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Photograph by Jim V. Scotti of Comet P/Swift-Tuttle made on October 23.11196 with the 0.91-meter Spacewatch Telescope of the University of Arizona on Kitt Peak, using a Tektronix TK2048E CCD. The integration time was 120 seconds. The field of view of this pint is about 15′ × 10′. The nuclear region is overexposed to make the ion tail visible.

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Contents

Useful Information

The February Issue *(WGN 21:1)*

The *February issue* is expected to be mailed during the first week of February 1993. Therefore, contributions are due *January 8* at the latest. They should be sent to *Marc Gyssens* (address on inside back cover).

WGN Subscription/IMO Membership 1993

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

Paul Roggemans and Brian Marsden: A Tribute

Marc Gyssens

When I think about it, editing this journal, issue after issue, year after year, is a strange pass-time. Yes, I admit that sometimes I look upon the vast amount of articles and the often complicated tables they contain with reservation, but once I start composing a particular issue, a kind of childish enthusiasm overcomes me, and each time when the work is finished and I bring the copy to the printer—not infrequently in the early morning hours—I have a deep sense of self-fulfillment. I guess it is this feeling that keeps me going...

In this respect, each issue of WGN*, be it thick or thin, is a special one to me. Notwithstanding this, I will not easily forget the editing of the October issue, for it was during this process that Comet P/Swift-Tuttle was rediscovered. Editing the October issue felt more like editing a newspaper than a bimonthly journal. Much of the work went into composing a summary report on the 1992 Perseid outburst and finally incorporating the initial data about the rediscovered comet. Thanks to the speed of modern communication, new information came in almost every day, forcing us to continually modify the journal's content.*

The excitement over the Perseid outburst and the rediscovery of P/Swift-Tuttle together with the feeling of proximity to these events caused by the editing process could in their own right explain why the previous issue is very special to me. But the way I feel really goes deeper than that.

My feelings are actually a combination of pride and humility. The former is the easier to explain: it is indeed the IMO's first big achievement to have unveiled the new Perseid peak and to have encouraged observers to monitor it—leading to the identification of the 1991 and 1992 outbursts, growing speculation about the proximity of the parent comet, and ultimately its rediscovery. In short, this chain of events constituted the ultimate legitimization of our Organization's existence.

But at the same time, I feel very humble, because our success is not at all the inevitable outcome of the course of history; quite to the contrary a lot of questions remain. Why, for instance, did Paul Roggemans not do away with the secondary peak in the 1988 Perseid activity profile—which then was little more than a shoulder on the classical profile—as a statistically insignificant fluctuation in the first place? The criticism that several people at that time leveled at Paul's conclusion indeed cannot simply be dismissed as unfounded. And when the secondary peak reappeared in the 1989 analysis, more distinct but still quite modest, what made Paul so certain of its reality to bring this relatively nondescript feature to the attention of the astronomical community in a magazine as renowned as Sky and Telescope? And why did Sky and Telescope trust the results of a society not even three years old to such a degree instead of editing out this seemingly insignificant detail? Furthermore, why did the Japanese believe the possibility of enhanced activity so much that they specially prepared for it? Let us not forget that, had it not been for such preparation, the 1991 outburst lasting only one hour might have easily gone by unnoticed or been so scarcely documented that nobody might actually have believed it really occurred! Next, when Brian Marsden suggested that the outburst could indicate the return of P/Swift-Tuttle provided the comet was identical to P/Kegler, why did everybody believe him? In a letter to Joe Rao just months before the recovery, Marsden himself described his own suggestion, perhaps overmodestly, as a very long shot out of desperation, expressing his fear that visual comet observers got carried away by it. Quite ironically in view of what eventually happened, Marsden told Rao that nobody would be more surprised than he if the comet were rediscovered visually... The truth is that the entire astronomical community allowed itself to be carried away by Marsden's predictions, ... and was proved right in doing so!

The point of all this is that science does not always progress in a very scientific manner, a fact that has struck me many times already, and that struck me once again on the occasion of P/Swift-Tuttle's rediscovery. Of course, science requires a solid methodology. It requires commitment and a lot of perseverance to obtain results. It also requires a good dose of scepticism and care in the evaluation and interpretation of results, in order not to make one's wishes color the conclusion. But if science is ultimately to be more than merely recapitulation and refinement of what is already known, then it also requires intuition, creativity, faith, and courage. It requires the ability to recognize the relevant from the irrelevant, to discriminate between the significant and the insignificant, beyond the capacity of pure statistics. In this respect, the doing of science as an activity is not so much a science as an art. Paul Roggemans and Brian Marsden, each on their own terrain, Paul as an amateur and Dr. Marsden as a professional, have once again proved to be masters of this art. They are examples for us all, and this unusually long editorial is my tribute to them.

With the Christmas season approaching, I hope that my rather long personal reflection merits some consideration when you are making up your intentions for the New Year regarding the IMO*. We are a still a very young organization, and in the short period since our foundation we managed to prove convincingly the legitimacy of our existence. This however may not become a reason for self-contentedness. The scientific community will force us—and rightfully so—to prove the legitimacy of our existence over and over again. To achieve this goal, we need the commitment and struggle of all our members, observers, and officers, for there is still much work to be done. We need the faith and courage to continuously move forward, yes, with caution and care, but, at the same time, with vision and an open mind! In this spirit, I wish that your commitment in the* IMO *in 1993 may result in the same fulfillment I now feel after having completed this issue!*

1993 Membership and Subscription Renewal

Ina Rendtel and Marc Gyssens

For the convenience of our readers, we repeat the renewal information from the previous issue. As the participation fee for the **1993 International Meteor Conference** has already been set—the event taking place from September 23 to 26, 1993, in Puimichel, Haute-Provence, France (see elsewhere in this issue)—we encourage prospective participants not yet having renewed their membership/subscription to pay both at the same time. In this way, you save on costs inevitably incurred with international payments. For the same reason, this is also a good time for ordering **IMO publications**. A price list figures on the previous issue's outside back cover.

The **membership/subscription dues** for 1993 are **25 DEM**. People outside Europe wishing **airmail delivery** pay **40 DEM**.

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

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

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

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

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

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

Letters to WGN

compiled by Marc Gyssens

Radio reflection duration and visual magnitude

Often within our Organization, radio meteors are designated as fireballs on the basis of reflection times. George Zay has an interesting observation regarding this common practice.

I routinely have my radio speaker next to me while I visually record meteors, just so that I can do a comparison. I see meteors that make radio reflections just about as often as I see them with no reflections. It appears that a visible fireball from anywhere in the sky usually gives off a radio reflection of some kind all the same. I have noticed that not on all occasions does a fireball magnitude has anything to do with radio reflection times.

I first became suspicious last April 21, 1992, when I noted a −3 visual make a 16 second radio reflection. And on May 4, I saw a −3 to −4 visual make a 27 second radio reflection. Then on May 26, I saw a −10 to −12 visual which made only a 3 second radio reflection. I have not had that many fireballs to make an extended comparison and I was just wondering if other people had encountered these kind of results? I am sure that most radio reflections match their assigned visual magnitude values, but this suggests to me that something else is involved here and that this should be taken into consideration when determining fireball rates based on radio reflections.

Possibly this has already been factored somewhere. I am not a mathematical wizard nor am I all that up to snuff on the effects of meteor activity on our atmosphere. Perhaps these observations will mean something to our more enlightened members so they can make sense out of it?

George J. Zay, October 16, 1992

Editor's comment: I think Mr. Zay made a very good point here. While, generally, brighter meteors tend to produce longer reflections, the relationship between both entities is much more complex than suggested by formulae such as the one used in previous issues of the Report Series, *and depends on a lot of other factors as well. As a matter of fact, the coefficients in the formula used in the* Report Series *were computed in the pre-*IMO *era by a linear regression with a poor correlation on a sample that was actually to small. Therefore we seriously consider to omit visual magnitude for radio fireballs in future reports as they are unreliable, and thus misleading.*

Meteor display on July 29?

Last month, Peter Brown received a letter from Mr. Orion Carlisle describing a spectacular meteor display on July 29 UT, 1992. We reproduce the letter below in case someone else also witnessed this display.

Recently I witnessed a fantastic display of celestial beauty above Yerkes Observatory, where I worked as an undergraduate summer intern.

On the night of July 28, 1992, within about 3 minutes, I saw at least 40 meteors! They were crossing the constellation Lyra, near zenith, heading East, with a few off to either side, of varying brightness, but all short (shorter than the width of my hand at arm's length, with some no longer than my fingers). The smallest one was no more than a dot, an instant star that exploded out of the heavens to vanish without a sound, all in a second. This flash was west of Lyra, three or four hand-widths. The shots to either side were brighter and longer (at least a good hands-width, and maybe longer). They seemed to curve from a spot west of Lyra. There was one moment that is etched in my memory like the scratch of a mountain lion—four, maybe five very dim red meteors, parallel and in unison, scratched the sky! A short scratch, but so permanent in my mind.

Then there was visual silence, no streaks across the sky, no flashes except from lightning low on the horizon. But then a few more; nothing; one; two; nothing.

In the first ten seconds, I saw about 10, then 5- or 10-second pause, and then another volley—for a total of maybe 50 in two or three minutes. Following were other small volleys with 10 or 15 in a minute, seemingly coming in clumps, and a few loners. Thus, in another five minutes I saw 40 or 50 more—but afterwards nothing more than a couple here and there.

Darren Dowell and John Briggs confirmed the direction of the shower, and Darren saw some activity himself around 21^h50^m CDT (2^h50^m UT), but he did not catch the peak, which was around 21^h35^m CDT (2^h35^m UT). By 22^h25^m CDT (3^h25^m UT) when John checked, there was no major activity. Perhaps other observers noticed unusual activity on this night!

Orion Carlisle, October 9, 1992

The 1993 IMO International Meteor Conference

Puimichel, France, September 23–26

Paul Roggemans

Since the successful *IMC* in Smolenice, several locations were considered for our annual meeting in 1993. Plans for an *IMC* in Canterbury, England, did not work out, so we searched for alternatives, and found two suitable sites, one in Belgium and the other the well-known observatory at Puimichel in the French Haute-Provence. Many successful observing campaigns at this site were reported in this journal during the last decade. After careful consideration of the pros and cons of both alternatives, we opted for Puimichel, the main reason being that we never had an *IMC* in Southern Europe.

It is therefore hoped that this choice will be particularly appealing to our members and observers in France, Italy, Malta, Slovenia, Spain, and Switzerland.

Furthermore, the beautiful nature of the Provence and the Haute-Provence, with its amazing variation in landscapes, its fine smells of lavender and other herbs, its excellent wines, and the rich cultural historical heritage of the region need little comment; a holiday in this area of France can easily be combined with the 1993 *IMC*!

Providing an average of over 200 clear nights per year, the Haute-Provence is also famous among observers for its excellent sky conditions. Puimichel is a fine place for meteor observing; moreover, several large telescopes are available. Therefore, we invite all participants to the *IMC* to come to Puimichel earlier. Several observers will stay there from September 18 onwards for joint meteor observing. Do not miss the opportunity to join them for at least part of this period!

While the Puimichel observers' residence "La Remise" has been improved a lot recently, and offers very reasonable comfort, it is not a conference complex, but a big house where the guests live together in an informal observing-camp spirit, a spirit that will dominate the upcoming *IMC*. While we were able to make arrangements for organizing a conference at Puimichel that meets the *IMO*'s standards, the site has one drawback, and that is its limited capacity. Therefore, do not hesitate to return your registration form as soon as possible!

International Meteor Conference

Puimichel, France, September 23–26, 1993

Registration Form

Each individual participant should fill out a form and return it to Paul Roggemans, Pijnboomstraat 25, B-2800 Mechelen, Belgium, **before the end of 1992**! Late registrations are accepted on a place-availability basis only! Your registration will be guaranteed only after Ina Rendtel received at least the pre-payment of 100 DEM. If you strongly 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. More information can be obtained from Paul (phone: +32-15-41 12 25).

Name: ______________________________ Birth date: ______________

Address: ____

____

Phone: ______________ Fax: ______________ E-Mail: ______________

- ○ wishes to register for the *IMC* from September 23 to 26;
- ○ intends to participate, cannot yet register, but wishes to stay on the mailing list;
- ○ wishes to stay in Puimichel before the *IMC* from __/__/1993 onwards at a price between 150 and 240 FRF per day;
- ○ prefers more private accommodation in a separate house within walking distance of "La Remise," at a supplement in price;
- ○ prefers a single/double room in a hotel at 10 min. driving distance from Puimichel, at a supplement of appr. 40 DEM per night.

I intend to travel by ________, together with ______________________________

____

For participants interested in car-pooling:

- ○ I have __ free places in my car from ____________________;
- ○ I would like a ride to Puimichel from ____________________.

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 180 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. Recall that Ina cannot accept bank checks! People wishing to pay in other currencies (USD, GBP, or JPY) should contact the appropriate *IMO* officer for exchange rates. Participants paying only 100 DEM have to pay the remainder upon arrival in Puimichel in French Francs, being 300 FRF

Method and date of payment: ____________________ Amount: __________DEM

Date and signature,

Now some practical information. Thanks to a special arrangement we could make with the Puimichel observatory, we can offer the entire conference with full board for the very moderate price of 180 DEM. We suggest that you pay the entire amount when you return your registration form. The participation fee must be paid to our Treasurer, Ina Rendtel, *in the same way as your membership/subscription fee*. To those who did not yet renew, we suggest that they pay both fees in one transfer to save on bank charges! If you cannot pay the full amount at once, *you must pay at least 100 DEM on sending in your registration form to guarantee your reservation*! In that case, you must pay the remainder at the conference *in French Francs* (which is 300 FRF).

Candidate-participants from Eastern Europe for whom the participation fee would pose unsurmountable problems may contact Paul Roggemans to check if some arrangement is possible.

While the conference participation fee includes lodging at "La Remise," more private accommodation is possible within easy walking distance, and hotel accommodation within easy driving distance, both at a supplement of course. A preference for one of these options can be indicated on the registration form.

The cost for staying in Puimichel *before* the *IMC* is in principle 240 FRF per day and per person for full board. However, we were promised a reduction if the number of people staying before the *IMC* is sufficiently high. Depending on the size of the group, the price per day and person will be between 150 FRF and the amount above.

If you wish to attend, fill out the registration fee as soon as possible, send it to *Paul Roggemans* (address on inside back cover), and send your (pre-)payment to *Ina Rendtel* in the customary way as soon as possible. But even if you are strongly interested in attending but cannot decide yet, you can use to form to indicate you wish to remain on the mailing list to receive further circulars. The next circular is planned for March 1993.

However, do not hesitate too long, since the number of participants is limited, so make sure you reach a decision before Puimichel is full!

Visual Observers' Notes: January–February 1993

Jeff Wood

1. Introduction

Although early January begins with the major shower, the Quadrantids, this period has been characterized as one with low rates, and so must therefore hold little interest to the meteor observer. This attitude, however, is based on a misconception. Even though rates may be low, there is still much to see as southern hemisphere observers and those in the northern hemisphere who have braved the winter weather have discovered.

Table 1 below gives an overview of some of the showers to be seen in January and February 1993. Table 2 shows observing conditions during these months moon-wise.

Table 1 – Some of the meteor showers to be seen in January and February 1993.

Shower	Activity	Max	Radiant			Drift		V_∞	r	ZHR
			α	δ	Diam.	$\Delta\alpha$	$\Delta\delta$			
Puppid/Velids	Sep 28–Jan 26	several	120°	−45°	20°/5°			41	2.9	
Coma Berenicids	Dec 12–Jan 23	Dec 19	175°	+25°	5°	+0.°8	−0.°2	65	3.0	5
Quadrantids	Jan 01–Jan 05	Jan 03	230°	+49°	5°	+0.°8	−0.°2	41	2.1	110
δ-Cancrids	Jan 05–Jan 24	Jan 17	130°	+20°	10°/5°	+0.°9	−0.°1	28	3.0	5
α-Crucids	Jan 06–Jan 28	Jan 19	192°	−63°	10°/5°	+1.°1	−0.°2	50	2.9	5
α-Carinids	Jan 24–Feb 09	Jan 31	95°	−54°	5°			25	2.5	
Virginids	Feb 01–May 30	several	195°	−04°	15°/10°			30	3.0	5
θ-Centaurids	Jan 23–Mar 12	Feb 01	210°	−40°	6°	+1.°1	−0.°2	60	2.6	
α-Centaurids	Jan 28–Feb 21	Feb 07	210°	−59°	4°	+1.°2	−0.°3	56	2.0	25+
o-Centaurids	Jan 31–Feb 19	Feb 11	177°	−56°	6°	+1.°0	−0.°3	51	2.8	
δ-Leonids	Feb 05–Mar 19	Feb 15	159°	+19°	8°	+0.°9	−0.°3	23	3.0	3
γ-Normids	Feb 25–Mar 22	Mar 14	249°	−51°	5°	+1.°1	+0.°1	56	2.4	8

Table 2 – Moonlight and observing conditions in January–February 1993.

Date	k	Date	k
Friday January 01	0.49+	Friday February 05	0.94+
Friday January 08	1.00+	Friday February 12	0.68–
Friday January 15	0.52–	Friday February 19	0.06–
Friday January 22	0.01–	Friday February 26	0.17+
Friday January 29	0.31+	Friday March 05	0.84+

New Moon:	December 24, January 22, February 21
First Quarter:	January 1, January 30, March 1
Full Moon:	January 8, February 6, March 8
Last Quarter:	January 15, February 13, March 15

2. Quadrantids

The Quadrantids are only observable from the northern hemisphere. There, during the last few hours before sunrise on the mornings of January 2-3 and 3-4, rates more than 30 meteors per hour can be recorded under good sky conditions. When we consider that the radiant altitude is still fairly low at this time, the corrected rates give a ZHR comparable to that of the η-Aquarids, Perseids, and Geminids, thus making the Quadrantids a truly major shower.

The Quadrantid radiant is situated in the northeast corner of the constellation of Bootes which used to be known as Quadrans Muralis from which the shower's name derives. Quadrantid meteors are very brilliant, and many produce trains. Frequent poor weather has meant that data on this shower are comparatively scarce. Thus with reasonable Moon conditions towards the early morning, observers are encouraged to brave the cold of winter and observe this shower in 1993. The maximum is expected around January 3, 10^h UT, favoring North America. However, as this prediction may be incorrect by up to about 5 hours, observers should be alert well before and after this time!

3. Coma Berenicids

This shower is active from December 12 through to January 23. Although the maximum occurs on December 19, rates are still moderate during January. The Coma Berenicids are best seen during the last few hours before sunrise from the northern hemisphere. They are fast meteors with a $V_\infty = 65$ km/s. Observers should have their field center situated no further than 30° from the radiant. All possible Coma Berenicid meteors should be plotted.

Table 3 – Radiant positions of the Coma Berenicids.

Date	α	δ	Date	α	δ
Jan 06	191°	+19°	Jan 16	199°	+16°
Jan 11	195°	+18°	Jan 21	203°	+15°

4. δ-Cancrids

Very little is known about this stream which can be seen from either hemisphere during mid January. The δ-Cancrids therefore need urgent attention from meteor observers. The δ-Cancrids are best seen during the early to middle part of the night. Meteor workers should monitor the period January 14 to 24 since before this time there will be interference from the Moon. As rates are low, observers should ensure they center their field of view no further away than 30° from the radiant and also plot all possible δ-Cancrids seen, as this ecliptical shower has a complex radiant structure. Therefore, the radiant diameters to be taken into account for shower association of meteors of different radiant distances differ a bit from those of sharply defined radiants (see [1]). The relevant part of the table concerned is reproduced below as Table 5.

Table 4 – Radiant drift of the δ-Cancrids. The x, y coordinates refer to chart 8 of the *Atlas Brno 2000.0*.

Date	α	δ	x	y	Date	α	δ	x	y
Jan 05	116	+22	288	236	Jan 20	130	+19	237	216
Jan 10	121	+21	269	228	Jan 25	134	+18	223	210
Jan 15	125	+20	252	222					

Table 5 – Optimal radiant area to be assumed for shower association of ecliptical radiant complexes. The major axes are given (α/δ).

Radiant distance	15°	30°	50°	70°
δ-Cancrids	20°/15°	25°/20°	27°/22°	30°/25°
α-Crucids	20°/15°	25°/20°	27°/22°	30°/25°
Virginids	30°/20°	32°/25°	35°/26°	40°/30°

5. α-Crucids

The α-Crucids are active from January 6 through to 28. With a radiant occurring near the Southern Cross this southern hemisphere stream has a complex activity period with several submaxima occurring on or around January 12, 15, 19, and 24. The January 19 peak seems to be the greatest when the ZHR can reach upward of 5. α-Crucid meteors are fastish and often colored. Since they have relatively low rates, all possible α-Crucids should be plotted. Observers should center their fields around $\alpha = 160°$ and $\delta = -55°$ so that both the tail of the Puppid/Velids and the α-Crucids may be monitored simultaneously. As there is a Full Moon on January 8, meteor workers should concentrate on the period January 15–28 in 1993. Please use Table 5 above for determining shower membership from the plots.

