$, and an increasing portion of brighter meteors occurred 45 minutes later at $\lambda_\odot = 139^\circ\!.83$.

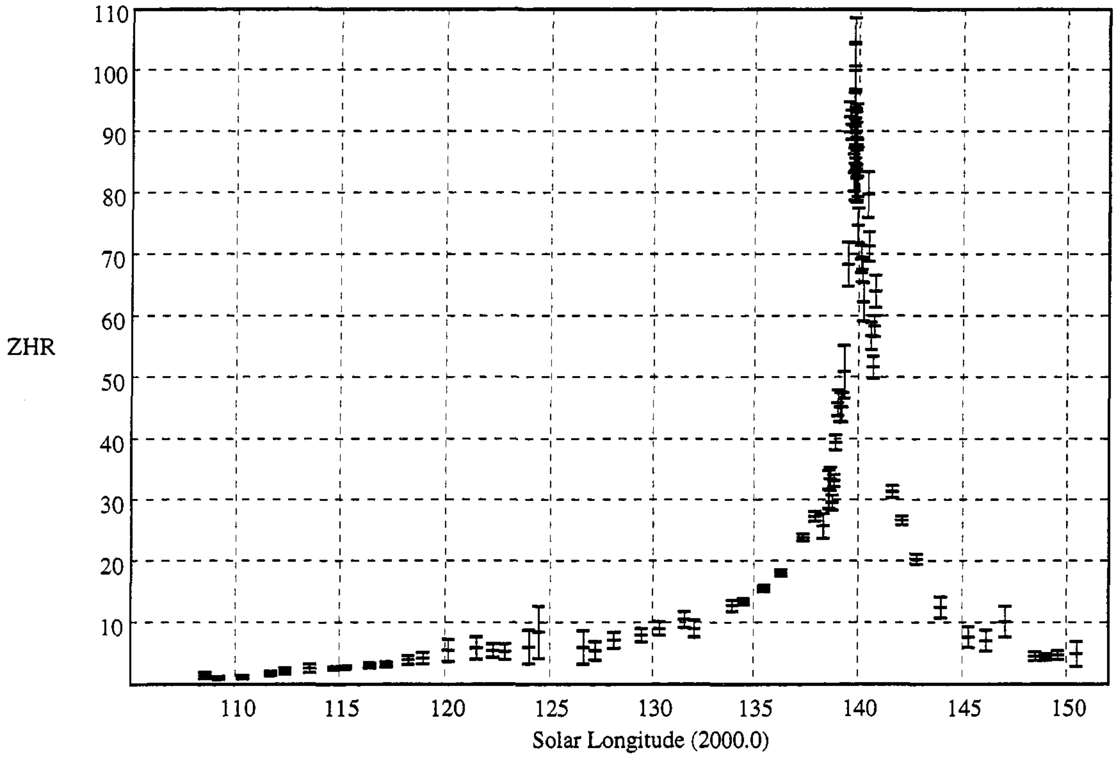

Figure 3 – Activity profile of the 1999 Perseids over the entire activity period.

In the beginning and end of their activity, the observers should be aware that the Perseids are effectively a minor shower. Since "counting" observations require an immediate shower association, more sources of observing errors occur than during "plotting" observations. While an erroneous association of, say, 5% of sporadic meteors to the Perseids does not influence the peak ZHR, it may strongly alter the Perseid ZHR in their outer regions. The graph nicely shows the gap near Full Moon and the larger error bars in the observations around this date.

Next, we look at the Perseid activity near the peaks in more detail. The huge amount of data obtained between $\lambda_\odot = 139\overset{\circ}{.}75$ and $\lambda_\odot = 139\overset{\circ}{.}95$ (August 12, 21^h50^m and August 13, 2^h50^m UT, respectively) allowed a high temporal resolution (Figure 4). The binning interval of $0\overset{\circ}{.}02$ length was shifted by $0\overset{\circ}{.}01$, giving a time step of 15 minutes especially around the first peak. As expected [2], this signature of the activity caused by "fresh" material occurring since 1988, returned again. This peak showed a maximum of ZHR $= 104 \pm 4$ at $\lambda_\odot = 139\overset{\circ}{.}80 \pm 0\overset{\circ}{.}01$ (August 12, 23^h05^m UT). Its position shifted further towards the so-called "traditional" maximum, expected near $140\overset{\circ}{.}0$. Surprisingly, this maximum appears quite weak in the analysis. The ZHR is just of the order of 85 shortly before $\lambda_\odot = 140\overset{\circ}{.}0$. An even lower value was found in the 1998 data, but an averse influence of the moonlight cannot be entirely ruled out. However, a look into analyses of earlier Perseid returns [3] hint on similarly low maximum ZHRs in about half of the investigated years.

Compared to the period mentioned above, the interval between $\lambda_\odot = 139\overset{\circ}{.}95$ and $\lambda_\odot = 141\overset{\circ}{.}0$ is less covered with data. We are optimistic to have more data at hand for a final analysis. This also concerns the post-maximum activity peak described in 1997 and 1998 [1,4] (see below). The two ZHR averages before the highest ZHRs at $\lambda_\odot = 139\overset{\circ}{.}80$ are based on a relatively small number of reports so far and should be updated for a final analysis as well.

