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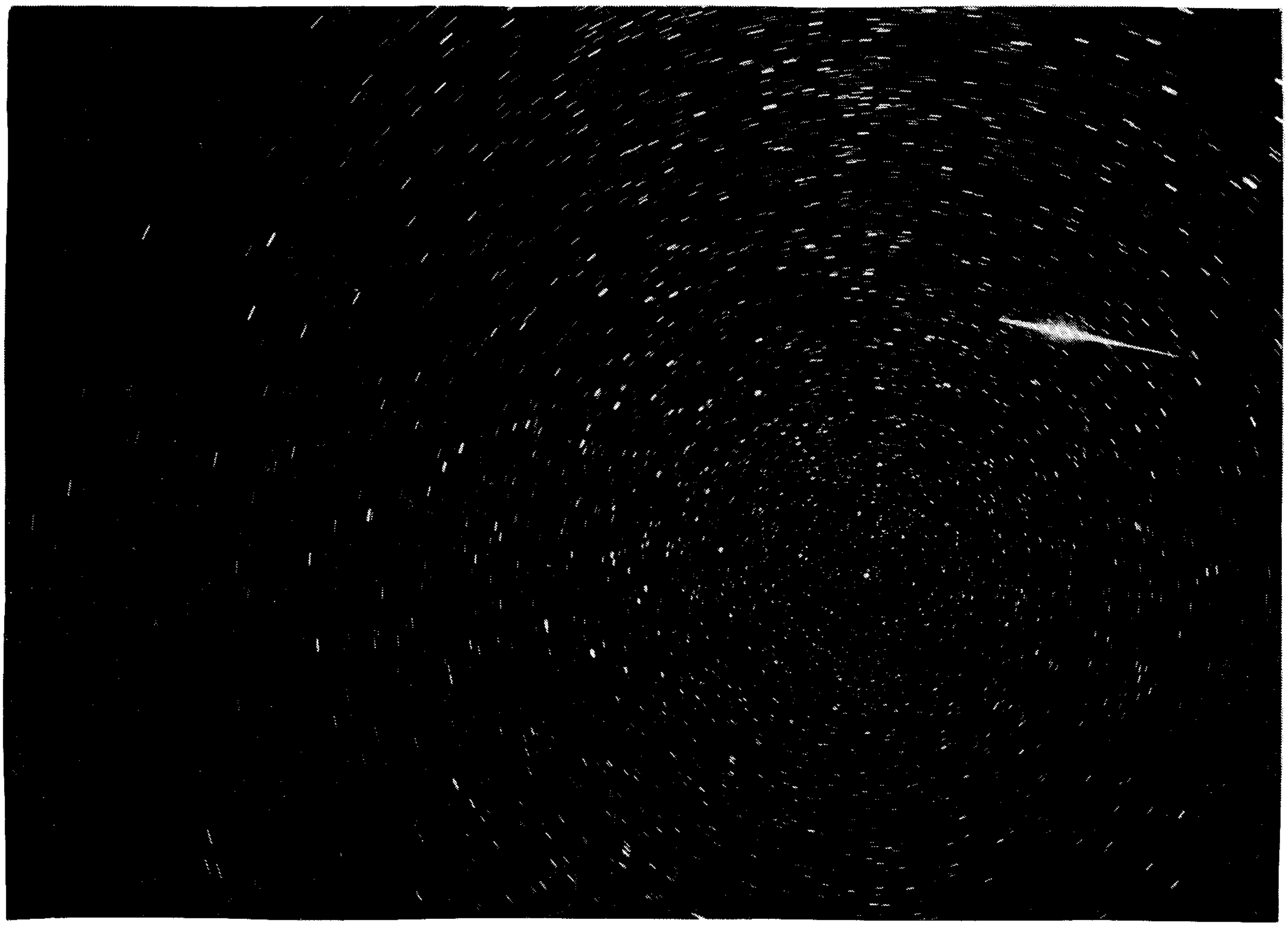

This spectacular $-5/-6$ fireball was photographed by Josep Trigo from Peñamoya Peak (1940 m), Teruel, Spain, on August 11, 1993. The photograph was exposed from $23^h50^m45^s$ to $23^h56^m05^s$ UT. A Zenit camera with 24 mm $f/2.8$ Vivizar lens was used. The visual limiting magnitude was 6.3. More information on this fireball can be found in this issue.

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. 21, No. 5, October 1993, pp. 219–242

Contents

Useful Information

The December Issue *(WGN 21:6)*

The *December issue* is expected to be a thick issue and will be mailed during the last week of November or the first days of December. Contributions are due on *November 12* at the latest. They should be sent to *Marc Gyssens.*

WGN Subscription/IMO Membership 1993

The subscription rate for volume 22 (1994) of the *Bimonthly Journal* is 25 DEM for six issues which are anticipated to contain over 250 pages in total. A combined subscription with the *Report Series* and *Fidac News* costs 60 DEM. You can also become a Supporting Member by paying at least 15 DEM extra. More information is on pp. 220–221 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

Marc Gyssens

Once again, the October issue is sent out with some delay for which two successful events are to blame. As in the last two years, the extraordinary performance of the Perseids is partly responsible for the delay. The other cause is the International Meteor Conference *in Puimichel which took place during the period in which most of the October issue is usually edited.*

One of the principal reasons for having chosen Puimichel as the site of this year's IMC *was to have an informal, "amateur-friendly" atmosphere. While one of our principal goals is to foster amateur-professional cooperation, the 1992* IMC *in Smolenice contributing greatly to that aim, we are also very concerned that in striving towards more professionalism we do not loose contact with the vast majority of our amateur observers. The* IMC *in Puimichel was therefore tailored to their needs. In this respect (as well as in all others) the* IMC *was a great success. Many new contacts were made and existing ones reinforced. The 1993* IMC *will be organized in the same spirit in the Bulgarian town of Belogradchik. More on the past and the next* IMCs *can be found elsewhere in this issue; in this editorial, I want to elaborate more on the special efforts made by the* IMO *with regard to the 1993 Perseid maximum.*

Last year, as well as in 1991, the role of the IMO *in the observation of the Perseid maximum was, apart from providing the usual information, collecting the data, and compiling an analysis when all data were received, restricted to pointing out to the observers the possibility of an outburst and encouraging them to be alert. As a consequence, we could provide observers in the respective October issues of* WGN *only with a very general picture of the stream's performance based on a limited number of observations. By the time that report appeared many observers had already distributed their observations throughout the world, often via electronic mail. The absence of a global perspective on the shower caused confusion among professional meteor astronomers on several occasions as isolated local observations—not corrected for, e.g., perception—were taken out of a global context and interpreted improperly. With the possibility of a storm in 1993, we decided to set up a fast-communication network for this year's Perseid maximum with central nodes in Puimichel, France and Hove in Belgium. This working method proved to be very efficient and rewarding. Several international press agencies were kept up to date almost in real time! As early as* 9^h *UT on August 12, a first release on the Perseid activity around the time of maximum was sent out via electronic mail to Brian Marsden, Daniel Green, and several professional and amateur meteor workers. Now that the euphoria around the Perseids has subsided, we can evaluate our achievements in a more sober light away from the intense media attention focused on the 1993 Perseid return.*

An important and very concrete result of our new working strategy is that a large and important institution such as NASA became aware of the IMO's work. Interesting contacts have been made with several people in NASA and a tentative relationship established which hopefully will become a basis for fruitful collaboration.

We were less successful in getting through to the general public. Although a lot of press releases were sent out and several of our members took personal initiatives using our texts, the IMO *was rarely quoted in the news media. Also, the press was not very receptive to the cautious tone of the* IMO *press releases. While we emphasized that all scenarios were possible, news media in many countries announced a Perseid storm as an event that was surely going to happen. As a consequence, many people were very disappointed by what they saw, whereas with good reporting they should have become excited without the need to resort to sensationalism. For next year, when activity may still be comparable to or even higher than this year, we probably need to make an extra effort here. Even though our main responsibilities are not towards the general public, we do have an obligation, I think, to provide the public with reliable information on meteor-related phenomena. In addition, a good press campaign may lead to greater visibility of our Organization and, in the long run, to new enthusiastic observers!*

Beyond any doubt, our Perseid information network was most successful vis-à-vis the professional and amateur meteor community. We were the first to circulate a comprehensive report on the Perseid activity around the maximum! In order to ensure that not only the meteor workers connected to electronic mail would receive this first information fast, we included a summary of the IMO *releases with the August issue of* WGN*—we hope this was appreciated. We also urged observers to send us their full data as soon as possible. This call has been followed very well as a consequence of which we are able to present you in this issue a reliable, quantitative analysis based on hard, global data instead of just a vague, qualitative analysis based on scarce information, something I would still have dismissed as unrealistic only one year ago!*

Having an analysis of the Perseid maximum available so soon after the shower also allows an assessment to be made of the reliability of the releases sent out immediately after the maximum. As you can judge for yourself, the profile we sketched up to August 11 around 4^h *UT agrees very well with the analysis. There are more discrepancies however for the later part of the activity. The reason for that is twofold. First, some American observers became so enthusiastic about the Perseids' performance that in their initial reporting they overestimated the shower's activity. Second, we still have way too few observers in the New World! Since the 1994 Perseid maximum will be ideally placed for American observers, we count on them to prepare for next year's event to the best of their abilities and to observe the shower massively so that the* IMO *will even outdo this year's accomplishments!*

Meanwhile, enjoy this issue!

New: A Combined Subscription to the Three IMO Periodicals!

Marc Gyssens

Now that it is time for the annual renewal of your subscription to *WGN*, it is also good to remind you that presently the *Bimonthly Journal* is but one of the three periodicals currently published by the *IMO*. Due to the ever increasing amount of data and articles that have to published, new publications had to be created to provide some "relief" to our journal. This first led to the creation of the *Report Series* in 1989. This series is aimed at publishing raw observational data in order to increase awareness of their existence and to ensure their preservation in the future. The introduction of the *Observational Report Series* made it possible to publish much less raw observational data in the journal thus making place for the growing number of articles submitted to the *WGN Bimonthly Journal*. More recently, we were witness to a large increase in fireball data to the extent that their integral publication became a problem for both the *Bimonthly Journal* and the *Report Series*. This evolution gave rise to the creation of *FIDAC News* earlier this year. *FIDAC News* takes the pressure off both the *Report Series*, in which fireball sightings are no longer published, and the *Bimonthly Journal*, in which only the most spectacular fireball events are still included.

Unfortunately, we have the feeling that the information contained in the two other *IMO* periodicals does not reach the meteor community as easily as this journal. One of the reasons is perhaps their more specialized nature, but the most important one is undoubtedly the difficulties involved in ordering these additional publications separately. International payments are often a hassle and especially with small amounts to pay you loose a lot in the currency exchange.

Therefore, we decided to offer you a combined subscription to the the three periodical series of *WGN*: the *Bimonthly Journal*, the *Observational Report Series*, and *FIDAC News*. For 60 DEM (surface mail) or 80 DEM (airmail) you will get 6 issues of the *Bimonthly Journal* totaling more than 250 pages, 2 issues of the *Report Series* (the visual data of 1993 and a catalogue of electrophonic fireballs) and 6 issues of *FIDAC News*.

I strongly encourage all readers of this journal to make use of this offer. You can make sure you will get all the meteor information the *IMO* has to offer, but avoid the hassle of ordering several times and gain a lot by having to make only one international money transfer. More information on how exactly to renew follows below.

