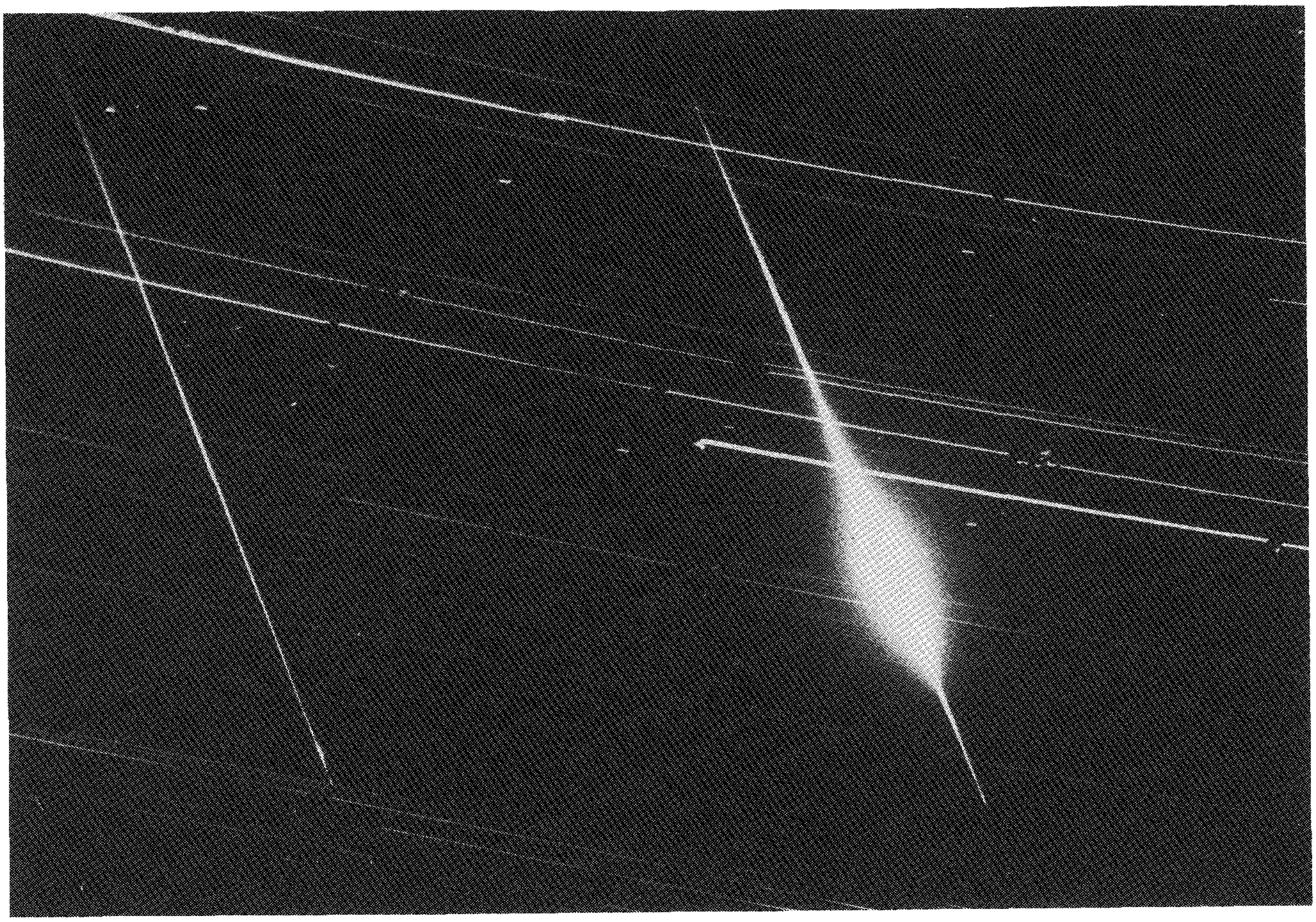
bimonthly

wgn

16 – 3
june 1988

the international circular for meteor observers



This photograph from the Crimean Meteor Station archives showing a fireball and another meteor, was taken in 1953 with a KSENON lens 1.2 f = 100 mm.

In case of non-delivery,return postage guaranteed. Please return to:
V.u. Paul Roggemans , Pijnboomstraat 25 , B-2800 Mechelen , Belgium.

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Contents

Useful Information

The July Issue *(WGN 16:4)*

This issue will appear in Belgium in the first week of August. Contributions for the *July issue* are due by *July 1* at the latest. They should be sent to *Marc Gyssens* (address on the inside of the back cover).

Subscriptions 1988

The subscription rate for volume 16 is 300 BEF. Persons living in Belgium pay 200 BEF. Subscribers from outside Europe can pay a supplement for airmail delivery: 100 BEF for North- and South-America (excluding Hawaii and other Pacific islands), 150 BEF for Japan and 200 BEF for Australia, New Zealand, Hawaii and other Pacific islands. Additional gifts are of course welcome.

Please make sure that we retain the full amount due after deduction of bank and/or exchange charges. It is recommended to pay by international postal money order to Ann Schroyens (address on the inside of the back cover). Other "safe" ways of payment are suggested in *WGN 16:1* on p. 2.

Administrative Correspondence

All payments should be addressed to Ann Schroyens. Complaints about not receiving *WGN* or changes of address should be sent to Paul Roggemans. Their addresses can be found on the inside of the back cover.

From the Editor

Marc Gyssens

First of all, we would like to thank all the contributors that sent us an article. Contributions are coming in really smoothly now and we hope this trend will continue. At the same time however, we must apologize to several authors and thank them for their patience. In order to make WGN more enjoyable to read, we try to group together related contributions. On the other hand, we wish to give priority to the latest news. As a consequence of this editorial policy, some articles get published right away, while others have to wait for several issues. We are however trying to do something about this. To shorten the queue of waiting articles considerably, we decided to make a special issue of August's WGN, with several additional pages of interesting meteor news. Meanwhile, we encourage everybody to write something for our - your - journal.

When you receive this issue of WGN, the summer holidays are coming closer. We hope the weather in your area will be fair and that many clear nights will be of use to you for meteor observations. Do not forget to take some time to write a report about your summer observations and send it to us! To those of you that are still going to school or university and have to pass examinations before they can think of meteor observations, much luck!

The main article in this issue of WGN comes from Ralf Koschack of the "Arbeitskreis Meteore" in the German Democratic Republic. He and his colleagues made a study about the determination of perception probabilities. He discusses a very original method, using double-count with shifted fields of sight. We also focus on two multiple-station meteors that were photographed from at least three different sights; the former from Kristiansand, Stavanger and Skien in Southern Norway, and the latter from Daisawa, Mikado and Ashigara in Japan.

The main news however comes - again - from IMO, the International Meteor Organization. Indeed, from March 25 till March 27, we enjoyed a most successfull International Meteor Weekend in Oldenzaal, the Netherlands. (By the way, information about how to order the proceedings of this International Meteor Weekend can be found on the back cover.) Many countries were represented: the BENELUX, Sweden, Norway, the FRG, the GDR, Hungary, France, Italy, Czechoslovakia,... maybe we even forget some! At the IMW, we had a discussion about the necessity and desirability of IMO. Although some people had strong reservations, most meteor workers were even stronger in favor. The same can be said for the persons that replied by letter on the proposals that were presented in previous issues of WGN.

Therefore, we decided not to wait any longer. We consider the International Meteor Organization to be founded on May 1. Its main activity will of course be the publishing of WGN, which will be sent in the future to each member of IMO. However, we will also offer the possibility to subscribe to WGN without becoming a member of IMO. People that are not feeling ready to participate in this initiative now, are always welcome to join in later, when they do. More information on the present state of affairs of IMO can be found elsewhere in this issues.

Of course, founding an organization requires founding members! Therefore, we included a form in the previous issue to invite subscribers to WGN to become a founding member of IMO. Several meteor workers replied positively to this request or confirmed they would sent in their form. As to now, the founding members of IMO are:

Christian Steyaert (B), Evelyne Blomme (F), Jeroen Van Wassenhove (B), Pekka Parviainen (SF), Trond Erik Hillestad (N), Ghislain Plesier (B), Robert Lunsford (USA), Axel Haas (D), Manfred Schank (D), Glenn Ticket (B), Jürgen Rendtel (DDR), Richard J. Taibi (USA), A.K. Terentjeva (SU), Paul Roggemans (B), Dieter Heinlein (D), Jeff Wood (AUS), Ann Schroyens (B), Marc Gyssens (B), Roberto Gorelli (I), Peter Brown (CAN), José Trigo Campoy Rodriguez (E), Lieven Smits (B).

This is only a preliminary list; so, please send in your form right now! During all of 1988, requests to become a founding member will be honored!

IMO: It is a Fact!

Paul Roggemans

Intensive correspondence about the subject of an International Meteor Organization (IMO) revealed that we should go on with it. Maybe, for some people, IMO came unexpected and probably too soon; we are confident, however, that time will work in its favor. Indeed, a rather inconstructive discussion at the International Meteor Weekend in the Netherlands clearly showed that although some people are not yet ready for this concept, a vast majority is very much aware of the need for such an international body. Questions as to who will do the work and who will be responsible, were raised. In this contribution, we summarize the current state of affairs as far as administration and membership are concerned.

Most of the people expressed their concern that the foundation of IMO might come down to the creation of yet another organization, bringing about a supplementary burden of administrative work upon persons being already very busy with the work they have now. Therefore, these people suggested to continue working around *WGN* and to develop the existing loose cooperation. Since this is indeed the easiest and also the safest way to start, we shall follow their advice. In order to overcome the danger of a too cumbersome administration, we need an intermediate period of time to establish a more organized official administative team. Meanwhile, we develop the present "loose" cooperation, which does not bring about more work than what we are already used to handle.

As Hans Georg Schmidt (FRG) put it on March 26: *We already have an international cooperation to some extent; the child should get a name.* A psychological milestone has been set by a number of people who are strongly in favor of the foundation of IMO. As it is a free right to establish an organization, they fixed May 1, 1988 as date of birth of the International Meteor Organization. Several persons have agreed to become a founding member of IMO; these founding members will decide about further developments. Their names can be found elsewhere in this issue.

An activity which may be very important to IMO, are the International Meteor Weekends. During the discussion in Oldenzaal, the Netherlands, Axel Haas (FRG) supported the author's concern about the continuity of these weekends. IMO will promote the IMW's and we hope to be ready to have the first General Assembly when we meet in Hungary, in the fall of 1989. Meanwhile, all important decisions will be made by the founding members via letter.

1. *WGN* as an IMO publication

As requested by several correspondents, we shall *not* waste time and effort in establishing another journal, but continue to build on *WGN*. At this stage, we should look at the history of *WGN*. *WGN*, derived from the original *Werkgroepnieuws*, started as a journal in December 1980. Before 1980, a non-periodic newsletter was sent from time to time to Belgian meteor workers only. The publication of this newsletter was discontinued in 1980. In December of that year, however, the author decided to publish *Werkgroepnieuws* as a Dutch language FEMA journal, because he felt its need to improve contacts among meteor workers in the Benelux. *WGN* had a multiple function in having information circulate among meteor workers world wide. As a part of this multiple function, *WGN* served as a circular for the VVS (Belgium) and the OSM (the Netherlands) for several years. A consequence of this approach was that part of the articles were published in Dutch whereas the others appeared in English. Since 1980 however, *WGN* gradually got a growing number of foreign subscribers; at the same time the number of contributions in Dutch declined. Around the time of the International Meteor Weekend in Hingene, Belgium (September 1986), it became clear that *WGN* had to grow into a real international journal. During the year that followed, it was felt ever stronger that the Dutch language section in *WGN* severely hampered the achievement of this objective.

Therefore, it was agreed upon by all parties involved, to continue *WGN* from December 1987 onwards as an independent international journal - without ties to the VVS or any other existing organization - around which IMO could be built. The principles that are now used by the staff of *WGN* are very straightforward:

1. Each subscriber has equal right to publish in *WGN*, provided his contribution is valuable;
2. Each person, wherever he or she lives, can subscribe to *WGN*;
3. The subscription rate should be equal to the production costs; in particular, the members of the *WGN*-team are not entitled to any form of financial compensation for their work, since this work is done on a voluntary basis.
4. No organization or society but IMO has the right to interfere with the publication of *WGN*.

