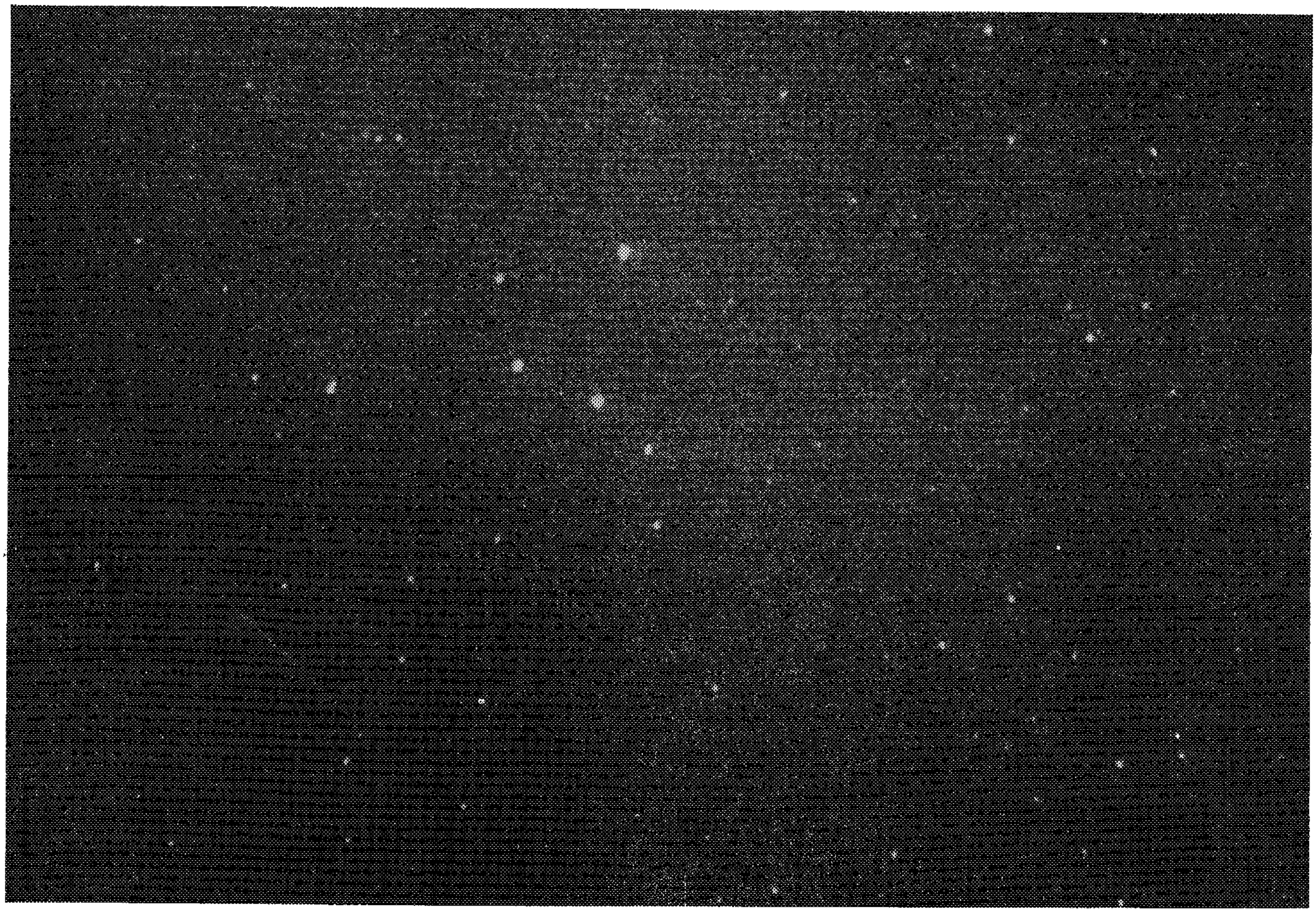
ISSN 1016-3115

# wgn

**23 -2**
**april 1995**

**bimonthly journal of the international meteor organization**



A magnitude +1 Ursid photographed at the *Tokyo Meteor Network* Fujisawa station in Japan on December 22, 1994, at $18^h08^m28^s$ UT. This meteor was photographed during a short period of enhanced Ursid activity. more about this event can be found in this issue.



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*WGN, Vol. 23, No. 2, April 1995, pp. 27–74*

# Contents



# Useful Information

## The June Issue *(WGN 23:3)*

The *June issue* will be mailed during the first week of June. Contributions are due *May 12* at the latest. They should be sent to *Marc Gyssens.*

## WGN Subscription/IMO Membership 1995

The subscription rate for Volume 23 (1995) of the *Bimonthly Journal* is 35 DEM for six issues which are anticipated to contain over 220 pages in total. A combined subscription with the *Report Series* and *FIDAC News* costs 70 DEM. You can also become a Supporting Member by paying at least 15 DEM extra.

# From the Editor-in-Chief

*Marc Gyssens*

*Our call in the previous issue for more articles was at least partially successful. We got a variety of papers of which we hope they will make this issue pleasant to read. Please keep up your efforts to supply our journal with your contributions: it is* the *way to keep your fellow observers informed on what you are doing.*

*Another issue I want to touch upon briefly is that several subscribers complained that they received the February issue very late. Most of these people also renewed their dues very late. I would like to remind these people that the* IMO *is run by volunteers who have to combine their task with professional obligations not even to speak about their own observations! One can simply not expect that these people run to the post office back and forth every day to send out an issue of* WGN *to a late subscriber whose dues arrived that day. It is much more efficient to combine these mailings, say once a month, and that is exactly what happens. This brief digression is meant to be a plea for two things: save the* IMO *officers a lot of work by renewing in time next year (that is, before the end of 1995) and to re-read my comments in my previous editorial about the way the* IMO *is staffed!*

# Letters to WGN

*compiled by Marc Gyssens*

### Meteoroid stream evolution in WGN?

*We received a letter from Andrey Grishchenyuk in which he suggests more articles on meteoroid stream evolution in* WGN. *We especially welcome letters like this one, because they give us an idea of what our readership is interested in. On the other hand, what was published in* WGN *up to now mainly relied on what was sent in. We may not exclude that in the future we should work more with invited contributions. This is certainly a matter the* IMO *Council should look into. Meanwhile, letters as these may be a source of inspiration to potential authors!*

One of the most important goals of the *IMO* is organizing the gathering of worldwide meteor observation data. At present, we can say that this goal is fulfilled. The available data are very important for the further processing by different methods.

There are many other interesting problems, however. I would like to attract the attention to one of these. It is beyond any doubt that *WGN* should be understandable for beginning amateur astronomers, but the journal also contains serious information about different problems in meteor astronomy. During the recent years one can find many very interesting articles in the journal and I think we owe a lot to Marc Gyssens on behalf of this.

I think that now is the most suitable time to publish several articles in *WGN* devoted to the problems of meteor stream evolution. Modern computers enable much work in this area. One such article was published in *WGN* in 1993 (D.W. Hughes, "Illustrating a Meteoroid Stream"). We can obtain the apparent distribution of particles in a stream by means of observations from the Earth's surface. The next step is to try to explain the structure of meteor streams. Therefore, I would like to read some articles in *WGN* not only providing a general description of the computation of meteor shower evolution, but with some specific formulae giving the orbit calculation for particles ejected from a comet as well as methods predicting, for example, the activity profile when the modeled stream meets the Earth. Of course, such an article should compare the predictions with the observational results.

I think the editorial board of *WGN* can apply to experts on this problem; in the first place in Russia, where such researches were conducted long ago. For instance, such experts are G.V. Andreev and G.O. Ryabova, as well as A.A. Sukhotin from Tomsk. I hope that the publication of such articles will help both experienced observers and beginners that can look in a new fashion at the quality of observations and find even more motivation and satisfaction in their observations.

*Andrey Grishchenyuk, February 1995*

### On dark meteors, electrophonic meteors, mysterious noises, and a IUFLO

*The phenomena mentioned in the title above are obviously fascinating to meteor observers, judging from the amount of contributions on these subjects published in this journal over the years. Below, George Zay gives his view on these phenomena.*

On occasions I have found myself feeling as if something is incomplete. It is rather like walking around with your shoe laces untied... important but not a big deal. I have in the past discussed dark meteors, mysterious sonic noises, and funny-looking objects. While I am going to briefly address each of these topics separately, I also want to say a word or two about electrophonic meteors.

On dark meteors, I have mentioned some possible sightings [1] in the past. I felt then that I was not sure "which side of my eyeballs these objects originated from." Since then, I have had many moments to reflect. I tend to not notice them as much as before, but I still see them on occasions. Some may simply be ordinary dim particles near the threshold of my sight that I have mis-identified. However, I now ignore the bulk of them, because I believe they are artefacts to my vision. That is, they originate somewhere in my head.

About those mysterious sonic booms I mentioned in the journal [2], well, I do not feel as comfortable in saying that these were some kinds of artifacts to my hearing. I have enlisted the help of various relatives in Southern California and Arizona to be on the lookout for news reports of sonic booms. A relative recently sent me a newspaper clipping from Arizona that reported the same kind of sounds as have been heard here. If meteors were this frequent of a noise-making source, however, you would think this would be a recognized common happening by now. Logic tells me that the bulk of these sounds probably originates with the military.

Electrophonic fireballs is a topic I have not discussed in the past. It deals with sound, however, so I am inserting it here. Before I became involved with meteors, I once witnessed a sky-crossing meteor that reminded me of a sizzling fireworks sparkler. After its passage, I was certain that I heard a sizzling-like sound. After thinking about it for a while, I have concluded that what I "heard" was a psychological thing. That is, I heard something that I thought should be associated with what I saw from other, non-related, experiences. When I was just a kid (only a couple of years ago), I recall seeing firework sparklers that made a sizzling sound. When I saw that meteor, it had the same look, but I highly suspect my mind filled in the missing sense of sound that would be seemingly associated. Outside of sonic booms and rumbling noises, I do not expect to hear any other kind of meteor sounds... and I have not. Of course, that does not mean they do not exist, it just means that I am skeptical.

As to my November 1st, 1994, IUFLO [3], the odds are that I did see this, because Robert Lunsford saw it also. Since then, I have read in *Sky and Telescope* about the WIND spacecraft being launched near that time [4]. I highly suspect what we witnessed was associated with this spacecraft. No real mystery here...

None of these topics involved much work utilizing the scientific method. I guess it can be said that I utilized the "Horse-sense Method." If the scientific method was applied, however, I imagine that the basic train of thought would point in the same direction. The simplest explanations are probably closer to the truth. I guess if there were to be a conclusion to all this verbage, it would lie in the area that we should not expect all our senses to be 100% honest.

[1] G. Zay, "Letters to WGN", *WGN* 21:3, June 1993, p. 81.

[2] G. Zay, "Letters to WGN", *WGN* 22:6, December 1994, p. 182.

[3] G. Zay, "Letters to WGN", *WGN* 22:6, December 1994, p. 182.

[4] "Mission Update", *Sky and Telescope*, February 1995, p. 16.

*George J. Zay, March, 1995*

### Some thoughts about meteor clustering

This is a theme of some controversy about which I think there is a couple of definitions to clarify. Since my first Perseids' observation, back in 1981, I have the feeling that Perseids come in clusters. We were two observers (including myself). Before we even began to hear about meteor clustering, one of our comments was about the feeling that Perseids came in small groups, with clear more or less extensive gaps, even in maximum shower time. We counted then 47 meteors during about $1^h25^m$ (corrected observing time). In spite of the small size of the sample the distribution of time difference between meteors fit with a random distribution except for a clear predominant value about 4–5 minutes.

Most recently I read Detlef Koschny and Roland Egger's work in the 1993 *IMC* proceedings. Beside the subject of the possible $2^m20^s$ clustering period preference (curiously about half the one we found then), one has to agree with them that most probably the meteor distribution in time is purely random.

To a reader not advised it may seem that clustering does not occur despite we all see it. At this stage, I think we are just talking about different things. One thing cannot be and not be at the same time. One cannot deny data fits on a random distribution nor the evidence of clustering seen by observers. The only way one thing fits with the other is that clustering is a natural consequence of the random distribution of meteors in space. Gaps between clusters maybe an effect of local sampling.

When I talk about clustering I do not mean a regular size of gaps more or less equally distributed on time but in the simple existence of them even with some irregular size and spacing.

Considering a random distribution, if we reduce samples' size there should be a value when the sample stops to fit in random distribution. After that, local features would become apparent.

Let us look at the exponential distribution of the frequency of time differences between meteors. We can see this also means that there are many more meteors with short time differences than large ones. In consequence, clustering is an obvious result of their random distribution.

Consider a linear distribution of points. To transform it in a random distribution we may apply random displacements until general distribution fits with random criteria. In simple words, to get one point away from another, it surely gets closer to another.

Let me propose a simple computer-simulated experiment. What happens if we consider a part of the left edge of the screen the origin of constant release of particles at space and time constant intervals and than apply to them small random variations in speed in random directions? We can do this working with independent random values for $x$ and $y$ axis components for each velocity vector. The particles' cloud slowly widens in all directions. If we make a close look we find that the particles are clustered in various forms, including globules, filaments, and arcs, sometimes with large voids between them. For large areas the distribution tends to be random.

In fact it is not a real random distribution, may be because my PC's random number generation is not really random.

In short, if we have a random distribution, there must be an irregular clustering, specially with the low numbers we find in meteor observations. Of course, that clustering is a local phenomenon in spite being spread all over.

Possible periods due to comets' rotation or ablation layers or whatever causes it will soon be diluted by the random forces applied in each particle released from the comet. Particles are hardly a perfect sphere with constant albedo all over. If they have even a small rotation, the various forces acting on them (especially the sun radiation and solar wind) will result in a random distribution of the particles along similar orbits. At this stage, all initial periodic phenomena (unless of great importance) will be lost. Any periodic clustering should have its origin in recent forces external to the comet or the meteor shower (Earth-sweeping through the meteors' swarm?).

*Elmano Dorio, March 12, 1995*

Comment by the Editor-in-Chief: *I too studied the phenomenon of meteor clustering quite some years ago now, and the conclusion of that study was that the mismatch between the random distributions we find and the impression of clustering observers have is most probably due to a poor human intuition for randomness. People tend to associate uniform distributions with randomness, which is of course entirely wrong. Similar phenomena have also occurred in other areas. It seems that people in London during World War II also thought bombing impacts tended to cluster while a study revealed they were mostly random. I guess what Mr. Dorio suggests basically is an explanation why we have such a poor intuition for randomness.*

### The $\delta$-Leonid radiant

I observed on the night of February 25-26, 1995. Going by the *IMO*'s radiant position for the $\delta$-Leonids [1,2], I noticed that I had 4 almost-Leonids. That is, I had 4 nicely plotted meteors of slow speed, that had a fairly tight intersect point, but were too far from the given radiant to be called $\delta$-Leonids. At first, I thought I might be looking at a possible new shower or sub-radiant. I felt very confident in these plots, so the hunt was on for possible explanations. I was able to borrow a copy of Gary Kronk's book [3]. I looked up the $\delta$-Leonids and found that J.P.M. Prentice in 1924 plotted several with a radiant of $\alpha = 155°$, $\delta = +13°$ during February 25–28. My resultant radiant ended up being $\alpha = 155°$, $\delta = +14°$. The accuracy value I gave my 4 plots were 2 that were normal and 2 being very accurate. Taking the two very accurate plots by themselves, I got $\alpha = 155°$, $\delta = +13°$ ... an exact match. I only watched within 30° of the radiant area for a two-hour period. The Leonids that I saw appeared during these two hours. After Leo moved out of my field of vision, I saw no more Leonids. My gut hunch is, that if I kept my center of vision on Leo's Sickle all night, I would have bagged a respectable number of Leonids. As slow the activity is at this time of year, I look forward to concentrating my efforts on the $\delta$-Leonids next year by following Leo's Sickle across the sky. I feel that eventually their radiant position will have to be corrected. It is also possible that multiple radiants may turn up.

[5] J. Wood, "Visual Observers' Notes", *WGN* 22:6, December 1994, p. 186.

[6] A. McBeath (comp), "1994 Meteor Shower Calendar", IMO, p. 10.

[7] G. Kronk, "Meteor Showers: A Descriptive Catalog", Delta Leonids, p. 29..

*George J. Zay, March, 1995*

### Does mass distribution affect the reception rate of radio meteor echoes?

The vast majority of radio setups that I have read by responsible authors have a horizontally directed antenna, pointed at a transmitter that is sending a more or less horizontal signal. The more successful stations have used the video signal of television channel 4 ($\pm 62$ MHz) at a distance of about $300 \pm 80$ km.

These systems do not seem to record the visual maxima of meteor showers accurately. A good example of this is the system of T.R. Manley who rather consistently has recorded radio meteor minima at the time of visual maxima. An example of this can be found in the April 1991 issue of *WGN*. Radio meteor counts for the Perseids of 1987–1990 are shown in this letter written by T.R. Manley, with meteor counts recorded by W.H. Black and T.R. Manley.

Relatively recently, J. Riggs developed a setup with a vertical antenna that receives meteor echoes from an FM transmitter that is sending its signal in a 60° cone directed toward the zenith. This setup seems to detect somewhat smaller meteors than the usual setups described above.

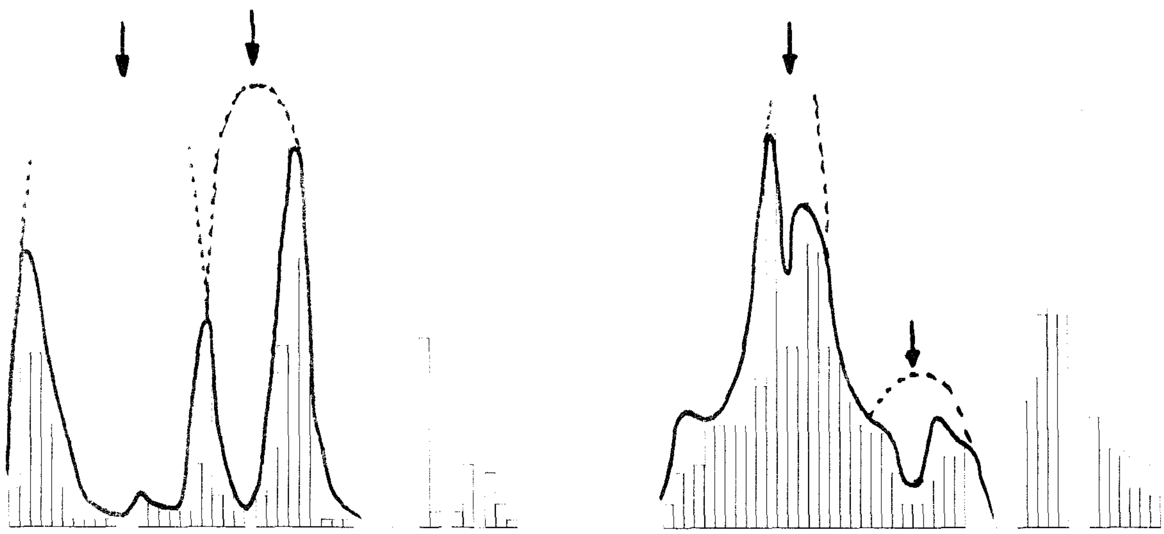

Figure 1 – Meteor echo rates during the 1994 Perseids at West Point, CA (*left*) and Sebring, FL (*right*) from August 12, $0^h$ UT, to August 13, $24^h$ UT. The arrows indicate the visual peaks.

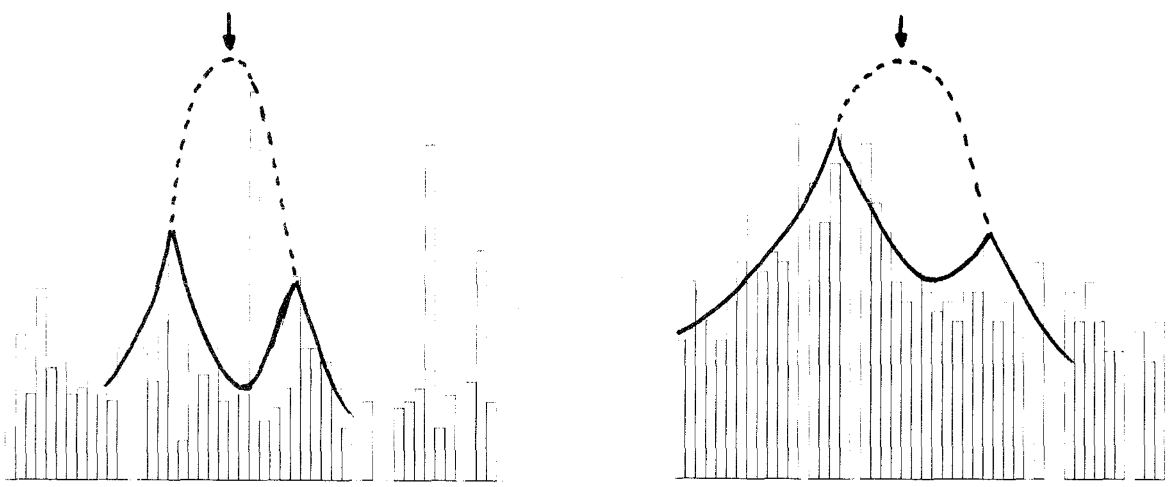

Figure 2 – Meteor echo rates during the 1994 Quadrantids at West Point, CA (*left*) and Sebring, FL (*right*) from January 3, $0^h$ UT, to January 4, $24^h$ UT. The arrow indicates the visual peak at $\lambda_\odot = 283.^\circ4$.

Examination of many records revealed that the vertical to vertical system of J. Riggs at West Point, CA, receives meteor echoes more favorably at $22^h \pm 6^h$ UT, while the most favorable hours at the Sebring, FL, setup of T.R. Manley are $12^h \pm 6^h$ UT. Figure 1, *left* and *right*, are graphs of the 1994 Perseids for West Point and Sebring respectively. Table 1 gives the elevation of the Perseid radiant for the two setups.

Table -3 – Elevation of the Perseid radiant for the two peaks at the discussed sites.

| Site | 1st peak | 2nd peak |
|---|---|---|
| West Point, CA | 45°–71° | 6°–34° |
| Sebring, FL | 36°–60° | −5°–13° |

The higher counts for Sebring in the first peak of the 1994 Perseids are within the most favorable hours for recording meteor echoes at Sebring, while the higher counts of the second peak are within the most favorable hours of observation for West Point. The highest counts in the California station for the first peak of the 1994 Perseids occurred on the previous day. This again makes us conclude that this station is picking up fainter meteors than the Florida station.

Figure 2, *left* and *right*, show the meteor counts for the 1994 Quadrantids of West Point and Sebring. The elevation of the radiant at visual maximum in California is about 27°, while at Sebring it is close to the horizon at visual maximum solar longitude $\lambda_\odot = 283.^\circ4$. The California radio minimum that corresponds to the visual maximum solar longitude, occurs close to the middle of the most favorable radio meteor hours for the site. The Sebring minimum is close to the midpoint of the most unfavorable hours of radio meteor observation there. The best developed pattern and the highest counts for the California station occurred two days earlier on January 1, 1994, close to the same hour as the radio minimum of January 3, 1994. This again makes me conclude the California station may be detecting smaller meteoroids than the Sebring station. The authors intend to do further research to establish the validity of the presented systematics. We would like to know if there are others interested in testing this concept.

Smaller-sized meteors observed with binoculars are called telescopic meteors. Many times, these telescopic meteors show maxima about 2 to 3 days before or after the visual maximum date of a meteor shower. The above example of the 1994 Quadrantids, where a relatively large surge of meteor echoes were recorded by Riggs on January 1, 1994, corresponds to this prevalent pattern. The 1995 Quadrantids were not observed by radio by Riggs because of equipment failure. However, Manley made telescopic observations on December 31, January 1, and January 2, from $10^h$ to $11^h$ UT, and observed 0, 11, and 4 telescopic meteors respectively.