New: Supporting Membership

Marc Gyssens and Ina Rendtel

As a matter of principle, we run this journal and both other periodical series on a tight budget. To keep these publications affordable for our many excellent observers in Eastern Europe we indeed have to keep the price low. For that reason, the *IMO* Council has decided once again *not* to raise the basic membership/subscription fee.

On the other hand, the journal and the related publications keep expanding. 1993 will see a record number of pages for a volume of the *WGN* journal. Also, mailing costs tend to increase, slowly but steadily.

For all these reasons, we have always invited the subscribers that can afford it to pay a little extra. This year, of course, we renew that request, but at the same time make it more concrete.

We invite you to become a *Supporting Member*. To achieve this you have to pay 15 DEM (or 10 USD) extra. We also ask that at the same time you send directly to Marc Gyssens (address on inside of back cover) a photograph and some short text of about 10 printed lines describing yourself and your interests in meteor astronomy. These will then be published in *WGN* in acknowledgment of your support. At the same time, you contribute in this way to give your fellow subscribers a more visual image of the readership of this journal!

So please consider becoming a Supporting Member if you can; the little extra you pay will be well-spent!

1994 Membership and Subscription Renewal

Ina Rendtel and Marc Gyssens

At the *IMC* in Puimichel, the *IMO* Council has decided to keep the annual **membership/subscription dues** at **25 DEM**. People outside Europe wishing **airmail delivery** pay **40 DEM**. In addition, the Council has decided to offer a **combined subscription** to the three periodical series of *WGN* (the *Bimonthly Journal*, the *Observational Report Series*, and *FIDAC News*) for just **60 DEM**. People outside Europe wishing **airmail delivery** pay **80 DEM** for this combined subscription. **Supporting Members** pay **15 DEM extra**.

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!** 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 in **cash**. 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). Personal checks drawn on any US bank are also acceptable. In this case the membership/subscription dues (this journal only) are 20 USD (without airmail delivery) or 30 USD (including overseas airmail delivery for destinations outside Europe). The combined subscription then costs 45 USD (without airmail delivery) or 60 USD (including overseas airmail delivery for destinations outside Europe). Supporting Members pay 10 USD extra. Please, **do not send checks to Ina Rendtel!**

To conclude, a few more words regarding your payment. First, indicate in the message accompanying your payment exactly what you order. If you pay for a combined subscription and/or supporting membership, or if you order publications as well, mention so explicitly. And secondly and perhaps most important, please **renew early**! By renewing early you help us to determine accurately how many copies we need to print of volume 22 of *WGN*! As well, we then do not need to send you back issues afterwards, which is a time-consuming business. Thank you for your understanding and your cooperation!

Letters to WGN

compiled by Marc Gyssens

Sporadic-E, noctilucent clouds, aurorae, and meteors

The following is a comment by Mr. Neil Bone to the extensive study by Alastair McBeath on the possible relationships between Sporadic-E, noctilucent clouds, aurorae, and meteor activity in the August issue (WGN 21:4, pp. 182–199).

I read with interest Alastair McBeath's speculative article [1] regarding the possible inter-relations between noctilucent clouds (NLC), aurorae, Sporadic-E, and meteor activity. One or two of McBeath's points could benefit from expansion and modification.

As stated, NLC are a summer phenomenon of high temperate latitudes. They are visible when the Sun is between 6° and 16° (*not* 12°) below the horizon—visibility curves are presented in my review [2]. For example, I recorded an excellent display, both visually and photographically, from Chichester as late as 22^h45^m UT on June 28-29, 1993, at which time the Sun lay 14° below the horizon.

The precise nature of the condensation nuclei around which NLC form remains a mystery, despite flights by sounding rockets into cloud fields over Scandinavia [3] which implicated meteoric debris. Equally, fine volcanic dust, carried aloft following violent events such as the Mt. Pinatubo eruption, or, as suggested by McBeath, "atmospheric" and/or meteoric ions present close to the mesopause may provide nuclei. On this basis, it is not possible to imply a purely meteoric origin for NLC nuclei.

An aspect which McBeath neglected to discuss is the origin of traces of water vapor which condense to produce NLC. Current theories propose that this is brought up into the high polar atmosphere from lower levels by springtime upwelling in the stratosphere. There are suggestions that the frequency of brightness of NLC has increased over the past several decades as the result of man-made pollution leading to larger quantities of water vapor leaking into the high atmosphere [4].

In the light of numerous recent observations of the two phenomena occurring together, McBeath is correct in stating that the formerly-assumed anti-correlation between aurorae and NLC is now less firmly accepted. It has always been difficult to account for heat transmission from auroral (100 km) to mesopause (80–85 km) altitudes in near-vacuum. Nonetheless, there is no disputing the relative dearth of NLC around sunspot maximum. I suspect that this may be explained by heating of the high atmosphere by X-ray and UV irradiation following solar flare activity. Wentzel [5] quotes a frequency of up to 25 flares per day at solar maximum. Such events need not necessarily be aligned close to the Sun's central meridian as viewed from the Earth to have an effect on the atmosphere: consequently, it would also be difficult to reconcile frequencies with the inverse of geomagnetic activity.

McBeath says little about the various movements of the high atmosphere. Circulation at the mesopause is such that temperatures there reach a minimum during the summer months [6]. Could it, perhaps, be more plausible to propose that NLC are most frequently seen from NW Europe in late June/early July [7] because this is the time at which the mesopause temperature is closest to the optimum for NLC condensation?

Atmospheric circulation makes it difficult to believe that skewing Sporadic-E frequencies forward by 14–16 days gives a credible correlation. Surely, the limited fields or clouds of ions would long since have dispersed or moved on from the observer's location in the interim?

It is interesting to speculate on the interactions between meteors and NLC, but it seems to me that these beautiful clouds retain most of their mystery in the face of McBeath's study.

[1] McBeath A., "The occurrence of Sporadic-E and Noctilucent Clouds, and Correlations with Meteors and Auroral Activities, May to August 1977–1991", *WGN* 21:4, August 1993, pp. 182–199.

[2] Bone N., "What are Noctilucent Clouds?", in *1993 Yearbook of Astronomy*, P. Moore (ed.), Sidgwick and Jackson, 1992, pp. 223–234.

[3] Soberman R.K., "Noctilucent Clouds", *Scientific American* 208:5, 1963, pp. 84–96.

[4] Thomas G.E. et al., "Relation between increasing methane and the presence of ice clouds at the mesopause", *Nature* 338, 1989, pp. 490–492.

[5] Wentzel D.T., "The restless Sun", Smithsonian University Press, 1989.

[6] Gadsden M., Schröder W., "Noctilucent Clouds", Springer-Verlag, 1989.

[7] Livesey R.J., "BAA Aurora Section Newsletter", August 1993.

Neil Bone, August 24, 1993

Regarding the article under discussion, the author sent us the following erratum:

Unfortunately, I spotted one error due to a late re-numbering of the references. The references given in the captions and column headings for Tables 1, 2, and 3 should have one added to them (i.e., they should be for references 26, 27, and 28, not 25, 26, and 27). My apologies for any inconvenience caused.

Alastair McBeath, August 23, 1993

Electrophonic fireballs

The letter by Graham Wolf in the August issue (WGN 21:4, pp. 143–145) *triggered the following reaction by Dr. Richard Taibi in which he also describes an electrophonic fireball event. Dr. Taibi was especially struck by the similarity in atmospheric conditions between the event he describes and the events mentioned by Graham Wolf.*

Dr. Charles Titus stood with a friend at the north end of Crested Butte, Colorado hoping to see Perseid meteors on August 12, 1993. After watching the swift meteors a while he noticed a slow-moving meteor falling from high in the sky towards the north northwest horizon. It became very bright and fragmented a few times.

He turned to his friends and said "I heard that one." His friend agreed about hearing a sound too. The fireball's sound was like that made by a "fountain" type firework display. The sound was louder than that made by an air conditioning ventilator system. Dr. Titus said there was a "roaring quality" at times too. The sound was simultaneous with the fireball's visibility.

Dr. Titus was watching meteors from about 4^h30^m to 5^h00^m UT on August 12, late evening in Colorado. His side was at longitude $106°59'16''$ W and latitude $38°52'21''$ N and an elevation of 2707 meters. He recalled that the temperature was about $+12°$ C to $+14°$ C. It is interesting to note that the variables of temperature and humidity at the doctor's site are identical to those cited by Graham Wolf as those presented in other electrophonic fireball observations: cool and dry. Also consistent with Wolf's specifications is the slow speed of Dr. Titus' fireball. He estimated that it traveled 45° in three seconds.

I was able to use the commercially available DOS software "EZ Cosmos" (Future Trends Software, Inc., 1601 Osprey Dr., Suite 102, DeSoto, Texas 75115, USA) to reproduce the sky scene above Crested Butte. It is possible that the fireball was a κ-Cygnid since that shower radiant would have been located in about the correct place to account for the height and direction of the fireball. The κ-Cygnids are also noted for their slow fireballs.

Dr. Titus' observation raises some questions about whether other observers saw bright κ-Cygnids and whether any of them, or other fireballs, were electrophonic too. Is there any rationale yet understood for the propagation of sound by these meteors?

Richard J. Taibi, September 20, 1993

Meteors with a curved trajectory

Also in the August issue, Graham Wolf describes a sighting of a meteor with a curved trajectory (WGN 21:4, pp. 209–211). *We received two reactions to this observation.*

Graham Wolf's curved trajectory raises some interesting points. On checking his Figure 1, however, I find that the path can be plotted as a perfectly straight line between the stars on a gnomonic chart. I am not sure whether the Figure is meant as an accurate representation or not, in this respect. If it is simply a sketch showing the apparent path with regard to the horizon, I did wonder if the possibility it might have been a flare or signal rocket had been investigated, since it is not mentioned in the text. I have had a couple of reports like this over the years, and in all cases, the objects have turned out not to be meteors.

Alastair McBeath, August 23, 1993

I am interested in the report by Graham Wolf of a remarkably curved meteor trail. I should like to express my scepticism and my reason for it.

In order to explain this, I need to digress to a discussion of geometry. Ordinary meteors travel through the ionosphere in paths that are, for all intents and purposes, straight. We see their paths projected against the celestial sphere. Of course, there is no object corresponding to the celestial sphere, but the concept of a celestial sphere corresponds to the appearance of the geometry of an observer's sky. As such, any observer is located at the center of his celestial sphere. Ordinary meteors can be thought of as straight line segments within the celestial sphere that do not intersect the center of the sphere. Now, a plane (i.e., an infinite two-dimensional surface) is defined by a line and a point that is not included in the line. If one imagines such a plane defined by a meteor's path (a line) and the observer (a point), one can see that the plane will bisect the celestial sphere, intersecting it along a great circle. This is true for all straight meteor paths. *Any meteor path for which there is a question concerning its straightness will be shown to be straight if the path can be shown to correspond to a great circle.*

In two different ways which I shall describe, I have shown that Mr. Wolf's meteor followed a great circle. Let me say that I do not in any way wish to criticize Mr. Wolf's observing skills, and I do not wish to say that his description of the meteor is erroneous. On the contrary, his description is excellent and it shows his high level of skill as an observer. It is the excellent quality of his description of the meteor's path that allows me to demonstrate that it traveled along a great circle.

