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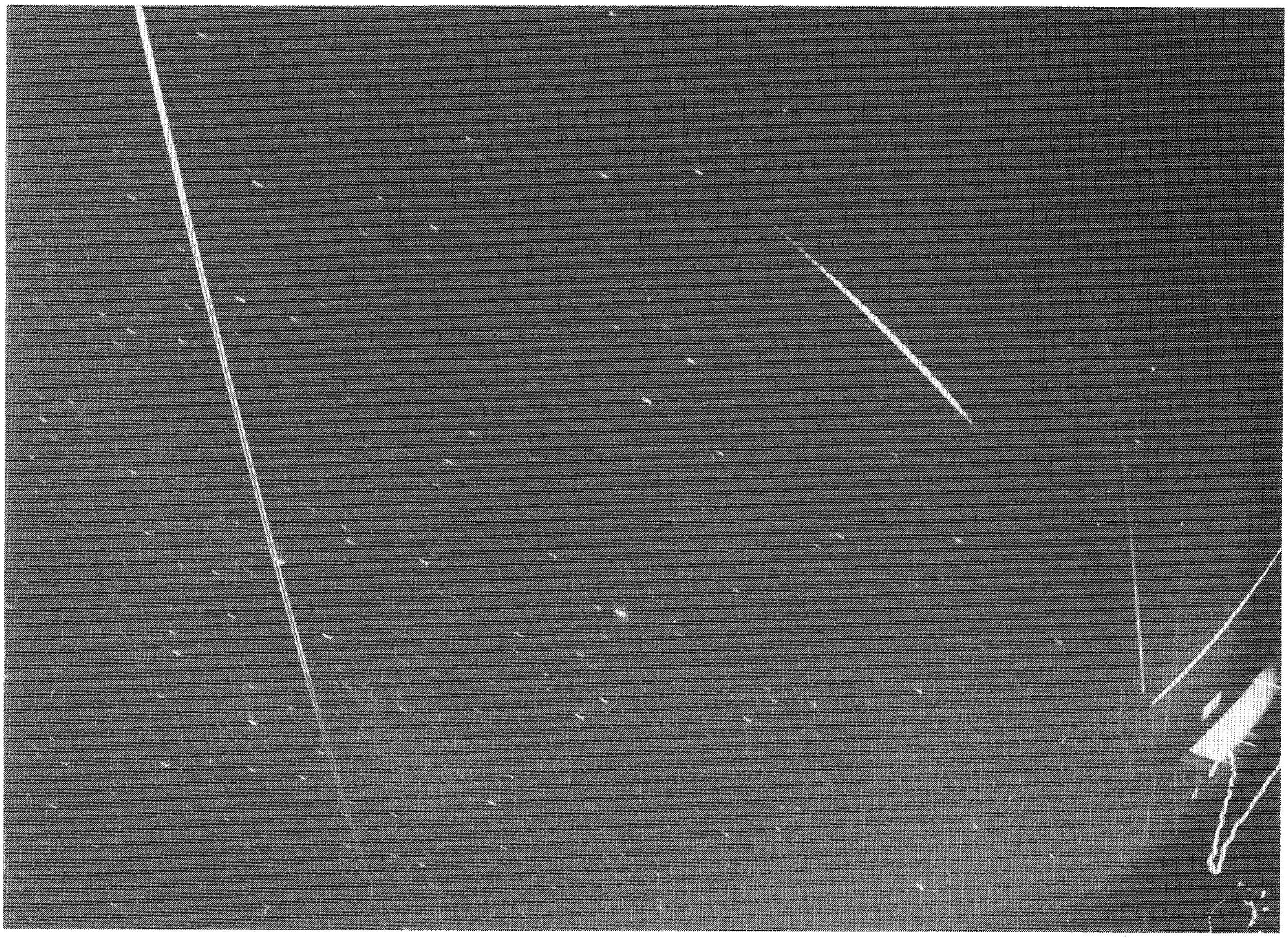

Fish-eye photograph of a Taurid fireball of about −10 to −12, captured by Jürgen Rendtel on October 21, 1989, 18^h30^m UT, in Golm, about 10 km west of Potsdam in Germany. Additionally, there are several trails caused by airplanes. The photograph was exposed from $17^h06^m26^s$ until $20^h07^m37^s$ UT.

In this issue:

- The International Meteor Weekend in Violau
- Practical information for observers
- A proposal for an International Leonid Watch
- On identifying minor showers
- Observational results

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WGN, volume 18, nr 5, October 1990, pp. 167–190

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Useful Information

The December Issue *(WGN 18:6)*

The *December issue* is expected to be mailed during the first week of December. Contributions are due *November 5*. They should be sent to *Marc Gyssens* or to any member of the editorial board (addresses: inside of back cover).

WGN Subscription/IMO Membership 1991

The subscription rate for volume 19 is 400 BEF for six issues. It is anticipated that volume 19 will contain over 240 pages. Subscriptions should be paid to Ann Schroyens or, for the USA and Canada, to Peter Brown, or, for Japan, to Masahiro Koseki (all addresses on the inside of back cover). Please make sure we retain the full amount due after deduction of bank and/or exchange charges. Therefore it is recommended to pay by international postal money order. Please refer to p. 168–169 of this issue for further details. Additional gifts are of course welcome.

Administrative Correspondence

In principle, all payments should be addressed to Ann Schroyens or Ina Rendtel. People from the United Kingdom can pay through Alastair McBeath; people from North America can pay through Peter Brown; and people from Japan can pay through Masahiro Koseki. However, *all* checks other than Eurocheques should be addressed to Peter Brown, including 2 USD for banking costs. Complaints about not receiving *WGN* or changes of address should be sent to Paul Roggemans. Al addresses can be found on the inside of the back cover.

From the Editor-in-Chief

Marc Gyssens

The previous issue, which contained 70 pages, received many favorable comments; some of them even designated it as the best issue that appeared up to now. The International Meteor Weekend that followed after the August issue appeared, is probably also the most successful ever. Amateur meteor work is truly conducted on an international basis, and, as a consequence, we may enjoy increasing support and encouragement from the professional community.

It is therefore surprising that, precisely now, we encountered for the first time the problem of not having enough contributions for WGN, which is the cause for the delay in the publication in this issue. Did the late publication of the August issue "wake up" too late potential authors to allow them to write something for the October issue? Or was the Weekend too early in September to give observing groups sufficient time to write something about their observations? Or is this just a random, chance fluctuation in the submission of articles? (One would be inclined to believe that articles appear in groups.) Whatever the reason may be—probably it is a combination of various factors—it is time again to take up your pen or go to your typewriter or computer keyboard. Do not forget that international cooperation thrives on the mutual exchange of each other's findings and knowledge in the field!

To conclude these editorial comments, I would like to clear up a misunderstanding that probably exists among many meteor observers and observer groups (see e.g. the letter of David Swann in the Letter Section of this issue). Some people seem think that WGN is no longer interested in observational reports. Of course, this is not true! The combined observational efforts are indeed the very core of the international meteor work; without these, there would be no reason for IMO's existence. Hence observational data must *receive a preferential treatment by WGN.*

Therefore, we decided to publish all *individual observations in WGN's newly created Observational Reports Series, on an annual basis. Of course, the introduction of the Reports Series now about one year ago obliged us to re-think the aim of observational reports in the WGN Journal, especially in view of the large number of submissions (at that time!) and the resulting increase of the period between submission and publication. As a result of all this, it was concluded that there was little point left in overloading the Journal with tables containing data from individual observers, since, out of a global context, these data are of little interest to the readers, and, furthermore, they are now published anyway in a comprehensive report.*

We mentioned this conclusion in our editorial comments about a year ago. However, we did not *say that the WGN Journal is no longer interested in observational reports! On the contrary, we would like to see that more groups report on their activities in WGN! (We regularly ask for this in our editorials.) Indeed, it is important that observers know from each other what they are doing. Moreover, through such reports, provided they are submitted shortly after the observation—we will then give them higher priority for publication—readers can get a qualitative idea of a shower's "performance", without having to wait for a comprehensive analysis or the publication of the individual raw data. Just leave out the tables with the individual data, and replace them by some global figures: day-by-day ZHR, magnitude distribution for the whole period, etc., provided you have enough data to make these figures meaningful.*

I hope there are now no misunderstandings left: we do *want articles about your observations and we want them fast!*

So, clear skies, and do not forget your *journal!*

Call for photographs: Last year, we received several spectacular photographs that we could use for the front cover. However, we have now ran out of these. So, if you have a photograph suited for the front cover, please send us a print!

IMO Contributions/WGN Subscriptions for 1991

Marc Gyssens

For the near future, some changes may be expected regarding financial matters in *IMO*. Recently, Ann Schroyens decided that, due to a lack of time, she is unable to stay Treasurer. Luckily, we found a good replacement in the person of Ina Rendtel, our President's wife. Therefore, *IMO* voting members find enclosed a ballot form to elect *Ina* in the Council, in order to make it possible to succeed Ann. Note that *all* voting members will find such a form in this issue; members who already casted their vote in Violau should of course ignore this form.

In anticipation of the voting members' decision, *IMO* funds will have to be converted into German Marks (see also Paul Roggemans' article on *IMO*'s 2nd General Assembly, in this issue). Therefore, prices for *IMO* membership and publications will now be expressed in DEM. Soon, a postal account for *IMO* will be opened in Germany. However, if it is more convenient to you, payment in BEF, USD, GBP and JPY will still be possible.

In *IMO*'s continuing effort to keep *WGN* as inexpensive as possible, subscription rates and membership fees for 1991 have been fixed at last year's level. Unfortunately, for that price, we can no longer guarantee automatic airmail delivery for *IMO* members outside Europe. Therefore, a supplement for airmail delivery (if desired) now applies to *IMO* members as well. Furthermore, our non-European members may notice that, although prices in Belgian Francs remained unchanged, prices in US Dollars and Japanese Yens went up; this is *solely* due to less favorable exchange rates for these currencies. This results in the following figures:

Surface mail delivery	20 DEM	400 BEF	8 GBP	15 USD	2000 JPY
Airmail delivery (outside Europe)	30 DEM	600 BEF	12 GBP	22 USD	2500 JPY

First year *IMO* members—who *must* fill in an application form!—should add to these prices 5 DEM, 100 BEF, 1.5 GBP, 3 USD or 500 JPY, respectively.