Now we look into some details of the particle population as derived from the population index r and the ZHR. It is obvious, that the maximum ZHR at $\lambda_\odot = 139\overset{\circ}{.}80$ coincides with a relatively high value of $r = 2.095 \pm 0.07$. Only after this time, the population index decreases to its minimum value of $r = 1.82 \pm 0.05$ at $\lambda_\odot = 139\overset{\circ}{.}83 \pm 0\overset{\circ}{.}01$. At this moment, the ZHR has already decreased to about 90.

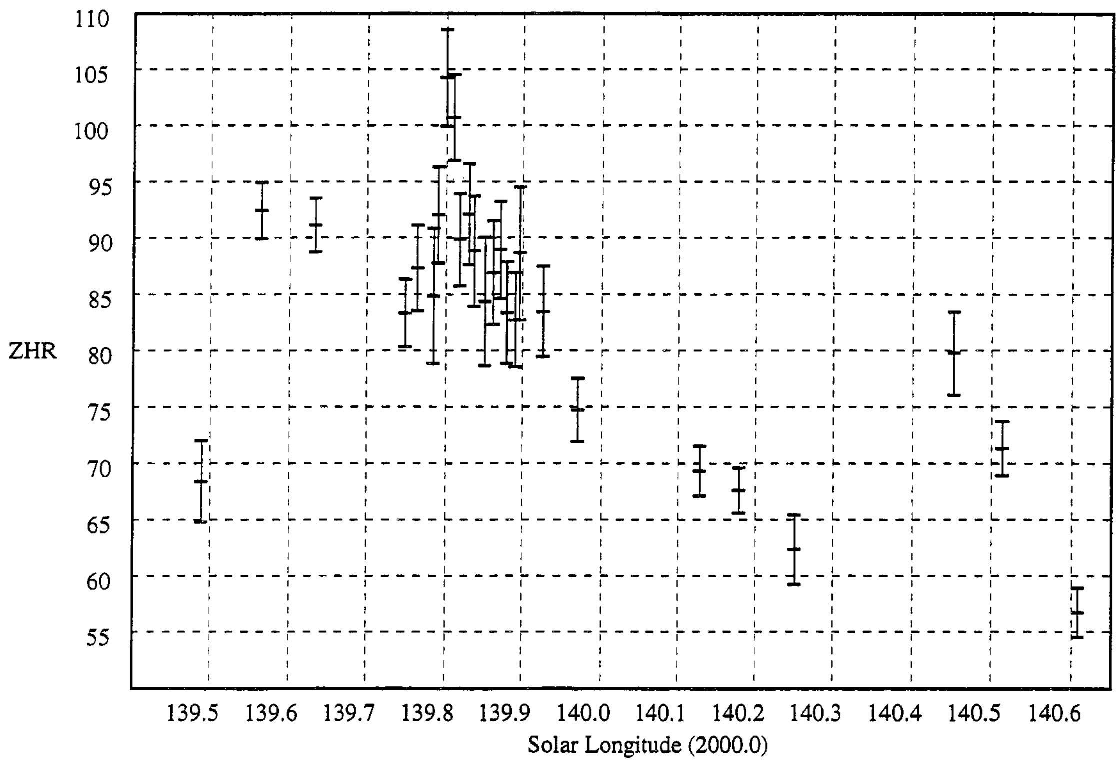

Figure 4 – ZHR-profile of the 1999 Perseids covering the maximum days with the highest ZHR caused by the early maximum at $\lambda_{\odot} = 139\overset{\circ}{.}80$ (August 12, $23^{\mathrm{h}}05^{\mathrm{m}}$ UT). Other features are discussed in the text.

The ZHR remains at this level for some time until about $\lambda_{\odot} = 139\overset{\circ}{.}9$ (August 13, $1^{\mathrm{h}}35^{\mathrm{m}}$ UT). During this period of roughly constant ZHR, the population index increases to 2.27 ± 0.07. This means, that the ZHR maximum did not coincide with the time where the portion of bright meteors, i.e., of larger meteoroids was highest. The largest portion of larger meteoroids was observed at the descending ZHR branch after the first peak.

The second minimum in r at $\lambda_{\odot} = 140\overset{\circ}{.}15 \pm 0\overset{\circ}{.}05$ does not refer to any feature in the rate curve. The time-scale of these features of 2 hours or less is too small to be associated with a radiant-elevation effect. Such effects can be found if only a few groups at certain locations contribute to the profile as is the case in this analysis, but the effect is supposed to act on a time-scale of about 6 hours. A last increase of activity is found near $\lambda_{\odot} = 140\overset{\circ}{.}45^{+0\overset{\circ}{.}06}_{-0\overset{\circ}{.}20}$ when the ZHR climbed up to 80 ± 4. A similar after-maximum increase was found in the 1997 and 1998 profiles [1,4], though about 2 hours earlier. Since we have no data between $\lambda_{\odot} = 140\overset{\circ}{.}3$ and $\lambda_{\odot} = 140\overset{\circ}{.}4$, we cannot rule out an actual maximum time falling on the position of 1997 and 1998.