The easiest way to demonstrate this is to plot its path along a map of the south circumpolar stars. Such a map can be found in *Norton's Star Atlas*, for example. Most such maps will not include objects located more than 40° from the pole, and it is therefore helpful to plot the location of ω Centauri on the page past the edge of the map. This object is at about $\alpha = 13^{h}24^{m}$ and $\delta = -47°$ and will be easy to plot. The other reference points mentioned by Mr. Wolf will probably already be on the map. Take care to plot the meteor's path as drawn by Mr. Wolf. You will see that the path is almost, but not exactly, straight, and passes within a couple degrees of the south celestial pole. Now, the geometry of the map is such that a great circle passing through the pole will be straight, while a great circle far from the pole—e.g., the celestial equator, were the map edges extended sufficiently to include it—will be markedly curved. Great circles plotted between the pole and the celestial equator—e.g., the galactic equator and the ecliptic—will have an intermediate amount of curvature on this map. So, great circles that are nearly, but not perfectly, straight on this map, must pass near the celestial pole. Conversely, a nearly straight line passing near the celestial pole on this map, curved concave to the pole, looks like a segment of a great circle, as does the meteor path in this case. It appears to me that any deviation from a great circle of the path drawn by Mr. Wolf is probably within the range of error of the drawing.

The second way I have shown this is with a popular computer program (*Dance of the Planets*, version 2.5s, ARC Science Simulations Software, Loveland, Colorado, USA, 1993). No program that I know will perform a "nearest fit to great circle" function, but any program that shows stars and horizon at any time from any location on the planet can be used to show this great circle. It is necessary to show the horizon, because the horizon is a great circle and it can, by trial and error in adjusting the observer's location and the date and time, be made to overlie the path of Mr. Wolf's meteor. This confirms that the meteor followed a great circle. For those readers who have *Dance of the Planets*, this can be achieved by first setting the program menu to `Earthview` and turning on `Constelines`, and then choosing `More options` from the menu, and then selecting `Site Coords`. Enter 2° N latitude and 0° longitude as your site coordinates. Then leave the menu, and set `Zoom` to `skymap`, `Pace` to `true`, and `Date` to `February 15.93, 1993`. Finally, select `Find` and enter the letters `hor`. You will then see that the broad stretch of horizon, from southwest to southeast, corresponds very well to the path of the meteor as drawn in Mr. Wolf's article (you will also see the limitations of plotting such a broad sky map on a flat surface: at these settings, ω Centauri rises before Spica, which can never happen at 2° N latitude. So there are minor inaccuracies in the path of the great circle as plotted this way, but the overall fit is very good). Keep in mind that this use of the computer program is not meant to duplicate the observing circumstances of Mr. Wolf, but is simply meant to find a horizon (great circle) to overlie the path of the meteor.

Great circles on the celestial sphere are often thought to be curved. We at temperate latitudes think of the curve of the celestial equator as it arches obliquely up from the horizon and curves across the sky. And the galactic equator, defined by the great glowing curve of the Milky Way, does not seem to be straight, to say nothing of the ecliptic, which is almost always represented on star maps as a curve. But on some clear night, hold a meter-stick up to any of these great circles and you will find that they are straight! Hold the meter-stick close to your eye, so that its ends project neatly from horizon to horizon, and you will confirm this. They are all projections of straight lines onto the celestial sphere. To understand what Mr. Wolf observed, think of an observer at a north temperate latitude looking south. He will perceive the celestial equator as an arc which ascends the sky on his right, curves high across the sky in front of him, and descends on his left. This is the motion Mr. Wolf observed in his curved meteor (though he was looking in another direction), and this is how he drew it. The impression of curvature is illusory and, I suspect, comes from being accustomed to perceiving our environment in Cartesian coordinates rather than in polar coordinates.

A few years ago I had the splendid pleasure of witnessing a display of crepuscular rays at sunset, with the rays fanning out from the clouds near the western horizon, spreading all the way across the sky, and converging together in the distant eastern haze. These rays, being straight lines from the Sun, appeared to arch across the sky as though they were curved, and the illusion was intense. In this year's Perseid meteor outburst, my family and I witnessed over 20 meteors during the time when the radiant was only 6° to 13° above the horizon. About five of these were very bright and long-lasting, appearing in the NNE and arching far to the SSW, some to my right, some to my left, and some overhead. I was not able to convince my family and friends, with whom I was observing, that these meteors moved in straight lines. The perception of great circles as curved is sometimes very difficult to overcome, especially when the radiant point is near the horizon.

Roger J. Venable, September 6, 1993

Editor's comment: *The really easiest way to verify the straightness of a meteor is of course to plot it on a gnomonic map, but then, many northern hemisphere observers may not have gnomonic maps of the region around the southern celestial pole at their disposal. Although most sightings are indeed optical illusions, curved meteors do exist, but are rare. They may be caused by explosions, bouncing on denser atmosphere layers, or the rotation of the meteoroid.*

Radio reflection duration and visual magnitude

The discussion conducted in previous issues of this volume on the relationship between radio reflection duration and visual magnitude was initially triggered by a letter by George Zay in last year's December issue (WGN 20:6, p. 210). *Below is another comment by Mr. Zay, in which he elaborates on his previous contribution to this discussion* (WGN 21:2, p. 57).

Stating that correlating radio durations and visual magnitudes is a "useless task" [1], was probably a poor choice of words on my part, and I apologize for that. Very good work is being done in the radio meteor arena. I am just trying to do my part in assuring that the data that is gathered is converted into the most accurate information possible. I am sure I was expressing some frustration in my attempts to get "ball park" results similar to others that I read about. I have no doubt that when a long radio noise is heard, it was a relatively big meteor that made it. What is troubling me, is that it appears that quite a few large meteors are making relatively short radio signals, and are thusly classified in a lesser category. For example, the −9 visual magnitude fireball that I saw in May 1992 made just a 3 second radio signal. If I had not seen this meteor visually, the radio signal would have been probably labeled as a −3 fireball at best. Again, the −15 fireball that I saw in December 1992 [2], that made only an 18 second radio signal, would most likely be classified somewhere in the −5 category if it were not seen visually. These two fireballs are well up in the upper magnitude ranges to create much longer radio signals based on the data Mr. Kristensen provided in June's *WGN* Journal [3]. Granted, fireballs are not frequent creatures in the skies. One mismatched radio/visual fireball, I consider an anomaly... but on the other hand, two makes me perk up my ears and take note. As I look over Mr. Kristensen's radio duration/visual magnitude chart, I find myself thinking that comparing his data with my data is like comparing "apples with oranges." To be useful over the long haul, my data should be somewhat similar to his,... but apparently they are not. From about +2 magnitude meteors and dimmer, I would say we are similar. But getting into the bigger stuff, things look different. What comes to my mind is that there is something fundamentally different in our data gathering efforts. At present, I can only think of three things: *(i)* the frequency I use (92.9 and 93.7 MHz), *(ii)* our locations (my longitude and latitude are 116° W and 32° N), and *(iii)* the meteor trajectory versus antenna alignment. Does an answer for more useful correlations lie buried within these three facts? Possibly.

Of the people who do radio work, I have not noticed anyone showing their results who monitor the FM band. I have nobody that I can compare with, other than to those who use frequencies longer than what I use. Perhaps my radio signal durations on the FM band should be equated somehow to other frequencies below the FM band? For example, maybe a 20 second radio signal on the FM band might be equal to a 60 second (or some other number) radio signal on, let us say, 66 MHz? If there turns out to be a genuine difference in signal durations on account of frequencies used, then the magnitude/radio duration formula presently in use is not compatible with my data. The current formula may be perfectly fine or just need some minor modifications for data that came from the lower frequencies used by Mr. Kristensen and others who use the lower frequencies. But to use on my data or the FM frequencies a major overhaul may be in store. To use them, so that they can be compared, you will have to find their equivalency. Whether or not the FM band responds differently over the radio is mostly speculative on my part at present.

I talked about different radio frequencies as a possibility for differences in radio data, and now for my speculation into different locations. Two aspects come to mind with regard to locations.

First is upper level winds. What kind of prevalent upper level winds exist at different locations? The question is the following: are the winds prevalently different, at different locations? Do they follow latitudinal patterns, with alternating wind and windless patterns? Do they vary erratically or are they homogeneous? The dispute about magnitude/radio durations revolves around the larger meteors mainly. These larger meteors would be the ones that will most likely reach the lower atmospheric levels, where their ionized radio reflecting planes can be distorted. It only stands to reason, if one area always has strong upper level winds and other areas little or no winds, different results may be obtained.

Second is different latitudes. I say this with the Earth's curvature in mind. Comparing any given meteor stream from a high latitude to a lower latitude, I believe their entry angles to be not the same due to the earth's curvature. Would it be possible that the ionized trails of different entry angled meteors be shifted by the winds perhaps in differing directions thus affecting radio durations?

In summary, it appears to me that radio fireballs are being undercounted by a significant percentage and that the very bright ones are being underclassified to lesser magnitudes. As I pointed out, the formula used by Mr. Kristensen and others below the FM band or at their locations may be accurate enough for their data, but I highly suspect a failure in using the same formula for at least me, at the frequencies I use, or my location. I know this gives the conceited appearance that I am at the "Center of the Universe", and that every one should "march to my drum," but I really feel that something is not earthly universal here and perhaps by bringing it out into the open, things will gradually find their place.

[1] G.J. Zay, "Letters to WGN", *WGN* 21:2, April 1993, p. 57.

[2] G.J. Zay, "Fireball over San Diego County", *WGN* 21:1, February 1993, p. 47.

[3] G.M. Kristensen, "Letters to WGN", *WGN* 21:3, June 1993, p. 79.

George J. Zay, July 28, 1993

Editor's comment: *I want to re-emphasize that the formula quoted and used up to quite recently is unreliable, cfr. the letter by Paul Roggemans in the February issue* (WGN 21:1, pp. 4–5). *Establishing the precise relationship between visual magnitude distribution and radio echo duration obviously requires much more study and must involve many other parameters as well.*

Meteors and mushrooms

When Martin Beech started the series on the history of meteor astronomy, he insisted that other meteor workers would complete the picture with their own comments, sources, and knowledge. I therefore think that Dr. Beech will be quite happy to read the following comment by Alastair McBeath on his contribution in the August issue (WGN 21:4, pp. 200–202).

I was most interested to read Martin Beech's latest part of "The Makings of Meteor Astronomy," especially his references to mushrooms/fungi being thought to be the result of meteor impacts. The brilliant yellow-orange *Tremella mesenterica* he mentions does look like something thrown onto rotting trees very often, and is commonly found throughout the year. Fairy rings too look like impact events (e.g., like ripples on a pond), and there are a number of varieties of fungi that grow in this fashion. The commonest of these is the Fairy Ring Champignon *(Marasmius oreades)*, which occurs in Europe's fall, and another two common mushroom types found as rings very often also fruit in the fall, the Field Mushroom *(Agaricus campestris)* and the Horse Mushroom *(Agaricus arvensis)*. It is interesting to reflect that northern hemisphere meteor activity is, and has been, highest in the late summer and throughout the fall and early winter for some centuries at least (with notable showers such as the Perseids, Leonids, and, more recently, Andromedids in particular, as well as the year's best sporadic rates), so perhaps it was not so unusual that a link should be drawn between the two phenomena. I would also be interested to learn if the *Geastrum*, or Earth Stars, have any folkloric associations with meteors, since they resemble stars lying on the ground, or arching away from it (e.g., *G. rufescens*, *G. fornicatum*, or *G. striatum*, the latter two looking rather like earthbound comets). Again, these type of fungi are autumnal.