In the 1993 Perseid meteor counts recorded by Riggs on the day before the visual maxima (August 11), two rather small radio minima were recorded near the two visual maxima of the 1993 Perseids. A rather large meteor count was recorded just about at the midpoint between the two visual maxima. It appears that Riggs picked up a maximum in the finer telescopic meteors that were dominant between the two visual maxima on the day before the visual maxima. Needless to say, we will have our binoculars trained on the 1995 Perseids.

Lastly, the California meteor data for the April 1994 Lyrids and the June 1994 Lyrids have high counts on each side of a radio minimum that occurred near the usual visual highs. This may indicate that these two showers have many telescopic sized meteors in them. Is it possible that the observed radio meteor minimum at visual maximum is due to the mass distribution of meteors?

*T.R. Manley and J. Riggs, January 28, 1995*

Editorial comment: *The most favorable hours for observing a shower are dependent on the radiant position of the shower, and can thus not be determined by the examination of records of different showers. The only observability function one could possibly obtain this way is that of the sporadic meteors. For showers, a program like* FORWARD *should be used. The elevation of the radiant alone does not tell much about the observability of a shower by radio. Finally, it is usually assumed that the radio maximum of the Quadrantids precedes the visual maximum by about 14 hours rather than 2 days.*

# Frequently Asked Questions on Observing Methods

*compiled by Rainer Arlt*

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**1. How do I correctly estimate the field correction factor?**

It often happens that just the interesting parts of a shower's activity period are affected by clouds passing through. Unfortunately, the correction factor is the most difficult to determine. Some items should help you to correctly estimate the cloud correction.

The field correction does not include the entire sky. As explained in last year's February FAQ the diameter of the effective field of view is not larger than about 100° [1]. Very few meteors are detected outside this area. If clouds appear you will naturally turn your head towards the remaining clear parts of the sky. Hence, the cloud factor still remains 1.0 unless the visible cloud gap is smaller than 100°.

Let us now consider clouds which cover more and more parts of the sky. When the usable field of view between the clouds becomes smaller than 100°, we shall note a cloud coverage. But be careful. You are probably centering your eyes into the cloud gap; this is the natural reaction on a restricted field of view. The perception probability to detect a meteor is very low at the edges of your field of view compared to the very good perception near the center of the field. Therefore, if the clouds cover 20% near the edges you will not miss 20% of the meteors.

It seems hardly possible to consider the influence of the perception distribution over the field of view on the number of missed meteors during the observation. I can only recommend to rather underestimate the cloud coverage. A coverage of 50% means that you suppose 50% of the meteors to be missed (compared to clear skies). According to the perception distribution over the field of view this corresponds to a field of only 32° diameter [2]. This is as small as if you could only see the constellation of Cygnus. It will be very seldom that somebody continues to observe although he sees nothing but a part of Cygnus anymore. A cloud coverage of 50% corresponds to a correction factor of 2.0. Hence, I would not expect correction factors larger than 2.0.

Unfortunately, many observations were not usable in the past as they reported cloud factors of more than 2 and even more than 3 which means in the above example that the observer did not see more than a part of Cygnus throughout his entire observation.

Table 1 – Solar longitudes 1995. Dates refer to $0^h$ UT.

| Date | $\lambda_\odot$ | Date | $\lambda_\odot$ | Date | $\lambda_\odot$ | Date | $\lambda_\odot$ | Date | $\lambda_\odot$ | Date | $\lambda_\odot$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Jan 1 | 280.16 | Mar 1 | 340.00 | May 1 | 40.23 | Jul 1 | 98.79 | Sep 1 | 158.17 | Nov 1 | 218.15 |
| Jan 2 | 281.18 | Mar 2 | 341.00 | May 2 | 41.21 | Jul 2 | 99.74 | Sep 2 | 159.14 | Nov 2 | 219.15 |
| Jan 3 | 282.20 | Mar 3 | 342.00 | May 3 | 42.18 | Jul 3 | 100.69 | Sep 3 | 160.10 | Nov 3 | 220.15 |
| Jan 4 | 283.22 | Mar 4 | 343.01 | May 4 | 43.15 | Jul 4 | 101.65 | Sep 4 | 161.07 | Nov 4 | 221.15 |
| Jan 5 | 284.24 | Mar 5 | 344.01 | May 5 | 44.12 | Jul 5 | 102.60 | Sep 5 | 162.04 | Nov 5 | 222.15 |
| Jan 6 | 285.26 | Mar 6 | 345.01 | May 6 | 45.09 | Jul 6 | 103.55 | Sep 6 | 163.01 | Nov 6 | 223.16 |
| Jan 7 | 286.28 | Mar 7 | 346.01 | May 7 | 46.05 | Jul 7 | 104.51 | Sep 7 | 163.98 | Nov 7 | 224.16 |
| Jan 8 | 287.30 | Mar 8 | 347.01 | May 8 | 47.02 | Jul 8 | 105.46 | Sep 8 | 164.95 | Nov 8 | 225.16 |
| Jan 9 | 288.31 | Mar 9 | 348.01 | May 9 | 47.99 | Jul 9 | 106.41 | Sep 9 | 165.92 | Nov 9 | 226.16 |
| Jan 10 | 289.33 | Mar 10 | 349.01 | May 10 | 48.96 | Jul 10 | 107.37 | Sep 10 | 166.89 | Nov 10 | 227.17 |
| Jan 11 | 290.35 | Mar 11 | 350.01 | May 11 | 49.92 | Jul 11 | 108.32 | Sep 11 | 167.86 | Nov 11 | 228.17 |
| Jan 12 | 291.37 | Mar 12 | 351.01 | May 12 | 50.89 | Jul 12 | 109.27 | Sep 12 | 168.83 | Nov 12 | 229.18 |
| Jan 13 | 292.39 | Mar 13 | 352.01 | May 13 | 51.85 | Jul 13 | 110.23 | Sep 13 | 169.81 | Nov 13 | 230.18 |
| Jan 14 | 293.41 | Mar 14 | 353.01 | May 14 | 52.82 | Jul 14 | 111.18 | Sep 14 | 170.78 | Nov 14 | 231.19 |
| Jan 15 | 294.43 | Mar 15 | 354.00 | May 15 | 53.78 | Jul 15 | 112.13 | Sep 15 | 171.75 | Nov 15 | 232.20 |
| Jan 16 | 295.44 | Mar 16 | 355.00 | May 16 | 54.75 | Jul 16 | 113.09 | Sep 16 | 172.73 | Nov 16 | 233.20 |
| Jan 17 | 296.46 | Mar 17 | 356.00 | May 17 | 55.71 | Jul 17 | 114.04 | Sep 17 | 173.70 | Nov 17 | 234.21 |
| Jan 18 | 297.48 | Mar 18 | 356.99 | May 18 | 56.67 | Jul 18 | 114.99 | Sep 18 | 174.68 | Nov 18 | 235.22 |
| Jan 19 | 298.50 | Mar 19 | 357.98 | May 19 | 57.64 | Jul 19 | 115.95 | Sep 19 | 175.65 | Nov 19 | 236.23 |
| Jan 20 | 299.52 | Mar 20 | 358.98 | May 20 | 58.60 | Jul 20 | 116.90 | Sep 20 | 176.63 | Nov 20 | 237.24 |
| Jan 21 | 300.53 | Mar 21 | 359.97 | May 21 | 59.56 | Jul 21 | 117.86 | Sep 21 | 177.61 | Nov 21 | 238.25 |
| Jan 22 | 301.55 | Mar 22 | 0.97 | May 22 | 60.52 | Jul 22 | 118.81 | Sep 22 | 178.59 | Nov 22 | 239.26 |
| Jan 23 | 302.57 | Mar 23 | 1.96 | May 23 | 61.48 | Jul 23 | 119.77 | Sep 23 | 179.56 | Nov 23 | 240.27 |
| Jan 24 | 303.59 | Mar 24 | 2.95 | May 24 | 62.45 | Jul 24 | 120.72 | Sep 24 | 180.54 | Nov 24 | 241.28 |
| Jan 25 | 304.60 | Mar 25 | 3.94 | May 25 | 63.41 | Jul 25 | 121.68 | Sep 25 | 181.52 | Nov 25 | 242.29 |
| Jan 26 | 305.62 | Mar 26 | 4.93 | May 26 | 64.37 | Jul 26 | 122.63 | Sep 26 | 182.50 | Nov 26 | 243.30 |
| Jan 27 | 306.64 | Mar 27 | 5.92 | May 27 | 65.33 | Jul 27 | 123.59 | Sep 27 | 183.48 | Nov 27 | 244.32 |
| Jan 28 | 307.65 | Mar 28 | 6.91 | May 28 | 66.29 | Jul 28 | 124.54 | Sep 28 | 184.46 | Nov 28 | 245.33 |
| Jan 29 | 308.67 | Mar 29 | 7.90 | May 29 | 67.25 | Jul 29 | 125.50 | Sep 29 | 185.45 | Nov 29 | 246.34 |
| Jan 30 | 309.68 | Mar 30 | 8.89 | May 30 | 68.21 | Jul 30 | 126.45 | Sep 30 | 186.43 | Nov 30 | 247.35 |
| Jan 31 | 310.70 | Mar 31 | 9.88 | May 31 | 69.17 | Jul 31 | 127.41 | | | | |
| Feb 1 | 311.72 | Apr 1 | 10.87 | Jun 1 | 70.13 | Aug 1 | 128.37 | Oct 1 | 187.41 | Dec 1 | 248.37 |
| Feb 2 | 312.73 | Apr 2 | 11.85 | Jun 2 | 71.09 | Aug 2 | 129.32 | Oct 2 | 188.39 | Dec 2 | 249.38 |
| Feb 3 | 313.75 | Apr 3 | 12.84 | Jun 3 | 72.04 | Aug 3 | 130.28 | Oct 3 | 189.38 | Dec 3 | 250.39 |
| Feb 4 | 314.76 | Apr 4 | 13.83 | Jun 4 | 73.00 | Aug 4 | 131.24 | Oct 4 | 190.36 | Dec 4 | 251.41 |
| Feb 5 | 315.78 | Apr 5 | 14.81 | Jun 5 | 73.96 | Aug 5 | 132.20 | Oct 5 | 191.35 | Dec 5 | 252.42 |
| Feb 6 | 316.79 | Apr 6 | 15.80 | Jun 6 | 74.92 | Aug 6 | 133.15 | Oct 6 | 192.33 | Dec 6 | 253.44 |
| Feb 7 | 317.80 | Apr 7 | 16.78 | Jun 7 | 75.87 | Aug 7 | 134.11 | Oct 7 | 193.32 | Dec 7 | 254.45 |
| Feb 8 | 318.82 | Apr 8 | 17.77 | Jun 8 | 76.83 | Aug 8 | 135.07 | Oct 8 | 194.30 | Dec 8 | 255.47 |
| Feb 9 | 319.83 | Apr 9 | 18.75 | Jun 9 | 77.79 | Aug 9 | 136.03 | Oct 9 | 195.29 | Dec 9 | 256.48 |
| Feb 10 | 320.84 | Apr 10 | 19.73 | Jun 10 | 78.74 | Aug 10 | 136.99 | Oct 10 | 196.28 | Dec 10 | 257.50 |
| Feb 11 | 321.85 | Apr 11 | 20.71 | Jun 11 | 79.70 | Aug 11 | 137.94 | Oct 11 | 197.27 | Dec 11 | 258.51 |
| Feb 12 | 322.86 | Apr 12 | 21.69 | Jun 12 | 80.65 | Aug 12 | 138.90 | Oct 12 | 198.25 | Dec 12 | 259.53 |
| Feb 13 | 323.88 | Apr 13 | 22.67 | Jun 13 | 81.61 | Aug 13 | 139.86 | Oct 13 | 199.24 | Dec 13 | 260.55 |
| Feb 14 | 324.89 | Apr 14 | 23.65 | Jun 14 | 82.56 | Aug 14 | 140.82 | Oct 14 | 200.23 | Dec 14 | 261.56 |
| Feb 15 | 325.90 | Apr 15 | 24.63 | Jun 15 | 83.52 | Aug 15 | 141.78 | Oct 15 | 201.22 | Dec 15 | 262.58 |
| Feb 16 | 326.91 | Apr 16 | 25.61 | Jun 16 | 84.47 | Aug 16 | 142.74 | Oct 16 | 202.21 | Dec 16 | 263.60 |
| Feb 17 | 327.91 | Apr 17 | 26.59 | Jun 17 | 85.43 | Aug 17 | 143.70 | Oct 17 | 203.21 | Dec 17 | 264.61 |
| Feb 18 | 328.92 | Apr 18 | 27.57 | Jun 18 | 86.38 | Aug 18 | 144.66 | Oct 18 | 204.20 | Dec 18 | 265.63 |
| Feb 19 | 329.93 | Apr 19 | 28.54 | Jun 19 | 87.34 | Aug 19 | 145.63 | Oct 19 | 205.19 | Dec 19 | 266.65 |
| Feb 20 | 330.94 | Apr 20 | 29.52 | Jun 20 | 88.29 | Aug 20 | 146.59 | Oct 20 | 206.18 | Dec 20 | 267.67 |
| Feb 21 | 331.95 | Apr 21 | 30.50 | Jun 21 | 89.25 | Aug 21 | 147.55 | Oct 21 | 207.18 | Dec 21 | 268.69 |
| Feb 22 | 332.96 | Apr 22 | 31.47 | Jun 22 | 90.20 | Aug 22 | 148.51 | Oct 22 | 208.17 | Dec 22 | 269.71 |
| Feb 23 | 333.96 | Apr 23 | 32.45 | Jun 23 | 91.15 | Aug 23 | 149.48 | Oct 23 | 209.17 | Dec 23 | 270.72 |
| Feb 24 | 334.97 | Apr 24 | 33.42 | Jun 24 | 92.11 | Aug 24 | 150.44 | Oct 24 | 210.16 | Dec 24 | 271.74 |
| Feb 25 | 335.98 | Apr 25 | 34.40 | Jun 25 | 93.06 | Aug 25 | 151.41 | Oct 25 | 211.16 | Dec 25 | 272.76 |
| Feb 26 | 336.98 | Apr 26 | 35.37 | Jun 26 | 94.02 | Aug 26 | 152.37 | Oct 26 | 212.16 | Dec 26 | 273.78 |
| Feb 27 | 337.99 | Apr 27 | 36.35 | Jun 27 | 94.97 | Aug 27 | 153.34 | Oct 27 | 213.16 | Dec 27 | 274.80 |
| Feb 28 | 338.99 | Apr 28 | 37.32 | Jun 28 | 95.93 | Aug 28 | 154.30 | Oct 28 | 214.15 | Dec 28 | 275.82 |
| | | Apr 29 | 38.29 | Jun 29 | 96.88 | Aug 29 | 155.27 | Oct 29 | 215.15 | Dec 29 | 276.84 |
| | | Apr 30 | 39.26 | Jun 30 | 97.83 | Aug 30 | 156.23 | Oct 30 | 216.15 | Dec 30 | 277.86 |
| | | | | | | Aug 31 | 157.20 | Oct 31 | 217.15 | Dec 31 | 278.88 |

**2. How do I obtain solar longitudes for 1995?**

The algorithms for converting the dates into solar longitudes and vice versa are very complicated. However, the solar longitude is the best measure for referencing meteor shower activities as it represents a fixed point on the Earth's orbit. Table 1 is a conversion table for all 1995 dates. Note that the table is only valid for one specific year. The given longitudes were calculated with the algorithm given in [3].

**References**


[1] Arlt, R., "Frequently Asked Questions on Observing Methods", *WGN* 22:1, February 1994, p. 7.

[2] Koschack, R., Rendtel, J., "Determination of Spatial Number Density and Mass Index from Visual Meteor Observations (I)", *WGN* 18:2, April 1990, p. 45.

[3] Steyaert, C., "Calculating the Solar Longitude 2000.0", *WGN* 19:2, April 1991, pp. 31–34.


# The 1995 International Meteor Conference

## Brandenburg, Brandenburg, Germany, September 14–17, 1995

*Ina Rendtel, Jürgen Rendtel, and Rainer Arlt*

As already announced in the December issue of *WGN*, the 1995 *International Meteor Conference* will be held near the city of Brandenburg in Germany. Although the deadline for pre-registration (which was set quite early) has passed, there are still some places available. However, you should not wait too long with your registration.

The meeting takes place in a kind of youth hostel, where no single rooms are available. For participants arriving earlier or leaving later by combining their journey with some sightseeing, for example, we offer assistance to get this prepared. Please contact one of the organizers. A first circular was already sent to those who registered or declared their interest to attend the IMC. People registering in the near future will receive this information promptly. Please do not forget to indicate on the registration form whether you need to be picked up at the Brandenburg railroad station or somewhere else. For the registration, please follow the information given on the registration form.

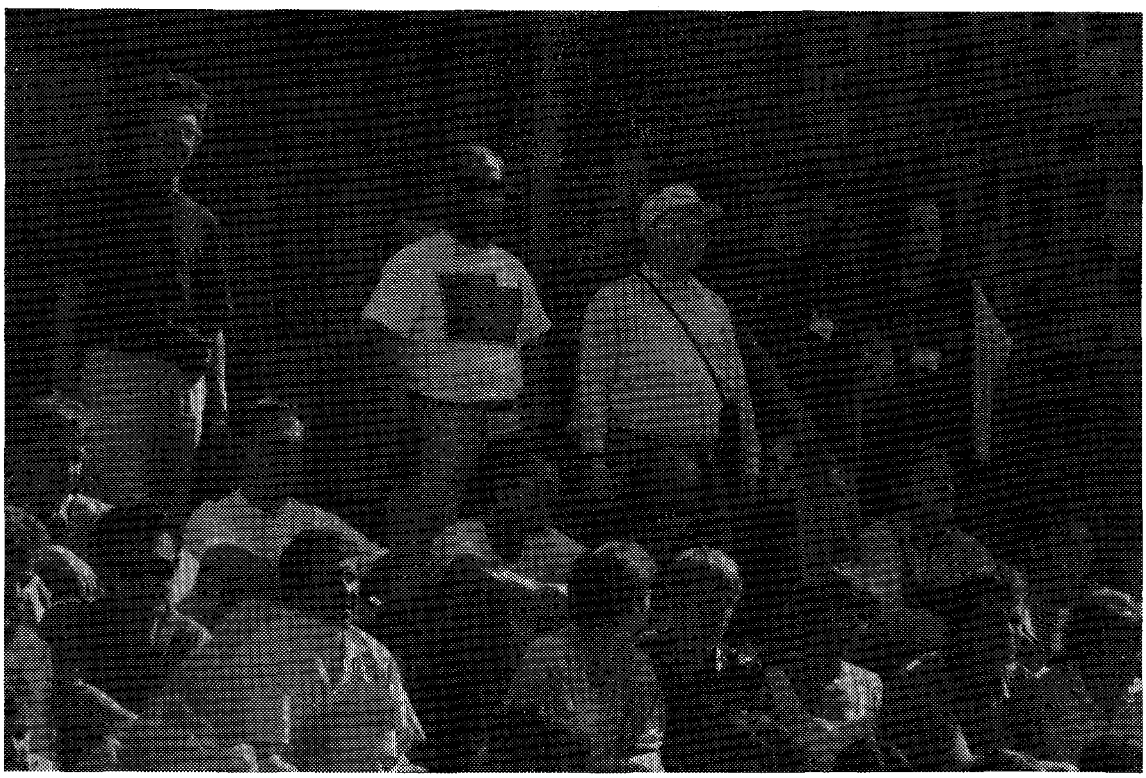


Figure 1 – Some of the participants of the 1994 *International Meteor Conference* in Belogradchik, Bulgaria, at the steps of the lecture hall.

# International Meteor Conference

## Brandenburg, Germany, September 14–17, 1995

### Registration Form

Each individual participant should fill out a form and return it to Ina Rendtel, Gontardstraße 11, D-14471 Potsdam, Germany, as soon as possible.

Your registration will be guaranteed only after Ina Rendtel has received the minimum pre-payment of 100 DEM.

If you wish to participate, but cannot yet decide, simply return this form with the proper option checked to stay on the mailing list for further circulars.

Name: ______________________________ Birth date: ____________

Address: ______________________________________________

______________________________________________________

______________________________________________________

Phone: ______________ Fax: ______________ E-Mail: ______________

- o wishes to register for the 1995 *IMC* from September 14 to 17;
- o intends to participate, cannot yet register, but wishes to stay on the mailing list.

I intend to travel by ________, together with ______________________________

Additional requests:

- o I need to be picked up at the Brandenburg railroad station;
- o I need travel information from ________________ to Brandenburg.

For participants wishing to contribute to the program:

Lecture: ______________________________________________

Duration: ________min. Required equipment: ______________________________

Workshop or discussion: ______________________________________

Poster presentation: ______________________________ Space: ________ m$^2$

Either the entire fee of 190 DEM or a pre-payment of at least 100 DEM should be sent to the Treasurer, *Ina Rendtel*, in the same way as your membership/subscription fee. Remember that Ina cannot accept bank checks! People wishing to pay in other currencies (USD, GBP, or JPY) should contact the appropriate *IMO* contact person for exchange rates.

Participants paying only 100 DEM have to pay the remaining 90 DEM upon arrival in Brandenburg.

Date and signature: ______________________________________

# Meteor Photography: Why Not?

*Marc de Lignie*

## 1. Introduction

Stimulating meteor photography has turned out to be difficult. Although meteor radiants and orbits obtained from photographic observations are highly valued, only few local organizations have succeeded in bringing together a significant number of people into a systematic program for meteor photography. As a result there is a sharp contrast within the *IMO* between the highly organized visual observations and the rather casual reports of photographic efforts. This is rather unfortunate because for many meteor streams good photographic observational material is very scarce [1,2]. Therefore, the *IMO* should consider it a challenge to give photographic observations more attention.

The aim of this article is to investigate possible reasons why people do not start photographic observations. It is felt that there are some obstacles which may be real or may merely exist in the minds of potential meteor photographers. If we know these obstacles some support can be offered to overcome them. Therefore, potential meteor photographers are asked to answer the simple questionnaire that follows the article below. The results of this questionnaire will be discussed during the next *IMC* in Brandenburg.

However, also the readers that can not attend the 1995 *IMC* are kindly invited to return the questionnaire.

## 2. Obstacles

Below some possible obstacles to starting meteor photography are listed.

1. Cameras and photographic film are too expensive.
2. Making the camera setup is too laborious.
3. Transport of equipment to the observing site is too cumbersome.
4. I have no means to measure meteor photographs.
5. I have no computer programs for astrometry and further analysis.
6. There are no other meteor photograpers in my local organization.
7. What is the use of meteor photography anyway?

Maybe just a single obstacle turns out to be the critical factor. It is also possible that a combination of obstacles gives the impression that serious photographic observations are too difficult.

## 3. Photography in the Netherlands

In order not to discourage potential meteor photographers, I want to show that the obstacles can certainly be overcome by amateurs.

In the Netherlands, meteor photography has been popular for a period of at least 20 years. Typically, about six groups of observers are active during the major shower maxima. Each group has its own observing site and photographic equipment. The equipment consists of so-called camera batteries, in which 6 or 8 cameras are mounted in a circle. Each battery has a rotating shutter for meteor velocity measurements and a cover plate to start and finish the exposures of all cameras simultaneously. To complete the setup, each camera has a cable release and lenses are heated to prevent fogging. Most groups have two or three of these batteries, implying that between 12 and 22 cameras are operative on a single site and most of the sky is covered continuously.