Contrary to other analyses, the period of the expected traditional maximum is characterized by a higher r between 2.2 and 2.3, but we expect more certain conclusions from a final analysis which may reveal more information about this specific period.

3. Conclusions

The near-maximum period shows the early ZHR peak connected with the recent return of 109P/Swift-Tuttle, a rather weak "traditional" maximum, and hints on a later rate maximum as observed in 1997 and 1998. Although we already received a large number of observational data, the present analysis can be regarded as a preliminary overview only. Further reports are expected to give more insight into the variations of the population index r and the Perseid ZHR.

Observers are highly encouraged to deliver a breakdown into very short observing periods for the night of August 12-13. Even if your individual observing period contains only a handful meteors, the large number of such 5-minute or 10-minute periods will provide us with a significant result. Magnitude distributions should cover no more than 30 minutes.

References

[1] R. Arlt, "Global Analysis of the 1998 Perseids", *WGN* 27:5, October 1999, pp. 237–249.
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[3] P. Brown, J. Rendtel, "The Perseid Meteoroid Stream: Characterization of Recent Activity from Visual Observations", *Icarus* 124, 1996, pp. 414–428.
[4] R. Arlt, "Global Analysis of the 1997 Perseids", *WGN* 26, 1998, pp. 61–71.

Luceafărul: A Romanian Meteor-Inspired Poem

Alastair McBeath and Andrei Dorian Gheorghe

The poem *Luceafărul*, written by Mihai Eminescu and first published in 1883, is considered as being the greatest Romanian poetic masterpiece. In commemorating the 110th anniversary of the author's death in 1999, we present here a short discussion of the poem's astronomical imagery, which includes the re-using of long-held beliefs about meteors from old Romanian myths and folklore.

Poets and authors have long been inspired by the wonders of the night sky. Many people reading this will have taken up astronomy after being shown the beauties of the night sky when they were very young. This is certainly true in the case of both the present authors. As such, this imagery tends to make a very lasting impact on impressionable young minds. Although many *IMO* members later became involved in the scientific study of meteors and other aspects of astronomy, it is clear from conversations we have had with people at the last few *IMC*s, in correspondence, and also in Godfrey Baldacchino's global survey of meteor astronomers [1], that a sizeable proportion of current meteor astronomers also feel an emotional attraction and response to viewing the night sky and meteors. This is of course unsurprising, as humans are not emotionless creatures. The fact that occasional poems, articles, and letters concerning meteor mythology have appeared in the pages of *WGN* is a further reflection of this. Indeed, we have already presented some discussion of Romanian meteor mythology to the meteor community [2] ourselves. Here, we take this concept a little further by examining the astronomical and meteoric imagery in the Romanian poem *Luceafărul*, itself based on much earlier Romanian myths and tales.

Mihai Eminescu (1850–1889) is considered the Romanian national poet *par excellence*, and the greatest Romanian spirit of modern times. Although this "Romanian Shakespeare" worked as a librarian, schools inspector, and journalist to earn a living, he loved astronomy and took astronomical courses during his time as a student in the 1870s at the universities of Vienna and Berlin. In many of his poetic works, he touched on astronomical topics, including cosmogony, astrometry, the Sun, Moon, stars, and various atmospheric phenomena, so much so that several later Romanian astronomical researchers, including Armand Constantinescu, Al. Dima, Virgil V. Scurtu, Dănuţ Ionescu and Ion Holban (from the Moldavian Republic), have prepared dedicated studies concerning astronomy in Eminescu's creations.

By far the most important of Eminescu's astronomically-influenced poems is *Luceafărul*, still regarded as the masterpiece of Romanian literature, despite being first published at Vienna in 1883 (in the *Almanac* of the *Young Romanians Society*). We have used a recent version published in [3] to draw upon, but have specially translated all the quotes into English here. It is a lengthy work, comprising 98 stanzas (396 lines), and was chiefly inspired by an aspect of Romanian meteor mythology, a variant concerning the fireball-dragon-man (in Romanian, the *balaur* or the *zmeu*—see [2]) as an erotic wizard, who magically appears in the dreams of young maidens. In the poem, this being is called Luceafărul, a name which in Romanian folklore is used to represent the brightest evening star (in practice, this is generally the planet Venus or Jupiter, whichever is more prominent at dusk, dependent obviously on the time of year and the location of the two planets). However, *Luceafărul* is at the same time a phonetic variant of Lucifer, proceeding from the Latin *lux* = "light" and *ferre* = "to bring." *Lucifer* can still be used in English as a, generally poetic, term for Venus, but as the morning star, heralding sunrise.

The tale-poem *Luceafărul* begins with the beautiful princess Cătălina, proud like

the Maiden among priests,
Or the Moon among the stars,

falling in love with the sky-being Luceafărul as the evening star, and asking him to visit her:

Come down, mild Luceafărul,
Sliding on a beam,
Enter into my house and my thoughts,
To lighten my life!

Thus she gives Luceafărul the means of entering her dreams as the magical *balaur*.