Alastair McBeath, August 23, 1993

The 1993 International Meteor Conference

Puimichel, France, September 23–26, 1993

Cis Verbeeck

This year's IMC was organized in Puimichel, France, amidst the beautiful surroundings of the French Provence. The participants lodged at the Puimichel Observatory and in hotels in nearby villages. The lectures and poster presentations took place in a romanesque chapel on the highest point of Puimichel. Some people took the opportunity to arrive a few days before the *IMC* and strengthen contacts with other people who were also present. This led to some very interesting discussions and future plans. In total, nearly 60 people attended the *International Meteor Conference*, representing 18 countries. Especially the Hungarians, Germans and Belgians, and groups of the former Yugoslavia were well represented. Some professionals attended the *IMC* too: Dr. Oleg Belkovich, Dr. Alexandra Terentjeva, Dr. Subhon Ibadov and David Asher.

The Conference was opened by Paul Roggemans on Thursday evening. All attendants presented themselves and their chief interests. The following morning, Jürgen Rendtel showed preliminary visual results on the 1993 Perseids. Activity was comparable to 1992, but the very low population index was striking in 1993. Further analysis, however, will be required to allow more detailed interpretations. After Jürgen's lecture, an electricity breakdown occurred. After about one hour, the electricity was available again, and the program continued with shorter breaks. André Knöfel presented the possible fireball radiants he found with the help of the program RADIANT on the basis of fireball observations.

Dr. Belkovich gave an interesting treatise on a model for the variation of the mass index of a stream in various parts of the stream and Korado Korlevic gave more information about the bolide explosion over North Italy, using, among other things, sticky traps for gathering meteorite material. Dr. Terentjeva continued with an intriguing lecture about meteor streams intersecting Mars' orbit. In the afternoon, Sirko Molau presented his video meteor observation equipment. He analyzes his video observations with self-made software on a computer. The video images of several tens of Perseids observed this summer were fascinating, and his workshop about video observations on Friday evening enjoyed much interest. Rainer Arlt showed the resulting radiants of visual meteor plottings, determined with the program RADIANT. Then it was Paul Roggemans's turn to present Perseid results, only he covered the whole period 1980–1993. He was only able to show some preliminary results, as he had some problems with the software for analyzing the data. He plans to investigate population index, ZHR and space number density of the Perseids from 1980 to 1994, with as much data as he can get. He proposes to analyze some pairs of consecutive years together, as too few global data are present to cover all of them individually.

Another lecture on radiant structure was that of György Szolcsany. He introduced a mathematical method to determine radiants, but this method seems to be likely to generate subradiants, whether they are real or not. Dr. Ibadov changed the usual viewpoint of a meteor observer, and told us how to regard meteors as space phenomena. Malcolm Currie presented the telescopic results of the 1993 Perseids, with a tentative population index derivation. The last lecture on Friday was given by Detlef Koschny. He discussed possible explanations for the observed clustering of meteors, results of discussions he had had with Roland Egger. These explanations included psychological ones (we do not know whether the commonly observed clustering phenomenon is real or due to the enhanced concentration of an observer after he has seen a meteor), and he stressed that severe statistical methods have to be applied to conduct further investigations.

After dinner on Friday evening, the 5th General Assembly of the *IMO* took place. First, some decisions of the Council were communicated. An important decision was not to increase the price of *WGN*. Further, the Council had decided to dismiss Jeroen Van Wassenhove as Director of the Radio Commission. Of most direct interest to the participants was the decision to have the following *IMC* in Belogradchik, Bulgaria. Also, reports were given on the financial situation of the *IMO* and on the accomplishments since last General Assembly. Voting Members will find an extended report with a voting bulletin in the December issue of *WGN*. Finally, the results of the Council election were presented. All candidates were elected.

The first part of Saturday morning was fully devoted to radio work. Werner Depoorter and Tom Roelandts opened the session with a presentation of the RAMSES automated forward scatter system in Urania, the Public Observatory of Antwerp, Belgium. Jean-Marc Wislez gave a clear picture of the radio meteor profiles predicted by meteor physics and observed by the RAMSES system. Cis Verbeeck explained how the height of an underdense meteor can be derived from forward scatter meteor profiles and which factors have to be taken into account. He also presented some meteor height results obtained with the RAMSES system. Finally Korado Korlevic introduced his VLF radio setup already briefly discussed in *WGN*. Next, Malcolm Currie presented José Trigo's lecture on space number densities from photographic projects. Valentin Grigore told us about the first Meteor Camp in Romania.

The afternoon was devoted to an excursion. André Gabriël guided us through the beautiful Gorges du Verdon, "the Grand Canyon of Europe." Before we returned to Puimichel, there was still some time left to wander around in the charming town of Moustiers-Ste.-Marie, close to the entrance of the Gorges. When we returned, we were treated to an excellent dinner.

Sunday morning, Jürgen Rendtel presented Ralf Koschack's lecture on annual and diurnal variation of the sporadic activity. The northern and southern hemisphere observations were treated separately, and some possible shower candidates were found. Daniel Očenáš presented the 1993 observations in Slovakia. Casper ter Kuile gave a short lecture in which he claimed to have observed the predicted meteoroid glow during the maximum of the 1993 Perseids. Jacob Kuiper has also observed this phenomenon, as well as Pierre Vingerhoets, who doubts, however, that it was the predicted Perseid glow. David Asher presented a theory explaining the alternation of many and few Taurid fireballs in different years by assuming that the orbit of a certain Taurid component is in resonance with Jupiter. His data support the theory, but more data are needed to confirm this. The last lecture was given by Korado Korlevic. He informed us about natural and artificial sticky traps for airborne dust. Finally, Jürgen Rendtel presided the evaluation and closing of the Conference.

The lectures were very interesting and varied, and lots of informal contacts were made. This *IMC* will certainly inspire many attendants in their future work. The general atmosphere was relaxed and congenial and gave rise to contacts which will remain long after this *IMC*. Also, the nice surroundings and the excellent food made sure that everyone will have enjoyed this conference. Paul Roggemans and the local organizer, the *Association Newton 406* that runs the Puimichel Observatory, in particular its manager Arlette Steenmans, are to be heartily congratulated for this large success in all aspects.

The 1994 International Meteor Conference

Belogradchik, Bulgaria, September 22–25, 1994

Marc Gyssens

At the meeting of the *IMO* Council at the 1993 *IMC* in Puimichel, the Council Members had to choose between two proposals for the next *IMC*: one possibility was to organize the *IMC* in conjunction with the *Meteoroids* Conference to be held in memory of Dr. Ján Štohl in Bratislava, Slovakia, from August 28 to 30, 1994, and the other to have the *IMC* in Bulgaria, either in Varna or in the town of Belogradchik. Although the 1992 *IMC* in Smolenice contributed greatly to improved contacts between professional and amateur meteor workers, the Council fears that such meetings might scare away many good observers who do not have deep scientific training. Although the Council encourages amateur meteor workers to also participate in the Bratislava meeting (more information on which you find elsewhere in this issue), the Council preferred the 1994 *IMC* to have the same atmosphere as the 1993 *IMC* in Puimichel. For these reasons, it was decided to have the next *IMC* in Bulgaria, and more particularly in Belogradchik, most likely from September 22 to 25.

Local organizers will be the members of the Astroclub "Canopus," based in Varna. The town of Belogradchik is situated in the northwest corner of Bulgaria, in the western part of the Balkan Mountains. It is the site of one of two observatories of the Bulgarian Academy of Sciences which is located at an elevation of 630 meter. Belogradchik is less than 200 km driving away from the capital city of Sofia. Apart from the observatory, major attractions of Belogradchik are strange geological rock formations and the old castle "Kaleto." The *IMC* will be held in the local tourist home, where participants will stay in rooms of 2–5 beds. Tentatively, the registration fee of the conference will be 170 DEM (with special arrangements being possible for participants from some East European countries).

The participants at the 1993 *IMC* in Puimichel where so enthusiastic that all to whom I had the opportunity of saying good-bye personally expressed their intent to come to Belogradchik as well. Therefore I hope that all those who missed the Puimichel event will not let go by this new opportunity to attend a fine meeting and will participate in the 1994 *IMC*! We hope to provide you with concrete, final information and a registration form in the next issue of *WGN*!

Visual Observers' Notes: November–December 1993

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 25	Nov 03	50°	+14°	10°/5°	Table 3		27	2.3	10
Taurids N	Sep 13–Nov 25	Nov 13	60°	+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 21	117°	−06°	5°	+1.°1	−0.°1	60	2.7	5
χ-Orionids	Nov 26–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 7		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 1993.

Date	k	Date	k
Friday October 29	0.98+	Friday December 3	0.86−
Friday November 5	0.73−	Friday December 10	0.15−
Friday November 12	0.05−	Friday December 17	0.15+
Friday November 19	0.30+	Friday December 24	0.77+
Friday November 26	0.90+	Friday December 31	0.95−

New Moon:	November 13, December 13, January 11
First Quarter:	October 22, November 21, December 20
Full Moon:	October 30, November 29, December 28
Last Quarter:	November 7, December 6, January 5

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 brightly 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 storm 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 4 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. They should be able to be seen in the early evening hours in dark skies. 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 1993. 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 activity reported to have occurred 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. Although strong arguments against the reality of this outburst have been given [3], it is perhaps not a bad idea to be alert as well on and around November 4, 23^h UT, to see what happens.

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 1993 is at 12^h UT on November 17. The Leonids are a periodic shower which peak every 33 years, the next peak time being 1998–99. Rates at minimum are about 5—15 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.

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 or so per hour observers are to refrain from plotting and use the classified counts technique.

The *International Leonid Watch (ILW)*, an *IMO* initiative coordinated by Peter Brown attempts to encourage the study of this shower in the years before and after the next expected storm. For more details, we refer to the *ILW Bulletins* published in *WGN* over the last three years. Following this article is a new bulletin of the *International Leonid Watch* with more information on this intriguing shower and how to observe it.

Table 4 – Radiant positions of the Leonids.

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

5. 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 1993. The *IMO* recommends that you observe both the Leonids and the November Monocerotids simultaneously whenever both radiants reach 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 α-Monocerotids.

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

6. χ-Orionids

This shower is active from November 26 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 1993. Observers should watch from December 4 to 15 with a center of field of view at about $\alpha = 90°$ and $\delta = +20°$. All possible χ-Orionids should be plotted.

Table 6 – Radiant positions of the χ-Orionids.

Date	α	δ	Date	α	δ
Dec 01	81°	+23°	Dec 10	91°	+23°
Dec 05	85°	+23°	Dec 15	97°	+23°

7. 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 partially affected by the moon in 1993. Even though viewing conditions are not too best, southern hemisphere observers are encouraged to check the night of the maximum to see if they will produce unusual behavior. The best times to view the shower are in the early evening hours.

8. 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 9 to 24 and December 7 to 22. 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 24, southern observers should choose a field center around $\alpha = 120°$–$150°$ and $\delta = -20°$ so that they can monitor the Leonids, November α-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 7 – 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°

9. 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.

10. σ-Hydrids

The σ-Hydrids radiate out from the head of Hydra during the period December 3–15. Maximum ZHR is 5 and this occurs on December 11. This shower can be monitored simultaneously with the Monocerotids, χ-Orionids and Geminids if a center of field of view of around $\alpha = 105°$ and $\delta = +15°$ is used. All possible σ-Hydrids seen should be plotted.