As said, these prices are kept as low as possible. Therefore, if you can afford to give something extra, please do so! You will help us in our continuous effort to improve *WGN* and the services *IMO* can render as well as in keeping subscription rates low and thus making the information available to the widest possible audience.

Please do not postpone your payment and, at least, renew before the end of the year! Having to send back-issues to late renewers means an extra workload for the administration.

Also, **you should observe the guidelines given below**. Otherwise, bank costs may constitute a considerable fraction of the entire subscription fee, and in view of our policies outlined above, we cannot afford such costs.

People in the *United Kingdom* can pay in GBP through *Alastair McBeath*. People in *North America* can pay in USD through *Peter Brown*. If you pay to Peter by postal money order, just transfer the required amount; if you pay by personal check, add another 2 USD. Contact these persons if you need further details.

People in *Japan* can pay in JPY on the postal giro account (nagano) 8-36-445 of *Masahiro Koseki*, referring to *WGN 1991* and mentioning name and address in Roman characters.

All others should pay in DEM to *Ina Rendtel* or in BEF to *Ann Schroyens*, whichever is the more convenient to you. For this, you have the following options:

- We prefer that you pay by *International Postal Money Order* obtainable at post offices throughout the world. Be sure to make it payable to Ann or to Ina, respectively, and *not* to *IMO*!
- If you have a *postal (giro) account*, you can transfer your renewal to Ann's account mentioned on the back. Belgian subscribers should of course use this option. If you have a non-Belgian *postal* account (you may *not* use a bank account for this purpose), you *must* mention the amount in Belgian Francs.

- Europeans can also pay by *Eurocheque*, *provided* it is either:
  - made payable to Ina, drawn in German Marks in a German city (mention e.g. Berlin) and mentions your Eurocheque card number on the back; or
  - made payable to Ann, drawn in Belgian Francs in a Belgian city (mention e.g. Brussels) and mentions your Eurocheque card number on the back.
- Please *avoid* using personal or bank checks, because, no matter what your bank may claim, they invariantly cause cashing expenses for us. If, for some reason, you see no alternative but paying by check (other than Eurocheque), *pay to Peter Brown* in USD (*not* your local currency) and add *at least* 2 USD to the amounts listed above!
- Finally, you might also want to consider paying cash by sending us bank notes of a convertible currency. However, you should be aware that postal regulations in many countries do not allow sending considerable amounts of cash and that we cannot accept any responsibility for loss or theft!

Please observe these simple guidelines. We cannot afford losing money through exchange or bank costs! Since making an international payment is, to some extent, a cumbersome procedure, we advise you to look at the list of publications on the outside back cover. If desired, you can order these publications together with your membership/subscription renewal. If you pay in GBP, USD or JPY, count 3 DEM for 1 GBP, 1.5 DEM for 1 USD and 1 DEM for 100 JPY.

The address of Ina Rendtel is, of course, the same as Jürgen's address. The addresses of all other persons mentioned above figure on the inside of the back cover!

Recent Remarkable Observations

compiled by Marc Gyssens

- There was a large number of fireball sightings by the general public in the early evenings of August 21 and 22, which were widely covered by the press. In part, they may have been triggered by the appearance of an extremely bright object (eyewitnesses compared it to an arc welder) at about 20^h30^m ADT on August 22, which is 23^h30^m UT. However, contrary to intial press reports, no unusually high meteor rates were seen around that period.

  communicated by Dr. Robert Hawkes, Mt. Alisson Univ.

- At 22^h30^m local time (5^h30^m UT) on the evening of Monday September 24, a brilliant fireball estimated to be −13 to −15 was seen low on the horizon by the general public and several amateur astronomers from the Edmonton area in Alberta, Canada. The fireball lasted in excess of 5 seconds and was followed to a height of only 2°–3° above the SSW horizon before ending in a terminal burst. From the eyewitness reports, it appears that the area of fall is in south-central Alberta, near the US border, and may even extend into the United States. No reports have been received from southern Alberta, at present but a media campaign to solicit eyewitnesses to the event has just begun in Calgary.

  About eight hours later, at 6^h30^m local time (13^h30^m UT), another bright fireball was observed over central Alberta traveling from south to north. The fireball was somewhat fainter than the first and lasted only 2–3 seconds ending without a terminal burst. More eyewitness reports are being collected and the possibility of meteorite recovery from one or both of these events is quite strong. In particular, the low ending height of the first fireball, coupled with its luminosity at such a low altitude, suggests it may have been −18 or brighter in absolute magnitude.

  communicated by Peter Brown

Letters to WGN

compiled by Marc Gyssens

About the editorial policy

Paul Roggemans received a letter from David Swann from which we publish the following:

I participated in monitoring the 1989 δ-Aquarids and the 1989 Taurids but am still waiting to see summaries of these two projects. Do you know why nothing has been published in *WGN* yet? I noticed that the August issue of *WGN* contains many detailed articles. These were obviously time consuming and well done and yet I noticed that there was almost no space allocated to observers' summaries of their observations. When I first started receiving *WGN* in 1988 many observers were submitting summaries. I liked being able to compare my data with other observers. If this change is due to the current editorial policy, I would appreciate you passing on my hope that it will be reversed.

David Swann, September 8, 1990

Editor's reply: The small numbers of observational reports in recent issues of WGN are not *due to the editorial policy; we simply receive considerably fewer reports! In fact, we would dearly like to receive* more *observational reports, to give the readership of WGN a quick first qualitative idea of a shower's activity. Please read what I wrote about this very important issue in my editorial comments on p. 167!*

Information for observers

It is good to know which information in WGN the observers find especially relevant to their work. In this respect, we gladly publish the following comment from a letter of Richard Taibi to Paul Roggemans.

I want to acknowledge Dirk Artoos' work in *WGN*. I appreciate knowing about upcoming potential outbreaks. I try to monitor them. I hope he will continue to keep us all apprised of possible showers.

Richard Taibi, September 3, 1990

The Second General Assembly of the IMO

International Meteor Weekend, September 6–9, Violau, Germany

Paul Roggemans

When the plan to create *IMO* was made at the end of 1987, it was put forward that the tradition of the *IMW*s should be incorporated in the *IMO*. In this way, the *IMO* could also host the *IMO*'s General Assembly. Now, we are about three years later, and we can safely say that the entire 1987 plan (see [1]) has been worked out.

Gradually, the *IMW* became the annual meeting place of *IMO* members in Europe. The 1990 edition got an overwhelming success. Many more participants wanted to come to Violau than what the organizers had expected. Never before, *IMW* organizers got so many registration requests, and it looks as if this trend is going to continue as *IMO* grows. Violau, the site of the 1990 *IMW*, is a typical, small village in Bavaria, Southern Germany. In this village, the "Bruder Klaus Heim" hosts congresses and conferences. Already in 1985, an *IMW* took place in Violau. Participants of the 1985 event were sure about the success of the 1990 edition, as they all had a good memory of the 1985 edition. The Bruder Klaus Heim is indeed a perfect site for such meetings. The director, Mr. Martin Meyer, is so dedicated to his work that, quite simply, nothing could go wrong! Moreover, Martin Meyer is an amateur astronomer himself who runs one of Europe's best equipped public observatories. This explains why astronomical conferences can count on more than 100% of support from the Meyer family. In name of the *IMO* we cordially thank Mr. and Mrs. Meyer for their hospitality and friendliness!

Several *IMO* members gathered at Detlef Koschny's parents house some days before the *IMW* started. It was a good occasion to discuss many aspects of meteor work. Special thanks are due to Detlef's mother who took great efforts to host these 10 meteor enthusiasts.

On September 7, people started to gather in Violau. The first evening, the official opening started very originally with Bavarian music and speeches of German officials of the city and the region. Never before, an *IMW* got so much interest from press, radio and officials! After the speeches, some participants introduced their activities, every presentation being introduced by a nice piece of Bavarian folk music presented by the Augsburg group "Lothar Legel mit den Schmuttertaler Musikanten". Since most of the participants were tired after the long trip to Violau, no lectures were scheduled the first evening, leaving some time for informal discussions.

However, this was not the case for the *IMO* officials! The *IMO* Council met at 23^h that night and council members could not go to bed before 2 o'clock! The following points are of interest to our members.

First of all, it was confirmed that the membership fee for 1991 remained fixed at 400 BEF. In anticipation of the probable election of Ina Rendtel as new Treasurer, a plan was worked out to transfer *IMO* finances into DEM, without losing any transfer costs. New revenues will be collected on an account in DEM, and will be used to form the new financial reserve while the current reserve in BEF will be gradually mobilized to cover printing and mailing costs in Belgium.

The Council also discussed the work load in *IMO*. This is indeed a problem since, although *IMO* has a large council, several council members do not really work. It was agreed that every council member has to decide for him- or herself whether he or she can spend enough time on *IMO*. It was also mentioned that a much smaller council (8 to 10 people) would probably be more efficient. It was concluded that, while "ordinary" members do not have any other obligation than paying their membership fee, Council members by choice carry a lot of responsibility, and are thus obliged to do the work connected to this responsibility. In accordance with this general philosophy, it was confirmed that directors are not automatically Council members. If they want to be part of the Council, they have to be elected as such.

Marc Gyssens reported on the procedure to obtain corporate status for *IMO*. Due to technical difficulties, the administrative procedure was started with a delay of about 10 months which causes some problems. It is however anticipated that the procedure can still be concluded this year.

Finally, the General Assembly was prepared and some topics of a more general were discussed, such as the publishing policy, etc.