On his first dream-appearance, Luceafărul seems beautiful like an angel, saying he is the son of the sky and the sea, and physically looking like a young king with soft, blonde hair. He asks Cătălina to become his wife, and go to live with him beneath the sea, among coral palaces, where he promises her an eternity of having the ocean world fulfill her every wish. Scared, she refuses.

The second time he appears in her dreams, Luceafărul looks like a beautiful demon, son of the Sun and the night, but is clad this time in a rather more meteoric form:

On his black hair,
A crown blazed forth fire.
He came floating in truth,
Bathed in the fire of the Sun.

As a child of the Sun and night, the picture of a brilliant meteor could easily be conjured up by such an image, especially as *balaur* is also the Romanian folkloric term for a bright meteor. Again, he asks Cătălina to become his wife, tempting her with further meteoric promises:

I will place in your yellow hair
Coronets of stars,
And you will rise in my skies,
Prouder than them.

These two appearances are typical of the way *balauri* transform themselves into superhuman conquerors of maidens' hearts in the girls' dreams, as demonstrated in various old Romanian tales and legends. The reactions of the maiden, both fascinated and scared or repelled by the fireball-dragon-man, are also typical. To this second call, Cătălina again refuses Luceafărul's advances, saying that although she hears his words, she does not understand them, but her temptation is too great, and she relents enough to suggest that their impossible love might become possible if only Luceafărul were a mortal man.

The love-struck Luceafărul shoots off immediately to seek permission from the Father of the Universe to become fully human, streaking away across the night sky, again with meteoric overtones:

Luceafărul started. His wings
Brought him up into the sky,
And the Way of Millennia
He crossed in seconds.

There are many fascinating flights described in various ways throughout the world's mythologies, but it is clear that Eminescu in describing Luceafărul's flight, has used the flight of a meteor as his starting point:

A sky of stars below,
A sky of stars above,
He looked like an unbroken flash
Lost between them.

After this, his flight goes off into the timeless, dark void between the stars:

It is nothing, but, it is
A thirst which drinks him,
It is an abyss like
Blind forgetfulness.

Some have suggested such imagery as descriptive of a black hole, which although generally thought of as modern concept, may actually date to 1798 in the work of Pierre Laplace.

On reaching the Father of the Universe, Luceafărul asks,

Take my immortal aura
And the fire from my glance,
And give me in exchange
A moment of love!

The Father is unimpressed and replies,

Hyperion rising from the abyss
With a whole world,
Do not ask me for signs and wonders
Without a face and name.

[...]

The people just have lucky stars
And unhappy destinies,
But we have not time and space,
And know not what death is.

[...]

From the eternal yesterday,
Today the mortals live,
If a star dies in the sky,
Another one rises again.

In this response, we find the popular tradition of shooting stars representing candles in the sky, lit when a person is born, falling to be extinguished when he dies, as well as the cosmological truth that life and death coexist in the Universe.

The Father continues by asking,

Do you want to die? For who?
Return, go back
To that wandering Earth
And see what awaits you!

His observation is well-founded. In Luceafărul's absence, Cătălina has fallen in love with Cătălin, a young man, though she cannot forget completely Luceafărul. She has realized that Luceafărul must remain eternally far from the world she inhabits, but continues to torture herself with thoughts of the impossible love she holds for the Evening Star. There is also a further meteoric possibility even here, as the love between Cătălina and Cătălin is born in the springtime, beneath the linden trees, and perhaps the swift-moving meteoric flash that helped inspire Eminescu's description of Luceafărul's rapid flight was a fast-moving, long-pathed η-Aquarid meteor, appearing in the morning spring twilight of late April or early May.

The poem ends with Cătălina seeing Luceafărul returning to the evening sky, and being overwhelmed by her feelings for him once more, calling to him to come down to her again, as he did in the past. Luceafărul is shocked by her betrayal of him, and remains in his high, distant place this time.

He asks her,

What do you care, earth-face,
If I'd be your lover, or another one?

The final lines have little comfort in them:

Living in your narrow circle,
Luck is your ally.
But me, in my world,
I am immortal and cold.

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Observational Results

Activities of the Spanish Photographic Network in 1998

Josep M. Trigo-Rodriguez, Julio Castellano-Roig, and Alberto Castro-Tirado

The *Spanish Photographic Meteor Network* (*SPMN*) has implemented an observing program in Spain by means of short to middle focus lenses, aimed at obtaining accurate meteor orbital data. Also a study of meteor showers from professional equipment as the recently developed BOOTES instrument was initiated during the last year. Here we present a short compendium of our activities in 1998 and, in particular, high-quality results for one bright Geminid simultaneously photographed from the East of Spain. This program is an initiative of the *University of València* and *SOMYCE*, two entities that promote meteor observations in our country.