This way of working is very favorable for double-station photography: due to the large sky coverage a large fraction of meteors is photographed from two or more stations. So, although the way of working seems a waste of photographic materials, in fact it is not. However, the distance between the camera stations should be well chosen, between 30 and 100 km.

As a result of this tradition, even unexperienced meteor photographers in the Netherlands start with building a camera battery. It is our experience that the money required for building a camera battery is not an inhibitive factor in most cases. This suggests that the most important condition for people to enter meteor photography is that they can join an already running organization. Within such an organization it is also very apparent that photographing meteors is fun and that it provides for an important binding factor between people. Double-station photography requires a lot of co-operation, both in the preparation of a campaign, during the observations itself and during the data reduction afterwards.

In the Netherlands we have experienced that meteor photography is characterized by a long learning curve. In the early eighties typically 10 or 20 double-station recordings were obtained each year. Later in the decade this number increased to 50, while in recent history on average more than 100 meteors are photographed from multiple stations each year. This experience shows that setting up a new photographic network asks for a lot of perseverance by the participants.

A much quicker way for beginning photographers to obtain results would be to join an existing network during an international campaign. For instance, Dutch observers have organized such campaigns in Southern France in 1990 and 1993 and similar campaigns are to be expected in the future.

For measuring the photographic negatives we have used a special measuring device of the Leiden University for many years. Recently, however, we developed a computer program for measuring meteor photographs on Photo CD. This program has turned out to speed up the measuring process enormously [3,4]. The calculations for double-station meteors are carried out with the FIRBAL program of the Ondřejov Observatory (Dr Z. Ceplecha).

Up till now several hundreds of double-station meteors have been reduced this way and our database is beginning to become a significant fraction of all orbits known in the entire history of meteor photography. The only missing step at present is the publication of all results in the scientific literature so that they become available for further research and general reference [5,6].

This description of the present situation in the Netherlands shows that serious photographic observations are well within the amateur's reach.

### Single-station or double-station?

Amateur meteor photography is plagued by an old discussion whether one should put effort in the reduction of any meteor trail or whether one should restrict oneself to meteors that are photographed from two or more sites.

The advantages of single-station photography are the following:

- any meteor trail is usable (provided that a rotating shutter was used and that the camera and meteor times are available); and
- no arrangements with fellow photographers are required.

The advantages of double-station photography are the following:

- observational results are not susceptible to systematic errors;
- it is more efficient from a statistical point of view;
- small samples are already valuable (minor streams); and
- individual orbits can be calculated.

The advantages of double-station photography are so great that references in the scientific literature are almost exclusively to double-station work. A more practical argument is that a successful group of photographers will soon find that the bottleneck is not in photographing more meteors but in reducing the data. Then, it is no problem anymore to just put aside the single-station trails. So, the goal should be to extend activities on double-station photography within the *IMO*.

However, single-station photography could be very helpful for observers to gain more experience with photography and to obtain results quicker. Furthermore, observers living too far from neighboring meteor observers will be able to provide single-station photographs. Therefore, a short term goal is also to coordinate the reduction of single-station trails and to publish analyses as soon as data samples of sufficient size are available. As a contribution to this goal, the procedure to measure prints of single-station meteors will be shortly recalled in a future article.

### Questionnaire

Please return the questionnaire on the next page to the author before May 31, 1995.

### References


[1] B.A. Lindblad, "The orbit of the Eta Aquarid meteor stream", in *Asteroid, comets, meteors* III, Uppsala, June 12–16, 1989, pp. 551–553.

[2] B.A. Lindblad, V. Porubčan and J. Štohl, "The orbit and mean radiant motion of the Leonid meteor stream", in *Meteoroids and their parent bodies*, Smolenice, July 6–12, 1992, pp. 177–180.

[3] M.C. de Lignie, "Measuring meteor negatives using photo CD: a small revolution", *Radiant* 16, 1994, pp. 5–12.

[4] H. Betlem and M.C. de Lignie, "Multi-station meteor photography in the Netherlands", in *Asteroid, comets, meteors* III, Uppsala, June 12–16, 1989, pp. 509–512.

[5] H. Betlem, C.R. ter Kuile, and M.C. de Lignie, "Three-station photographic observations of the 1990 Geminid meteor shower", in *Meteoroids and their parent bodies*, Smolenice, July 6–12 1992, pp. 161–164.

## Questionnaire

Please return this questionnaire before May 31, 1995, to Marc de Lignie, Prins Hendrikplein 42, NL-2264 SN Leidschendam, the Netherlands.

Name: ______________________________

Country: ______________________________

1. Did you photograph any meteors in the past few years? If so, how often?

Yes/No ________

2. What are the main obstacles for you to start or extend your efforts on meteor photography? (indicate three obstacles in decreasing priority from the list in the article)

1. ____________ 2. ____________ 3. ____________

3. Do you feel additional obstacles not mentioned in the list? If so, please explain.

Yes/no

______________________________

______________________________

4. What kind of support from the *IMO* would be the most helpful?

______________________________

______________________________

______________________________

______________________________

# Meteor Photographs Received for the PMDB

*Jürgen Rendtel*

After the note in the February issue, a number of further meteor photographs has reached us for inclusion into the *Photographic Meteor Data Base* (*PMDB*). Some of the images were sent to Rainer Arlt together with visual data or letters. Of course, observers may put their results into one envelope if they regard visual and photographic results because these data will arrive at the respective desk in Potsdam for further analysis. However, it may happen that some results are not listed promptly in *WGN* as it happened in the last issue. Nevertheless, we very much acknowledge further meteor photographs for the *PMDB* archive received from:

> Anton Antonov (Bulgaria), Valentin Grigore (Rumania), Violeta Ivanova (Bulgaria), Ralf Koschack (Germany), Robert Lunsford (USA), Vasile Micu (Rumania), Vaselka Radeva (Bulgaria), Ala' Shalin (Jordan), Rumen Shopov (Bulgaria), Marina Stomeo (Italy), and Valentin Velkov (Bulgaria).

May be you have meteor photographs in your personal archive as well and might consider sending these for inclusion into the *PMDB*.

As already pointed out in the summary in the February issue, the number of meteors from ecliptical sources is very low. This is also the case in the records listed above. Many meteors are photographed during visual meteor observations or during other activities while the photographer witnesses the meteor. In these cases the time of appearance should be noted with the best possible accuracy. This also holds for the begin and end of the exposure. If you photograph regularly, you certainly have a log book which is also useful to identify exposures later for other investigations.

# Visual Observers' Notes: May–June 1995

*Jeff Wood*

## 1. Introduction

The months of May and June contrast greatly between the northern and the southern hemispheres. In the northern hemisphere there are few showers active and hence overall meteor rates tend to be low. In the southern hemisphere there are quite a few showers to be seen. This together with the ecliptic being high overhead ensures that good rates are seen.

Table 1 lists some of the meteor showers to be seen in May and June 1995. Table 2 shows moonlight and observing conditions. 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. Note that the activity period data for the June Bootids and the $o$-Cetids are uncertain.

The Visual Commission of the *IMO* although requiring data on all streams realizes practical considerations like work, study, family, Moon and weather prevent people from observing regularly on a day by day basis throughout most of the year. With this in mind, it has been decided to encourage everyone who has time to observe to concentrate on a couple of showers per month rather than the whole lot. This means we should be able to get a good set of data on these few rather than sparse data on many showers. The showers chosen for special investigation for the months of May and June are the Scorpio-Sagittarid showers, the $\eta$-Aquarids, and the June Bootids.

Table 1 – A list of some of the meteor showers to be seen in May–June 1995.

| Shower | Activity | Max | Radiant | | | Drift | | $V_\infty$ | $r$ |
|---|---|---|---|---|---|---|---|---|---|
| | | | $\alpha$ | $\delta$ | D. | $\Delta\alpha$ | $\Delta\delta$ | | |
| $\eta$-Aquarids | Apr 19–May 28 | May 05 | 336° | −02° | 4° | +0°.9 | +0°.4 | 66 | 2.7 |
| $\beta$-Corona Australids | Apr 23–May 30 | May 18 | 284° | −40° | 4° | +0°.9 | +0°.1 | 45 | 3.1 |
| Southern Ophiuchids | May 10–May 29 | May 20 | 258° | −24° | 5° | +0°.9 | −0°.1 | 30 | 2.9 |
| Northern Ophiuchids | Apr 25–May 31 | May 13 | 249° | −14° | 5° | +0°.9 | −0°.1 | 30 | 2.9 |
| $\kappa$-Scorpids | May 04–May 27 | May 19 | 267° | −39° | 4° | +0°.9 | 0°.0 | 45 | 2.8 |
| $\theta$-Ophiuchids | Jun 04–Jul 15 | Jun 13 | 267° | −20° | 5° | +0°.9 | 0°.0 | 27 | 2.8 |
| $\gamma$-Sagittarids | May 23–Jun 13 | Jun 06 | 272° | −28° | 5° | +0°.9 | 0°.0 | 29 | 2.9 |
| $\lambda$-Sagittarids | Jun 05–Jul 25 | Jul 01 | 276° | −25° | 5° | +0°.9 | 0°.0 | 23 | 2.6 |
| Lyrids (June) | Jun 11–Jun 21 | Jun 16 | 278° | +35° | 5° | +0°.8 | 0°.0 | 31 | 3.0 |
| Bootids (June) | Jun 26–Jun 30 | Jun 28 | 219° | +49° | 8° | | | 14 | 3.0 |
| $o$-Cetids | May 06–Jun 05 | May 15 | 25° | −04° | 5° | | | 36 | 3.0 |
| $\alpha$-Scorpids | Mar 26–Jun 04 | May 03 | 246° | −25° | 5° | +0°.9 | −0°.1 | 35 | 2.5 |

Table 2 – Moonlight and observing conditions in May–June 1995.

| Date | $k$ | Date | $k$ |
|---|---|---|---|
| Friday April 28 | 0.03− | Friday June 02 | 0.12+ |
| Friday May 05 | 0.23+ | Friday June 09 | 0.77+ |
| Friday May 12 | 0.89+ | Friday June 16 | 0.88− |
| Friday May 19 | 0.77− | Friday June 23 | 0.21− |
| Friday May 26 | 0.10− | Friday June 30 | 0.04+ |

| | |
|---|---|
| New Moon: | April 29, May 29, June 28 |
| First Quarter: | May 7, June 6, July 5 |
| Full Moon: | May 14, June 13, July 12 |
| Last Quarter: | May 21, June 19, July 19 |

## 2. $\eta$-Aquarids

This fine shower is active from April 19 through to May 29 and reaches a maximum ZHR of 50 to 60 meteors per hour on May 5. The $\eta$-Aquarids have an unusual activity curve with ZHRs remaining above 35 from about May 3 to May 10. In some years, this period is even greater such as in 1980 when it extended from May 2 to May 15. Another unusual feature of the $\eta$-Aquarids is a second maximum on May 8 which has been detected on at least five occasions in the last 15 years. Studies by Z. Sekanina in the USA during the 1960s and 70s involving radio meteors showed that the $\eta$-Aquarids consisted of two sub-streams, the "proper" $\eta$-Aquarids which reached maximum around May 5 and the so-called Halleyids, which reached maximum on May 8. Since the radiants are very close together, it is impossible to visually separate meteors belonging to these sub-streams, and so naked-eye results show their combined activity.

The $\eta$-Aquarids, which where produced by debris from Halley's Comet, are a very spectacular stream, especially for southern hemisphere observers. Unfortunately, because the radiant reaches culmination during daylight hours, the $\eta$-Aquarids cannot be viewed in all their glory. Although the radiant is equatorial with a declination of $-2°$, the seasons are such that it is daylight in much of the northern hemisphere before the radiant can rise more than 20° above the horizon. The southern hemisphere is more favorably placed, and the radiant is able to rise above 50° before sunrise.

The $\eta$-Aquarids are best viewed the last couple of hours before sunrise, approximately $3^h45^m$ to $5^h45^m$ am local time. They are characteristically fast, yellow in color, and have a train. It is not unusual for these trains to be very persistent, lasting more than 30 seconds. The $\eta$-Aquarids produce many brilliant fireballs, the best on record being a magnitude $-9$ green meteor seen during their 1980 display. This meteor also had a yellow-green train that lasted for some 5 minutes after the meteor itself disappeared from view.

The year 1995 is favorable moon-wise to observe the $\eta$-Aquarids. The *IMO* encourages observers in both hemispheres to make this stream a special target for their attention.

### 3. Scorpio-Sagittarids

The Scorpio-Sagittarids encompass a number of streams that occur in the constellations of Scorpius and Sagittarius during the months of March, April, May, June and July. Named by Dr. C. Hoffmeister during the 1930s, these ecliptic streams are thought to have originated from Comet Lexell (1770 II). The Scorpio-Sagittarid showers are noted for greatly varying rates. At times, they are virtually not active while on other occasions, ZHRs of around 10 have been recorded. The Scorpio-Sagittarid showers are noted for bright colored fireballs and the occasional meteor that produces a persistent train.

As mentioned previously, the Scorpio-Sagittarids consist of a number of sub-streams. The major components whose details are described in Table 1 are the $\alpha$-Scorpids, Northern and Southern Ophiuchids, $\beta$-Corona Australids, $\kappa$-Scorpids, $\gamma$-Sagittarids, $\theta$-Ophiuchids, and $\lambda$-Sagittarids. Since Scorpio-Sagittarid meteors have velocities similar to those of the majority of sporadic meteors, great care needs to be taken in identifying them. Observers should be facing the radiant area and plot all meteors seen.

### 4. June Bootids

The June Bootids were produced by the debris of Comet Pons-Winnecke (1915 III) and appeared as a new shower in 1916. For several years, they produced high ZHRs of up to 100, but in recent years the shower has mostly been absent, though on rare occasions low rates of 1–2 meteors per hour have been recorded. The last of these were in the late 1960s and early 1970s. The June Bootids are expected to be active around June 28. They have a visual radiant diameter of approximately 8° and are extremely slow-moving. Although there are some bright meteors, observations of the shower indicate that it is unusually rich in fainter members. In 1995, there is no interference from the Moon. Observers should begin the watch from June 24 and continue until July 1 or 2. All meteors seen should be plotted and great care taken to identify possible shower members.

### 5. Daytime showers

Since the southern hemisphere is approaching the winter solstice, the long nights mean that the radiants of several of the major daytime streams can rise substantially above the horizon before daylight. The two best candidates for viewing are the May $o$-Cetids and the June Arietids. Past observations of these streams indicate that during the last hour of darkness before dawn visual rates can rise up to 5 meteors per hour. Both the $o$-Cetids and the Arietids produce fast blue-white colored meteors which often have a train. Intending observers should look as close to the radiant area as possible and plot all possible shower meteors seen.

### 6. Theoretical radiant of Comet 1983 VII

The orbit of the long-period comet 1983 VII approaches the Earth at a minimum distance of 0.003 AU on May 12, yielding a theoretical radiant at $\alpha = 289°$ and $\delta = +44°$ with $V_\infty = 45.4$ km/s. This radiant is well situated for observers in the northern hemisphere. The geocentric velocity as well as the very close approach of the Comet's orbit leave a chance that there will be a detectable shower. The actual radiant position may differ somewhat from the predicted one. To determine it, plot all meteors possibly radiating from an area of about 15° radius around the predicted radiant, fill out a list as for the Aquarid project [1] and send it to the Visual Commission. Using *PosDat* and *Radiant*, it will be investigated whether there is a radiant and where. For plotting, the *Gnomonic Atlas Brno 2000.0* is recommended. The field of view should be centered at a distance of about 10° to 30° from the predicted radiant. For observations the time from around May 5 until May 20 is recommended.

### Reference

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

# Photographic Observers' Notes: May–June 1995

*Jürgen Rendtel*

The $\eta$-Aquarids are the only significant cometary meteor shower active in this period of the year. While visual observers north of about 45° N latitude in fact see nothing of this shower, it becomes better observable from low latitudes. Thus we ask particularly the photographers south of about 40° N for respective attempts in the period May 1 to 8. In 1995, the activity period is not affected by moonlight—the waxing moon sets long before the radiant rises.

Because of the high atmospheric entry velocity of 65 km/s, the angular velocity is large for meteors distant from the radiant and close to zenith. The favorable area is about 40 degrees from the radiant. Since the regions too close to the zenith and towards the twilight should be avoided, this leads to a field mainly west of the radiant.

The radiant of the ecliptical meteor complex has moved into the southernmost region of the ecliptic by May. As in the previous months, only little is known about the radiant structure and the activity level during this period of the year. The shower is now designated as the Scorpids, but is a similar complex of radiants as the Virginids earlier.

The naming of the ecliptical showers is a kind of relict from the beginning of the radiant searches done in the last century. There is a source or a number of sources close to the ecliptic active throughout the year. The superposition and low activity from the individual sources does not allow to distinguish between them by means of visual observations. The complex of minor bodies to which these showers belong as well as the frequent orbit perturbations may be the reason for variable rates and radiants from one year to the next. Since the ecliptical meteors are related with all kinds of objects which can be found at short period orbits, the individual meteoroids may be of very different type.

# Telescopic Observers' Notes, May–June 1995

*Malcolm J. Currie*

In stark contrast to last year, the Commission has had a successful observational start to the year. In the UK, there has been an abnormal number of clear or partially clear nights during February and March—some 55% clear at my site up to the spring equinox. Excluding periods around the full moon when observation was not possible I have been able to view meteors on 19 nights, including many at weekends. It is as if Mr. Murphy is on a long vacation. Further north in England, Chris Hall has not been as fortunate, but still has recorded over 60 meteors during the last two dark periods, that being his best start to a year. In all there are well over 700 meteors reported for the first three dark periods in about 90 hours of observing.

The surfeit of good weather and a higher than normal level of correspondence too has meant that I have not had the time to analyze the data, even superficially. In some respects I could do with lots of cloud for a couple of months. Of note are that I saw a brief burst of activity on January 22-23 with six approximately parallel meteors in 18 minutes ($02^h29^m$–$02^h47^m$ UT), which might be from the shower detected by radio. This only gives an arc along a great circle where the radiant might be located. It suggests the Lynx-Auriga region. Unfortunately, the other field centers did not evidence an obvious triangulation. On March 6-7, 15 of the 41 meteors recorded during 3.67 hours ($22^h27^m$–$04^h05^m$, lm = +6.7) seen in five fields appeared to emanate from $\alpha = 155°$ and $\delta = +15°$. The meteors were mostly faint and had medium to slow speed, say $V_\infty \approx 25$ km/s. It is not clear if this is a known shower. Various lists do suggest weak radiants in this region. Of these, the $\beta$-Leonids is the best fitting, though that is not to say that it gives a good match. It does not seem likely that it is part of the *JASMS* Virginid Region 1, because the center of that lies about 18° to the south east. Also the Virginid area was diffuse, whereas the March 6-7 radiant was observed to have a diameter less than a degree across. This would imply a youthful stream, so perhaps attempts to tie into earlier records will prove fruitless.

Another reason for my optimism is an increased interest from potential observers. There were six enquiries around New Year and February. One of these has already submitted data—Joseph Lawrence of Fort Wayne, Indiana—whom we warmly welcome to the Commission.

After a year or so of experience with the telescopic charts both observing and preparing these notes, I found that there were some gaps that hampered coverage of certain showers including the Taurids, July Pegasids, and Leonids. At the same time there were some overlaps that had little benefit. (They had been compiled from three lists.) So I relocated 19 of the fields. Of these, eight had slight displacements to reduce or eliminate an overlap with another field, or to avoid a bright star, like Altair in 151 (A set only). The remainder had more drastic shifts. Of these only a couple have been referred to in these notes, and one of those was an alternate. Where possible I have tried to retain the declination banding. Those with the charts should have received the replacements. The total number of charts per set remains unchanged. Those fields that have moved significantly are denoted by a "†" in the remainder of these notes.

**Forthcoming events**

Twilight plays a major role in these months. The short northern nights prevent an extended observing sessions and hence our meteor totals are miniscule. Data from those south of latitude +45° are especially encouraged as twilight is less constraining.

A case in point is the *η-Aquarid* shower. There are many hardened meteor observers in Europe who have never seen a meteor from this shower, as the radiant does attain a decent elevation before the dawn comes up. It is part of the 1P/Halley stream that also gives rise to the Orionids of October. It is believed that there are distinct streamlets that give rise to multiple maxima and radiants. Of most interest telescopically is to map the distribution of these radiants through the encounter with the stream. With careful plotting at least three components can clearly be resolved. I have more to say about this in a later set of notes for the Orionids, which are also favorably placed this year. Suffice it to say that this stream is probably the most important one for the Telescopic Commission, and I urge all well-placed observers ($\varphi < +40°$) to investigate this shower from late April until mid-May. You do not have to stay up all night; just set your alarms to catch the last couple of hours of darkness. Suggested charts are 137, 163, and 114$^\dagger$.

The *θ-Herculids* are faint, medium-speed meteors believed to be associated with C/IRAS-Araki-Alcock, discovered independently by Mark Vints from telescopic observations and by members of the *Nippon Meteor Society*. This shower gives observed rates comparable with the sporadic background, and so is one of the strongest telescopic showers. We know it has a compact radiant of diameter about 1° around $\alpha = 270°$ and $\delta = +37°$. What we do not know and could measure are its duration, time of maximum, radiant motion and size throughout the activity period. There is also some disagreement in the radiant position between different observers in different years. Clearly there is much to learn, and telescopic and video techniques are best given this shower's dearth of naked-eye meteors. The lunar phase is ideal, with new moon occurring close to the supposed maximum. Please attempt watches for this shower during the fortnight centered on May 29. Suggested chart sets are 85, 111, and 112$^\dagger$; and 67 and 131.

At this time of year, there are numerous radiants near the ecliptic, stretching from Libra to Sagittarius, many of which we believe are caused by complexes of related streams. Whilst these dominate the night-time shower-meteor flux when the whole two months are considered, the subdivisions and long durations caused by perturbations to the stream orbits have diluted the showers so that any individual shower only gives weak activity, and most are near the detection limit.

This is especially true of the *Scorpid-Sagittarid Complex*. The best components are the α-Scorpids and γ-Sagittarids, which are only observable from $\varphi < +30°$. This complex needs a long-term detailed telescopic program from sites in around $\varphi = -35°$ to delineate the various constituent branches, finding their radiant positions and sizes, and to determine their activity dates. The fact that there have been no significant southern telescopic observations means any sustained campaign is bound to result in many discoveries and unfurl a great tapestry.

In compensation to those in the north, the weaker, more-northerly showers of the Complex have high population indices, and most have medium or slow speeds, both of which help the telescopic watcher. Of the ecliptic showers in this region, the best telescopically appears to be the bifurcated *Ophiuchids*, giving rates much better than one would expect from its visual performance. Even from mid-northern latitudes it gives rates up to a third of sporadic although its elevation is in the low twenties. At a site where the radiant is high this could be a major telescopic shower and warrants detailed investigation. In the north the observing strategy is to select at least three fields about 20° north of the ecliptic separated by 15°–25°, and where possible, to add a field to the east ot west of the the complex to give a better definition of the declination of the radiants. Suggested charts are (in right ascension order) 160, 10$^\dagger$, 162, and 163; or 65$^\dagger$, 148, 161, and 151. In June discard the westernmost centers. In the southern hemisphere select five centers in a W shape, three 20° south of the ecliptic and two 20° north that span the region.

The field centers for the southern complexes are also amenable for revealing new showers to the north. For those north of $\varphi = +50°$, where the ecliptic complexes skirt the southern horizon, you might prefer to hunt for new showers at higher declinations. As I indicated earlier, there are few data for these months and the appearance of a new shower is far from unlikely. The June Lyrids and the θ-Herculids are two recent examples. Some suggested charts are 43, 28, 47, and 7; or 44, 68, 33, and 7. The first three in each set are separated by about 30° at similar declinations. Field 7 will help to pinpoint the right ascension of any radiant situated between the first three fields. Cycle through a set, changing fields about every 30 minutes.