2. Membership of IMO

A number of people have expressed their wish to join an organization such as IMO. Since 1988 is the year in which IMO is founded, one might ask: *who is founding IMO?* Long travel distances prevent all persons involved to decide or to discuss in a meeting. To unite people that wish to be involved in the establishment of IMO, a *founding membership* has been created. The founding members consist of 1988 *WGN* subscribers who wish to be an IMO member and complete the IMO registration form and send it to Paul Roggemans (address on inside of back cover). No membership fee is required for 1988. If you paid your subscription to *WGN* for 1988, it is possible to obtain a registration form to become a founding member. These founding members will decide on all propals concerning IMO.

From 1989 onwards, the founding members will renew their membership automatically with their subscription to *WGN*: IMO members will receive this journal as part of their membership. However, readers who do not wish to join IMO will be offered a separate subscription to *WGN* as well. From 1989 onwards, founding membership will no longer be granted. Candidate members will obtain the status of "associate member" until the next General Assembly meets and changes it into "voting member", on proposal of the Council. Associate members will enjoy the same benefits as voting members, except the right to vote and to hold office. This precaution has been built in to protect the reliability of IMO, especially towards the professional meteor community. Indeed, IMO wants to be a serious organization for people who enjoy meteor astronomy as a serious activity. Too often, colorful stories about meteors that made no sense at all were produced by persons, who, by doing so, severely damaged the reputation and credibility of amateur meteor workers in general. The above procedure guarantees that the reputation of IMO will not be destroyed by such persons. However, it is to be expected that the transition from associate member to voting member will be almost always automatic. As said, we hope to have the first General Assembly at the International Meteor Weekend in Hungary, in the fall of 1989.

3. The administration of IMO in 1988 and 1989

Who will do the administrative work? As it has been decided to start from the existing international cooperation around *WGN*, the staff of *WGN* will take care of the paperwork, the correspondence, the publications and the financial management, until Council and Executive Committee members have been elected at the first General Assembly which is to be held in the fall of 1989. Meanwhile, we need a temporary staff. Although the staff of *WGN* volunteered to do this job, we welcome other persons to help us in some way. The tasks of the "founding" Executive Committee are:

- synthesizing all propals and comments;
- proposing new ideas and suggestions;
- proposing candidates for the Council of IMO;

- proposing candidates for the Executive Committee;
- proposing statutes and bye laws;
- preparing a first General Assembly of IMO.

The temporary administration is very grateful for any comments and/or ideas that may help IMO. We wish to take into account all suggestions, viewpoints and ideas expressed by meteor workers worldwide. Our desire is to create IMO and make progress, not to postpone or cancel future activities.

4. More comments on IMO

In this issue we want to mention two more reactions. The first is from Gotfred Møbjerg Kristensen, a most active radio meteor observer in Denmark. He wrote us:

Concerning the International Meteor Organization (IMO), I think it is a good idea. When I read about the plans in WGN, I agreed with the intentions in the article.

Gotfred Møbjerg Kristensen
March 12, 1988

The other reaction comes from Dr. A.K. Terentjeva. We are very honored to welcome her as a candidate for the IMO Council. It is most important for amateurs to receive guidelines from professional astronomers. Below, we publish an open letter that Dr. Terentjeva wrote about this subject. More professional astronomers showed their interest in IMO; we hope to publish their comments in future issues of *WGN*.

In the field of meteor investigations, amateurs have achieved a lot, but much is still to be done. In this direction, IMO can be welcomed. AAVSO is a good example to follow, though it is not an international organization. Work can be organized well if there is an intitiative team of amateurs, but the guidance should come from professional astronomers to avoid "wandering in the darkness" and waste of time.

Visual observations are the most available type of observations in amateur astronomy. And at present, in spite of the rapid development of space technique, the visual method of meteor investigations is still far from being exhausted from the scientific point of view. Modern instrumental methods do not exclude it, on the contrary, all of them are mutually complementary. As is known, the so-called meteor visual observation "programme-maximum", developed and used in the fifties in the UUSR (Ashkhabad) by Prof. I.S. Astapovich, used all the capabilities of the observer's trained eye and thereby in a number of cases left far behind the possibilities of instrumental observations, though being inferior to them in some cases. It is only necessary to know for sure the reliance of results obtained by one or another method and the limits of their applicability. Regretfully, it should be noted that the interest to visual observations has noticably decreased everywhere in recent years. There are practically no professional astronomers engaged in visual observations. Thus, all hopes here are on amateurs whould strive, having studied the rich heritage of the past, to master the art of meteor visual observations and solve new problems of today.

I think that one of the top-priority tasks of amateurs in the field of meteor astronomy where they could make an invaluable contribution to science is the "Minor Meteor Showers Service". This is a large, complex and many-sided programme that should be planned for a number of years. Basically it consists of two parts:

1. *Investigations of time activity and visibility period of the known minor showers and discovery of new ones to elucidate the questions of meteor shower evolution, which is of a cosmogonical importance.*

   Most of minor streams are connected with Jupiter group comets and are often subjected to significant perturbations caused by Jupiter. There-

fore minor streams, being a considerable and rather important part of the meteor complex, are evolving at a comparatively high rate. And it is necessary to know the condition of meteor systems at least every half-century. According to our studies, the "half-life" of minor meteor streams amounts to about 70 years (Terentjeva A.K., "Minor meteor streams", Issled. Meteorov - Rezultatedy Issled. MGP, No 1, 1966, pp. 62-132).

2. *Determination of spatial density of minor meteor streams. Major meteor streams of which about ten are known (Perseids, Geminids, Orionids, etc.) are studied rather well in terms of activity. And it is time to change from ZHR to the determination of spatial density of meteor particles in streams. Here, special observations are necessary to be carried out by the "multiple skilled count" method. Such observations were carried out in the USSR as early as 1950-1960's. Regretfully, at present, work in this direction is carried out almost nowhere. This task is important for major streams and the more so for minor streams which are totally unstudied. Thus, if IMO has an observation camp in the south of France, this will be an excellent base to solve such a problem as the "Minor Meteor Showers Service". The correct procedure and methods of these observations should be discussed separately, as well as some other aspects of this programme. I hope that minor showers will find their enthusiasts!*

A.K. Terentjeva
Astronomical Council
USSR Academy of Sciences

Short Notes

Bright Radio Meteor over Belgium

Dirk Artoos

Has someone seen a bright meteor in the night of April 21-22 at $23^h05^m30^s$ UT? That night, I was observing meteors by radio in eastern direction (Az. = 275°) at a frequency of 66.90 MHz (Krakow, Poland). At the time mentioned above, I observed a very long reflection (1^m45^s) without any disturbance. It may have been caused by a -9 to -11 magnitude meteor, maybe a Lyrid fireball. Unfortunately it was cloudy where I observed (Belgium). Perhaps someone else saw or heard this meteor in Belgium or one of the surrounding countries. In that case, I would appreciate it if you could send me a full report of your observation, including the geographical coordinates of your observing site, at the following address: *Nattenhofstraat 74, B-2800 Mechelen, Belgium*

For Sale

Dirk Artoos

1) Radio Sony ICF 7600 D (FM 76-108 MHz, LW, MW, SW 153-29995 kHz). Digital receiver, only a few months old. Price: 9000 BEF.
2) Canon A-1 (body) camera + 50 mm f/1.8 (Canon) + 28 mm f/2.8 (Canon) + 70-210 mm f/4.0 (Canon) + 58 mm f/3.5 (Vivitar) + motordrive MA (Canon) + Vivitar 200 mm 285 flash + filters + leather bag + Velbon tripod.

Interested persons should contact: *Dirk Artoos, Nattenhofstraat 74, B-2800 Mechelen, Belgium.*

Observer's Notes: July–August 1988

Paul Roggemans

1. Introduction

The Southern Hemisphere gets the δ- and ι-Aquarid activity during long winter nights; the observers on the Northern Hemisphere, however, will get a Perseid year without any disturbing moonlight. We should mention to the European observers that 1980 had a comparable Perseid return.

Table --- Moonlight and observing conditions in July and August 1988

Date	k	Date	k
Friday July 1	0.98-	Friday August 5	0.48-
Friday July 8	0.34-	Friday August 12	0.00-
Friday July 15	0.01+	Friday August 19	0.34+
Friday July 22	0.49+	Friday August 26	0.97+
Friday July 29	1.00+	Friday September 2	0.62-

New Moon:	July 13, August 12, September 11
First Quarter:	July 22, August 20, September 19
Full Moon:	July 29, August 27, September 25
Last Quarter:	July 6, August 4, September 3

The illuminated part of the moon is always given for 0^h UT on the date indicated.

2. The δ-Aquarids

This major shower is well known for its fine rates observable from more southern latitudes during the shower maximum on July 29 (solar longitude of 125°). Unfortunately, the 1988 shower maximum will be spoiled by Full Moon. Hence,no high δ - Aquarid activity is to be expected for 1988.

Not all hope is lost, however. The δ-Aquarid shower is peculiar in the sense that is split into two distinct branches. The main activity is produced by the southern branch. Its activity has been confirmed for the period July 21-August 18. Activity is suspected one week before and after these limits. At the time of maximum activity, the radiant is located at α = 339° and δ = -17°. It moves eastwards in right ascencion and northwards in declination; its daily motion is $\Delta\alpha$ = +0°.8 and $\Delta\delta$ = +0°.18.

The northern δ-Aquarids are less pronounced. During a long time, people were even not sure whether this branch actually existed! Only around 1950, accurate observational data enabled astronomers to confirm the existence of the northern δ-Aquarids.

Radiant positions exist in numbers equal to the number of investigations. A very weak maximum coincides with the Perseid peak at a solar longitude of 139° (August 12) and should be observed in 1988. The radiant position would be at α = 339° and δ = -5°. The radiant drift is $\Delta\alpha$ = +1°.0 and $\Delta\delta$ = +0°.2. We warn for the uncertainty on this position: other authors gave for August 13, α = 344° and δ = +6° (G. Kronk), for August 14, α = 347° and δ = +1° (B.A. Lindblad), for August 20-23, α = 353° and δ = +6° (Nilsson), for August 15, α = 346° and δ = +5° (Sekanina) and for August 4, α = 341° and δ = -2° (Wood). There are indications that the activity period runs from July 16 to September 10.

3. The ι-Aquarids

This stream also consists of two separate branches. The southern ι-Aquarids, active from July 15 to August 25, show a flat maximum on August 5, at a solar longitude of 131°, from a radiant at $\alpha = 333°$ and $\delta = -15°$ (compare with G. Kronk's data: August 6, $\alpha = 337°$ and $\delta = -12°$) with a daily motion $\Delta\alpha = 1°07$ and $\Delta\delta = 0°18$. For the northern branch, a maximum activity might appear at a solar longitude of 147° (August 20) from $\alpha = 327°$ and $\delta = -6°$. Stream activity is guaranteed between August 11 and September 10. G. Kronk, however, mentions August 25 (at a solar longitude of 152°) as time of maximum with $\alpha = 350°$ and $\delta = 0°$.

All these radiants, active in Aquarius, may leave a rather confused impression upon observers. Indeed, it is very difficult to distinguish between the meteors of these radiants. This is possible for meteor trails in the immediate vicinity of the radiant, but at more distant areas in the sky, the observer will only be able to tell that the apparent velocity appears right for *an* Aquarid and that the path direction was right away from the Aquarius quartet. At northern latitudes it is hopeless to try to make separate counts and statistics for the different Aquarid radiant positions. Therefore, our observing project is aimed towards the following goals:

1. We advice all observers to prepare themselves in advance. By carefully locating radiant positions and path directions at the sky, you will be able to identify Aquarids correctly, even at large radiant distances. Everyone is invited to cover the overall Aquarid activity to monitor the hourly rate variation and the magnitude distribution.
2. Observers who are able to make accurate plottings of Aquarid trails as seen from southern latitudes, as well as photographs using standard cameras with sensitive 800 or 1600 ASA films, may contribute with precise positional data of meteor trails, helpful in solving the confusing radiant picture.
   - visual observations: send us date, location, time (UT), magnitude, α and δ for beginning and ending point;
   - photographers: send us a paper print, along with exposure time, date and time of appearance and brightness of the meteor. Astrometric results will be registered in the Photographic Meteor Data Base, which is now run be IMO.
3. The world's most experienced observers may attempt to follow the δ-Aquarids North and South and the ι-Aquarids North and South separately in order to follow the four radiants' characteristics in detail. Perfect sky conditions, a favorable elevation of the radiants and much self-criticism are a prerequisite. Most visual observers tend to believe too much in detailed pictures derived from visual radiant determinations. In many cases, the observer is misled by statistical radomness: he will always find a radiant position, a ZHR, etc. However, everybody should remain aware of the relevance of his or her data and question at each stage the reliability of the observational results before jumping to a conclusion.