1. Introduction

We began meteor research in the 1980s when *SOMYCE* was created as an active group of young meteor observers [1]. Since the 1990s, our society has been well-structured in several commissions, and we can tackle new organizational projects. From 1993, a little group of meteor enthusiasts has built an infrastructure to obtain double-station photographs throughout the year. The first good results already obtained during Perseids 1991 and 1993 campaigns were published recently in *WGN* [2,3] and the diffusion of *SOMYCE* activities in conferences has raised the interest in meteor investigation in Spain. During the past year, we decided to extend our Network with the help of new meteor workers who appeared coinciding with the high activity associated to several streams' outbursts. The main aim of our observations is to obtain high-quality meteor orbits and to develop lines of investigation on meteor photography in Spain such as meteoroid flux determination and spectroscopy.

We report here our first results that have been obtained after an important effort of several members of *SOMYCE* to obtain double-station photographs and spectra of meteors. The participating people in 1998 were as follows:

Pedro Arranz, Toño Bernedo, Josep M. Bosch, Julio Castellano, Alberto Castro-Tirado, Germán Domínguez, Enric Fraile, José Gómez, Antonio Gutierrez, Francisco Reyes Andrés, Julián Ruíz-Garrido, Jaime Izquierdo, Antonio del Solar, Josep M. Trigo, and Helena Valero.

Our *SPMN* system is actually based in successive campaigns prepared throughout the year. The number of our stations is variable depending on the possibilities of each observer in each period.

The participating people normally receive by e-mail the equatorial coordinates of the center of the photographic field to point the camera at. For this purpose, we have developed software to obtain these centers to assure double- or multiple-station photographs. In general, the distances between the sites are 30–100 kilometers. Taking into account the accuracy of short to middle focus lenses (24–60 mm) and the common distance between stations, the velocity errors can be in the order of 5% and the positional errors of $2'$–$5'$.

2. First photographic and CCD results

Several campaigns were established in 1998 covering activity of different showers. For example, we prepared several double or multiple stations to obtain orbital data of the Aquarids, Perseids, α-Aurigids, Giacobinids, Leonids, and Geminids. We are working now in photographic data processing, but, generally, during the first part of the year, the majority of double-station meteors were placed very distant and only great fireballs could be photographed. However, we recruited new meteor enthusiasts in September, principally incited by our previous activities. Hence, a large number of people has allowed to create two principal networks: one in the Comunidad de Madrid and another in Valencia and Catalonia. Also some sporadic single stations have been established in Andalucia, Murcia, and Mallorca. The first good results were obtained during the Leonids, but only from single-station photographs, because the fireball night saw covered skies in several regions of the Iberian Peninsula. Highly variable cloud cover did not allow to obtain double-station photographs in all our stations.

Amongst the activities developed by our team during the Leonids, we mention the participation of the *Burst Observer and Optical Transient Exploring System* (BOOTES), considered as a part of the preparations for the ESA's satellite project INTEGRAL. This is a project that is currently being developed in Spain, in collaboration with two Czech institutions: the Ondřejov Astronomical Institute and the Technical University of Prague (see [5] for a detailed description). The project makes use of a set of wide-field cameras (field of view of $16° \times 11°$) atop a robotic 0.3-m telescope. The first observing station (BOOTES-1) is located in Mazagon (Huelva), Southern Spain, and the first light was obtained in July 1998. During the test phase, to be completed by July 1999, it has provided rapid follow-up observations for gamma-ray bursts (GRBs) and also covered meteor activity at some occasions. The full system (two observing stations 240 km apart) will operate in late 1999.

Forty images of two adjacent fields (with 5% of overlap) were obtained for $4\overset{h}{.}6$ during November 18, 1998. The exposure times of 300 s for each of the images, allowed to reach a limiting stellar magnitude of +13 in the Johnson I-band. The field centers were chosen as $\alpha = 10^h32^m$, $\delta = +30°$ and $\alpha = 10^h12^m$, $\delta = +22°$, in order to match the head of Leo and obtain a single-station position for the apparent radiant of the meteors. From four meteors detected between 1^h03^m and 5^h30^m UT (see Figure 1), we derive the coordinates of the radiant as $\alpha = 153\overset{\circ}{.}5 \pm 0\overset{\circ}{.}5$ and $\delta = +21\overset{\circ}{.}75 \pm 0\overset{\circ}{.}25$.

Now, we are processing all images to analyze the spatial number density of the 1998 Leonids using a similar method as in our 1997 analysis [4]. Finally, during December the sky conditions were very good and the campaign very productive, especially during the Geminid period. The detection of a -4 Geminid double-station fireball during the night of December 13-14 was especially remarkable. We called this fireball "SOMYCE 981201." The mean velocity was obtained using a rotating shutter working at 12 breaks per second. From the length of the trajectory, a mean atmospheric velocity of 36.1 km/s was obtained, close to the expected velocity of Geminid meteoroids. The focal length of working lenses is usually too short to make a detailed estimate of the atmospheric deceleration in the velocity of the meteor, but we decided to improve this in the near future. If we assume a mean velocity, the inaccuracy with respect to the pre-atmospheric velocity causes a great effect on the determination of the semi-major axis and the eccentricity of the meteoroid's orbit. Nevertheless, the data obtained from this Geminid are the best obtained by our team until now. The proximity between stations allowed for a photographic field near the zenith and a detailed imaging with several 50-mm and 24-mm lenses.