The lecture program started Friday morning at 9^h. We will not list all lectures as you can read the contributions in the *IMW* Proceedings, which will be available soon. The program was not too heavy, leaving a lot of time for informal talks. The session chairmen were successful in staying on schedule, timewise. The contents of the program, however, had to be modified about all the *IMW* through for speakers leaving earlier or arriving later than expected, but despite the extra flexibility these changes required from the organizers, everything went very smooth. Several interesting papers were presented and it seems that the one year periodicity is the right timing to prevent *IMW*s from having too heavy programs. Indeed, the periodicity of the *IMW*s used to be 18 months and then, after such a long time, 3 days were really insufficient to tell all there was to tell.

On Friday afternoon, after a visit to Mr. Meyer's public observatory, the second General Assembly of *IMO* took place. The President opened the meeting at 17^h.

The Secretary-General described the tasks of the Council and informed the meeting about a proposal of the Council to elect Ina Rendtel as Council member in order to allow the Council to nominate Ina as Treasurer in replacement of Ann Schroyens who has no time any more. Because of the urgency of the situation, a form was given to the *IMO* members present, for a secret vote on the election of Ina as council member, as well as on the acceptance of 55 associate members as new voting members. If you were not in Violau, you find the voting form enclosed in this issue. Deadline for returning the votes is November 30, 1990, on which date the form must have been received by the Secretary-General. It goes without saying that no votes, including those cast in Violau, will be consulted or counted before the deadline.

Ina Rendtel presented a review of the 1990 financial situation as well as the budget for 1991. From the figures shown by Ina, we learn that *IMO* is in good financial shape. Several publications are scheduled for next year, and a good part of our financial reserves will be used to cover printing costs. No questions about the financial accounts were asked.

Also, the Commission Directors reported about their activities. Christian Steyaert first reported on the Computer Commission where the main activity consisted in the translation and reworking of a publication on photographic astrometry. In the absence of Jeroen Van Wassenhove, he also said a few words about the Radio Commission. In this commission, a start was made with the Radio Handbook. André Knöfel reported on *FIDAC*, *IMO*'s fireball center. Here, a lot of work has been done concerning the collection of fireball reports and the setting up of a database for fireball data. The 1989 report is ready for publication. Malcolm Currie announced the plans of the Telescopic Commission which was rather silent over the past year. A lot of activity in the Visual Commission where the improvements in the report forms was generalized and a lot of valuable programs are undertaken. Ralf Koschack also mentioned that a new version of the Visual Handbook is under preparation now.

The president, Jürgen Rendtel, explained a few organizational points. First, a committee has been set up within the IAU Commission 22 to consider amateur-professional cooperation. *IMO* plays an important roll in this development as all but one of the committee members are also *IMO* members. Secondly, Jurgen explained the agreement that *IMO* made with Tomsk State University (USSR) for mutual cooperation in different fields. Next, Jürgen introduced a detailed proposal from Peter Brown who made a plan to coordinate within *IMO* the International Leonid Watch. More about this project can be read elsewhere in this issue.

A final point to be mentioned is that the Council confirmed that the next *IMW* will take place in Potsdam from September 20 till 22, 1991. Malcolm Currie informed the meeting about the possibility of having the *IMW* 1992 at the University of Kent in Canterbury, England. As it was dinner time and no remarks or questions turned up, the President closed the meeting at $18^{\rm h}$.

Friday evening had the workshops visual and telescopic work on the program. Almost everybody wanted to attend these workshops, so that, despite of a very clear list of points that had to be discussed, the conversation often deviated to fundamental questions. The problem with the workshops at *IMW*s is not new.

Within *IMO*, many technical and organizational matters are now well-defined. The aims of the *IMW* workshops are to improve and fine-tune the *IMO* commissions programs, and, also, to provide a forum of discussion for the work done in these commissions. These goals are difficult to realize when non-*IMO* members interfere questioning the need of international coordination altogether. While visual work is already organized in *IMO* on a global scale, someone turned up with another method to be coordinated in a different way. Some people are really specialists in disorganizing and randomizing things. There is simply no point in endless discussions from which no single concrete result comes out. Maybe, future *IMW*s need additional workshops to discuss general matters, so that the various commissions' workshops can do their work more efficiently.

The Computer and the Radio Workshops got much less participants than the Visual Workshop and were more efficient as only people involved in the field did participate. The Photographic

Workskop, that met on Sunday morning, was attended mainly by dedicated participants and was thus much more conclusive than any other workshop. Dieter Heinlein agreed to act as coordinator of the *IMO* Camera Network. The cooperation with Dr. Ceplecha was arranged and the work on a Photographic Handbook was presented. Christian Steyaert promised to go on storing astrometric data in *PMDB* for a while, but made it clear that somebody else has to be found for this task.

On Friday evening, after the first workshop, many people stayed awake and watched the humorous presentation on the Tunguska Expedition of some *IMO* members by Korlevic Korado. After the story about the terrible horrors in Siberia, Korado tried to convince people to form a new expedition in 1991. Of course, *IMO* members are ready to go... despite Korado's funny description of the horrors of Siberia.

A lot of fun was made in the evenings and many people did not see their bed before the early morning hours! It always surprised me to see still that many people at breakfast at 8 o'clock!

All *IMW*s end with an evaluation of the event. Hans Georg Schmidt took care about the final part of this *IMW*. He mentioned one complaint concerning the great influence of *IMO* on the whole happening, put forward by Jan Lanzing. The *IMO* President added the information that the next *IMW* will be organized by *IMO* in Potsdam, from September 20 to 22, 1991. He also mentioned that most of the efforts and contributions came from *IMO* members now as well as in the past and that *IMW*s would not be possible without *IMO*. Proposals for future events should be made to the *IMO* Council which will decide when and where future *IMW*s will take place. Hans Georg then asked who in the meeting room was *IMO* member and this turned out to be the overall majority. It was stressed that, although *IMO* got the responsibility for the continuation of the *IMW* tradition, non-*IMO* members will always be welcome at these events. *IMO* wants to improve cooperation and bring together meteor enthusiasts. While everybody who wants that too is welcome to join *IMO* as a member, the organization keeps its publications and activities unlimitedly accessible to people who prefer not (yet) to join.

The final words to thank the organizers were pronounced by the *IMO* President. Our Council Member Detlef Koschny, who was the main organizer of the event, thanked the participants and reminded meteor observers are one big family that belong together! In name of all participants we thank Detlef, Hans-Georg, Dieter and the family Meyer for the excellent *IMW* 90! We all went home happily and with a nice memory of Violau and its *IMW*. We all look forward to see you next year in Potsdam!

Visual Observers' Notes: November–December 1990

Jeff Wood

1. Introduction

The months of November and December are characterized by the large number of major showers that are active at this time of the year. The Geminids, Puppid/Velids, Ursids, Taurids and Leonids together with a host of minor streams make for an excellent period of viewing. Even though southern hemisphere observers are favored by summer weather, northern hemisphere observers are to be encouraged to get out and brave the cold winter nights. Table 1 lists some of the more important showers that occur during November and December.

Table 1 – A list of visual meteor showers to be seen during November and December. Streams marked with an asterisk only produce the indicated ZHR in certain years, and otherwise produce much lower activity.

Shower	Activity	Max	Radiant			Drift		V_∞	r	ZHR
			α	δ	Diam.	$\Delta\alpha$	$\Delta\delta$			
Orionids	Oct 02–Nov 07	Oct 21	95°	+16°	10°	+1.°2	+0.°1	66	2.9	25
Taurids S	Sep 15–Nov 26	Nov 03	51°	+13°	10°/5°			27	2.3	10
Taurids N	Sep 13–Dec 01	Nov 13	59°	+23°	10°/5°			29	2.3	8
Leonids*	Nov 14–Nov 21	Nov 18	152°	+22°	5°	+0.°7	−0.°4	71	2.5	storm
Monocerotids (Nov)	Nov 15–Nov 25	Nov 20	117°	−06°	5°	+1.°1	−0.°1	60	2.7	5
χ-Orionids	Nov 16–Dec 15	Dec 02	82°	+23°	8°	+1.°2	0.°0	28	3.0	3
Phoenicids* (Dec)	Nov 28–Dec 09	Dec 05	18°	−53°	5°	+0.°8	+0.°1	18	2.8	100
Monocerotids (Dec)	Nov 27–Dec 17	Dec 10	100°	+14°	5°	+1.°2	0.°0	42	3.0	5
σ-Hydrids	Dec 03–Dec 15	Dec 11	127°	+02°	5°	+0.°7	−0.°2	58	3.0	5
Geminids	Dec 07–Dec 17	Dec 14	112°	+33°	4°	+1.°0	−0.°1	35	2.6	110
Coma Berenicids	Dec 12–Jan 23	Dec 17	175°	+25°	5°	+0.°8	−0.°2	65	3.0	5
Ursids*	Dec 17–Dec 26	Dec 22	217°	+75°	5°			33	3.0	50

Table 2 – Moonlight and observing conditions in November–December 1990.

Date	k	Date	k
Friday October 26	0.42+	Friday November 30	0.92+
Friday November 2	0.99+	Friday December 7	0.72−
Friday November 9	0.56−	Friday December 14	0.09−
Friday November 16	0.02−	Friday December 21	0.13+
Friday November 23	0.26+	Friday December 28	0.80+

New Moon:	October 18, November 17, December 17
First Quarter:	October 26, November 25, December 25
Full Moon:	November 2, December 2, December 31
Last Quarter:	November 9, December 9, January 7

2. Orionids

Details of this shower were described in the last issue of *WGN*. The section of Orionid activity in November is badly affected by the moon and so will not provide good viewing in 1990.

3. Taurids

Table 3 – Radiant positions for the Taurids South and North.

Date	Taurids S		Taurids N	
	α	δ	α	δ
Nov 09	55°	+14°	56°	+22°
14	58°	+15°	58°	+22°
19	62°	+16°	60°	+23°
24	65°	+16°	63°	+23°
29			66°	+24°

Like the Orionids, this shower was fully described in the last issue of *WGN*. The Taurids reach a maximum on November 3 for the southern branch and November 13 for the northern branch. With the full moon occurring on November 2, much of the Taurid maximum period is badly affected. The *IMO* therefore recommends that monitoring of the Taurids begin from November 8 onwards starting first in the evening sky and then progressing to all the night as the moon wanes and rises later. All Taurid meteors should be plotted. To aid in distinguishing meteors from both branches, preferable centers of field of view should be located around $\alpha = 30°$–$40°$, $\delta = +15°$–$+20°$ or $\alpha = 80°$–$90°$, $\delta = +15°$–$+20°$.