11. 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 November 29, conditions are very favorable for viewing the Geminids in 1993. 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 8 – Radiant positions of the Geminids.

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

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.

Table 9 – Radiant positions of the Coma Berenicids.

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

13. Ursids

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

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.

[3] P. Jenniskens et al., "No Meteor Outburst on November 5, 1991", *WGN* 21:1, February 1993, pp. 32–36.

Bulletin 3 of the International Leonid Watch

Peter Brown

1. Introduction

Now that three years have passed since the *IMO* formally started the *International Leonid Watch (ILW)* campaign, it is gratifying to see both an increase in interest in the professional and amateur communities in this important and poorly understood shower. The 1992 Leonid campaign during the 2nd *ILW* period was severely hampered by moonlight; as a result only some 360 Leonids were recorded and reported to the *IMO* worldwide by 28 observers. Nevertheless, fully 263 of these Leonids were also assigned magnitudes, a massive percentage increase over the 1st *ILW* period where, despite good lunar conditions, fewer than 1 in 4 Leonids had an associated magnitude estimated. Though the number of Leonids recorded in 1992 is insufficient for a serious analysis, each year brings more Leonid data into the cumulative index; as a result by next year there might be nearly 4000 Leonids recorded and reported to the *IMO* since 1987 making a new 7-year cumulative analysis possible. This along with the obvious increase in the number of Leonids reported with magnitudes, bodes well for the future of the *ILW*. As no data from 1992 can be analyzed, in this Bulletin we take an opportunity to outline some of the recent literature on the subject of the Leonids which has been published in the last year and summarize the outlook for the 3rd *ILW* period in 1993.

2. Recent work related to the Leonids

Though no Perseid storm occurred in 1993, an event which would have certainly laid the ground work for the final practical touches on the reductional techniques needed for data analysis during meteor storm conditions, several authors have addressed the issue of how to observe and report meaningfully during such high activity. The article by Koschack and Hawkes [1] is particularly valuable reading for the aspiring Leonid storm observer in addition to the original guidelines laid down in Bulletin 1 of the *ILW* [2]. Of the amateur groups actively observing the Leonids, the *Nippon Meteor Society (NMS)* of Japan, deserves special mention for their accelerated observing campaigns during the past few Leonid returns. Indeed, some early results of their work have already appeared. Koseki [3] reviewed the Leonid observations made by the *NMS* back to 1949, paying special attention to the returns since 1987. Lindblad et al. [4] analyzed the data in the *IAUMDC* orbital list and derived a mean orbit and radiant for the Leonids from 29 photographic Leonid orbits. Clearly, more photographic data is desperately needed during the current epoch if a wider understanding of the stream is to be obtained. A more detailed analysis of the last unusually active Leonid return in 1969 by Porubčan and Stohl [5] revealed a higher population index during that return than the "normal" returns.

On the theoretical front, several attempts have been made to model the stream computationally. Wu and Williams [6] followed the motion of about 50 test particles from 1699 to 1965 and found that most small particles end up outside and behind the comet. The model distribution of material at the descending node of the comet they derive suggests that the Leonid returns at the end of the 1990s will be strong. Brown and Jones [7] integrated 12000 particles ejected at each return of P/Tempel-Tuttle between 1699 and 1933 and followed their evolution into the early 22nd century. Most small particles were found to end up outside and behind the comet and the outlook for the returns in the late 1990s was found to be promising. An excellent review of meteor storm dynamics and history, including the Leonids, has been given by Kresák [8].

3. The third ILW period: November 5–25, 1993

In the ongoing effort to obtain as much Leonid data as possible, observers are urged to record Leonids during the entire time of the 3rd *ILW* period. When rates are below 10 per hour, all Leonids should be plotted. The Moon in 1993 will set well before the Leonid radiant rises, being some four days past new. The peak rates for the Leonids should occur in the early morning hours of November 17 for most locations; the nominal peak time is about 12^h UT on November 17, but equally high rates may be present for up to 6 hours on either side of this time. Of particular importance are observations carried out after the maximum, very little data is available from recent observations in this window.

If further motivation is required to send you outside on the cold winter nights when the Leonids are active this year, recall that in 1961, some 4 years before the return of P/Tempel-Tuttle, activity of order 10 times normal was recorded by visual observers. In 1993 we will experience similar geometry as P/Tempel-Tuttle is due back to perihelion early in 1998. Also remember that the Perseids showed their now famous double peak some 4 years before the comet returned so who knows what will happen this year. Perhaps 1993 will be best remembered for its Leonid return rather than that of the Perseids!

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Telescopic Observers' Notes: November–December 1993

Malcolm J. Currie

Again bad weather hit and greatly reduced the expected number of Perseid reports. Even observers in the Canary Islands were prevented from observing by cloud. Nevertheless one conclusion is clear: Perseid telescopic activity was its normal low self. There was no evidence of enhanced rates though we have no coverage during European daylight hours, and so the possibility cannot be entirely eliminated. The radiant shows some structure, though it is far from being significant. A report will appear in the next issue of *WGN*. If there are any unsubmitted Perseid reports, please send them to me as soon as possible so they may be included in that analysis.

Stanimir Metcheff had better fortune a month earlier. He plotted 123 meteors in an effective time of 11.58 hours between July 14 and 21 from Avren in Bulgaria. Stanimir compiled a sequence of six nights, only missing July 19-20, during the week. Although his fields were at $\delta \approx 50°$, about 20% of the meteors appear to be α-Capricornids and Aquarids. This early collection is a welcome supplement to the accumulated telescopic data for these showers. The α-Lyrids showed some weak activity around 20% of the sporadic background. The o-Draconids were weaker than in 1988 and 1990, giving 4 meteors (about 30% of the sporadic background) on July 16-17 (the normal date of maximum) and hardly any away from that night.

Forthcoming Events

The latter half of 1993 continues to be favorable for the major showers. Moonlight will be absent for the *Leonids*. It is only a few years until the Earth encounters the dense concentration of Leonid meteoroids, yet the density may already be climbing, especially for the particles that give rise to telescopic meteors. This occurs because they are more susceptible to perturbing forces than larger meteoroids. These forces change the meteoroid orbits and the particles become more dispersed. The particles are also ejected from the parent comet, P/Tempel-Tuttle, into slightly different orbits. The result is an expanding cloud of debris—the ortho-Leonids. To test the models of stream evolution and to estimate the meteoroid-ejection parameters it is imperative that we secure observations for the ortho-Leonids over a wide range of meteoroid masses during the years before and after the possible storms.

Given that the *IMO* is a worldwide organization it should be possible to secure Leonid data every year. However, in the north, where the shower is best placed for observation, cloudy skies are normal during mid-November. So if your skies are clear, please endeavor to observe, since your data might be the only ones collected at that time. Observations made outside the normal activity dates would also be of interest. Viewing need only begin after midnight local time, or even later if you are situated south of the equator. This year, the maximum occurs midweek, so you might prefer to have some sleep during the evening, set the alarm to 1^h local time and only observe in the few hours before dawn if the sky is clear. Since our main goal is to estimate particle fluxes rather than determine radiant parameters, instruments with a wide-field (larger than 60° apparent) will collect more meteors, and so are preferred. The Leonids are rich in small particles and so the telescope aperture is not critical. Since the Leonids have the highest known geocentric velocity of any major meteor shower, the field centers should be no further than 25° from the radiant.

In December, the *Geminids* come to the fore. In 1990, four observers recorded over 1000 telescopic meteors during the nights around the Geminid maximum. These are being reanalyzed with the latest version of the RADIANT software using the probability mode with appropriate plotting errors, and the intersection method. Preliminary analysis shows a secondary radiant to the north appearing after the maximum composed of very faint particles, as well as indications of some substructure in the main radiant. This secondary peak was also seen weakly in 1991 by Torsten Hansen. This year, the Moon is new at the maximum, offering another opportunity to study these radiant features. Are they reproducible? Of particular importance is to secure data with larger instruments, so I would encourage observers with a choice of apertures to choose ones larger than 70 mm. The long nights in the northern hemisphere make it possible to collect large samples giving greater confidence to our analyses and statistics; and also it is possible to estimate fluxes, the time of maximum, and a reliable population index. Further, it lets us select many field centers, which reduce artifacts in the radiant density distribution. See [1,2] for background information.

There are a number of minor showers active during the Geminids, and which can be observed simultaneously. At this time, visual Geminid rates are so high that plotting is not possible, and contamination by a small fraction of Geminids greatly enhances the apparent rates of the minor shower. So, to follow these showers around the Geminid maximum we rely upon video and telescopic methods. The best known are the *o-Hydrids*, the *December Monocerotids*, and the two-component χ*-Orionids*. They all possess a high population index of 3.0 and are quite evident telescopically. In 1990, the Monocerotids appeared approximately 4° north of the visual position, and most strongly around $\lambda_\odot \approx 261°$. The 1990 data also show a radiant in Lynx ($\alpha = 149°$, $\delta = +39°$) emanating swift, faint meteors. This shower or a relative might be responsible for the excess of "sporadic" meteors of high population index seen in mid-December [3].

In 1988, I observed a number of very-slow-moving meteors radiating from northern Auriga around $\lambda_\odot = 255°$. Since then I have received no reports of this distinctive shower. It could be the ζ*-Aurigids*, though the angular velocity exhibited by the meteors was incompatible with the V_∞ of 32 km/s [4] of this shower. It may be one of a number of ζ-Aurigid sub-components in a diffuse radiant complex [4]. Whatever it is we should try to determine its activity period, and accurate radiant position. Again some of the Geminid fields are suitable for this shower. Evening watches before moonlight interferes are possible for most of the first half of December.

In case the southern-hemisphere observer feels left out, there is the fascinating *Puppid-Velid* complex whose structure can be mapped with careful plotting. Many of its components are rich in faint meteors, suggesting that they are worthwhile telescopic targets, though I have no telescopic data to support this view. Visual rates are variable, but no one knows whether or not this is reflected in telescopic activity too. There are also the *Phoenicids*. These can be followed during the evening before the waning moon rises. Normal visual rates are those of a good minor shower, but there is the chance of much stronger than normal activity, especially if there is an 18-year periodicity. (High rates were recorded in the year of discovery, 1956, and in 1974.) Phoenicids will be quite obvious due to their very slow speed.

Charts for all the above showers are obtainable from me. State the aperture and field size of your binocular or telescope. Please allow a few weeks for their production and return post.

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Ongoing Meteor Work

Perseids 1993: A First Analysis of Global Data

Jürgen Rendtel

The 1993 Perseid return gained a lot of publicity in advance. Several sophisticated programs have been prepared. Here we present a first analysis of visual Perseid data obtained during the nights of August 11-12 and 12-13 only by 78 observers round the globe. The analysis contains well over 20 000 Perseid meteors within a total of over 400 hours of effective observing time. The time resolution is about 0.3 hours in this investigation. After a steep increase in the ZHR after August 12 at 0^h UT ($\lambda_\odot = 139\overset{\circ}{.}42$), a peak ZHR of slightly above 300 (per 0.5 hour interval) was reached at $\lambda_\odot = 139\overset{\circ}{.}535 \pm 0\overset{\circ}{.}02$ (3^h20^m UT). There is less data concerning the decreasing branch of the profile because it coincided with nighttime over the Atlantic Ocean. The "regular" maximum of the Perseids follows at about $\lambda_\odot = 140\overset{\circ}{.}3 \pm 0\overset{\circ}{.}1$ with the usual activity level (ZHR slightly above 100). Although no "meteor storm" occurred, we obtained an enormous amount of high-quality data for investigations with a higher time resolution.