Table 6 – Radiant positions of the α-Crucids.

Date	α	δ	Date	α	δ
Jan 06	178°	−60°	Jan 19	192°	−63°
Jan 11	183°	−61°	Jan 24	198°	−64°
Jan 16	189°	−62°	Jan 28	202°	−65°

6. δ-Leonids

The δ-Leonids are thought to possibly be related to the minor planet 1987 SY and so a top priority of the *IMO* is to investigate the activity of this shower to see if this is indeed the case. Despite some interference from the Moon during early February, much of their activity period can be observed in dark skies. δ-Leonid meteors are of average brightness, slow in speed ($V_\infty = 23$ km/s) with very few leaving a train. Since there are numerous sporadic meteors as well as the Virginid meteor shower occurring in the vicinity of the δ-Leonid radiant area, great care needs to be taken in identifying them. Observers should center their field of view around $\alpha = 180°$ and $\delta = +20°$ or $\alpha = 160°$ and $\delta = 0°$. As the δ-Leonids are few in number, all should be plotted. Meteors coming from the radiant area should only be classified as δ-Leonids if their path lengths and their angular velocities are appropriate.

Table 7 – Radiant drift of the δ-Leonids. The x, y coordinates refer to chart 8 of the the *Atlas Brno 2000.0.*

Date	α	δ	x	y	Date	α	δ	x	y
Feb 05	141	+25	202	234	Feb 28	161	+18	144	210
Feb 10	145	+24	189	228	Mar 05	165	+17	131	205
Feb 15	150	+22	176	223	Mar 10	169	+15	119	201
Feb 20	154	+21	164	218	Mar 15	173	+13	105	196
Feb 25	158	+19	151	213	Mar 20	177	+12	92	192

7. Virginids

As there are a large number of low activity radiants close together, it is very difficult to delineate what branches of the Virginids are active at which time and also to classify each individual meteor seen into its appropriate stream. Consequently, observations over the years have shown a whole myriad of Virginid showers, some real, some fictitious. Also reported rates have varied from nil to over 10 meteors per hour! With this in mind then, the *IMO* has for the time being to incorporate all of the Virginids seen into the one "shower". The "Virginids" are active from February 1 to May 30. They have a V_∞ of 30 km/s and are reknown as fireball producers, though their population index r of 3.0 indicates there are many fainter members as well.

The *IMO* would appreciate your efforts to monitor this shower in 1993. Intending observers should locate their center of field of view no more than 40° away from the radiant and should plot all meteors seen. Since the Virginids have a velocity typical of the sporadic background and also come from a large radiant area, careful attention to path length and angular velocity should be given before classifying a meteor as Virginid. As for the δ-Cancrids, please use Table 5 for determining the radiant area.

Table 8 – Radiant drift of the Virginids. x, y coordinates refer to charts 8 and 5 respectively of the the *Atlas Brno 2000.0*.

Date	α	δ	x_8	y_8	x_5	y_5	Date	α	δ	x_8	y_8	x_5	y_5
Feb 03	159	+15	149	199			Apr 04	200	−06			169	144
Feb 13	167	+09	125	181			Apr 14	204	−08			157	138
Feb 23	174	+05	103	169	256	179	Apr 24	208	−09			146	135
Mar 05	182	+01	74	157	226	164	May 04	211	−11			137	129
Mar 15	189	−02	45	146	202	155	May 14	214	−12			128	126
Mar 25	195	−04	15	138	183	150	May 24	217	−13			120	123

8. θ-Centaurids

This shower has a complex radiant structure and is active from January 23 to March 12. With the complex radiant structure also comes a complex activity period with several submaxima. The main ones seem to occur on or around February 1, 21 and 26 with a peak ZHR of between 5 and 10 meteors per hour. θ-Centaurid meteors are fast and often leave a train. They are also noted for producing fireballs of a lemon yellow or greenish hue. They are best seen in the morning hours from the southern hemisphere. Observers should center their field of view around $\alpha = 200°$ and $\delta = -50°$ to aid in separating the θ-Centaurids from the other two Centaurid showers that occur at a similar time in mid February. In late February and mid March, the observer's field should be centered around $\alpha = 200°$ and $\delta = -20°$ so that the θ-Centaurids and the Virginids can both be monitored. All possible θ-Centaurids should be plotted.

Table 9 – Radiant positions of the θ-Centaurids.

Date	α	δ	Date	α	δ
Jan 23	185°	−37°	Feb 20	209°	−40°
Jan 31	192°	−38°	Feb 28	213°	−41°
Feb 10	202°	−39°	Mar 12	222°	−43°

9. o-Centaurids

The o-Centaurids are a minor shower that occurs during a similar time to the other two February Centaurid showers. The o-Centaurids are active from January 31 through to February 19 with a maximum ZHR of about 5 meteors per hour occurring on February 11. The o-Centaurids are visible only from the southern hemisphere and can be seen in dark skies during the late evening hours post-maximum when the Moon has waned sufficiently for the shower to be observed. The o-Centaurids are fast meteors. Observers should plot all possible o-Centaurids seen. To aid in identification, their center of field of view should be located at $\alpha = 200°$ and $\delta = -50°$.

Table 10 – Radiant positions of the o-Centaurids.

Date	α	δ	Date	α	δ
Jan 31	165°	−52°	Feb 12	177°	−56°
Feb 06	171°	−54°	Feb 18	183°	−58°

10. Call for radio observations

In the past, Dirk Artoos has noticed enhanced radio activity on January 22-23 several times. This can hardly be a coincidence any more. The highest peak occurred during early morning hours ($\lambda_\odot = 301.°7$, eq. 2000.0). Therefore we suggest radio observers to be alert between January 19 and 25.

Reference

[1] R. Koschack, "Analysis of Visual Plotting Accuracy and Sporadic Pollution and Consequences for Shower Association", *WGN* 19:6, December 1991, pp. 225–241.

Telescopic Observers' Notes, January–February 1993

Malcolm J. Currie

I have produced some draft charts at last. These can include data for stars fainter than magnitude +10 derived from the *Hubble Space Telescope Guide Star Catalog*, and so will be suitable for instruments with apertures larger than 50 mm. There is a magnitude key, and an inset of a magnified part of the field with stars individually annotated with their magnitudes for estimating the limiting magnitude. These charts have been used in anger, and I have already received useful comments. One additional improvement that I should like to make is to mark the bright deep-sky objects. Now I have access to numerous catalogues, each for a type of object, but it would be more convenient to read a compilation of the brightest objects, say to magnitude +12, that also includes the sizes and shapes of the objects. If anyone knows of such a catalogue in the public domain, please send me details of how to obtain it. In the meantime, I shall soon be circulating the charts and report sheets to telescopic observers for comment.

Forthcoming events

For me, January and February conjure up frozen toes and icicles on the nose, but they also show some of the most-transparent skies after a front has passed through, removing the dust from the atmosphere. Indeed my best naked-eye limiting magnitude from Britain (+7.4) occurred one February morning twenty years ago.

Moonlight partially interferes with the *Quadrantids*, though a few hours of darkness is possible each night. Given the often atrocious weather at this time of year in the north, and the shower's short duration, I urge all telescopic observers north of latitude +30° to make watches after midnight local time. Last year, the telescopic peak seemed as pronounced as the visual activity. Earlier studies suggested a broader activity curve for the faint meteors. The peak activity occurs some hours before the visual maximum, depending on the magnitude, and most favors those situated in North America. Brighter Quadrantids are known for their electric-blue color, and many leave persistent trains whose decay is thrilling to view. Choose at least two and preferably three fields about 20° from the radiant.

The *Coma Berenicids* were also active last year from investigation using RADIANT, and reports of Czechoslovakian observers [1]. This shower lasts from mid-December through most of January. There may be several related showers in this area during this period known by various names, such as 38 Lyncids and Leo Minorids. Scarce data and diffuse radiants make it hard to see a pattern in the activity. However, all radiants seem to be rich in faint meteors. They have a high velocity. Watches in late December and mid-January would be particularly helpful in mapping the components.

Moonlight will affect the first part of the *δ-Cancrids*, though the Moon will be rising after midnight, before the shower's maximum. This shower is an excellent target for telescopic investigation because of its complex radiant that should be resolvable, and it is rich in faint meteors of moderate speed. Choose at least three well-separated centers around the radiant, but no pair should be diametrically opposite the radiant. If different observers choose different fields, there is less chance of artifacts appearing in the RADIANT prolongations to confuse the interpretation. The δ-Cancrids are observable from all latitudes and is the main project for this period.

Dark skies favor the southern showers, where nothing is known of the telescopic activity from the *α-Crucids* and the *λ-Velids II*. Both of these showers have a high population index suggesting that they ought to be amenable to telescopic study. Any telescopic data for these will break new ground. For instance, it would be fascinating to find if the α-Crucid radiant is elongated, as seen visually, or even multiple. By choosing a couple of field centers in Carina and western Centaurus, it is possible to study the showers simultaneously. Just a small group of telescopic observers in South America, Australia, New Zealand, and southern Africa could produce an incredible quantity of new facts about southern showers, so I am rather surprised that the *IMO* currently has no telescopic observers south of the equator.

Back to the north, the *δ-Leonids* give some weak rates during February. Their low velocity should help to identify them from the sporadic background. The maximum occurs during February's dark time. Kronk [2] mentions a possible southern telescopic branch based on radio data. Its activity period is mid-January to late February, with a peak around February 3 at $\alpha = 135°$ and $\delta = +8°$. I have not seen evidence of this shower in the telescopic records, but that may reflect the paucity of data in late January.

Although not in the *IMO* radiant list, the *α-Leonids* give good telescopic rates. In recent years, they seem to be prominent during mid-January from $\alpha = 140°$ and $\delta = +17°$, but Kronk [3] believes the maximum to be in the final week of January from $\alpha = 156°$ and $\delta = +9°$. So let us observe then and find out.

For those in the cold north, wrap up well, and take regular breaks. You will see more meteors.

References

[1] P. Pravec, "The 1992 Quadrantids in Czechoslovakia", *WGN* 20:3, June 1992, pp. 156–157.
[2] G.W. Kronk, "Meteor Showers: a Descriptive Catalog", Enslow, Hillside, NJ, 1988, pp. 29–31.
[3] G.W. Kronk, "ibid.", p. 21.

The Makings of Meteor Astronomy: Part I

Martin Beech, University of Western Ontario

This is the first in a series of articles on the history and makings of modern meteor astronomy. An overview of developing ideas is presented, and the path is paved for future discussion.

1. Blindly groping

Astronomy is often described as one of the oldest of human activities. Certainly it is clear that even the most ancient of civilizations have used the rhythmical cycles of the Moon, planets and stars to construct their calendars, and guide their daily lives. Astronomy as a science, however, is an all together more modern human activity. Science is a process fundamentally concerned with doing. By this I mean that science is about observing, constructing models, both schematic and mathematical, and then comparing the model predictions with the observations.

Making progress in scientific understanding is by no means easy. The scientist must, through the very nature of the game that is being played, spend a lot of time groping in the dark. Nature may not be malicious, but it is certainly protective. Teasing understanding from the observations can take more than the work of a life time, and often more than a generation of life times. In spite of such restrictions progress has seemingly been made, and some aspects of nature are now amenable to prediction, and even definition. Unlike boxing, however, there are no Marquis of Queensbury rules of fair play in science. The models are only as good as the collective pedestal upon which the scientific community places them. In other terms, one can ask where are Aristotle's theories today, and receive the answer that they are nowhere in modern science.

Our present-day understanding of the meteoric phenomena has not been won easily. Just as the other branches of science have had to claw their way from the pit of ignorance, so meteor astronomers have had to founder and flail in their quest to understand the humble shooting star. It is along the tortuous path that joins the most ancient of times with the present that the makings of meteor astronomy is to be found. Where are Aristotle's theories today? Some at least are alive and kicking in the pages of meteor history.

2. Ancient and modern

The father of the motor car, Henry Ford (1863–1947), once remarked [1] that "history is more or less bunk." While Voltaire (1694–1778) was to explain [2] that, "history is nothing more than a tableau of crimes and misfortunes." And in similar tones to Voltaire, Thomas Carlyle (1795–1881) suggested [3] that, "history is a distillation of rumor." The history of meteor astronomy, as we hope to explore in this series, is all of these and more. Modern meteor astronomy has a glorious heritage. It is packed full of both learned, and for want of a better term, eccentric practitioners. Certainly, mistakes have been made, and incorrect beliefs long held. Great insights have been ignored, half-truths propagated, and the banter of fools raised to high distinction. Yet, in spite of this, today we have a reasonably coherent picture of what shooting stars are, and where they come from.

The history of meteor astronomy has traditionally been split into two eras: the ancient and the modern [4,5,6]. The modern era of meteor astronomy essentially began in the early 18th century with the investigations of Edmund Halley (1656–1742). Previous to this time, the ancient views of the Greek Philosophers, in their various guises, held sway.

The earliest discussion of the meteoritic phenomena traces back to at least the fifth century BC, where, for example, we find the works of Anaxagoras of Clazomenae (circa 500 BC–428 BC). By far the most dominant voice on matters meteorological, however, was that of Aristotle (384 BC–327 BC). While Aristotle died in 327 BC, his ideas on meteor formation survived in essentially undiluted form for two thousand years. This is equivalent to about 70 human generations. We shall explore the ancient ideas more fully next time, but needless to say, it was the overthrow of Aristotle's teachings that enabled the modern era to flourish.

Overthrowing Aristotle's meteoric theory was not easy, and the best part of a century was required to hammer home the inadequacies of the old and the correctness of the new. For the historian of meteor science, the transitional century, which we round off as circa 1700 to circa 1800, is a happy hunting ground of wild conjecture and new discovery.

The fundamental lesson that the transitional workers in meteor astronomy learned was to observe, and to make conjectures upon their observations. Most importantly, however, meteor astronomers realized that they had to continually test their new ideas against the observations. It may seem remarkable to the modern day practitioner, but our predecessors did have to learn that if the theory does not explain the observations, then it is not always the observations that are wrong!

The later half of the 18th century was the great observational era of meteor astronomy. A vast store of data became available in this time. Part of this data base was collected through diligent work, and part through serendipitous events. This period saw the development of ideas concerning meteoroid streams, and the origin of meteors. Of particular importance to this era, however, was the occurrence of several spectacular meteor storms. Not only did these great spectacles of nature inspire, and in some cases frighten the general public, but they served to catapult meteor astronomy to the fore-front of astronomical research. Indeed, the glory days of meteor astronomy are squarely rooted in the 19th century.

With the turn of this century, new branches of meteor astronomy began to blossom. Meteors became something more than streaks of light with a position and time to record: they became the descendants of meteoroids, and these had shape and form. No longer just scratches of light in the sky, meteors were ablating grains, and the destruction of these grains could reveal, for example, a wealth of data about the hitherto unexplored upper atmosphere. It was such realizations that oversaw the development of meteor physics.

Prior to the mid-nineteenth century meteor astronomy was a purely visual past-time. Gradually, however, as general interest grew, various scientific instruments were turned towards the shooting stars. First spectroscopic, then photographic techniques were employed in the study of the meteoric phenomena, and much later radar and radio techniques were developed. By using and developing these more accurate observational techniques, meteor astronomers have been able to probe the structure and origins of the meteor with ever greater accuracy. The development of meteor astronomy owes a large debt therefore to the practitioners who toiled over instrumental design, and their story is an integral part of meteor history.

3. An invitation

The playing field for this series has now been revealed. In a more or less scrap-book fashion we shall explore its domain in future articles. By its very nature, however, history cannot be owned. History is a collective of ideas and interpretations. This series will hence only be a success if the readers of *WGN* offer-up their own historical researches and ideas. I look forward to hearing from you.

References

[1] H. Ford, *The Chicago Tribune*, May 25, 1916.

[2] Voltaire, "L'Ingenu", 1767, Ch. 10.

[3] Thomas Carlyle, "History of the French Revolution", Bk. VII, Ch. 5.

[4] Charles P. Olivier, "Meteors", Williams and Wilkins, 1925, Ch. 1.

[5] David W. Hughes, "The History of Meteors and Meteor Showers", *Vistas in Astronomy* 26, 1982, p. 325.

[6] John G. Burke, "Cosmic Debris: Meteorites in History", University of California Press, 1986, Ch. 1–3.

Fireballs and Meteorites

Fireball

Germany, July 24, 1992, $21^h09^m08^s$ UT

Pavel Spurný, Ondřejov Observatory

In the evening of July 24, 1992, a fireball of approximately −10 maximum absolute magnitude was photographed over Germany.

A slow-moving fireball of −10 maximum absolute magnitude was photographed by four Czech stations of the European Network. The fireball traveled a 77-km luminous trajectory in 2.9 seconds and terminated its light at a height of 49 km. The following results are based an all available records measured by J. Keclíková.

Table 1 – Trajectory data.

	Beginning	Maximum light	Terminal
Velocity (km/s)	24.92	24.36	18
Height (km)	89.85	61.0	48.57
Latitude (° N)	48.3808	48.727	48.8787
Longitude (° E)	12.977	12.65	12.506
Abs. magnitude	− 3.3	−10.2	− 3.4
Photom. mass (kg)	6	3	none
Z R (°)	57.73		58.31

Fireball type: III A

Ablation coefficient: 0.102 s^2/km^2

Member of the α-Capricornid stream.

Table 2 – Radiant data.

Radiant (1950.0)	Observed	Geocentric	Heliocentric
α (°)	299.2	299.8	
δ (°)	− 04.55	− 07.90	
λ (°)			247.72
β (°)			+ 07.38
Initial velocity (km/s)	24.93	22.15	37.25

Table 3 – Orbital data.

Orbit (1950.0)	
a	2.47 AU
e	0.755
q	0.605 AU
Q	4.33 AU
ω	266°.5
Ω	121°.6237
i	9°.11

Meteorite Fall in Uganda

summarized by Marc Gyssens

A summary is given of a meteorite fall on Mbale, Uganda, on August 14, 1992. A team of the *Dutch Meteor Society* examined the event at the site of impact.

In *Radiant 14:4, August 1992*, Hans Betlem reports an extensive meteorite dropping on the town of Mbale, Uganda, which took place on August 14, 1992, at 15^h40^m local time (which corresponds to 12^h40^m UT).

Around that time, following a heavy explosion causing a prolonged rumbling, a bright fireball appeared, leaving a smoke train. After another explosion, the fireball fell apart into several smaller ones, dropping dozens of meteorites.

The *Dutch Meteor Society* was able to organize an expedition to the impact location, and managed to recover about 50 fragments varying in mass from about 20 g to 15 kg. Impact positions were marked on a map of the area, and the place of the explosion was located. Unfortunately, there is little known of the fireball trajectory.

A Fireball over the Netherlands?

Friesland, August 19, 1992, 20^h30^m UT

communicated by Peter Brown

An explosion-like noise heard and registered over the northern Netherlands in the evening of August 19 may have been caused by a fireball. Clouds prevented an unambiguous identification of the event, but several other likely explanations could have been eliminated.

On Wednesday evening, at around 22^h30^m local time (20^h30^m UT) in the northern part of the Netherlands, a loud, explosion-like noise was heard.

At the time, the air space over this area was closed (it is controlled by a military air base), and no other military or civilian air activity was going on. Also, no accidents were reported. The European Space Organisation reported no space junk entering the atmosphere at that time in that area.

The Royal Dutch Meteorological Institute has six seismic measuring stations in and near that part of the Netherlands to measure seismic activity in the gas fields there. All six stations registered the explosion, and the seismograms indicate that it was a sound wave and not a seismic wave. From the order of reception of the sound waves it was concluded that something caused a shock wave above or near the town of Joure in the province of Friesland.

Eyewitnesses of the event said that they saw a "pillar of fire in the sky." Alas, at the time that part of the Netherlands was heavily overcast, so whatever these people saw was filtered by the clouds.

The best guess is that a meteorite of approximately 30 cm diameter entered the atmosphere and exploded at a height of 10 kilometers above the town of Joure. No fragments have been found thus far.

Information communicated to Peter Brown by Harm Munk.

Meteorite-Dropping Fireball over the Eastern USA

Peekshill, NY, October 9, 1992, 23^h50^m UT

Peter Brown

In the local evening of October 9, 1992, one or several fireballs were seen over the eastern seaboard of the USA and Canada. At least one meteorite was dropped on a car in the small town of Peekshill, NY, a suburb of New York City.

On October 9, 1992, at 23^h50^m UT a brilliant fireball was seen over the eastern seaboard of the USA and Canada. The event traveled from an initial starting point over West Virginia and ended nearly half a minute later near the Pennsylvania/New York border.

The fireball produced at least one known meteorite which landed on the trunk of a 1980 Chevy Malibu car in the small town of Peekshill, NY, a suburb of New York City. The meteorite, an L6 chondrite, was later measured to weigh 13 kg and was sold by the car's owner, Michelle Knapp, several weeks after the fall, for a reported 69 000 USD. The car's trunk was destroyed and the impact was violent enough for the meteorite to penetrate through the car metal and leave an impact crater in the driveway.

The impact sound caused windows to shake in the neighborhood of the fall; no detonations from the fireball itself have been reported.