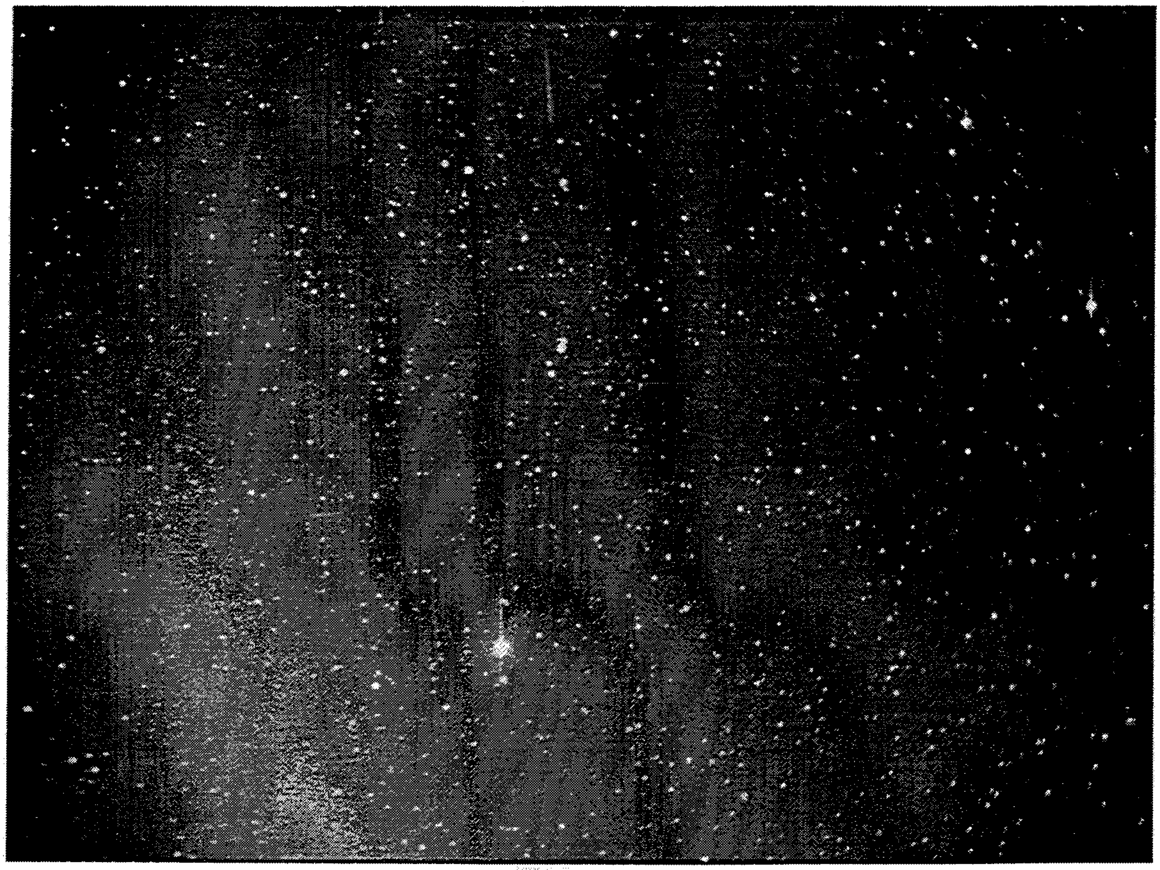

Figure 1 – Sum of three positive exposures obtained with the instrument BOOTES during the 1998 Leonid maximum. The brighter star is γ Leonis. The field of view is $15° \times 11°$.

The two *SPMN* stations that photographed the Geminid fireball, which appeared on December 13, 1998, at $22^{\mathrm{h}}36^{\mathrm{m}}$ UT, are Desert de les Palmes (J.M. Trigo-Rodriguez, $\lambda = 0°02'40''$ E, $\varphi = 40°04'55''$ N, $h = 390$ m) and Pla d'Arguines (J. Castellano-Roig, $\lambda = 0°23'50''$ W, $\varphi = 39°45'34''$ N, $h = 260$ m).

The astrometry of the meteor was done using digitized images of the negatives. On the basis of the measurements of the Cartesian coordinates of the beginning and end points of the stars and the meteor, we obtained the conversion to equatorial coordinates using the dependencies method from the ASTFMX software developed by Steyaert [7]. The standard deviation obtained for the beginning and end of the photographic positions of the fireball was $3'$ in the two exposures.

The fireball started over $\lambda = 0°06'19''$ W and $\varphi = 39°56'31''$ N, at 99.8 km, and ended over $\lambda = 0°26'12''$ W and $\varphi = 40°04'40''$ N, at 65.5 km.

From the photometric analysis of the negative we obtained an $M_{\mathrm{v}} = -4$ at the maximum light according to the procedure given in [8]. With these data and from the mean atmospheric velocity that we have obtained (36.1 km/s), a mass of approximately 1 gram is derived following the formula given by Hughes [6]: $\log m(\mathrm{g}) = 25.7 - 4 \log V(\mathrm{cm/s}) - 0.4 M_{\mathrm{v}}$.