4. Leonids

The Leonids are fast, often blue, green or white meteors that frequently have a train. They are active from November 14 to 20 and are best seen during the last few hours before sunrise. Their predicted maximum in 1990 is at 7^{h} UT on November 18. The Leonids are a periodic shower which peaks every 33 years, the next time being 1998-99. Rates at minimum are about 5 meteors per hour and at maximum can be well into the tens of thousands per hour. Surprise activity can occur several years before and after the peak and so *IMO* wishes to find out if something extraordinary happens this year. A proposal to monitor the Leonids in the years around 1999 can be found in the next article; however, we should start already *now* to closely follow the Leonid activity.

With the favorable moon conditions, the *IMO* would like to obtain a complete activity profile of the 1990 Leonids. Observers should plot all Leonids seen using the standard identification procedures outlined for other showers in previous *Observers' Notes*. They should refer to the relevant angular velocity tables (V_∞ for the Leonids is 71 km/s). Please note that if the Leonid ZHR rises to above 10 per hour observers are to refrain from plotting and use the classified counts technique.

Table 4 – Radiant positions of the Leonids.

Date	α	δ
Nov 14	150°	+23°
Nov 17	152°	+22°
Nov 20	154°	+21°

5. November Monocerotids

This stream is active from November 15 to 25. Maximum occurs on November 20. The November Monocerotids are noted for their variable activity. In some years, they are virtually non-existent whereas in others the maximum ZHR has exceeded 100 meteors per hour. With the favorable moon conditions, the *IMO* has targeted the stream for a thorough investigation in 1990. The *IMO* recommends that you observe both the Leonids and the November Monocerotids simultaneously whenever both radiants have an elevation of 20° or more. To do this, the observing field should be centered in the region $\alpha = 120°$–$150°$, $\delta = -20°$–$+30°$. All possible Monocerotids should be plotted as long as the ZHR is less than 10. Thereafter, use classified counts.

Table 5 – Radiant positions of the November Monocerotids.

Date	α	δ
Nov 15	112°	−05°
Nov 20	117°	−06°
Nov 25	123°	−07°

6. Phoenicids

The Phoenicids are active from November 28 through to December 9, with a maximum occurring on December 5. The Phoenicids produce variable activity wich ranges generally from 2 to 10 meteors per hour. On a couple of occasions, notably 1956 and 1974 the rates reached 100 and 25 per hour respectively. The Phoenicids are badly affected by the moon in 1990. Even though viewing conditions are not to best, southern hemisphere observers are encouraged to check the night of the maximum to see if they will produce an unusual behavior.

7. Puppid/Velids

From late October to late January there are a series of radiants active in the constellations Carina, Puppis and Vela. These are known as the "Puppid/Velids". Since there are several sub-streams in the complex, the Puppid/Velids exhibit several maxima. The strongest of these occur during the month of December and in early January. Rates at this time can reach 12 to 15 meteors per hour. On some occasions, notably during the period December 3 to 12, rates of 20 to 25 meteors per hour have been recorded!

As with all long duration showers, the moon is invariably going to affect some of the activity period. With this in mind, the *IMO* requests that southern hemisphere observers concentrate on this shower over the following dates: November 12 to 18 and December 9 to 28. Observers should plot all possible Puppid/Velids seen unless the rate exceeds 10 per hour when classified counts should be made. From November 14 to 25, southern observers should choose a field center around $\alpha = 120°$–$150°$ and $\delta = -20°$ so that they can monitor the Leonids, November Monocerotids and the Puppid/Velids simultaneously. From December 9 to 18 they should look close to the radiant area and observe the Puppid/Velids only when the Geminid radiant is below 20° in altitude. Once the Geminid radiant reaches this altitude, they should then concentrate on this shower. After December 18, the Puppid/Velids may be monitored all night with the observer having a field center on or within 35° of the radiant position.

Table 6 – Radiant positions of the Puppid/Velids in November and December.

Date	α	δ	Date	α	δ
Nov 12	113°	−43°	Dec 09	123°	−45°
Nov 17	114°	−43°	Dec 14	127°	−45°
Nov 22	116°	−43°	Dec 19	128°	−45°
Nov 27	117°	−45°	Dec 24	134°	−46°
			Dec 29	136°	−47°

8. Geminids

This is one of the major calendar events of the meteor year. The Geminids are visible from both hemispheres and provide excellent rates of around 100 meteors per hour each year. The Geminids are active from December 7 to 17 and reach maximum on December 14. They are noted for their many bright yellow-orange meteors. With the full moon occurring on December 3, conditions are very favorable for viewing the Geminids in 1990. Observers should only plot any Geminids seen if the ZHR is less than 10 and this will be the case outside the period December 10–15. Otherwise classified counts should be made. The Geminids are good viewing for most of the night in the northern hemisphere. In the southern hemisphere they are best observed from midnight through the dawn when the radiant reaches an elevation of 20° or more. Before midnight, southern observers should monitor the Puppid/Velid stream. Observers should have a field center situated no more than 40° away from the radiant position.

Table 7 – Radiant positions of the Geminids.

Date	α	δ
Dec 07	107°	+33°
Dec 12	111°	+33°
Dec 16	115°	+33°

9. December Monocerotids

This shower is active from November 27 to December 17 with a maximum ZHR of 5 on December 11. The *IMO* requests that observers give this shower attention after the full moon period of early December. The shower should be observed in conjunction with the Geminids. Care should be taken to distinguish between meteors from both showers. To aid this, the observer's center of field of view should be located at $\alpha = 105°–120°$ and $\delta = 00°–+20°$. All possible December Monocerotids as well as meteors possibly belonging to the Geminids or Monocerotids (i.e., those difficult to distinguish) should be plotted. Meteors belonging to the Geminids or sporadics should be counted only. On the nights of December 12-13 and 13-14 it is senseless to analyze the Monocerotids since the activity of the Geminids is vastly superior and the ZHR of the December Monocerotids becomes polluted by the high Geminid activity. Therefore, observers are asked to concentrate on the Geminids on these dates.

Table 8 – Radiant positions of the Dec. Mon.

Date	α	δ
Dec 05	94°	+14°
Dec 10	100°	+14°
Dec 15	106°	+14°

10. Ursids

The Ursids are active from December 17 to 26 with a maximum on December 22 at 21^h UT. The radiant position is at $\alpha = 217°$ and $\delta = +76°$ which means it can only be observed from the northern hemisphere. The Ursids display variable activity with ZHRs of around 50 being recorded on occasions. Unless the ZHR reaches or passes 10, all Ursids seen should be plotted. To aid in identification, $V_\infty = 33$ km/s.

11. Coma Berenicids

The Coma Berenicids are active from December 12 through to January 23. The maximum of 5 meteors per hour occurs on December 17. They are best seen during the last few hours before sunrise from the northern hemisphere. Northern observers should endeavor to monitor the Coma Berenicids after the period of maximum Geminid activity (December 12–14). From December 17–26, both the Coma Berenicids and the Ursids can be observed providing the observer's field is centered around $\alpha = 150°–180°$ and $\delta = +40°–+60°$. All possible Coma Berenicid meteors should be plotted.

Table 9 – Radiant positions of the Com.

Date	α	δ
Dec 12	174°	+26°
Dec 17	175°	+25°
Dec 22	179°	+24°
Dec 27	183°	+22°

During the International Meteor Weekend in Violau, Bavaria, Germany, that took place from September 6 to 9, a proposal from Peter Brown was presented to coordinate Leonid observations in the years around the expected peak year 1999 (see also Paul Roggemans elsewhere in this issue). However, we think it is worthwhile to start monitoring the Leonid activity evolution already now, especially since observing conditions are ideal this year, as pointed out by Jeff Wood above. In order to focus attention to this very interesting and fascinating stream, and to encourage meteor enthusiasts to observe this stream next month, we decided to publish Peter's proposal in full, even though the text was not originally intended for publication in WGN. Consequently, the reader should mind the possibility that the proposal will still undergo some polishing or fine-tuning in the months to come. Also, comments to the proposal are welcome! (Ed.)

Proposal for the International Leonid Watch (ILW)

Peter Brown

1. Introduction

With the beginning of the 1990s, the *IMO* is looking forward to a decade of progress in meteor science both through amateur efforts and cooperative work with professional astronomers. In the 1990s, many new discoveries will undoubtedly be made about various processes in meteor astronomy, with the Leonid meteor shower at the end of the decade offering an unparalleled opportunity in this regard.

With this in mind a working committee within *IMO* specifically devoted to handling results from the Leonid shower should be set up to analyze results and promote the shower as a means to direct more amateurs to become involved with meteor astronomy.

The showers to be rigorously investigated by the committee will be the 1996, 1997, 1998, 1999 and 2000 A.D. returns of the Leonids. These returns are expected to be active due to the proximity of the ortho-Leonid stream as a result of the passage of Comet P/Temple-Tuttle through perihelion in early March of 1998, in the middle of this period. The 1999 return will receive particularly intense scrutiny because of the strong possibility of a meteor storm at this time.

From now until the 1996 return, Leonid data will be gathered through the normal *IMO* channels and observers will be asked to keep the Leonids as a special project shower for each year to help collect data regarding the stream in the years just before the return of the main ortho-Leonid stream and to watch for the possibility of an unexpectedly strong Leonid return in the years preceding the predicted peak years.

2. Organizational setup and duties

The Leonid sub-committee within the *IMO* will be charged with the promotion, collection and archiving of Leonid data for the years leading up to the 1999 main return and for organizing specific research projects related to the shower. During the 1996–2000 return, the normal *IMO* responsibles charged with data collection will be the principle means by which observers send observations to *IMO*, in an effort to avoid confusion. However, for commission leaders not involved with the committee's work, the *ILW* committee will ask that their sections' data be submitted immediately to the appropriate committee member for analysis.