The *α-Bootid* are a poor minor shower rich in faint slow-moving meteors. In 1995 its maximum occurs during dark skies of late April and early May. We know little of its telescopic output. Suggested charts are 65, 148, and 109; or 83 and 84.

# Theoretical Radiants of Minor Planets and Comets

*Dirk Artoos*

Below is a list of theoretical radiants of minor planets and comets, some of which may cause meteor activity during May and June.

Table 1 – Theoretical radiants of asteroids and comets in May–June 1995.

| Name | $\lambda_\odot$ | Date | $\alpha$ | $\delta$ | $V_\infty$ | Distance |
|---|---|---|---|---|---|---|
| P/–86 (Halley) | 41°.13 | May 01 | 334° | – 2° | 67 km/s | 0.03933 AU |
| 1994 CJ1 | 42°.89 | May 03 | 155° | – 7° | 12 km/s | 0.03373 AU |
| P/1853 II | 43°.48 | May 04 | 299° | +14° | 65 km/s | 0.06413 AU |
| Anteros (1943) | 44°.85 | May 05 | 114° | –46° | 12 km/s | 0.08666 AU |
| 1994 RC | 46°.95 | May 07 | 202° | + 6° | 16 km/s | 0.07172 AU |
| P/1910 (Halley) | 48°.23 | May 09 | 340° | + 1° | 68 km/s | 0.06140 AU |
| P/1986 VII (Halley) | 48°.40 | May 09 | 340° | + 1° | 68 km/s | 0.06202 AU |
| P/1991 a1 | 48°.40 | May 09 | 322° | +26° | 62 km/s | 0.07722 AU |
| P/1983 VII | 49°.12 | May 10 | 289° | +44° | 45 km/s | 0.00384 AU |
| 1981 VA (3360) | 51°.05 | May 12 | 213° | –46° | 26 km/s | 0.11485 AU |
| 1988 TA (5704) | 51°.73 | May 12 | 215° | –21° | 17 km/s | 0.02694 AU |
| Apollo (1862) | 51°.97 | May 13 | 233° | – 7° | 20 km/s | 0.03126 AU |
| P/1968 IV | 54°.00 | May 15 | 312° | –62° | 60 km/s | 0.15363 AU |
| P/1757 | 54°.46 | May 15 | 45° | + 8° | 37 km/s | 0.06630 AU |
| P/1748 I | 56°.48 | May 17 | 348° | –64° | 57 km/s | 0.13709 AU |
| P/1875 I | 56°.78 | May 17 | 212° | +16° | 20 km/s | 0.17285 AU |
| Anteros (1943) | 58°.12 | May 19 | 102° | –40° | 12 km/s | 0.07389 AU |
| P/1952 I | 58°.43 | May 19 | 306° | – 5° | 66 km/s | 0.19254 AU |
| 1989 FB (5803) | 58°.84 | May 19 | 269° | +17° | 15 km/s | 0.18422 AU |
| Xanthus (4544) | 59°.52 | May 20 | 270° | +17° | 15 km/s | 0.18430 AU |
| P/1766 I | 60°.97 | May 22 | 308° | –37° | 63 km/s | 0.11331 AU |
| P/1990 VIII | 63°.37 | May 24 | 209° | +27° | 17 km/s | 0.03369 AU |
| P/1892 I | 63°.98 | May 25 | 140° | –76° | 28 km/s | 0.07109 AU |
| 1989 JA (5818) | 65°.31 | May 26 | 237° | +25° | 17 km/s | 0.02816 AU |
| 1991 JR | 66°.43 | May 28 | 230° | +47° | 13 km/s | 0.05661 AU |
| P/1846 VII | 66°.72 | May 28 | 319° | –30° | 65 km/s | 0.18821 AU |
| P/1937 V | 67°.83 | May 29 | 349° | +14° | 66 km/s | 0.14068 AU |
| 1993 PC | 68°.28 | May 30 | 58° | +28° | 19 km/s | 0.07250 AU |
| 1991 JW | 70°.71 | Jun 01 | 274° | +26° | 12 km/s | 0.07166 AU |
| P/1863 II | 71°.64 | Jun 02 | 3° | –43° | 60 km/s | 0.09481 AU |
| P/1863 III | 71°.68 | Jun 02 | 326° | –66° | 54 km/s | 0.17587 AU |
| P/1863 II | 73°.10 | Jun 04 | 2° | –43° | 60 km/s | 0.06927 AU |
| Oljato (2201) | 76°.66 | Jun 07 | 79° | +27° | 23 km/s | 0.00026 AU |
| 1994 AH2 | 77°.78 | Jun 09 | 89° | + 6° | 22 km/s | 0.16700 AU |
| P/1927 IX | 78°.07 | Jun 09 | 32° | +34° | 52 km/s | 0.03926 AU |
| P/1930 VI | 78°.63 | Jun 09 | 221° | +47° | 17 km/s | 0.02014 AU |
| 1994 CC | 79°.58 | Jun 10 | 211° | –34° | 14 km/s | 0.01509 AU |
| P/1976 V | 81°.88 | Jun 13 | 329° | + 6° | 71 km/s | 0.17851 AU |
| 1991 BA | 82°.03 | Jun 13 | 91° | +27° | 21 km/s | 0.02028 AU |
| Icarus (1566) | 83°.01 | Jun 14 | 48° | +32° | 32 km/s | 0.03917 AU |
| 1991 OA | 83°.99 | Jun 15 | 163° | –22° | 14 km/s | 0.07472 AU |
| P/1618 II | 84°.06 | Jun 15 | 279° | + 2° | 39 km/s | 0.04486 AU |
| 1994 XD | 84°.15 | Jun 15 | 260° | –16° | 23 km/s | 0.01757 AU |
| 1993 KH | 85°.49 | Jun 16 | 272° | +13° | 16 km/s | 0.13819 AU |
| P/1924 II | 85°.70 | Jun 17 | 22° | +33° | 58 km/s | 0.16327 AU |
| P/1781 I | 86°.42 | Jun 17 | 338° | +60° | 53 km/s | 0.18597 AU |
| P/1870 IV | 87°.36 | Jun 19 | 22° | +24° | 65 km/s | 0.11263 AU |
| P/1910 I | 87°.92 | Jun 19 | 314° | – 7° | 59 km/s | 0.03365 AU |
| P/1860 III | 88°.02 | Jun 19 | 41° | +47° | 52 km/s | 0.15535 AU |
| P/1990 VIII | 88°.39 | Jun 20 | 197° | +37° | 17 km/s | 0.08873 AU |
| P/1864 II | 91°.09 | Jun 22 | 10° | + 6° | 72 km/s | 0.00378 AU |
| P/1684 | 92°.43 | Jun 24 | 63° | –46° | 42 km/s | 0.02461 AU |
| P/1874 II | 93°.62 | Jun 25 | 20° | –11° | 70 km/s | 0.05209 AU |

# Ongoing Meteor Work

# The Bielids of 1872 and 1885 Witnessed from Malta

*Adrian J. Galea*

An overview is given of Bielid observations as communicated to the local press, and the influence they had on people's understanding of the meteor phenomenon.

> *Shooting stars and meteors are the hot and dry products of evaporation which, on rising to the upper layer of the atmosphere are dragged along its rotation and thereby become ignited.*
>
> Aristotle, *Meteorologica* (c. 330 BC)

The natural phenomenon of the shooting star, which is scientifically known as a meteor, has seen a steady development of understanding by humankind. It is not surprising that meteors and meteorology, whilst coming to describe different natural phenomena at this time and age, are linguistic brothers. In Classical Greek, meteor literally meant "in the air" and up to the 18th century encompassed atmospheric phenomena from cloud formations and rain through hail and lightning to rainbows, all phenomena now studied in meteorology. [1]

Some two hundred years ago, W.H. Brandes and J.F. Benzenberg, two German students at the University of Göttingen, applied the principle of triangulation by observing the same meteors from two different locations. This yielded information such as the altitude in the atmosphere at which such phenomena occur as well as their velocity. From the latter results they deduced, in a paper published in 1800, that meteors were of extraterrestrial origin. [2]

By the mid-19th century the origin of meteors, which are the particles in space before entering the Earth's atmosphere and becoming luminous meteors, was still unresolved. Pierre Simon de Laplace suggested the Moon as a possible source of origin. Others looked at interplanetary space. [3]

In the mid-nineteenth century, the American astronomer Daniel Kirkwood was the first to suggest a possible association between meteors and comets. From observations of the annual August Perseid meteors, the Italian astronomer Schiaparelli (1835–1910) came to the conclusion that they were produced by Comet P/Swift-Tuttle, a conclusion published in a paper in 1871. In no time at all, from a comparison of cometary and meteor stream orbit data, the well-known Comet P/Halley was proved to be the parent of the $\eta$-Aquarid and Orionid meteor showers (observable in May and October annually), while Comet P/Temple-Tuttle was identified to be the parent of the well-known Leonid meteor shower, which has produced spectacular meteor storms in 1799, 1833, and 1866. [4]

If a dynamic proof of the comet-meteor association was still needed to convince the sceptic, this was quickly provided by the almost fairy-tale story of Biela's Comet. The comet was first observed by the Frenchman Jacques Montaigne in 1772 and was again observed in 1805 by his compatriot Jean Louis Pons. [5]

Wilhelm von Biela, a major in the Austrian army, came across a presumed new comet while observing from South Africa in February 1826. A few days later, the French astronomer Gambert independently discovered the comet, calculated its orbit and deduced its periodicity, i.e., the length of time it takes to orbit once around the Sun, as 6–7 years. The link with the 1772 and 1805 comets was promptly made. [6]

The next return was due in 1832, and was observed, whilst the next apparition in 1839 was too unfavorable to lend itself to observation as the comet was too near the Sun. The 1846 return sprung one of the pleasant surprises in astronomical history: there were two comets on the same orbit with two different trails! It was so unheard of that the first astronomer who observed this dismissed it as being an optical illusion in his telescope! [7]

In 1852 the two comets were picked up again traveling in the same orbit but at a greater distance from each other, in the order of two million kilometers. That was the end of Comet Biela. Careful searches in 1859 and 1865 and 1872 could find no trace of the twin comets. [8]

Meanwhile on November 27th, 1872, a brilliant meteor display running into 6 000 meteors per hour at its peak regaled European observers. Orbit determination of the original particles giving rise to this display was surprising: they had the same orbit as Comet Biela—the comets had disintegrated into particles! [9]

This display was visible from Malta, and was the second meteor storm to grace the Maltese night sky in six years. [10] Recent research has allowed the author to imagine what it could have been like. The available information comes from an eyewitness account in the local press by a person signed W. Watson [11]:

> *Sir,*
>
> *Will you have the kindness to grant me a small portion of your valuable columns, to bring to the notice of your readers, especially those who feel an interest in such subjects, a few particulars respecting the beautiful Shower of Meteors, which was observed here, during the night of the 27th Nov.?*
>
> *I did not see the commencement of the shower and, consequently, cannot state, precisely, at what hour it began, but I have been informed that many meteors were seen as early as 8 o'clock in the evening. On going upon the terrace a little before nine, my attention was speedily arrested by the fine meteors that were shooting across the heavens in various directions. The number and brightness of these fiery messengers continued to increase till about 9.30, when, I think, the shower was at its maximum intensity.*
>
> *At this time the heavens presented a brilliant spectacle, being literally alive, if I may be allowed the expression, with burning balls which were darting down, towards the horizon, to almost every point of the compass.*
>
> *Two friends and myself directed our attention to different parts of the starry firmament, and, astonished and charmed by the sublime scene, we continued to exclaim, "Oh, look there!", at the same time calling out the number of the most brilliant and conspicuous meteors that presented themselves, in rapid succession, to our view. I think I speak within bounds, if I quote the number of meteors, which came within the range of our vision, during the maximum intensity, at 300, to 500 per minute. The shower continued with diminished brilliancy till after midnight. These Meteors were, I may observe, more remarkable for their number, than their magnitude and brightness. They were, of course, very, very far inferior in size, number, and splendor, to those which we had the pleasure of beholding on the ever memorable night of the 13th–14th of November, 1866. But, still, many of them were very fine, bright, conspicuous, objects. A considerable number left bands, or trains of light, in their paths, but these were, comparatively, faint and evescent. I did not see any of the balls explode, as many of the Leonides were observed to do in 1866.*
>
> *The radial point was, apparently, near to, or in the Constellation Perseus. Many became visible in other parts of the heavens, but when lines of direction were imagined they generally passed through, or near the constellation named.*
>
> *These celestial visitors, no doubt, were members of one of those meteoric systems, which, at well defined periods, encounter the earth, in its annual path round the Sun, but, I have not been able to ascertain if the radial point of this group has previously been determined. The well known August meteors have their radial point in Perseus and are hence called Perseides. The famous November meteors are designated Leonides, because they have their radial center in Leo.*

The letter continues to give a brief overview of what was known of the subject at the time, and showing us that in Malta there were people who were well versed in this specialized subject.

> *More than one hundred Meteoric systems are now recognized as belonging to, and forming no insignificant portion, of the Solar system. If we could take up a commanding position in space, whence to look abroad over the Solar system, we would perceive that the interplanetary spaces are not void, but are replete with cometary, or nebulous matter. This matter constitutes thousands, or even millions of clusters and rings, which, in orbits of every degree of eccentricity, and inclination to the plane of the ecliptic circle round the Sun.*
>
> *Parts of these numerous clusters and rings are continually arriving at points where the Sun or planets have sufficient attractive force to overcome the projectile motion of countless millions of their constituent members of atoms, which fall into, and become portions of the larger bodies.*
>
> *Professor Newton has calculated that not fewer than 808 millions of these meteoric bodies are consumed, in the atmosphere of the Earth alone, in a single day! Of these vast numbers, many are exceedingly minute, but at least 8 millions are sufficiently large to be visible to the naked eye, and a few are of considerable size and weight. One is known which weighs about 15 tons. It is estimated that the earth gathers to itself yearly, no less than 350 tons of the cometic matter! What then must be the grand aggregate absorbed by the Sun and planets in one year!*

The letter ends with what must be a universal feeling for all those who engage in meteor observation:

> *When we look at the sublimity and grandeur of these considerations and facts, is it not strange that so very few ever give themselves the trouble to observe or study the magnificent operations which are going on in the earth and in space around them! How few have ever witnessed a Shower of Meteors! Thousands will turn out, and endure hear or cold, in order to witness the insignificant display of fireworks prepared by the feeble skill of a man, but how very few will deprive themselves of ever an hour's ease or sleep in order to observe and admire the wonderful and sublime displays, which, prepared in Nature's pyrotechnical laboratory, are continually being exhibited, without fee or charge, on the grand stage of the Universe.*

The year 1885 would have coincided with another return of Comet Biela had it been still alive and well. Again there was no sign of the comets but another meteor storm, with peak rates of 75 000 Andromedids per hour reported by British observers. The storm was already visible upon nightfall in Britain [12]. Not surprisingly then, the meteor shower was also visible in Maltese skies, and even before British observers could start observing them, Malta being geographically east of the British Isles. The local press furnishes us with eyewitness accounts and debates about meteor astronomy, again showing us what an interest such a natural phenomenon can generate, and that some people were interested in observing them:

> *A remarkable phenomenon was witnessed last night, when almost as soon as darkness had set in stars were noticed crossing the firmament from all quarters; and in such numbers and quick succession that the sight might well be described as continual shower of fiery rockets, so great was the brilliancy of some of the luminaries.*
>
> *We should be glad to be favored, for the information of our readers with an explanation of this remarkable occurrence—a parallel of which, we are informed, is not within the recollection of our oldest inhabitants.*
>
> *More especially as a description of the phenomenon will be sure to be of intense interest to astronomical students abroad." [13]*

This note in the Maltese press evoked a reply by an anonymous person, writing in with an essay overviewing the subject of meteor astronomy at that time [14]. However, there is no evidence that the author of this essay was himself an eyewitness of the 1885 event as well. It is also pertinent to note that as yet no expert explanation could be found for their unexpected display of meteors. It was only a few days later that their true nature could be explained:

> *From your last week's issue, writes a kind correspondent, I am given to understand that Malta has seldom had the good fortune to witness such a heavenly display of fireworks as she did for many hours of the evening of Friday week last. The spectacle naturally called forth a certain amount of awe and wonder among certain of the inhabitants, such as may be discovered among many of the villagers in England when the glimmering Northern Lights happen to be dancing over-head.*
>
> *Shooting stars are the Sun's "more weakly" children—they have none of the massive grandeur of the planets—yet are true planets in that they are wanderers through space—unseen and unheard by us—in fixed orbits.*
>
> *There are two well known systems of these planetules—or minute planets—each a metallic orstony mass—namely those of B Camelopardi and G Leonis—met with respectively about August 10th and November 13th.*
>
> *They are so named from the fact that the shooting stars of the systems seem to radiate or diverge from—or from near—the two abovementioned stars.*
>
> *The Meteoric Shower, of Friday week last was due to the Earth's path crossing that of another such system as the above viz. that of G. Andromeda. This latter system contains the Comet of Biela which sweeps out its course around the Sun, in about 6 and 3/4 years—and has a vast number of Meteors or Planetules widely distributed along its orbit. Those who were in England in 1872 may remember the very fine shower of meteors which accompanied Biela's Comet that year. From that date till November 27, 1885, an interval of two periods of 6-3/4 years has elapsed—or more exactly of 2410 days—and supposing the Aerolites to be distributed widely throughout the comets path, we may expect to witness another display about the 3rd of July 1892 and again in 1905. [15]*

Another correspondent wrote about the display in the local press, but there is no indication that this person was an eyewitness:

> *Sir,*
>
> *The unusual display of meteors on the night of 27th cannot have failed to attract the attention of many of the readers, and some of them will doubtless be glad to see what explanation astronomers are able to give of phenomenon.*
>
> *To begin with, the display is not so rare or unexpected as most people would think. The time from Nov. 27 to Nov. 29 is one of the periods during which meteors may be expected every year, and in 1872 a display similar to that of last Friday night was seen in Europe, and was doubtless visible here also. The particular stream of meteors which the Earth has just passed through is known as the "Andromedes," because all the meteors are seen to travel along paths in the sky, which, when projected backwards by the observer, lead his eye to one spot were all the lines would cross each other, ... This point is the radiant. The position of the radiant varies for the different meteoric showers. For the "Perseids" on Aug. 10, it is in Perseus and for the "Leonids" on Nov. 13–14 it is Leo. At present Andromeda is directly overhead at 9.30 pm, the meteors of Friday, therefore, appeared to descend towards the horizon all round.*
>
> *This shower of Nov. 27–29 has a special interest of its own, as having thrown some light on the nature of comets. In 1872 it was known by calculation that a comet, called Biela's Comet, would cross the Earth's orbit on Nov 27–28 at a point through which the Earth would also pass at the same time. The collision was anxiously expected, but when the time came nothing happened beyond a copious display of meteors; no interference*

*with the motion of the Earth or the Moon was perceptible, the mass of the comet being comparatively nil.*

*It is now thirteen years since that passage of the Comet, and the Comet is known to have a periodic time of between 6 and 7 years, so that the swarm of meteors seen on Friday last may be the same that produced the display of 1872, and may be expected to revisit the Earth in 1898.*

*Now why do these meteors appear suddenly, shine for a second and then disappear, leaving frequently a luminous trail which remains visible for a few seconds and sometimes for more than a minute?*

*The explanation of these things is sought in the development of heat, by friction. The small bodies composing the meteoric shower are traveling through space with a velocity greater than that of the Earth, so that when they meet the Earth, they cleave their way through the atmosphere with a velocity of over thirty five miles per second. The intense friction against the air produced by such a velocity is calculated to be quite sufficient to raise the solid bodies to incandescence, and to make them burn, if the material of which they are composed be some metal easily oxidized. Thus the Meteors remain invisible until they enter the atmosphere of the Earth, and then they betray their presence by the intense heat developed by the energy of their motion through it. A few will be stopped in their course by striking against the Earth, some will be consumed during their passage through the atmosphere, but the greater number, after being raised to a very high temperature, emerge once more from the Earth's atmosphere and rapidly cool down, as they pursue their way.*

*Yours respectfully, J. Scoles S.B., St. Ignatius' College, 2nd December, 1885 [16]*

Whilst further returns of the Bielids were anxiously expected, there were only weaker displays in 1899 and 1904. Perturbations, i.e., gravitational disturbances, by Jupiter, have diverted the meteor stream so that the Earth does not cross it anymore. However, computer models indicate that they may be set to return in the 22nd century. Who knows? [17]

## References


[1] Roggemans P., "Handbook for Visual Meteor Observations", Sky Publishing Corporation, 1989, p. 12.

[2] ibid., p. 12.

[3] Bone N., "Observer's Handbook of Meteors", George Philip Ltd., 1993, p. 51.

[4] ibid., p. 52, p. 53.

[5] ibid., p. 54.

[6] Sagan C. and Druyan A., "Comet", Michael Joseph Ltd., 1985, p. 78.

[7] ibid.

[8] ibid.

[9] Bone N., "Observer's Handbook of Meteors", George Philip Ltd., 1993, p. 54.

[10] Galea A.J., *The Sunday Times*, November 13, 1994.

[11] Bone N., "Observer's Handbook of Meteors", George Philip Ltd., 1993, p. 54.

[12] *The Malta Times and United Services Gazette*, 7th December 1872.

[13] *The Malta Times and United Services Gazette*, 28th November, 1885.

[14] *The Malta Times and United Services Gazette*, 5th December, 1885.

[15] *The Malta Times and United Services Gazette*, 12th December, 1885.

[16] ibid.

[17] Bone N., "Observer's Handbook of Meteors", George Philip Ltd., 1993, p. 54.

# The Makings of Meteor Astronomy: Part IX

*Martin Beech, University of Western Ontario*

Chladni's ideas on the origin of fireballs, shooting stars and meteorites were not fully formed when he first published his thesis in 1794. Below we discuss some of the initial debate concerning the origin of Chladni's cosmic masses. We also discuss a couple of hybrid meteor models.

## 1. Solid or gelatinous?

As we saw last time, Ernst Chladni first suggested in 1794 that bright fireballs were the harbingers of stone and iron meteorites. Not only this, however, Chladni also suggested that the bodies that produced fireballs in the Earth's atmosphere were extraterrestrial in origin [1].

When it came to the shooting stars Chladni argued that they were, in most cases, essentially the smaller brethren of fireballs. Rather than plunging through the Earth's atmosphere to produce a fireball and a meteorite, it was suggested by Chladni that shooting stars were produced whenever extraterrestrial masses just skimmed the Earth's upper atmosphere. In this way, rather than being captured by the Earth's gravity, and consequently falling to the ground, the Earth-skimmers were ignited for just a few seconds before they returned to outer space. In addition to Earth-skimming masses, Chladni also suggested the existence of a second kind of shooting star. This second kind of meteor being produced by the ignition of a spongy, gelatinous material which formed in the Earth's atmosphere. Chladni invoked this additional meteor class on the basis of reports he had received suggesting the fall of gelatinous material from the sky (see [2] for details).

As is often the case with investigations concerning meteoric phenomena, Chladni closed his 1794 treatise with a plea to observers to continue their observations. In particular, he called for two-station observations to be made. Such observations are of great value since they can be used to calculate the true atmospheric path of a meteor. It was mainly through the influence, once again [1], of George Lichtenberg that two-station observations of shooting stars were eventually made. Indeed, Lichtenberg persuade two of his then students, Heinrich Wilhelm Brandes (1777–1834) and Johann Friedrich Benzenberg (1777–1846) to make simultaneous observations of the sky between September 11 and November 4 in 1798. We shall explore the work of Brandes and Benzenberg more fully next time, and for the moment we simply note that the two observers recorded a total of 22 simultaneous shooting stars during their extended meteor watch.