1. Introduction

The 1993 Perseid meteor shower was the most publicized meteor event in history, and the exceptional attention paid to the shower resulted in some strange events. Most remarkable of all, the launch of the Space Shuttle Discovery was delayed by nine days by cautious NASA officials, to avoid a potential Perseid meteoroid collision. Observational programs were established by experienced meteor observers as well as occasional observers. Fast communication permitted a first, rough picture of the event, almost in real-time.

Despite all the publicity, the Perseids continued to defy all predictions. The shower actually peaked about 2 hours after the predicted time of 1^h UT on August 12, with maximum zenithal hourly rates exceeding 300 (within a half-hour interval) near 3^h30^m UT on August 12. The peak rates were not near storm levels but still excellent.

2. Observational data

There was an immediate data collection organized by the *IMO*. This allowed us to provide substantial and reliable information to various authorities, and was also published in *IAU Circular* 5841. In the weeks after the maximum, we already received a lot of data from observers around the globe. Many provided detailed data, like short-term intervals and magnitude distributions split for short intervals of time necessary for analyzing variations in the population index, or the mass index along the cross-section of the Perseid stream. Peter Brown and Junichi Watanabe helped in obtaining such data from North America and Japan, respectively.

The current analysis, however, includes only intervals of at least 0.3 hours duration and was meant to give a first reliable profile for comparison with the results of the previous years [1]. There are more interesting findings to be expected from the 5 and 10-minute counts. This will be a topic of a later report. The present analysis of only the nights of August 11-12 and 12-13 UT contains well over 20 000 Perseid meteors obtained by 78 observers within a total of over 400 hours of effective observing time. This period covers both the expected peak and the regular Perseid maximum. Since the analysis primarily deals with the short peak of high activity, we expect there will be also more precise data for the period after $\lambda_\odot = 140°$, thus including the "regular" maximum.

Because of time pressure, we had to be selective in the observations we entered for this analysis. From a certain point onwards, when the ascending branch of the profile became sufficiently stable, no more European observations were entered. On the other hand, all American data were entered to clarify the post-peak period. In the final analysis, of course, *all* data will be used. At that time, we shall print the list of all contributing observers. Already now, we thank all observers who by submitting their observations timely permitted this preliminary analysis.

3. Description of the shower

Many observers reported their subjective impressions concerning the event, of which we include some passages which may reflect expectations and feelings after the Perseid peak had passed.

Let us start with the period before the peak, which was best observed in Japan. The observers noted no activity increase during their observations. The ZHR was at a level of about 50, this was also the case when European observers started their observations around 18^h UT on August 11. Observers situated in the more eastern regions of Europe, such as Bulgaria, Greece or the island of Crete, had good observing circumstances, while observers in northern and western Europe had to contend with mainly cloudy skies. Since most people knew about these weather conditions in advance through good forecasts, many observers moved to the south where they found good conditions. For example, about 20 German observers went towards the Alps for cloudless skies. An international team assembled in Puimichel, Southern France, with additional stations and observers in the surrounding area. At all these stations visual, photographic, and low-light level video observations were carried out. Here we report the visual data only, while other results will be analyzed elsewhere in *WGN*. Some of the results have been presented at the *International Meteor Conference* in September 1993, also held in Puimichel.

The peak was predicted to occur at 1^h UT; therefore all observers expected a steep rise in the following hours. Indeed, rates started to increase after midnight (UT), when much of the public already went home, being disappointed with the event. This rise of activity continued until the observers were forced to finish because of the beginning of twilight, even in France and Spain. However, the rates reached their peak at about 3^h30^m UT, never approaching the expected storm level. Observers at the Canary Islands were able to continue until about 4^h UT, and they saw the rates going down after 3^h30^m UT.

Next, the North American observers were center stage for the show. Unfortunately, much of the East coast was cloudy or hazy on the night of August 11-12 and many missed the shower entirely. Interference from the Moon also degraded viewing, but even so, we received a record number of Perseid observations from North American observers. Some reported that they witnessed the best Perseid display in many years of observing the shower, while others were disappointed. We will see the reasons for these discrepancies soon.

Bob Lunsford and George Zay observed the display under excellent conditions with stellar limiting magnitude better than 6.5 most of the night near Descanso, California. Lunsford noted that he had "seen much stronger displays in the past and even the number of bright Perseids was not very striking." The reason becomes obvious from our analysis: their best observation interval—when the radiant reached sufficient elevation—coincides precisely with the dip between the high-activity peak and the "regular" maximum, thus yielding "only" a ZHR of approximately 70. This also underlines, that impressions or even data from a single location can not provide a realistic picture of a shower's activity. Any observer may cover only 7 hours at best with his data and therefrom he may not say anything about the remaining 17 hours of twilight and daytime until his next observation. Only worldwide data may solve this.

Some observers suffered as a direct result of the intense media attention. Paul Dickson of the *Saguaro Astronomy Club* recalled how a fellow observer was being questioned by a local TV crew just after he arrived at an observing site near Tortilla Flat, Arizona: "When Rick saw a meteor on went the camera's spotlight and at a distance of three feet he was questioned about what he saw. A by-stander quipped that he won't be seeing any more for the next half-hour." Other observers elsewhere may have had similar experiences.

A few weeks after the event, the amount of data gathered from all observers is larger than for any previous meteor shower. The different projects started by various *IMO* commissions and other groups will yield interesting results. For example, there are many double station photographic and video recordings allowing orbit determination and investigation of the radiant, data to study fragmentation processes and trains left by many of the Perseids.

Observers in Hawaii reported that rates started to increase in their morning hours, although the above described peak remained completely invisible from this area. Here we see the rise towards the annual, "regular," maximum which we are familiar with from observations over the last few decades. This effect was also observed by the Japanese on the night of August 12. Even in the European evening hours of August 12, meteor numbers were still remarkable despite the low radiant position. During this night the activity gradually decreased and thus the entire maximum period passed into history and the analyses began.

4. The population index

Figure 1 shows a preliminary profile of the population index r for the near-maximum period of the 1993 Perseids. Unfortunately, no magnitude data were available from the Japanese observers. But since the variations were rather small in the recent maximum periods and we also do not see significant changes during the analyzed period, we may assume that there was no particular feature during the remaining period.

We tried several choices of magnitude intervals to minimize the influence of high observable rates on the number of recorded faint meteors. It was shown recently, that in the case of high observed numbers, the perception for faint meteors tends to decrease. However, there occurred no difference in r for starting the calculation with meteor magnitudes being 2.5, 3.0, or 3.5 magnitudes above the observer's limiting magnitude, i.e., including only meteors being at least by this difference brighter than the reported limiting magnitude. Hence, the result seems to be quite reliable, and the values of r are a little lower than in 1991 and 1992 [1].

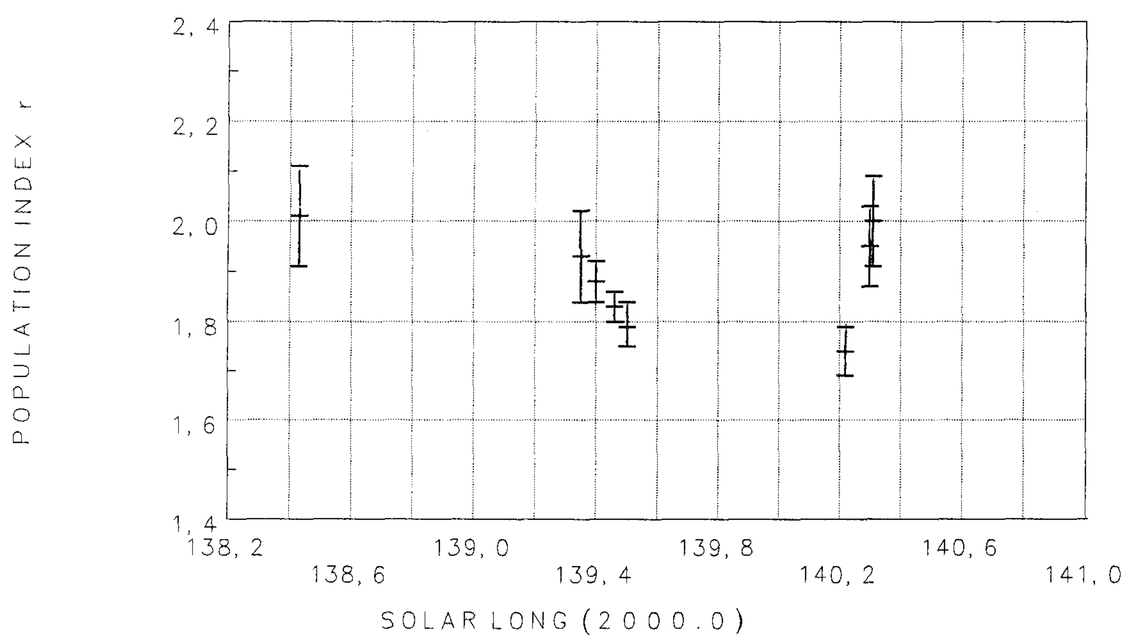

Figure 1 – Values of the population index r derived from the available magnitude distributions. We used the magnitude classes being at least 3 magnitudes brighter than the observer's limiting magnitude. The result does not significantly change for thresholds 0.5 magnitudes brighter or fainter.

5. The ZHR profile

With these values of r, we calculated the ZHR profile which is shown in Figure 2. The distribution of the rate data is not comparable for the ascending branch and the post-peak period. Therefore we had to choose different sampling periods for several parts of the present profile (Table 1).

Table 1 – Sampling intervals used for the calculation of the rate profile for the 1993 Perseids in this analysis.