The day of the week (a Friday) and the early evening time (near 8 p.m. EDT) resulted in a large number of video recordings of the event by private citizens and regional news-crews at numerous high-school football games. To date, two dozen separate video recordings have been identified, and nearly half of these are in the possession of the investigators.

From the video footage, the event lasted longer than 17 seconds, was brighter than the Full Moon, and fragmented heavily near its endpoint. At least twenty separate fragments are visible near the end of the fireball path.

News stations throughout the USA ran stories on the event that night, as did CNN, with accompanying footage of the fireball. Unfortunately, the date coincidentally is the peak night for the Giacobinids, and as a result of poor information, the mass media reported the event to be associated with the Giacobinid shower. In fact, the ground path was from SSW to NNE, yielding a radiant incompatible with a Giacobinid origin.

Although still not entirely certain, it appears that several other bright fireballs occurred within an hour of the event. In all, dozens of fireballs may have been associated with the main meteorite-producing fireball. The ground paths of these events have not been determined.

Positional data from the video footage and further data of many kinds is being uncovered from the event. The event is being followed up by a a group from the USA and Canada. If you have information about the event, or if you saw a fireball in the period October 7–11, please contact one of the following:

- *Martin Beech, Department of Astronomy, University of Western Ontario, London, Ontario, N6A 3K7, Canada;*
- *Peter Brown* (address on inside back cover);
- *Robert Hawkes* (address inside back cover); or
- *George Wetherill, Dept. of Terrestrial Magnetism, 5241 Broad Branch Rd. NW, Washington, DC 20015, USA.*

We look forward to receiving your information!

About the Brazilian "Tunguska event"

Roberto Gorelli

The author reports that he has been able to trace back the Brazilian counterpart of the Tunguska event, on August 13, 1930, to the original source.

A Tunguska-like event took place in Brazil on August 13, 1930, at about 8^h local time (13^h UT) in the area of the river Rio Curaca, an affluent of the Javari river. This area is located near the border of Brazil with Peru and Columbia. Probably, remains of the event can also be found in these countries. After three big thunders, heard within a radius of several hundreds of kilometers, ashes rained down during 4 hours: this was described by witnesses in the cities of Remate de Males and Esperanca. I calculated the mass of the meteorite, only using the descriptions of an article and hence with a large uncertainty. The mass of the object would lie between 1000 and 10 000 tons, intermediate between that of the event of Revelstoke (USA), March 31, 1965 (an explosion with a power of some tens of kilotons) and that of the event of May 4, 1892 (causing the fall of 500 tons of meteoritic dust in Scandinavia). This implies that the event is comparable to that of August 10, 1972, in Utah (USA).

The original source of the event was the Missionary Father Fedele d'Alviano, who died in 1956. His accounts were reported by the news agency *Informazioni Fides* and published in *L'Osservatore Romano*, the newspaper of the Vatican, number 50, March 1, 1931, p. 5. Soon, I shall have access to the original documents left by Father d'Alviano, which may contain other details. Meanwhile, I shall write to the Missionaries of São Paulo de Olivenca, whom I already asked for reports on the phenomenon in 1991. Research on magnetic and seismic perturbations, satellite photography, etc. are underway.

A more detailed report will follow as soon as possible.

Eyewitness Reports of Electrophonic Sounds from the 1985 Taieri Plains Fireball in New Zealand

Graham W. Wolf

At $17^h48^m50^s$ UT on May 6, 1985, a magnitude -20 electrophonic detonating fireball was widely observed in the Taieri (pronounce *tie-ree*) Plains Region near Dunedin (pronounce *done-ee-din*) in New Zealand by some 60 persons about 90 minutes before sunrise. Outlined in more detail in the 1991 *IMC* Proceedings [1], this report concentrates on the actual eyewitness accounts of electrophonic sounds from this event. This is by far the most widely observed electrophonic fireball in New Zealand.

1. Introduction

Briefly summarized, the electrophonic fireball was of $30'$ by $25'$ dimensions, and left a train that was visible to the naked eye for 530 seconds, that is, nearly nine minutes. The ambient temperature was 3°2 C, and the relative humidity was 80%. The atmospheric pressure was 1008 hPa, and the wind was dead-calm. The zenith angle of the fireball was about 25° to the horizon, and it approached from the North, heading almost South East. Electrophonic sounds were claimed to be heard at some 14 sites located up to about 15 km either side of the flight path, which itself was about 5° west of magnetic north, and passed directly over two observing sites, namely Tirohanga (pronounce *tear-row-hung-gar*) and Mt. Allen sheep station.

The Taieri Plains are a natural lowland amphitheater of some 30 km by 20 km dimensions, surrounded on all sides by several hills extending from 500 m to 1000 m in height.

It was possible to test several observers shortly afterward, with both a calibrated audio oscillator and decibel meter, to try and simulate both the pitch and intensity of any electrophonic sounds they may have heard. As a result of this exercise, it was possible to estimate the pitch to within about 1 kHz, and the intensity to within 5 dB(A).

Table 1 – Prime electrophonic sites on May 6, 1985.

Location	Longitude	Latitude	From end point
Fairfield	170°23′.0 E	45°54′.1 S	10.9 km
Mosgiel	170°20′.5 E	45°52′.1 S	10.0 km
Three Mile Hill	170°24′.5 E	45°51′.0 S	13.2 km
Tirohanga	170°17′.8 E	45°50′.8 S	11.1 km
Allanton	170°15′.7 E	45°55′.4 S	0.8 km
Momona Airport	170°11′.9 E	45°55′.8 S	4.8 km
Flagstaff	170°28′.2 E	45°51′.3 S	20.5 km
Abbotsford	170°25′.3 E	45°54′.3 S	15.0 km
Berwick	170°07′.5 E	45°57′.5 S	11.0 km
Otokia	170°12′.8 E	45°57′.5 S	4.5 km

2. Eyewitness reports

The following are eyewitness accounts of the fireball's electrophonic sounds. The end point was calculated by triangulation to be at about 7 km in height, and at coordinates $\lambda = 170^\circ\!.250$ E and $\varphi = 45^\circ\!.933$ S, just 0.8 km from an observer at the township of Allanton. By extrapolation, the impact zone is calculated to be at $\lambda = 170^\circ\!.015$ E and $\varphi = 46^\circ\!.100$ S, about 10 km east of the small 100-person township of Milburn in South Otago (pronounce *oh-tar-go*).

Graham Wolf at Fairfield:

"Spluttering crackle" like an arc welder for the first two seconds, then "whine" for last 1.5 seconds. Whine started at about 60 dB(A) and increased to an estimated 75 dB(A). "Whine" was Doppler-shifted from about 8 kHz down to about 2 kHz. Sonic detonation 38.2 seconds (stopwatch) after end point reached. Sonics lasted 1 s and consisted of 4 deep "thumps" lasting a total of nearly 1 s, followed by a loud bang at about 110 dB(A) estimated intensity. Wire fence within 1 m, power lines within 10 m distance.

"Mary" and "Donna" at Mosgiel:

Out for a morning jog, off Factory Road, into Reid Road, facing towards south-east. Heard Doppler-shifted "whine" for about 2 s. Intensity estimated at about 70 dB(A), pitch falling from about 10 kHz to about 2 kHz. Heard a "whizz-bang" about 1 s after detonation. "Whizz-bang" not heard elsewhere. Power lines within 10 m. Sonics heard 40 s (counted) after end point, and sounded as a "rumble" for about 1 s ending in a "boom" (like thunder).

"Steve" at Three Mile Hill:

On ten-speed bicycle. High pitched "whine" and crackling sounds heard simultaneously like a log fire. Sonics heard 58 s (counted) after end point, sounded as a deep "crash" like thunder. "Boom" echoed out across the plains at least 4 or 5 times from different directions. High tension power pylons and cables about 50 m distant. Farmer's fences about 10 m distant.

Athol Bayne at McFadden Drive, Mosgiel:

Loud thunderclap preceded by a stuttering "whine" of about 60 dB(A) intensity. Thought a jet had passed overhead at speed. Saw nothing as view was blotted out by house next door, but bedroom illuminated through curtains by strong glare.

Lou and Fiona Williams at Allanton:

Having breakfast in kitchen, less than 1 km from end point. Heard high pitched "whine" outside lasting about 3 s. Sounded like sky rocket. Intensity 85 dB(A). Frequency fell from about 12 kHz to about 5 kHz in pitch. Brilliant glare passed through kitchen window and cast moving shadows on kitchen floor. Rushed outside to see detonation, which was blinding, and almost directly overhead (angle about 80° above the horizon). "Whine" lasted about 1.5 s after detonation. Sonics heard at 22 to 24 s (counted) after detonation. Saw smoky trail extending from zenith to about 20° above north-east horizon. Detonation shook kitchen windows, and consisted of about half a dozen "thumps" immediately followed by a piercing "bang." Power lines on both sides of property at about 20 m distance.

"Peter" at Tirohanga Road, Tirohanga: Heard Doppler-shifted "whine" at about 90 dB(A), with a simultaneous "crackling" sound at about 70 dB(A) (quieter). Fireball cast moving shadows of nearby power lines (about 10 m distant) across the paddocks, and passed through the zenith. Loud "rumble" and shattering "boom" like a thunderclap heard at about 40 s (counted) after end point.

Air traffic controller at Momona Airport tower:

Bright glare filled tower, but no electrophonics heard due to high ambient noise from air traffic on FM frequency of about 121 MHz. Noted that FM signals magnified at least 5 times in intensity for about 10 s, as the fireball passed over. Heard shattering "boom" about 22 s (counted) after end point, which was estimated at 60° above southern horizon.

3. Comments

The above eyewitness accounts represent 7 of the 14 accounts of electrophonic sounds, and are all the more important, since 6 of these 7 persons took the trouble to note the time delay from end-point to detonation, and thus, by triangulation, establish the geographical coordinates of the end point.

Reference

[1] Wolf G.W., *Proceedings 1991 IMC*, Potsdam, 1991, pp. 67–72.

Fireballs over Scandinavia in October 1991

Gotfred Møbjerg Kristensen

Descriptions are given of two fireball events over Scandinavia that occurred during the night of October 4-5, 1991.

On the evening of October 4, 1991, many people in Sweden and Denmark saw an unusually bright fireball. Some described it as similar to a missile. It must have been brighter than magnitude −9. The fireball lighted up around 19^h UT. Checking my pen-recorder paper, which continuously registers radio meteors shows a long-duration radio meteor at $19^h02^m35^s$ UT lasting 194 seconds.

Some 5 hours later, I observed another fireball. I stood in the doorway when it was lighted up by a red glow throwing shades. I looked up and saw a very bright meteor leaving a persistent train with a knot of magnitude 0. It burned out after 8 to 10 seconds. The fireball itself must have been around magnitude −8. This event happened on October 5, 1991, $0^h23^m08^s$ UT, and a distant thunder occurred at $0^h29^m47^s$ UT. A radio signal with a duration of 114 seconds was registered at $0^h23^m09^s$ UT.

UK Visual Results for the Virginids, 1988–1992

Alastair McBeath

Results of a five-year plotting project to examine the Virginid streams made by *JAS Meteor Section* members between 1988–1992 are presented and discussed. Despite problems with observer inexperience and often large radiant zenith distances, a general level of agreement between these and earlier data is apparent, although some previously unknown radiant areas may have been found too.

1. Introduction

In 1987, it was decided to establish a spring project for the *JAS Meteor Section (JASMS)* to encourage more observers to be active at what is often a quiet time of year for northern hemisphere meteor workers.

The Virginids were chosen as an obvious target for attention, since they are active at the right time of year, produce quite low rates of relatively slow-moving meteors, so new observers would not be overcome by trying to record too much data, and their radiants are complex, and have been poorly studied in recent times.

A brief survey of results obtained from 1984 to 1987 showed that in a good year, about 30–40 Virginids were reported to the Section, so in an attempt to defeat possible cloud and moonlight difficulties, as well as increase the total number of meteors available for study, an extended project over five consecutive springs was proposed.

The project's aims, in order of decreasing importance were as follows:

1. to encourage more spring meteor observations;
2. to introduce Section members to the techniques, problems, and advantages of visual meteor plotting;
3. to indicate that sustained effort over time is sometimes necessary to obtain useful results in meteor work; and
4. To obtain interesting and potentially meaningful data on a little-known shower complex.

The low priority assigned to the acquisition of viable information was a direct result of the inexperience of most *JASMS* members, particularly with regard to plotting meteors, an all-but forgotten technique in mainstream British meteor astronomy for many years.

2. Observing method

A version of the present *IMO* visual counting method detailed in [1], called the standard naked-eye watch was, and still is, in general use by the *JASMS* when the project was set up. This technique is described in [2]. The method was modified by a special project sheet issued to all taking part, which gave basic meteor plotting information and instructions to plot only well-seen meteors which seemed to emanate from the general direction of Virgo during the months of March and April from 1988 to 1992. These meteors were to be noted as "possible Virginids" on the accompanying report forms.

Three different plotting charts were issued. Two were based on gnomonic charts modified and redrawn by hand from a computer-generated chart atlas [3], and were centered on $\alpha = 180°$, $\delta = +45°$ and $\alpha = 180°$, $\delta = 0°$, areas chosen as covering the expected main regions of Virginid activity. The third was an all-sky stereographic projection chart, typical for a mean UK latitude at 0^h UT in early April, based on a chart published in 1977 by the Royal Observatory, Edinburgh. This map was primarily intended to allow casual observers to participate in the project, and no plots made in this way were used in the final analysis.

3. Participating observers and overall totals

Sixteen observers contributed results to the project, most from the UK:

> Roy Barclay, David Cameron, Shelagh Godwin, Mark Harris, Sebastian Jay, Craig Johnson, Trevor Law (Middle East), Richard Livingstone, Alastair McBeath, Dusko Novakovic, Steve Phipps, Graham Pointer, Ian Rigney, Christopher Willott, Simon Wragg, and Kyriacos Xylaris (Cyprus).

Several of the above submitted data in two or three separate years—most in just one, however—while only two people collected data in each of the five years, an indication perhaps of the difficulties in obtaining the necessary long-term commitment to a project of this kind.

Table 1 – Hours (T_{eff}), meteors (N), and plotted possible Virginid trails (V) totals for March and April, per year. Plotted trails are broken down into experienced (Ex) and inexperienced (In) totals too. An overall mean limiting magnitude figure is given as well, taken from reliable, good-condition watches only.

Year	March			April			Totals				
	T_{eff}	N	V	T_{eff}	N	V	T_{eff}	N	V	Ex/In	$\overline{\text{Lm}}$
1988	25.17	115	18	79.18	290	66	104.35	405	84	18/66	5.64
1989	31.05	77	19	29.20	62	10	60.25	139	29	14/15	5.89
1990	57.30	142	30	45.20	99	17	102.50	241	47	45/ 2	6.00
1991	13.42	40	7	48.42	228	20	62.24	268	27	20/ 7	5.90
1992	18.35	32	9	12.45	20	2	31.20	52	11	9/ 2	6.00
Tot	146.09	406	83	215.25	699	115	361.34	1105	198	106/92	5.89

Table 2 – Global magnitude distributions for probable Virginid and sporadic meteors, 1988–1992. Corrected mean magnitude ($\overline{m}_{6.5}$), train number (Tr) and train percentage (%) figure have been calculated in addition.

Magnitude	-3^-	-2	-1	0	$+1$	$+2$	$+3$	$+4$	$+5^+$	Tot	$\overline{m}_{6.5}$	Tr	%
Virginids	0	3	5	5	9	18	27	7	0	74	2.54	4	5
Sporadics	5	5	7	27	42	93	117	46	19	361	2.89	25	7

Table 1 gives the total hours, meteors and plotted trails achieved, along with the mean limiting magnitude, per year. Table 2 presents global magnitude distributions for the most probable Virginid meteors and the sporadics over the same time, details taken solely from reliable, clear-sky sources. Train numbers and percentages are also noted.

4. Analytical methods

Although it was possible to derive magnitude and train data from the results, it was not deemed feasible to attempt computing ZHRs for the Virginids. Activity observed was never better than low, with two or three shower members reported in an hour about average for the better observers on very favorable nights.

Since the project turned out to be relatively small-scale in terms of meteor numbers, it was felt impractical to analyze the meteor plots by computer, even had suitable hardware been available, so the reduction of this data was carried out as carefully as possible by hand. Only plots from experienced workers in the UK were analyzed in the first instance, and all of these were diligently traced onto master sheets, and back-projected, allowing for path length, towards the Leo-Coma-Virgo region. Obvious errors in the plots, and meteors which clearly did not originate from this area were removed at this stage, reducing the useful plot total to 69.

The solar longitude (eq. 2000.0) was then calculated for each remaining trail, to the nearest degree, and any trail coincidences within $\lambda_{\odot} = \pm 5°$ of one another were noted. One meteor trail may contribute to several possible radiants as a result. These possible radiants were then assigned a priority number according to the following classification:

1 = Same year, different observers;
2 = Same year, same observer;
3 = Different years, different observers; and
4 = Different years, same observer.

While not foolproof, this scheme does at least give a reasonable degree of plausibility to the results. Ultimately, it was necessary to combine 1 and 2 as well as 3 and 4 in some cases, for the sake of simplicity.

Once this was done, a general area of Virginid radiation and several more obvious subcenters of activity could be defined, as detailed in the following sections. It is important to note that these areas are not necessarily definite radiants: they are simply regions where a higher probability of Virginid emanation is likely, from these results.

5. Trail distributions results

Before looking at the possible radiants themselves, it is important to comment on the temporal and spatial distribution of the trails analyzed, since these may give rise to a variety of problems.

Temporally, out of 60 possible solar longitudes from $\lambda_{\odot} = 341°$–$40°$, 38 (63%) were covered at least once between 1988–1992, although only 5 (8%) received attention in two or more years. Those solar longitudes not covered at all were: 341°, 343°–345°, 347°, 350°, 352°, 353°, 358°, 3°, 6°, 10°, 12°, 13°, 15°, 17°, 20°, 21°, 23°, 28°, 30°, and 37°.

Spatially, the large radiant zenith distances create a bias which cannot be overcome from Britain. Looking at experienced observers' trails only, 46 (67%) of the 69 paths were predominantly south-north oriented, 19 (27%) east-west or west-east directed, while a mere 4 (6%) moved north-south. This strong south-north predominance may create particular difficulties when trying to define radiant declinations, since only a very minor shift of the path direction when making the plot can alter this parameter quite dramatically.

6. General radiation region results

Once all the possible radiants were worked out, a general area of roughly pentagonal shape could be defined within which all of the more probable radiants fell. This area is shown in Figure 1.

The approximate positions of its corners are: $\alpha = 185°$, $\delta = +21°$; $\alpha = 157°$, $\delta = +10°$; $\alpha = 168°$, $\delta = -22°$; $\alpha = 200°$, $\delta = -25°$; and $\alpha = 218°$, $\delta = +12°$. Within this general zone, there is a clear tendency for radiants to be active in the more westerly area in March, which then seems to track eastwards later on into April. This is not unexpected, of course, though not all the radiants found follow this pattern.

7. Results on specific radiant groupings

In order to look more closely at what are probably individual radiants or radiant groups inside this general area, the analysis was broken down into three time periods: Period 1 corresponds with $\lambda_{\odot} = 341°$–$360°$ (roughly March 1–21), Period 2 with $\lambda_{\odot} = 1°$–$20°$ (March 22–April 9), and Period 3 with $\lambda_{\odot} = 21°$–$40°$ (April 10–30). As a result, ten specific areas of clusters of observed radiants were identified, several of which seem to link together to indicate an eastward radiant motion, giving further support to their reality perhaps. These radiant clusters are shown in Figures 2–4, and each is described below.

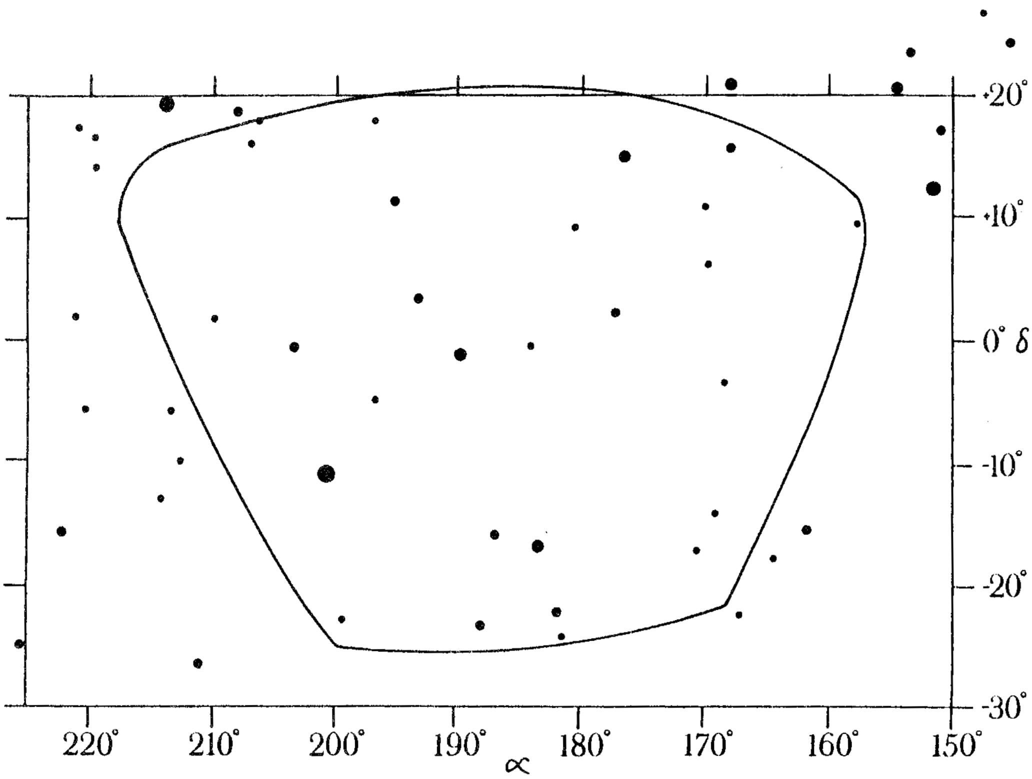


Figure 1 – General area of Virginid radiation.

