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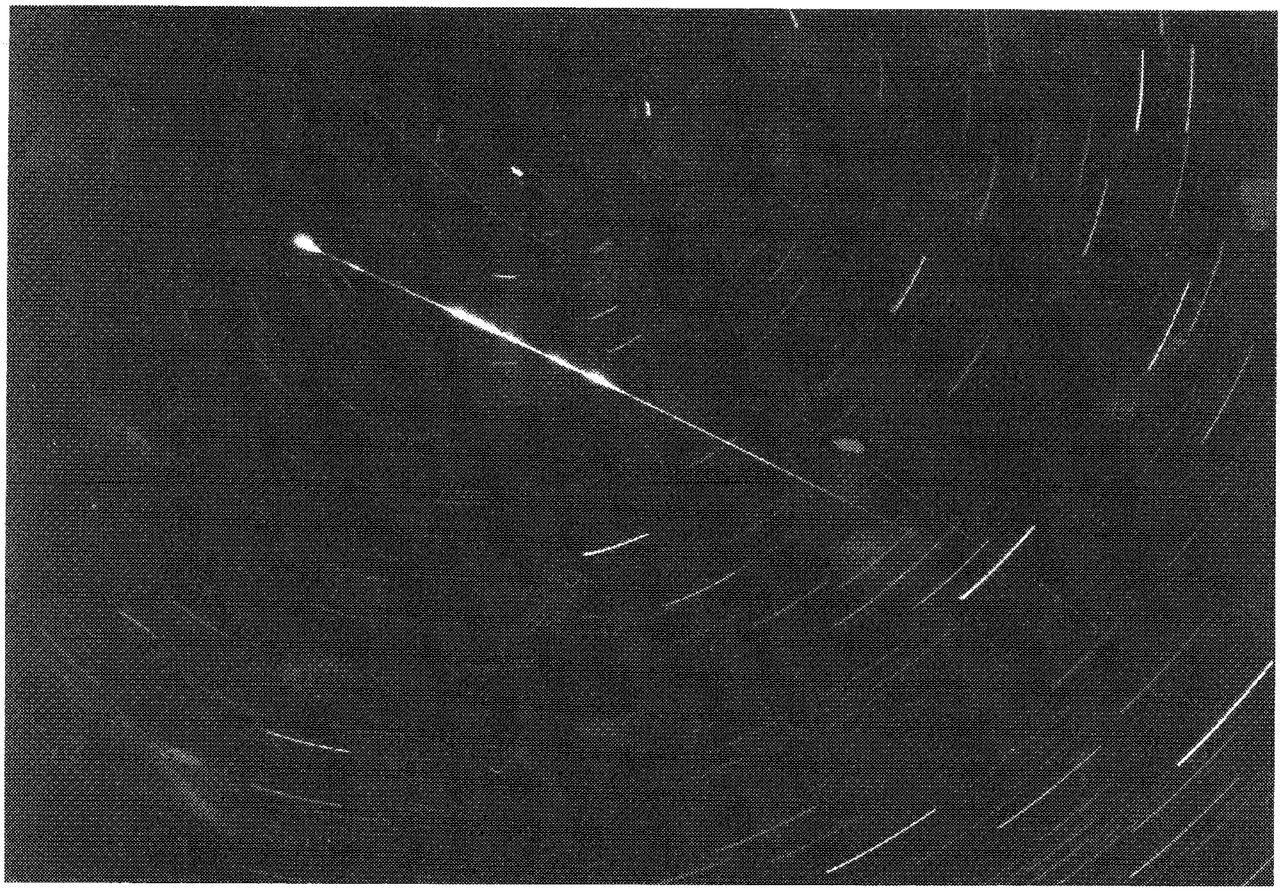


This bright meteor has been photographed by the Slovak observer J. Škvarka during the night of July 30-31, 1992. The photograph was exposed from 22^h27^m UT till 0^h20^m UT. The meteor itself appeared at $23^h48^m17^s$ UT.

In this issue:

In case of non-delivery, return postage guaranteed. Please return to:
v.u.: Marc Gyssens, Heerbaan 74, B-2530 Boechout, Belgium

WGN, Vol. 20, No. 5, October 1992, pp. 185–208

Contents

Useful Information

The December Issue *(WGN 20:6)*

The *December issue* is expected to be mailed during the last week of November 1992, in order to avoid the delays in the mail typical for the Christmas season. Therefore, contributions are due *November 6* at the latest. They should be sent to *Marc Gyssens.*

WGN Subscription/IMO Membership 1993

The subscription rate for volume 21 (1993) is 25 DEM for six issues. Additional gifts are of course welcome. It is anticipated that volume 21 will contain over 240 pages. Full subscription information can be found on the first page of this issue.

Administrative Correspondence

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

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

From the Editor-in-Chief

Comet P/Swift-Tuttle Rediscovered!

Marc Gyssens

In my first draft, I started this editorial with an apology for the small delay by which the October issue is sent out. As last year, the Perseids are responsible in part for this delay, because the shower produced another outburst, and in order to present you a sufficiently accurate account of what happened, we had to wait until enough reports were available. Now, I do not feel sorry any more at all, because the delay allowed Comet P/Swift-Tuttle to catch up with this issue! As you probably know by now, the long-awaited Perseids' parent comet was rediscovered on September 26, and proved to be identical indeed to Comet P/Kegler. In the week that followed the rediscovery, we have done what we could to provide you in this issue with as much information as possible. In order to avoid any further delays however, we decided to make the October issue again a normal issue.

In contrast to two months ago however, a lot of articles are coming in, for which we thank their authors, so you may expect a thick December issue, despite the fact that we already had three thick issues this year! The prospects are good that WGN*'s Volume 20 will set a new record, if not in number of pages then surely in information content!*

We do hope you appreciate the work and effort we put in our journal and we take it you probably want to receive Volume 21 as well. Many participants at the latest IMC *did not wait for a renewal call and made use of the convenient opportunity to pay personally to our Treasurer. If you were not among these persons, we would be very appreciative if you would be so kind to spend a few minutes of your time to renew your subscription* now. *It is indeed important for us to have a good estimate of the number of 1993 subscribers soon, so that we can determine as accurately as possible the number of copies that will have to be printed of Volume 21. Remember that it is the* IMO*'s policy to offer* WGN *at the lowest price possible. (In this spirit, membership fees were not raised at the latest Council meeting.) The more you allow us to work efficiently, the more we can actually offer you in return for your membership or subscription fee. We hope we can count on your cooperation!*

1993 Membership and Subscription Renewal

Ina Rendtel and Marc Gyssens

At the *IMC* in Smolenice, the *IMO* Council has decided to keep the annual **membership/subscription dues** at **25 DEM**. People outside Europe wishing **airmail delivery** pay **40 DEM**.

Preferably, payments should be made in in German marks (DEM) to the **postal (giro) account** of Ina Rendtel, Gontardstraße 11, D-O-1570 Potsdam, Germany. The account number is 5472 34-107 and the post office code is 100 100 10 (Postgiroamt 1000 Berlin). **Please note that post office code and postgiroamt must always be mentioned together with the postal account!** Contrary to last year, it is now also possible to pay Ina by **international postal money order**.

If you do not mind violating some postal regulations and if you are prepared to take the risk, you could also consider sending the required amount to Ina **cash**, in bank notes. This is by far the easiest way to pay! To reduce the risk, make sure that the bank notes are not visible through the envelope!

People who can only pay **from a bank account** should make an **international bank draft** payable in USD to Peter Brown (address on inside of back cover). In this case you pay 20 USD (without airmail delivery) or 30 USD (including overseas airmail delivery for destinations outside Europe). Both amounts contain 2 USD for banking costs. Please, **do not send checks to Ina Rendtel!**

Contrary to last year, there are no special arrangements any more for **Belgian members/subscribers** to pay in their own currency. They are kindly asked to pay directly to Ina in DEM as explained above.

British readers can pay 10 GBP through Alastair McBeath. Finally, Japanese subscribers may contact Masahiro Koseki to arrange their subscription. All addresses appear on the inside of the back cover.

Apart from this bimonthly journal, the *IMO* has a lot of other publications to offer. A price list is printed on the back cover. We take the liberty of suggesting you to order the publications you are interested in **together** with your renewal; in this way, you minimize the hardships involved in international payments. Please note that **all** publications can be ordered through any of the above persons, provided you pay in the prescribed manner.

Finally, two more words. First, we want to remind our readers that as a matter of principle we run *WGN* on a tight budget. Therefore, additional gifts are very welcome. Please pay a little extra to support your journal, if you can. Second, renewals came in very late last year. As a consequence, we had serious difficulties in determining the number of copies that had to be printed of the February issue. Therefore, we urge you to renew early this year. Thank you for your cooperation!

Letters to WGN

compiled by Marc Gyssens

The face of the IMO

In reaction to the illustrated article about the IMC *in Smolenice in the previous issue of* WGN, *we received the following reaction from George Zay. We will bear his letter in mind and do our best to further give shape to the face of the* IMO ...

After reviewing my August 1992 edition of *WGN*, I was pleased to see good quality photographs of some *IMO* members. I think an occasional photograph or two helps erase the robotic feeling within our organization and creates a more personal bonding. We are already bonded by a common interest, so let us not hide ourselves from each other. I have written André Knöfel many times already without a clue as to what he looks like. I now have a mental image for André and when I do write him again in the future, I won't feel like I'm writing to a non-person. When I first wrote Peter Brown inquiring about *IMO* membership, I interpreted his handwriting to be that of a 70 plus year old man with fish bowl eye glasses. Since then I have found him to be a 22 year old individual that I enjoy communicating with. If he wore fish bowls for glasses it wouldn't have mattered, nor would it if he were 70 plus years old. The point is, it helps to visualize a real live person when communicating. In the previous issue of *WGN (the June issue, ed.)*, I had the pleasure of "visually meeting" Jeroen Van Wassenhove from the photograph printed in that issue. We all see Paul Roggemans's name all over the place and I admire his work and dedication, but you wouldn't believe the mental image I have for him ... Probably, he also has an accent that can cut mustard. The "Mustard Cutting Accent" (*IMO* code `MCA`) is something I visualize all the Europeans to have. God only knows what kind of hopefully "distorted" image I project.

I think it would help that in some future *WGN* issue(s) that a "Mug" shot be printed of all the Council Members, the Commission Directors, and the individuals involved in putting together the journal. This way, we can get acquainted with our leaders and feel comfortable with the people we correspond with. For members who frequently write each other and find it wouldn't be much of an inconvenience to do so, enclosing a self image would be a nice gesture also.

George J. Zay, September 4, 1992

The interpretation of radio meteor data

*In the August issue (*WGN *20:4, pp. 177–184), Cis Verbeeck suggested in his article on his group's radio observations of the Quadrantids that the* FORWARD *program overcorrects. Below is a reaction from Christian Steyaert and the author's reply.*

In his article, Cis Verbeeck applies a correction to the observed number of forward scatter reflections based on the *Observability Function (OF)* obtained with *FORWARD*. The OF basically gives what it says: a measure for the effectiveness of receiving a particular stream. Originally, it was meant as a planning tool for radio observers, but in the meantime, it has gone much further. It is a big step from the OF to correcting a total number of observed reflections.

Not enough data of the set-up are given to be able to check if *FORWARD* was correctly applied. The receiver, tuned to 66.39 MHz, will receive several stations. In the range 66.24–66.54 MHz, corresponding roughly to the bandwidth of the receiver in use, there are 16 stations, most of which with a power of more than 10 kW. I doubt if these have all been included, and how those at the end of the band were weighed with respect to the central one. Adding up all these stations in an azimuth range of approximately 90° (Poland to Bulgaria) must give a fairly smooth OF.