4. The α-Capricornids

A radiant at $\alpha = 307°$ and $\delta = -10°$ produces a noticeable activity around July 30, characterized by slowly moving meteors. 1988 will see the α-Capricornid display disturbed by bright moonlight. Shower members have been recorded in the past from July 15 until August 25. This means that some α-Capricornids will be seen and hopefully photographed during the major Perseid observations!

5. The 1988 Perseid display

In 1980, European observers saw a very strong Perseid return with peak rates on August 12, between 1^h and 2^h UT, shortly after New Moon. In 1984, the same peak could again be observed around midnight from European skies; unfortunately, there was a bright Full Moon. Already in 1980, European observers talked about the next opportunity to verify the 1980 peak, in 1988. Now it is so far.

In 1988, the theoretical maximum is predicted for August 12 at 7^h UT. Maximum rates cover a period stretching over 6 hours at both sides of this time. At some occasions, a short peak has been observed, preceeding the main maximum by about 6 hours, such as the one witnessed in 1980. It is by no means certain that we shall see anything special, but careful observations are required!

On August 12, the radiant is located at $\alpha = 46^{\circ}.2$ and $\delta = 57^{\circ}.4$. You can calculate the radiant positions on other nights using the following radiant drift: $\Delta\alpha = +1^{\circ}.35$ and $\Delta\delta = +0^{\circ}.12$. Perseids are fast meteors (60 km/h) and about 30% produce trains. Keep the path direction in mind and think a little bit about the geometry. Perseids within 30° from the radiant or more than 150° away from it show short trails due to perspective. Also, at lower elevations, meteor trails always look shorter due to their larger distance to the observer. Short trails are easily missed and difficult to identify as shower members if not close to the radiant.

IMO calls for hourly rate counts and magnitude distributions from both meteor observing groups and individuals world wide. Make sure to:

- report all rates and magnitude distributions:
  - separately for each individual observer (no combined group counts);
  - per night and detail hourly rates per one hour interval;
  - use Universal Time (UT) wherever you are; also mention your geographical coordinates.
- mention for each one hour interval:
  - mean limiting magnitude; try to obtain an accuracy of about ± 0.1 magnitude;
  - cloud cover or obscured sky correction factor;
  - netto effective observing time in hours and decimals of hours;
  - number of meteors seen. At least, a distinction should be made between Perseids, Aquarids, α-Capricornids and other meteors (detailing further if possible);
- send your observing report to Paul Roggemans, Pijnboomstraat 25, B-2800 Mechelen, Belgium.

The Fallen Star

A star is gone! a star is gone!
There is a blank in Heaven,
One of the cherub choir has done
His airy course this even.

He sat upon the orb of fire
That hung for ages there,
And lent his music to the choir
That haunts the nightly air

But when his thousand years were pass'd,
With a cherubic sigh
He vanish'd with his car at last,
For even cherubs die.

Hear how his Angel-brothers mourn,
The ministrels of the spheres,
Each chiming sadly in his turn
And dropping splendid tears.

The planetary Sisters all
Join in the fatal song,
And weep this hapless brother's fall,
Who sang with them so long.

But deepest of the choral band
The Lunar Spirit sings,
And with a bass-according hand
Sweeps all her sullen strings

From the deep chambers of the dome
Where sleepless Uriel lies
His rude harmonic thunders come
Mingled with mighty sighs.

The thousand car-borne cherubim,
The wandering Eleven,
All join to chant the dirge of him
Who fell just now from Heaven.

George Darley (1795-1864)

On the Determination of the Probability of Perception for Visual Meteors

Ralf Koschack

A more accurate method is presented to determine perception probabilities for visual meteors, based on double-count analysis, using fields with shifted centers.

1. Introduction

One result of a visual meteor observation is the ZHR of a shower. The variation of this rate during the activity period allows conclusions about the variation of the spatial number density along the Earth's orbit, but not about the real number density.

An observer is only able to survey a restricted field of view. In this field, he will see only a fraction of the meteors. Thus it is necessary to determine the dimensions of the field of view and the probability of perception p therein.

First of all, p depends on the magnitude of the meteor and on its angular distance from the direction of view. The magnitude of a meteor is estimated in magnitude classes m with a width of one magnitude. Analogously, we use in this study distance classes R, each 5° wide, for the point of first sighting of the meteor's path. E.g. R = 10° includes the interval (7°5 , 12°5). The innermost class R = 5° includes all distances less than 7°5.

The perception of a meteor depends on the amount of light attaining the retina and its contrast to the sky background, not only the magnitude m. This limit of perception is characterized by the visual limiting magnitude lm. For the perception it is important to know the difference between m and lm. A meteor of magnitude +3 seen on a sky with lm = 5.0 should have the same probability of perception as a meteor of +4 seen on a sky with lm = 6.0. The difference:

$$\Delta m = lm - m \quad (1)$$

should be used as a measure for the meteor's brightness. The dimensions of the field of view of an observer (e.g. the maximal angular distance at which meteors can be seen) strongly depends on Δm, but there is no sharp boundary. The brighter a meteor is, the greater the field of view. A fireball of magnitude -6 (Δm = about 12) can be seen in every direction. The number of such meteors is relatively low. Thus it makes no sense to take these as a reference. It seems to be useful to take the meteors with Δm = 7 to 8 into account as upper magnitude limit. Outside their field of view, the number of meteors can be neglected. The calculation of the flux density is reduced to this field of view (which is assumed to be circular) using the true number of meteors. To calculate the true number of meteors, one has to determine p for the different (Δm,R) classes. The result is the probability of perception as a mean value over the field p_F for a meteor of Δm within a distance R from the direction of view.

2. The double-count method

A possibility to determine p is the double-count method described by Öpik. The observers use a recording method without interruptions and look at the same point. Meteors seen by both are marked. We have:

- p_1: probability of perception for observer 1;
- p_2: probability of perception for observer 2;
- n_1: number of meteors seen by observer 1;
- n_2: number of meteors seen by observer 2;
- n_0: number of meteors seen by both observers;
- ϕ : true number of meteors.

We have the following relationship between those parameters:

$$p_1 = \frac{n_1}{\phi} \text{ and } p_2 = \frac{n_2}{\phi} \tag{2}$$

$$n_0 = p_1 n_2 = p_2 n_1 \tag{3}$$

$$p_1 = \frac{n_0}{n_2} \text{ and } p_2 = \frac{n_0}{n_1} \tag{4}$$

Let us now examine the mathematical method more in detail. We only consider the derivation of p_1; for p_2, it is analogous. The whole procedure is based on (3). n_2 is assumed to be a representative sample of the total number of meteors ϕ. The number of meteors n_0 of the sample n_2 seen by observer 1 determines the probability of perception p, as given by (4).

Every observer, in particular observer 2, perceives especially meteors with favorable characteristics (such as a large Δm and a small R). Compared with ϕ, the sample n_2 includes a relatively high amount of such favorable meteors. Similarly, observer 1 prefers these meteors. Hence:

$$\frac{n_0}{n_2} \quad \frac{n_1}{\phi}$$

As a consequence, the derived probabilities of perception are too high. To exclude this effect, one has to include only meteors "of the same type". As described above, we use classes $(\Delta m, R)$. Up to R = 15°, this method works well. For higher values of R, the discussed effect acts again. For large R and therefore small values of p, some other characteristics (such as apparent angular velocity, length of trail, train, etc.) become increasingly important in the determination of the perception.

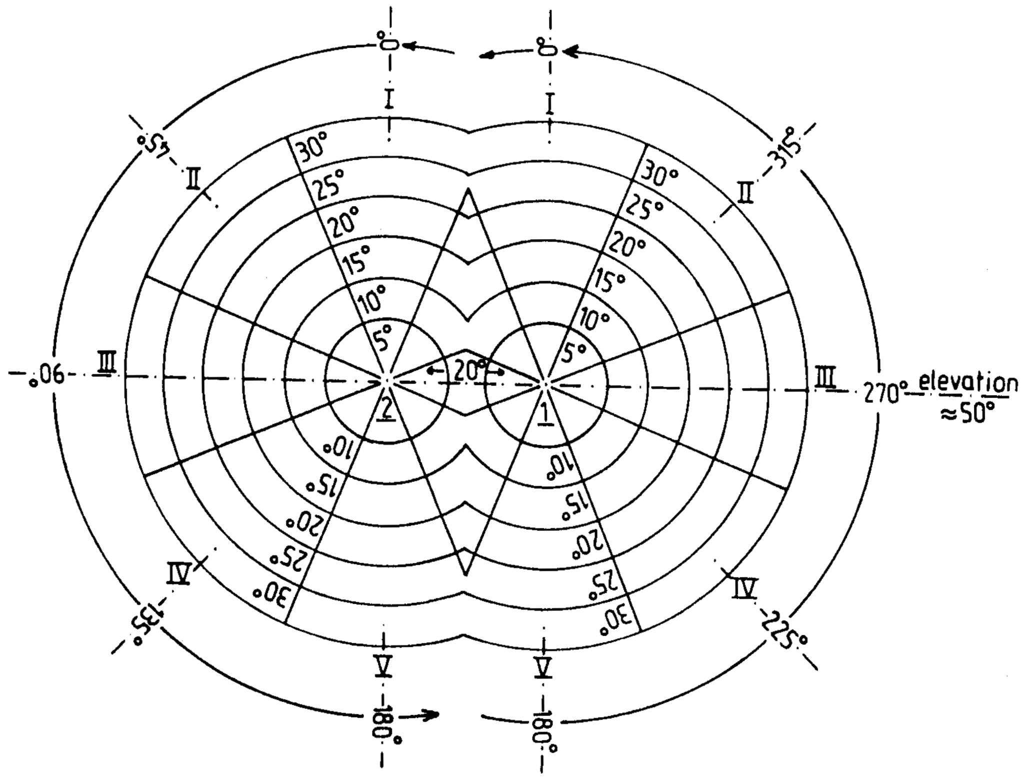


Figure 1 --- Double-count observation with shifted fields of view. The centers are shifted by 20°.

In n_2 we again have a great amount of such peculiar meteors. A stronger differentiation seems to be necessary. But because of the huge number of quantities affecting p, this is senseless. A stronger differentiation would lead to very small samples for every class.

The problem is solved in another way: both observers do not look at the same point in the sky, but fix on points at a certain angular distance. For the first example we used two points with 20° distance and the same altitude of about 50° to 60°.

In addition to m and R the observer noted the position angle of the beginning of the trail (to which the value R refers, too). These angles are estimated in steps of 45°. Now one can subdivide the field of view in sectors. For observer 2, these sectors are numbered anticlockwise: I_2:0°=(337°.5-22°.5),II_2:45°=(22°.5-67°.5), and so on. In the case of observer 1, the numbering is in clockwise direction: I_1:0°=(337°.5-22°.5), II_1:315°=(292°.5-337°.5), and so on. With these sectors and the R-classes, the entire field of view is divided into several limited areas (see Figure 1).

Meteors near the direction of sight of observer 2 (I_2-$VIII_2$;R_2=5) are situated in class R_1 = 20° for observer 1. Thus p_2 should be larger than p_1. One can assume that the described effect of selection is not present here. n_2 should be a representative sample of all meteors with a certain Δm appearing in this area. With the help of those meteors of the sample seen by observer 1, too, we can calculate p_1 for Δm and R_1 = 20° using (5):

$$p_1(\Delta m;R_1=20°) = \frac{n_0(\Delta m;I_2-VIII_2;R_2=5°)}{n_2(\Delta m;I_2-VIII_2;R_2=5°)} \qquad (5)$$

For classes with R_1 larger than 20°, one can combine the sectors II_2-IV_2 with suitable R_2; for instance:

$$p_1(\Delta m;R_1=40°) = \frac{n_0(\Delta m;II_2-IV_2;R_2=20°;R_2=25°)}{n_0(\Delta m;II_2-IV_2;R_2=20°;R_2=25°)} \qquad (5')$$

In these cases, p_2 is still significantly higher than p_1, reducing the selection effect for meteors in n_2. A distance of 20° for the points fixed by both observers, allows a calculation of p_1 up to values of 45° to 50° for R_2. (The opposite numbering of the sectors causes that the same sectors and distance-classes for one observer have the same angular distance to the line of sight of the other observer.

During July and August of 1985, 1986 and 1987, observations with identical fields and shifted fields were carried out by 5 experienced observers of the "Arbeitskreis Meteore im Kulturbund der DDR" (AKM). They all observed regularly during the entire year: J. Rendtel, I. Rendtel, R. Arlt, A. Knöfel and R. Koschack. During these double count observations, 1355 meteors were noted.