8. Period 1, $\lambda_\odot = 341°$–$360°$

This was the poorest of the three periods, perhaps indicating lower Virginid activity, since only 18 reliable trails were available, hence all the radiants found were weak associations only. Observer activity totaled $94^{\mathrm{h}}.21$, and the three possible radiant areas found are illustrated in Figure 2.

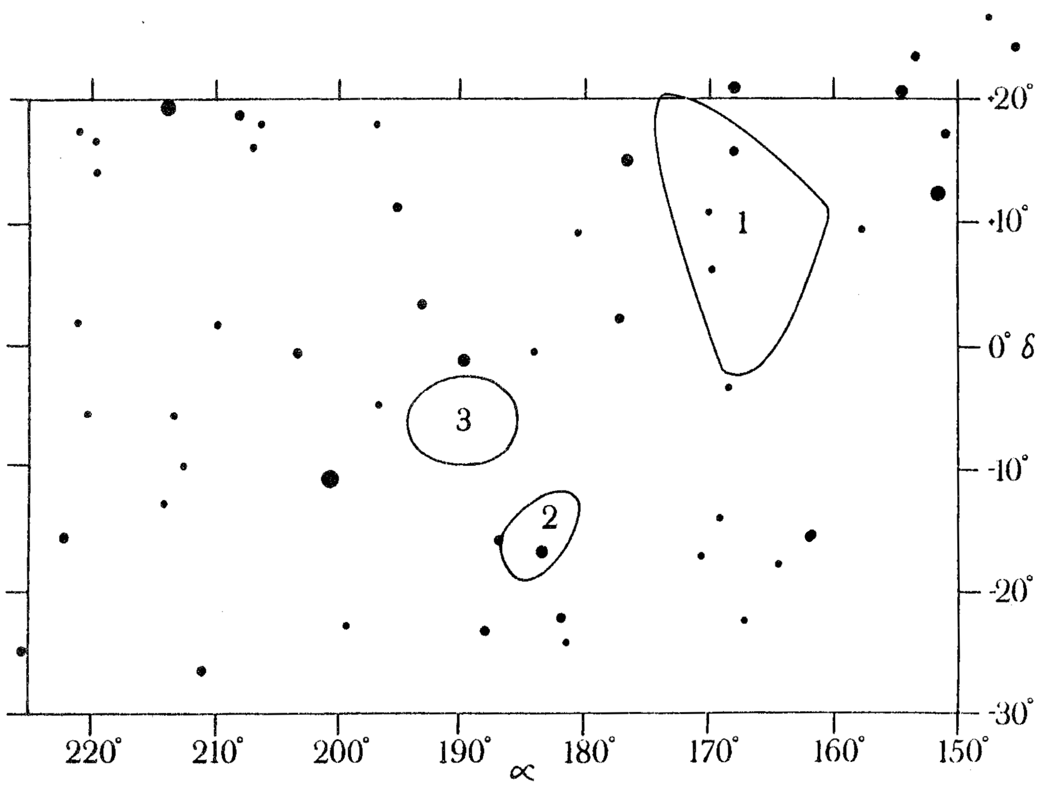


Figure 2 – Possible Virginid radiants found in Period 1 ($\lambda_\odot = 341°$–$360°$).

Radiant area 1: Activity detected: $\lambda_\odot$ = 341°–345°; center of area: $\alpha \approx 168°$, $\delta \approx +10°$; brightest star near center: ι Leonis; radiants observed: 4, all class 3 or 4.

This is a very weak, diffuse source. All four possible radiants lie very close to the edges of the region, and it is rather dubious as to whether a genuine radiant area is present or not.

Radiant area 2: Activity detected: $\lambda_\odot$ = 351°–355°; center of area: $\alpha \approx 184°$, $\delta \approx -15°$; brightest star near center: γ Corvi; radiants observed: 4, one class 1, one class 2, two class 3.

A weak, but compact, center. This may form an earlier part of the activity of areas 6 or 7 (see further).

Radiant area 3: Activity detected: $\lambda_\odot$ = 351°–359°; center of area: $\alpha \approx 190°$, $\delta = -6°$; brightest star near center: γ Virginis (not in area); radiants observed: 5, all class 3. Another weak, but reasonably compact, cluster. As with radiant area 2, this may represent early activity from areas 6 or 7(see further).

9. Period 2, $\lambda_\odot = 1°$–$20°$

This may well represent the main core of Virginid activity, as 26 useful trails were recorded in $105^h.43$. Four plausible radiant groupings became apparent, as shown in Figure 3.

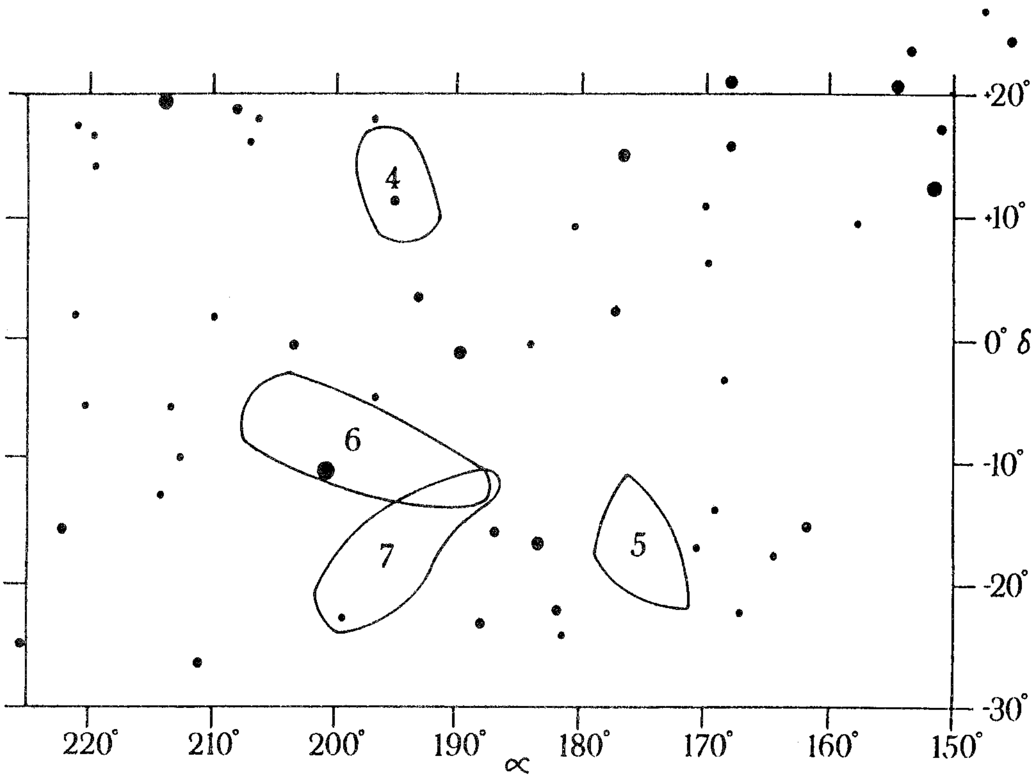


Figure 3 – Possible Virginid radiants found in Period 2 ($\lambda_\odot$ = 1°–20°).

Radiant area 4: Activity detected: $\lambda_\odot$ = 1°–20° (mainly 8°–14°); center of area: $\alpha \approx 195°$, $\delta \approx +12°$; brightest star near center: ε Virginis; radiants observed: 11, seven class 1/2, four class 3/4.

This is a moderately strong, compact source, which was recognized in several years. It is quite conceivable that it links with area 8 (see further), forming an earlier part of that group's activity.

Radiant area 5: Activity detected: $\lambda_\odot$ = 4°–9° in 1990 only; center of area: $\alpha \approx 175°$, $\delta \approx -18°$; brightest star near center: ζ Crateris (not in area); radiants observed: 6, all class 1 or 2.

A weak source, which is something of an oddity, since activity was detected from a fairly compact region only in 1990. Observations were made during the period $\lambda_\odot$ = 4°–9° in both 1988 and 1989 too, but no trace of any meteors from this area was recorded then. Perhaps an occasional shower, if it is not spurious.

Radiant area 6: Activity detected: $\lambda_\odot = 7$–$11°$; center of area: $\alpha \approx 195°$, $\delta = -10°$; brightest star near center: α Virginis; radiants observed: 22—4 possibly shared with area 7, 16 class 1/2, 6 class 3/4.

Second in strength, judged by numbers of individual radiant positions, only to area 8, there is a suggestion of some eastward drift over time here, though it is possible two close-together radiant groups are actually present. This may link into area 10, active still further eastwards subsequently.

A strong cluster of radiants was detected just to the north-west of Spica (α Virginis) around $\lambda_\odot = 7°$–$9°$, although other radiants here were more dispersed. Two "shared" radiants were class 1/2, two 3/4.

Radiant area 7: Activity detected: $\lambda_\odot = 14°$–$19°$; center of area: $\alpha \approx 193°$, $\delta \approx -17°$; brightest star near center: γ Hydrae; radiants observed: 13—4 possibly shared with area 6, five class 1/2, eight class 3/4.

Although this seems to be a moderately strong group with quite a good central cluster of four radiants, plus the likelihood of a slight eastward motion, the fact that most radiants were of classes 3 or 4 raises some doubts about the area's reality. However, as three short meteor trails could conceivably have come from nowhere else (albeit one of these forms a "shared" radiant with area 6), this tends these negative effects to some extent.

10. Period 3, $\lambda_\odot = 21°$–$40°$

A slowing-down of Virginid activity seems to be apparent here, with 25 trails from experienced watchers seen in 161^h30. Three further radiant clusters were noted, as depicted in Figure 4, shown below.

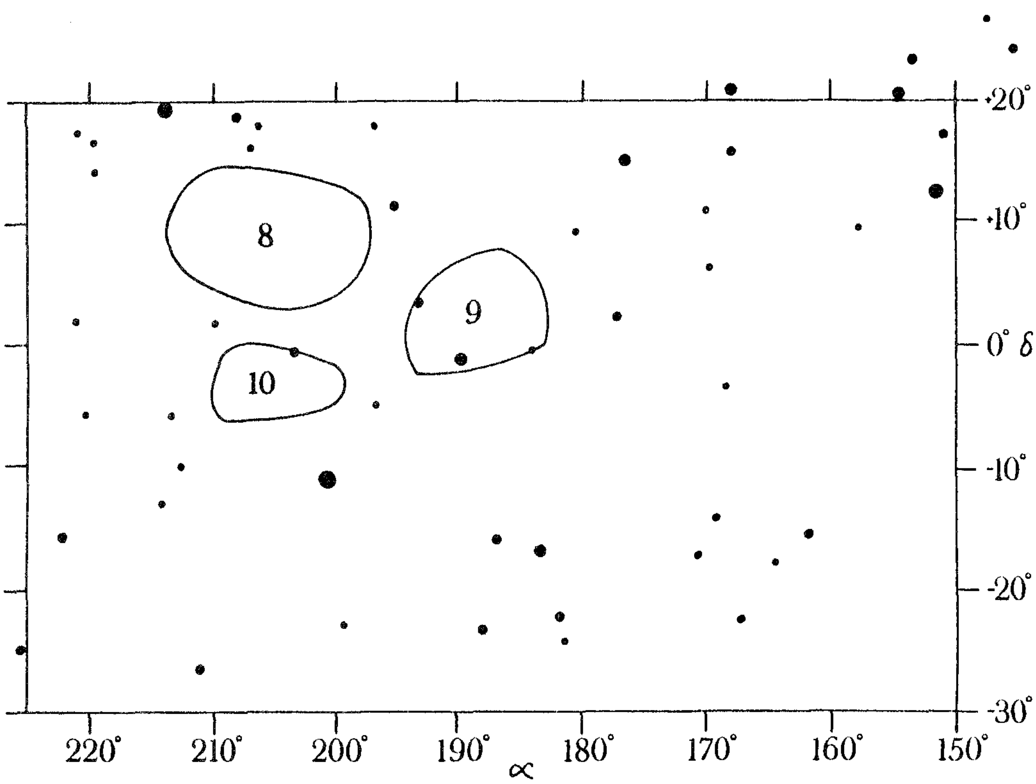


Figure 4 – Possible Virginid radiants found in Period 3 ($\lambda_\odot = 21°$–$40°$).

Radiant area 8: Activity detected: $\lambda_\odot = 21°$–$40°$; center of area: $\alpha \approx 207°$, $\delta \approx +10°$; brightest star near center: η Bootis (not in area); radiants observed: 24, fifteen class 1/2, nine class 3/4.

A strong, but somewhat diffuse region. The radiants within the area show little evidence for any but a very slight drift. One cluster towards the extreme eastern end may form a short-lived separate radiant, active chiefly around $\lambda_\odot = 22°–25°$, since it is improbable that a real radiant of this type would drift east to west.

Radiant area 9: Activity detected: $\lambda_\odot = 27°–33°$; center of area: $\alpha \approx 188°$, $\delta \approx +3°$; brightest star near center: γ Virginis; radiants observed: 9, one class 1, eight class 3/4.

A weak, diffuse association. Two short-pathed meteors probably emanated from here, however, although the lack of class 1/2 radiants calls its reality into question.

Radiant area 10: Activity detected: $\lambda_\odot = 31°–35°$; center of area: $\alpha \approx 206°$, $\delta \approx -3°$; brightest star near center: ζ Virginis; radiants observed: 7, one class 1, one class 2, five class 3/4.

Again, a weak grouping, but with a central cluster of four radiants very close together. As an extension of area 6, the probability of its genuineness would be somewhat strengthened.

11. Discussion and comparison with previous results

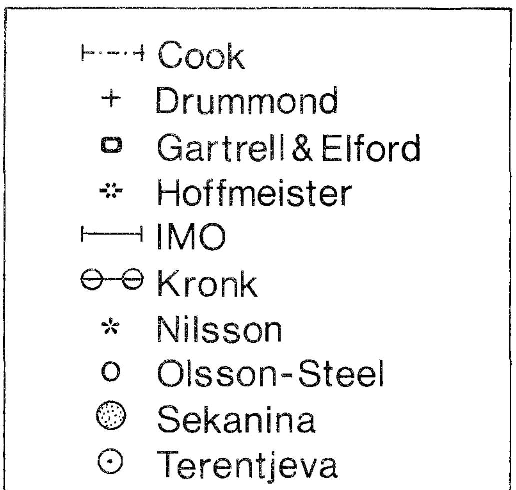
Overall, the ten radiant areas defined above, assuming all are real, fall into five solitary or linked groups: area 1; areas 2/3, 6/7, and 10; areas 4 and 8; area 5; and area 9. Having determined the results as outlined to this stage, a literature search was carried out to ascertain how, or indeed if, these radiant areas matched with those found by other observers in the past.

Suitable radiant data for comparison were obtained from the following authors: Hoffmeister [4], Ellyett and Roth [5], Nilsson [6], Terentjeva [7,8], Cook [9], Sekanina [10,11], Gartrell and Elford [12], Drummond [13], Kronk [14], Olsson-Steel [15], Roggemans [1], and McBeath [16].

The most obvious result of this search, once all the postulated radiants were plotted out, was the large spatial spread of radiants reported by several authors, plus the fact that there was often very little close correlation between radiants noted in different years by different people, with a few exceptions.

Figures 5 to 8 show the position of these assorted radiants for roughly the same solar longitudes as Periods 1–3 above, and thus can be compared directly with Figures 1–4. Note that mean radiant positions were calculated for Terentjeva's data, especially from [7].

The key to Figures 5 to 8 is shown below:



Key to Figs. Five to Eight

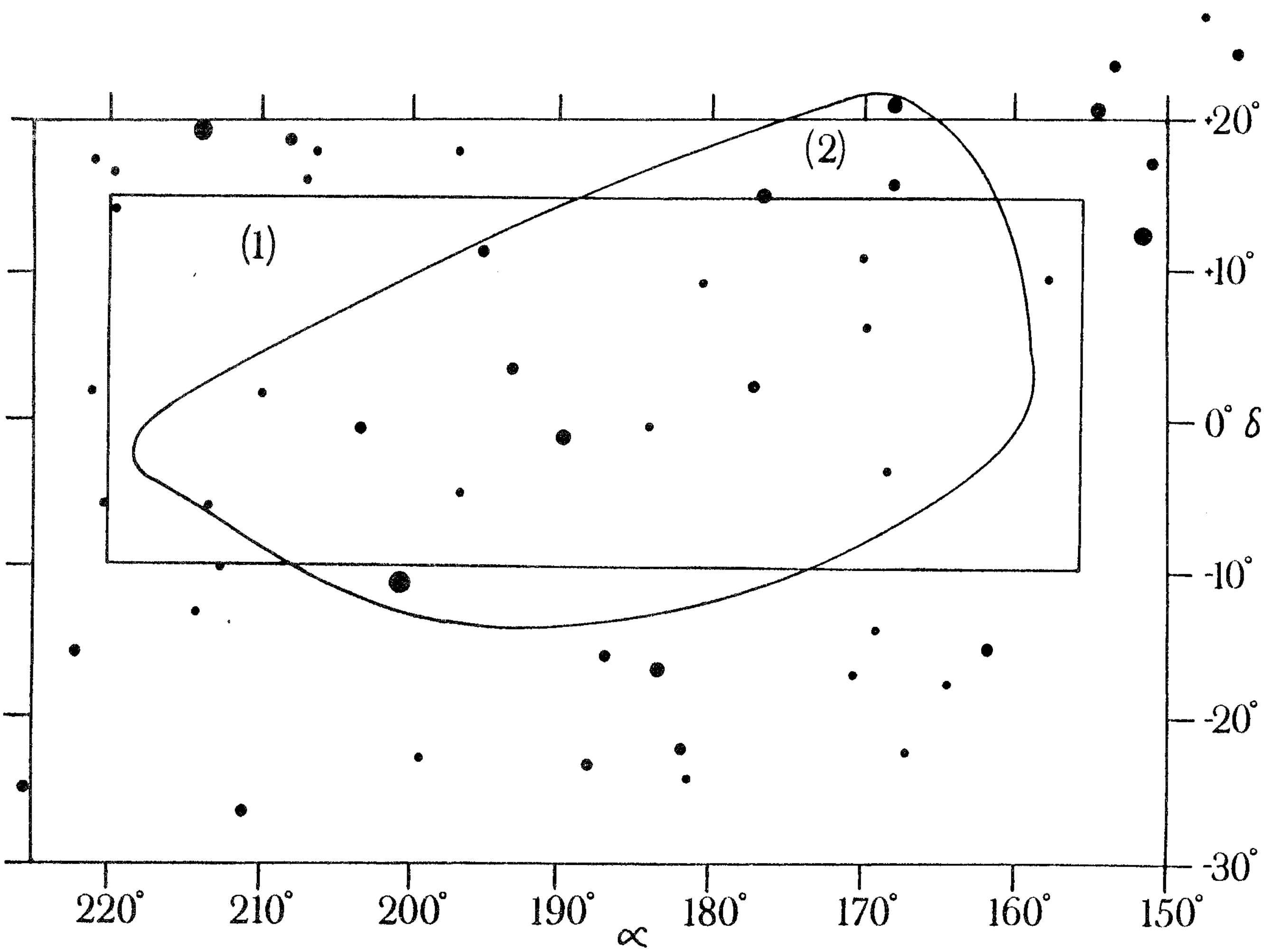


Figure 5 – Sekanina's "Virgo Cluster" positions, from [10]. Position (1) is based on the text description, while (2) is redrawn from the accompanying figure in [10]. Both are approximate only. Compare to Figure 1.

The general region of radiation, defined in Section 6 above, was essentially confirmed by most sources, though Ellyett and Roth's Virginids [5] are only partly within the easternmost edge, and two of Hoffmeister's radiants also fall just outside this zone too, along with several of Terentjeva's groups. Sekanina's Virgo Cluster [10] covers most of the northern two-thirds of the general region found here (whichever alternative is preferred—see Figure 5), but none of the sources checked (including several others not listed above) reported any notable activity in the region from approximately $\alpha = 170°–200°$, $\delta = -10° - -25°$.