The committee will consist on an *ILW* coordinator and members responsible for the various means of data collection (visual, radio, etc.) and analysis who will closely together with the *IMO* commission directors in these areas. The *ILW* coordinator will be responsible for promoting the shower in the popular astronomy media and through *WGN*, with writing a comprehensive review handbook/article on the Leonids and developing meteor storm observing methods with the help of other committee members. Also, the coordinator will of course act as head of the committee and will be responsible to the *IMO* Council for the committee's progress and results.

For a tentative timeline, the committee members should be identified and have specific areas of study by the end of 1991.

3. Specific research goals

1. To study the Leonid stream using visual, still photographic, radio, video, telescopic and spectrographic observations.
2. To study the main ortho-Leonid stream on a year-to-year basis.
3. To determine the radiant size and radiant drift of the Leonids to new levels of accuracy and the radiant size as a function of mass of the incoming particle. In this way, new, small particles with small radiant sizes may be separated from old, large particles with large radiant sizes may be separated from old, large particles with large radiant sizes.
4. To determine if newly ejected particles easily fragment in space due to the presence of volatiles as suggested by Bronsten (1967) through observation of simultaneous meteors and fragmenting meteors near the time of maximum.
5. To use the high expected rates of the Leonids near the 1999 peak to perform an observational test of the need for a zenith exponent factor in ZHR corrections. Since meteor rates will be high, the statistical error will be small and the controversy surrounding the need for such a factor may be resolved.
6. To investigate the nature of a periodic stream such as the Leonids and attempt to determine if the ortho-Leonids are best described as a ribbon-like structure in the stream or a small dense cloud of particles.
7. To study each Leonid return through use of the population index.

These are only meant as broad preliminary suggestions with more concrete and specific goals of the project to be the first item of business for the *ILW* committee.

4. Observing conditions during the ILW period

1996: Maximum will occur at roughly 19^h UT on Monday, November 18. The moon will be at the first quarter phase, so the peak Leonid rates occurring when the radiant is near culmination in the early morning hours will favor Japan and Australia.

1997: Maximum will occur at roughly 2^h UT on Tuesday, November 18. The moon will be four days after full, so the shower will experience severe moonlight interference. Additionally, the moon will be quite far to the north on the ecliptic, so it will be above the horizon at temperate latitudes during most of the night. The favored area is the Western USSR and much of Europe.

1998: Maximum occurs at approximately 7^h–8^h UT on Wednesday, November 18. The moon will be three days before new and effectively out of the picture. The shower peak will favor the Atlantic Ocean region and the East Coast of North America. This is likely to be the first strong return of the Leonids since 1966 and a good prelude to the 1999 return, perhaps even reaching storm proportions. The Earth will pass 0.0080 AU outside of Comet P/temple-Tuttle's orbit only 257 days after the comet passed the same point so fresh particles will be present to form a strong, young display.

1999: This is the long-awaited return of the main part of the ortho-Leonid stream and will probably prove to be one of the strongest meteor showers of the 20th century. The maximum is predicted for roughly 13^h UT on Thursday, November 18. The moon will be 2 days after first quarter and, therefore, will set in the early morning hours, permitting dark viewing of the return of the main part of the stream. The best geographical area to view the shower will be the

West Coast of North America, the peak time being only about 1 hour later than in 1966. The Earth will pass 0.0080 AU outside of the comet's orbit some 622 days after the comet passed the same point. Similar combinations have historically led to meteor storms so the shower is likely to be very strong.

2000: This return of the Leonids may also produce high meteor rates and so is included as one of the main returns for concentration by the *ILW*. The peak is expected at roughly 18^h–19^h UT on Saturday, November 18. The moon will be 1 day before last quarter and will be a major source of light interference being high on the ecliptic as well. Japan and Australia along with the rest of the Pacific rim countries will be best placed to observe this return, though lunar interference will dim the show. The comet will have passed through the region of the Leonid stream encountered by the Earth almost 1000 days before, but may still produce a good show as large displays have been seen when the comet was more than 1500 days past the Earth encounter point.

Telescopic Observers' Notes: Nov–Dec 1990

Malcolm J. Currie

1. Telescopic Project—1990 Orionids

The lack of interference from the moon during the period of the Orionid meteor shower this year offers the Telescopic Commission a golden opportunity for its first special project. The main aim of the Project is to study the complicated radiant structure. All telescopic and video observers are urged to make as many observations as possible during watches on nights during October 16–27, and especially October 19–24. Please try to observe for as long as possible. Note that the radiant does gain a respectable altitude until after midnight and only reaches culmination around 4^h20^m. The highest rates will therefore occur between 2^h and 5^h.

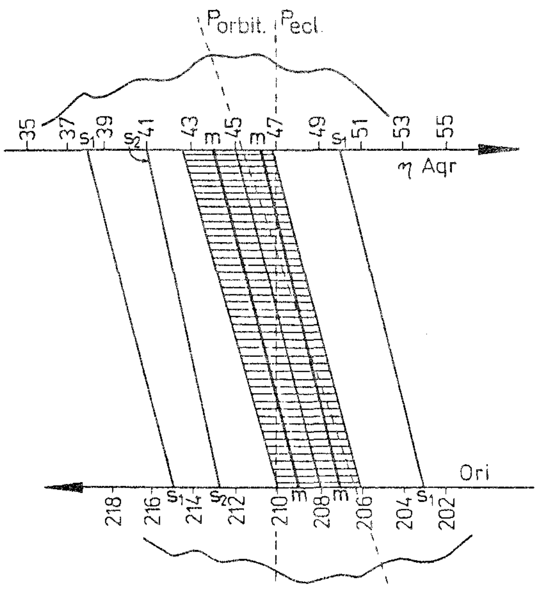

Figure 1 — Activity of the η-Aquarids and Orionids as a function of solar longitude, at a typical shower return.

Background

The Orionids and η-Aquarids are both associated with Halley's Comet. Radar, visual and television observations during the last sixty years revealed that the Halley showers have similar complicated structures. Both have durations around 15 days during which there are several maxima in the activity curves. They provide similar rates, although, during the Orionid shower, Earth is more than twice the distance from Halley's orbit than during the η-Aquarid shower. An exact correspondence exists between the maxima for the two showers. Typical activity curves are shown in Figure 1 (from [1]).

Each shower has a relatively stable, flat period of increased activity lasting some five days. Within this period there is a small dip that delineates the two main maxima. There are two other stable secondary maxima well separated from the central period of enhanced activity, and evidence for a further, weak maximum. The times of maxima shift gradually at consecutive returns over several years.

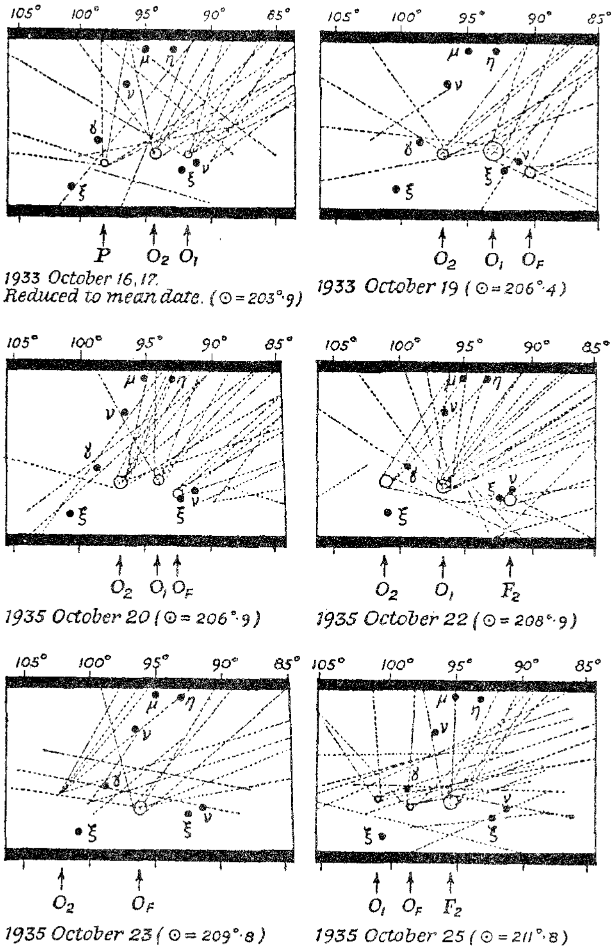

Figure 2 — Orionid radiants observed by Prentice on successive days in 1933 and 1935.

McIntosh and Hajduk [1] have explained these characteristics by a model in which the cross-section of meteoroid orbits are ribbon shaped rather than circular. Currently the stream structure comprises about five separate, but overlapping, belts or shells of meteoroids. These belts give rise to the various periods of increased shower activity in complicated activity curves. See Figure 1 for a diagram—the diagonal lines are the belts. The overall activity variations are probably due to filaments of denser material along the stream orbit created by variations of the ascending node in consecutive revolutions that bunch orbits. The shifts in the time of maxima can be explained by the change of orbital period. The shells arise due to the orbital evolution of Halley's Comet, and has been confirmed by numerical modeling [2], as have the clumping of orbits.

In addition to the complicated activity the Orionids are known to have a complex radiant comprising at least four sub-centers. Early this century this misled some observers, such as Denning, into believing that the radiant was stationary. A solution was postulated by Prentice [3] from his naked-eye radiant work (probably the most accurate naked-eye observations ever carried out), which seemed to show that the Orionids come from a sequence of sharply defined radiants which do move—about 1°3 per day—each of which in turn becomes active crossing the same region of sky, hence giving the impression of a stationary radiant. See Figure 2.