Due to the varying conditions (lm) for every night and observer, it is,strictly speaking, only possible to calculate $p(\Delta m,R)$ per night and per observer. The number of meteors in each class however, will then be too low. Hence we add up all the results of observations under identical sky conditions (lm). $p(\Delta m)$ is most sensitive for small Δm's. Therefore, we only combined observations with small variations in limiting magnitude. The calculated mean values are weighted with the number of meteors in the corresponding Δm-classes.

A comparison of several observers is not possible. But it is known from many other observations throughout the years (within groups), that their perception does not differ significantly. Thus the probabilities of perception derived should be valid for all these experienced observers.

Table 1 --- Summarized classes of Δm.

lm	m	mean Δm
7.12	+7	+0.12
6.35-6.50	+6	+0.42
6.60-6.68	+6	+0.64
7.12	+6	+1.12
6.35-6.68	+5	+1.58
7.12	+5	+2.12
6.35-6.68	+4	+2.56
6.60-7.12	+4	+2.79
7.12	+4	+3.45
6.35-6.68	+3	
7.12	+3	+4.43
6.36-6.68	+2	
7.12	+2/+3	+4.80
6.35-6.68	+1/+2	
7.12	0-+2	+5.74
6.35-6.68	-1-+1	

The result of these double count observations is a series of p-values for all Δm listed in Table 1 and for R = 5° to 50°. The values were graphically smoothed, first for every value of Δm over R (Figure 2, left), and, second, for every value of R over Δm (Figure 2, right).

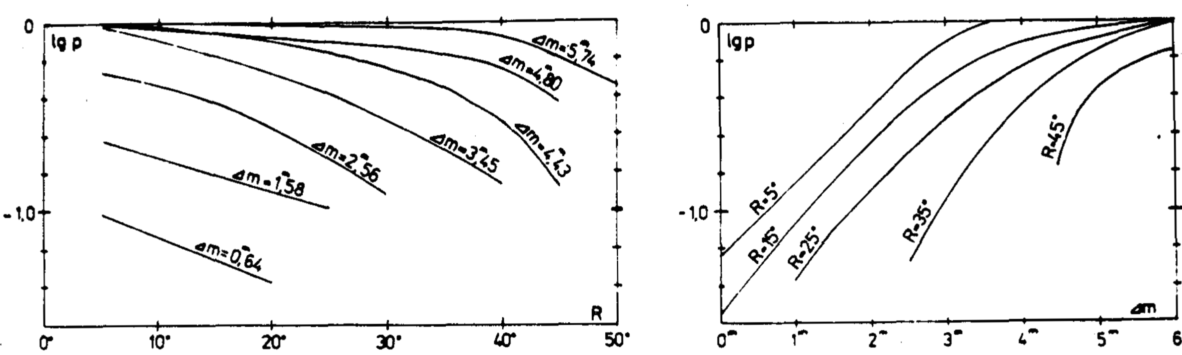


Figure 2 --- Probabilities of perception p determined by double)count observations and their dependence on R (left) and Δm (right) respectively.

Using the diagrams, it is possible to determine p for every (m,R). If Δm does not exceed +6, we get reliable values for p. A disadvantage of the method is the low number of meteors seen by both observers when p is low. In the case of low Δm-values, this is compensated for by the low number of meteors in this magnitude range. In the case of larger Δm and larger R, we reach the limits of the method. We can assume that probabilities p that are less than 0.02 are not available using the double-count method. But the area of the outer distance classes mainly near the limit contributes a noticeable portion of the total number of meteors. Thus a determination of p is necessary for these areas too.

3. Analysis of distance-distributions

The problem mentioned above can be solved by means of an analysis of the distribution of meteor distances to the direction of sight. Besides the double-count observations, some more observations of the same observers were included (which were not sufficient for regular double-count analysis). 1442 meteors with known angular distances to the line of sight, were available. They were put together as described in the previous paragraph (Table 2).

Table 2 --- Summarized classes of Δm, including some additional observations of the same observers.

lm	m	mean Δm
6.88-7.12	+7	+0.08
6.35-6.50	+6	+0.44
6.55-6.68	+6	+0.64
6.88-7.12	+6	+1.04
6.35-6.68	+5	+1.56
6.88-7.12	+5	+2.06
6.35-6.68	+4	+2.55
6.88-7.12	+4	+3.06
6.35-6.68	+3	+3.53
6.88-7.12	+3	+4.39
6.35-6.68	+2	
6.88-7.12	+2	+5.36
6.35-6.68	+1	
6.88-7.12	+1	+6.33
6.35-6.68	0	
6.35-7.12	0/-1	+7.02

The brightest meteors had a Δm = +7.5. Within the distance classes with R not over 50°, 99.8% of all meteors appeared. In the class R = 50° itself, 1.6% of all meteors were registered. The outside border of the class R = 50° is favorable as outer limit of the field of view; we defined the field of view for an observer to have a radius of 52°.5.

After this, we can add some p-values. The ratio of the number density of meteors for a class (Δm,R) to the meteor number density in the center of the field of view (R = 5°) should have a direct relation to the ratio of both perception probabilities:

$$\frac{n_{5^\circ}}{p_{5^\circ} \cdot A_{5^\circ}} = \frac{n_R}{p_R \cdot A_R} \quad (6)$$

with A_R the are of the ring at distance R. From (6) we calculated relative probabilities of perception $p'_R(\Delta m)$ for each class m. $p_{5^\circ}(\Delta m)$ was set to 1.

$$p'_R = \frac{n_R \cdot A_{5^\circ}}{p_{5^\circ} \cdot A_R} \quad (7)$$

We refer to Figure 3 for the calculation of the areas of the various distance classes.

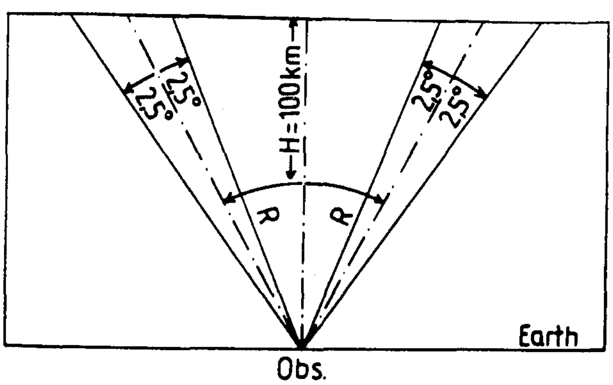


Figure 3 --- Calculation of the portion of the area of distance classes.

We have:

$$A_{5^\circ} = (\tan 7^\circ.5 \,.H)^2 \pi \quad (8)$$

and, in general:

$$A_R = (\tan(R+2^\circ.5).H)^2\pi - (\tan(R-2^\circ.5).H)^2\pi \quad (8')$$

For the calculation of p', we only have to know the ratio of the distance-class areas to the total field of view. These values are given in Table 3, on the next page.

Table 3 --- Contribution of the distance classes to the field of view.

R	A'_R	R	A'_R
5°	0.0102	30°	0.0794
10°	0.0187	35°	0.108
15°	0.0296	40°	0.148
20°	0.0425	45°	0.206
25°	0.0585	50°	0.259

The calculated values of p' were smoothed as for Figure 2; the results are given in Figure 4.

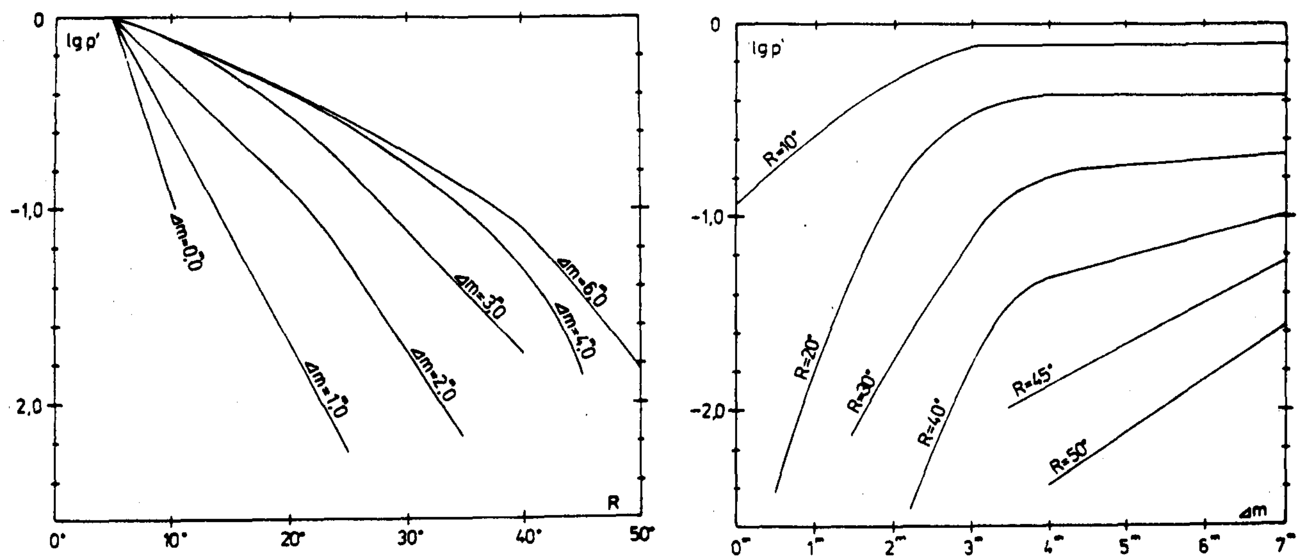


Figure 4 --- Relative probabilities of perception p, and their dependence on R (left) and Δm (right) respectively.

4. Supplement to the double-count values

According to (6), one would expect a parallel progress. In reality, $f(R) = \lg p'$ decreases much stronger than $f(R) = \lg p$ for all values of Δm. This is caused by the former: up to $R = 30°$ and from Δm-values of +3 to +4, the value of p' seems to be constant, even with increasing Δm (Figure 4, right). This holds, although the meteor still appears brighter with increasing Δm, implying that p reached its maximum value $p = 1$. For the same values, we find a decreasing p' (Figure 4, left). There may be a good reason for this behavior. A distance class R has geometrical, sharp boundaries. Because of the length of meteor trails, it is apparently enlarged, as it is also the case for telescopic meteor observations. This effect is stronger for smaller fields of view (inner distance classes) than for larger fields of view (outer distance classes). Thus it contributes to the decrease of the graph of $f(R) = \lg p'$.

In the case of small p-values, we are at the limit of the double count method. Therefore it is necessary to derive a value of p for these areas from a value of p'.

We have values p' for the whole extent of R. Now we have to find out the relation between p and p' to convert p' into p. We have to fit $f(R) = \lg p$ to $f(R) = \lg p'$ (see Figure 5, on the following page).

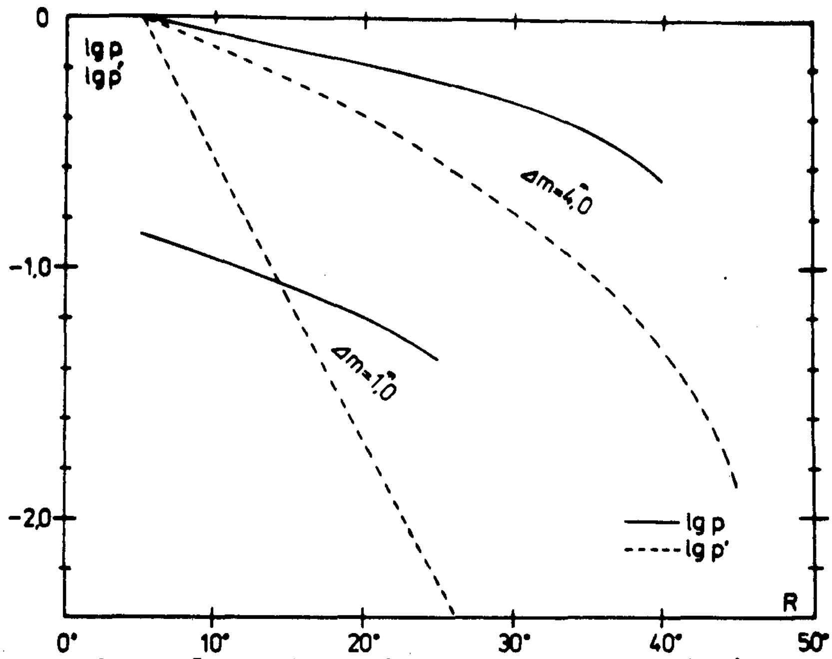


Figure 5 --- Comparison between the relationships between p and p' to R, for two different values of Δm. In all cases, the decrease of p' is steeper than the decrease of p.