$\lambda_\odot$	Sampling interval	Shift	Remarks
< 139°20	0°80	0°40	
139°20–139°48	0°04	0°02	Start of ZHR increase
139°48–139°58	0°02	0°01	Peak period
139°58–139°85	0°12	0°06	Less data available
> 139°85	0°40	0°20	Regular maximum

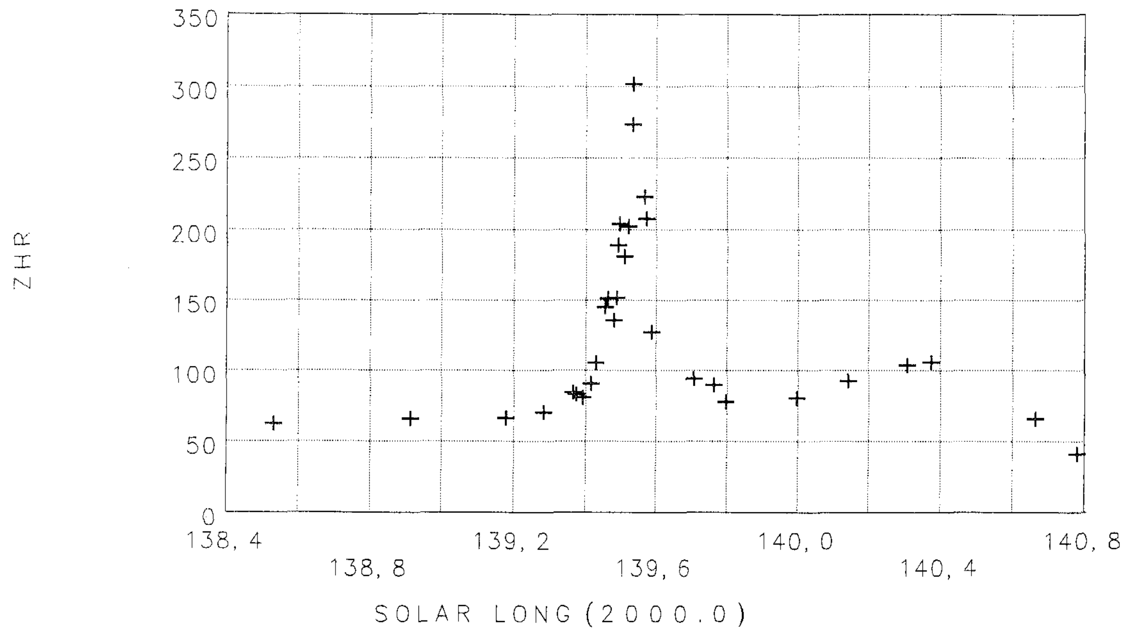

Figure 2 – Profile of the ZHR for the period August 10–13, 1993, obtained from a preliminary sample of more than 20 000 Perseid meteors. The values at the beginning and the end of the graph are based on a smaller sample and are only meant to show the further shape of the profile. The averaging periods are given in Table 1. For this analysis no perception correction was included. The error bars are not shown because the data points are too close, particularly during the increasing branch of the curve. The respective values are given in Table 2.

The ascending section of the activity curve before the peak of the outburst is well defined. It is 0^h UT on August 12 before observers first noted an increase in the meteor rates. Note that 0°04 in solar longitude corresponds to 1 hour. For the next 3.5 hours there was an explosive increase in meteor rates culminating near 3^h30^m UT with ZHRs exceeding 300. For this period, we have many short-time intervals of 10–30 minutes broken down by helpful observers in reporting their results. They permit us to choose a shorter sampling period than in previous analyses. Even here, each ZHR average is based on at least 500 Perseids. More details will certainly be obtained on the 5–10 minute interval time-scale which is also available. After 3^h30^m UT, the amount of data rapidly decreases. To obtain reliable ZHRs for this period, we had to use a longer sampling period. For test purposes we also applied a 1 hour interval, but the scatter is quite large in this case and does not provide more information. Note that in this preliminary analysis we did not introduce perception coefficients as in previous, final analyses. These may decrease the scatter in the final analysis and therefore allow a finer time resolution. For the remaining period, which mainly covered the regular maximum of the Perseids we used longer intervals since the variations are comparably small. From this analysis, we find a full width at half-maximum of the peak activity of approximately 2 hours.

Table 2 – Numerical data of this activity analysis of the 1993 Perseids.

$\lambda_\odot$ (2000.0)	Date (UT)	r	Interv.	$\overline{\text{lm}}$	Per	ZHR
138°531	Aug 11.08	2.00 ± 0.10	16	6.13	524	62 ± 13
138°912	Aug 11.45	1.97 ± 0.09	65	5.92	1657	66 ± 5
139°179	Aug 11.75	1.94 ± 0.09	103	6.10	2419	66 ± 3
139°284	Aug 11.86	1.93 ± 0.09	58	6.29	1482	70 ± 3
139°364	Aug 11.94	1.92 ± 0.07	15	6.20	414	84 ± 9
139°373	Aug 11.95	1.91 ± 0.06	35	6.27	962	83 ± 6
139°391	Aug 11.97	1.89 ± 0.05	36	6.21	946	80 ± 6
139°415	Aug 12.00	1.87 ± 0.03	41	6.07	1255	91 ± 6
139°429	Aug 12.01	1.85 ± 0.03	40	6.08	1390	105 ± 7
139°455	Aug 12.04	1.83 ± 0.03	43	6.12	2078	145 ± 10
139°471	Aug 12.05	1.81 ± 0.03	42	6.07	2104	145 ± 15
139°487	Aug 12.069	1.80 ± 0.04	15	5.99	768	150 ± 15
139°492	Aug 12.073	1.80 ± 0.04	39	5.95	2239	185 ± 15
139°504	Aug 12.088	1.79 ± 0.05	45	6.08	2479	195 ± 20
139°521	Aug 12.104	1.79 ± 0.05	9	5.75	369	205 ± 25
139°533	Aug 12.132	1.79 ± 0.05	13	5.54	755	275 ± 22
139°535	Aug 12.135	1.79 ± 0.05	9	5.50	572	305 ± 25
139°567	Aug 12.154	1.79 ± 0.05	4	5.49	216	225 ± 25
139°572	Aug 12.160	1.79 ± 0.05	5	5.61	205	205 ± 35
139°586	Aug 12.175	1.79 ± 0.05	7	5.78	276	130 ± 45
139°707	Aug 12.30	1.78 ± 0.05	3	6.23	117	94 ± 26
139°762	Aug 12.36	1.78 ± 0.05	5	6.34	240	90 ± 13
139°796	Aug 12.39	1.77 ± 0.05	4	6.43	196	78 ± 7
139°997	Aug 12.60	1.76 ± 0.05	18	5.98	515	80 ± 5
140°141	Aug 12.77	1.81 ± 0.06	42	6.14	1528	92 ± 4
140°308	Aug 12.93	1.93 ± 0.08	56	6.17	2925	103 ± 4
140°374	Aug 13.00	1.99 ± 0.09	38	6.13	2255	106 ± 6
140°664	Aug 14.30	2.00 ± 0.09	8	6.53	382	66 ± 13
140°779	Aug 14.42	2.00 ± 0.09	4	6.77	143	41 ± 8

Detailed analysis of the 1991 Perseids by the *IMO* suggested a peak ZHR of 350 at solar longitude $\lambda_\odot = 139°58$, while the 1992 data, which are far more uncertain, hint at a peak ZHR near 220 at solar longitude $\lambda_\odot = 139°50$. The 1993 Perseid return was back "in time" to a peak position at $\lambda_\odot = 139°535 \pm 0°020$, later in time than most expected from the $\lambda_\odot = 139°46$ value for the descending node of P/Swift-Tuttle, and shows activity comparable to 1991 and 1992. We are left to guess what the unpredictable Perseids will do in 1994!

6. Conclusions and reference

This first analysis, comprising 20 000 visual Perseids obtained by 78 observers around the globe during a total of about 400 hours of effective observing time, yields an almost complete profile for the 1993 Perseids which permits comparison with the returns of 1991 and 1992. The Perseid peak occurring with P/Swift-Tuttle in the Earth's vicinity re-occurred in 1993 at $\lambda_\odot = 139°535 \pm 0°020$. This is by about 2 hours later than expected. The predicted storm activity did not occur. The peak ZHR reached about 300. Future analyses of short-period intervals will probably show more interesting features of the stream's cross-section. The fast communication and cooperation within the *IMO* permitted presentation of a reliable picture of the 1993 return of a quality which is almost comparable to previous final analyses. Predictions for the next returns are more or less educated guesses. Probably, observers in the West of North America are in the best location for the 1994 return; but surely, we live to see more surprises in the 1990s.

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Observational Results

Perseids 1993: A General Impression

compiled by Marc Gyssens

A general idea is given on how the Perseids were observed in 1993.

Due to lack of space, we have to defer all reports on Perseid observations to the December issue, for which we apologize. Nevertheless, we want to use the few remaining pages in this issue to give you a first, general impression on the immense activity shown by the international community of meteor observers on the occasion of the 1993 Perseids.

During and after the activity period of the Perseids, we received by electronic mail a lot of summary reports as well as full data from an enormous lot of people mainly in Europe and North America. The combined effort of all these observers helped greatly in getting together a reasonably reliable picture of the Perseid activity right after the event. Apart from all these e-mail reports, we also received data, photographs, figures, and/or short articles from the Jordanian team of Khalil Konsul and Ala' Shahin, the Crimean team of Andrey Grishchenyuk, the Slovak team of Daniel Očenáš, the Belgian team of Peter Aneca and the Dutch team of Klaas Jobse and Robert Haas, both of which observed in the French Provence, the Spanish team of Josep Trigo, the Danish observer Gotfred Kristensen, the English observer Terry Holmes, and the American observers Joe Rao, Richard Taibi, Tom Webb, and George Zay. Those who sent us a descriptive report will see their contribution appear in the December issue.

The preliminary global analysis by Jürgen Rendtel gives a fairly accurate picture of the visual activity. Therefore I will restrict myself here to the following quote by the Jordanian observers, describing how much commotion the 1993 Perseids caused among the general public: *The news of a possible meteor storm had a great influence on the public here; a hysteria swept across the whole country since most of the public thought that the sky was going to rain meteorites. Others thought that a vast disaster was going to happen causing life to come to a tragic end. Also it seemed that people had nothing to talk about but meteors! The Jordanian Amateur Astronomers Society (JAAS) made every effort to explain the phenomenon to the public via radio, T.V., and other media.* Like the *JAAS*, many groups—apart from observing—also made an effort to inform the general public. All these efforts combined have certainly helped to introduce a lot of unaware people to the meteor phenomenon and—who knows—contributed to form the next generation of meteor observers...

In anticipation of the final analysis, may I urge all observers who did not yet do so to send in their observations as soon as possible! The final analysis will mention the names of all observers who have contributed to this gigantic effort.

As was to be expected, a lot of beautiful photographs were made. One of the more spectacular examples is the photograph by Josep Trigo on the front cover, showing a $-5/-6$ Perseid. This fireball showed a persisting train that lasted for 1.5 minutes visually and 3–4 minutes with 7×50 binoculars. Figure 1 shows the distortion of the train caused by upper-atmospheric winds.

Typical of most Perseid photographs communicated to me is that they contain several meteors. The negative of Trigo's photograph shows five other Perseids and one sporadic meteor. Also photographs by the Belgian, Dutch, and Slovak observers contain up to four meteors. Figure 2 shows three Perseid meteors captured by Daniela Rapavá during the Slovak Meteor Expedition Camp in Žliabky ($\lambda = 19°27'38''$ E, $\varphi = 48°45'08''$ N). The photograph was exposed from 1^h22^m to 2^h02^m UT on Foma special 800 ASA film with a 30 mm $f/3.5$ lens. The film was developed during 12 minutes in Fomal Developer at 22° C.

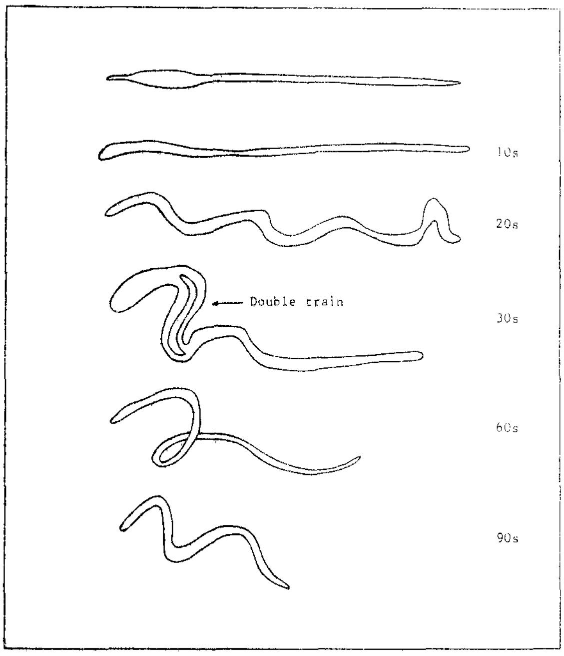

Figure 1 – Train evolution of the fireball on the front cover.