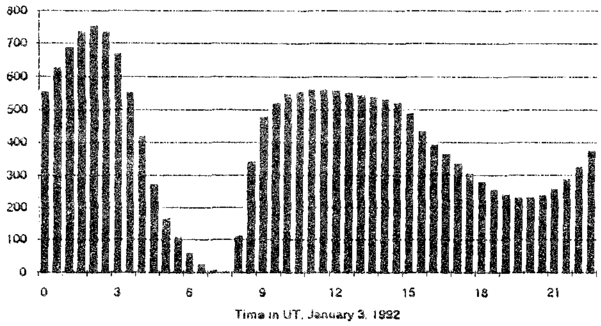
Nor is it clear which observing technique was used: an automatic recording or an "auditive" observing (by several persons, with the risk of differences among them).

Another element is the background noise level, corresponding to the limiting magnitude in visual work.

In correcting the observed number of meteors, first the number of sporadic meteors should be subtracted. The exact number of sporadic meteors should be deducted. The exact number of sporadics during the stream observation cannot be known; second best is to observe the sporadic background shortly before and after the stream. (The sporadic background exhibits seasonal variations, hence no standard for the whole year can be used). Next, the error margin on both the total number of reflections and the sporadic background is determined. In deducting the sporadic background from the total number, the error margins are added. If the OF has a low value, the correction factor will be high, and the error margin increases accordingly. Rather than bar graphs, diagrams indicating error margins are to be used.

Christian Steyaert, August 23, 1992

I would like to react to Christian Steyaert's letter. Christian argues that several radio stations should be taken into account, but does not give any advice on the problem of weighing the stations with respect to the central one. I only included the central radio station when calculating the OF because I did not know how to weigh them and thought it more safe to consider only the main station than to obtain a meaningless mixture of all stations in the neighborhood of 66.39 MHz. As an experiment, I calculated the OF for the Quadrantids on January 3, 1992, first for the radio station Kosice (66.38 MHz) and then the sum of the OFs for all neighboring radio stations. As you can see in Figure 1, the results are quite similar. I think this justifies my approach to the problem. Furthermore, as the graphs are similar, the fact that the OF overcorrects remains, and is not due to my restriction to one radio station.



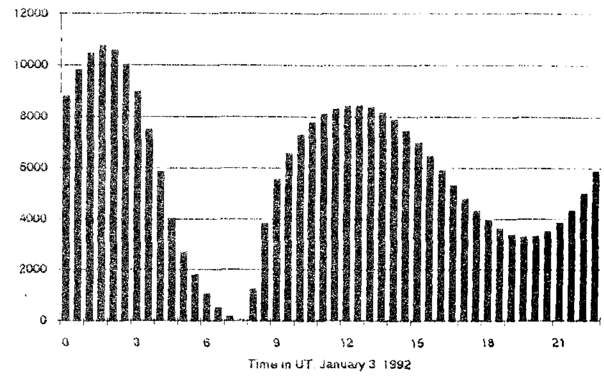


Figure 1 – The OF for the central station *(left)* and the sum of the OFs for all neighboring stations *(right)*.

Our observations were performed by a team consisting of some 15 observers who worked in shifts of 30 minutes. As Christian points out, this entails the risk of different interpretations of the reflections. Still, I think it better to have an overview of 24 hours of shower activity with a little uncertainty because of the difference between the observers than 1 or 2 hours observing time a day, performed by one person. We can search for the exact time of maximum, whereas the latter observer can only conclude that the Quadrantid maximum fell on January 3, which is not very informative. Also, I would like to remark that, unlike most observers, we have attached a multimeter to our set-up and the observer looks at the variations in the voltage while listening to the radio. A second person notes down all the data, so the observer does not get distracted by noting down the data himself. These factors improve the reliability of our observations and reduce the differences between the observers.

Christian proposes to determine the sporadic background shortly before and after the stream. This can be done for major showers with short activity periods, like the Quadrantids. However, my experience as a radio observer has taught me that such streams are exceptions. For instance, during the activity period of the Perseids, some three other streams are active, and the Perseids themselves are active three weeks before their maximum. It is clear that there is no such thing as a sporadic background in this period. Christian then proceeds to determine the error margin on both the total number of reflections and the sporadic background (possibly he means taking the square roots of the numbers), and calculates the error margins on the difference between the total number and the sporadic background. The error margin on the corrected number of Quadrantids would "increase according to the decrease of the OF", i.e., no errors on the OF are supposed. It would of course be difficult to determine what such an error should look like, but just ignoring it seems to create error margins that have no physical meaning. I prefer working without error margins to using dubious error estimates which do not indicate a range where the real value lies in with a certain (fixed) probability.

I fully admit that the graph interpretations I made are not devoid of doubt. But I think it is the best we can do at this moment, better than not analyzing the streams in detail. What we need is a program that takes more factors into account than *FORWARD*, based on geometry, diurnal atmospheric variations etc.

Cis Verbeeck, September 10, 1992

About the Visual Meteor Train Observing Form

Mark Vints

A number of people have started to send in report forms of meteor train activity. Already, some problems have become apparent. For instance, observers who do not have an *IMO* Observer Code and/or Site Code are asked to write their name and/or geographic coordinates on the top of the page. Next, let me point out that one page per night is needed; observations over a period of several days may not be combined. Also, I hope it is clear that reports are also useful when no trains were seen for a given shower or even during the entire night. The main problem so far is the absence of an explicit request for the magnitude distribution of the minor showers and sporadics in the list at the bottom. However, this magnitude distribution is essential! I suggest that observers who fill out the report form use two lines for each minor shower: the first line for the magnitude distribution, the second for the train activity. If you run out of lines, just continue on the back.

These errors will be corrected in a second version of the report form. Meanwhile, I welcome other suggestions or comments.

Observers' Notes: November–December 1992

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 and Table 2 shows the observing conditions moon-wise.

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°	Table 3		27	2.3	10
Taurids N	Sep 13–Dec 01	Nov 13	59°	+23°	10°/5°	Table 3		29	2.3	8
Leonids*	Nov 14–Nov 21	Nov 17	152°	+22°	5°	+0.°7	−0.°4	71	2.5	storm
α-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 06	18°	−53°	5°	+0.°8	+0.°1	18	2.8	100
Puppid/Velids	Oct 15–Jan 22	several	120°	−45°	20°/15°	Table 4		40	2.9	12
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 19	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 1992.

Date	k	Date	k
Friday October 30	0.19+	Friday December 4	0.66+
Friday November 6	0.82+	Friday December 11	0.99−
Friday November 13	0.92−	Friday December 18	0.37−
Friday November 20	0.23−	Friday December 25	0.01+
Friday November 27	0.07+	Friday January 1	0.49+

New Moon:	October 25, November 24, December 24
First Quarter:	November 2, December 2, January 1
Full Moon:	November 10, December 9, January 8
Last Quarter:	November 17, December 16, January 15

The illuminated part of the Moon is always given for 0^h UT on the date indicated. The dates of the phases of the Moon are also given in UT.

2. Taurids

This shower is broken up into several substreams, the most important of which are called the Northern and the Southern Taurids respectively. The Taurids have one of the longest periods of activity known and last from September 13 through to early December. They reach a broad maximum in late October and early November. Although the date of maximum for the Southern Taurids is given as November 3 and that of the Northern Taurids as November 13, these were derived from the orbital elements and not from visual observations. At maximum, Taurid activity can be very erratic with rates ranging from 1 or 2 to as high as 10 or 15 meteors per hour.

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

Date	Taurids S		Taurids N	
	α	δ	α	δ
Sep 20	25°	+10°	29°	+16°
30	29°	+10°	37°	+17°
Oct 10	36°	+10°	41°	+18°
20	41°	+11°	46°	+19°
30	48°	+13°	51°	+20°
Nov 09	55°	+14°	56°	+22°
19	62°	+16°	60°	+23°
29			66°	+24°

With the radiant positions reaching culmination just after midnight, Taurid meteors can be observed for most of the night. The Taurid meteor stream is noted for its many bright colored meteors. Although the dominant color is yellow, many orange, green, red and blue fireballs have been recorded. This together with their relatively low geocentric velocity means that they can be recorded more easily on film than most other showers. Perhaps you could try and photograph some for the *IMO Photographic Meteor Database*.

Although the Moon affects viewing towards the middle of November, the Taurids are generally free of its influences for most of the period of major activity. Observers are encouraged to carry out an extensive Taurid watch this year. They should center their field of view some 20°–30° east or west of the radiant positions at a declination of +10° to +20°. All possible Taurid meteors should be plotted.

3. Andromedids

Produced by the debris of Comet P/Biela, the Andromedids are one of two November meteor showers that on occasion produced meteor storms, though in their case the last of these was about 100 years ago. Since then, the Andromedid orbit has been perturbed by the planet Jupiter so that the center of the stream's orbit misses the Earth by a considerable margin. Thus the likelihood of another appearing is very remote. However, observations have indicated that there is a remnant shower to be seen each year as the Earth passes through the outer fringes of the stream.

The modern-day Andromedid shower is active from November 8 to 30 with a broad maximum of between 1 and 3 meteors per hour occurring around November 15. The Andromedids are characterized by their very slow geocentric velocity and their often ruddy hue. Although badly affected by the Full Moon on November 10, they should be able to been seen in the early evening hours in dark skies after November 13. The Andromedid radiant is fairly diffuse being situated at $\alpha = 25°$ and $\delta = +40°$ and having a diameter of 15°. They are best observed from equatorial and northern hemisphere latitudes. Andromedid meteors are noted for their extremely low velocity of about 20 km/s. The *IMO* wants a special effort put into this shower in 1992. To observe both the Andromedids and the Taurids, observer field centers need to be located near $\alpha = 40°$ and $\delta = +30°$. All possible Andromedids should be plotted.

With regard to the Andromedids, the meteor outburst seen in Hawaii on November 5, 1991, around 11^h *UT, from a radiant at* $\alpha = 6°$ *and* $\delta = +17°$ *[1] should be mentioned here. In [2], Paul Roggemans suggested that this outburst may have been connected to the P/Biela complex. It is therefore perhaps not a bad idea to be alert as well on and around November 4,* 17^h *UT, to see what happens. (Ed.)*

4. Leonids

The Leonids are the second November meteor shower that has produced a meteor storm, the last occasion of which was in 1966. They are a young stream, being produced by the debris of comet P/Tempel-Tuttle which means that, like the parent comet, they have a 33-year periodicity in their maximum activity. As we are now within 8 years of the next return of the parent comet and hence the next predicted storm, Leonid rates should be on the increase.

In 1992, the Leonids will be subject to some interference from a Last Quarter Moon at maximum on November 17. Despite this, the *IMO* observers are encouraged to watch this shower. The Leonids are best seen during the last few hours before dawn when the radiant is high above the horizon.

5. Geminids

The maximum of this stream occurs just after the Full Moon which should reduce the normal rates by a factor of between 5 and 7. Despite this handicap, Geminid activity is so high that even with this handicap rates of between 10 and 20 meteors per hour can be seen, which is still good viewing.

Even though their radiant has a declination of $+32^\circ\!.5$, the Geminids can be observed well from both the northern and the southern hemispheres. The Geminid radiant is easy to find being situated near the bright stars Castor and Pollux. Geminid meteors have an average type speed and a yellowish hue. Very few leave a train. Another feature of the Geminids is the large number of bright meteors produced.

6. α-Monocerotids

This November Monocerotid stream is active from November 15 to 25. Maximum occurs on November 20. The November α-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 1992. The *IMO* recommends that you observe both the Leonids and the November Monocerotids simultaneously whenever both radiants have an elevation of 20° ore more. To do this, the observing field should be centered in the region $\alpha = 120^\circ$–150°, $\delta = -20^\circ$–$+30^\circ$. All possible Monocerotids should be plotted as long as the ZHR is less than 10. Thereafter, use classified counts.