Radiant area 1, although of dubious existence from these results—perhaps because observers were not specifically recording meteors from the Leo-Virgo border—seems to coincide quite well with the various minor Leonid streams, especially those given by Kronk and Terentjeva, as well as the latter part of the *IMO*'s δ-Leonids [16]. This area also covers the early Virginid activity reported by several sources, including the *IMO* and Cook.

Area 2 is not particularly close to any previously-known shower, though it is about 7° south of Sekanina's Southern η-Virginids [10].

Moving on to area 3, a remarkable, almost perfect, coincidence with Nilsson's Virginids [6] is found. This region is also close to a number of other radiants or drift tracks, e.g., Kronk's η-, θ- and possibly α-Virginids [14], the latter based on an assumed daily drift (an average of the other Virginid drifts in this source) of $\Delta\alpha = +0.^\circ9$ and $\Delta\delta = -0.^\circ3$ from the peak position given. Hoffmeister's $\lambda_\odot = 355.^\circ7$ (eq. 1950.0) Virginid radiant [4] is nearby too. Although this was noted as only a weak source here, its proximity to other, established, radiants strengthens its actuality.

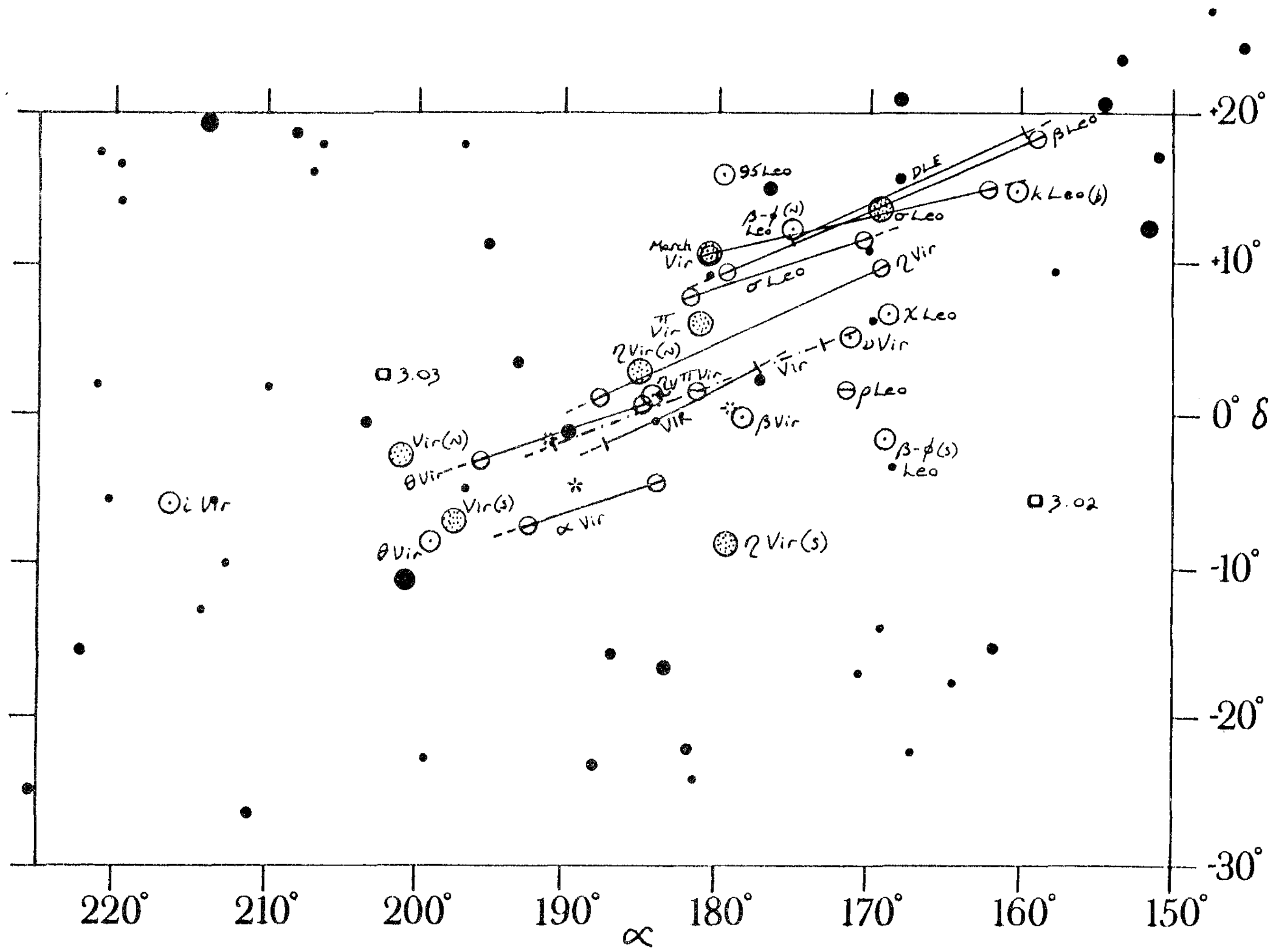


Figure 6 – Near-Virgo radiants from various others (see text and figure key) for $\lambda_\odot$ = 341°–360°. Radiant names, defining numbers, or *IMO* codes are given where available. Nilsson's shower is simply called "Virginids," while no names are given for Hoffmeister's radiants. Continuation beyond the above limits is shown by dashed lines for radiants with known drifts. Compare to Figure 2.

Area 4 is well to the north of where most sources give the Virginid radiants as lying. Its relative strength suggests it may be genuine, however. Terentjeva's δ-, ε-, and 71-Virginids [7] all lie within a few degrees of it, certainly.

Radiant area 5 may have been an on-off or irregular shower, as already suggested in Section 9 earlier, and only Terentjeva's Northern Hydrids [8] are particularly close to its center.

The eastern half of area 6 matches well with a number of radiants or drifts near Spica, but the western part is less-reliably confirmed. The western tip of this area, which may also form part of area 7, is within a couple of degrees of the position for Drummond's theoretical long-period Comet of 1834 radiant [13].

Area 7, despite being moderately strong, does not tally with any other known radiant at this time.

Only Terentjeva's δ- and 71-Virginids, plus the α-Corona Borealids and η-Bootids [8] lie at all close to area 8, while almost none fall anywhere near the postulated eastern subradiant. The strength of this region is therefore somewhat puzzling, unless it is newer than the previous results available for examination.

Area 9 sits closer to the "mainstream" Virginid activity areas, and seems to fit especially well with Kronk's γ-Virginids, so again a dubious area gains more credibility thanks to earlier data. Olsson-Steel's theoretical radiants for asteroids 2340 Hathor and 1954 XA [15] are some degrees to the north of it.

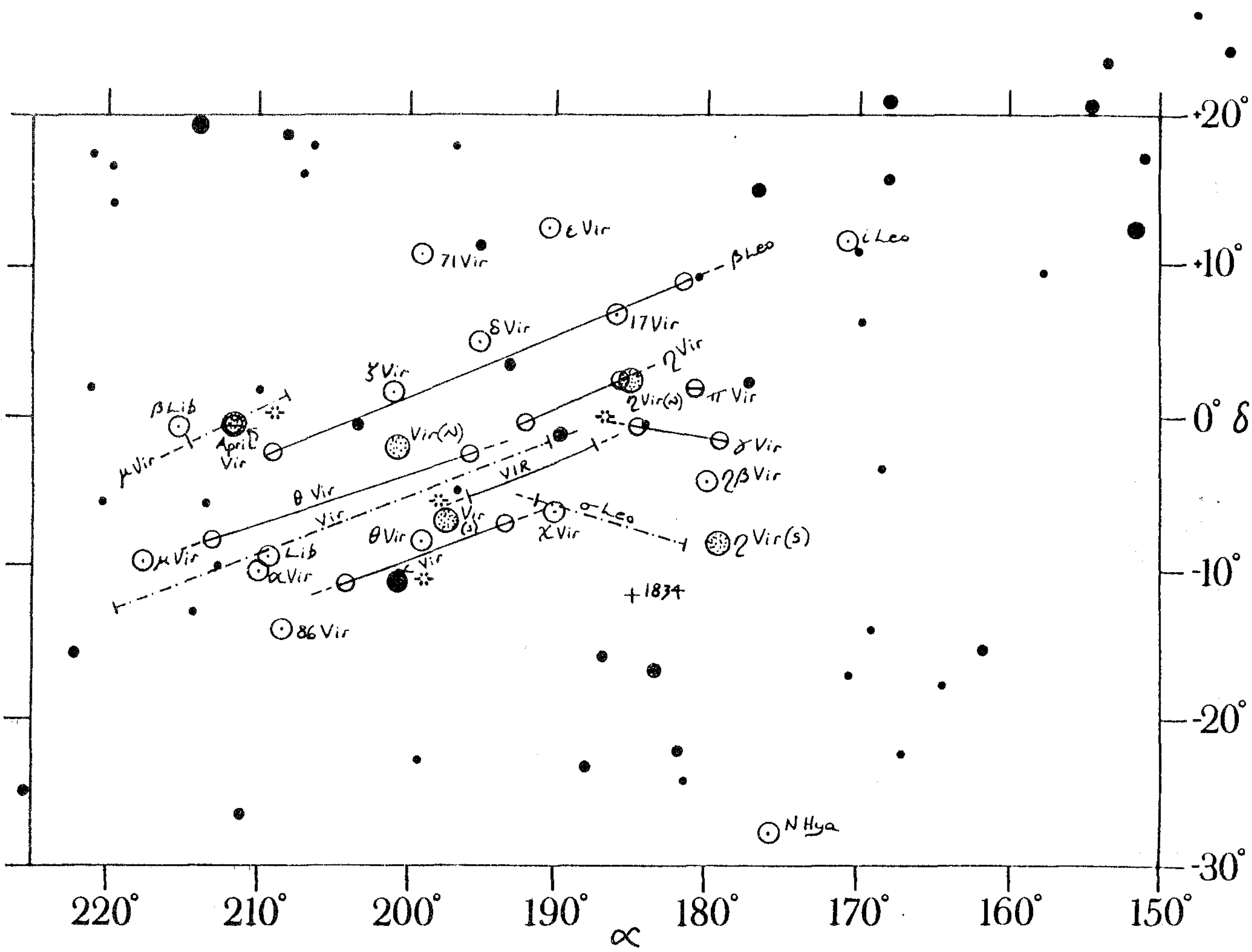


Figure 7 – Near-Virgo radiants from various others (see text and figure key) for $\lambda_\odot$ = 1°–20°. Compare with Figure 3. See Figure 6 caption for more details, but note the curious nomenclature for Cook's σ-Leonids. This radiant is never closer than ~ 20° to the star σ Leonis, but passes within ~ 6°–7° of both α and γ Virginis.

The final zone, area 10, is again in close proximity to the main axis of Virginid radiant drifts, overlapping at its eastern end with part of Ellyett and Roth's Virginids [5].

On the whole, then, there is a reasonable likelihood of areas 1 and 9 having been previously detected, along with the area 3-6-10 group, and possibly areas 4-8 and 2, but areas 5 and 7 are rather more mysterious.

The fact that several radiants clustered to the north and south of the main line of Virginid radiant drifts noted by earlier workers may perhaps have come about through the high proportion of south-north aligned trails. Here, a slight positional error of a degree or two could easily result in a radiant error of 10° or more in declination, although the right ascension should be less-affected. The fewer east-west and north-south moving meteors may have reduced this problem somewhat, as may taking the path lengths of possible Virginids into account when assigning radiants, but are unlikely to have eliminated it entirely. The south-north trails may also have resulted in the general area defined by all the possible *JASMS* radiants being slightly triangular, with the narrowest point further to the south. The possibility remains that these radiant areas are genuine, however, and it would perhaps be worthwhile for observers active in late March 1990 to check for other meteors detected from area 5, for instance.

Several workers have in the past suggested short-lived Virginid radiants may be apparent, not all of these in consecutive years (area 5 is perhaps an example of this), but the temporal coverage of the showers in one year, or in the same period between years, prevented further examination of this facet.

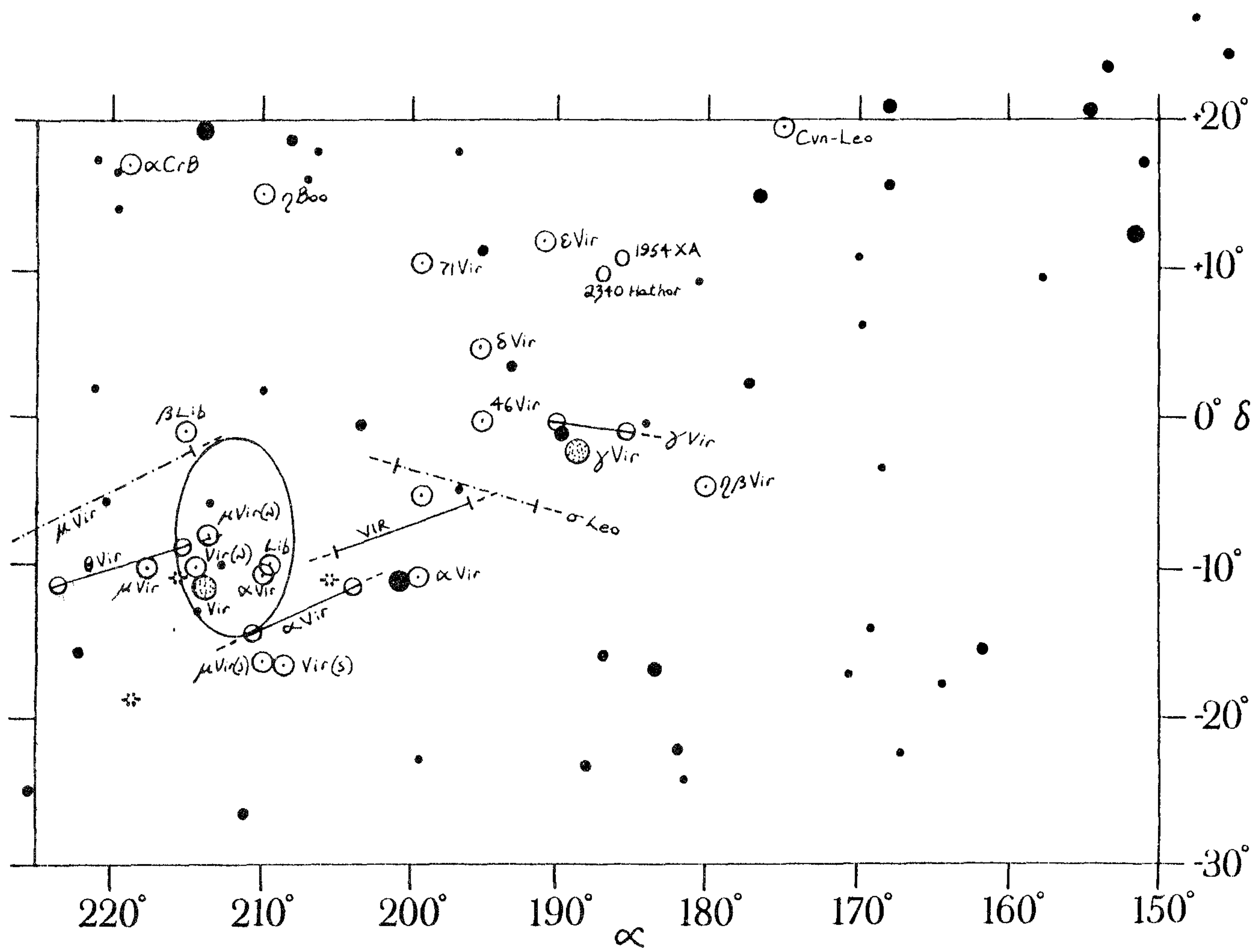


Figure 8 – Near-Virgo radiants from various others (see text and figure key) for $\lambda_\odot = 21°–40°$. Compare with Figure 4. See Figure 6 caption for more details.

In some respects, it is unfortunate that the first year of the project provided some of the best opportunities to observe, for although this almost certainly helped improve the quality of the data received subsequently (contrast the hours and experienced/inexperienced meteor plot totals in Table 1 in 1988 an 1990, for instance), a more even spread of data over the five years would probably have improved the accuracy of the final result.

No great surprises in the global magnitude distributions were found, confirming that Virginid meteors generally are relatively sporadic-like in terms of brightness and train production (see Table 2).

12. Conclusion

The results collected between 1988 and 1992 suggest the Virginids remain complex, with multiple radiants apparent, often simultaneously. Several previously-detected radiants are apparently confirmed by the present analysis, but some seemingly new—in one case, possibly short-lived—ones were also noted. Although the quality and quantity of data did not warrant an analysis such as that by Arlt, et al. [17], it gives some idea of what even a small, enthusiastic group can achieve. As [17] also indicated, there are times when even very experienced *IMO* visual observers cannot overcome the difficulties involved in this type of work. The Virginids are a group of showers the *IMO* should perhaps consider for a serious study in the near future.

Acknowledgment

I should like to thank all the named *JASMS* observers for their time and effort on this project over the past five years.

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Figure 9 – This summer, *IMO* President Jürgen Rendtel *(right)* visited Vice-President Alastair McBeath *(right)* on the occasion of a holiday in Great Brittain.

P/Swift-Tuttle and the Earth

Brian G. Marsden, SAO, Cambridge, Mass.

This note contains data regarding past and future encounters of the Perseids' parent comet, P/Swift-Tuttle, reprinted from IAU Circular 5636, *with the kind permission of Dr. Marsden. (Ed.)*

Orbital computations by the undersigned, and also by S. Nakano, Sumoto, Japan, have so far failed to link all the observations, even when allowance is made for nongravitational forces. Although a reasonable fit can be made to the 1862 (except October) and 1992 observations, the resulting transverse nongravitational component is so large that the resulting eighteenth-century perihelion time is 15 months too late. Alternatively, although the three perihelion times can be well represented without any consideration of nongravitational forces at all, there are strong systematic errors, amounting to more than $1'$, in 1862 and 1992. The gravitational orbital elements below satisfy the observations in 1992 and in October 1862 very well, and they also represent the presumed 1737 perihelion time within 1 day.

Backward computation of this solution reveals few candidates for earlier appearances of the comet, although the one of −68 fits within 1 year (there being 15 revolutions between then and 1862), and the comet of +60 may also belong. Future extrapolation gives the next return to perihelion as 2126 July 11, although the problem with the computation of the nongravitational forces must introduce some uncertainty; a change by +15 days could cause the comet to hit the Earth on 2126 August 14. It therefore seems prudent to attempt to follow P/Swift-Tuttle for as long as possible after the present perihelion passage, in the hope that an adequate independent orbit determination, uncontaminated by nongravitational effects, can be made from mid-1993 (at $r = 3$ AU and far to the south) to, say, 1998 (when $r = 15$ AU and an assumed nuclear absolute magnitude of +14 yields an apparent magnitude of +26).

Epoch: 1992 December 4.0 TT

T = 1992 December 12.323 TT		$\omega = 153^\circ.013$	
$e = 0.96359$		$\Omega = 139^\circ.456$	(eq. 2000.0)
$q = 0.95812$ AU		$i = 113^\circ.430$	
$a = 26.31666$ AU	$n = 0.007301$	$P = 135.00$ years	

19th Century Observations of P/Swift-Tuttle

communicated by Jürgen Rendtel

Some 1862 observations of P/Swift-Tuttle that were reported in *Astronomische Nachrichten* are reviewed.

Now that P/Swift-Tuttle has finally been rediscovered, and meanwhile extensively observed by all professionals and amateurs with some interest in this comet, our curiosity is raised as to how the Perseids' parent comet was seen at its previous return.

In what follows, we try to give an (incomplete) answer to this question based on some reports that have appeared in *Astronomische Nachrichten*.

Comet 1862 III P/Swift-Tuttle was discovered by Swift in Rochester, New York State, on July 15, 1862, and, independently, by Tuttle at the Harvard Observatory in Cambridge, Massachusetts, on July 18. On July 22, the comet was "discovered" in Florence. Two days later, J.V. Schiaparelli manages to observe the comet from the Brera Observatory in Milan, using the data telegraphed from Florence. The observation is reported in Issue No. 1373 of *Astronomische Nachrichten* under the title "observations of the new comet discovered in Florence." Apparently, Schiaparelli was at that time (July 25) not yet aware of the earlier viewings of the comet. He describes his observations as follows: "... I found indeed a beautiful comet, the head of which had the brightness of star of the 6th magnitude, that was even visible with the naked eye, though with some difficulty. A thin, straight tail extended over 1°5 in direction 312°. The condensation was very strong towards the center of the head, but the nucleus was nevertheless poorly delineated, and hard to observe. The visible part of the luminous hue had a diameter of 8′."

On September 10, S.H. Schwabe reports observations from Dessau between August 15 and September 4, which were published in No. 1384. Besides the actual drawings we reproduce here, Schwabe also gives extensive descriptions for which there is not enough room here. Both the drawings and the accompanying descriptions however illustrate the strong activity of the comet, which is responsible for both the beautiful shower we are allowed to witness each year, and the large non-gravitational forces that made it so difficult to predict its return.