Of the 22 shooting stars that Brandes and Benzenberg decided as being observed simultaneously, two were deduced to have risen upwards from the lower to the upper atmosphere, one traveled horizontally, and the rest moved downwards from the upper to the lower atmosphere. The fact that not all the shooting stars moved downward was taken as support evidence for the existence of meteors of a terrestrial (that is atmospheric) origin.

The apparent observation that some shooting stars moved from the lower to the upper atmosphere clearly worried Chladni, and on this point Chladni argued, in 1817, that perhaps the observations of ascending meteors were in error, and that what had really happened was that the meteoric masses had "bounced" off a dense layer of air in the Earth's atmosphere. He also suggested that perhaps spongy material as well as iron material entered the Earth's atmosphere from outer space [3]. Chladni reversed his ideas on the possible existence of extraterrestrial, spongy material just one year later, and in 1818, returned to the ideas presented in his original 1794 thesis [4].

## 2. What origin have the stones?

One of the far reaching conclusions of Chladni's thesis of 1794 was that all space was permeated by a particulate sea of solid fragments. While Chladni's contemporaries were generally willing to accept the idea that stones and iron masses fell from the sky, they were more reserved when it came to the suggestion of their extraterrestrial origin. Chladni offered the suggestion that the cosmic masses might be the fragments of an exploded, or collisionally fragmented celestial body. Shortly after the publication of Chladni's thesis, however, Heinrich Olbers suggested (circa 1795) that the masses that produced fireballs and meteorites were ejecta from lunar volcanoes [5]. Piere Simon de Laplace also picked-up on the lunar origin hypothesis and in 1802 produced a detailed treatise on the transport dynamics of "moonstones."

Chladni did not look too warmly on the lunar hypothesis idea, and indeed, argued directly against the idea in his writings of 1818 [4]. Slowly, the idea that the Moon might be an active source of meteoric material fell into disfavor, although as late as 1834, John Benzenberg was to publish a book detailing the particulars of several active lunar volcanoes. The final death-blow to the lunar origin hypothesis and, indeed, the triumphant vindication of Chladni's cosmic origin hypothesis took place on the night of November 13, 1833. It is not often that precise dates can be given to events that completely changed the direction of science, but the Leonid meteor storm of 1833 is one instance when the observations offered clear evidence in favor of one hypothesis only. We shall pick-up the story of the 1833 Leonids at a later date, but essentially it was the observation of a distinctive shower radiant that enabled astronomers to reason that the shooting stars were traveling along near parallel paths and that their parent bodies (i.e., the storm-producing meteoroids) originated well outside of the Earth's atmosphere.

Not every one was hostile to Chladni's hypothesis and in England, for example, Sir Humphrey Davy was an important support of most of what Chladni claimed. Indeed, Davy specifically addressed the physical issue of the fireball ignition process [6]. Chladni believed that fireballs resulted through the brief ignition of solid bodies—the heating being caused by atmospheric friction. Writing in 1817, however, Davy argued,

> *the luminous appearances of shooting stars and meteors cannot be owing to any inflammation of elastic fluids, but must depend upon the ignition of solid bodies... The velocity of motion of these bodies must in all cases be immensely great, and the heat produced by the compression of the rarefied air from the velocity of motion must be probably sufficient to ignite the mass...*

Demonstrating considerable physical insight, Davy is arguing that the meteoroids are not heated by direct impacts with atmospheric molecules (i.e., through friction), but that they are ignited as a result of the heat given off by an air-cap which was heated through compression.

Davy did not supporter the idea that masses capable of producing fireballs and shooting stars permeated the whole of space. Rather, he believed that such phenomena were derived from,

> *small bodies moving around the earth in very eccentric orbits which become ignited only when they pass with immense velocity through the upper regions of the atmosphere, and of the meteoric bodies which throw down stones with explosions be supposed to be similar bodies which contain either combustible or elastic matter.*

The interesting point that we can attach to the above argument is that Davy is essentially implying that shooting stars should reappear on a cyclical basis, the return time being equal to their orbital period of the object about the Earth. Also, Davy is suggesting that meteorites are the fragments of meteoric bodies that have exploded. The explosion being caused by the ignition of some (unidentified) flammable matter in the interior of a fireball-producing cosmic mass.

## 3. Two theoretical hybrids

Chladni's hypothesis on the origin of shooting stars did not receive immediate and universal acceptance. For example, writing in the *Annals of Philosophy* for 1818, Professor E.D. Clarke, of Cambridge University declared that the meteoric phenomena could be explained by a very simple theory, and that their appearance was ... *entirely due to the heat and light evolved during the transition of a body from the aeriform to the solid state...* [7]. Once again, a modified Aristotelean argument is being put forward to explain the meteoric phenomena. In support of his hypothesis Clarke gives reference to an experiment in which,

> *...the ignition of platinum wire, coiled around the wick of a spirit-lamp, which exhibits heat and light for hours after the extinction of the the lamp so long as any of the alcohol remains... [the result is explained on the basis that]... the hydrogen of the alcohol combining with the oxygen of the atmosphere, forms water; consequently heat is evolved.*

Clarke's model is rather vague on how the "aeriform" material gathers, but it is an interesting use of an experimental argument to explain the light phenomena associated with meteors. Rather than the light from a meteor being produced through combustion, Clarke is apparently suggesting that the light is produced by a chemical reaction.

An argument similar in tone to that proposed by Clarke was also put forward by William G. Reynolds in 1818. Writing in the *American Journal of Science* [8], Reynolds argued,

> *That meteors proceed from the Earth, that they arise from certain combinations of its elements with heat, and that meteoric stones are the necessary result of the decompositions of these combinations.*

To this he adds a detailed calculation about how much material has to be "raised" in order to maintain the observed influx of meteors,

> *...it be sufficient to detach from a square foot of the Earth's surface the 104023 part of a grain in twenty four hours, the quantity taken from 100 square miles, in the same time and proportion, would amount to ten pounds, which is abundantly sufficient for all meteoric phenomena; and the loss of each square foot, supposing the process to be uninterrupted would be no more than one grain in 264 years.*

Reynolds's argument is an interesting one for several reasons. Firstly, it represents an early attempt at a detailed analytic argument to justify a meteoric hypothesis; it is presumably intended that the reader should be impressed that so little material is required to explain the meteoric phenomena—indeed, no one could ever hope to detect, or observe the loss of terrestrial material postulated. It is not clear why Reynolds believed that "ten pounds" of material was sufficient to account for all the meteors that might be observed in one day, but again, it is a quantity that will not greatly stretch the reader's incredulity.

Since the Sun is the primary heating agent in Reynolds's theory, he offers the interesting argument that meteors should be more,

> *frequent and stupendous in tropical countries, where the heat of the Sun is more intense; and less frequent in our climate in the winter and spring, while, and after the Earth has been covered with snow for many weeks in succession; and they are most frequent in the higher latitudes towards autumn, after a continuation of hot dry weather.*

This is again an interesting argument since it implies a reasonably detailed knowledge of the appearance of sporadic (shower?) meteors throughout the year. The argument about the tropics is not correct, but meteors are generally more numerous during the summer and autumnal months in the northern hemisphere [9].

## References


[1] *WGN* 22:6, December 1994, pp. 214–217.

[2] *WGN* 21:4, December 1993, pp. 200–202.

[3] Burke, J.G., "Cosmic Debris: Meteorites in History", University of California Press, Berkeley, 1986, pp. 80–81.

[4] ibid., pp. 68–69.

[5] ibid., pp. 61–65.

[6] Davy, H., *Phil. Trans. Roy. Soc.* 107, 1817, pp. 45–79.

[7] Clarke, E.D., *Annals of Philosophy* 11, 1881, pp. 273–274.

[8] Reynolds, W.G., *American Journal of Science* 1, 1818, pp. 266–276.

[9] Hughes, D.W., in *Cosmic Dust*, McDonnell, J.A.M., ed., J. Wiley, Chichester, p. 141, Fig. 9.

# An Analysis of the Publication Flow on Meteor Astronomy in 1982–1988

*G.O. Ryabova, Research Institute of Applied Mathematics and Mechanics, Tomsk*

In total, 1002 publications on meteor astronomy and zodiacal light were considered. About 68% of these publications fall into the category of periodicals and serials with 50% if the articles contained in 9 sources. The dominant languages are English (65%) and Russian (33%). A distribution of publications according to sub-topics of meteor astronomy is obtained.

Sometimes it is useful to have statistical data on the most productive editions in some branch of science, on the distribution of literature in different languages, and so on. The proposed analysis is based mainly on the publications reviewed in *Referativnyj Zhurnal "Astronomiya"* (RZh). It is the analog of *Astronomical and Astrophysical Abstracts* and is published by VINITI (All-Russian Institute of Scientific and Technical Information).

Table 1 – Distribution of publications among types of sources.

| Type of source | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 |
|---|---|---|---|---|---|---|---|
| Periodicals and serials | 80 | 71 | 113 | 93 | 96 | 138 | 87 |
| Conference proceedings | 51 | 7 | 16 | 88 | 23 | 98 | 10 |
| Books | 6 | 3 | 5 | 1 | 1 | 1 | 1 |
| Preprints | – | 1 | 2 | – | – | – | – |
| Deposited manuscripts | 1 | 1 | 1 | 3 | 1 | 1 | 2 |
| Total | 138 | 83 | 137 | 185 | 121 | 238 | 100 |

In Table 1, the distribution of publications among six types of sources is presented. As one can see from the table, the papers in periodicals and serials make up the main part of all publications—on the average 68%. Papers published in the proceedings of conferences and symposia make up about 29%. Publications included in books (volumes of articles, monographs, catalogues, etc.) together with deposited manuscripts, and preprints make up about 3%.

(Deposited manuscripts are a kind of publication used in the former Soviet Union and now in Russia. It is meant mainly for papers having a very limited circle of readers or in case when an author does not wish to be bound up by size limitations of journals. You should send your article to VINITI, where it is registered as a publication, and its abstract is published in RZh.)

For astronomy as a whole, journal articles comprise 71%, proceedings, etc. about 10% [1]. For meteor astronomy, a deficiency of books is noticed compared to general trends in astronomy. The distribution of the numbers of publications over the years for periodicals and serials is about uniform. The mean annual number of publications for periodicals is 93.

Table 2 is a list of symposia and conferences included in the analysis. Only Proceedings (not Abstracts) were used with the exception for *Lunar and Planet. Sci.*, where abstracts are very informative.

The analysis shows that the dominant languages in the field of meteor astronomy are English (on the average 65% of publications) and Russian (33%). In astronomy as a whole, these percentages are 66% and 22%, respectively [1]. Unfortunately, only two books were published in translation during the considered seven years. In 1983, a monograph by B.A. Bronshten was published in English by D. Reidel Publ. Co. In 1982, a monograph by D.E. Brownly was published in Russian translation in the USSR.

Table 2 – Conferences, symposia, meetings, etc., included in the analysis

| Event | Period | Location | Published | Papers |
|---|---|---|---|---|
| Sun and Planet. Syst. | Oct 13–23, 1981 | Dubrovnik | 1982 | 5 |
| Comp. Study Planets | Sep 14–25, 1981 | Vulcano | 1982 | 1 |
| Meteor Matter Interp. Space | Sep 09–11, 1980 | Kazan | 1982 | 39 |
| Lunar and Pl. Sci. 13 | Mar 15–19, 1982 | Houston | 1982 | 7 |
| Highlights Astron. 6 | Aug 17–26, 1982 | Patras | 1983 | 5 |
| Lunar and Pl. Sci. 15 | Mar 12–16, 1984 | Houston | 1984 | 13 |
| Ices Solar Syst. | Jan 16–19, 1984 | Nice | 1985 | 3 |
| Dyn. Comets Origin | Jun 11–15, 1984 | Rome | 1985 | 5 |
| Lunar and Pl. Sci. 16 | Mar 11–15, 1985 | Houston | 1985 | 12 |
| Propert. Interact. Interpl. Dust | Jul 09–12, 1984 | Marseilles | 1985 | 70 |
| Comet Nucl. Sample Return Miss. | Jul 15–17, 1986 | Paris | 1986 | 1 |
| Light on Dark Matter | Jun 10–14, 1985 | Noordwijk | 1986 | 1 |
| Asteroids, Comets, Meteors II | Jun 03–06, 1985 | Uppsala | 1986 | 18 |
| Lunar and Pl. Sci. 17 | Mar 17–21, 1986 | Houston | 1986 | 16 |
| Lunar and Pl. Sci. 18 | Mar 16–20, 1987 | Houston | 1987 | 22 |
| Pl. and Proto-Pl. Neb. | Sep 08–12, 1986 | Vulcano | 1987 | 1 |
| 8th Assem. SU Astron.-Geodez. Soc. | Apr 15–19, 1987 | Leningrad | 1987 | 1 |
| First GLOBMET Symp. | Aug 19–24, 1985 | Dushanbe | 1987 | 58 |
| Dyn. Mech. Syst. | Jun 24–04, 1986 | Tomsk | 1987 | 4 |
| NIPR Symp. Upper Atmos. Phys. | | | 1988 | 1 |
| Dyn. Proc. Upper Atmos. | Nov 19–22, 1985 | Obninsk | 1988 | 7 |

Table 3 – Distribution of publications on meteor astronomy in Russian periodicals and serials.

| Journal | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | Tot |
|---|---|---|---|---|---|---|---|---|
| Astronomicheskij Vestnik | 9 | 12 | 10 | 11 | 6 | 4 | 5 | 57 |
| Meteornye Issledovaniya | – | 3 | 11 | 5 | 5 | 8 | 15 | 47 |
| Doklady Akademii Nauk TadjSSR | 1 | 2 | 4 | 4 | 11 | 3 | 3 | 28 |
| Astronomiya i Geodeziya | – | – | 8 | 3 | 3 | – | – | 14 |
| Problemy Kosmicheskoj Fiziki | 4 | 4 | 2 | 3 | – | – | – | 13 |
| Rasprostranenie radio voln | – | 2 | 9 | – | – | 2 | – | 13 |
| Astronomicheskij Tsirkular | 1 | 4 | 1 | 2 | 3 | – | 1 | 12 |
| Vestnik Kievskogo Universiteta | 2 | 1 | 2 | 2 | 1 | 1 | 1 | 10 |
| Izvestiya Akademii Nauk TurkmSSR | – | – | 1 | – | 2 | – | 7 | 10 |
| Komety i meteory | 1 | – | 2 | 4 | – | 2 | – | 9 |
| Bulleten Instituta Astrofiziki TadjSSR | 5 | 1 | – | 1 | – | 1 | – | 8 |
| Pisma v Astronomicheskij Zhurnal | 1 | – | 3 | – | – | 2 | 2 | 8 |
| Trudy Instituta Exp. Meteorologii | – | – | 2 | – | 2 | 3 | 1 | 8 |
| Doklady Akademii Nauk SSSR | – | – | 1 | 1 | 2 | 1 | – | 5 |
| Trudy Kazanskoj Gorodskoj Obs. | – | – | – | 1 | 2 | – | 1 | 4 |
| Other editions | 1 | 3 | 2 | 5 | 3 | 8 | 1 | 23 |
| Total | 25 | 32 | 58 | 42 | 40 | 35 | 37 | 269 |

Table 4 – Distribution of publications on meteor astronomy in others periodicals and serials.

| Journal | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | Tot |
|---|---|---|---|---|---|---|---|---|
| Bull. Astron. Inst. Czechosl. | 9 | 8 | 12 | 9 | 8 | 12 | 4 | 62 |
| Meteoritics | 4 | 7 | 11 | 11 | 11 | 5 | 4 | 53 |
| Astron. and Astrophys. | 7 | 3 | 2 | 4 | 3 | 12 | 6 | 37 |
| Publ. Astron. Inst. Czechosl. Acad. Sci. | – | – | – | 2 | – | 29 | – | 31 |
| Mon. Not. Roy. Astron. Soc. | 5 | 4 | 1 | 3 | 4 | 4 | 3 | 24 |
| Icarus | 4 | – | 1 | 2 | 6 | 4 | 2 | 19 |
| Nature | 1 | 2 | 4 | 1 | 2 | 4 | – | 14 |
| Contr. Astron. Obs. Skalnate Pleso | – | 1 | 3 | 3 | 3 | – | 1 | 11 |
| Science | – | 2 | 2 | – | 2 | 4 | 1 | 11 |
| Planet and Space Sci. | – | 2 | – | 2 | 1 | 1 | 1 | 7 |
| Earth, Moon and Planets | 1 | 1 | – | – | – | 1 | 4 | 7 |
| Acta Astron. et Geophys. Univ. Comen. | – | – | 1 | – | – | 3 | 3 | 7 |
| Sky and Telescope | 3 | 2 | 1 | – | – | – | – | 6 |
| South. Stars | 1 | 2 | 2 | – | – | 1 | – | 6 |
| Nuovo Cim. | 1 | – | 1 | 1 | 1 | 1 | – | 5 |
| Bull. Amer. Astron. Soc. | – | – | – | – | – | – | 5 | 5 |
| J. Brit. Astron. Assoc. | 2 | 1 | 1 | – | – | – | – | 4 |
| Sterne und Weltraum | 4 | – | – | – | – | – | – | 4 |
| Geotimes | 1 | – | 1 | – | 1 | – | 1 | 4 |
| Astrophys. J. | 1 | – | 1 | – | – | – | 2 | 4 |
| Astron. J. | – | – | – | – | 2 | 1 | 1 | 4 |
| J. Geophys. Res. | – | – | – | 1 | – | 3 | – | 4 |
| Meteors | – | – | – | – | – | 1 | 3 | 4 |
| Astron. Glas. Zvjezd. Hrv. | – | – | – | – | – | 4 | – | 4 |
| Other editions | 11 | 3 | 7 | 12 | 12 | 13 | 9 | 67 |
| Total | 55 | 39 | 55 | 51 | 56 | 103 | 50 | 409 |

In the considered period of time, the papers on meteor astronomy were published in 80 periodicals and serials (26 were published in the Soviet Union and 54 in other countries). Distribution of publications among editions was investigated by a simplified method. All the sources were divided into two groups. The sources in which the quantity of publications on meteor astronomy in the considered period of time does not exceed two are referred to the sources of small efficiency; in Tables 3 and 4 they are given in the line "Other editions." The second group—all the rest of the editions—are listed in Tables 3 and 4. This group contains 85% of journal papers. The productivity of sources decreases sufficiently quickly. The first four sources from Table 3 and the first five ones from Table 4 form the "core" zone containing 50% of the journal publications.

(In connection with Tables 3 and 4, we wish to note that *Astronomicheskij Vestnik* is published in English translation as *Solar System Research*, and that in the 1987 volume of *Publ. Astron. Inst. Czechosl. Acad. Sci*, the Proceedings of the 10th European Regional Meeting of the IAU (Prague, August 24–29,1987) were published.)

The formalized analysis of the dynamics of information flow on meteor astronomy was carried out on the basis of the list of key words presented in Table 5. This list does not claim to be complete. The classification of publications was done by the author of the present paper on the basis of the information contained in the articles' abstracts. In some cases when abstracts were inaccessible, only titles were used. The whole bunch was divided into seven macro-themes (see Table 5). They hardly intersect one another with the exception of macro-themes 1 and 2, where classification sometimes posed some difficulties, and in a number of cases was carried out formally.

Table 5 – Distribution of publications according to main topics.

| Topic | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 |
|---|---|---|---|---|---|---|---|
| Meteoroids in the Earth's atmosphere | | | | | | | |
| Total | 39 | 16 | 29 | 26 | 22 | 73 | 31 |
| – physics | 14 | 11 | 14 | 20 | 15 | 15 | 16 |
| – heights | 2 | 1 | 2 | 2 | 5 | 9 | 1 |
| – velocities | – | 1 | 1 | 2 | 1 | 2 | 2 |
| – masses | 5 | 1 | – | 2 | – | – | 2 |
| – densities | 2 | – | 1 | 2 | 3 | 3 | 1 |
| – trajectories | 2 | – | 1 | 1 | – | – | 3 |
| – spectra | 6 | 1 | – | – | 2 | 3 | 4 |
| – radio wave propagation | 1 | 1 | 8 | 1 | 3 | 2 | – |
| – others aspects | 10 | – | 5 | 3 | 1 | 47 | 8 |
| Meteor complex in the vicinity of the Earth (except showers) | | | | | | | |
| Total | 16 | 11 | 11 | 15 | 7 | 16 | 7 |
| – selectivity | 5 | 6 | 5 | 1 | 3 | 2 | – |
| – influx to Earth | 2 | 2 | 3 | 2 | 1 | 2 | 1 |
| – structure | 1 | – | – | 3 | 2 | 2 | – |
| – flux density | – | – | 3 | 4 | – | 5 | 2 |
| – radiants | 4 | – | 2 | 3 | 2 | 2 | – |
| – orbits | 9 | 2 | 2 | 6 | 1 | 3 | 1 |
| – velocities | 3 | – | 1 | – | – | 3 | – |
| – other aspects | 1 | 1 | 1 | 2 | – | 3 | 1 |
| Meteor streams | | | | | | | |
| Total | 40 | 17 | 38 | 26 | 26 | 57 | 25 |
| – rate | 9 | 4 | 8 | 7 | 10 | 14 | 4 |
| – flux density | 7 | – | 1 | 3 | – | 7 | 1 |
| – structure | 10 | 6 | 13 | 2 | 5 | 8 | 6 |
| – orbital evolution | 7 | 4 | 8 | 10 | 7 | 12 | 6 |
| – other char. of evolution | 1 | 1 | – | – | 1 | 1 | 1 |
| – origin, genetic assoc. | 10 | 2 | 7 | 8 | 9 | 18 | 5 |
| – radiants | 3 | 1 | – | – | 2 | 4 | 2 |
| – orbits | 6 | – | – | 1 | – | 1 | 2 |
| – planetary perturbations | – | – | 3 | 1 | 2 | 2 | 2 |
| – simulation | 4 | 2 | 4 | 3 | 6 | 9 | 6 |
| – others aspects | 2 | – | 2 | 2 | – | 7 | 2 |
| Interplanetary dust complex | | | | | | | |
| Total | 5 | 10 | 11 | 45 | 16 | 17 | 14 |
| – spatial distribution | – | 2 | 4 | 6 | 3 | 9 | 8 |
| – orbits | – | – | – | 3 | 1 | 3 | 3 |
| – orbital evolution | – | – | 1 | 4 | 1 | 1 | 3 |
| – radiation eff., optical prop. | 1 | 1 | 1 | 7 | 4 | 2 | 2 |
| – charge | 1 | 1 | 5 | 4 | 2 | 3 | 1 |
| – collisions | – | 5 | 3 | 1 | 4 | 2 | – |
| – sublimation | 1 | 1 | – | – | – | – | – |
| – other nongravitational | – | 1 | 1 | 4 | 2 | 3 | 1 |
| – comet-meteor-asteroid assoc. | 1 | – | – | 2 | 2 | 2 | 2 |
| – others aspects | 1 | 4 | 2 | 15 | 2 | 2 | 1 |

Table 5 – Continued.

| Topic | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 |
|---|---|---|---|---|---|---|---|
| Laboratory research of micrometeoroids | | | | | | | |
| Total | 13 | 11 | 29 | 40 | 20 | 33 | 9 |
| Zodiacal light | | | | | | | |
| Total | 14 | 5 | 3 | 24 | 5 | 7 | 1 |
| Bolides | | | | | | | |
| Total | 4 | 9 | 5 | 6 | 3 | 10 | 5 |

Some types of publications did not enter the presented scheme. These are, e.g., publications elaborating on equipment, publications on the history of meteor astronomy, etc., 23 in all.