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 16 to December 5 and December 15 to 31. Observers should plot all possible Puppid/Velids seen unless the rate exceeds 10 per hour when classified counts should be made.

From November 1 to 25, southern observers should choose a field center around $\alpha = 120^\circ$–150° and $\delta = -20^\circ$ so that they can monitor the Leonids, November Monocerotids and the Puppid/Velids simultaneously. After this date, observers should center their fields on or near the radiant position.

Table 4 – Radiant positions of the Puppid/Velids in November and December.

Date	α	δ	Date	α	δ
Nov 05	111°	−43°	Dec 09	123°	−45°
Nov 12	113°	−43°	Dec 14	127°	−45°
Nov 17	114°	−43°	Dec 19	128°	−45°
Nov 22	116°	−43°	Dec 24	134°	−46°
Nov 27	117°	−45°	Dec 29	136°	−47°

8. Phoenicids

The Phoenicids are active from November 28 through to December 9, with a maximum occurring on December 6. The Phoenicids produce variable activity which 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 not affected by the moon in 1991. Southern hemisphere observers should endeavor to get as many observations of this shower as possible. They should center their field of view within 40° of the radiant position and plot all possible Phoenicids seen.

9. χ-Orionids

This shower is active from November 6 to December 15. A maximum ZHR of 3 is reached in early December. The χ-Orionids are characteristically very slow brightly colored meteors. The *IMO* requires urgent observations of this shower in 1992. They should watch from November 15 to December 4 with a center of field of view at about $\alpha = 90^\circ$ and $\delta = +20^\circ$. All possible χ-Orionids should be plotted.

10. December Monocerotids

This shower is active from November 27 to December 17 with a maximum ZHR of 5 on December 10. The *IMO* requests that observers give this shower attention before the Full Moon period of December 4–15. 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.

11. Ursids

The Ursids are active from December 17 to 26 with a maximum on December 22 at 10^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.

12. Coma Berenicids

The Coma Berenicids are active from December 12 through to January 23. The maximum of 5 meteors per hour occurs on December 19. 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 to 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.

References

[1] P. Brown, D. Asher, D. Steel, "The Strong Meteor Display of November 5, 1991", *WGN* 20:1, February 1992, pp. 28–31.

[2] P. Roggemans, in "Letters to WGN", Marc Gyssens (comp.), *WGN* 20:2, April 1992, pp. 55–57.

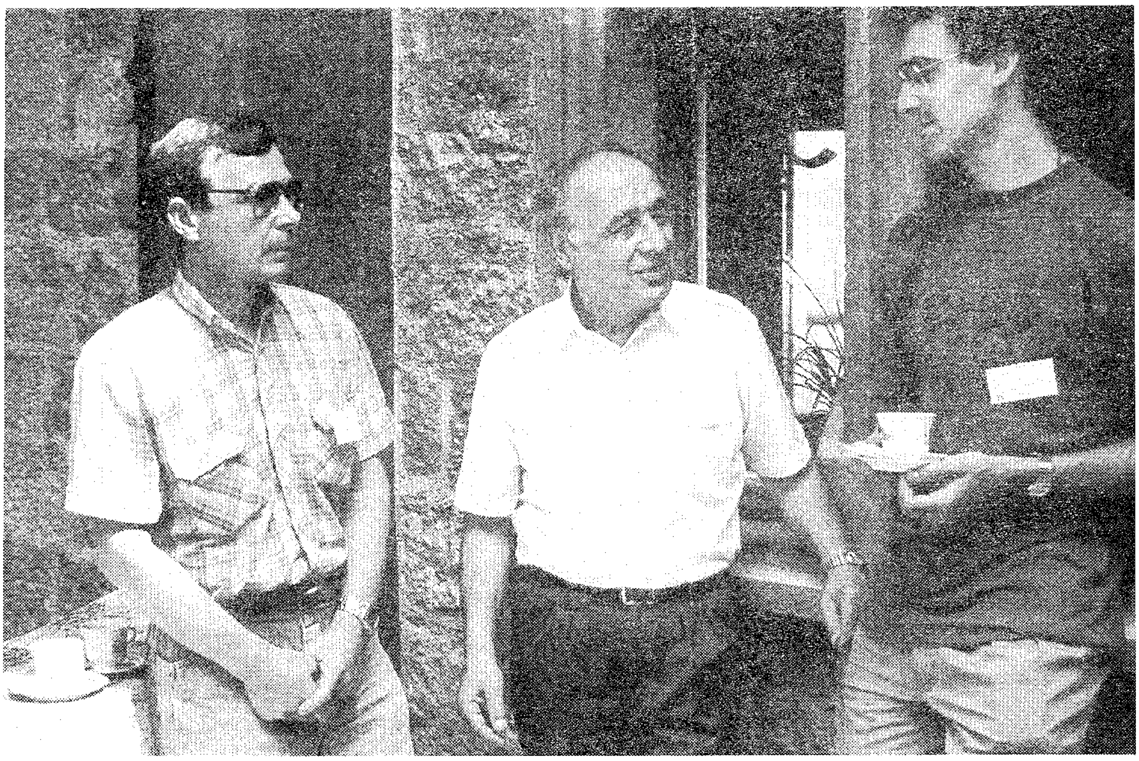


Figure 1 – Coffee break during the 1992 *IMC* in Smolenice Castle: *(from left to right:)* Yuri Obrubov and Pulat Babadzhanov of the Astrophysical Institute of Dushanbe, Tadjikistan, discussing with Marc de Lignie of Leiden, the Netherlands.

The 1992 Perseids

New Outburst Announces Return of P/Swift-Tuttle

Peter Brown, Marc Gyssens, and Jürgen Rendtel

An overview of visual and radio observations made during the peak time of the 1992 Perseids is given. The shower is found to have produced high activity near $\lambda_\odot = 139.^\circ45$ (eq. 2000.0). This is in good agreement with the nodal longitude of the newly rediscovered comet P/Swift-Tuttle (1992 t). This year's Perseid outburst appears to have been rich in large particles and roughly of similar or possibly greater intensity than the 1991 Perseid outburst. No entirely accurate indication of absolute activity levels is possible due to the presence of high correction factors resulting from moonlight. Both the 1991 and the 1992 outburst are clearly due to the presence of P/Swift-Tuttle being in the vicinity of its descending node.

1. Introduction

Before saying anything substantial about the Perseid shower in 1992, an important point must be made. The visual data received thus far demonstrate clearly—to the extent this was still necessary—that ZHR values obtained under a moonlit sky are meaningless as absolute figures. Indeed, the ZHRs various groups computed for their observations differ in some cases by more than an order of magnitude during the same time intervals! The explanation for this discrepancy is quite straightforward: if the atmospheric conditions are near-perfect, the lower contrast of the sky-background will affect the meteor limiting magnitude to a much greater extent than the stellar limiting magnitude, resulting in undercorrection. Poor atmospheric conditions, on the other hand, will yield a statistically small sample and result in huge correction factors, which can easily lead to overcorrection. Finally, observations obtained under moon-lit skies do not permit one to compute a reliable r-value and hence ZHR-value. Particularly in the case of an outburst, one cannot use the literature values for the population index for the Perseid stream, as the particles that gave rise to the outburst may have had different physical characteristics than the "main stream." Therefore, comparing observations of different observers, let alone correlating them by a perception analysis, is simply out of the question for the 1992 Perseids. The only relevance the rate data might have is that the ZHR profile obtained by a single observer over one night may give a clue as to how the shower activity evolved during the observing session.

In this overview, we will quote ZHRs of visual observations very sparingly to avoid later misinterpretations. In the instances where we do mention ZHR values, once again, these should only be used to compare shower activity during the various intervals of one observer's watch, and should *not* be attributed to any absolute value. As a consequence, we present here a largely qualitative—as opposed to a quantitative—picture of the 1992 Perseid activity around the shower maximum. This picture will be completed with descriptive features mentioned by various observers and radio data. Several observing groups have also sent us their data in article form, which is highly appreciated. These articles follow this summary report. Despite all this, most of the interpretations made below regarding the 1992 Perseids will have to remain tentative.

2. The 1992 outburst – observations in China and Japan

If the 1991 Perseid outburst were to recur in 1992 at exactly the same solar longitude (i.e., at $\lambda_\odot = 139.^\circ56$, eq. 2000.0 [1]), then European observers would have been ideally placed to witness the event on August 11 around 22^h UT, well into their night. That is why most observing groups on that continent were alert, despite the Full Moon.

Unfortunately, European observing groups did not see any outburst of Perseid activity around the predicted time. Several West-European observers, however, reported the impression that Perseid activity at dusk seemed to be much better than during the actual observing session, despite the low radiant elevation. This feeling was confirmed by Central-European observers who during their first hour of observing noted high activity, which rapidly dropped afterwards.

It turned out that a Perseid outburst had indeed occurred, but about 0°1 in solar longitude earlier than last year, thereby now precisely coinciding with the longitude of the descending node of the parent comet, P/Swift-Tuttle.

This shift caused Asia rather than Europe to once again be ideally placed to observe the outburst. Unfortunately, the weather over most of China and Japan was cloudy and rainy. Two Chinese observers, Ouyang Tianjing and Chen Yu, nevertheless went out and saw Perseid activity pick up very sharply around 18^h50^m UT. One observer, Chen, saw 33 Perseids during 20 minutes in a sky that was 40% cloud-covered, under a limiting magnitude of only 3.3! From 20^h15^m UT onwards, rates started to decline rapidly, and around 21^h UT, most of the outburst was over. Both observers were very amazed by the spectacular show they had witnessed. They said that they saw many fireballs through the clouds "like small moons flying behind the clouds or like lightning flashing during a storm." A full report on the Chinese observations can be found after this article.

S. Nakano reports that he heard from Y. Yabu that an amateur group of 8 observers in Okinawa, Japan, saw about 200 meteors between 19^h and 20^h UT, under limiting magnitude about 3 [2]. J. Watanabe has also communicated that a group of 7 persons in the Niigata prefecture saw some 70 meteors between 18^h and 19^h UT [3]. These figures agree at least in order of magnitude with the Chinese data. Japanese radio observations confirm high activity around 19^h UT [3].

At the time of this writing, we have not yet received any news from the C.I.S. Their data could prove useful in complementing the picture we get from the few Far-Eastern groups that were not forced indoors by the poor weather.

3. European visual observations

In-as-far as it is possible to make such a statement in the given circumstances, most European groups report "normal" activity during much of their observing session. Dutch observers in the Netherlands and Switzerland report normal activity between roughly 21^h00^m and 0^h30^m UT. Higher activity, however, was noticed at late dusk (20^h30^m–21^h00^m UT), while several observers independently saw 3–5 Perseid fireballs in the preceding half hour to one hour, at early dusk. [2,4]

In most other West-European countries, observers seem to have missed the outburst altogether. This has at least been the case for Belgium, France, Norway, and England [2]. In Norway, however, observers report rates after 23^h30^m UT to be about 25% lower than between 21^h30^m and 23^h30^m UT. At several places in England, observing was hindered by cloudy weather. The editor for instance was in Slough at the time of the maximum, a few kilometers west of London Heathrow airport, and was unable to do anything meaningful. Alastair McBeath writes: "I seem to have caught the tail end of the Perseid outburst this year on August 11–12, although I was only able to watch from 21^h10^m to 21^h30^m UT. With a limiting magnitude of +4.0, bright Moon, twilight, and an average of 5% drifting clouds (until complete overcast returned shortly after 21^h30^m UT), I thought I had done quite well to spot 5 Perseids and a sporadic, bearing in mind the low Perseid radiant elevation." [5]

In Central Europe, several observers and observing groups noticed the end of the outburst as part of their regular observing. The Potsdam group (Rainer Arlt, Jürgen Rendtel, Ulrich Sperberg, Manuela Trenn and Nikolai Wünsche) was able to start only at 20^h40^m UT, thereby just missing the outburst. The ZHR was of the order of 100, and the number of brighter Perseids decreased remarkably after 0^h UT. André Knöfel started even later, in Langewiese. Ralf Koschack, however, managed to start observing at 20^h04^m UT from Weißwasser under—apart from the Moon—perfect sky conditions. We present his data for the night of August 11–12 in Table 1. The listed ZHR values probably suffer from undercorrection as explained in the Introduction, but we have to bear in mind the scatter in the whole sample of reduced data. The rates are lower than the average for the given period. With a corrected rate in the first interval about double the rates in subsequent periods, it is nevertheless clear that Ralf witnessed the final part of the outburst.