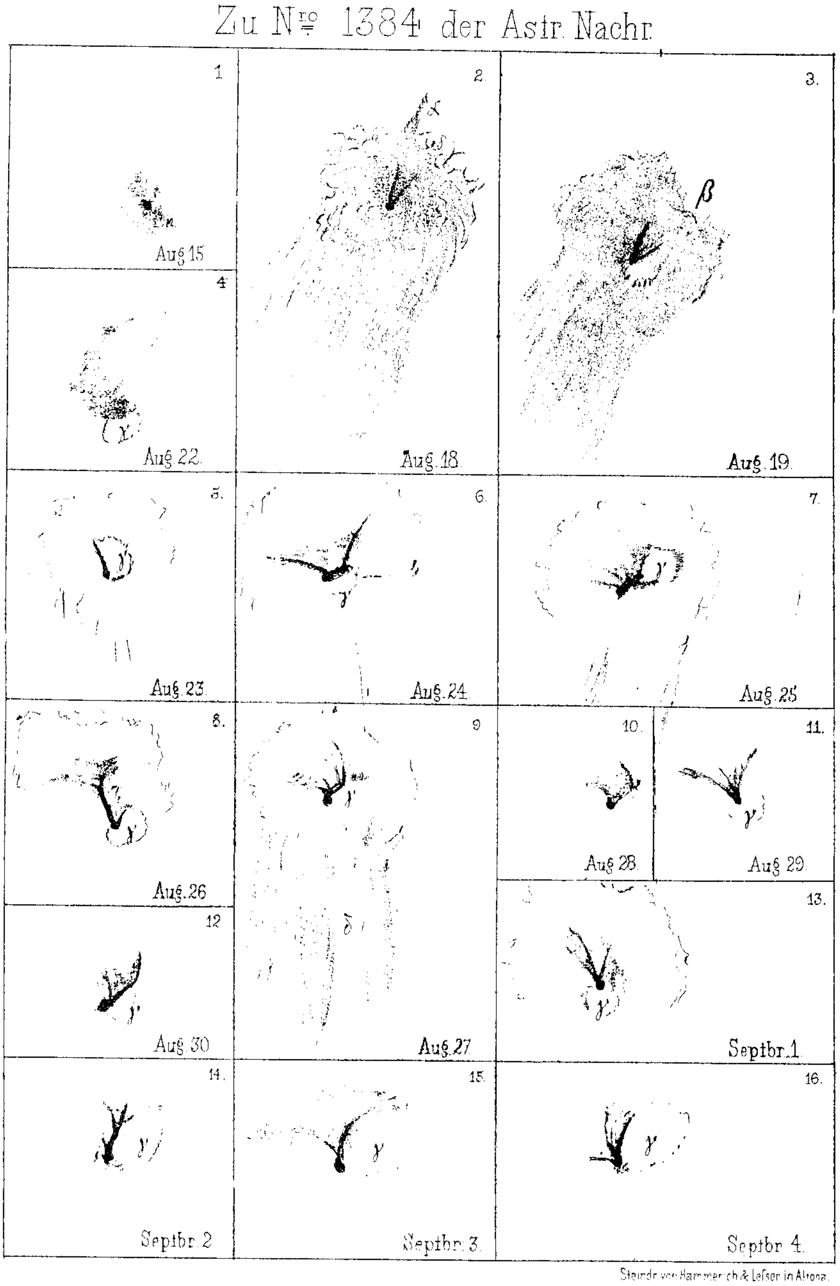

Figure 1 – Observations of P/Swift-Tuttle by S.H. Schwabe from Dessau between August 15 and September 4, 1862.

In the same issue, Theodor Oppolzer from Vienna reports orbital calculations. His results were as follows (eq. 1862.0):

$T = 1862$ August 22.91542 GMT	$\pi = 344°41'15''.5$
$e = 0.961160$	$\Omega = 137°26'49''.8$
$\log q = 9.983466$	$i = 66°25'23''.2$ (retrograde)
$a = 24.785$ AU	$P = 123.4$ years

As was customary in those days, the longitude rather than the argument of the perihelion is given. Also, the inclination is given as an angle between 0° and 90° rather than 180°. Finally, some caution is needed when interpreting $\log q$. The "real" value of $\log q$ above is −0.016534.

Using this elements, Oppolzer computes the smallest distance between the orbits of P/Swift-Tuttle (which at that time is referred to as "the second comet of 1862") and the Earth, and finds 0.00472 AU, roughly twice the distance to the Moon.

Observational Results

Australian Meteor Observations

Jeff Wood

An overview is given of Australian observations of the 1991 Geminids, the 1992 Grigg-Skjellerupids, and the 1992 η-Aquarids.

1. 1991 Geminids

1991 saw Australian meteor observers carry out an excellent series of observations of the Geminid Meteor Shower. Taking advantage of the clear, dark, warm Australian summer skies, 83 man hours of data were obtained over 10 nights from December 5-6 to 16-17. A total of 10 observers participated. Their names were as follows:

Martin Coroneos, Darren Ferdinando, Jeff Wood, George Platt, Roger Vodicka, Mark Glossop, Barry Smith, Peter Soumanis, John Odgers, Maurice Clark, Jim Trainor, Lance Kelly, Adam Marsh, Darren Simpson, and David Batten.

Table 1 – 1991 Geminid activity in Australia.

Date	ZHR	Nr. Obs.	Date	ZHR	Nr. Obs.
Dec 05-06	3.8 ± 1.2	3	Dec 12-13	43.1 ± 8.1	14
Dec 07-08	2.4 ± 0.2	2	Dec 13-14	80.6 ± 25.2	25
Dec 09-10	7.9 ± 3.6	7	Dec 14-15	89.9 ± 30.6	7
Dec 10-11	11.2 ± 1.1	3	Dec 15-16	17.0 ± 1.6	4
Dec 11-12	14.6 ± 2.8	9	Dec 16-17	2.0 ± 0.6	2

Table 2 – Magnitude distribution of the 1991 Geminids seen in Australia.

Magnitude	−4⁻	−3	−2	−1	0	+1	+2	+3	+4	+5	+6	Tot	$\overline{m}$
Number	12	12	18	35	68	175	354	554	452	223	32	1935	2.84

Among the meteors of magnitude −4 and brighter, there was one of magnitude −11, one of −8, one of −5, and there were nine of −4. The r-value for the Geminids in the magnitude range between −2 and +5 was 2.66.

Of the 674 Geminids of magnitude +2 and brighter, 47% were white, 37% yellow, 6.4% orange, 5.5% blue, 2.5% green, 1.3% red, and 0.6% violet.

The number of Geminids having a train was 4.8%. All of these were of a short duration except that of a magnificent −11 violet-colored fireball seen on December 14-15. This train lasted for 25 seconds.

2. 1992 Grigg-Skjellerupids

With Comet P/Grigg-Skjellerup reaching perihelion in 1992, Australian meteor workers decided to carry out observations of the related meteor shower. The Grigg-Skjellerupids were monitored on five successive nights from April 21-22 to 25-26. All told 34 man hours of data were collected by six observers who were as follows:

David Batten, Martin Coroneos, George Platt, Mark Glossop, Jeff Wood, and Craig Hinton.

Table 3 – 1992 Grigg-Skjellerupid activity in Australia.

Date	ZHR	Nr. Obs.	Date	ZHR	Nr. Obs.
Apr 21-22	0.5 ± 0.5	6	Apr 24-25	0.8 ± 0.7	6
Apr 22-23	1.1 ± 0.4	3	Apr 25-26	0.7 ± 1.2	5
Apr 23-24	2.3 ± 1.2	13			

In 1992, Grigg-Skjellerupid activity was low with a maximum ZHR of 2 on the night of April 23-24. A total of 40 Grigg-Skjellerupid magnitude estimates were obtained. These are tabulated in Table 2.

Table 4 – Magnitude distribution of the 1992 Grigg-Skjellerupids seen in Australia.

Magnitude	−4	−3	−2	−1	0	+1	+2	+3	+4	+5	+6	Tot	$\overline{m}$
Number	0	1	0	0	6	6	9	6	7	4	1	40	2.33

The color distribution of all Grigg-Skjellerupids of magnitude +2 or brighter is as follows: 59% were yellow, 27% were orange, and 14% were white. Very few Grigg-Skjellerupid meteors have a train. In 1992, there was only one train recorded and this was of 4 seconds duration produced by a −3 fireball.

3. 1992 η-Aquarids

1992 has seen Australian meteor observers carry out a series of observations of the η-Aquarid Meteor Shower. Data were obtained on 8 nights covering the period April 29-30 to May 9-10. Four observers participated:

Mark Glossop, Maurice Clark, John Drummond, and Jeff Wood.

Table 5 – 1992 η-Aquarid activity in Australia.

Date	ZHR	Nr. Obs.	Date	ZHR	Nr. Obs.
Apr 29-30	8.3 ± 0.1	2	May 05-06	27.3 ± 10.2	3
May 02-03	24.3 ± 3.3	3	May 06-07	37.2 ± 3.3	2
May 03-04	27.8 ± 10.1	3	May 08-09	22.9 ± 2.1	2
May 04-05	35.2 ± 6.8	2	May 09-10	19.2 ± 1.2	2

Table 6 – Magnitude distribution of the 1992 η-Aquarids seen in Australia.

Magnitude	−5	−3	−2	−1	0	+1	+2	+3	+4	+5	+6	Tot	$\overline{m}$
Number	1	5	12	17	37	71	71	94	83	41	5	437	2.29

The following color distribution was derived from 214 η-Aquarid meteors of magnitude +2 or brighter: 50% were white, 39% yellow, 5.1% orange, 4.2% blue, 0.9% red, and 0.5% green.

221 or 51% of the η-Aquarid meteors seen had a train. Most of these were of short duration, but there were eight that lasted 5 seconds or more. The best of these, which was produced by a −5 fireball, had a train that lasted for 25 seconds. There was noticeable distortion of this train by the upper atmosphere winds before it disappeared.

JAS Meteor Section 1992 Summer Results

Alastair McBeath

A summary of visual data obtained by the *JAS Meteor Section* from the UK is presented. Conditions were generally poor, although two streams—the Perseids and δ-Aquarids—received moderate coverage, and one spectacular fireball was widely seen on August 16, 1992, at about 21^h50^m UT.

1. Introduction

Seventeen *JASMS* members reported results during July and August 1992, observing 944 meteors in 125.5 hours, mostly from British sites:

> Phillip Blackstaffe, Charlotte Bland, Neil Bone, Chris Durman (Portugal), Shelagh Godwin, Terry Holmes, David Jenkins, Craig Johnson, Richard Livingstone, Tony Markham, Alastair McBeath, Stewart Moore (France), T. Oldroyd, Graham Pointer, Ian Rigney, Alan Smeaton (Germany), and Roy Watson.

Apart from 459 sporadics, the main contributors to the meteor totals were the Perseids (320), δ-Aquarids (92), and α-Capricornids (30). Handfuls of Scorpid-Sagittarids, ι-Aquarids and κ-Cygnids wered noted too, along with a few members of "showers" not recognized by the *IMO* due to their low to nonexistent activity.

All nights except July 25-26 between July 19-20 and August 13-14 received some coverage, but often with skies too poor to allow useful analysis of the data obtained. Some further details on the three best-observed showers follow.

2. Perseids

Although by far the most numerous shower source during July and August, sky conditions only permitted 76 to survive through the analysis stage. Magnitude and train data for these and the summer sporadics are given in Table 1.

Table 1 – Global magnitude distributions and train percentages (%) for the 1992 Perseids, δ-Aquarids, α-Capricornids, and July-August sporadics.

Shower	-3^-	−2	−1	0	+1	+2	+3	+4	$+5^+$	Tot	$\overline{m}_{6.5}$	%
Perseids	2	2	5	16	11	14	17	4	3	76	+2.0	42
δ-Aquarids				6	1	9	10	3	0	29	+2.8	0
α-Capricornids	1	1	2	4	5	2	3	1	0	19	+1.4	11
Sporadics	2	0	5	13	35	41	73	47	23	239	+3.3	4

Perseid ZHRs rose from about 4 ± 3 on July 23-24 to about 11 ± 6 by August 6-7, albeit the spread of data points during this time was patchy. No reliable ZHRs could be computed for UK sites after this latter date.

On the critical night of August 11-12, conditions over the UK could scarcely have been worse, with very few people able to observe anything at all. Those who could watch in more reasonable skies reported good, but not exceptional, rates. In retrospect, this was not too surprising, since the Perseids' main maximum had already occurred before nightfall from Britain. Indeed, members of the Radio Society of Great Britain have reported that the 1992 Perseids were the best for many years, with some exceptional reflections taking place from approximately 18^h–21^h on August 11, allowing almost continual reception for large parts of that time.

3. δ-Aquarids

Details for the δ-Aquarids seen in better skies are given in Table 1. Virtually every shower member seen by reliable witnesses was allocated to either the northern or southern radiant (most—22—to the northern one, however), but with so few meteors, it would be pointless to give anything other than a combined global tally. Rates were normally low, but somewhat more obvious in late July. The few ZHRs that could be properly computed give no indication of any genuine maximum, although southern branch meteors were more in evidence around July 26–28 than at other times.

4. α-Capricornids

Despite their small numbers, the α-Capricornids were notable for a quantity of bright events. Several observers commented that these meteors were particularly memorable, their bright, slow nature more than compensating for their low rates. A global magnitude distribution for them is in Table 1. Activity from this source was never high, but more members were observed between July 27–29 than before or after, suggesting perhaps a peak at some point within these dates.

5. August 16 fireball

One of the most widely-seen fireballs to occur over the UK in many years was reported at around 21^h50^m UT on August 16, 1992. Dozens of casual witnesses forwarded sightings to the police and media from sites between Bristol in South-West England to the Outer Hebrides, off the west coast of Scotland, and further reports are still coming in. The object probably reached at least magnitude -10 before fragmenting, and one site (Portmadoc, North Wales) recorded a sonic boom after this event. Some 75 km further east-north-east at Mold in Clwyd (also North Wales) a loud swishing sound was heard by two observers simultaneously with the sighting of the meteor too, and other similar events may have occurred elsewhere. The *BAA Meteor Section* is still compiling the reports forwarded to it, and publication of these results in the *BAA Journal* is expected once this work is complete.

6. Conclusion

With many of the better meteor showers affected by moonlight in 1992, it was never going to be an especially productive year, and that combined with some worse-than-normal weather over Britain has helped keep meteor numbers and hours tallies well down. Even so, the summer still produced some good nights and impressive meteors to help sustain interest in the subject generally. Next year's Perseid return is already eagerly awaited in case another outburst should take place in the wake of Comet P/Swift-Tuttle's recent recovery.

Acknowledgments

As always, I am indebted to all the *JASMS* observers named above for their efforts this summer, but I would also like to thank Norman Fitch of the *RSGB* for forwarding confirmation of the British Perseid radio reports so quickly, and also to *BAAMS* Director Neil Bone for further information on the August 16 fireball.

The 1992 Perseids in Czechoslovakia and the Problem of Overcorrection

Vladimír Znojil

Various causes of overcorrection of hourly rates are discussed in connection with the 1992 Perseid outburst: a too high value for the population index, a too high correction for cloudiness, and a too low value for the limiting magnitude. Additional Czech observational data are given for the night of August 11-12. Attempts are made to estimate the population index from these observations, and to recompute formerly-obtained ZHR data accordingly.

This year's extraordinary return of Perseids painfully revealed some problems related to the processing of various observing data gathered at the same time. Attentive readers of the various *WGN* reports on the Perseid outburst noticed a very striking phenomenon: the corrected hourly rates of the Perseids obtained by different observers differ considerably from one another; the worse the observing conditions were, the higher the derived rates!

It is quite clear that this result can only originate from the enormous corrections that were applied to the observing data. When searching for the causes, we immediately came across several factors that played a role.

The problem with the present investigation is that due to the Moon excellent observing conditions were nowhere present during the Perseid return of 1992. That is why the conventional method of simply ruling out observations carried out under poor observing conditions cannot work.

The first and probably most obvious cause is the use of a wrong value for the population index. The value $r = 2.6$ which is found in many *IMO* publications is too high. In my opinion, the most reliable average value is $r = 2.3$, in accordance with [1], which pays much attention to estimating the population index, and uses a wide range of methods. Even this value, however, is apparently too high to describe the bright Perseid returns of the past two years. Because the population index occurs in the base of the exponential function which gives the correction factor for the limiting magnitude, the error has even more effect than an error on the limiting magnitude estimate due to poor observing conditions.

Thus the first question we have to ask concerns the actual value of the population index during this year's peak.

Table 1 – Observing data from Jan Kyselý on the Perseids obtained during the night of August 11-12, 1992.

Period (UT)	Lm	F	T_{eff}	Per	Spor
19^h30^m–19^h55^m	4.2	1.0	0.42	6	2
19^h55^m–20^h20^m	4.3	1.0	0.42	16	1
20^h20^m–20^h45^m	4.3	1.0	0.42	4	3
20^h45^m–21^h10^m	4.3	1.0	0.42	5	2
21^h10^m–21^h35^m	4.3	1.0	0.42	6	1
21^h35^m–22^h00^m	4.3	1.0	0.42	4	2
22^h04^m–22^h29^m	4.1	1.0	0.42	5	1
22^h29^m–22^h54^m	3.7	1.0	0.42	11	0
22^h54^m–23^h24^m	4.0	1.0	0.50	7	0
23^h24^m–23^h54^m	4.0	1.0	0.50	16	2
00^h00^m–00^h30^m	5.0	1.0	0.50	20	1
00^h30^m–01^h00^m	5.3	1.0	0.50	8	4
01^h00^m–01^h30^m	5.3	1.0	0.50	15	3
01^h30^m–02^h00^m	5.5	1.0	0.50	20	6

Table 2 – Magnitude distributions of the Perseids *(top four lines)* and the sporadics *(bottom two lines)* observed by Jan Kyselý during the night of August 11-12, 1992.

Period (UT)	$\overline{Lm}$	−4	−3	−2	−1	0	+1	+2	+3	+4	+5	?
19^h30^m–21^h10^m	4.3	2	5	6	0	4	3	5.5	3	1	0.5	1
21^h10^m–22^h54^m	4.0		1	2	4.5	1.5	3	3.5	8	2	0.5	
22^h54^m–23^h54^m	4.0		2.5	3	3	3	2	2	4.5	3		
00^h00^m–02^h00^m	5.3	1	0	2	5.5	12.5	6	7.5	15	9	3.5	1
19^h30^m–23^h54^m	4.2				1	0.5	3.5	1	3.5	4	0.5	
00^h00^m–02^h00^m	5.4			0.5	0.5	0	1	0.5	5.5	5.5	0.5	

Of course, the problem is that the commonly-used methods to estimate this value depend on gathering rather extensive observing material, obtained under favorable and constant observing conditions. For the 1992 Perseids, we do not have and will never have such observing material at our disposal. Nevertheless, it is possible to find suitable approximate estimates, even in this situation.

In our country, we managed to cope with a similar problem when we wanted to evaluate population indices of small showers, where the stream members make up only a small percentage of the meteor activity. Several methods to estimate the population index of such small showers were developed, more or less based on certain assumptions on the sporadic background [2].

Observing data from I. Miček and T. Nasku [3,4], as well as data from Jan Kyselý (KYSJA) who observed from Vlašim ($\lambda = 14°54'$ E, $\varphi = 49°42'$ N), were used for computing the population indices of this year's Perseids. The data obtained by Jan Kyselý can be found in Tables 1 and 2.

Mean values of the Perseids' population indices shown in Table 3 were determined from data obtained by these three observers in Czech countries using three calculation methods.

Table 3 – Population index for the Perseids on August 11-12, 1992

Period (UT)	Population index
19^h30^m–21^h03^m	1.96 ± 0.24
21^h03^m–22^h56^m	2.43 ± 0.12
22^h56^m–01^h30^m	2.22 ± 0.26

As can be seen in Table 3, these values are much lower than all alternative values that have been used for correction. This by itself explains why the maximum ZHRs for the observers at the Šibenik hill in [3] are overestimated. The calculation of the Perseid hourly rates using our values for the population index yields the profile shown in Figure 1. I have also recalculated the hourly rates given in [5]. I only used Chen Yu's observation, who has a longer series of observations. The results are given in Table 4.

Table 4 – Re-corrected ZHRs for the Perseids during the night of August 11-12, 1992, as observed by Chen Yu.