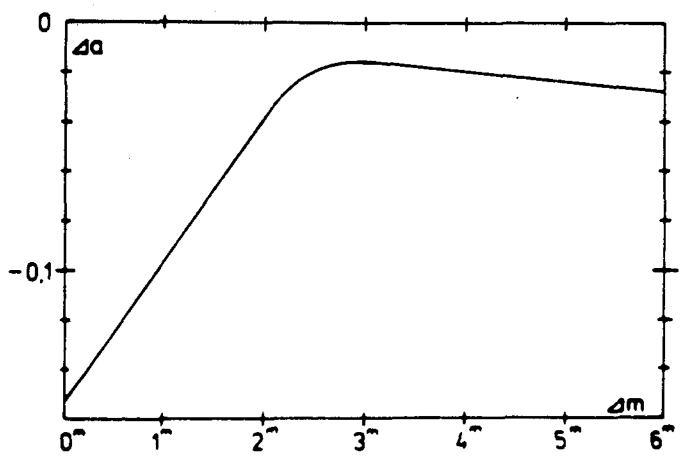


Figure 6 --- Differences of the ascent a of the functions $f(R) = \lg p$ and $f'(R) = \lg p'$ as a function of Δm.

Because of the slight curvature of both graphs it is necessary to take a linear regression for several intervals, with:

$$\lg p = a_p . R + b_p$$
$$\lg p' = a_{p'} . R + b_{p'} \qquad (9)$$

The following intervals for R were chosen: (5°,20°), (20°,35°) and (35°,50°). For every interval we calculated the difference of the ascent Δa, with:

$$\Delta a = a_{p'} - a_p \qquad (10)$$

The value Δa depends on Δm (see Figure 6), but obviously not on R. From (9) and (10), we derived the relationschip:

$$\lg p = \lg p - \Delta a . R + c \qquad (11)$$

in which c is some constant. We calculated a mean c from the two outermost values of p for the same Δm, using:

$$c = \lg p - \lg p' + \Delta a . R \qquad (12)$$

We then could calculate the probability of perception using equation (11).

4. Derivation of the true probabilities of perception

All values p were first smoothed for every Δm depending on R, and second, for every Δm depending on Δm (Figure 7, right). Finally, the second values were smoothed for every Δm depending on R (Figure 7, left).

Table 4 gives all calculated values of p in relationship to R and Δm.

Table 4 --- Probabilities of perception p of meteors in function of Δm. E.g.: lm = 6.70 and m = 4 gives Δm = 2.70 and p = 0.079.

	0	+1	+2	+3	+4	+5	+6	+7
.0	0.0013	0.011	0.038	0.10	0.25	0.49	0.72	0.87
.1	0.0017	0.012	0.042	0.11	0.27	0.51	0.74	
.2	0.0022	0.014	0.047	0.13	0.29	0.54	0.76	
.3	0.0029	0.016	0.052	0.14	0.31	0.56	0.78	
.4	0.0039	0.019	0.057	0.15	0.33	0.59	0.79	
.5	0.0050	0.022	0.064	0.16	0.35	0.62	0.81	
.6	0.0060	0.024	0.071	0.18	0.38	0.64	0.82	
.7	0.0070	0.027	0.079	0.19	0.40	0.66	0.83	
.8	0.0081	0.030	0.087	0.21	0.43	0.68	0.85	
.9	0.0091	0.034	0.095	0.23	0.46	0.71	0.86	

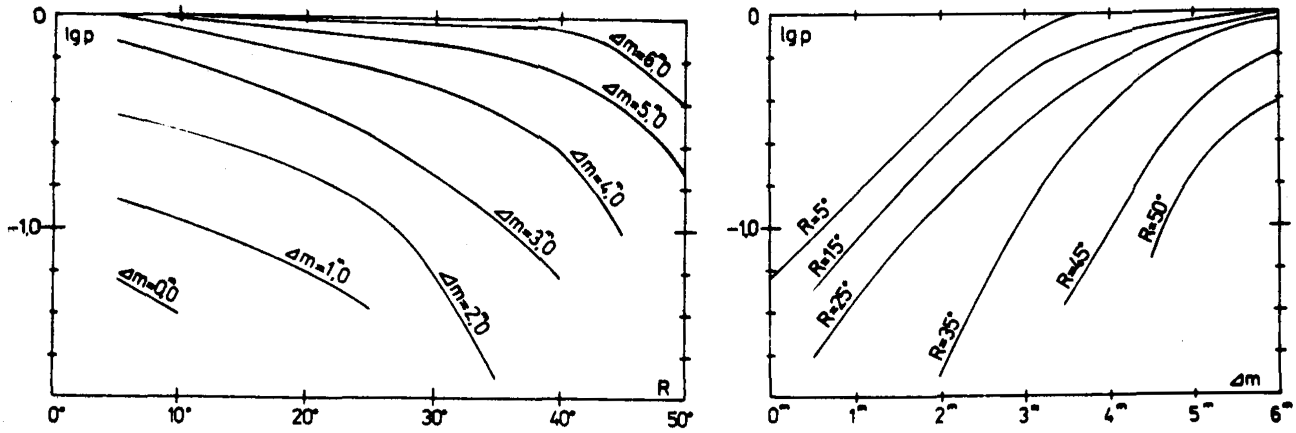


Figure 7 --- "True" probabilities of perception p and their dependence on R (left) and Δm (right) respectively.

The goal was the calculation of the probabilities of perception $p_F(\Delta m)$ for meteors depending on their magnitude as a mean value over the field of view (determined to have a radius of 52°5. We calculated $p_F(\Delta m)$ by averaging all values $p_R(\Delta m)$, weighted according to the areas of the corresponding distance classes R (see also Table 3), using:

$$p_F(\Delta m) = \Sigma\, p_R(\Delta m).A'_R \quad (13)$$

The calculated values were finally smoothed graphically (Figure 8), with a further extrapolation up to $\Delta m = +7$. The true number of meteors for a given Δm within a field of view with a radius of 52°5 is given by:

$$\phi(\Delta m) = \frac{n\ (\Delta m)}{p_F(\Delta m)} \quad (14)$$

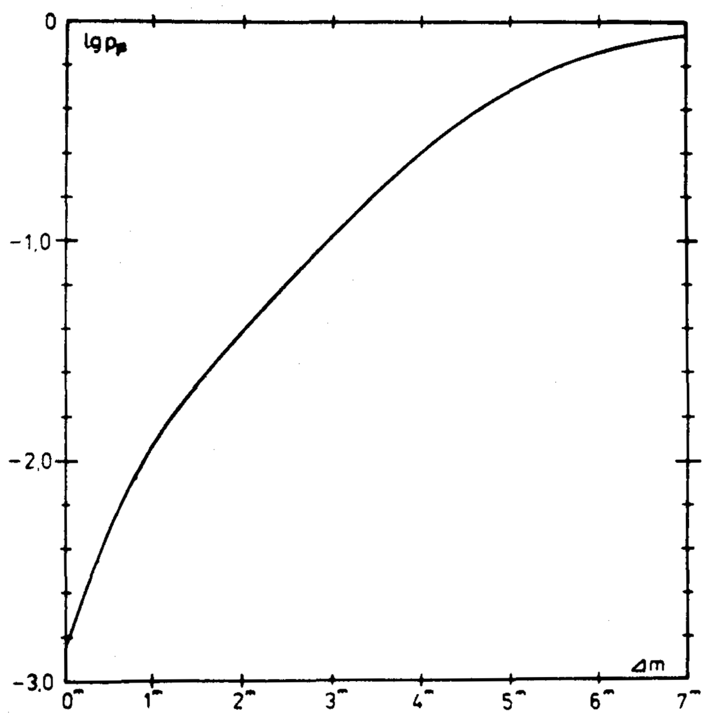


Figure 8 --- Probabilities of perception for the field of view with radius 52°5, as derived from the modified double-count observations.

More in particular, the calculated probabilities of perception are valid for a group of observers. The number of meteors was not large enough to derive similar values p_F for every individual observer. This would require about 30 hours of double-count observing under good circumstances and a high level of meteor activity. The observers of the "Arbeitskreis Meteore" intend to continue double-count observations in order to determine individual probabilities. Using the values p_F presented here, as well as our magnitude distributions, one can calculate further data, such as the population index, with better accuracy. Taking into account our determination of the field of view, we may derive true number densities of particles from zenithal hourly rates.

The author wishes to thank Jürgen Rendtel, for many valuable hints and for the translation of this article into English.

A Multiple-Station Perseid over Norway

Trond Erik Hillestad

On August 12, 1986, a -4 Perseid was seen by four observers near Kristiansand in southern Norway. The same meteor was also seen by two observers in Stavanger, and by two people near Skien. It was also photographed from all three sites. This article describes the simultaneous results that have been calculated about the meteor.

Figure 1 --- The multiple station Perseid of magnitude -4 that appeared on August 12, 1986 at $22^h12^m05^s$ UT, as photographed from Kristiansand (Norway) by T.V. Lian.

Table 1 --- Observers and observing methods.

Observer		Method
TF	T. Fredriksen + R. Gibala	Vis + Photo
TL	T. Løvik	Vis
JA	J. Åsland	Vis + Photo
TVL	T.V. Lian	Photo
KG	K. Gaarder	Vis
LTH	L.T. Heen	Vis
TEH	T.E. Hillestad	Vis
KS	K. Stokkeland	Vis

The VVS Meteor Section in Belgium assisted with the simultaneous calculations. I wish to thank Paul Roggemans who did the astrometric work, and Christian Steyaert who computed the trajectory of the meteor.

Table 2 --- Details of the photographic observations.

Photographer:	T.V. Lian	J. Åsland	T. Fredriksen
Site:	Kristiansand (N)	Stavanger (N)	Skien (N)
Geograph. pos.:	08°05'00" E 58°21'30" N	05°42'08" E 58°58'27" N	09°27'43" E 59°18'18" N
Date:	August 12, 1986	August 12, 1986	August 12, 1986
Time of meteor:	$22^h12^m05^s$	$22^h12^m05^s$	$22^h12^m05^s$
Period of exposure	$22^h11^m15^s$ till $22^h15^m55^s$	$22^h08^m18^s$ till $22^h12^m08^s$	$22^h10^m05^s$ till $22^h12^m10^s$
Visual magnitude:	ca. -4	-1	-4
Smoke train:	5-8 s	0.5 s	2 s
Shower:	Perseids	Perseids	Perseids
Camera:	Canon FTb	Nikon FE2	Cosina
Lens:	50 mm f/1.8	28 mm f/2.8	50 mm f/2.0
Film:	Kodak Tri-X	Kodak Tri-X	Kodak Tri-X
Development:	400 ISO	8 min in D-76 at 20 °C	12 min in D-76 at 20 °C
Begin path:	near β Lac	near 77/80 Peg and NGC 7743	near ζ Aql
End path:	near ρ Cyg	near ι Psc	

In Table 3, on the next page, the estimated exposure time is the difference in UT of end and begin of exposure, as given by the observer. The calculated exposure time is the difference in right ascencion, as measured on the star trails.

Table 3 --- Results of the astrometric calculations.

Photographer:	T.V. Lian	J. Åsland	T. Fredriksen
Estim. exp. time:	4 min 20 s	3 min 50 s	2 min 05 s
Calc. exp. time:	4 min 29 s ± 12 s	3 min 33 s ± 8 s	2 min 17 s ± 4 s
Begin meteor, α:	$22^h36^m41^s$	$23^h42^m08^s$	$19^h13^m22^s$
δ:	53°.44'46"	08°.31'03"	16°.22'20"
End meteor, α:	$21^h26^m19^s$	$23^h35^m55^s$	$19^h01^m18^s$
δ	44°02'37"	05°40'11"	21°26'19"
Begin meteor, A:	085°.872	115°.560	200°.558
h:	69°.007	24°.408	45°.782
End meteor, A:	130°.725	118°.487	203°.033
h:	71°.352	22°.597	39°.976
Calc. path length:	15°.0	3°.2	6°.1

The trajectory was computed using results from two observers at a time, as shown in Table 4, below. This yielded different values for beginning and ending point for the three combinations. As can be seen in Figure 2, the three sets of positions simply describe six different points of the trajectory.

Table 4 --- Results of the trajectory calculations.