Table 1 – Observational data of Ralf Koschack on the Perseids during the night of August 11-12, 1992, including tentative ZHR values computed with $r = 2.6$ and $r = 2.3$ respectively.

Period (UT)	Lm	F	T_{eff}	h_{rad}	Per	$\text{ZHR}_{2.6}$	$\text{ZHR}_{2.3}$	non-Per
20^h04^m–20^h40^m	6.46	1.0	$0^h.58$	28°	28	103	102	6
20^h40^m–21^h15^m	6.46	1.0	$0^h.58$	32°	11	37	37	6
21^h31^m–22^h54^m	6.44	1.0	$1^h.12$	39°	44	65	65	5
23^h21^m–00^h45^m	6.34	1.0	$1^h.15$	51°	39	51	50	6

Elsewhere in this issue, Petr Pravec reports Czech observations from Sibenický vrch that started even earlier. Although most of the effort was in telescopic work, two observers, I. Míček and T. Nasku, watched visually in order to catch any unusual activity. Their data are given in Table 2. Note that both observers give a constant limiting magnitude for the whole observation which was identical. Obviously this is more a guess than a determined value; it is however a very critical parameter in the calculation of the ZHR. Nevertheless, both observers report rates during their first interval about three times as high as during most of the remainder of their observing session. Also notice that the Czech observations confirm a decline in Perseid rates after 23^h30^m UT, also mentioned by the Norwegian observers, which is consistent with the decline in the number of bright Perseids after midnight UT noticed by the German observers.

Table 2 – Observational data of I. Míček (MICIV) and T. Nasku (NASTO) on the Perseids during the night of August 11-12, 1992, including tentative ZHR values computed with $r = 2.6$ and $r = 2.3$ respectively.

Period (UT)	Lm	F	T_{eff}	h_{rad}	Per	$\text{ZHR}_{2.6}$	$\text{ZHR}_{2.3}$	non-Per	Obs
19^h38^m–20^h04^m	4.5	1.0	$0^h.43$	24°	19	720	565	6	MICIV
20^h04^m–20^h33^m	4.5	1.0	$0^h.48$	26°	10	315	247	6	MICIV
20^h33^m–21^h03^m	4.5	1.0	$0^h.50$	28°	9	252	197	3	MICIV
21^h03^m–21^h27^m	4.5	1.0	$0^h.40$	31°	9	293	229	4	MICIV
21^h27^m–22^h01^m	4.5	1.0	$0^h.57$	34°	14	296	232	5	MICIV
22^h01^m–22^h32^m	4.5	1.0	$0^h.52$	37°	9	192	150	1	MICIV
22^h32^m–22^h56^m	4.5	1.0	$0^h.40$	40°	11	286	224	1	MICIV
22^h56^m–23^h37^m	4.5	1.0	$0^h.68$	44°	19	270	212	3	MICIV
23^h37^m–00^h18^m	4.5	1.0	$0^h.68$	49°	14	184	144	4	MICIV
00^h18^m–01^h10^m	4.5	1.0	$0^h.87$	55°	9	85	66	4	MICIV
19^h38^m–20^h04^m	4.5	1.0	$0^h.43$	24°	19	720	565	0	NASTO
20^h04^m–20^h33^m	4.5	1.0	$0^h.48$	26°	13	410	320	5	NASTO
20^h33^m–21^h03^m	4.5	1.0	$0^h.50$	28°	7	196	153	3	NASTO
21^h03^m–21^h27^m	4.5	1.0	$0^h.40$	31°	10	325	254	2	NASTO
21^h27^m–22^h01^m	4.5	1.0	$0^h.57$	34°	8	169	133	3	NASTO
22^h01^m–22^h32^m	4.5	1.0	$0^h.52$	37°	8	170	133	3	NASTO
22^h32^m–22^h56^m	4.5	1.0	$0^h.40$	40°	9	234	183	1	NASTO
22^h56^m–23^h37^m	4.5	1.0	$0^h.68$	44°	14	199	156	8	NASTO
23^h37^m–00^h18^m	4.5	1.0	$0^h.68$	49°	7	92	72	3	NASTO
00^h18^m–01^h10^m	4.5	1.0	$0^h.87$	55°	12	113	88	8	NASTO

The Slovak observers from Banská Bystrica also reported their observations to *WGN*. As you can read in their contribution, about 12 visual observers watched between 20^h00^m and 1^h40^m UT. Again, strongly enhanced activity was noticed during the first hour of observing.

Istvan Tepliczký reports that Hungarian observers recorded very high activity around 19^h00^m UT, which returned to normal by 20^h15^m UT. A high number of bright Perseids was apparent. [2]

In a pending submission to *WGN*, Mark Kidger mentions Slovenian and Croatian observations. Herman Mikuz communicated data of the Javornik Astronomical Society (Ljubljana, Slovenia) yielding a ZHR of 730 between 20^h00^m and 20^h30^m UT under lm = 3.5 skies, compared to an average 300 for the rest of the session. Korado Korlevic of the Visnjan Astronomical Society (Istra, Croatia) reported ZHRs of 225 between 20^h00^m and 21^h00^m UT compared to 148 between 21^h45^m and 22^h50^m UT, also under a limiting magnitude of 3.5.

At the time of this writing, we unfortunately do not yet have Bulgarian, Rumanian, Crimean, Tadjik or Siberian observations to further complete the picture drawn by Chinese and Japanese observers on the one hand and West- and Central-European observers on the other hand.

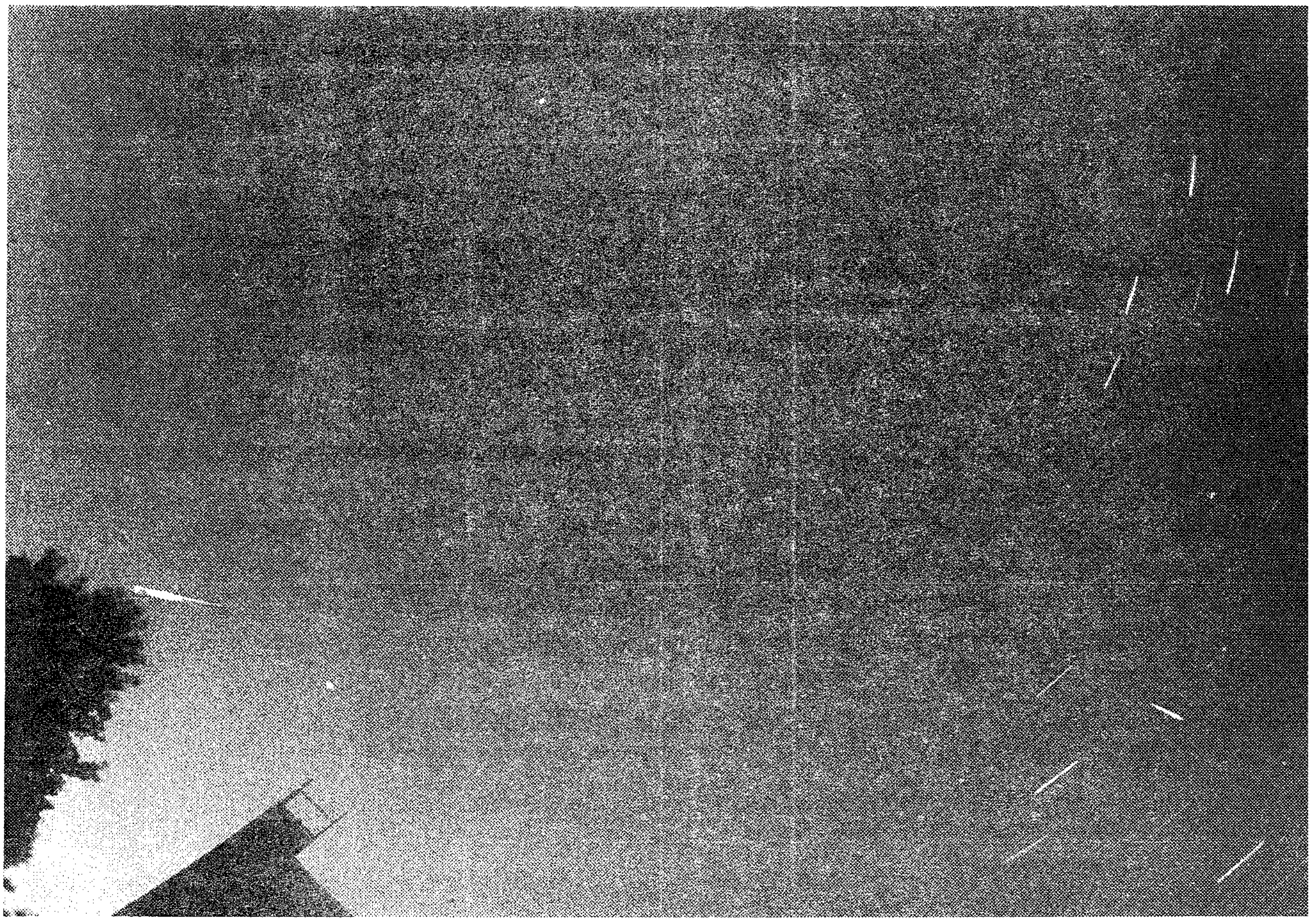


Figure 1 – Although the densest part of the Perseids was already passed, some bright shower meteors appeared later in the night of August 11-12, 1992. This exposure between $00^h03^m30^s$ and $00^h18^m00^s$ UT shows a −2.5 Perseid in Perseus at $00^h09^m25^s$ UT and another −4.5 Perseid in Camelopardalis at $00^h09^m40^s$ UT. The photo was taken by Jürgen Rendtel using a fish eye $f/3.5$, $f = 30$ mm and ORWO ISO 400/27° film in Gottsdorf, south of Potsdam, Germany.

4. North American visual observations

North America was worst-placed for viewing a possible return of last year Perseid's outburst, although they had the "traditional" Perseid maximum during their night time.

Most observers actually recorded their peak activity some 10 hours after the outburst, when the "usual" Perseid maximum coincided with high radiant elevations. Starting on the East Coast, the first author recorded Perseid rates topping 30 meteors per hour near 5^h UT, for corrected ZHR values near 150–200, falling off later in the session from London, Ontario, Canada. James Kirby, observing from Allegheny Observatory near Pittsburgh, Pennsylvania, had similar counts from 7^h–8^h UT, seeing 25 Perseids under lm = 5.0 skies. Bill Burmeister of Orlando, Florida, also saw 22 Perseids from 8^h–9^h UT under a limiting magnitude of +4, confirming the "traditional" Perseid peak near that time.