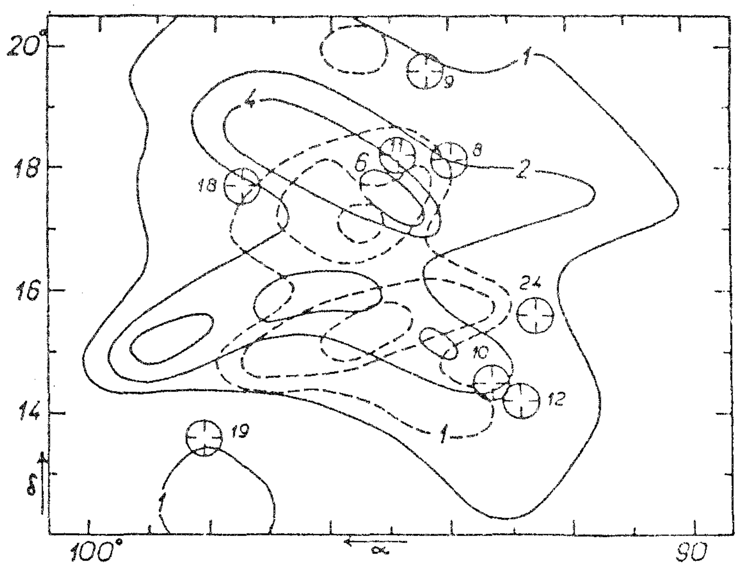

Figure 3 – Contour maps of the distribution of Orionid radiants determined from telescopic observations organized at Brno Observatory. Full lines show the 1965 data—note the similarity to Prentice's data, and dashed lines are for 1966.

Since Prentice's work, little has been done to confirm or disprove his observations and analysis. Naked-eye plotting of late has not achieved anything like Prentice's accuracy, and radar imaging, which has yielded radiant sizes, has a resolution of about 2°. Careful telescopic observations can probe into the internal structure with resolutions an order of magnitude better than radar. Video data should also be capable of providing similar accuracies. Indeed, only the telescopic work reported by Znojil [4] appears to confirm Prentice's observations (see Figure 3). Notice the good agreement of the 1965 data and Prentice. (Prentice [5] later observed the northern component).

Aims

- To determine the changing radiant structure throughout the shower. This will form part of a longer study over many years as there are clearly variations.
- To look for correlations between the structure and the activity curves (at both visual and telescopic magnitudes). For example, which components give rise to enhanced activity? Are there any correlations between the changing time of maxima as observed visually and the radiant structure or size?
- To determine the luminosity function and hence r for each main component. (Some work has already been done on this topic [6].)
- At this time there are a number of other possible radiants awaiting confirmation.

Observations

Observers should concentrate on plotting the path and direction of each meteor as carefully as possible. All other data are subsidiary. Select at least two pairs of stars that are close and straddle the meteor path. They should span the length of the track so as to give good leverage on the orientation of the path. Estimate the position of the path as the fractional distance between each pair of stars, *e.g.,* one third from star A to star B. This information can then be transferred to the chart. The high percentage of trained Orionids should help to define the meteor tracks. Inaccurate positions should be indicated in the reports, so they are given less weight in the analysis.

My suggested field-center pairs for 40–60° N latitudes are $\alpha = 6^h40^m$, $\delta = +39°$ and $\alpha = 5^h00^m$, $\delta = +23\overset{\circ}{.}5$, especially before 1^h local mean time, or $\alpha = 7^h40^m$, $\delta = +23\overset{\circ}{.}5$ and $\alpha = 5^h15^m$, $\delta = +41°$ after 1^h. An additional pair are $\alpha = 5^h50^m$, $\delta = +28°$ and $\alpha = 5^h35^m$, $\delta = +09\overset{\circ}{.}7$. For further south I suggest the following pairs: $\alpha = 5^h22^m$, $\delta = +01°$ and $\alpha = 7^h50^m$, $\delta = +01°$, or $\alpha = 5^h35^m$, $\delta = +09\overset{\circ}{.}7$ and $\alpha = 6^h50^m$, $\delta = -02°$. It will help if observers select different centers, as this will reduce the effect of occlusions of the sub-radiants. *It is very important to alternate between the two fields about every 30 minutes.*

Notice that the centers are about 15°–20° away from the radiant and the paths of meteors emanating from the Orionid radiant in the two fields meet at right angles at the radiant. The telescopic rate is highly dependent on the sky condition, so try to observe from a dark site.

The Orionid shower is probably the most interesting for the telescopic observer, yet very few telescopic observations of it exist. Given the number of observers and their widespread locations we in *IMO* should be able to provide a large number of accurate meteor paths through the shower even if some sites are cloudy. How about it? Report sheets, charts and details of the observing method are available from the Commission Director.

2. Telescopic Project—1990 Geminids and December Monocerotids

December is probably the most interesting for the telescopic observer—there are several strong showers of faint meteors like the Geminids, numerous minor radiants such as the Monocerotids and σ-Hydrids, coupled with a good sporadic rate. In 1990 the moon is well placed to observe several of these showers. In particular I should like to concentrate on the Geminid and Monocerotid showers. For a detailed rationale and background of this project see [7]. (Copies may be obtained from the Director.) Please try to observe during the period December 7–20.

Aims

The aims of the project are ambitious and knowing the weather will take several years before we can achieve them. Even if we tackle but a few of them it will provide more new science than visual watches of the same duration. They are:

- The professionals bemoan the lack of data describing the detailed structure of the Geminid shower. The most important data we can obtain are the identification of any strong sub-radiants, and their sizes; the size of the radiant as a whole as the shower progresses, and as a function of meteor magnitude. If distinct sub-radiants are active they could indicate the cause of the variation in visual rates, as the relative strengths of the sub-radiants vary due to their different periods and meteoroid concentrations.
- The time of maximum, half-life and activity periods of the showers as a function of meteor magnitude are poorly determined. These may depend which sub-radiants are active. Good data sets obtained with *both* small 30–80 mm, and large 90–200 mm apertures are needed because they give rate curves for different mean magnitudes (approximately +6 and +8.5 respectively.) It is important to observe away from $\lambda_{\odot}^{max}$.
- Estimate the faint-end of the luminosity function for all the showers and the sporadics. The relative contributions of particles of different masses are needed to give clues to the meteoroids' place of origin, formation mechanism and the perturbations they have experienced. It also permits an estimate the total mass of a stream.
- Determine whether or not the 11 Canis Minorid shower [8] is active (or periodic given several years data), and if so, determine the radiant size and position on each night. Compare the properties with the Geminid meteors of similar brightness (*e.g.*, light curves, trains, activity half-life) to enhance the view that the shower really is a southern component of the Geminids.
- Monitor other concurrent shower activity.

Observations

For this project both accurate paths and magnitude estimates are required. The selection of field centers is made difficult because the radiants are visible all or most of the night, they rise quickly at mid-northern latitudes, and the distribution of the radiants can cause occlusions. My field-center pairs for 40–60° N latitudes are as follows. before 21^h local mean time, I suggest: $\alpha = 5^h15^m$, $\delta = +41°$ and $\alpha = 8^h34^m$, $\delta = +65°$. Between 21^h and 23^h, take: $\alpha = 5^h50^m$, $\delta = +20°$ and $\alpha = 8^h58^m$, $\delta = +48\overset{\circ}{.}5$. During the rest of the night try: $\alpha = 5^h50^m$, $\delta = +20°$ and $\alpha = 8^h34^m$, $\delta = +20°$. South of 40° N, the night is shorter, and the Monocerotid radiant can attain a higher elevation by some 24°. Therefore, after 22^h, try the following pairs: $\alpha = 8^h00^m$, $\delta = -03°$ and $\alpha = 5^h35^m$, $\delta = +09\overset{\circ}{.}7$, or $\alpha = 7^h35^m$, $\delta = -14°$ and $\alpha = 5^h22^m$, $\delta = +01°$ to concentrate on the Monocerotids. These fields will also serve for observations of the Puppid/Velids, though their distance from this radiant complex is larger than ideal.

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[6] V. Znojil, J. Hollan, A. Hajduk, "Concentration of Small Particles in Orionids", *Bull. astr. Inst. Czech.* 38, 1987, pp. 372–375.

[7] M.J. Currie, *BAA Meteor Section Newsletter, Telescopic Appendix* 31, 1988, pp. 3–6.

[8] K.B. Hindley, M.A. Houlden, "The 11 Canis Minorids—a New Meteor Stream Probably Associated with Comet Mellish 1917 I", *Nature* 225, 1970, pp. 1232–1233.

Call for Radio Observations: 1989 UR Again!

Dirk Artoos

In [1], I did a call for radio observers to turn on their radio for a likely activity produced by this earth-grazing asteroid. I hope that some colleagues have done so because I surely detected a higher number of reflections the 10th of June. Between 12^h15^m and 12^h45^m UT, there were 92 echos (see Figure 1), 40% of which had a duration of 1 second or longer.

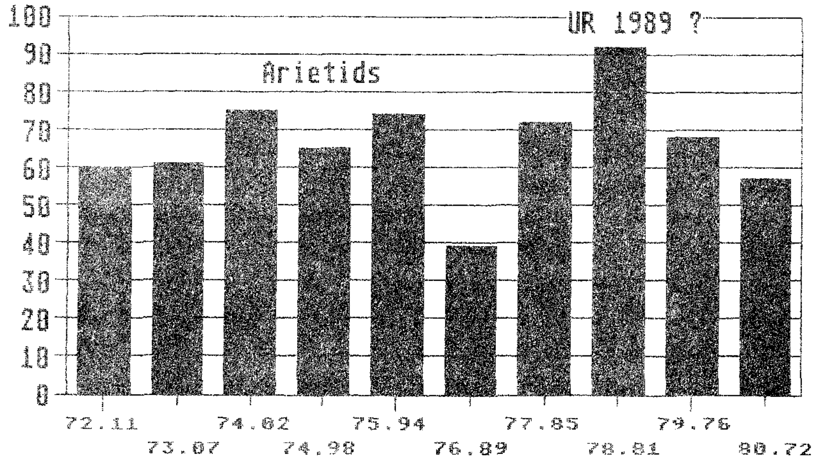

Figure 1 – Radio activity observed in the period June 6–12, 1990 by Dirk Artoos at 66.45 MHz with an antenna elevation of 40° and azimuth of 275°. Observations were carried out between 9^h45^m and 10^h15^m UT. (Epoch 1950.0.)