Observer-comb.	TF-TVL	TF-JA	TVL-JA
Sub-meteor point, begin:	08°.79 E, 58°40 N	08°.66 E, 58°.33 N	08°.76 E, 58°.33 N
end:	08°.55 E, 58°.28 N	08°.53 E, 58°.26 N	08°.43 E, 58°.20 N
Distance from meteor to:	TF: ca. 155 km	TVL: ca. 100 km	JA: 210 km
Earth-point:	07°.43 E, 57°.68 N	07°.29 E, 57°.56 N	07°.31 E, 57°.55 N
Length of meteor:	40.2 km (from begin TF-TVL to end TVL-JA)		

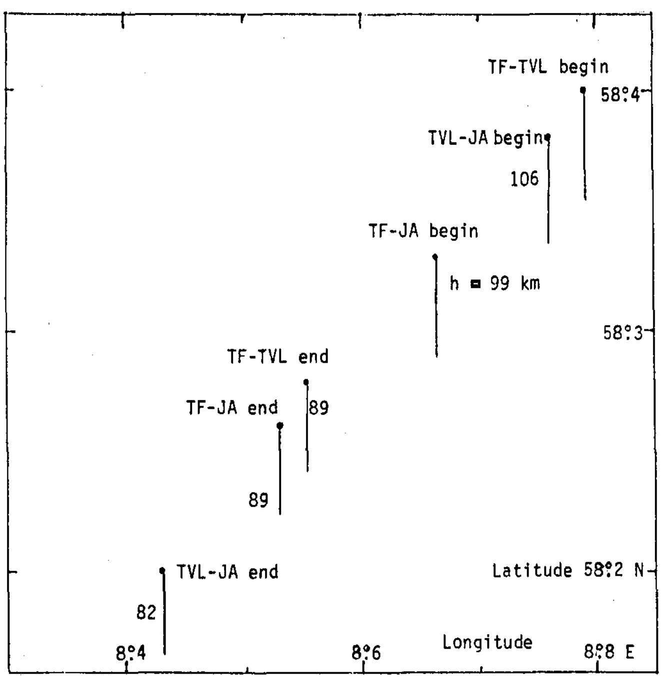


Figure 2 --- "Three-dimensional" view of the trajectory.

The sub-meteor point is a point on Earth from which the meteor appears to be in zenith. The meteor started some 108 km above Arendal, and vanished again about 82 km above Lillesand. It is likely that the meteor followed a relatively straight line through the atmosphere, and that its speed was close to constant (like for most other meteors, according to (1) and others). The Earth-point is the point on Earth where an imaginary lengthening of the trajectory would "hit" the surface. (In (2), some of these terms are explained.) Reference (3) gives begin = 114.1 km and end = 94.3 km as average heights for the Perseid shower. "Our" meteor appeared some 10 km lower than average. Maybe this is so, because it was a large (bright) one.

A radiant position of $\alpha = 47^\circ.3$ and $\delta = 57^\circ.1$ was found from the positions of TVL-JA, while the combination TF-JA gave $\alpha = 46^\circ.4$ and $\delta = 56^\circ.9$. TF-TVL resulted in $\alpha = 40^\circ.8$ and $\delta = 58^\circ.5$. The first two combinations match the radiant position given in (3) very well, but the last one deviates by about 4°.

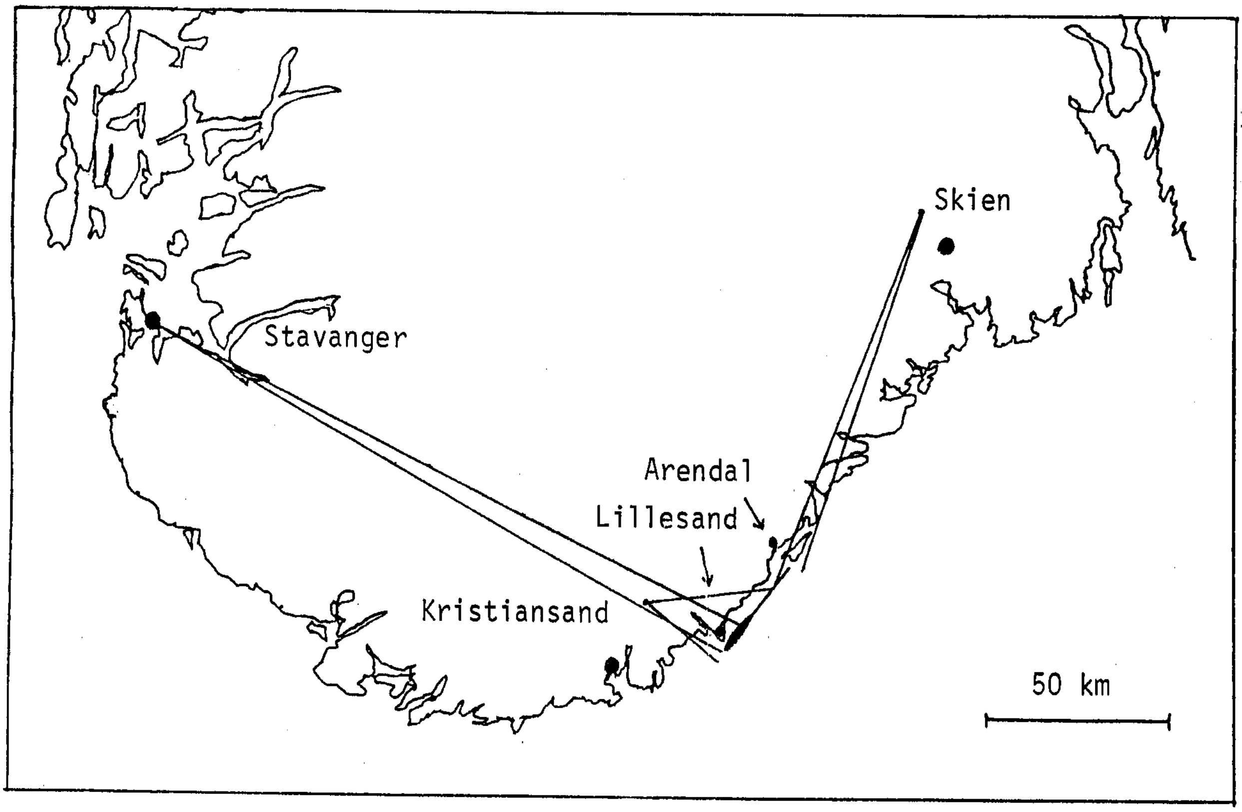


Figure 3 --- Observing sites and the meteor trajectory plotted on a map of Southern Norway. Directions are based on photographic observations.

In Table 5, below, we give the visual data on this meteor.

Table 5 --- Details of the visual estimates.

Observer:	TF	TL	JA	TVL	KG	LTH	TEH	KS
Site:	Skien	Stavanger		Kristiansand				
Longitude:	09°27'43" E	05°42'08" E		08°05'00" E				
Lattitude:	59°18'18" N	58°58'27" N		58°21'30" N				
Time (UT):	$22^h12^m00^s$	$22^h12^m05^s$	$22^h12^m05^s$		22^h12^m	22^h12^m	$22^h12^m05^s$	22^h12^m
Vis. magn:	-4	-1	-1		-3	-5	-3	-5
Abs. magn:	-5	-3.6	-3.6		-2.7	-4.7	-2.7	-4.7
Shower:	P	P	P		P	P	P	P
Color:	Y				W/Y	Y	Y	
Duration:	1.5 s						0.8 s	
Speed:					F		M	
Train:	2 s	0.5 s			5 s	6 s	8 s	1 s
Begin, α:	20^h50^m						23^h30^m	
δ:	+46°						+65°	
End, α:	19^h30^m						21^h40^m	
δ:	+05°						+50°	

We now discuss the various data in Table 5.

Time (UT): This column lists the estimates for the time when the meteor appeared. As can be seen, differences are quite large - up to almost 30 s. Some observers did not register seconds at all. However, this is not always necessary for visual observing. Seconds should always be included in photographic work, though. An accuracy of 4 s in time will cause an uncertainty of 1 ^{m} in right ascencion, which is highly inaccurate.

Visual magnitude: The visual estimates range from magnitudes -1 to -5. These values cannot be compared directly. The brightness of a meteor greatly depends on its altitude above the horizon (extinction) and the distance to the observer. We tell our observers to register the magnitude in the point in its path where the meteor is at its brightest. In this case, the meteor was the brightest at the end. There is a staggering similarity between the magnitude notings: those observers who observed physically next to each other (within a few meters) have exactly the same magnitude values. This could indicate that the observers actually discussed their estimates before registering them! Most observers used cassette recorders; this made it possible for each person to hear what the other was recording onto the tape. Experience tells us that estimating the brightness of a meteor is a far from easy task. This is especially true when bright fireballs occur, because there are few bright celestial objects around to compare them with. Some people get surprised and overexcited, and estimate too bright. Others may be too careful; they estimate too faint. Both errors are of course equally wrong!

Absolute magnitude: The absolute magnitude of a meteor is the brightness the meteor would get if we imagine that it could be placed in the observer's zenith at a height of 100 km. Most meteors occur much lower in the sky and also at greater distances. The apparent magnitude of such a meteor will be fainter than its absolute magnitude. (In addition, the magnitude also depends on the altitude of the radiant, see also (4).) In order to calculate the absolute magnitude of this meteor, the extinction effect of the atmosphere was taken into account. Another formula corrected for the distance of the meteor, relative to the absolute distance of 100 km. (See references (3) and (5) respectively.) Calculating the extinction is not easy. Here, a "sky quality constant" of 0.7 was used (a relatively clear atmosphere with some absorption). The resulting accuracy after correcting for extinction is more than 1 magnitude. (No corrections have been applied for the "radiant height effect".) The computed values, which should be more or less directly comparable, once again show the difficulty in estimating meteor magnitudes.

Shower: All observers agreed that it was a Perseid. The photographic results confirm this.

Color: Yellow, according to those who noted colors.

Duration: Trajectory calculations gave a meteor length of about 41 km. Keeping the geocentric velocity of the Perseid stream in mind, it is easy to calculate the duration: 0.68 s. Both visual estimates deviate quite a lot from this value. Could it be that observers are overwhelmed by bright meteors and that the sense of time halts for a while? There is however another explanation: it is very unlikely that the cameras managed to capture the entire meteor path. The visual path was probably much longer than what has been recorded on film. If we could correct for this, the photographic length would be longer, whence the photographic duration would also be longer and perhaps even comparable with the visual estimates.

Speed: Most people do not register meteor speeds at all. Speeds are noted either as F (fast), M (medium) or S (slow). We can "translate" this into geocentric velocities: 60 km/s = F, 40 km/s = M, 20 km/s = S. A meteor seen at a distance of 100 km will then have an angular velocity of 31, 22 or 11 °/s respectively. This is true when the meteor is seen from the "side". The angular velocity of meteors moving directly towards the observer will of course be much smaller. The angular velocity was then calculated for two observers, yielding 45°/1.5 s = 30 °/s for TF and 25°/0.8 s = 31 °/s for TEH. This is in perfect agreement with the Perseid angular velocity! Because of the above mentioned problem with the meteor's direction, this does not necessarily "prove" the shower velocity. However, the meteor was seen fairly well from the "side" from both observing sites. The ratio path-length/duration is also remarkably constant between the two observers.

Train: The Kristiansand observers more or less agreed on the duration of the smoke train. The estimate of 1 s seems much too short. From Skien and Stavanger, the smoke train was fainter (longer distance to the meteor). These observers should therefore have seen the train lasting shorter. Their results seem to confirm this.

Path: Estimating the path of a meteor is indeed very difficult. The visual results do not fit the photographic ones by far. However, none of the observers tried to plot meteors. All observers worked either visually counting meteors, or photographically. The meteor path was not registered on maps, but on cassette recorders; the observers themselves say the estimates are inaccurate. The reason why some took note of meteor paths, was to help the photographic workers in finding meteors on the film later on. Visual and photographic results on path estimates cannot be directly compared. The eye has a much fainter limiting magnitude than a camera (at least those cameras most amateurs can afford to use). The visual length of a meteor is most often longer than what can be measured on a photograph of the same meteor. Of course, the meteor should still be heading directly from the radiant, independent of the observing method. The visual results deviate from this, but, again, they were never intended to be very accurate.

References

(1) John A. Kennewell, "The Flight of a Meteor", *Sky and Telescope 1/87*, pp. 83-84, January 1987, and *Sky and Telescope 2/87*, p. 197, February 1987.

(2) Paul Roggemans/IAU, "Basic Definitions in Meteor Astronomy", *WGN 15:1*, pp. 18-19, February 1987.

(3) Paul Roggemans, ed., "Handboek Visuele Meteoorwaarnemingen - deel 1", 1982, p. 119 and p. 126.

(4) Paul Roggemans, "Perseids 1985 and the Zenith Distance Corection", *WGN 14:5*, pp. 149-152, October 1986.