Further to the West, in Edmonton, Alberta, Canada, the Royal Astronomical Society of Canada held a watch with twelve participants. Their highest individual counts came from 10^h00^m–10^h30^m when Bruce McCurdy saw 20 Perseids with a limiting magnitude just above 5. This continuation of the regular peak was confirmed further South by observers such as Twyla Stickelman of Corning, California, who recorded 30 Perseids between 10^h30^m and 11^h30^m UT with a limiting magnitude better than 5.5. Bob Lunsford of the *ALPO* reports that most observers who had reported to him had recorded peak raw rates between 20 and 30 in the morning hours of August 12, his personal best being 35 Perseids from 11^h to 12^h UT under a 5.8 sky. The final North-American peak night observations were made by members of the Hawaii Meteor Group who, according to Mike Morrow, recorded roughly 20 Perseids in the interval 10^h45^m–12^h45^m UT under bad conditions.

Many observers also mentioned the high proportion of bright meteors during the peak this year; as this may be due to the Moon, no real conclusions can be drawn without better supporting data.

5. Radio observations

When poor observing conditions make it hard to interpret visual data, it becomes logical to turn to radio observations. A radio amateur in Wuppertal, Germany, said: "In my opinion, it was quite a poor shower, except for two hours on August 11, between 18^h30^m and 20^h30^m UT." According to a French amateur, the peak was at 19^h30^m UT. [2]

As Jeroen Van Wassenhove mentions in this issue, several radio observers did not cover the relevant period. Those who did (e.g., the team of the Urania Public Observatory in Belgium, and Gotfred Kristensen and Knud Bach Kristensen in Denmark), actually recorded an increase between 17^h30^m and 20^h15^m UT. In his *WGN* contribution, Gotfred Kristensen more particularly reports a real bombardment of bright and very bright radio-meteors starting at 17^h30^m and ending at 21^h10^m UT, quite remarkably a second outburst between 23^h15^m and 1^h25^m UT, and a less pronounced peak around 11^h UT on August 12, possibly corresponding to the "traditional" maximum.

Most radio reports however come from the United States. We give a brief overview based on a report communicated by Joe Rao [6].

Long time Perseid radio observer Shelby Ennis of Elizabethtown, Kentucky, listened from 14^h00^m to 20^h00^m UT. At 18^h45^m UT, "pings suddenly began picking up." A big long burst of nearly 5 minutes from the northeast was heard. Another burst followed at 18^h58^m, while at 19^h00^m, "a big flurry of activity commenced." By 19^h30^m UT, the bursts were "tapering off,"and at 19^h35^m, the activity was over. Ennis thought the activity lasted shorter than in 1991, but was comparable in strength.

Paul Kelly in Milo, Maine reports that the Perseid outburst commenced very suddenly at 18^h56^m UT. According to Kelly, the actual peak occurred around 19^h30^m UT, and ended less than half an hour later as activity quickly subsided. He also reports a lot of long-lasting signals, suggesting the particles causing the outburst were quite large. Kelly compared the 1992 outburst to that in 1991 as "as good as, if not better than last year's intense display."

Emil Pocock of Lebanon, Connecticut, reports a sharp radio peak between 19^h00^m and 19^h35^m UT. During that period, communication thanks to meteor scatter was possible at least 50% to 75% of the time. Pocock described the rise to the Perseid maximum as "sudden and dramatic", and felt that activity was—at least for a short time—comparable to 1991.

Radio observers in California and Colorado also witnessed the Perseid outburst, but give a somewhat earlier time for it. These differences in the peak times reported by several radio observers and the wide variations in activity levels underscore the difficulty in interpreting radio observations made with differing forward scattering geometries. It should also be noted that most of the ham radio operators mentioned observed at higher frequencies than most radio meteor observers and hence recorded activity mainly due to large particles, hence the great number of long lasting echoes are from truly large meteoroids.

6. Conclusions

In summary, we can say that all data available right now are reasonably consistent, so that there can be little doubt there was a Perseid outburst on August 11 starting with a very sharp rise in activity around 18^h50^m and ending with a somewhat less sharp decline around 20^h30^m. As to the intensity of the outburst, it is very difficult to draw any definite conclusions. Tentatively, we suggest that, based on both the visual and radio observations reported, the outburst was comparable to last year's. The scarce data from China and Japan, however, leave some room for speculating about even higher activity. Perhaps the time of the peak is the only parameter we can obtain with certainty, while the activity level may remain unreliable even if many more data are being included in a global analysis.

7. Postscript

The very day this article was finalized, we learned about the rediscovery of the Perseids' parent comet P/Swift-Tuttle, the details of which can be found elsewhere in this issue. To some extent, the rediscovery is the logical conclusion of a series of events [7,8,1] starting with a tiny new peak in the rate profile of the 1988 Perseids [7], the last of which was the 1992 outburst, at a solar longitude precisely corresponding with the nodal longitude of P/Swift-Tuttle. In this regard, Paul Roggemans and Dr. Brian Marsden deserve a lot of credit, the former for having recognized the reality and the relevance of the double peak of the 1988 Perseids, and the latter for having revived as early as 1973 the suggestion that P/Swift-Tuttle is identical to P/Kegler [9].

Of course, the return of P/Swift-Tuttle raises expectations for enhanced Perseid activity in 1993 as well. Regarding the intensity of the previous Perseid outbursts, Rao [6] makes an interesting observation. It turns out that the orbits of P/Swift-Tuttle and the Earth have drawn closer together during the past two centuries. Presently, the orbits are separated by only 0.001 AU at the descending node, compared to 0.005 AU in the 19th and 0.024 AU in the 18th century. This may explain why no records exist of remarkable Perseid rates in the 18th century, while rich displays were seen in 1861 and 1862. If this explanation is correct, there is good reason to suspect that yet another outstanding Perseid display will indeed occur in 1993. It should be noted here that the actual orbital distance of 0.001 AU is comparable to the orbital distance between the Earth and the Leonids in 1833!

If the solar longitude of this outburst remains the same, it should be expected on August 12, 1993 around 1^h UT, ideal for Europe, while the end of it may be noticeable form North America's East Coast. In view of what happened this year, however, it is possible that the peak will occur up to 0.1 day (i.e., 2 to 3 hours) earlier. The Moon will be some 4 days before New and should not present as much interference as in 1992. Whatever exactly happens in 1993, we can look forward to some exciting Perseid returns in the coming years!

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The 1992 Perseid Outburst in China

Xu Pin-xin, Purple Mountain Observatory

Despite the very poor circumstances, the observations of two Chinese observers between 18^h32^m and 21^h00^m UT clearly show a strong and very bright Perseid outburst between 18^h50^m and 20^h30^m UT.

Prior to the 1992 Perseid shower, I had written to Chinese observers and asked them to watch for a possible outburst of the Perseids on August 11 despite the Moon's interference.

Although it was cloudy and rainy in most parts of China around that night, two observers, Ouyang Tianjing in Wuhan ($\lambda = 114°17'$ E, $\varphi = 30°25'$ N) and Chen Yu in Tianjin ($\lambda = 117°52'$ E, $\varphi = 38°47'$ N) were nevertheless able to watch and send in data. They wrote that they were amazed by so many bright meteors and fireballs they had never seen in a cloudy and moonlit sky. They wrote that they saw many fireballs through the clouds just like small moons flying behind the clouds, or like lightning flashing during a storm. Table 1 shows rate data and Table 2 shows magnitude data.

Table 1 – Observational data of Ouyang Tianjin and Chen Yu on the Perseids during the night of August 11-12, 1992, including very tentative ZHR values.

Period (UT)	Lm	F	T_{eff}	Per	ZHR	Observer
18^h32^m–18^h52^m	4.40	1.43	$0^h.33$	8	242	Chen
18^h52^m–19^h07^m	3.80	1.43	$0^h.25$	19	1182	Chen
19^h07^m–19^h20^m	3.25	2.00	$0^h.22$	16	2407	Chen
19^h19^m–19^h40^m	≈ 0		$0^h.32$	7		Ouyang
19^h20^m–19^h42^m	3.00	3.33	$0^h.37$	12	2099	Chen
19^h42^m–19^h52^m	3.10	2.00	$0^h.17$	15	3116	Chen
19^h40^m–20^h00^m	≈ 1		$0^h.29$	11		Ouyang
19^h52^m–20^h12^m	3.30	1.67	$0^h.33$	33	2396	Chen
20^h00^m–20^h20^m	3.10	1.00	$0^h.28$	13	886	Ouyang
20^h12^m–20^h32^m	3.50	1.67	$0^h.33$	10	606	Chen
20^h20^m–20^h40^m	3.10	1.00	$0^h.30$	7	431	Ouyang
20^h40^m–21^h00^m	3.10	1.00	$0^h.31$	5	292	Ouyang

Table 2 – Magnitude distributions of the Perseids observed by Ouyang and Chen in the night of August 11-12, 1992.

Observer	−6	−5	−4	−3	−2	−1	0	+1	+2	Tot	$\overline{m}$
Ouyang	1	0	4	6	6	4	11	4	7	43	−0.88
Chen	2	5	5	22	38	20	14	4	3	113	−1.85

From the relative tendency of the ZHR, we can find the beginning and the end of the outburst, although the correction factors are too high to give reliable ZHR values. The outburst seems to begin at 18^h50^m UT and end at 20^h30^m UT. Chen Yu recorded the whole course of the outburst, while Ouyang Tianjing began in the middle of the outburst, hampered by the weather. Where no F-value is quoted for Ouyang Tianjing in Table 1, the observer actually saw most meteors through the clouds.

Also, the magnitude distributions in Table 2 have no absolute value as the limiting magnitude is much too poor, but they are nevertheless an indication for the brightness of the outburst. (Ed.)

Telescopic and Other 1992 Perseid Observations in Czechoslovakia

Petr Pravec, Ondřejov Observatory

An overview of Czechoslovak 1992 Perseid observations is given. Although telescopic work from August 8 to 13 was the main objective, visual observations were also performed on August 11-12. About 800 telescopic meteors were recorded and a decline of very high activity of the Perseids after August 11.82 UT was recorded visually.

The Perseid meteor shower is in the center of attention of Czechoslovak telescopic meteor observers since 1988. This year, three groups were ready for observing within the 1988–1992 Perseid Project (see, e.g., [1]). Two of them were successful in obtaining interesting data; they recorded about 800 telescopic meteors. Considering the poor observing conditions (strong interference of moonlight, average limiting magnitude of about 5.0), this result is rather gratifying. The evaluation of data obtained over the whole observing period 1988–1992, which contains about 6000 telescopic records of meteors, will yield interesting results about telescopic activity of the Perseids, and the data from 1992 are of particular interest due to very high activity of the shower.

Because of a Perseid outburst expected on August 11.9 UT [2], two observers, I. Míček and T. Nasku, decided to observe the shower visually that night. Under poor observing conditions (moonlight, limiting magnitude of 4.5), they recorded 123, respectively 107, Perseids and 37, respectively 36, non-Perseids in 5.5 hours of effective observing time from August 11.82 to 12.05 UT. As their data represent a rather homogeneous sample (constant observing conditions and almost continuous watching), it is interesting to analyze them in order to see how the Perseid activity evolved during the observing session.