Table 1 – Observability function for a four-element antenna elevated at 45° for each hour of the day (local time), four cardinal directions and four latitudes (100 = best observability, 0 = radiant below the horizon). For the calculations a transmitter distance of 1000 km and a transmitter power of 30 kW were assumed.

Lat.	Dir.	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
+50	S	0	20	73	95	100	96	87	76	70	56	44	34	21	31	40	51	65	78	83	93	99	98	83	43
+50	W	0	2	5	20	45	67	76	72	56	39	26	18	15	16	22	32	46	62	85	96	100	99	93	80
+50	E	0	69	89	93	100	98	91	77	54	38	26	18	15	16	22	33	48	65	76	75	57	31	8	1
+50	N	0	43	78	96	100	97	89	79	68	57	46	36	26	33	42	52	64	75	86	95	99	98	86	57
+35	S	87	92	90	99	98	88	72	57	33	7	0	0	0	0	0	0	24	49	66	83	95	100	95	78
+35	W	43	30	39	55	70	76	67	47	24	5	0	0	0	0	0	0	17	42	66	85	95	100	98	69
+35	E	34	60	95	100	98	89	73	50	24	5	0	0	0	0	0	0	17	39	61	75	73	61	45	32
+35	N	1	20	69	94	100	94	79	58	34	8	0	0	0	0	0	0	25	50	73	89	99	98	81	39
00	S	83	100	99	90	70	42	7	0	0	0	0	0	0	0	0	0	0	0	0	30	61	84	97	100
00	W	100	98	94	86	70	43	7	0	0	0	0	0	0	0	0	0	0	0	0	33	60	81	93	99
00	E	100	100	97	87	69	46	8	0	0	0	0	0	0	0	0	0	0	0	0	31	61	81	91	97
00	N	77	84	98	99	81	48	8	0	0	0	0	0	0	0	0	0	0	0	0	35	71	95	100	89
−35	S	82	100	69	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	50	94
−35	W	100	93	63	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	46	85
−35	E	100	93	63	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	46	85
−35	N	97	100	66	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	47	93

Now, everyone still has the opportunity to see and to listen around the second approach between the Earth and the asteroid on November 26. Moreover, this approach is closer than the first one in June (June 11: 0.09 AU, November 26: 0.035 AU). The coordinates of the possible radiant are $\alpha = 68°$ and $\delta = +46°$.

Table 1 shows the observability function, which is given for 50° N, 35° N, 0° and 35° S. The value (a percentage) is given for each hour local time for the directions South, West, East and North. 100% corresponds to the best observability, 0% with the radiant under the horizon. For the calculations, a four element antenna at an elevation of 45°, a transmitter distance of 1000 km and a transmitter power of 30 kW were assumed.

Unfortunately, the radiant is badly placed for people living at southern latitudes. For those colleagues, I have calculated the observability function for another Earth-grazing asteroid, 1989 UP, which is perhaps a meteor producer (see Table 2). The best time to observe in the southern sky is November 18. The coordinates of the radiant are $\alpha = 358°$ and $\delta = -23°$. The closest approach to the earth's orbit is 0.0052 AU. Good Luck!

Table 2 – Observability function for a four-element antenna elevated at 45° for each hour of the day (local time), four cardinal directions and four latitudes (100 = best observability, 0 = radiant below the horizon). For the calculations a transmitter distance of 1000 km and a transmitter power of 30 kW were assumed.

Lat.	Dir.	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
+50	S	29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	35	72	97	100	98	73	37
+50	W	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	49	79	95	100	95	80	50
+50	E	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	49	79	95	100	95	80	50
+50	N	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	38	76	100	95	100	77	39
+35	S	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	30	64	90	100	97	100	91	66
+35	W	45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	44	79	90	98	100	97	89	72
+35	E	48	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	41	71	88	97	100	98	90	79
+35	N	29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	26	62	88	100	93	100	89	63
00	S	80	45	3	0	0	0	0	0	0	0	0	0	0	0	0	41	77	99	98	61	17	58	97	100
00	W	70	48	3	0	0	0	0	0	0	0	0	0	0	0	0	47	76	93	100	83	74	68	68	73
00	E	79	51	4	0	0	0	0	0	0	0	0	0	0	0	0	45	69	73	69	67	73	83	100	94
00	N	62	35	2	0	0	0	0	0	0	0	0	0	0	0	0	32	60	80	88	100	87	100	88	81
−35	S	87	66	38	7	0	0	0	0	0	0	0	0	0	4	35	63	85	99	100	85	90	84	100	99
−35	W	70	70	48	8	0	0	0	0	0	0	0	0	0	5	46	74	85	94	100	65	44	31	32	55
−35	E	86	75	50	9	0	0	0	0	0	0	0	0	0	5	45	69	69	56	32	31	44	82	100	96
−35	N	93	77	55	29	1	0	0	0	0	0	0	0	0	26	52	75	92	100	92	56	0	54	92	100

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Earth-Grazing Asteroids

Christian Steyaert

Information is provided on possible meteor shower radiants associated with the newly discovered asteroids 1990 MF, 1990 OS and 1990 MU, as well as with the period comet 1990f P/Honda-Mrkos-IAU.

1. The frequency of Earth-Grazing Asteroids

In 1981, E. Shoemaker wrote: [1]

> ... *About 40 Earth-crossing asteroids have been discovered to date: these include about half of the known Amors, as well nearly all the Apollo and Aten asteroids* ...

Yet, early 1990, those figures had increased to 65 Amor, 63 Apollo and 9 Aten-type asteroids. The newly discovered Apollo have typical diameters of 0.2 to 0.6 km. Still smaller objects appear even more frequently, but are less likely to be detected by photographic methods. The number of Earth-crossing asteroids seems to be much larger than once believed: the total population is estimated to be about 1000. Hence, the possibility of collisions of very small asteroidal objects with the Earth is real. Meteorites can be fragments of asteroids disrupted by mutual collisions in the main belt and then injected into the inner regions of the solar system.

2. New earth-grazing comet and asteroids

Periodic comet P/Honda-Mrkos-IAU has been rediscovered as 1990f (IAU Circular 5035). Its orbit has two close approaches with that of the Earth:

$$\lambda_\odot = 324^\circ\!.2, \text{ shortest distance: } 0.060 \text{ AU on Feb } 13.7$$
$$V_\infty = 26.8\text{km/s}, \quad \text{Radiant: } \alpha = 328^\circ\!.5, \ \delta = -20^\circ\!.0$$

and:

$$\lambda_\odot = 142^\circ\!.5, \text{ shortest distance: } 0.060 \text{ AU on Aug } 16.2$$
$$V_\infty = 26.8\text{km/s}, \quad \text{Radiant: } \alpha = 325^\circ\!.5, \ \delta = -14^\circ\!.5$$

Although the stream associated with the second approach could be related to the ι-Aquarids, it is unlikely. The comet is severely disturbed by Jupiter (recently, its inclination changed from 14° to 4°). The ι-Aquarids orbit is much smaller, and stays outside the influence of Jupiter.

The discovery of planetoid 1990 MF was reported in IAU Circular 5050. The approaches are:

$$\lambda_\odot = 105^\circ\!.8, \text{ shortest distance: } 0.032 \text{ AU on Jul } 8.8$$
$$V_\infty = 14.2\text{km/s}, \quad \text{Radiant: } \alpha = 248^\circ\!.0, \ \delta = -22^\circ\!.5$$

and:

$$\lambda_\odot = 178^\circ\!.4, \text{ shortest distance: } 0.018 \text{ AU on Sep } 22.2$$
$$V_\infty = 14.2\text{km/s}, \quad \text{Radiant: } \alpha = 214^\circ\!.0, \ \delta = -08^\circ\!.0$$

Following calculations about 1990 OS used the elements of IAU Circular 5068:

$$\lambda_\odot = 230^\circ\!.7, \text{ shortest distance: } 0.017 \text{ AU on Nov } 13.9$$
$$V_\infty = 14.9\text{km/s}, \quad \text{Radiant: } \alpha = 257^\circ\!.0, \ \delta = -25^\circ\!.5$$

and:

$$\lambda_\odot = 138^\circ\!.4, \text{ shortest distance: } 0.010 \text{ AU on Aug } 12.0$$
$$V_\infty = 15.0\text{km/s}, \quad \text{Radiant: } \alpha = 294^\circ\!.0, \ \delta = -25^\circ\!.5$$

The orbital elements of 1990 MU are based on only 6 observations between June 24 and July 26, 1990. The approaches are:

$$\lambda_\odot = 244^\circ\!.5, \text{ shortest distance: } 0.108 \text{ AU on Nov } 27.6$$
$$V_\infty = 26.3\text{km/s}, \quad \text{Radiant: } \alpha = 75^\circ\!.0, \ \delta = -15^\circ\!.0$$

and:

$$\lambda_\odot = 74^\circ\!.0, \text{ shortest distance: } 0.029 \text{ AU on Jun } 5.5$$
$$V_\infty = 25.9\text{km/s}, \quad \text{Radiant: } \alpha = 53^\circ\!.0, \ \delta = +48^\circ\!.0$$

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Minor Streams

Vladimir Znojil

Methodological aspects of the problem of searching for minor streams are discussed.

Problems of searching minor streams are closely linked with the distribution of meteor tracks and radiants as a whole and with its change within a year. From radar observations according to the Davies method, where, within a relatively short period, many individual trails of meteor bodies are obtained, one finds a considerable "grayness" of large radiants areas [1,2]. The question arises when a cluster of trails yielding a radiant in, e.g., a toroidal or an anti-helion source, can be considered as a meteor shower. I must observe that this question has not yet been satisfactorily answered.