We note that the final portion of the fireball exhibits fragmentation in the shape of sparks. The fireball radiant and orbital data resemble closely the mean orbital data obtained for the Geminid shower associated to the asteroid (3200) Phaethon [9].

The observed radiant of the fireball was at $\alpha = 113\overset{\circ}{.}22$ and $\delta = +31\overset{\circ}{.}09$ and the corrected radiant at $\alpha = 114\overset{\circ}{.}79$ and $+31\overset{\circ}{.}01$; the orbital elements of the corresponding meteoroid were $a = 1.248555$ AU, $e = 0.896679$, $q = 0.1303$ AU, $i = 21\overset{\circ}{.}960$, $\Omega = 261\overset{\circ}{.}739$, $\omega = 326\overset{\circ}{.}933$, and $T = 2451124.0347 =$ November 6.535, 1998.

Recently, the first author has imparted a course on meteor photographic and CCD techniques in the Department of Astronomy at the University of Valencia. We hope to initiate several graduate students in meteors to develop this science professionally in our country. In the last years, the number of persons participating in the *SPMN* has increased significantly. It will allow to establish more stations and to continue the intensive monitoring of meteor showers around the year. A first consequence is that we will improve our photographic meteor observations and techniques. We hope to obtain help of other institutions in the near future in order to spread our activities in Spain. In the next years, we will continue working in our *SPMN* project and we would appreciate receiving comments and suggestions from other meteor photography networks.

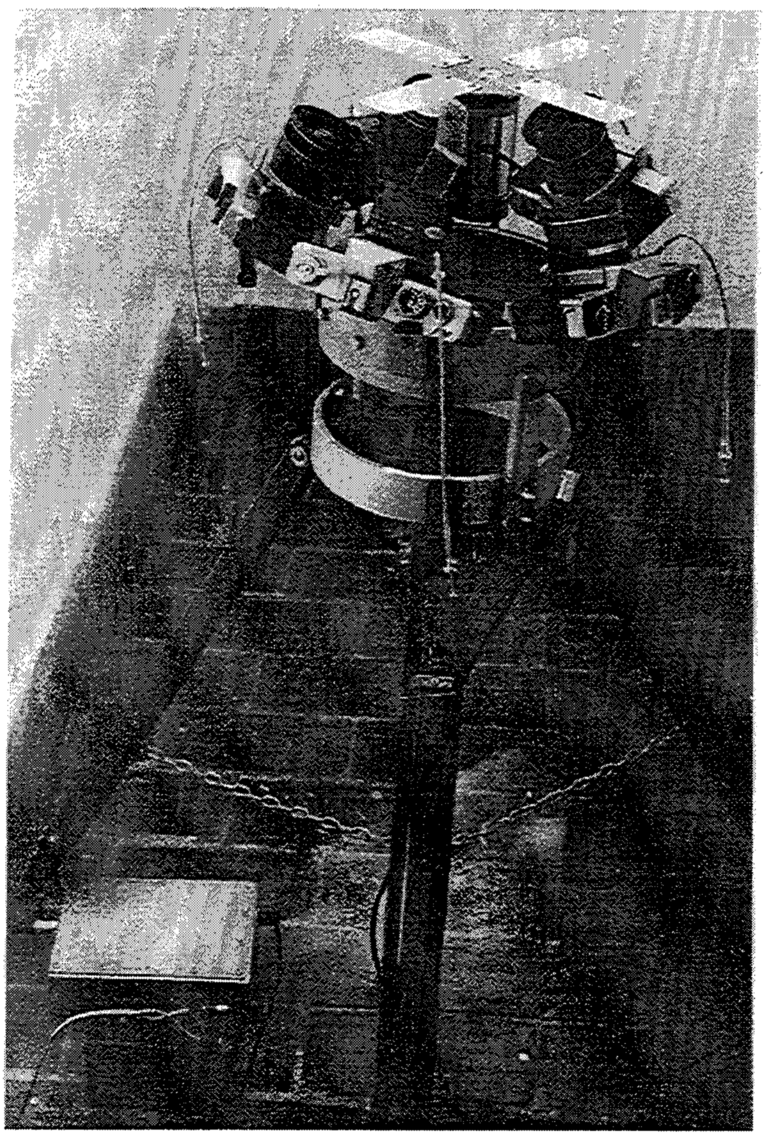

Figure 2 – The battery of five cameras with rotating shutter established in Castelló by the first author. A total of eight cameras were operated from the two stations on the night of the Geminid maximum.

Acknowledgments

The first author is indebted to Dr. Zdeněk Ceplecha, Dr. Jiří Borovička, and Dr. Pavel Spurný for their help and suggestions that were essential to start up our *SPMN* Network.

We also appreciate the decisive collaboration of Bertus van Gemeren which resulted in the implementation of our rotating shutters and other astronomical instruments.