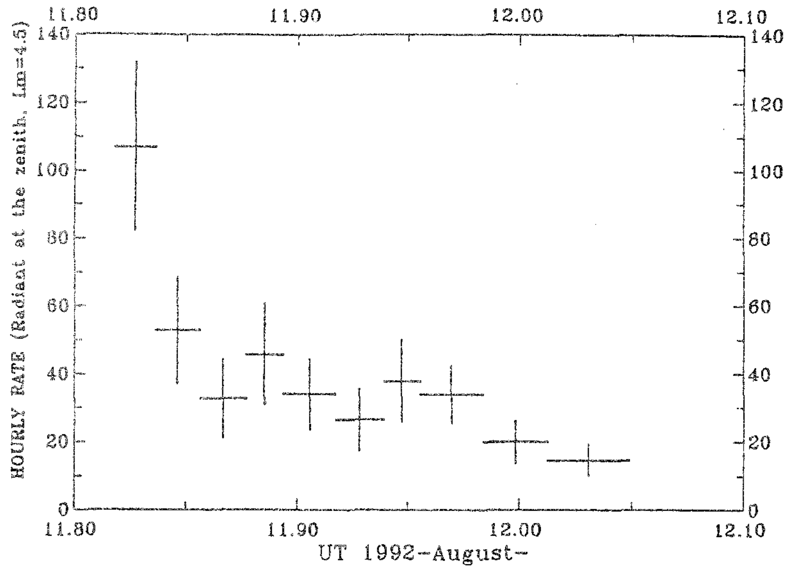

Figure 1 – Visual observations of the 1992 Perseids on August 11-12 by I. Míček and T. Nasku in Sibenický vrch, Czechoslovakia. The graph shows the average HR, reduced for radiant elevation, but not for limiting magnitude. The limiting magnitude was 4.5. Horizontal bars indicate the relevant intervals, vertical bars are error bars.

The Perseid activity profile from August 11.82 to 12.05 UT is shown in Figure 1. Hourly rates presented were reduced for radiant elevation, but not for the low limiting magnitude, as this correction would be very questionable. The activity of the Perseids was quite high during the first interval (19^h38^m to 20^h04^m UT, with HR = 107±25; it faded in the next interval and a gradual, systematic decrease during the rest of the night is apparent. Within the error margins, the same activity curve was obtained after selecting only meteors brighter than magnitude +2, so the gradual decrease seems to be real (i.e., not connected to possible non-recorded changes in observing conditions).

It is interesting to add, that all visual and telescopic observers saw visually about ten bright Perseids in 15 minutes around 11.80 UT (limiting magnitude about 1 or 2 at that time). Comparing our results with reports given by A. Mizser, P. Jenniskens, and J. Rao [3], and by Japanese observers [4], we can conclude that we probably saw the descending branch of the Perseid activity peak caused by a filament of young particles of the Perseid stream, met by the Earth around August 11.80 or 11.81 UT, very near to the point of its orbit closest to the orbit of the Perseids' parent comet P/Swift-Tuttle.

References

[1] Pravec P., "Precision of Telescopic Meteor Recordings", *WGN* 20:2, April 1992, p. 70.

[2] Roggemans P., Gyssens M., Rendtel J., "One-Hour Outburst of the 1991 Perseids Surprises Japanese Observers!", *WGN* 19:5, October 1991, p. 181.

[3] Mizser A., Jenniskens P., Rao J., *IAU Circular 5586*, 1992.

[4] Brown P., *personal communications*, August–September 1992.

The 1992 Perseids from Central Slovakia

Miroslav Znášik and Peter Zimnikoval

An overview of Slovak 1992 Perseid observations is given. While the activity before the maximum night was normal, observers saw the end of a Perseid outburst in the beginning of the maximum night of August 11-12

1. Introduction

Due to bad conditions this year (almost Full Moon around the maximum), we observed the Perseids in two stages. The first part of the observation program took place at Žliebky hill ($\lambda = 19^\circ\!.3$ E, $\varphi = 48^\circ\!.7$ N, $h = 1160$ m) from July 28 to August 7, 1992. About 20 observers participated in these observations. The observation was set up to watch the meteor shower's activity in that period. One group counted meteors, while the other group plotted on gnomonic charts.

The second part of our Perseid observations took place at the Banská Bystrica Observatory ($\lambda = 19^\circ\!.1$ E, $\varphi = 49^\circ\!.7$ N, $h = 568$ m) during the night of August 11-12. We performed this observation to detect unusual Perseid activity that might occur during the maximum.

The observers who participated in our observations are as follows:

S. Babnič, V. Čillik, M. Diková, J. Fabricius, M. Hlušík, S. Kaniansky, V. Kordík, J. Majerová, J. Mäsiar, D. Očenáš, D. Rapavá, M. Rapavý, P. Rapavý, Š. Ružička, B. Ružičková, J. Sojka, M. Svancárová, J. Škvarka, E. Šušková, I. Švachulová, P. Zimnikoval, and M. Znášik.

2. Preliminary results

The first part of the observing campaign:

The sky conditions during this observation series were relatively good. Twenty observers registered 3222 meteors in 8 observing nights.

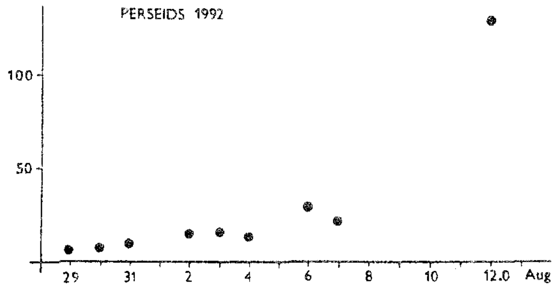

Figure 1 – The 1992 Perseids in Slovakia outside the outburst.

Among these meteors, 1051 Perseids were counted. Some 949 meteors were plotted on gnomonic maps. The Perseid activity in that period seemed normal; mean values of Perseid ZHRs are given in Figure 1. The graph gives the number of Perseids that appeared to one observer, calculated from all the observations of that night and corrected to get the radiant in the zenith (using the mean elevation of the radiant above the horizon during the time of observation) and corrected for the influence of the limiting magnitude (using the mean value of lm). Consequently, these numbers must be seen as rough estimates.

The observation of the Perseid maximum:

Despite the Full Moon, two groups with each 6 observers and 1 person for data registration observed from 20^h00^m till 1^h40^m UT on the night of August 11-12, 1992. The result is given in Table 1.

Table 1 – Slovak observations of the 1992 Perseids on August 11-12. For each observer and each interval, three numbers are given: the number of Perseids, the number of sporadics, and the effective observing time as a fraction of the interval.

Obs	Intervals				
	20^h00^m–21^h00^m	21^h15^m–22^h15^m	22^h30^m–23^h30^m	23^h45^m–00^h45^m	01^h00^m–01^h40^m
DIKMA	22, 2, 1.00	10, 2, 1.00	10, 1, 0.75	16, 1, 1.00	16, 0, 1.00
OCEDA	24, 1, 1.00	13, 1, 1.00		9, 1, 0.75	
ZNAMI	27, 8, 1.00	14, 3, 1.00	18, 4, 1.00	23, 2, 1.00	20, 3, 1.00
KORVL	16, 2, 1.00	14, 3, 1.00	16, 3, 1.00	5, 0, 0.25	14, 1, 1.00
BABSL	14, 2, 1.00	10, 1, 1.00	9, 2, 1.00	11, 0, 0.75	11, 1, 1.00
RAPDA	17, 2, 1.00	11, 2, 1.00	17, 1, 1.00	19, 1, 1.00	16, 0, 1.00
$\overline{\text{Lm}}$	4.3	4.0	4.8	4.8	5.0

Table 1 – continued.

Obs	Intervals				
	20^h15^m–21^h15^m	21^h30^m–22^h30^m	22^h45^m–23^h45^m	00^h00^m–00^h45^m	00^h45^m–01^h30^m
GERJA	18, 6, 1.00	10, 1, 0.92	7, 3, 1.00	16, 3, 1.00	23, 3, 1.00
MASJA	17, 3, 1.00	8, 0, 0.75	7, 7, 1.00	11, 3, 1.00	20, 4, 1.00
RAPPA	9, 2, 1.00	11, 0, 1.00	10, 5, 1.00	12, 6, 0.93	12, 4, 1.00
RAPMA	17, 5, 1.00	10, 1, 1.00	8, 2, 1.00	11, 3, 0.84	6, 1, 0.87
ZIMPE	12, 1, 1.00	9, 0, 1.00	11, 3, 1.00	13, 1, 1.00	15, 1, 1.00
KANST	11, 0, 0.75	11, 1, 1.00	10, 5, 1.00		
$\overline{\text{Lm}}$	4.2	4.0	4.6	4.8	4.8

The ZHR evolution can be followed in Figure 2. Because the Perseid frequency decreased in the first interval, it was separated in 2 or 3 parts. Classical processing to determine the ZHR has a qualitative value only. High correction factors, mainly in the beginning of the observation yields results with a low reliability. It is nevertheless possible to conclude that both groups have seen the end of a strong Perseid activity. Despite the increase of the radiant's altitude and the limiting magnitude, the activity was decreasing that night.

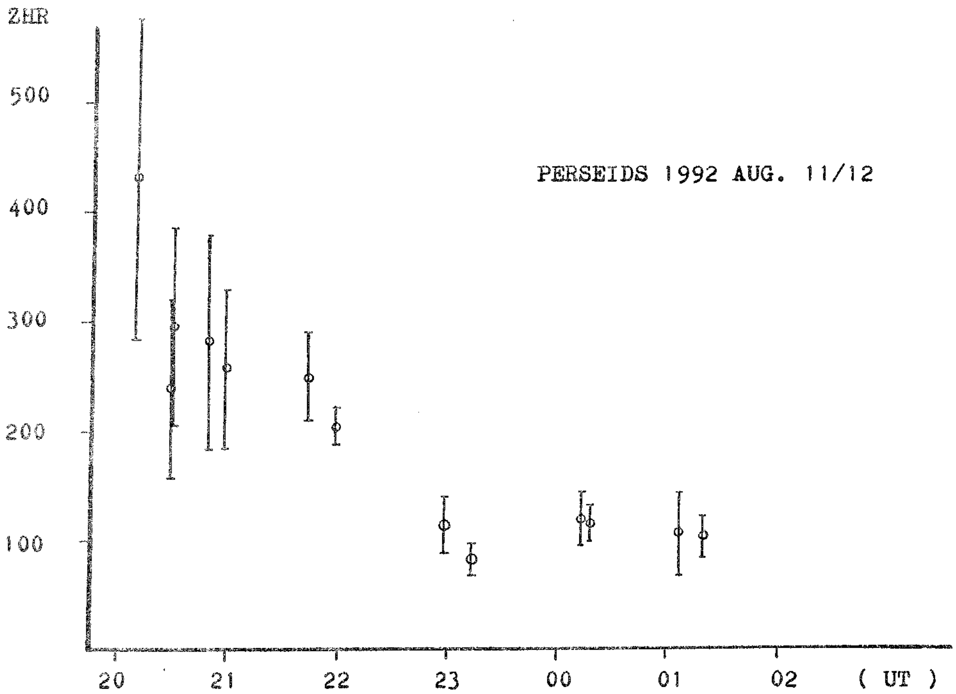

Figure 2 – Tentative ZHR profile for the Slovak observations of the 1992 Perseids in the night of August 11-12.

Radio Observations of the 1992 Perseids in North-West Europe

Jeroen Van Wassenhove

An overview is given of some radio observations in Belgium, Germany, and Denmark around August 11-12. In-as-far as the observations cover the period of the visual outburst, enhanced radio activity was registered.

In *IAU Circular 5586*, European visual observers reported a very high Perseid activity during twilight on August 11.79 lasting to 11.84, and possibly to 11.87 UT. Below is an overview of some radio observations conducted that night in Belgium, Germany, and Denmark.

Belgium:

Four individual observers, Dirk Artoos, Maurice De Meyere, Rik Van Laethem, and Jeroen Van Wassenhove, and one team of observers from the Public Observatory Urania monitored the Perseid activity. Only the team of Urania covered the above-mentioned period, and has an increase. Unfortunately, the results cannot be compared with the day before or after (same period) as no observations were carried out then.

Germany:

Ingo Reimann made extensive observations, unfortunately not around August 11.8 UT.