Table 6 – Distribution of publications according to some main meteor streams.

| Topic | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | Tot |
|---|---|---|---|---|---|---|---|---|
| Geminids | 19 | 7 | 10 | 9 | 9 | 8 | 3 | 65 |
| Orionids | 7 | 4 | 4 | 2 | 1 | 13 | 2 | 43 |
| Perseids | 12 | 4 | 6 | 4 | 5 | 9 | 2 | 42 |
| Quadrantids | 14 | 3 | 10 | 5 | 5 | 1 | – | 38 |
| $\eta$-Aquarids | 7 | 1 | 1 | 2 | – | 7 | 2 | 20 |
| Draconids | 3 | 1 | – | 2 | 6 | 5 | 1 | 18 |
| Lyrids | 3 | 1 | 1 | 1 | 3 | 2 | 4 | 16 |
| Taurids | 5 | – | 4 | – | 2 | 4 | – | 15 |
| Leonids | 4 | 2 | 1 | 2 | – | 2 | – | 11 |
| Andromedids | 5 | 1 | 1 | – | 2 | – | – | 9 |
| Arietids | 2 | – | 1 | 1 | 1 | – | – | 5 |
| Others | 13 | 2 | 4 | 1 | 2 | 4 | 4 | 30 |

The largest number of publications is devoted to meteor streams. The statistical data on various streams presented in Table 6 are of certain interest. The indisputable leader is the Geminid meteor stream. In total, 48% of the publications is devoted to that stream, the Perseids, and the Orionids.

The present article was presented at the Second GLOBMET Symposium (Kazan, July 11–16, 1988). In full version (28 pp.), it was published as deposited manuscript in Russian. For *WGN*, the last version was shortened, corrected, and improved. In spite of all my efforts, however, some gaps are quite possible. So all additions and corrections will be gratefully accepted.

## Reference

[1] Zapolskaya I.I., Shcherbina-Samojlova I.S., Selected results from a study of the astronomy document flow, with special reference to the "Astronomiya" Abstract Journal Nauchno-tekhnicheskaya informatsiya.-1978.-Seriya 1, N9.-P.21- 26. (In Russian).

# Poplar Springs Meteor Patrol: A General Description

*Jim Richardson*

An experimental setup for forward-scatter radio meteor observing is described.

## 1. General description

The Poplar Springs Meteor Patrol is an amateur-operated system used for monitoring the meteor flux through forward-scatter radio techniques. The project is still in the development and testing phase, and is sponsored by the *American Meteor Society* (*AMS*).

Basically, the station consists of two parts; a radio receiver system, set up to monitor for meteor echoes, or "bursts," using distant channel-2 television transmitters as the signal source, and an Apple IIe computer system, programmed to monitor the output from the radio system, detect meteor events, and store data on each event to floppy disk.

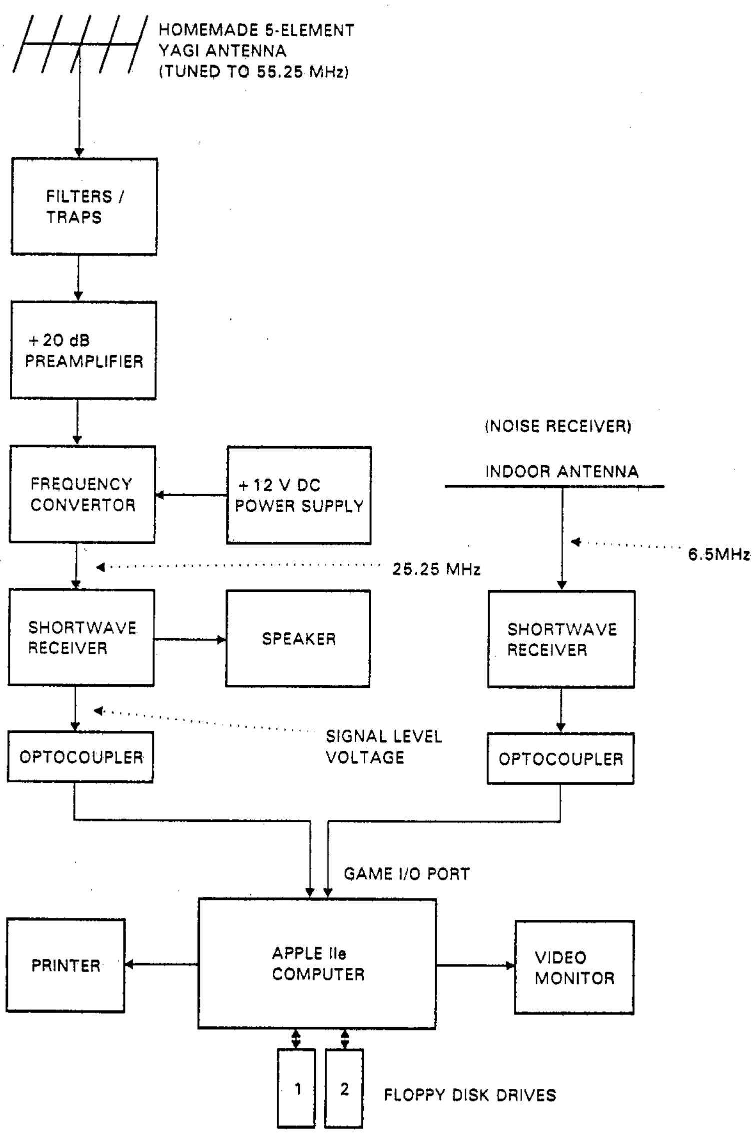


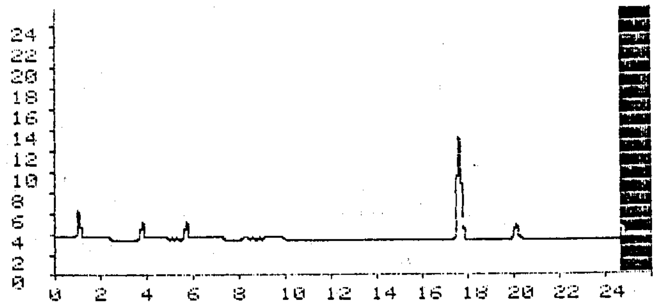

Figure 1 – System block diagram.

The computer detects events by using a simple algorithm which calculates an average background signal level, and then monitors for the sudden amplitude rise, characteristic of a meteor event, above that background level by a predetermined "threshold" amount. The program then marks the beginning and end time of the event using the computer's internal clock, and also marks the maximum signal strength achieved by the event above the background level. A routine is also included to prevent oscillating events from being detected more than once.

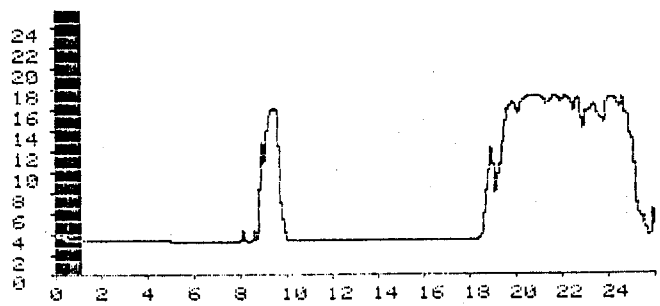
The system is designed to collect data around the clock with minimal interruptions. Other programs for the Apple can then use the collected data to generate graphs showing meteoric rates, signal amplitudes and event durations.

A block diagram of the radio system is shown in Figure 1, and is fairly typical of amateur meteor burst detection systems. It uses a home-made frequency convertor to monitor the channel-2 TV video carrier frequency (either 55.24, 55.25, or 55.26 MHz), and changes it to a frequency usable by a standard shortwave (SW) receiver. The output from the "signal level" circuits in the SW receiver is then sent to the computer for display and event detection. A BFO and an audio speaker in the SW receiver also allow the user to listen to the carrier wave meteor bursts.

In addition to the meteor burst radio, the computer also receives input from a second off-frequency SW receiver. This is for electrostatic noise cancellation, which prevents noise spikes (such as lightning) from being detected as meteor events. If a noise spike occurs, it will appear on both receivers, and the computer will ignore it.




| | | |
|---|---|---|
| DATE. 4. 4. 93 | | |
| | SS: 99 | NF: 0 |
| ST: 17:19:43:10 | DR: 1.5700 s | D#: 2 |
| ET: 17:19:44:67 | WT: 54 s | R#: 1540 |



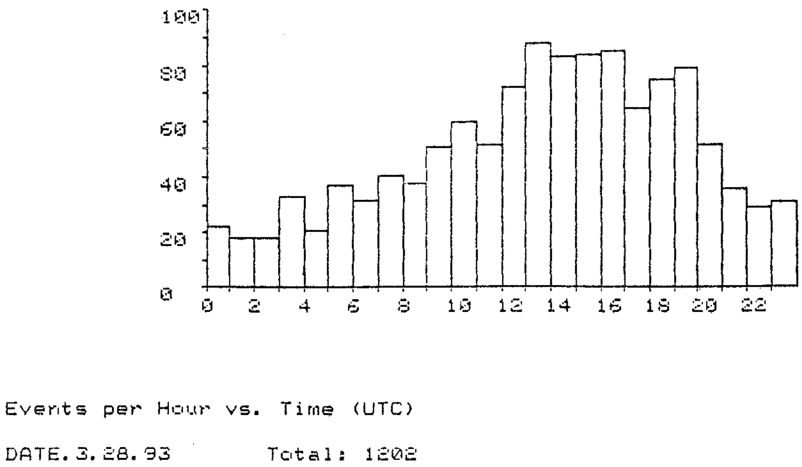

| | | |
|---|---|---|
| DATE. 4. 4. 93 | | |
| | SS: 141 | NF: 0 |
| ST: 17:35:6:28 | DR: 16.780 s | D#: 2 |
| ET: 17:35:23:6 | WT: 28 s | R#: 1576 |

Figure 2 – Display for the "data collection" mode.

Figure 2 shows the display for the "data collection" mode for the computer. The display shows a moving-point "strip chart" type display of signal amplitude (0-255 divisions) over time (0-260 samples, 0-58 seconds). The upper part of the figure shows underdense meteor events, and the bottom part is a sample of overdense meteor events, as detected by the system.

The bottom of the screen displays text data about the event last detected by the computer, with the following abbreviations:

1. DATE: Self explanatory, also the name of the disk file to which data is being stored.
2. ST: Start time of event (UTC), to 1/100 seconds.
3. ET: End time of event (UTC), to 1/100 seconds.
4. SS: Signal strength (maximum), 0-255 divisions.
5. DR: Signal duration, in seconds.
6. WT: Wait time in seconds. Length of time from this event to last event.
7. NF: Noise flag status: 0 = no noise, 1 = noise.
8. D#: Disk drive in use.
9. R#: Event record in current file, also total number of events for the day up to that time.



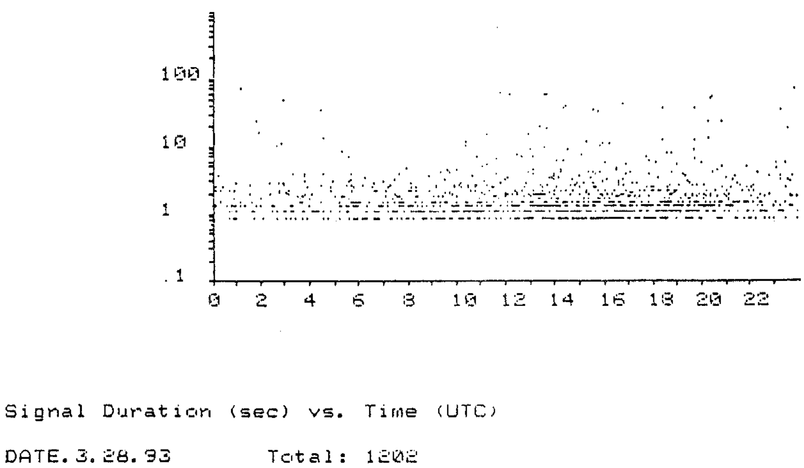




Figure 3 – Graphs than can be generated using the collected data.

Figure 3 shows two of the graphs that can be generated using the collected data. The upper graph shows the diurnal curve for March 28, 1993, using standard bar graph format. The lower graph is one of my "raw data" displays, with the duration (in seconds) for each event plotted at the time of that event.

You may wonder why I am using such an archaic computer for this project. The main reason—affordability. In all, the entire system uses about 1000 USD worth in equipment and parts.

As budget allows, more sophisticated radio and computer equipment will be obtained to help achieve the following goals:

1. Increase sample rate to 1K to 2K per second. Current sample rate is a slow 5 samples per second.
2. Eliminate computer "dead-time" after each event. Disk storage currently requires a break from the monitor mode. Multitasking would allow continuous monitoring and perform disk storage as a background function.
3. More accurate and calibrated signal amplitude measurement, in dBm or $\mu$V (microvolts).
4. Event "snapshot" mode; to allow storing selected event signatures to disk for diffraction pattern studies, etc.

The current goal for the system is to continue developing the hardware and software to the point of collecting good meteoric data, and test system performance over a period of months, checking diurnal curves, shower performance and annual flux variation. It also must be determined to what degree other propagation modes will affect data collection, such as Sporadic E. System reliability and downtime are also being monitored.

It is hoped that I can produce data of a good enough quality for both the *AMS* and the *IMO*. I then intend to conduct a "meteor patrol" over a number of years, making system improvements as possible.

Comments and suggestions are welcome.

## Fireballs and Meteorites

# Optical Light Sensors Record Two Fireballs

*communicated by SrA. Amy Webb, AFTAC Public Affairs*

Two fireball events recorded on the same day by United States Department of Defense satellites are described.

Optical light sensors aboard two Department of Defence satellites recorded the bright flash of two separate fireballs in the atmosphere at $3^h02^m04^s$ UT and $13^h05^m47^s$ UT on February 16 somewhere over the Pacific Ocean.

Using a 6000 K black-body model for the flashes, peak radiant intensities measured by the satellites were $1.5 \times 10^{10}$ and $1.0 \times 10^{10}$ W/steradian respectively. These correspond to visual magnitudes of $-19.1$ and $-18.4$ respectively. Radiant energies of the events using the same models were $1.75 \times 10^{10}$ and $6.0 \times 10^{10}$ Joules respectively.

For further information, contact SrA. Amy Webb, Air Force Technical Applications Center, Office of Public Affairs, Patrick AFB, Florida 33925-3002, USA, phone +1-407-494-7332.

# Observational Results

## SPA Meteor Section Results: July–December, 1994

*Alastair McBeath*

An overview of results collected by *SPA Meteor Section* members and other correspondents to the author during the period from 1994 July–December is presented. The main points of interest were another high and double Perseid maximum, an unexpectedly intense Leonid return, a reasonably-observed Geminid epoch and some forward-scatter radio data for the Leonid and Geminid returns.

### 1. Introduction

The second half of 1994 provided no real respite from poor conditions for British observers, but those elsewhere were not so affected, which has greatly helped increase the Section's observing totals beyond what we would expect in even a good year "at home." The data submitted to the Section are described below in two-monthly stages.

### 2. July–August

July failed to provide skies clear enough to allow much meteor watching anywhere. Barely 13.3 hours of visual observing were completed by five watchers, with the best conditions found over Malta by Alexei Pace. August, fortunately proved much better almost everywhere, and 29 557 meteors (16 519 Perseids) were reported in 874 visual hours. In addition, 35 photographic trails (the majority Perseids) were captured in almost 130 camera-hours, and results from ten radio amateurs, nine of which were provided by Norman Fitch, the VHF/UHF report coordinator at the *Radio Society of Great Britain* (*RSGB*), were also received.

All nights from August 1 to 15 received some coverage, but August 8-9, 11-12 and 12-13 were especially impressive. For the first time since the double peak's discovery in *IMO* results in 1988, *SPA Meteor Section* data showed both Perseid maxima. The primary one, when Perseid ZHRs briefly peaked at about 220, was around $10^h30^m$–$11^h$ UT on August 12, followed by the secondary maximum, when ZHRs were between about 85 and 100, around $2^h$ UT on August 13.

The first peak was seen visually by a group of the German *Arbeitskreis Meteore* (*AKM*) observers, including *IMO* President Jürgen Rendtel, who had gone to the western USA especially for this purpose, but radio reports to the *SPAMS* have also helped confirm what happened and when. As night fell over Europe on August 12-13, Perseid activity was very good, with ZHRs initially around 100, falling slightly to about 80–90 towards dawn. The next night saw Perseid rates down to circa 40 or so. Corrected mean magnitudes for the Perseids and sporadics were +2.5 and +3.4 respectively, with trains visible for 30% of Perseids and 9% of sporadics. European *SPAMS* observers recorded 34 fireballs, 26 on August 12-13, but none brighter than about magnitude −8.

British watchers, including those who traveled to France for the shower, enjoyed rather better skies for the Perseids than in 1993, with most people able to manage around 8–14 visual hours during the month. Several photographers trained cameras on the skies for some Perseid trails, but only one meteor was caught on film. Notable efforts were made by Shelagh Godwin (partly in France, partly from her home site in Surrey), Alastair McBeath, Tom McEwan, Tony Markham, Ian Rigney and Roy Watson. Most active British photographer was Terry Holmes.

Splendid efforts from overseas have come from Alexei Pace (aided by his marvelous site on Malta; he managed almost 41.5 visual hours in August, as well as some successful photography), Peter Craven in Finland (another visual and photographic observer), and members of the lucky *AKM* team in America.

The Rumanians mounted a huge national campaign, PERSEIDE '94, the best results of which came from leading watcher Vasile Micu, together with reports from Zoltan Deak, Valentin Grigore, and successful photographer Victor Bortas. Their access to very dark sites gave them a distinct advantage over many other locations in Europe, and consequently, a large number of meteors were reported from this project.

Another successful project for the Perseids was mounted by 22 members of the Meteor Group of the *Astronomical Society of Malta*, led by Godfrey Baldacchino. Around 183 hours of observations were carried out, and 4711 meteors (3575 Perseids) were seen, as shown by their recently published report. The Maltese findings are in-line with data from other European sites, and the "traditional" (now secondary) Perseid maximum was well-seen on the night of August 12-13, yielding a peak ZHR of roughly 85–100 at best.

Other July-August observers included Keith Darbyshire, Michael Duplock, Dave Gavine et al., *Guernsey Society Astronomical Section*, Paul Haworth, Alan Heath et al. (radio and some group visual work), Brian Kelly, Cliff Meredith et al., Graham Pointer, and George Spalding. A useful *BAA Meteor Section* Perseid rate summary was submitted to the *SPAMS* by Neil Bone too.

## 3. September-October

September was one of the better months of the six covered by this report from the perspective of the weather. A special *SPAMS* meteor plotting project for the Aurigids ran from late August to mid September, which also seems to have helped keep observers interested in the wake of the Perseids. Sixty-three plots were made, most of these by Vasile Micu at two sites in Rumania, but Peter Craven in Finland, Keith Darbyshire, Shelagh Godwin, and Alastair McBeath in England, plus Alexei Pace on Malta were able to make some trail plots too. Unfortunately, too few potential Aurigids were seen to make a useful analysis possible, but further Section plotting projects are planned for the Aurigids and Taurids in the fall and the Virginids in spring.

October was less helpful, with most observers restricted to short watches—a repeat performance of September in this respect, but fewer nights were clear. Roy Watson was the leading UK October watcher, but even he only just reached 5 hours of work.

During these two months, 82.7 hours of visual observing were carried out, with 941 meteors seen, mostly sporadics, but a dusting of minor shower meteors was noted as well. Sixty-three Orionids, away from the bright Moon near their peak, and a few Taurids occurred too. Most active observers were Vasile Micu and Shelagh Godwin, together with several *AKM* members, notably Jürgen Rendtel in Germany. The *AKM* photographers were also out in force with their fireball patrol cameras, netting 826.8 camera-hours, but with no trails reported as yet.

Two fireballs in this spell were notable enough to make the general media, one at $19^h05^m$ UT on September 7 (apparently over 50 reports, although no *SPA Meteor Section* ones, from Dunbar in Southern Scotland to the Humber Estuary in England of one or more bright lights out over the North Sea), and at an unspecified time on September 14 (a BBC radio news report of a bright object seen over South Africa).

Other early fall contributors included Valentin Grigore, Tony Markham, and Graham Pointer.

## 4. November–December

Most of November's observations were concentrated (if such a word can be applied to a month when no British watcher managed more than 1.5 hours of observing) in the first half of the month, although in Rumania, skies also favored the enhanced, if moonlit, Leonid peak on November 18. In total, 686 meteors (83 Leonids) were seen in almost 60 hours, with *AKM* photographers reporting nearly 450 photographic hours for one trail. Other good contributions came from Alexei Pace in Malta, Vasile Micu in Rumania, and Graham Wolf in New Zealand.

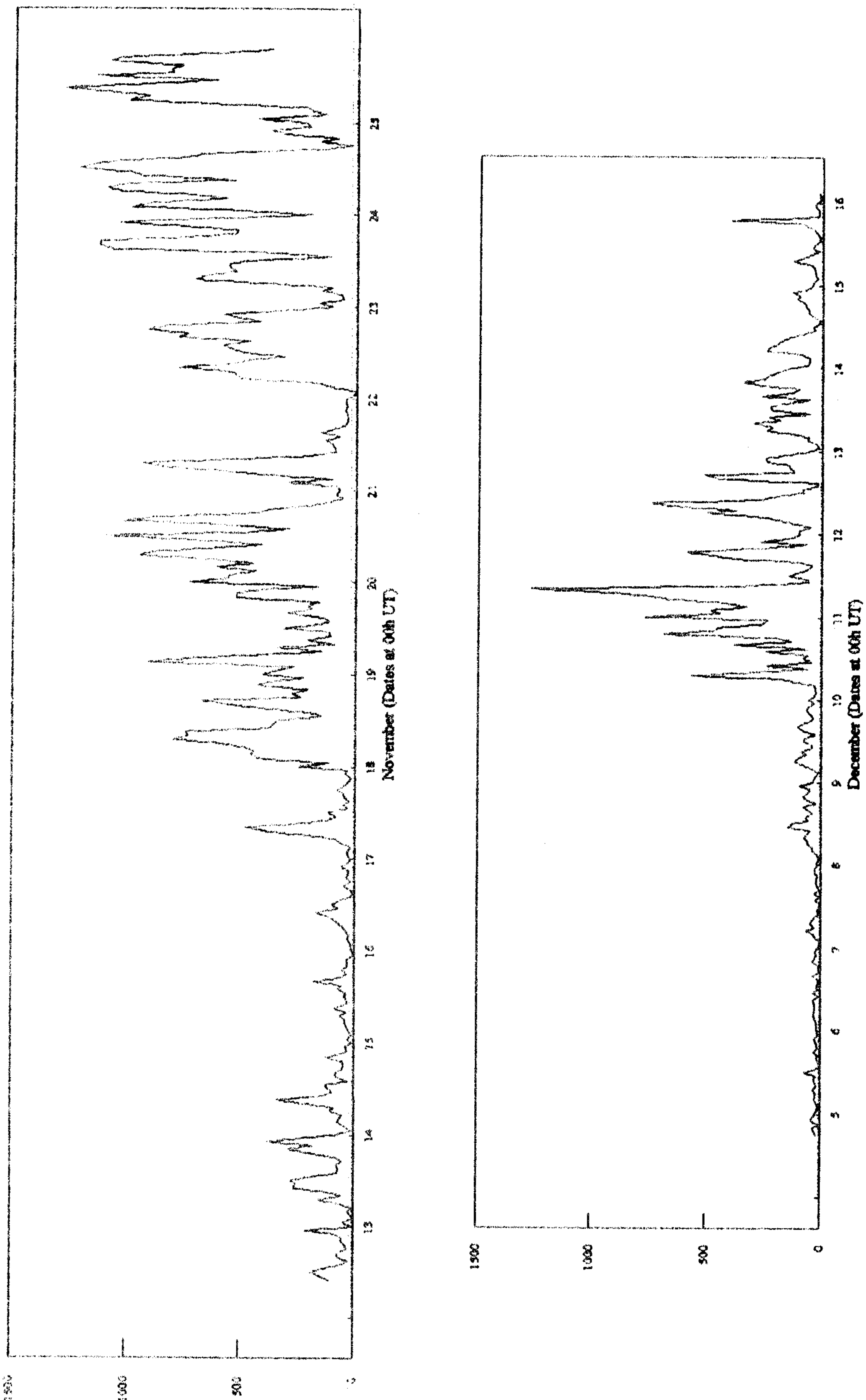



Figure 1 – Radio observations (raw hourly counts) by Robert White in November and December 1994.