Time (UT)	ZHR	Time (UT)	ZHR
$18\overset{h}{.}70$	106 ± 43	$19\overset{h}{.}78$	1135 ± 498
$18\overset{h}{.}99$	259 ± 107	$20\overset{h}{.}03$	934 ± 349
$19\overset{h}{.}23$	875 ± 366	$20\overset{h}{.}37$	244 ± 107
$19\overset{h}{.}52$	693 ± 324		

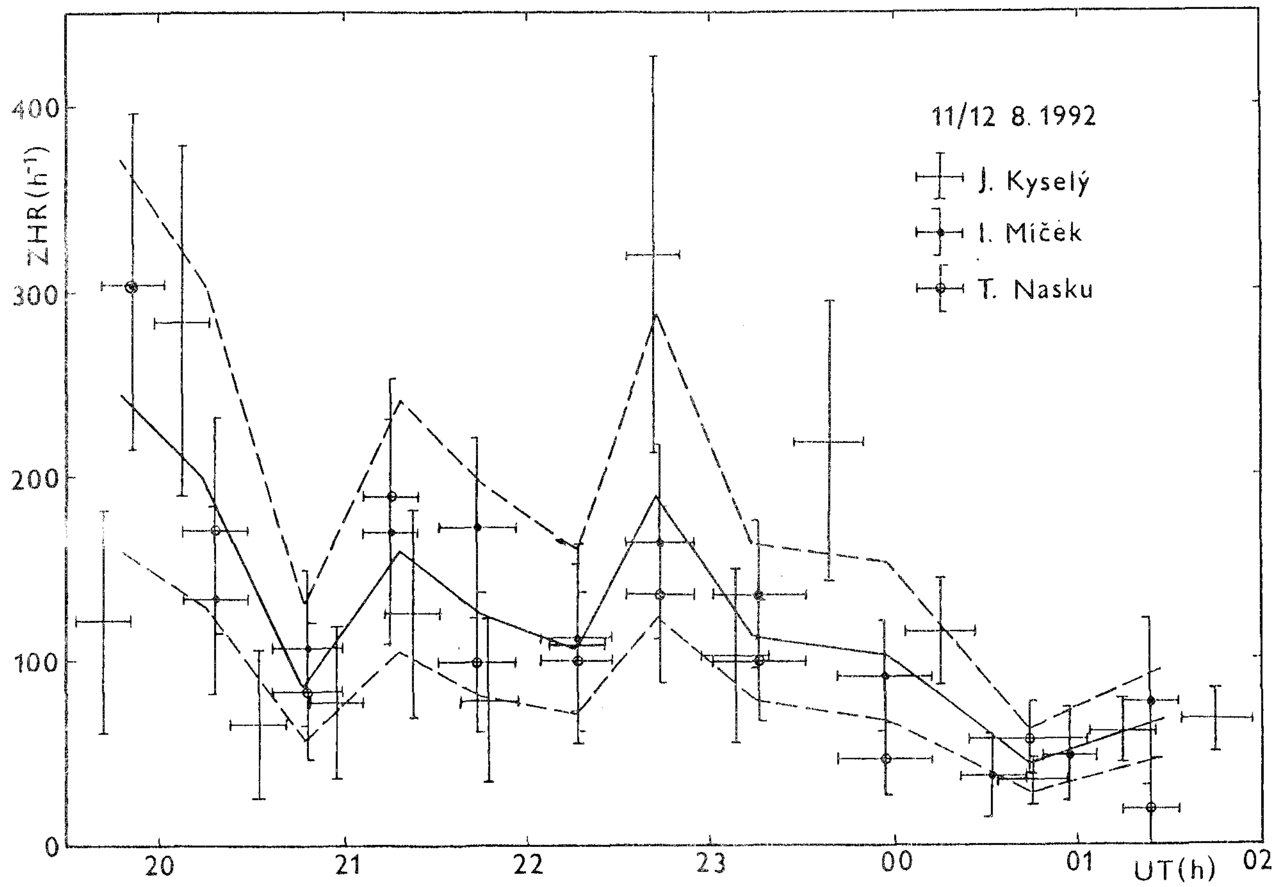

Figure 1 – Recomputed activity profile for the Czech 1992 Perseid observations.

Our critical view on these and further corrected data also points at several other problems connected with the correction of observed rates. The first of them (and the simplest one) is connected with the correction for cloudiness.

Observations carried out under skies covered with a serious percentage of clouds are usually disregarded, but we cannot always afford to do this. The problem then is that correction for cloudiness also leads to overcorrection. This is easily understood, when we realize that a meteor is a moving object which can be partly visible, even if a part of its trail is hidden behind clouds. This is why the correction depends on the kind of cloudiness and the length of the meteor paths. If we observe long meteors under a torn cloud cover, the correction can be very small. Therefore the following formula was proposed to correct cloudiness:

$$F = \frac{1}{(1-k)(1+kt)},$$

where k is the cloud-covered part of the sky, and t is a correction factor depending on the cloud type and the length of the meteors. In the classical formula, we have $t = 0$. The value of t can vary considerably from compact ($t \approx 0.03$) to very tattered cloudiness ($t \approx 0.3$, for bright meteors even more). It can be estimated to be 0.5 and more for variable cloudiness and very long meteors (e.g., bright Perseids).

Another problem, noticed by rather few observers, is the estimate of the limiting magnitude itself. I have tested groups of observers estimating limiting magnitudes, and I can only confirm that the differences between the individual observers can be pretty large. You see, the value of the limiting magnitude depends to a large degree on the effort which is made to find the faintest star, the brightness of the sky background, and other factors as well.

Roughly, we can distinguish about four types of limiting magnitudes: *(i)* the one applied to longer-lasting observations, *(ii)* the one obtained from passing over the fainter stars, *(iii)* the one resulting from a detailed examination of a chosen field, and *(iv)* the one obtained by drawing a chosen area to determine the faintest star. These four types are ordered according to increasing resulting value. Typical average values are about 5.7, 6.2, 6.6, and 7.2 at good visibility, respectively. Limiting magnitude estimates according to the *IMO* method approach the third value, while it is the second method that is used in Czechoslovakia. Another problem with limiting magnitude estimates is that under poor conditions a lack of brighter stars make it harder on the eyes to focus, causing more strain. These factors will lead to underestimating the limiting magnitude, and thus to overcorrected ZHRs.

After considering the influence of all these factors, it is my opinion that the observations of this year's Perseids provided evidence for a narrow central cloud of a stream in the parent comet's vicinity. The population index is unusually low there, may be even lower than 2.0. Passing through this cloud lasted about 0.8 hours, and the hourly rates reached about 400 meteors per hour, −100, +200.

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Dutch Meteor Observations of the 1992 Perseids

Koen Miskotte

This article introduces the group *Delphinus* from Harderwijk, the Netherlands, and gives an overview of its 1992 Perseid observations.

1. The Delphinus group: 1980–1991

Around 1977-1978, the author made the first attempts to observe meteors. After a beautiful observing night on August 9-10, 1978, and some two Orionid nights, I felt the need to establish an observing group with observers who would not restrict themselves to Perseid maxima, but would observe throughout the year.

The Delphinus group was founded in May 1980. The name stems from the world-famous dolphin park of Harderwijk. The period 1980–1983 saw a strong increase in both the activities and the number of observers. The number of observing nights rose from 13 in 1980 to 35 in 1983. The observations were performed from the top of an almost 100 years old water tower, which is still in use. It is located in the middle of a forest, 3 km southeast of Harderwijk. The number of observers increased from 4 to 8 in 1983. In this period, we gained a lot of experience.

Photographically, things also kept improving. In those days, Delphinus was involved in tens of simultaneous meteor photographs. There is a lot of cooperation with the groups Cyclops (Oostkapelle), Laurentius (Lattrop) and Pisces Orientalis (Varsseveld), all of which are active in the Dutch Meteor Society.

In 1984, another observing site was adopted, at least throughout that year's Perseid campaign. Also, Carl Johanninck from Laurentius, Bauke Rispens, and the author went to Southern France, to the observatory of Dany Cardoen and Arlette Steenmans in Puimichel. This campaign was an enormous success, due to the excellent dark nights with skies of limiting magnitude 6.9! The three observers saw some 4000 meteors during 10 nights. Since then, a lot of European observers visited Southern France to watch meteors.

In the period 1984–1987, the Delphinus observers visited Puimichel six times. This period produced 20 000 visual meteors and more than 100 photographed meteors (with only a few cameras), observed by 2 to 4 people in average. The top years were 1985 and 1986. Also, a lot of clear nights in Harderwijk were used to observe.

Unfortunately, the number of active observers decreased from 1984 onwards. In 1987, only one observer was active (Bauke Rispens). The decrease continued until 1988, when the author started again with visual and photographical observations in Harderwijk. The photographic part is already a success, but the visual part is still a bit disappointing.

In 1989, the observing post in Harderwijk was revived, and the Perseid action was a success. Due to the marriage of the author, the observations were postponed till April 1990. Since that time, the observations become better and better: in 1990 we managed to observe during 23 nights; 1991 even produced 44 nights!

1991 was a beautiful year, with successful Lyrid, Perseid, and Geminid campaigns. A −10 fireball with three flares was seen on April 20. Photographically speaking, 1991 constituted a record. Not less than 54 meteors were photographed from Harderwijk. After a disappointing spring in 1992, we enjoyed a successful Perseid action in late July and in August.

2. The 1992 Perseids

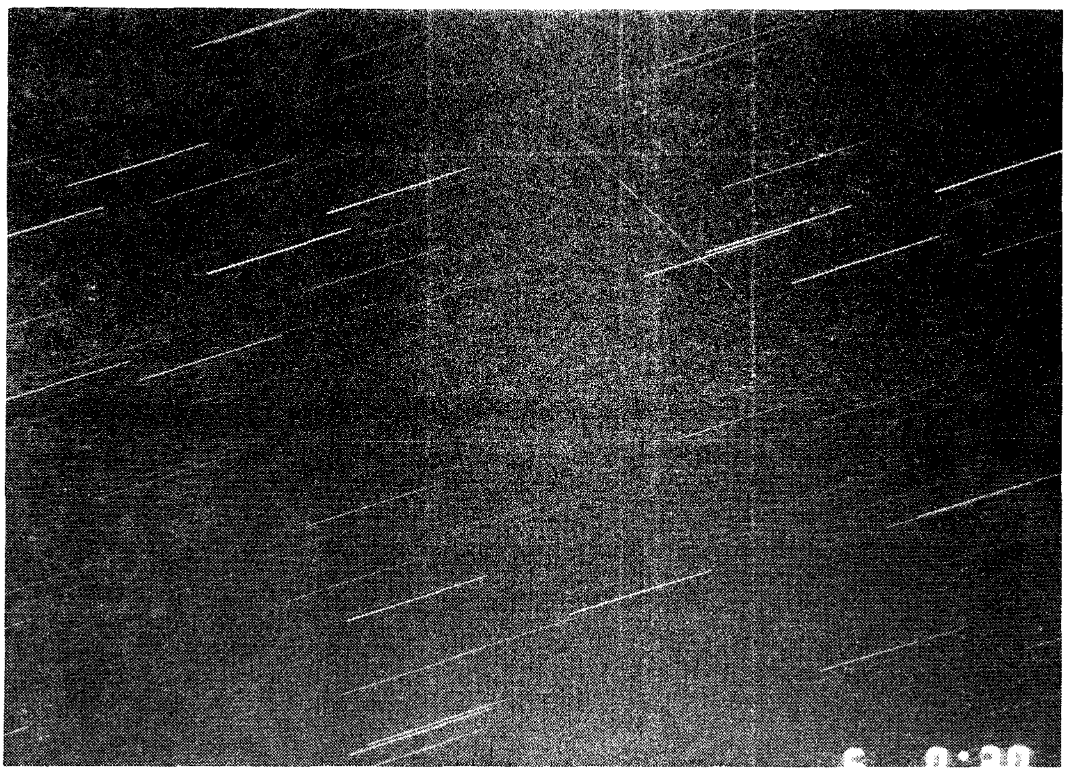

Figure 1 – A −1 Perseid in Aquarius photographed on August 5, 1992, $0^h33^m02^s$ UT with a Canon T-70 with Canon 50 mm $f/1.8$ lens. The meteor has been photographed simultaneously in Lattrop and Varsseveld.

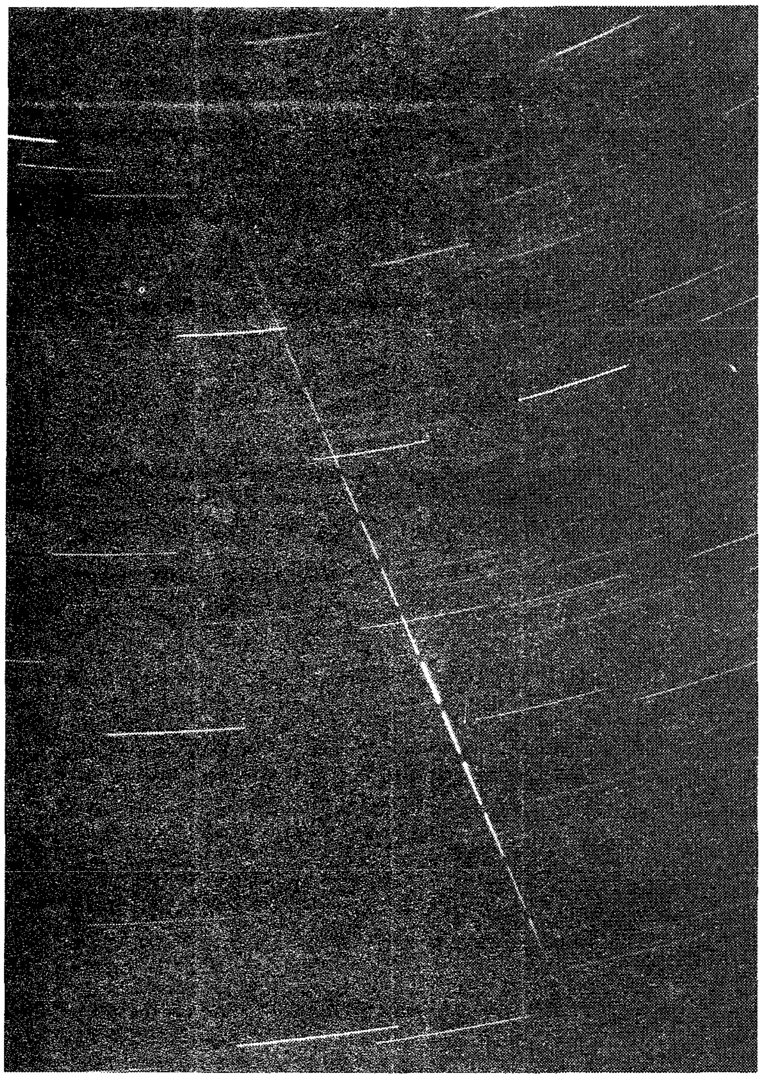

Figure 2 – A −3 Perseid in Draco photographed on August 4, 1992, $22^h49^m50^s$ UT. The meteor showed a train that lasted for 12 seconds. The meteor has been photographed simultaneously in Lattrop.

During nine more or less clear nights, the Perseids could be monitored. The first Perseids were seen in the night of July 6-7 and 7-8.

We also noticed a radiant between κ Cygni and γ Draconis in the night of July 27-28 ($\alpha = 18^h\!.40$ and $\delta = +55°$). The three observers saw some meteors of this radiant. They were very conspicuous, with a medium velocity (40 km/s). They lighted up slowly to end abruptly, sometimes with a short final flare.

The observers from Lattrop observed these meteors independently. On the night of July 29-30, we still saw meteors from the suspected radiant, but the activity seemed to be halved.

We also tried to see something of the Perseid maximum on August 11-12, in case an outburst would occur around 21^h UT. Around that time, normal rates were noted under moderate conditions (Moon and some clouds). It turned out that the peak had occurred somewhat earlier. Striking in this respect was the observation of some bright Perseids just after the beginning of the observations (20^h25^m UT).

We can conclude that this action was a success according to Dutch standards. Reports with raw data and magnitude distributions have been forwarded to the *IMO* and will appear in the *WGN Report Series*.

The 1992 Aurigids in California

Robert Lunsford

An overview is given of Aurigid observations in California on the mornings of August 31 and September 1, 1992.

George Zay and I were able to obtain observations of the Aurigid stream on the mornings of August 31 and September 1. August 31 was overcast at our normal site near Descanso, so we traveled eastward until skies cleared near the town of Jacumba which is situated on high desert terrain near the Imperial county line. We set up beside the road and were able to watch for 1.5 hours before the wind and cold forced us home. The sky was very dark and transparent with the limiting magnitude exceeding 7.0 for the first hour. Although conditions were favorable, the Aurigids were very weak with only three being seen the entire hour and one half. As we drove home we saw a bright train from a meteor neither of us witnessed. We stopped and could follow the train for nearly five minutes before clouds covered it.

The next morning was much more hospitable and we were able to observe from our normal location much closer to home. The sky was again dark and transparent with a limiting magnitude near 7.0 all night. The Aurigids were much more active with both of us combining to see 15 shower members during $8^{\text{h}}26$ of effective observing time. In total, 18 Aurigids and 120 sporadics were seen during $11^{\text{h}}06^{\text{m}}$ of effective observing time, at an average limiting magnitude of +6.93. A magnitude distribution of the Aurigids is given below.

Table 1 – Magnitude distribution of the 1992 Aurigids seen in California.

Magnitude	−4−	−3	−2	−1	0	+1	+2	+3	+4	+5	+6	Tot	$\overline{m}$
Number					2	2	6	4	2	2		18	2.44

October 1992 Hourly Radio Counts from Georgia

William H. Black

An overview of the author's monitoring of the radio activity in October 1992 is presented. The activity of the Draconids and the Orionids is discussed.

Radio monitoring was started at $12^{\text{h}}00^{\text{m}}$ UT on October 5. Heavy atmospheric noise from thunderstorm activity in the Southeast United States forced shutting down the system after $16^{\text{h}}00^{\text{m}}$ UT.

The station was started again at $4^{\text{h}}00^{\text{m}}$ UT on October 6, and except for a minor outage on the 8th due to a power failure, data were collected continuously through most of the 16th. The run was discontinued from $14^{\text{h}}00^{\text{m}}$ UT on the 16th until $20^{\text{h}}00^{\text{m}}$ UT on the 18th. Monitoring resumed at $21^{\text{h}}00^{\text{m}}$ UT on the 18th and continued through $11^{\text{h}}00^{\text{m}}$ UT on the 25th.

Previous years of monitoring the Draconids have indicated a very sharp peak near October 8, usually around 17^{h} to 20^{h} UT. This leap year, the 8th was very quiet. Some counts occurred at $8^{\text{h}}00^{\text{m}}$–$9^{\text{h}}00^{\text{m}}$ UT on the 7th and there was an apparent peak at 8^{h} UT on the 10th.

The Orionids, "scheduled" for the 21st, apparently peaked early, with moderately high radio counts per hour between $5^{\text{h}}00^{\text{m}}$ and $13^{\text{h}}00^{\text{m}}$ UT on the 19th. The rest of the monitoring period through the 25th was very inactive.

I look forward to comparing my results with other observers, both radio and visual.

Table 1 – Meteor counts for October 1992, 67.250 MHz, Lilburn, Georgia, USA

Day	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
05													12	13	23	98	42							
06					0	1	3	1	0	2	3	3	2	1	0	3	4	7	4	3	7	2	4	3
07	4	4	8	8	6	9	9	12	50	59	17	3	48	13	1	1	0	1	1	0	0	1	2	1
08				2	0	0	1	3	3	0	2	0	2	4	6	7	4	4	8	6	2	0	6	1
09	1	1	4	4	1	2	2	7	7	8	5	7	10	3	8	12	21	4	9	4	5	3	3	4
10	7	3	15	10	12	14	7	57	73	17	15	7	4	11	14	7	29	3	15	5	2	0	0	0
11	3	7	21	18	26	3	1	8	7	10	13	10	7	3	29	25	8	13	9	5	9	3	8	4
12	6	5	10	5	10	18	16	17	8	15	21	16	4	50	10	9	14	8	0	4	2	5	3	4
13	8	3	7	9	4	7	12	14	18	9	8	6	3	16	4	2	6	4	3	2	4	2	5	0
14	6	0	1	6	5	9	14	4	1	0	3	2	0	1	3	3	5	13	7	2	3	4	6	2
15	2	1	1	1	1	1	3	7	4	3	1	4	4	3	3	7	4	0	1	7	2	4	1	1
16	1	3	6	5	3	4	1	4	4	5	3	5	4	4										
17																								
18																						9	5	4
19	4	6	38	33	19	31	60	84	82	55	47	72	36	9	11	26	13	9	5	11	17	1	5	4
20	1	5	11	7	6	10	13	11	12	9	14	17	11	8	12	8	11	3	4	4	1	2	2	3
21	8	8	6	4	7	15	13	8	1	4	2	5	3	7	10	6	3	2	5	3	3	4	4	0
22	2	3	5	6	3	15	16	12	16	16	16	19	11	7	3	2	5	2	0	2	1	4	39	2
23	3	2	1	0	4	2	0	6	3	4	2	2	4	1	10	0	5	1	2	2	1	4	3	2
24	0	0	3	1	0	2	4	4	0	1	6	1	1	2	2	2	1	3	4	0	2	2	0	1
25	3	4	3	2	2	4	0	3	2	0	3	3												

Meteor Observations in New Zealand: 1991 and 1992

Graham W. Wolf

Meteor observations made in New Zealand from December 1991 to November 1992 are summarized. The author remains the only New Zealand member of the *IMO*, and is currently encouraging other New Zealanders to observe for the *IMO*, using its methods.