Denmark:

Two observers were able to monitor the Perseids: Gotfred M. Kristensen and Knud Bach Kristensen. Both have a high increase of activity during the suggested period. Gotfred Kristensen recorded very high activity between August 11.73 and 11.88 UT *(see Gotfred's article in this issue, ed.)*. Knud Bach Kristensen measured the echo duration of each meteor reflection, which will make a more detailed analysis possible.

Danish Radio Observations of the Perseid Maximum

Gotfred Møbjerg Kristensen

The results of the author's continuous radio monitoring of meteor activity are discussed for August 11 and 12 UT, 1992. Three peaks were recorded: August 11, 17^h30^m–21^h10^m UT, August 11-12, 23^h15^m–01^h25^m UT, and August 12, 9^h05^m–12^h30^m UT. The first and third peak most likely correspond to the outburst and the "traditional" maximum of the 1992 Perseids, respectively.

Naturally I was very curious as to what my radio observations of the Perseids would show this year. I had seen predictions for a first peak between 22^h and 23^h UT on August 11, and a second peak around 9^h UT on August 12. I still monitor radio meteors 24 hours per day throughout the year by pen recorder, so all changes in the radio meteor activity should be noticed.

A little over 17^h30^m UT on August 11, a real bombardment of bright and very bright radio meteors started. Up to 32 of them had durations between 30 and 132 seconds! All could easily have been fireballs. Sometimes, the pen recorder could not follow the activity because signals of different reflections overlapped. Active listening indicated between 8 and 23 radio meteors per minute during the maximum. Then the activity dropped markedly around 21^h10^m UT. Remarkably, a second outburst started around 23^h15^m UT on August 11 and dropped steeply again at 1^h25^m UT on August 12. In this period, 24 radio meteors were recorded with durations from 30 seconds to 101 seconds. A third and more flat peak occurred around 11^h00^m UT on August 12, beginning at 9^h05^m UT, and disappearing at 12^h30^m. There were 21 radio meteors which lasted between 30 seconds and 98 seconds. But even in low-activity periods, some very bright signals appeared.

It is not simple to draw conclusions from uncorrected data of radio observations, because of the different factors that influence the number of reflections, but altogether, it is certain that the 1992 Perseids had an outburst in the early evening of August 11.

Despite the nearly Full Moon, I also observed visually in the night of August 11-12, from 20^h18^m until 1^h07^m UT, with a limiting magnitude of 5.3. At best, I observed 34 meteors per hour, with magnitudes between −4 and 4.5, which looks like a normal Perseid display. But before I started observing, when the first stars appeared, I saw 6 meteors of magnitude 2 and brighter in 5 minutes! I thought at that moment: "It will be a great night for observing meteors."

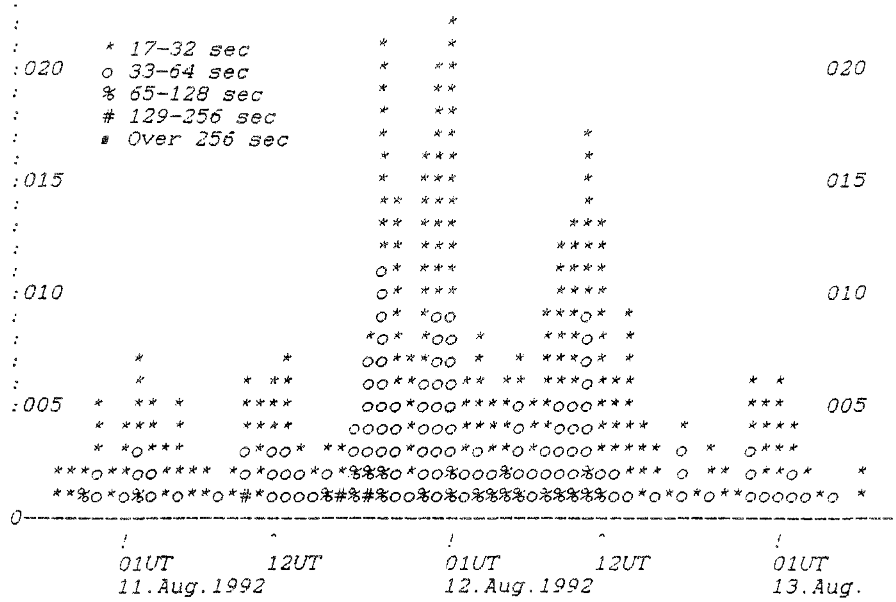

Figure 1 – Uncorrected number of bright radio meteors recorded by G.M. Kristensen during the 1992 Perseid maximum.

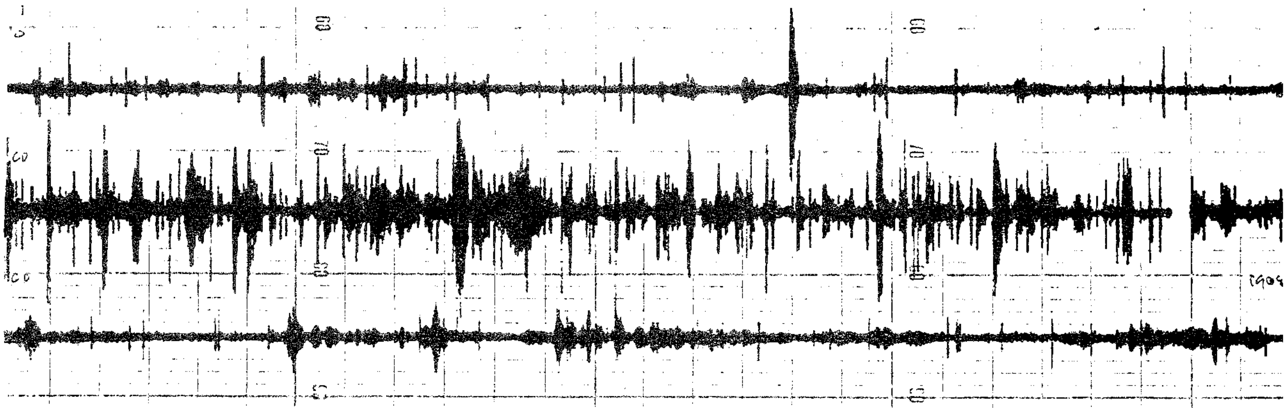

Figure 2 – Pen recordings by G.M. Kristensen on August 3 *(top)*, August 11 *(middle)*, and August 19 *(bottom)*, each time between roughly 19^h00^m and 19^h50^m UT.

Figure 1 shows the number of bright radio meteors hour per hour during the 1992 Perseid maximum. Figure 2 gives an idea as to how the outburst looked like on my pen recordings.

The Rediscovery of P/Swift-Tuttle

Brian G. Marsden, SAO, Cambridge, Mass.

This note contains data regarding the rediscovery of the Perseids' parent comet, P/Swift-Tuttle, reprinted from IAU Circulars 5620 *and* 5621, *with the kind permission of Dr. Marsden. (Ed.)*

A message from H. Kosai, National Astronomical Observatory, Tokyo, reports the discovery of a comet by Tsuruhiko Kiuchi, with the suggestion that it might be Comet 1862 III P/Swift-Tuttle with perihelion time in mid-December. Confirmation of the discovery by several observers in Canada, the United States and Japan leaves no doubt that this identification with the Perseids' parent comet is correct. The identification in turn confirms the suggestion (Lynn 1902, *Obs.* 25, 304; Marsden 1973, *A.J.* 78, 662; see also *IAUC* 5330 and 5586) that Kegler's observations (1737 II) were indeed of P/Swift-Tuttle. P/Swift-Tuttle was assigned the number 1992 *t*.

Table 1 – Rediscovery data of P/Swift-Tuttle. (Eq. 2000.0)

Date (UT)	α	δ	m_1	Observer
1992 Sep 26.75694	$11^h47^m.5$	$+59°00'$	11.5	Kiuchi
27.22465	$11^h50^m34^s.71$	$+59°04'35''.3$		Tatum
27.41424	$11^h51^m45^s.90$	$+59°05'26''.6$	12.5	Sugie
27.42326	$11^h51^m49^s.22$	$+59°05'33''.1$		Sugie
27.43368	$11^h51^m53^s.49$	$+59°05'34''.1$		Sugie
27.44792	$11^h51^m58^s.70$	$+59°05'37''.0$		Tatum
27.49897	$11^h52^m.23$	$+59°05'.5$		Scotti

- T. Kiuchi (Usuda, Nagano), 25 × 150 binoculars, comet diffuse without condensation, diameter 4′.
- J.B. Tatum (University of Victoria), 0.25-m Schmidt.
- A. Sugie (Dynic Astronomical Observatory), 0.25-m $f/3.4$ Schmidt, strong condensation, communicated by S. Nakano.
- J.V. Scotti (Kitt Peak), 0.91-m Spacewatch telescope, well-condensed nucleus, fan-shaped coma more than 3′.4 wide, tail to southwest.

Precise linkage of the observations, even at two apparitions, is not possible without the involvement of large non-gravitational forces. The following orbital elements (eq. 2000.0), by the undersigned, are a compromise that fit the current observations exactly but leave large discordances in 1862:

Epoch: 1992 December 4.0 TT

$T =$ 1992 December 12.391 TT		$\omega = 152^\circ\!.979$
$e = 0.96362$		$\Omega = 139^\circ\!.430$
$q = 0.95876$ AU		$i = 113^\circ\!.408$
$a = 26.35441$ AU	$n = 0.007285$	$P = 135.29$ years

Some total visual magnitude estimates shortly after the rediscovery: Sept 27.41 UT, 9.1 (D. Machholz, Colfax, CA, 29 × 127 binoculars; coma 4′); 27.47, 9.1 (C.S. Morris, Pine Mountain Club, CA, 0.260-m reflector; diffuse and uncondensed, coma 5′.2); 27.48, 10.2 (A. Hale, Las Cruces, NM, 0.20-m reflector; coma 4′).

Table 2 shows an ephemeris (eq. 2000.0) from the above orbital elements.

Table 2 – Ephemeris for P/Swift-Tuttle (eq. 2000.0).

Date	α	δ	Δ	r	Elong.	m_1
Sep 25	$11^h37^m\!.16$	$+58^\circ52'\!.3$	1.837	1.595	$60^\circ\!.1$	9.3
Oct 05	$12^h44^m\!.86$	$+59^\circ16'\!.7$	1.610	1.478	$64^\circ\!.1$	8.7
15	$14^h10^m\!.11$	$+57^\circ17'\!.5$	1.407	1.364	$66^\circ\!.6$	8.1
21	$15^h04^m\!.94$	$+54^\circ06'\!.5$	1.307	1.299	$67^\circ\!.1$	7.7
27	$15^h57^m\!.26$	$+49^\circ05'\!.6$	1.230	1.236	$66^\circ\!.6$	7.4
Nov 02	$16^h43^m\!.69$	$+42^\circ21'\!.4$	1.182	1.177	$64^\circ\!.9$	7.1

The Perseids: Prospects for the 1993 Return

Paul Roggemans

The recent behavior of the Perseids is compared to the behavior of the Perseids around the 1862 perihelion passage of the parent comet P/Swift-Tuttle. Arguments are given in favor of a strong 1993 Perseid return.

The recent rediscovery of the Perseids' parent comet P/Swift-Tuttle was the last missing piece of evidence in the picture we had developed of the Perseid stream.