Another highlight was a splendid set of radio data from Robert White: 322 hours and 100 454 echoes. He operated his forward-scatter set-up (for details, see [1]) from November 12 to 25, and seems to have detected enhanced rates from the Leonids from November 17 to 20, with a notable peak coinciding roughly with the visual one, though this is based only on his raw data. Atmospheric problems made some of the latter stages of his observations difficult to interpret, unfortunately. Figure 1 shows his raw hourly counts.

The most significant visual event of November was undoubtedly the unusually high Leonid peak on 1994 November 18. Reports from Rumania noted especially enhanced activity around $3^h$–$4^h$ UT in spite of the Full Moon, confirmed by radio reports from elsewhere in Europe in news provided by Norman Fitch of the *RSGB*. Valentin Grigore in Targoviste, Rumania, provided most details, recording 66 Leonids in just over 3 hours, 35 of those from $2^h48^m$–$4^h03^m$ UT (effective observing time $1^h01^m$). He also noted eight Leonid fireballs, the brightest magnitude −6. ZHR estimates based on this data suggests activity was perhaps comparable with a weak secondary Perseid maximum from recent years.

December brought a fine haul of Geminids, even with the waxing Moon. 754 shower members were seen from 1197 meteors in 63 hours. Those Geminids seen in good skies yielded a corrected mean magnitude of +3.44 compared to the sporadics' +4.1, with very few leaving a train. Most observers tried to cover the shower peak, and the bulk of the month's data was obtained between December 12 and 15, with a little earlier than this, and one or two people braving the waning Moon to try to spot some Ursids, mostly without success, later on.

Leading UK watchers were Shelagh Godwin, Martin Plater, Ian Rigney, and Roy Watson (who also managed 1.25 hours of photography, capturing a single Geminid trail), although no one was able to perform more than eight hours' watching. Rainer Arlt in Germany also provided an excellent summary of his Geminid maximum observations.

Robert White was again active with his radio equipment, this time recording 32 363 echoes in 273 hours, operating continuously from December 4 to 16—see Figure 1. His data shows a very significant peak on December 11, although visually, the Geminids reached a peak, with a ZHR of roughly 100 or so from SPAMS data, on December 13-14, as expected. Whether Robert's unprocessed results indicate enhanced rates of small meteor particles in advance of the main visual maximum (where larger meteoroids might perhaps be more likely), or some other effect, remains a matter for further investigation.

The remaining November-December watchers included Charlotte Bland, Michael Maunder, and Ian Ransome.

## 5. Conclusion

I must apologize to those who expected rather more detailed shower reports for 1994 from *SPAMS* data, as was the case in the past. Unfortunately, ill health and other problems have restricted my time available for carrying out analyses and preparing reports during the past year, but I hope to be able to get back to a more normal level of activity soon, and would like to thank not only all the observers named above for their excellent efforts, but also all those who have sent me their good wishes during the past twelve months. Clear skies to one and all!

## References

[1] G. Baldacchino, "The 1994 Perseid meteor stream from Malta", Meteor Group—The Astronomical Society (Malta), 1994.

[2] A. McBeath, "SPA Meteor Section Results: January–June 1994", *WGN* 22:6, December 1994, pp. 229–232.

# The 1994 Perseid Meteor Stream from Malta

*Godfrey Baldacchino*

A summary is given of an analysis of Maltese observations of the 1994 Perseids.

## 1. Overview

The Meteor Group of the *Astronomical Society of Malta* set about its first major observational project by taking the main responsibility for the Society's 1994 Perseid effort. This involved the typical coordination and planning of observations, the collection of standardized report forms and the subsequent data analysis. Apart from these relatively routine operations, however, the Meteor Group also set itself two other relatively new "targets": First, the experimental resort to a fast technique for meteor observation with next to nil dead time, humorously given the accolade of WART (Watching Activity with Rapid Techniques). Second, the almost immediate dispatch of the total, semi-processed observational information to the world Perseid data center of the *International Meteor Organization*, this year at Western Ontario, Canada. Both these targets were agreed to during a Meteor Group meeting held at Zabbar on July 21.

Both targets were successfully met. The group designated Umberto Mulè Stagno to serve as the national recipient for all observational reports, with information being passed as the national recipient for all observational reports, with information being passed on to him by phone to eliminate delays. 22 observers logged almost 200 observing hours, spread over 146 observations. The designated limits of the project—August 5-6 to 12-13—were all extremely well covered, the last two nights in particular. In total, 3 575 Perseids and 1 136 other meteors were recorded visually over 10 nights, apart from a fair number of photographed meteor trails. The data was sent to Canada by fax barely 24 hours after the observational project epoch had elapsed. Observers used WART on August 11-12 and 12-13, when the largest number of meteors, as expected, was recorded—83% of the total number reported. It is worth adding here that certain Group members took the initiative to use toilet paper for WART purposes in a pilot study; and the results were published on the first page of the August 1994 issue of the *IMO* Journal *WGN* [1].

This report sets out to provide a summary of a comprehensive analysis of the 1994 Perseid meteor shower as seen by Maltese observers; this is being done within a few months from the conclusion of the project. This goes to demonstrate the crucial importance of "quality" data analysis fast. It is not enough to observe and then fail to process the resulting observational data, or else do so only after many months, if not years.

## 2. Observers

The following members of the *Astronomical Society of Malta* submitted Perseid observations for analysis. This list includes seasoned observers, a number of newcomers, as well as the return of some "old hands," or should we say "old eyes": the Perseids never fail to tempt! The observer code follows the observer's name, together with the number of accumulated observing hours:

> Stephen Abela (ABEST, $2^h55^m$), Anna Baldacchino (BALAN, $7^h15^m$), Godfrey Baldacchino (BALGO, $7^h15^m$), Edwin Camilleri (CAMED, $13^h05^m$), Nadia Demicoli (DEMNA, $3^h45^m$), Deborah Esposito (ESPDE, $5^h05^m$), Erika Esposito (ESPER, $5^h30^m$), Michael Farrugia (FARMI, $3^h30^m$), Adrian Galea (GALAD, $11^h05^m$), Martin Galea (GALMA, $20^h40^m$), Alexander Gambin (GAMAL, $1^h55^m$), Franco Gatt (GATFR, $11^h10^m$), Antoine Grima (GRIAN, $15^h20^m$), Sandro Lanfranco (LANSA, $5^h15^m$), Umberto Mulè Stagno (MULUM, $32^h15^m$), Michael Schembri (SCHMI, $7^h15^m$), Annabelle Scicluna (SCIAN, $2^h25^m$), Mark Scicluna (SCIMA, $8^h50^m$), Louise Suban (SUBLO, $13^h40^m$), Tony Tanti (TANTO, $1^h00^m$), Leslie Vella (VELLE, $3^h55^m$), and Yosanne Vella (VELYO, $1^h55^m$).

These observations were carried out from a variety of sites. The most popular of these was definitely "l-Ahrax tal-Mellieha" (35°51′52″ N, 14°22′12″ E), a relatively dark site which hosted a number of group watches. On pre-maximum nights, MULUM observed from Naxxar and Dingli, ESPDE observed from Xghajra, and CAMED from Zabbar, while a large number of observers organized a number of group watches from Mtahleb. The observers BALAN and BALGO, LANSA, and GAMAL observed from Marsascala (35°51′36″ N, 14°34′19″ E), San Gwann (35°54′50″ N, 14°29′15″ E), and Qala, Gozo (36°02′03″ N, 14°19′42″ E) respectively, throughout the project epoch.

## 3. Analyis

The analysis of this—for Malta, voluminous—amount of data is no easy task. First of all, not one single observation has been carried out under what is internationally considered as a standard sky condition, this being a clear, moonless, cloudless sky with unobstructed views enjoying a stellar limiting magnitude (SLM) of +6.5. While this is definitely intended to be an ideal approximation, the Maltese conditions in August are somewhat far removed from this desirable state of affairs. In spite of cloudless and moonless nights all along the project, the best sky condition reported is an SLM of +6.3 and the worst an SLM of only +4.5. The mean (average) sky condition reported for the duration of the project is that with a mean SLM of +5.64, while the mode (most common) SLM reading is only +5.4. Under such conditions, rates of only about one third of those expected under a standard sky would be reported. The condition is a pitiful one and underscores the importance of the light pollution campaign which the *Astronomical Society of Malta* is currently engaged in. Also to be borne in mind is the typically reduced transparency of the August night sky in Malta. This is due to a larger density of dust particles in the atmosphere, accumulating in the absence of precipitation. The last, previous substantial rainfall had occurred way back on April 6, 1994!

A low average stellar limiting magnitude makes the compilation of zenithal hourly rates (ZHRs) particularly difficult. But, apart from the poor SLM, at least 4 observers had little or no observing experience, while at least 4 others were definitely "rusty," their last proper observation prior to the 1994 Perseids going back some years. This can be clearly assessed from a critical glance at the meteor magnitudes quoted these are typically reported to be brighter than they actually are.

Furthermore, non-Perseid shower meteors active in the period under review (such as the $\delta$- and $\iota$-Aquarids, Capricornids and Cygnids) were united with sporadic meteors and collapsed into one category, as suggested by *IMO* guidelines [2]. This was recommended both because of the difficulty of exact identification of shower meteor identities belonging to the Aquarid complex by visual methods, as well as to cut down on dead time. The exercise however made it impossible to compute a pure sporadic rate from which a reliable absolute sporadic magnitude and, subsequently, a magnitude ratio for the Perseids, could be derived.

In view of these setbacks, the activity rate for the 1994 Perseid meteor stream as seen from Malta was computed using the standard technique. The value of the population index $r$ was taken as 2.4, this being suggested typical value for the Perseid stream [3,4]. The resulting activity curve is reproduced as Figure 1.

A more refined analysis was resorted to in the case of observations carried out during the two nights of maximum activity: August 11-12 and 12-13. Data were grouped into time intervals and the mean Perseid and non-Perseid magnitudes were worked out from the respective magnitude distributions.

One can assume that non-Perseid shower meteor activity over the two nights was similar. If this is acceptable, then any variation in the non-Perseid category would be due to the imputed increase in the hourly sporadic rate, and this would also be practically similar if comparisons are made at approximately the same time of night for the same group of observers.

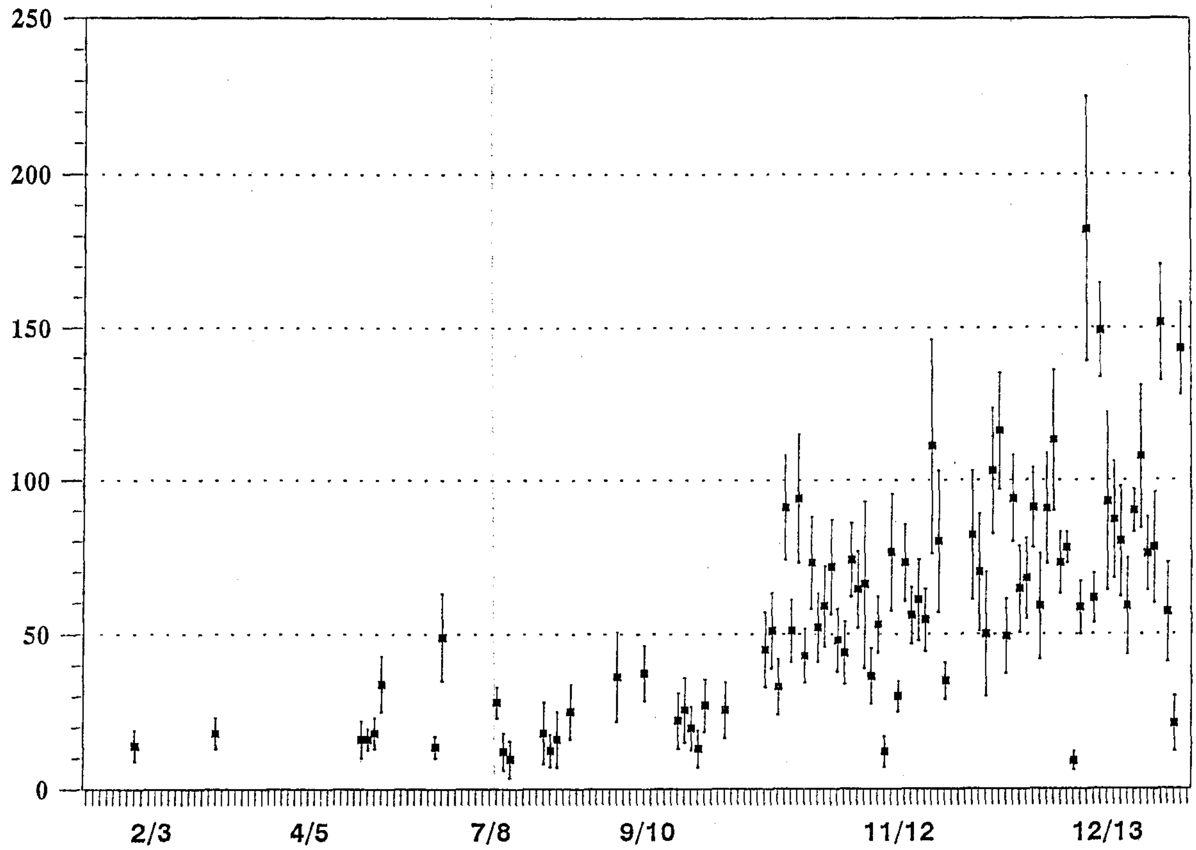



Figure 1 – Activity profile of the Perseids of August 1994 as seen from Malta.

These "ifs" are far from absolute facts, but they suggest that it is valid to compare activity between the two nights at around the same time of night. Analyzing the difference in the mean magnitudes has the effect of canceling out the difference of diverse SLM conditions and diverse individual coefficients of perception. Hence, the difference between the mean Perseid and mean non-Perseid magnitudes is particularly free from any effect [5]. Also, any resulting difference between Perseid and non-Perseid mean magnitudes would be solely attributable to changes in the brightness profile of the Perseid stream. Hence, the mean Perseid magnitude on August 11-12 emerges as consistently some 0.43 to 0.66 magnitudes brighter than that observed on the subsequent night, August 12-13, with a greater proportion of bright meteors on the former night.

After some filtering aimed at removing observations carried out by inexperienced observers or under poor conditions, the regular, second, peak was recorded from Malta at about ZHR = 100, at solar longitude $\lambda_\odot = 140\overset{\circ}{.}175$ (that is, August 13, $1^h30^m$ UT). The regular Perseid maximum for 1994 is reported, on the basis of a preliminary global analysis, to have registered a ZHR of 90 and was reached at the same solar longitude as determined from the reliable Maltese data [6].

## 4. Conclusion

This report has managed to wrap up, perhaps in record time, a major observational project. There are however important lessons to be learnt from this experience.

First of all, it is crucial to approximate as much as possible the standard sky conditions. This enables one to keep to a minimum the resort to coefficients of stellar limiting magnitude, radiant altitude and obscuration. Obscuration is mercifully insignificant during August nights from Malta; but SLM and radiant altitude correction factors have been sorted to by most observers. This is due to the following causes:

1. unsatisfying observing sites; and
2. an excessive enthusiasm to start observations when the radiant is still very low down in altitude.

Decent observing sites should be chosen, even if this means that observers may have to leave the comfort of rooftops! Mean SLM values of less than +5.2 should mean that the observation may as well be aborted. If radiants lie at a low, southerly declination, then low radiant altitudes cannot be done away with; but the Perseid radiant is no such candidate. Hence, observers should refrain from observations where radiants are less than 45% above the horizon, especially if the radiant in question is expected to continue to rise during the rest of the night.

**Acknowledgments**

This report is based on the processing of raw observations by 22 contributors; coordination and further analysis by Umberto Mulè Stagno and Anna Baldacchino; feedback from Adrian Galea and Sandro Lanfranco; graphics and settings by Edwin Camilleri; critical comments from Meteor Group members, following discussion on draft report on December 16, 1994.

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[3] Roggemans P., ed., "Handbook for Visual Meteor Observations", Sky Publishing Corporation, 1990.

[4] Koschack R., Arlt R., Rendtel J., "Global Analysis of the 1991 and 1992 Perseids", *WGN* 21:4, August 1993, pp. 152–167.

[5] Kresáková M., "The Magnitude Distribution of Meteors in Meteor Streams", *Contributions of the Astronomical Observatory Skalnate Pleso* 3, 1966, p. 85.

[6] Rendtel J., "A First Global Analysis of the Perseids", *WGN* 22:6, December 1994, pp. 205–209.

# Preliminary Report on BAA Observations of the 1994 Geminids

*Neil Bone*

An overview is given of *BAA* observations of the 1994 Geminids.

Following good coverage of the shower in 1990 [1] and 1992 [2], *BAA* observers were encouraged to make best use of the "windows" of dark sky between moonset and dawn during the 1994 return of the Geminids. As in 1993, weather conditions were the dominant influence for those in northwest Europe, and observations were largely restricted to the night of maximum (December 13-14). Conditions on this night were similar to those in 1993, with cold front clearing southwards across the British Isles; those in Scotland enjoyed the best conditions.

A total of $50^h30^m$ of watch data, amounting to 1253 meteors (1041 Geminids, 208 sporadics, and 4 others) was reported by the 27 observers listed below:

S. Beaumont, G. Bone, N. Bone, E. Britton (Eire), O. Caulfield (Eire), T. Crann, S. Evans, M. Flowers, D. Gavine, P. Girard, J. Glover, M. Green, C. Hall, R. Johnson, B. Kelly, J. Lancashire, J. Lashley, T. McEwan, A. Pace (Malta), B. Pullar, I. Ransom, R. Schmude (USA), J. Shepherd, G. Simmons, D. Simpson, G. Spalding, and M. Taylor.

The vast majority of watch time was obtained on December 13-14. Highest weight should, naturally, be accorded to those results from the post-moonset interval after $3^h30^m$ UT on maximum night. Results were analyzed by standard methods described previously [3] to obtain corrected Zenithal Hourly Rates, presented in Table 1. Population index $r = 2.44$ has been used for

Geminids, $r = 3.42$ for sporadics. As in the last couple of returns, excellent Geminid activity is apparent, with ZHR probably in excess of 100 around the expected maximum [4] at solar longitude (2000.0) $\lambda_{\odot} = 262\overset{\circ}{.}0$.

Table 1 – ZHR values for the Geminids in December 1994 from *BAA* observations.

| Day | UT | $\lambda_{\odot}$ | $T_{\text{eff}}$ | $\overline{\text{Lm}}$ | Spor | HR | Gem | $h_{\text{rad}}$ | ZHR |
|---|---|---|---|---|---|---|---|---|---|
| 05 | $23^h27^m$ | 253°68 | 2.00 | 6.00 | 7 | $6.5 \pm 2.5$ | 1 | 51°6 | $1.0 \pm 1.0$ |
| 08 | $23^h32^m$ | 256°73 | 3.00 | 5.83 | 18 | $13.7 \pm 3.2$ | 12 | 54°0 | $9.0 \pm 2.6$ |
| 09 | $02^h50^m$ | 256°87 | 1.00 | 5.80 | 4 | $9.5 \pm 4.7$ | 7 | 69°1 | $14.0 \pm 5.3$ |
| 12 | $23^h45^m$ | 259°90 | 1.00 | 5.50 | 1 | $4.3 \pm 4.3$ | 10 | 56°2 | $29.4 \pm 9.3$ |
| 13 | $02^h20^m$ | 260°91 | 1.42 | 5.80 | 5 | $8.3 \pm 3.7$ | 8 | 70°1 | $11.2 \pm 4.0$ |
| 14 | $00^h35^m$ | 261°85 | 1.00 | 5.50 | 1 | $3.4 \pm 3.4$ | 10 | 62°0 | $27.6 \pm 8.7$ |
| 14 | $02^h30^m$ | 261°94 | 2.00 | 5.45 | 5 | $11.4 \pm 5.1$ | 44 | 66°8 | $68.7 \pm 10.4$ |
| 14 | $03^h44^m$ | 261°99 | 4.50 | 5.34 | 20 | $19.7 \pm 4.4$ | 134 | 61°6 | $97.9 \pm 8.5$ |
| 14 | $04^h31^m$ | 262°02 | 4.00 | 5.38 | 24 | $23.8 \pm 4.9$ | 133 | 54°7 | $110.6 \pm 9.6$ |
| 14 | $05^h23^m$ | 262°06 | 6.58 | 5.61 | 41 | $18.6 \pm 2.9$ | 216 | 47°7 | $98.2 \pm 6.7$ |
| 14 | $06^h26^m$ | 262°10 | 5.32 | 5.38 | 25 | $18.6 \pm 3.7$ | 154 | 38°5 | $126.3 \pm 10.2$ |
| 15 | $00^h56^m$ | 262°89 | 1.07 | 5.55 | 3 | $9.0 \pm 5.2$ | 16 | 61°2 | $39.8 \pm 10.0$ |

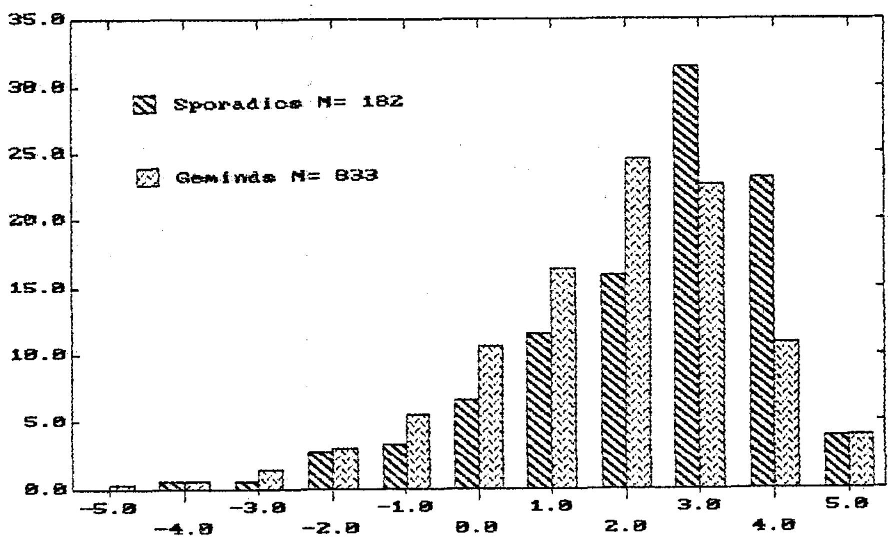


Figure 1 – Percentage-wise magnitude distributions for experienced *BAA* observers during the 1994 Geminid campaign.