(5) Tony Vanmunster, ed., "Handboek Simultane en Fotografische meteoorwaarnemingen", 1986, pp. 40-41.

Book Review

Paul Roggemans

Gary W. Kronk, "Meteor Showers".
Published by Enslow Publisher, Bloy Street and Ramsey Avenue, Box 777, Hillside, NJ 07205, USA, ISBN 0-89490-072-2, 1988, 320 pages.
Price: 22.50 USD or 22.50 GBP

It has been a very long time ago that the state of knowledge on meteor showers has been summarized, more precisely since 1953 when A.C.B. Lovell wrote his "Meteor Astronomy" including some chapters on the history and nature of meteor showers. Since then, major discoveries have been made and impressive progress has been made to understand the dynamics and evolution of the meteor complex. Thousands of research papers have been published over the past 35 years and at some occasions, amateurs wrote brief summaries on the history and dynamics of meteor showers. Many people were waiting for a book that covered the subject in detail. Gary W. Kronk took the challenge and collected all details he could get on meteor streams. In his preface, Mr. Kronk states that a first search yielded over 600 potential radiants, used for a final selection of the strongest and most consistent meteor showers. Finally, 112 radiants were distinguished to write down a complete review of all data available on its history and its orbital and physical characteristics.

After the preface and a note on abbreviations and symbols, a brief review of the history of meteor astronomy cover the highlights of meteor science. The meteor showers were grouped within chapters according to their first date of maximum activity. Appendices cover the scientific definitions, shower associations with cometary and asteroidal bodies, the "D-criterion" (often used in orbit associations), source abbreviations and a very useful name index.

For each major shower, we find the "observer's synopsis", a summary of all information the observer has to know. A most detailed account is given on the observational history. Such historical reviews are very difficult to compile, as only the most essential has to be derived from the often extensive original reports. Selection effects may bias this kind of work. Gary Kronk sticks very close to the original data, adding few personal notes. Authorities are referenced in footnotes. The number of pages dedicated to a stream is not proportional to its importance. E.g. the ι-Aquarids get 6 pages, whereas the much better studied Perseids are covered on 7; the November Leonids, on which an entire book could be spent, are described on 9 pages. Gary Kronk successfully balanced the accounts on the various meteor streams, without leaving out essential information.

While reading this book, I found no errors in the data mentioned, although I did not check everything, as there is so much in the book. The highly controversial υ-Pegasids are mentioned too, which might question the reliability of the book. The author chose however to describe the information as he found it, without any prejudice. Therefore, it requires some well developed knowledge of the reader to interprete the massive amount of data. Especially unexperienced meteor workers may get easily lost. The author used a mixture of professional research and amateur work, which will surely encourage the latter. Professional scientists however may be somewhat unhappy to see tentative and often questionable amateur results treated. E.g. visual radiant determinations and color observations are of little value. Numeric values are often quoted without error limits and with insignificant decimals. E.g. a ZHR of 2.02 ± 0.45 should be 2.0 ± 0.5, indicating only that activity was very low. Some facts were not verified, such as ZHR's for α-Leonids (p. 21), Capricornids-Sagittariids (p. 25) and α-Virginids, which are definitely incorrect. The story about a Perseid peak in 1983 is in clear contradiction with overall analyses indicating a normal return. Single observers' reports are often biased because of observational and statistical effects. Gary Kronk however wanted to review facts the way they were reported. Rather, some amateurs are to be blamed for their lack of respect for scientific reporting procedures.

Printed in 1988, the book is very up to date. Readers will find the strong Ursid display of 1986 mentioned; it is however remarkable that the 1985 outburst of the Draconids is not covered, as most reviews are up to date to 1986. Anyhow, it is the most complete book ever published on the subject. It should be on the bookshelf of each amateur or professional. It is written in educative style and contains a wealth of historical and observational data and will therefore become beyond any doubt an often used source of references. It invites amateurs to continue their efforts to acquire more knowledge on the meteoric complex. Mr. Kronk is to be congratulated for the vast amount of work that was put in writing this book. Meteor workers now have a fine and reliable synthesis on the current knowledge of meteor showers. The attractive price cannot constitute a problem, so I assume the book will find its way to meteor workers; it is strongly recommended!

A Triply-Photographed Meteor over Japan

Katsuhito Ohtsuka and Yoshihiko Shigeno

In this article, trajectory calculations and orbital elements are presented for a triply-photographed meteor over Japan, on July 28, 1985. It is concluded that this meteor was probably an early Perseid.

A meteor (TN 10) with a flare of magnitude -4 was photographed simultaneously from three stations of the Tokyo Meteor Network on July 28, 1985 at $17^h49^m14^s$ UT (which is July 29, $2^h49^m14^s$ JST), with equatorially driven 35 mm cameras (1). Because of the moonlight, a Kodak 2481 high speed infrared film was used, in combination with a Hoya R-60 filter. The positional and instrumental data are listed in Table 1, below.

Table 1 --- Positional and instrumental data.

Station	λ	φ	height	lens	rot. shut.
Daisawa	139°40'41"1 E	35°39'07"4 N	36 m	50 mm f/2.0	25 br./s
Mikado	140°22'09" E	35°16'46" N	40 m	50 mm f/1.8	20 br./s
Ashigara	139°10'47"3 E	35°19'49"5 N	208 m	24 mm f/1.4	-

Standard deviations from plate (film-) constants are in the order of 30". The results of the trajectory calculations are shown in Table 2.

Table 2 --- Results of trajectory calculations.

App. radiant pos.:	α = 25°11 ± 0°04	δ = 54°87 ± 0°05
Cor. radiant pos.:	α = 24°98 ± 0°04	δ = 55°17 ± 0°05
Beginning height:	106.9 km	
Ending height:	79.1 km	
sin Q:	0.915	
cos Z:	0.868	
Mean obs. velocity:	59.1 km/s	
Geocentric velocity:	58.0 km/s	
Helioctr. velocity:	41.3 km/s	

In Table 2, the radiant positions are referenced to the equinoctium of 1950.0. Q is the angle between the great circles defined by the meteor path as seen from Mikado and Ashigara. Z is the zenith distance of the apparent radiant point. In Table 3, the orbital elements are listed and compared to those of Comet 1862 III (P/Swift-Tuttle) (2) (all 1950.0), which is known as the parent body of the Perseids.

Table 3 --- Orbital elements, compared to those of 1862 III

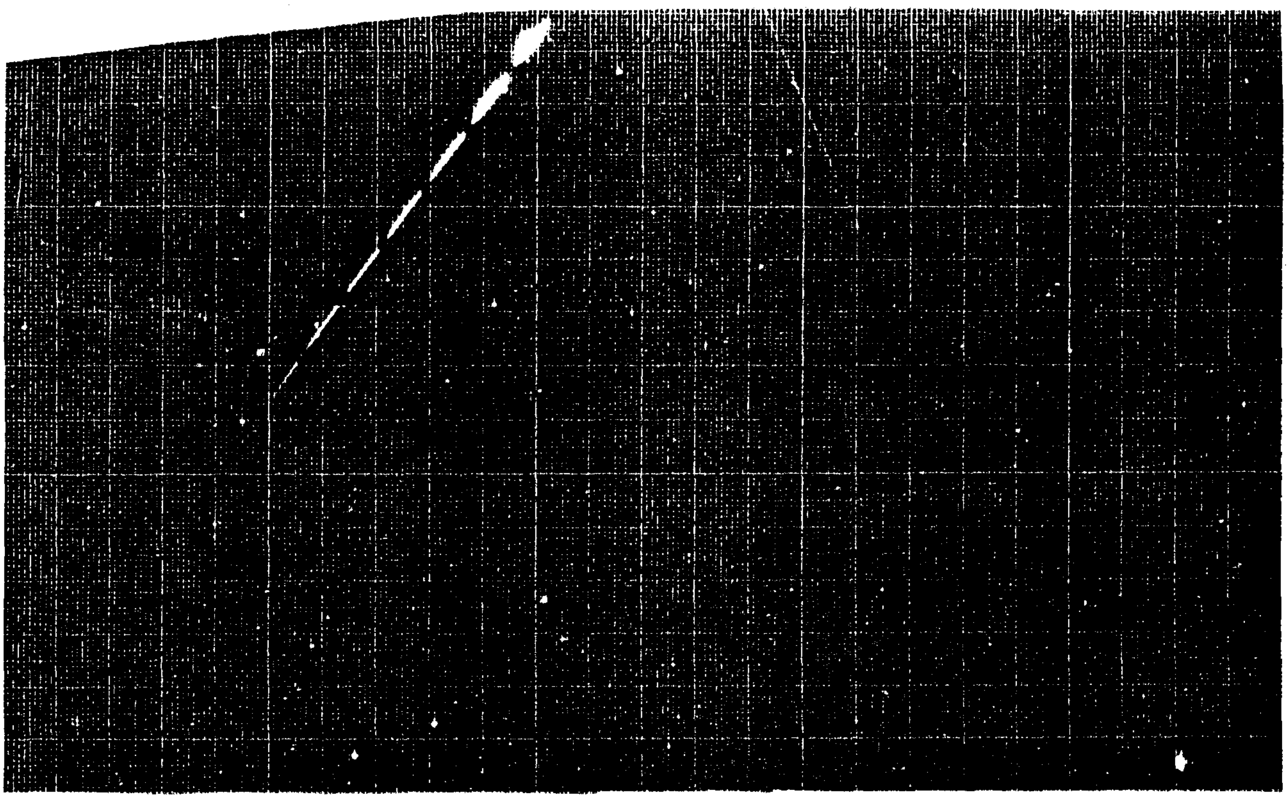
Element	Meteor	1862 III (2)
ω	155°6	152°8
Ω	125°1	138°7
i	109°5	113°6
e	0.956	0.960
q (AU)	0.971	0.963
a (AU)	22.27	24.33
V_∞	59.2 ± 0.6 km/s	

The time at which the meteor appeared, corresponds to a solar longitude of 125°.09 (1950.0). A theoretical radiant predicted for Comet Swift-Tuttle at a solar longitude of 125° has α = 30° and δ = 53°. The closest distance of the Earth and the comet's orbit at that time is 0.226 AU and the geocentric velocity of potential meteors 58.8 km/s. The meteor TN 10 shows much similarity to the cometary radiant and orbit. Therefore, TN 10 is probably an early Perseid.

References

(1) *Sky Watcher 3:10*, 1985, p 83 (in Japanese).

(2) B.G. Marsden, "Catalogue of Cometary Orbits", SAO, Cambridge MA, 1986.