For many years, the activity profile of the Perseids showed a single maximum, slightly variable in strength, but stable. A surprise came in 1988 when a double maximum was found. Its first peak was due to a new filament more or less parallel to the ancient core. Whether or not this filament was already met prior to 1988 is difficult to say due to the lack of international coordination in the pre-*IMO* epoch. In any case, the new maximum in 1988 was neither sharp nor rich in bright meteors, and of equal strength as the "traditional" maximum. The meteoroids in the head of the new filament were rather dispersed and typical fresh cometary particles producing very bright meteors were not present at all. Also, the first peak occurred still $0^\circ\!.2$ in solar longitude past the nodal longitude of the parent comet. In 1989, the first maximum was somewhat sharper and more distinct, but apart from that, the situation was identical to 1988. Moon and poor weather yielded insufficient data to tell something about 1990. In 1991, the first maximum became a very sharp spike-like outburst very rich in bright meteors showing the characteristics of a meteor stream of very recent origin. It occurred 1.5 hour earlier in solar longitude than the 1989 peak. Hence the occurrence of the 1992 outburst, still 2.5 hours earlier, exactly at the nodal longitude of the parent comet, possibly even richer in bright meteors and more intense though wider than the 1991 outburst, made it very likely that P/Swift-Tuttle was nearby.

Since the 1991 outburst, it is clear that the Perseid stream is composed of three distinct components. The "traditional" maximum, at $\lambda_\odot = 140\overset{\circ}{.}1$ (eq. 2000.0), was formed many revolutions ago. The flat long-duration profile visible from 20 days before to 10 days after the maximum is due to a very scattered stream of perturbed particles. This is the oldest component. The new maximum is due to a filament formed relatively recently. Up to now, all meteors seen from this filament moved ahead of the comet. These particles must have been ejected under very particular conditions. The ejection process must have been rather intense and continuous to achieve the compact, well-determined shape of the filament. Indeed, the dust that formed the first peak of the 1988 maximum must have been released many revolutions ago in view of the large distance from the cometary nucleus, especially when ejection velocities up to 10 m/s are considered. Since 1991, while approaching the comet, we gradually enter more and more recently released dust, which is less dispersed and richer in larger particles.

The new filament developed under a small angle relative to the cometary orbit as the first maximum has shifted year after year towards the longitude of P/Swift-Tuttle's descending node. In 1992, we met the filament at the nodal longitude of the comet, 4 months ahead of the comet itself. Therefore, it is reasonable to expect that, next year, we will meet the dust concentration 8 months behind the comet still up to two hours earlier. It is therefore appropriate to assume that the first maximum will occur between August 11, 22^h UT and August 12, 3^h UT. The meteoroid concentration to be encountered will probably be more dispersed but still very dense.

In order to get a better idea of what may be expected in 1993, it is interesting to compare the present behavior of the Perseids with their behavior in the period 1861–1864.

A detailed literature search yielded no reports on enhanced activity from Europe and America in 1861 and 1862; only in the Far East, exceptional Perseid displays were reported. This situation is quite similar to what happened in 1991 and 1992. Now, what happened in 1863 and 1864? No direct reports were found, but some indirect references may give us a clue. In [1], an account is given of the 1871 Perseids, which happened to be very strong. The Perseids of that year were like the Andromedids of 1872 (a meteor storm)! The author of [1] writes: *"1871 Perseids exceeded considerably the ordinary scale of their annual frequency and brightness as observed at several Italian observing stations..."* Further, the author compares this exceptional maximum to the year 1863, with the *marked* maximum of the Perseid shower. Two years earlier [2], Herschel compared the Bielid meteor storm to two great shooting-star showers: November 1866, after Comet 1866 I, and August 1863, after Comet 1862 III (P/Swift-Tuttle). Finally, W.F. Denning too indirectly refers to 1863, as a year with 3 to 4 times the normal maximal Perseid rates, while for 1864 only slightly better than normal activity is mentioned.

In 1993, we will be closer to the comet than in 1863: about 8 months compared to 12. Also, the orbital distance between the Earth and P/Swift-Tuttle is much shorter: 0.001 AU compared to 0.005 AU. The actual distance is of the same order of magnitude as the orbital distance between the Earth and the Leonid stream at the 1833 storm! From these historical records, it seems the current encounter is just a repetition of the previous one, but under slightly better circumstances, and so I have very good hope for a splendid Perseid shower over Europe in 1993.

There still is another argument in favor of a strong Perseid return in 1993. From Marsden's orbital elements based only on 1992 data [3], we see that the comet's period has increased with another 5 years. Such changes involve large non-gravitational forces, and when these occur, a lot of dust is produced. Depending on when this dust was produced (perhaps already as early as 1863) and in view of the very small distance between the Earth's and the comet's orbit, there is a reasonable chance we might actually encounter some of that dust in 1993!

References

[1] A.S. Herschel, *Mon. Not. Roy. Astr. Soc.*, 1874, pp. 211–215.

[2] A.S. Herschel, *Mon. Not. Roy. Astr. Soc.*, 1872, pp. 355–359.

[3] B.G. Marsden, *IAU Circular* 5620, 1992, *see also this issue.*

Bulletin 2 of the International Leonid Watch

Peter Brown

The results of the 1st *International Leonid Watch* period are discussed. Radiant drift of the Leonids is determined from photographic and radar data, while rate data from the period 1987–1991 is combined to yield a mean activity curve. The second *ILW* period is announced and additional instructions given for observers based on results of *ILW* 1.

1. Introduction

In the first bulletin of the *ILW* published in [1], the scientific aims were set forth and the observing techniques presented. A call for observations for the 1991 return of the Leonids was made and the first *ILW* period was established for November 5–25, 1991.

Having presented the aims and techniques we hope to employ to study the shower, we now move on to the task of interpreting what data is collected regarding the shower. To provide some framework for study of the upcoming Leonid showers, we present what recent observational data is available and report on the observations made during the first *ILW* period in 1991. The second *ILW* period in 1992 is outlined and changes to the observing procedure discussed based on the experience gained during *ILW 1*.

2. Observational data

Radiant drift:

To determine the best values for the radiant drift of the "quiet" part of the Leonids (the Clino-Leonids), the data available through the *IAU* Meteor Data Centre in Lund, Sweden have been used. Orbits were selected from the available data by using the 1965 orbital elements of P/Tempel-Tuttle and determining which orbits had a value for the Southworth-Hawkins D-Criterion of 0.3 or better (i.e., smaller) with respect to this initial orbit. All orbits (photographic and radar) which satisfied this condition were used to determine the radiant drift. Values of $+0\overset{\circ}{.}67$/day in right ascension and $-0\overset{\circ}{.}3$/day in declination were found. While the correlation coefficient is very good for the former, the declination plots show much smaller correlation coefficients—a result possibly due to the inclusion of less accurate radar data. When the photographic data alone are analyzed, the correlation coefficients increase, and the resulting values for the radiant drift are $+0\overset{\circ}{.}61$/day in right ascension and $-0\overset{\circ}{.}39$/day in declination. The often quoted values from Cook [2], $+0\overset{\circ}{.}70$/day in right ascension and $-0\overset{\circ}{.}42$/day in declination, are in good agreement with the present results, especially since the true size of the radiant is not well-determined and the number of meteors used is quite small.

From the analysis, it was also apparent that some meteors appearing as early as late October and as late as mid-December satisfy the 0.3 condition on D. It is likely that some of these outliers are chance associations, but the possibility that the Clino-Leonids are active during a longer period cannot be discounted.

Rate Data:

The recent activity of the Leonids is of some interest to determine if the advanced edge of the Ortho-Leonids has yet encountered the Earth, and to provide good reference baselines for normal activity returns. No photographic or telescopic data have been recorded for the Leonids in recent years, while the little radio data available are not well calibrated, and can only be used to gauge relative strengths from one station. Some visual data do, however, exist in the *IMO* archives.

The results of *ILW* 1 in this regard are somewhat disappointing: only 605 Leonids were recorded, and of those only 154 with magnitude estimates. This is not adequate for serious analysis.

If it is assumed, however, that the stream maximum has not shifted significantly over the past 5 years, it is possible to combine the data from 1987–1991, and derive a mean ZHR curve (Figure 1). The graph consists of 2664 Leonids reported by 86 observers over the 5-year interval.

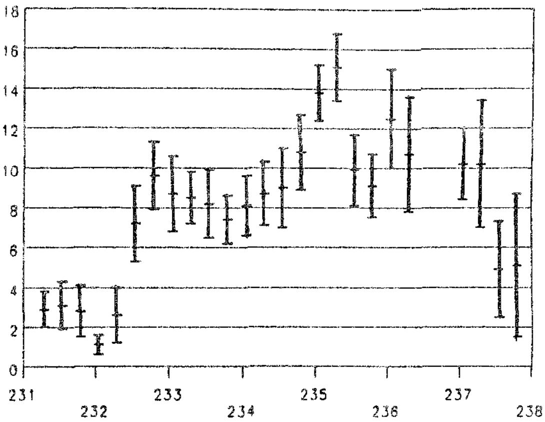

Figure 1 – Leonid ZHR profile based on data from 1987–1991 (see text).

While the amount of data is still very small, a few features are noticeable that may be real. The shower appears to increase activity significantly around $\lambda_\odot = 232\overset{\circ}{.}5$ (eq. 2000.0) or roughly November 15, and a broad plateau of activity is apparent until $\lambda_\odot = 234\overset{\circ}{.}5$ at which time activity sharply increases and reaches a maximum at roughly $\lambda_\odot = 235\overset{\circ}{.}3$. The times of maximum of the 1966 shower and the *IMO*'s predicted maximum are both shown in Figure 1. The present maximum is at virtually the same longitude as the 1966 maximum; *IMO*'s maximum is several hours later. The data available after $\lambda_\odot = 235\overset{\circ}{.}5$ are sparse—as a result, the error bars and scatter in the data are significantly greater than before the apparent maximum. This results in a large uncertainty in the true time of maximum and its extent; the apparent secondary peak at $\lambda_\odot = 236\overset{\circ}{.}0$ is almost certainly the result of the small amount of data, and hints at the possibility of a rather broad peak starting at $\lambda_\odot = 235\overset{\circ}{.}3$ and ending perhaps around $\lambda_\odot = 236\overset{\circ}{.}0$.

The level of sporadic activity throughout this time interval is at about 15—the derived Leonid peak at $\lambda_\odot = 235\overset{\circ}{.}3$ is the only point at which the Leonids are comparable to the sporadic background.

Much more data are needed to refine the ZHR curve. In particular, sufficient visual data are needed for each year, so each return can be properly analyzed. This will become increasingly important in the coming years.

3. The second ILW period: November 5–25, 1992

In an effort to gather as much data as possible, observers are strongly urged to concentrate on the Leonids during the period November 5–25. Though this is the main ILW period, the possibility of early and late activity as mentioned in Section 2 means that observers should also concentrate on plotting both earlier and later than these dates, so indications of the radiant's position can be ascertained using *Radiant*. Please record angular velocities for each meteor plotted.

From the results of *ILW* 1, several important points should be emphasized. First, when activity is quite low, plotting each possible Leonid is the most valuable activity, as this gives data on the radiant's position and structure. Second, please send in magnitude estimates per night per observer for the Leonids and sporadics. In this way, a population index profile of the stream may be derived in the future. Also, observations made after November 17–18 are very important as little information exists over this time period.

As no telescopic or photographic data were recorded during *ILW* 1, it is also very important that data on the Leonids be recorded using these techniques. The associated methods were described in Bulletin 1 of the *ILW* [1].

Video techniques are one of the most valuable ways to study the Leonids, and groups with this capability are asked to make single- and, if possible, double-station observations near the time of maxima. Further details on this method of observation will be presented in a future bulletin.

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[1] Brown P., "Bulletin 1 of the International Leonid Watch", *WGN* 19:5, October 1991, pp. 193–197.

[2] Cook A.F., "A Working List of Meteor Streams", in *Evolutionary and Physical Properties of Meteoroids*, Hemenway C., Millman P.M., and Cook A.F., eds., NASA SP-319, Washington, 1973, pp. 183–191.

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