Magnitude data from experienced observers are summarized in Figure 1. As usual, the Geminids show an excess of bright events, by proportion, relative to the contemporaneous sporadic background. Mean sporadic magnitude was 2.4, mean Geminid magnitude 1.8. Persistent train phenomena were shown by 12.6% of sporadics, but only 6.5% of Geminids.

While moonlight and weather conditions rather restricted our coverage of the Geminids in 1994, it seems reasonably safe to conclude that activity close to the shower maximum remains on a par with that from the Perseids or Quadrantids in a "normal" year. All *BAA* observers will be urged to continue Geminid coverage, weather permitting, in the hours before moonrise around the shower maximum in 1995.

## References


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[4] *BAA Handbook*, 1994.

# Enhanced Activity of the 1994 Ursids from Japan

*K. Ohtsuka, H. Shioi, and E. Hidaka*

Enhanced activity of the Ursids was observed in Japan on the night of December 22, 1994, when a shower maximum occurred at around $18^{h}10^{m}$ UT. The time corresponds to the solar longitude (eq. 2000) of $\lambda_{\odot} = 270\overset{\circ}{.}75$. This is almost the same position as the maximum in 1981 ($\lambda_{\odot} = 270\overset{\circ}{.}82$) and 1993 ($\lambda\odot \approx 270\overset{\circ}{.}81$). From the Ursid observations in 1981, 1993, and 1994, we infer that a Ursid stream with high influx rates exists around P/Tuttle in at least the the range $-12° < \Delta M < +28°$.

## 1. Prediction

Enhanced activity of the Ursids in 1994 had been forecast by Ohtsuka [1]. The parent comet, P/Tuttle (1992 *r*), returned in 1994 and passed the descending node 200 days prior to the Earth (i.e., te-tc at the node is +200 days, corresponding to $\Delta M = +14\overset{\circ}{.}6$, where $\Delta M$ indicates the difference of mean anomalies between P/Tuttle and the meteoroid stream), approaching the Earth's orbit to 0.06 AU. In the records around previous returns of P/Tuttle, more specifically on the night of December 22, 1981, corresponding to one orbital period before 1994, enhanced activity of the Ursids in Japan with several fireballs was noted. Five bright members (at least magnitude −2) were photographed at Kiso Observatory, using an all-sky camera with fish-eye lens of $f/4$, $f = 8$ mm, during exposures of six hours [2]. An estimated maximum ZHR was in the range of 30 to 80. At that time, P/Tuttle passed the descending node 394 days prior to the Earth ($\Delta M = +28\overset{\circ}{.}4$), approaching the Earth's orbit to 0.08 AU.

Therefore, taking into account the difference of mean anomalies between P/Tuttle and the meteor showers and the distance of both orbits of the comet and the Earth, the condition of meteor shower production in 1994 should have been more favorable than in 1981. With respect to the present comet's return, Lunsford [3] has witnessed a strong activity with maximum ZHR over 100 on December 22, 1993, when te-tc at node and $\Delta M$ were −165 days and $-12\overset{\circ}{.}0$, respectively.

The shower maximum occurred at a solar longitude (eq. 2000) of $\lambda_{\odot} = 270\overset{\circ}{.}82$ in 1981 and $\lambda_{\odot} \approx 270\overset{\circ}{.}81$ in 1993. Hence, taking into account the positions for these solar longitudes, we expected an enhancement of the Ursid activity with a maximum around December 22.82 UT in 1994 [1], a favorable time for visual and photographic observations in Japan.

In the present paper, we deal with preliminary results of the 1994 Ursids activity observed on the predicted night in Japan, and briefly discuss the existence of Ursid streams around P/Tuttle.

## 2. Visual observations

Although the condition of meteor shower production in 1994 may have been better, the observing condition in that night was definitely worse than in 1981 because of moonlight (age of the moon near 19.5 days), Moreover, there was a haze.

Therefore, most of the Japanese visual observers have failed in detecting the Ursids' activity. However, with the aid of the above prediction, H. Shioi has successfully observed the shower activity under good weather conditions. The rate data of his observations are summarized in Table 1. (See also Figure 1.) In Table 1, "*k*" represents the percentage of clouds in the observed part of the sky, "Dir" indicates the direction in which the observer looked, and "Loc" refers to one of these locations:

(1) $\lambda = 140°07\overset{\prime}{.}04$ E, $\varphi = 35°44\overset{\prime}{.}19$ N, $h = 7$ m;

(2) $\lambda = 140°06\overset{\prime}{.}23$ E, $\varphi = 35°44\overset{\prime}{.}34$ N, $h = 22$ m.

From a more detailed analysis, it follows that the shower maximum may have occurred around $18^{h}10^{m}$ UT with an HR of 30 ($N = 5$).

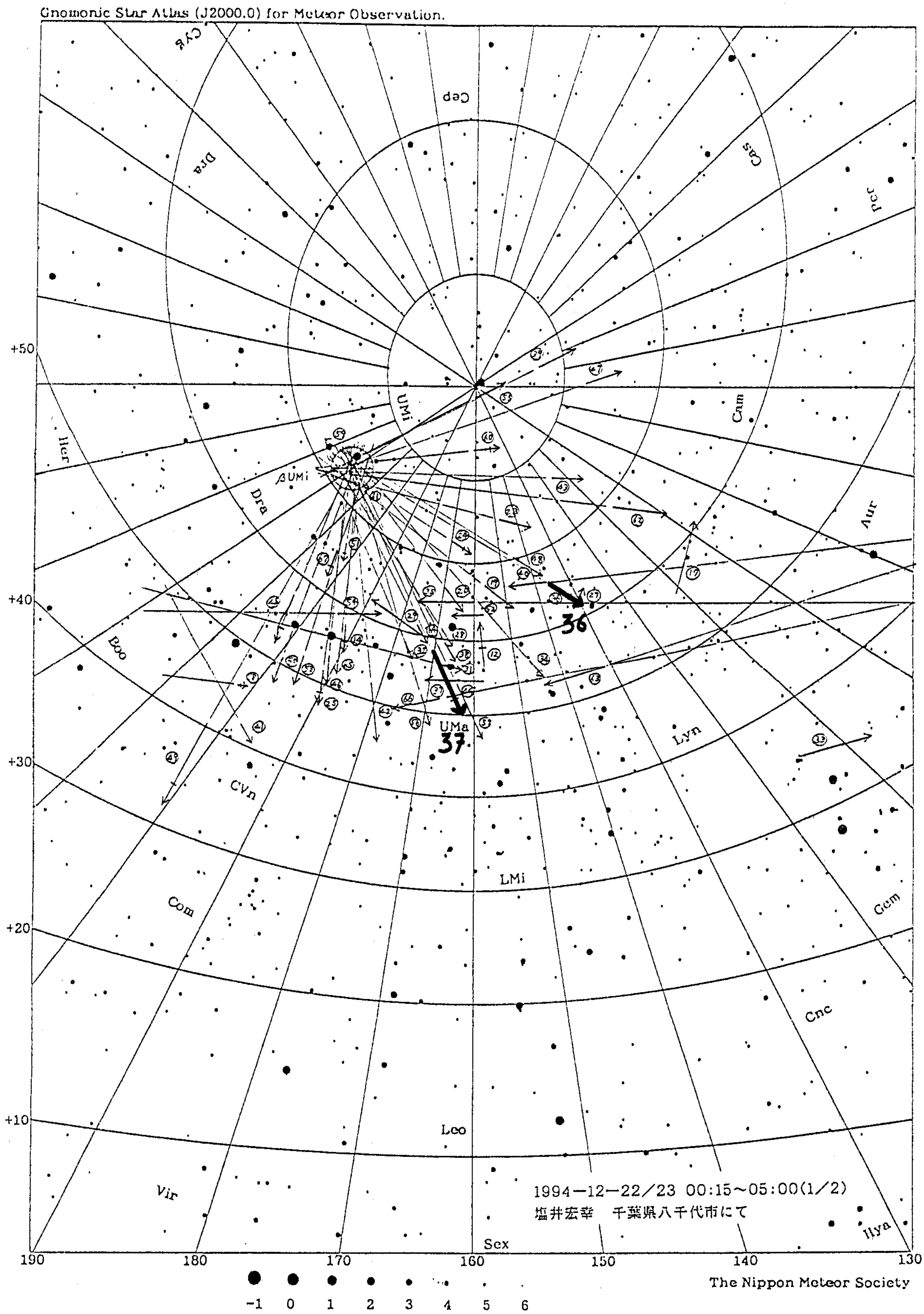


Figure 1 – Visual Ursid observations by H. Shioi. The "twin meteoroids" mentioned in the text are the pair (36,37).

Table 1 – Rate data of the Ursids on the night of December 22, 1994, as observed by H. Shioi from Yachiyo, Japan.

| Period (UT) | $T_{\text{eff}}$ | Lm | Urs | Oth | $k$ | Dir | Loc |
|---|---|---|---|---|---|---|---|
| $09^h00^m$–$10^h00^m$ | 1.00 | 4.8 | 2 | 8 | 0% | Lac | (1) |
| $15^h15^m$–$16^h00^m$ | 0.75 | 5.2 | 3 | 4 | 0% | Lyn | (2) |
| $16^h00^m$–$17^h00^m$ | 1.00 | 5.2 | 3 | 3 | 30% | Lyn | (2) |
| $17^h00^m$–$18^h00^m$ | 1.00 | 5.2 | 5 | 6 | 10% | Lyn | (2) |
| $18^h00^m$–$19^h00^m$ | 1.00 | 5.2 | 13 | 5 | 0% | Lyn | (2) |
| $19^h00^m$–$20^h00^m$ | 1.00 | 5.2 | 11 | 4 | 0% | Lyn | (2) |

In particular, at $18^h08^m$, two Ursids of magnitudes 1 and 0, respectively, have appeared in a short time span of 15 seconds in Ursa Major. We may regard them as "twin meteoroids" split from one another.

The magnitude distributions for the 1994 Ursids and other meteors were also recorded in Shioi's observations. They are listed in Table 2.

Table 2 – Magnitude distributions of the meteors in Table 1.

| Shower | −1 | 0 | +1 | +2 | +3 | +4 | Tot | $\overline{m}$ |
|---|---|---|---|---|---|---|---|---|
| Ursids | 1 | 2 | 3 | 7 | 11 | 13 | 37 | 2.7 |
| Others | 0 | 0 | 2 | 1 | 15 | 12 | 30 | 3.2 |

Although the magnitudes are not absolute but apparent (visual) ones, we can tentatively estimate the population index $r$ as 2.2 for the 1994 Ursids. If we assume this $r$-value, the correction factor for limiting magnitude will be 2.79. The apparent radiant of $\alpha = 217°$, $\delta = +76°$, usually observed [4], should rise about 40° above the horizon at around $18^h10^m$ UT, if we take into account the correction for the Earth's attraction. Thus, we can derive a maximum ZHR of more than 100. Due to the large correction, this may be overestimated, however.

## 3. Photographic observations

It is very important to determine orbits of photographic Ursid meteoroids, because orbital elements of only three Ursids were obtained by the Harvard photographic meteor program so far [5]. Therefore, photographic observations were also carried out by the *Tokyo Meteor Network* (*TMN*) team using Canon T-70s with lenses of $f/1.2$, $f = 85$ mm, and by *Japanese Fireball Network* (*JN*) stations using fish-eye and wide-angle cameras during that night.

Although a possible Leo Minorid was simultaneously photographed by two *TMN* stations, we regret to say that no double-station Ursid meteor or fireball image was obtained.

A single-station Ursid, however, one of the twin meteoroids mentioned above, was photographed at the *TMN* Fujisawa station at $18^h08^m28^s$ UT (see front cover). The film reduction was carried out using Mitutoyo's digital comparator TM-100, measuring up to a graduation of 0.001 mm. The results of the reduction for this Ursid are summarized in Table 3. In Table 3, $\lambda$, $\mu$, and $\nu$ are direction cosines of the pole. The standard deviations of the positions for 7 reference stars and for rectilinearity of 27 break points on the trail are $6''$ and $8''$, respectively. Applying the direction cosines, if we assume the right ascension of the apparent radiant of the trail as 217°, then the declination will be $+76.^\circ4$ on the great circle of the trail. This is fairly identical with the apparent radiant of $\alpha = 217°$ and $\delta = +76°$ as mentioned above.

Table 3 – Photographic Ursid (eq. 2000.0).

| | |
|---|---|
| Time | Dec 22.75588 UT |
| Magnitude | +1 |
| Begin | $\alpha = 202\overset{\circ}{.}347 \quad \delta = +66\overset{\circ}{.}376$ |
| End | $\alpha = 201\overset{\circ}{.}280 \quad \delta = +64\overset{\circ}{.}982$ |
| Lenght | $1\overset{\circ}{.}46$ |
| $\lambda$ | −0.0981556 |
| $\mu$ | +0.9873489 |
| $\nu$ | +0.1245297 |
| Duration | 27/50 s (or breaks) |

## 4. Discussion

A shower maximum of the 1994 Ursids occurred at around $18^h10^m$ on December 22, 1994, which corresponds to a solar longitude (eq. 2000) of $\lambda_\odot = 270\overset{\circ}{.}75$. This is a little earlier than those observed in 1981 ($\lambda_\odot = 270\overset{\circ}{.}82$) and 1993 ($\lambda_\odot = 270\overset{\circ}{.}81$), or the prediction, but not much. However, to determine the real shower maximum, we must analyze not only Japanese data but also global data in visual observations. An enhanced activity of the 1994 Ursids, though, is quite certain.

We think the profile of the 1994 Ursids was not so rich in larger meteoroids as the 1981 stream, because no photographic fireball image was obtained this year. This is supported by Shioi's visual observations. However, on the next night, an Ursid fireball of −4 was photographed at the *JN* Hario station. This may also have been photographed by the all-sky camera of the Kiso observatory, and we will survey the fireball image on a corresponding film.

From the observations in 1981, 1993, and 1994, we infer that an Ursid stream with high influx rates exists around P/Tuttle in at least the range $-12° < \Delta M < +28°$. It is important to watch in 1995 to see whether the stream extends beyond that range or not, moreover since Maeda [6], using FM radio, detected a number of forward-scatter echoes, probably due to the Ursids in 1982, with an influx rate twice as high as regular Ursid activity.

On the other hand, another Ursid stream with the highest influx rates in the whole complex is located far from P/Tuttle, at $\Delta M \approx 165°$ [7]. This densest part was observed in 1945 and 1986, returning about 6 years later than the comet [4,8]. Therefore, it is predicted that the next return of this stream will be in 1999 or 2000, and must be watched again.

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[2] A. Miyashita, in *Proc. Annual Meeting of the Astronomical Society of Japan in spring*, 1982.

[3] R. Lunsford, *Meteor News* 103, 1994.

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[7] N.A. Belyaev, L. Kresák, E.M. Pittich, A.N. Pushkarev, "Catalogue of Short-Period Comets", Astron. Inst. of SAV, Bratislava, 1986.

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# International Astronomy Meetings Related to Meteors and Interplanetary Dust

*compiled by Robert Hawkes, Mount Allison University*

**1995 May**

- May 01–06: *Le systeme solaire, La 19ème Printemps d'Astrophysique de Goutelas.*

Contact: "Le Comité d'Organisation": Daniel Benest, Claude Froeshelé, Monique Fulconis. O.C.A. Observatoire de Nice, B.P. 229, F-06304 Nice Cedex 4, France. Phone: +33-92-00-31-08, +33-92-00-30-24, +33-92-00-30-29. Fax: +33-92-00-30-33. E-mail: `goutelas@obs-nice.fr`.

- May 09–12: *IAU Colloquium 156: The Collision of Comet P/Shoemaker-Levy 9 and Jupiter, Baltimore, Maryland.*

Contact: Ms. Cheryl Schmidt, Space Telescope Science Institute, 3700 San Martin Drive, Baltimore, MD. E-mail: `schmidt@stsci.edu`.

**1995 June**

- June 19–23: *Origins of the Solar System (1995 Gordon Research Conference), New Hampton, NH.*

Contact: Anneila Sargent. E-mail: `afs@mmstar.caltech.edu`.

**1995 July**

- July 03-08: *IAU Symposium No. 172 : Dynamics, Ephemerides and Astrometry in the Solar System, Paris, France.*

Contact: Bureau des Longitudes, IAU Symposium No. 172, 77 avenue Denfert-Rochereau, F-75014 Paris, France. E-mail: `bdl95@bdl.fr`.

- July 20–23: *Ecological Consequences of Earth Collisions with Small Bodies of the Solar System, Tomsk, Russia.*

Contact: Gennadij Andreev, Astronomical Observatory of the Tomsk State University, Box 1106, 634010 Tomsk, Russia. Phone: +7-3822-909721. Fax: +7-3822-230450.

**1995 August**

- August 14–18: *IAU Colloquium No. 150: Physics, Chemistry and Dynamics of the Interplanetary Dust*

Contact: IAU Colloquium, c/o Dept. of Astronomy, University of Florida, P.O. Box 112055, Gainesville, FL 32611-2055. E-mail: `IAU-95@astro.ufl.edu`. Fax: +1-904 392 5089. Phone: +1-904 392 2052.

**1995 September**

- September 11–14: *The Role of Dust in the Formation of Stars (ESO Workshop), Garching bei München, Germany.*

Contact: Hans Ulrich Kaufl, ESO, Karl-Schwarzschild-Str. 2, D-85748 Garching. E-mail: `hukaufl@eso.org`. Tel: +49-89-32006-414. Fax: +49-89-32006-480. You can also contact Ralf Siebenmorgen, ESA/ESTEC, ISO Science Operation Team, Kepplerlaan 2, NL-2200 AG Noordwijk. E-mail: `rsiebenm@iso.estec.esa.nl`. Phone: +31-1719-85877. Fax: +31-1719-85434.

**1995 October**

- October 07–14: *AAS Division for Planetary Sciences, Kohala Coast, HI.*

Contact: Karen Meech. E-mail: `meech@pavo.ifa.hawaii.edu`.

**1995 November**

- November 06-10: *Basic Space Science (5th UN/ESA Workshop), Karachi, Pakistan.*

Contact: Hans JHaubold. E-mail: `hjh2@aip.org`. You can also contact Willem Wamsteker.
E-mail: `ww@vilspa.esa.org`. Ftp: `ftp://ecf.hq.eso.org/pub/un/un-homepage.html`.

**1996 July**

- July 08–12: *6th Asteroids, Comets, Meteors Conference (International Conference co-sponsored by ESA, NASA, Université de Versaille, Aeronomie CNRS, Observatoire de Paris) Versailles, France.*

Contact: ACM, Aeronomie CNRS, B.P. 3, F-91371 Verrières, France. Fax: +33-1-69-20-29-99.
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Only a selection of conferences of interest to Commission 22 of the IAU are given here. See the above sources for the complete list of International Astronomy Meetings.

# Physics, Chemistry, and Dynamics of Interplanetary Dust

## IAU Coll. No. 150, Gainesville, Florida, USA, August 14–18, 1995

*communicated by the organizers*

This colloquium is sponsored by *IAU* Commissions 21 and 22 and co-sponsored by Commissions 15, 16, and 20. Symposia or colloquia on interplanetary dust have been held approximately every five years since 1967. The last meeting, *IAU* Colloquium 126 in Kyoto in 1990, was very successful and attracted about 150 participants from 16 countries. The field has recently witnessed several important advances, mostly due to satellite measurements.

Planned topics are dynamics of the interplanetary dust cloud, meteoroids and streams, chemistry of the interplanetary dust, physical processes and laboratory analyses, zodiacal light and thermal emission, cometary dust, dusty planetary rings, origin of the interplanetary dust cloud, relationships to interstellar dust, and instrumentation.

There will be time allocated to poster sessions and all posters will remain on display for the duration of the meeting. Each poster can occupy an area of approximately 3 feet wide by 4 feet in height (90 × 122 cm). Approximately 15 minutes will be devoted to each contributed oral presentation whereof no more than 12 minutes is for the main presentation so that a minimum of three minutes remain for questions and comments. There will be no parallel sessions. Abstracts must be received by June 15 to guarantee their inclusion in the abstract booklet. All contributions will be refereed.

The meeting is hosted by the Department of Astronomy of the University of Florida, in Gainesville, Florida. Located in North Central Florida, midway between the Gulf of Mexico and the Atlantic Ocean and approximately 160 km north of Orlando, the city of Gainesville (about 100 000 inhabitants) is dominated by the university community of approximately 36,000 students, 4000 faculty, and 8000 staff. You may sign up for a visit to the Laboratory for Astrophysics at the registration deck. Observational facilities include an optical observatory with a 24 inch and an 18 inch telescope. The 24 inch reflector is primarily used in a long-term survey of quasars. The Dixie County Radio Observatory operates the world's largest decametric dipole array, it is primarily used in a long-term study of the Jovian emission. The Kennedy Space Center and other interesting places can be visited.

We have arrangements with two hotels that provide a special rate (approximately 47 USD +9% tax or 48 USD +9% tax) for meeting participants. Both hotels are located next to campus, within one mile walking distance of the Reitz Union where the meeting is held. Gainesville is serviced by a regional airport with shuttle service to the conference hotels.

The registration fee of 120 USD is due at the meeting. This will cover the cost of the abstract booklet and the published Proceedings. If you want to attend the colloquium, or if you want further information, please contact *IAU* Colloquium 150, c/o Department of Astronomy, University of Florida, 211 SSRB, Box 112055, Gainesville, FL 32611-2055, USA. Phone: +1-904-392-2052. Fax: +1-904-392-5089. E-mail: `IAU-95@astro.ufl.edu`.

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# Recent Meteor and Interplanetary Dust Papers

*compiled by Robert Hawkes, Mount Allison University*

- Fulle M., Bohm C., Sette G., "Current meteor production of comet P/Swift-Tuttle 1992*t*," *Astronomy and astrophysics* 292:1, December 1, 1994, p. 304.
- Hills Jack G., Leonard, Peter J.T., "Earth-Crossing Asteroids: The Last Days Before Earth Impact," *The astronomical journal* 109:1, January 1, 1995, p. 401.
- Huziak R., Sarty G., "The value of fireball reports from the general public," *Journal of the Royal Astronomical Society of Canada* 88, 1994, p. 332.
- Whitman Patrick G., Matse John J., "Meteoroid Streams as Probes of the Subsurface Regions of Comets," *Icarus* 109, 1994, p. 258.

# The International Meteor Organization



# Addresses of authors not mentioned elsewhere


A. Grishchenyuk, Astronomical Observatory of the Crimean Regional Young Technicians Station, P.O. Box 52, Simferopol, *Crimea* 333 000, *Ukraine*
G. Zay et al., 3946 Paula Street, La Mesa, *CA 91941, USA*
E. Doria, Trav. do Giestal, 34 6 Dt., P-1300 Lisboa, *Portugal*
Thomas R. Manley et al., 614 Killarney Drive, Sebring, *Florida 33872, USA*
J. Wood, 4 St. Kilda Road, Rivervale, *Western Australia 6103, Australia*
D. Artoos, Nattenhofstraat 74, B-2800 Mechelen, *Belgium*
A. Galea, "Edmar," Sardinella St., Fgura Pla 16, *Malta*
M. Beech, Astronomy Dept., Univ. of Western Ontario, London, *Ont. N6A 3K7, Canada*
G. Ryabova, Research Inst. of Applied Math. and Mechanics, 634 050 Tomsk GSP-14, *Russia*
J. Richardson, Route 2, Box 118, Graceville, *Florida, USA*
N. Bone, The Harepath, Mile End Lane, Apuldram, Chichester, West Sussex, P020 7DZ, *Engl.*
Godfrey Baldacchino, "Sirius" Triq Il-Migbha, Marsascala, *Malta*
K. Ohtsuka et al., 1-27-5 Daisawa, Setagaya-ku, 155 Tokyo, *Japan*
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