The Perseids were not only covered by visual and photographic observers. Sirko Molau showed some impressive images of video observations at the latest *IMC*. Furthermore, a lot of radio observers followed the Perseid activity carefully. One of these was Gotfred Møbjerg Kristensen, who listened at 100.50 MHz. Gotfred confirmed strong but not storm-level Perseid activity. Figure 3 shows his graphs for both 1992 and 1993. When interpreting these graphs, of course, the geometry of the station-receiver-radiant configuration should be taken into account. Gotfred also managed to get attention from the Danish television: DR-TV made a short program about his radio observations in the night of August 11-12! Unfortunately, visual observing conditions were very poor in Denmark during the night of the Perseid maximum: many Danes stayed up hoping for a few clear bits of sky in between the clouds, but few saw anything.

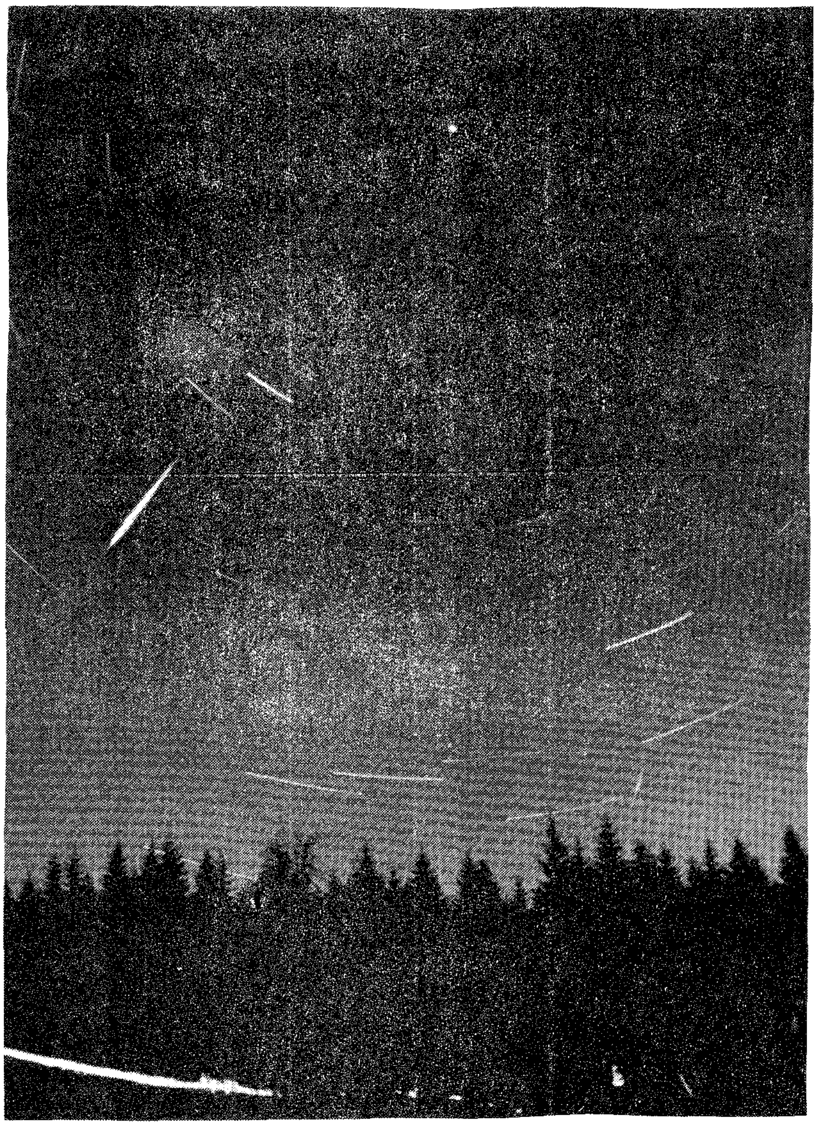
Figure 2 – An impression of the Slovak Meteor Expedition.

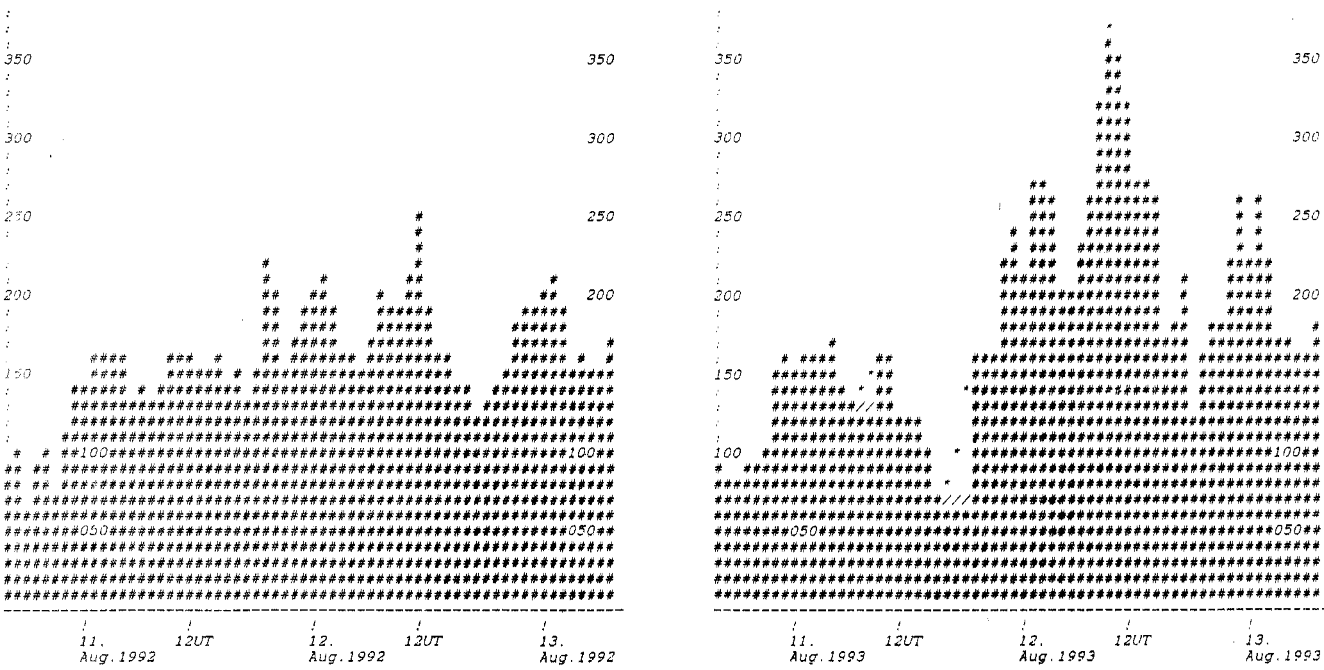

Figure 3 – Radio counts by Gotfred Kristensen for the 1992 Perseids *(left)* and the 1993 Perseids *(right)*.

Meteoroids

Bratislava, Slovakia, August 28–30, 1994

Vladimir Porubčan, Astronomical Institute SAV

Meteoroids is a scientific meeting dedicated to the memory of *Jan Štohl* to be held in Bratislava, Slovakia, at the Comenius University, from August 28 to 30, 1994.

The topics include the following:

- structure and evolution of meteoroid streams and of sporadic background;
- meteoroid parent bodies—comets, asteroids;
- physics of meteors and chemistry of meteoroids;
- sources and dynamics of interplanetary particles;
- the Perseid meteor stream; and
- observational programs.

The scientific organizing committee consists of I.P. Williams (chairman), Z. Ceplecha, D.W. Hughes, J. Jones, Ľ. Kresák, B.A. Lindblad, V. Porubčan, H. Rickman, D.I. Steel, and M. Šimek.

To receive further announcements or for additional information, please contact Anton Hajduc (chairman of the local organizing committee) or Vladimir Porubčan at the following address:

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When asking for more information, indicate your intent to participate in the meeting (definitely, probably), the number of accompanying persons and your potential contribution title, if applicable. Answers are not binding, but assist us in planning. The **deadline** for responding is **November 30, 1993**. We would appreciate your prompt answer.

The International Meteor Organization

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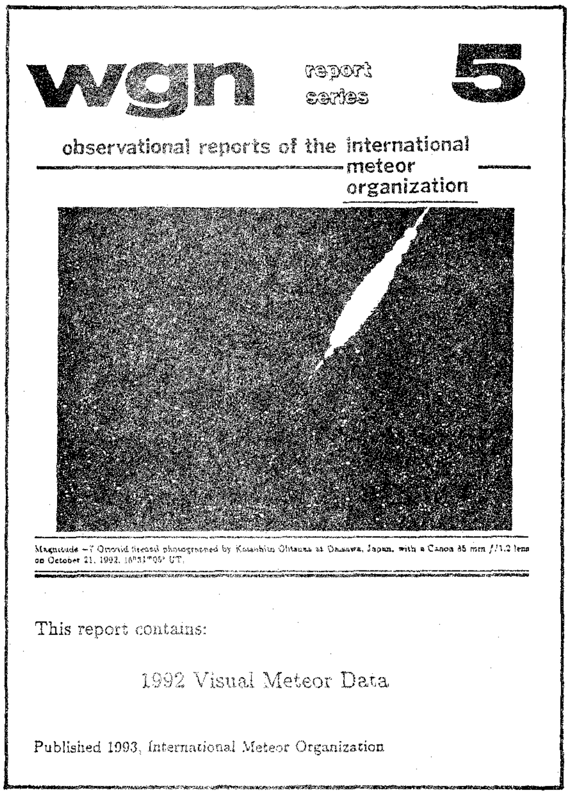

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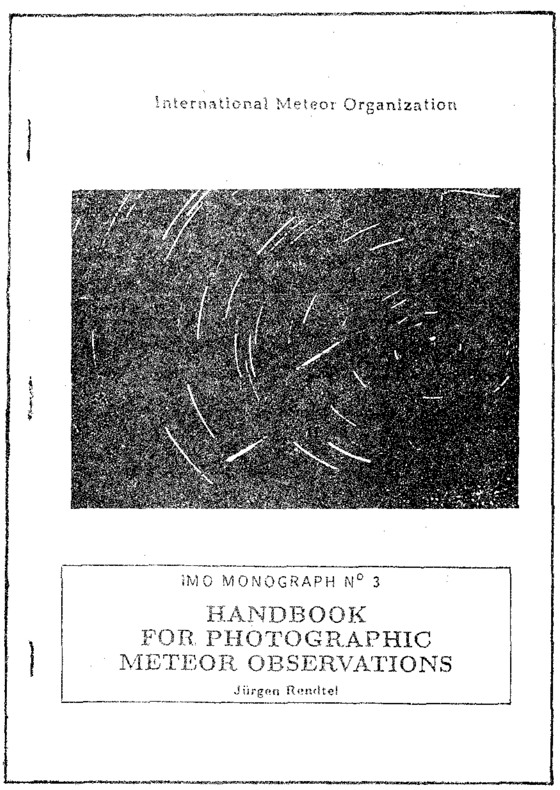

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