Although the imposing of several conditions, such as the reoccurence of the phenomenon in different years, is a very reasonable way to resolve the question, some problems still remain. It is indeed necessary to realize that it may be impossible to e.g. ascertain the activity of an existing minor stream during several years, due to fluctuations of the number of meteoroids along its orbit. The μ-Pegasid shower has shown significant activity only photographically, in fact during two hours in 1952 [3,4]. Similarly, the β-Lacertid shower [5], registered for the first time telescopically in 1968—when it nearly reached the activity of the δ-Aquarids—could only be confirmed as late as 1982; the observation from 1973 cannot be considered as significant, if considered independent of the 1968 and 1982 events.

These problems in ascertaining the existence of minor streams often give rise to vivid controversies. From recent years we recall, for example, the discussions about the υ-Pegasids [6,7] and the ε-Cassiopeids [8,9]. I do not intend to be a judge in these discussions and do not want to decide in favor or against the existence of these showers. Rather, I want to discuss some methodological aspects of this problem.

First and foremost, I would like to point out that the most frequently used purely statistical method with radiant determination directly from the sky, is not very suited for minor stream detection or studying. During a several-hours observing night, a few meteors of a shower unknown to the observed will most probably be attributed either to the sporadic background or to other showers. It is indeed common that several showers are simultaneously active during a certain period. According to [3,4], for example, as many as 14 radiants—often quite close to each other—are active in early August. Under such circumstances, meteor shower identification is so difficult that even experienced observers often disagree as to which stream a particular meteor belonged.

An important aspect of studying minor streams is "contamination" by sporadic meteors, the elongated trails of which pass close to the radiant by chance, or by meteors whose radiant is close to the minor stream. Rendtel, e.g., discussed this in the context of the α-Aurigids [10]. In summary, statistical observations of shower with a frequency lower than 5 meteors per hour are rather unreliable, and showers with a frequency under 2 meteors per hour cannot be observed at all with this method.

With statistic observation methods –as well as with others—the occurrence of coincidental meteor "outbursts" plays an important role. During such an outburst, a number of meteors is observed that is larger than expected on purely statistical grounds. The most likely explanation for this phenomenon is the fact that the observer's attention has increased shortly after the passage of a meteor, and, as a consequence of his reaction, often also the attention of the other members of his observing group. If a number of meteors from such an outburst can have the same radiant, the observer will usually notice this.

According to my statistical calculations, this situation can occur once in some hundred to some thousand observing hours. I myself saw such occurrences several times, but in one only case, it was caused by a real display of minor stream activity.

Quite understandably, an observer seeing some more meteors that align with the "radiant" suspected during the outburst will be sure he detected a meteor shower. Equally understandable, observers on other places who did not notice an outburst, will find no sign of a "new" meteor shower. To decide whether a real shower was observed or whether a chance line-up of meteors or an observational error occurred, is very difficult. With statistical observations, the question of the authenticity of possible radiants largely depends on the confidence in the observer's experience and sense for self-criticism. Of course, high ZHR-values caused by a short outburst are the first reason for not trusting the interpretation of the observer—but on the other hand, how else could he observe a radiant?!

Therefore, I think it is necessary to publish observations of such kind in a proper form, so that the other observers have the possibility to go through their own observations during the critical period and can see, whether certain features indicate the presence of potential shower activity.

From the facts discussed above, it is evident that purely statistical observations are not convenient for studying minor streams. The observation of minor streams should always be combined with meteor plotting. After all, plotting is a necessity with telescopic observations. Even experienced observers are unable to classify meteors without it. Moreover, plottings are a valuable documentation you can refer back to any time. If a large number of data were obtained—many thousands of plottings from a number of observers and from a number of nights, or years, if needed—it is possible to detect very minor streams with ZHRs of about 0.3 meteors per hour, to reliably subtract the radiant's sporadic background contamination, etc., by analyzing the plottings from various points of view. Reference [11] illustrates working with such methods.

Nowadays, it has of course a great advantage to do the required classifications and calculations with the help of a computer, after digitization of the plottings.

Naturally, observing with plotting has some disadvantages as well. However, time "loss" required for meteor plotting— although mentioned very often—is *not* among these. With common frequencies, the plotting time is not large and its influence can be eliminated in an easy and rather precise way from the final values through modification of observing time into effective observing time. The main disadvantage of plotting will show up later, with the interpretation of the data.

Proper observation processing is very complicated, unless we content ourselves to estimate shower membership based on the plottings, in wich case we only use a small part of the information contained in the observational material. In such a way, we cannot eliminate spurious radiants near strong stream radiants, and ghost radiants, particularly when the processing is not detailed enough, not using several various data classification and collection methods. Due to the limited possibilities of data collection, Hoffmeister [12] was e.g. not able to find the ε-Geminid shower in his material, although its presence with a ZHR of about 3 meteors per hour is apparent.

I would like to add some comments for less experienced observers at this place:

- It is of great importance to use a ruler for plotting. Plotting by hand only can cause considerable inaccuracy.
- The average errors in meteor direction are greater than often assumed: 5° to 10° is common for experienced observers.
- It is recommended to avoid plotting near the edges of a gnomonic map. That is the reason for making the *Atlas Brno 2000.0* maps smaller compared to [13].
- If observations of one shower are required, it useful to observe close to its radiant.
- It is not useful to observe meteors below 30° above the horizon. The center of the observed area should have an altitude of 50° to 60°.

- While sporadic meteors may also seem to originate from a shower's radiant, shower meteors are predominant in the vicinity of the radiant. Therefore, it is useful to select two areas close to the radiant to have two independent determination standards. It is of use to select the area sizes taking into account the dispersion caused by observing errors. These can be derived through parallel observations by a number of observers.

Finally I would like to list what we can offer to observers of minor meteor streams, at present or in the very near future:

1. The *Gnomonic Atlas Brno 2000.0*: the atlas can be ordered from *IMO* at the price of 5 DEM or 100 BEF, to be paid in the same way as your *WGN* subscription. It contains stars up to magnitude 6.5. The sphere mapping radius is 160.43 mm. The atlas covers the sky north of declination $-40°$ on 9 maps of A3 format (the actual charts being 280×350 mm). The maps are machine-made and have an accuracy of 0.05 mm. An explanation of the atlas is given on a separate sheet.

   For observing actions organized by *IMO* individual observers are allowed to copy separate maps for their personal plottings.

2. We have quite a wide range of computer software, that is continuously extended. For meteor plotting evaluation, the software listed below is of particular importance:

   - calculation of individual observers' plotting errors from group observations;
   - calculation of radiants and meteor altitudes observed from a number of stations with a non-linear model for observing errors;
   - statistical detection of shower radiants from visual and telescopic observations (under preparation).

   We have not yet enough detailed manuals in English for this software. Their acquisition therefore depends on the presence of a wider interest in its use. The using condition of our software may be discussed.

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1990 Summer Observations in Canada

Peter Brown

An overview is given of observations carried out in Canada during the period June-September, 1990.

Observing over the summer months this year has been surprisingly good. While the peak of the δ-Aquarids was destroyed by a large magnetic storm, moonlight succeeded in only partially hiding the Perseids, which almost everyone seemed to have given up for lost in 1990. The first couple of sessions of the interval took place just north of Edmonton while I was waiting with Marc Zalcik for the possible appearance of noctilucent clouds. While heavy twilight was present in the first session, the limiting magnitude remained low as did the activity. The second session did not fare as well with the moon and cloud wiping out the sky.

The next session took place under fantastically dark skies in southern Saskatchewan. The limiting magnitude was near 6.6 for the entire night, making this one of the darkest locations I have ever observed from. Rates were respectable with the Perseids dominating and the α-Capricornids putting on a strong display near the end of the session with some fainter stream members. After several days of cloudy skies, the weather improved to permit observations on July 25-26 from a location several hundred kilometers further south. Again the sky was very dark and rates responded after midnight with the Perseids dominating. South δ-Aquarid activity was quite strong once the radiant rose in altitude with the North δ-Aquarids all but absent. The final clear night of the Aquarid campaign took place on the night of the South δ-Aquarids' maximum. Observing from Alberta this time, the effects of the aurora became obvious well before twilight disappeared. A large magnetic storm provided a brilliant all-sky aurora which destroyed the limiting magnitude and the Aquarid peak. In fact, only one faint South δ-Aquarid was seen in the two hour session, while two quite bright α-Capricornids made that showers' presence felt even through the aurora.

The next shower for concentration was the Perseids with the nearly full moon in the sky for all dark hours. The weather was quite good for the pre-peak and peak night, allowing the brighter Perseids to stand out quite well. Rates on August 10-11 barely topped 10 meteors per hour due to the light of the moon. However, the peak of the Perseids was not at all disappointing with a combined rate of nearly 1 meteor per minute visible just before dawn. The Perseids manage to climb to nearly 50 meteors per hour, even with the moon high in the sky, suggesting that the true ZHR was near to levels in 1988 and 1989 under good conditions. While no true fireballs were observed on the peak night, several bright Perseids left long enduring trains.

The relatively good limiting magnitudes recorded on this night reflect the difficulty in recording a traveling meteor through moonlight as compared to stationary stars and the effects a relatively small star count regions available in the field of view quite far from the moon, meteors occurring closer to the moon are affected by a very different limiting magnitude. The useful limiting magnitude for the Perseid night in fact probably close to 5.5.

The last two sessions of the interval took place from Maqua Lake near Forth McMurray. After reports from the East Coast of a possible meteor outburst on August 22-23, I was eager to check rates and see if this mysterious shower might still be in progress. The first clear night was August 26-27 and, despite above average skies from the site, no unusual activity was observed. A similar session the next night revealed some weak activity form upper Cygnus, though not associated with the κ-Cygnids, I believe. Indeed, the sporadic activity on this night in the last usable hour before the sky clouded over was the highest of the entire interval and suggests that the 6 or 7 members of the upper Cygnus complex might have been significant.

Due in part to the trip to southern Saskatchewan, the sessions in this interval have been remarkably free of auroral interference. This is unusual considering the sunspot peak in 1990 and suggests that there may be hope yet for dark skies for northern meteor observers.

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