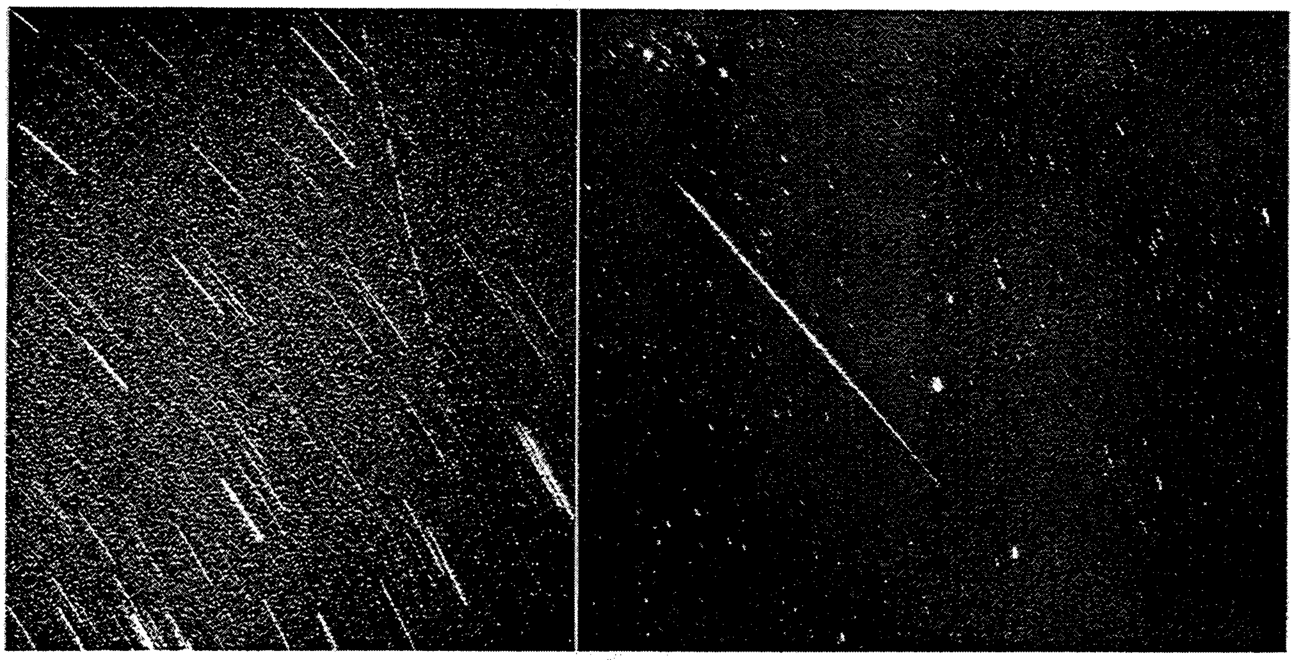

Figure 3 – The −4 Geminid fireball photographed from Desert de les Palmes (*left*) and Pla d'Arguines (*right*).

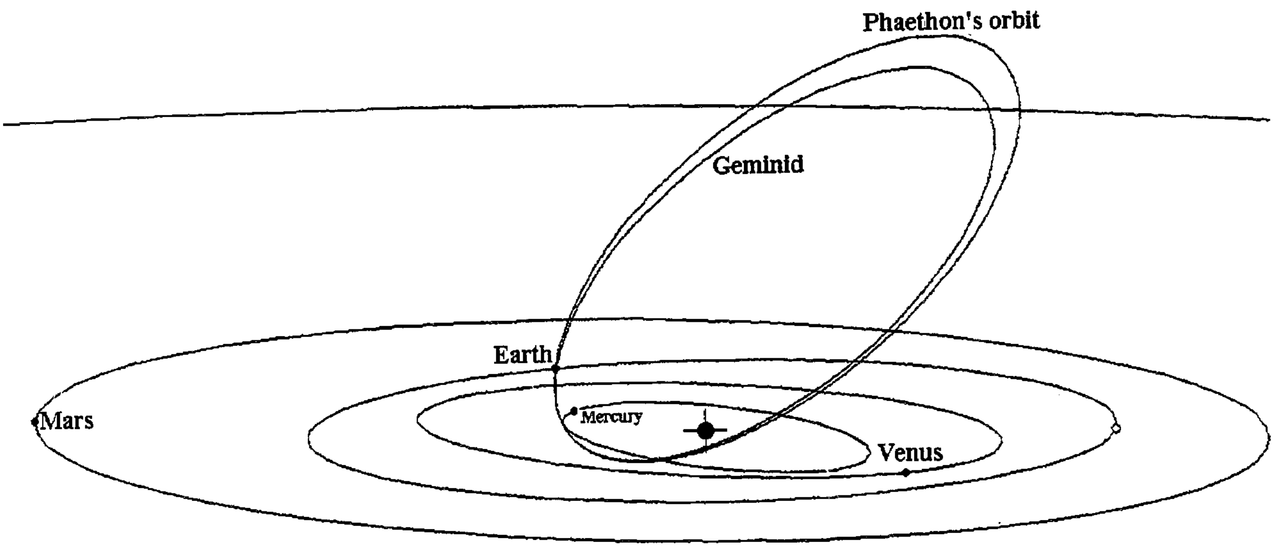

Figure 4 – Orbit of the Geminid SOMYCE981201, showing the resemblance with the orbit of asteroid Phaethon.

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