1. Introduction

New Zealand is a small three-island nation of less than 3.5 million people, located across the Tasman Sea just 2000 km east of Australia, in the South Pacific. Our weather and temperatures are mild and not unlike that of England or Germany. In 1992, weather conditions in my capital city of Wellington have been amongst the worst in living memory, with few days available for meteor viewing. From April 24 to November 2 (inclusive), 1992, only 40 dates have not been clouded out, or rainy. This has meant that many maxima dates of meteor showers have been missed.

The *Royal Astronomical Society of New Zealand (RASNZ)* had a Meteor Section from 1975 to 1984, but it disbanded before the return of Comet P/Halley and the *IHW*. It therefore made sense when the *IMO* was formed, to join this global organization, and start to do meteors properly at last.

Observations by me for the *IMO*, here in New Zealand started in December 1991 with the Geminid shower, which is not prominent at my southern latitude of 41°19′. The radiant itself could be seen in the early morning hours, but several of the Geminids were below my local horizon. Thanks to the excellent *IMO* pamphlets published by Alastair McBeath, I have been able to follow other southern showers that I would not have otherwise known about, in addition to the η-Aquarid and Orionid showers that I regularly observe since 1984, for *IHW* Meteor Recorder Mike Morrow in Hawaii.

Most of the southern shower work was first pioneered in the 1920s in New Zealand, and afterward, by my late countryman Ronald McIntosh (FRAS) of Auckland, who was a close working colleague of Charles Olivier in the USA. It is disappointing to see that the only major contribution to global meteoritics by New Zealanders in recent years, has been professionally in the field of radio meteors by professors Colin Keay, Bill Elleyett and Jack Baggaley. New Zealand amateurs should also be making an effort, and this is what I am trying to achieve. I regularly write a meteor column in the *Canterbury Astronomical Society (CAS)* magazine *CASMAG*, in which also appears *IMO* news of interest to New Zealand astronomers.

Up to November 1992, which this report covers, light pollution in the center of Wellington city has been an ongoing problem, with a zenith limiting magnitude of typically 3.5, and 4.0 to 4.5 in the outlying parks. A dark sky site is located at Pauatahanui near the Kapiti coast some 40 km away, but this is seldom able to be used, except for some *Wellington Astronomical Society (WAS)* Star Parties. However, most of these in 1992 have been rained out!

In 1992 to November 2 inclusive, I have spent 110 hours observing, and seen 526 meteors, including sporadics. The worst data came from the Orionids. Nearly all of October was torrentially rained out, with surface flooding taking place in some part of the Wellington province! Orionids were looked out for, on October 25 and 28, November 1 and 2, with no Orionids being seen at all in seven hours of observing... a very disappointing result. Better observing conditions are hoped for in 1993, and with the ongoing encouragement of Jürgen Rendtel and Alastair McBeath, I hope to further contribute with my small nation to the *IMO* global meteoritics scene.

Meteor Observing Associations in Rumania

Valentin Grigore

During the last four decades, it was not possible to set up some free associations in Rumania for purposes such as meteor observing, or more generally, for amateur astronomy. Such things became possible since 1990, but the start is hard due to a lack of experience and materials. This accounts for the fact that at present we have only one *IMO* member, Valentin Grigore from Tirgoviste City. He performs visual observations.

A serious group of meteor observers has come up in the *Universzum Association* of the City Odorheiu Secuiesc; this group also does visual observations and is acquainted with Mr. Istvan Tepliczky from Hungary. In 1992, two new meteor observing groups were formed, but they are still in the first stages of getting organized; both of them are located in Bucharest. The first group participates in the *Bucharest's Center Astroclub*, the association of amateur astronomers from Bucharest. The second is linked with a scholar amateur astronomers' society, *SAGE*.

The newborn *Rumanian Astronomical Foundation*, containing both professional and amateur astronomers, has the intention to stimulate meteor observing in all parts of the country; we know that there are good human resources for visual, telescopic, and also radio observations. The Foundation only has to find some material support for starting up these activities, and to find and distribute the appropriate documentation.

The Rumanian Astronomical Foundation was founded May 22, 1992, out of a need to coordinate astronomical activities in Rumania. Members can be professionals, amateurs, as well as other persons and associations that have similar interests. Its main goals are to facilitate the flow of scientific information, to provide a better link between professional and amateur astronomers, to facilitate the cooperation between its members and institutions that have similar scientific aims in Rumania or abroad, and to support research and education in astronomy.

The Rumanian Astronomical Foundation welcomes all contributions to its work. Donations and subsidies will be gratefully received to provide for funds to maintain and expand the activities. Contributions in the form of documentation, publications, scientific materials, educational items, as well as astronomical instruments or similar devices will aid enormously to get things started. Any kind of computers, printers, or copiers, even second-hand and obsolete, will be very useful.

The Rumanian Astronomical Foundation is very interested, especially now, in any information concerning the activity of similar organizations, groups, and associations around the world. It will be grateful to any such organization which will inform us about its activity or which can help us in any form.

Finally, the *SAGE Society* wants to realize an Astronomical Observatory at the international research level. We invite every interested person who wants to contribute to the realization of this goal to contact us, specifying his interest in research field. It is possible that this Observatory will participate in the *Fireball Observing European Network*. For more information, contact the author (address on inside back cover).

30th International Astrophysical Colloquium
Observations and Physical Properties of Small Solar System Bodies
Liège, Belgium, June 24–26, 1992

Peter Brown

This meeting was the first of three to be held in Europe during the summer of 1992 related to meteors, opened at 9^h a.m. on Wednesday, June 24 at the University of Liège. The conference concentrated mainly on asteroids and comets with only a few poster papers related to meteors. I will try and summarize some of the major results presented, in particular those related to meteors.

Some of the preliminary results of imaging from the Gaspra encounter were presented by M. Belton, including indications of grooves or linear surface features over part of the asteroid. This was one of the major highlights of the conference as the new high resolution photographs had only been released a few days earlier, and for many this was their first detailed look at a main-belt asteroid.

Much of the conference was concerned with Near-Earth Objects or NEOs and both space missions to NEOs and various current efforts to observe NEOs were presented in a number of papers.

The emphasis on NEOs was highlighted in D. Morrison's presentation of a proposal for the International Spaceguard Survey to catalogue as many NEOs as possible. He highlighted the effects of large bodies impacting the atmosphere and paid much attention to the effects various-sized objects would have on the Earth. The Spaceguard Survey concluded that the largest objects (in excess of 1–2 km diameter) were the most dangerous. Morrison also presented results of simulations which suggest that the Tunguska body was a rather strong object, unlikely to be a friable cometary mass. The Spaceguard Survey report was prepared for the Congress of the USA and may result in the funding of a global search network for NEOs.

Another interesting finding was that of M. A'Hearn and P. Feldman who presented evidence that the largest asteroid, Ceres, emits small quantities of OH near perihelion. This could indicate the presence of a polar cap, or perhaps that Ceres is comet-like to some degree.

Amongst poster papers was Z. Ceplecha's detailed look at the distribution of solar system bodies over 36 orders of magnitude in mass. By linking the recent results from discoveries of asteroids in the 10–100 m range with population indices for meteoric and dust sized particles, he was able to construct a flux estimate for the entire Earth, which worked out to 1.7×10^8 kg of accumulated mass per year. The most significant contributions are from the largest bodies.

Despite the overriding themes of comets and asteroids, many informal discussions involving meteors took place amongst the participants, and all agreed that this was an excellent lead-up to the two major meteor related conferences of the summer to be held in Czechoslovakia a week later.

International Astronomical Symposium
Meteoroids and Their Parent Bodies
Smolenice, Slovakia, ČSFR, July 6–12, 1992

Peter Brown

Following on the heels of the *IMC*, the *IAS* professional conference featured one of the largest gatherings of meteor astronomers in history and provided an interesting insight into the activities of professional researchers involved in studies of asteroids, comets and meteors. In all, over 100 participants delivered lectures and posters over a period of 5 days.

The conference was an appropriate follow-up to the *IAU* meeting held in Czechoslovakia in 1967 which several of the members present in Smolenice had attended. Many significant solar system astronomers from all around the world were present, and it is noteworthy that this conference was dedicated to Dr. Lubor Kresák of the Slovak Academy of Sciences on the occasion of his 65th birthday; Kresák has been one of the most prodigious workers in this field over the past five decades.

In addition to the large number of professionals present, a substantial number of amateur meteor astronomers stayed on after the *IMC* to attend the *IAS*. Among them were a large delegation from Japan comprised of amateur workers from the *NMS* and *TMN*.

The number and variety of lectures devoted to meteors was impressive. It is only possible to summarize a small fraction of the works presented, but the proceedings are to be available sometime in 1993 for those wishing more detail.

The sessions began in the morning on Monday, July 6, with a review of the basic mechanics behind meteor stream development presented by I. Williams. He showed some numerical integrations of meteor streams and demonstrated how asteroidal collisions might generate streams. In the same session, Y. Obrubov presented work on the orbital evolution of P/Halley and predicted that, if the comet was sufficiently old, there may actually be four showers related to the comet, two of which are the Orionids and η-Aquarids. He gave theoretical radiants for the two additional showers.

On Tuesday morning, attention turned again to meteors as R. Hawkes presented an extensive review of the field of television meteor observations. The review examined the various equipment alternatives employed by television observers and touched on the digital processing techniques used to study the resulting images. Typical modern video systems can record meteors as faint as +9, and capture tens of meteors per hour during showers. The reductional methods used to get height and orbital information were portrayed, and it was mentioned that height accuracies of 0.2 km and velocity errors of 3% were typical values. The small number of TV orbits currently published (less than 1000) suggests the minute sample of this population of meteoroids which has been studied, and hints at the value of this mode of meteor observations. Results of light curve analysis of several dozen meteors were presented in a separate paper, and lead to the conclusions that there was little evidence for flares supporting the concept that the meteors consisted of dustball clusters which completely fragment before grain ablation.

T. Jopek presented results of his analysis of over 500 TV meteor orbits in which detailed stream searches were made. Using the D-criterion he found some 30 streams amongst the sample.

On Tuesday afternoon, Z. Ceplecha presented a review of the interaction of meteoroids with the atmosphere. He stressed that previous determinations of meteoroid bulk densities have not accounted for fragmentation and he presented a model for gross-fragmentation in which the meteor is modeled to fragment at one or more points during its flight. The residuals between the observed and calculated trajectories are then used to best determine the point at which fragmentation may have occurred. The model suggests that the current values for meteoroid density are too low.

In the same session, C. Keay presented work on electrophonic sounds from fireballs. He suggests that the transduction of electrical energy to acoustic energy takes place by natural objects in the vicinity of the observer and that this is the means for sound generation. A reporting system for simultaneous sounds recorded from fireballs was suggested and the need for more research into the mechanism causing electrical energy to be generated within the fireball plasma was emphasized.

Later, D. ReVelle proceeded with the focus on meteoroid interactions with the atmosphere by presenting a detailed model of the entry of meteoroids. He solved the problem exactly, using iterative techniques, and investigated the number of possible types of interaction.

On Wednesday morning, G. Elford presented a comprehensive review of the field of radar meteor observations. The theory behind meteor echoes was given and the various modes of observation discussed. The difficulty in interpretation of radio observations was highlighted by noting the varying qualities between underdense and overdense echoes, the height ceiling effect, the polarization of the radio wave in relation to the trail orientation, and the effects of electromagnetic fields on the diffusion of ions in the trail.

D. Steel introduced the radar facility AMOR in operation in New Zealand which has now recorded over 200 000 orbits. The design and narrow-beam technique for observations was given and the advantages of the facility over past radars highlighted. Later in the morning, Steel presented evidence from the AMOR facility that a few percent of the meteors recorded by that radar had hyperbolic orbits. Among these meteors there are some with extremely high velocities, on the order of hundreds of km/s. He showed that down to the radar's limiting detection size of some 100 μm there is convincing evidence from the radar records of truly hyperbolic meteors.

On Thursday morning, B.A. Lindblad presented results of a search through the *IAU* Meteor Data Center for members of the Leonid stream. He derived the motion of the radiant and found that the orbit of the stream was identical to that of P/Tempel-Tuttle from the roughly 30 true members of the stream found in the photographic data archive.

Later, L. Kresák presented a very interesting review on meteor storms. He determined from historical records that on average five storms with visual rates exceeding one meteor per second are visible each century. He found that from the data on past storms the largest storms are visible when the Earth passes close to the node of the comet's orbit. A review of the dynamics of formation of meteor storms was given and some predictions for future storms, such as the Leonids later this decade, were made.

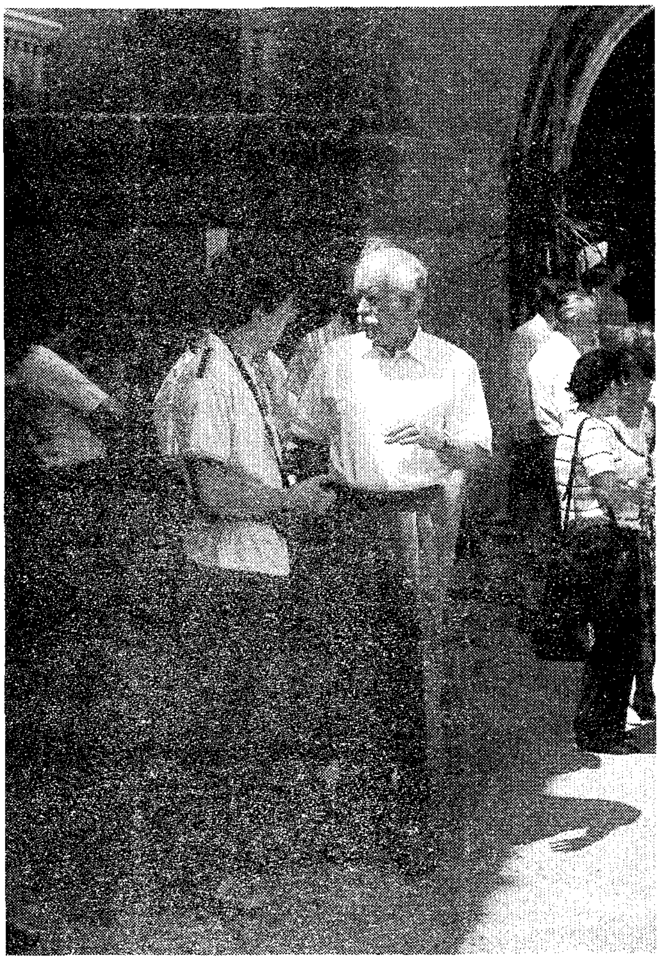

Figure 1 – *IMO* Honorary Member Dr. Bertil Lindblad *(right)*, discussing with Paul Roggemans *(left)*.

In the same session, Y. Yabu presented extensive details of amateur observations made in Japan during the 1991 Perseid outburst. Visual, photographic, and FM radio observations were summarized, with the conclusion being that the outburst lasted for about 2 hours centered around $\lambda_\odot = 138^\circ\!.85$ (1950.0) with the proportion of large particles increasing towards the peak.

In the afternoon on Thursday, a spirited debate on the origin of the Corvid meteors took place. Taking the position that the Corvids were ejecta from the impact of a body observed on the Moon in 1178 was J. Hartung. He estimated that the period of the stream was an integer factor of the difference between the impact date and the single observed return of the Corvids observed by Hoffmeister in 1937. A. Harris's talk followed the presentation, and he showed that on the basis of the mechanics involved a huge number of non-integer periods are possible for the stream. Also, he argued that to remain in a dense clump for almost eight centuries, the ejecta from such an impact would have to have a relative dispersion of the order of meters per second, while the ejecta must necessarily have an overall velocity greater than 2 km/s to escape from the Moon. He suggested that this was an improbable set of circumstances and that the Corvids were not related to the Canterbury event of 1178.

J. Stohl later contributed a review paper on meteor streams with possible asteroidal origin. Although the Geminids and 3200 Phaethon have been well-established as a related complex, many smaller streams appear to be correlated with several Apollo asteroids as well. A list of possible asteroid-meteor stream relations was presented.

W. Napier continued the asteroid-meteoroid focus by presenting currently understood details of the Taurid meteor complex. He found that the Taurid stream is likely linked not only to P/Encke, but to a handful of near-Earth asteroids, and that an association with the β-Taurids in late June is also likely. The lifetime of this group is on the order of 20 000 years. D. Steel followed with another presentation on the Taurids and showed through orbital factors that there are several asteroids related to the Taurid complex and that this may imply the break-up of a large comet in the recent past.

On the final day of paper presentations, Friday, J. Borovicka presented the results of an analysis of a bright fireball spectrum obtained at the Ondřejov observatory. He was able to model the thermal behavior of the fireball and determine the abundances for 8 elements along a 20 km length of the fireball trajectory. He suggested that the highly excited states of several elements resulted from the fireball shock wave and that material is ablated in the liquid phase.

During the Friday afternoon session, I. Hasegawa presented a detailed review paper on the available historical information on meteor showers. Most major showers, particularly the Perseids and Leonids, are prominent in the ancient chronicles from both Europe and Asia, and several minor and lost streams were rediscovered based on new historical information.

To close the event, D. Hughes presented a complete review of our present knowledge of meteoroids, making the bold suggestion that asteroids and comets are distinct and that no "dead-comet" asteroids exist.

During the week, many informal activities gave opportunities for casual contact amongst conference participants. An open-air dinner on Thursday evening became the venue for various groups to entertain those present with national hymns and popular regional songs. A fire-jumping contest, good food and healthy doses of locally-made wine enabled participants to extend this event into the early morning hours.

After the *IAS* many attendees went across Slovakia to visit the laboratory and the Skalnate Pleso observatory of the Slovak Academy of Sciences, near Tatranska Lomnica in the High Tatra Mountains. The observatory has a long history of meteor observations, particularly telescopic, but is presently used for solar observations and astrometry.

The hospitality from our Slovak hosts and the high degree of organization of the conference made the Symposium an event few will forget. We can only hope another conference will follow the tradition of *IAU* Symposium 33 in 1967 and the *IAS* in 1992 to bring meteor workers together again in the future in beautiful Slovakia.

Asteroids, Comets, Meteors 1993

Villa Carlotta, Belgirate (Novara), Italy, June 14–18

communicated by Peter Brown

This conference will be the fifth of the *ACM* series, started in Uppsala, Sweden, in 1983. All aspects of studies of asteroids, comets, meteors, and their interrelations, including orbital dynamics, laboratory studies, and space missions, will be included.

The format will feature two kinds of sessions: Morning plenary sessions will be devoted to invited reviews outlining the present status of the various fields of research and major unresolved problems, followed by a selected number of contributed papers of very broad interest; afternoon parallel sessions will be devoted to small workshops highlighting areas of particular and recent activity. During the workshops, both contributed papers of specific interest and round-table discussions will be scheduled. Poster presentations will be strongly encouraged. Authors of abstracts will be invited to submit manuscripts for a proceedings volume and possibly to a special issue of an international journal (to be determined).

The planned meeting site is the Hotel Villa Carlotta, situated in the small town of Belgirate on the western coast of the beautiful Lago Maggiore, the largest lake of the Italian region of Piemonte. Belgirate is relatively close to the international airports of Milano Malpensa (30 minutes) and Milano Linate (1 hour) and is connected with the cities of Milan and Turin by the Sempione railroad directed towards Switzerland and Germany. Information about board and lodging will be given in a second announcement.

The meeting will be organized by the Astronomical Observatory of Turin and Pisa, Italian Astronomical Society, CNR, Regione Piemonte, Provincia di Novara, and the Alenia Company.

About a week after the main meeting, a specialized workshop devoted to "Catastrophic Disruptions of Small Solar System Bodies," following the previous ones held in Pisa, Belgrade and Kyoto, will be organized in Gubbio (Umbria, central Italy). This workshop is intended to be restricted to about 50 people. If you are interested in attending, please contact Paolo Paolicchi, Dipartimento di Fisica, Universita di Pisa, Piazza Torricelli 2, I-56126 Pisa, Italy; the e-mail address is `stargas@icnucevm.bitnet`.

Scientific Organizing Committee: V. Zappala (Chairman), E. Bowell, A. Brahic, A. Carusi, Z. Ceplecha, M. Coradini, D. Davis, P. Farinella, M. Festou, Cl. Froeschle, A. Harris, J. Henrard, Y. Kozai, C.I. Lagerkvist, A.C. Levasseur-Regourd, B. Lindblad, D. Lupishko, B. Marsden, A. Milani, J. Rahe, H. Rickman, E. Shoemaker, A. Sokolsky, G. Valsecchi, I.P. Williams, and P. Weissman.

Local Organizing Committee: M. Di Martino (Chairman), C. Blanco, C. Casacci, A. Cellino, G. De Sanctis, P. Jones, and A. Manara.

A second circular is expected during the late spring of 1993. To receive this and subsequent mailings, write to: *Pam Jones, Program Services Department, Lunar and Planetary Institute, 3600 Bay Area Blvd., Houston, TX 77058-1113, USA.*

The International Meteor Organization

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