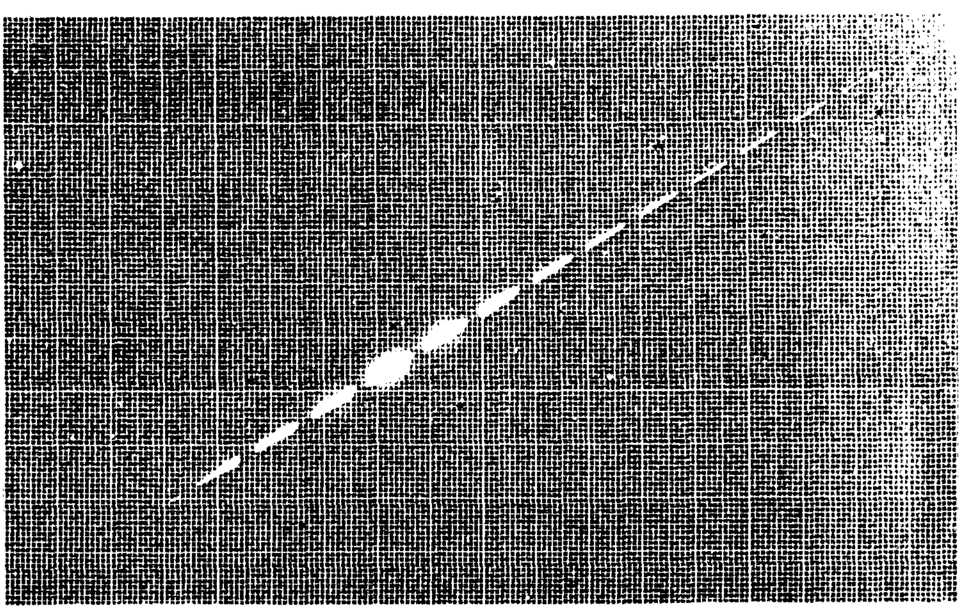


Figure 1 --- Two of the three photographs of TN 10. Top: Mikado, Bottom: Daisawa

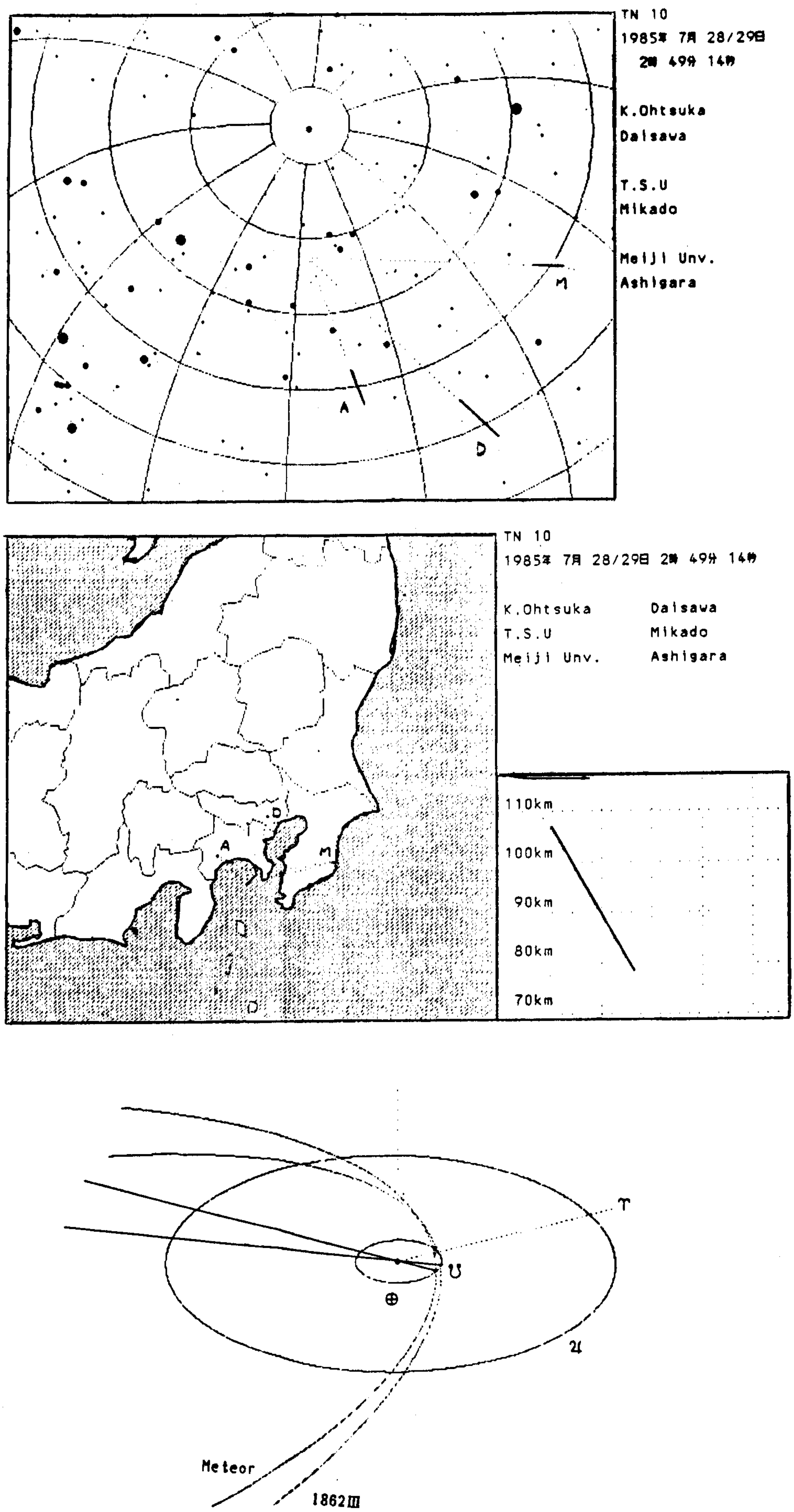


Figure 2 --- Trails, trajectory and orbit of TN 10.

Japanese η-Aquarids Observations in 1987

Masahiro Koseki

An overview is given of Japanese η-Aquarids observations. From an expedition to Australia, two double-station photographs were obtained.

The Nippon Meteor Society has been carrying out the H-project in cooperation with the International Halley Watch. This project was aimed at observing η-Aquarids and Orionids. In 1987, η-Aquarids were observed under the most favorable circumstances since many years. As a result, significant data were obtained by Japanese amateurs.

Observations were done visually as well as photographically and by radio. It is worth mentioning that in 1987 as well as in previous years, some of our members took part in an Australian expedition. This report shows combined results obtained from Japanese and Australian observations.

Table 1 --- ZHR's of the η-Aquarids in 1987. Mean values are calculated from observations with 10.HR > ZHR.

$\lambda_\odot$	ZHR	Nr. Obs.
41°.4	48 ± 21	2
42°.3	59 ± 30	5
43°.3	73 ± 23	11
44°.2	105 ± 36	6
45°.2	52 ± 11	3
46°.2	21 ± 6	2
47°.2	36	1
48°.1	25 ± 5	2

Table 1 summarizes the visual observations, in which ZHR's are calculated on the basis of the usual formula. A zenith exponent of 1.5 was assumed. ZHR's are quite different from Australian observations (1), i.e. the activity deduced from Japanese observations is not that low. It is suggested that an increase in the r-value from 2.32 in 1986 (2) to 2.52 in 1987 (1) caused an apparent decrease in meteor rates.

Table 2 --- r-values for the η-Aquarids in 1987

Observer	Day	Nr. Met.	lm	r
Y. Yabu	total	66	5.5	2.65
K. Maeda	total	36	5.6	2.41
N. Kawamura	total	39	6.0	2.41
Y. Shikoku	total	22	6.0	2.60
T. Maruyama	total	21	6.0	2.01
Y. Shiba	total	18	6.3	2.59
Y. Fujiwara	total	18	6.0	2.54
S. Yanagi	May 3	29	6.0	2.07
	May 5	109	6.0	2.27
	May 6	54	6.0	2.84
M. Toda	May 5	67	6.5	2.02
	May 6	77	6.5	2.46

The r-values for each observer are given in Table 2. Their average is given by $r = 2.41 \pm 0.27$. This value slightly differs from what is obtained from Australian observations. This seems to result from the different calculation methods; the former value is not based on the mean magnitude of the sporadic meteors.

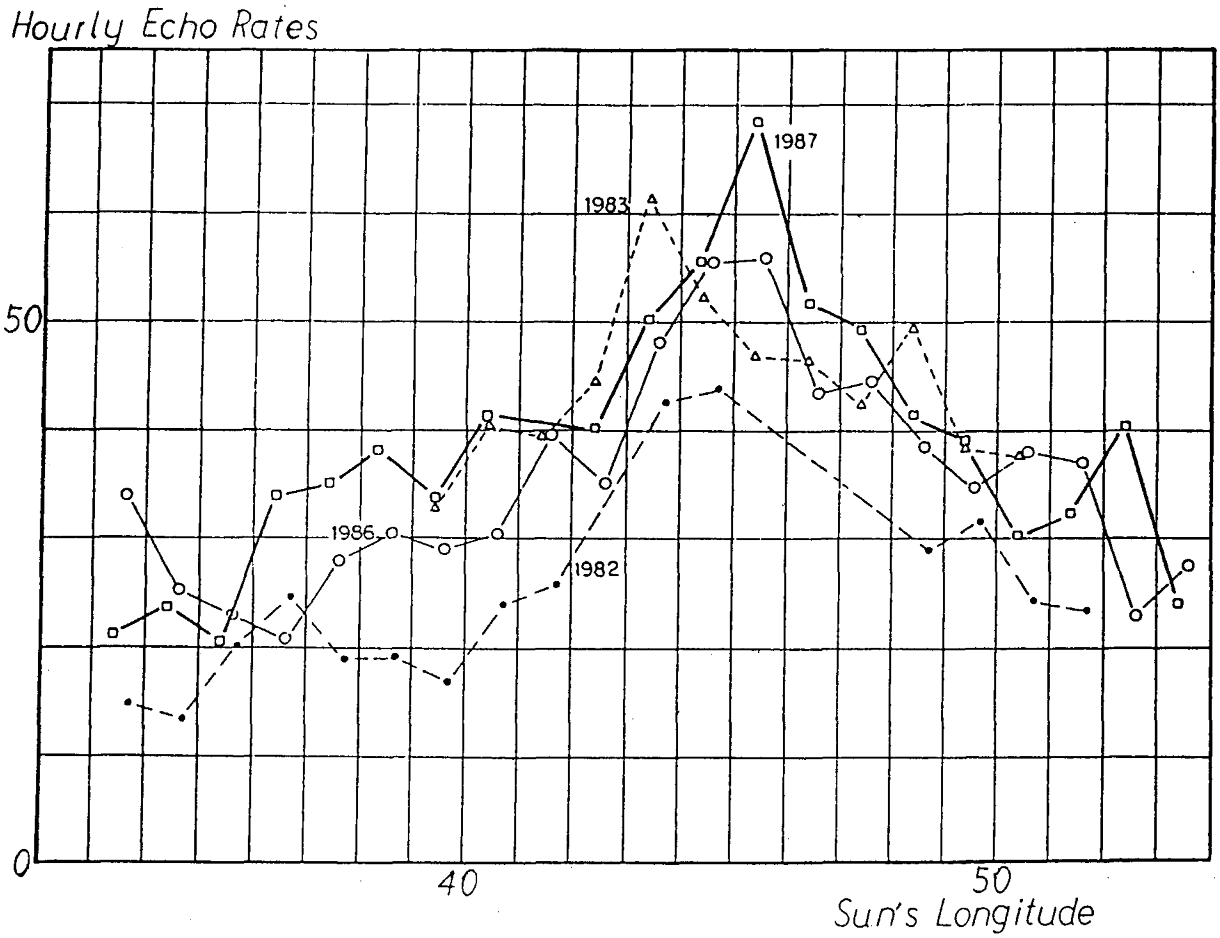


Figure --- The profiles of the η-Aquarid activity between 1982 and 1987, as obtained from FM radio observations by T. Shimoda.

T. Shimoda obtained excellent results by using FM radio and confirmed visual observations (Figure). They indicate that the η-Aquarid profile is rather stable and that the time of maximum shifted forwards. Some other radio observers got similar results. Whether or not the time of maximum depends on the particle size, needs further investigation.

Japanese amateurs could gather two double station meteors in the period before 1987. However, no orbital elements were calculated for one of them. In 1987 the Australian expedition could add two more η-Aquarids to our list. On the other hand, though several observers carried out photographic observations in Japan, they could get none.

Table 3 --- Photographic η-Aquarids (1950.0)

Number:	82001	8701	8702
Year:	1982	1987	1987
Radiant, α:	336°.6	334°.6	335°.6
δ:	-1°.7	-2°.0	-1°.7
Geoc. vel.:	67.1 km/s	67.3 km/s	64.9 km/s
e:	0.99	1.02	0.91
q:	0.68 AU	0.63 AU	0.57 AU
i:	164°.0	163°.8	163°.3
ω:	97°.9	105°.2	94°.5
Ω:	43°.5	43°.3	43°.3

Table 3 shows the results of the Australian expedition and the former observation. It is suggested that the use of 35 mm cameras permits us to obtain more accurate results than with graphical reduction (3). (3) lists seven η-Aquarids, though they are not identified as such. The dispersion in velocity however hampers the comparison of their orbits, thirty years apart.

K. Yoshida and others performed telescopic observations under favorable sky conditions. K. Yoshida determined radiant positions from single station meteors using the method of Guth. He suggested that fainter meteors radiate from a different area than the brighter ones, and that the η-Aquarid maximum depends on the particle size.

Y. Fujiwara recorded 14 meteors on video tape by using an image intesifier. His results are summarized in Table 4:

Table 4 --- Video observations of the 1987 η-Aquarids.

Date	T_{eff}	Nr. Met.
May 04-05	0.83	6
05-06	1.50	8

He determined the radiant position from eight meteorsin the night of May 05-06:

$$\lambda_{\odot} = 43.22 - 43.26 \quad \alpha = 335^{\circ}.13 \quad \delta = -3^{\circ}.01 \quad R = 1^{\circ}.23$$

He observed the meteor trails on a screen using a personal computer.

References

(1) J. Wood, "The η-Aquarids in 1987 in Australia", *WGN 16:2*, April 1988, pp. 38-52.

(2) J. Wood, "The η-Aquarids in 1986", *WGN 15:3*, June 1987, pp. 95-96.

(3) R.E. McCrosky, A. Posen, "Orbital Elements of Photographic Meteors", *Smiths. Contr. Astrophys., 4 (2)*, pp. 15-84.

Japanese/Australian Contacts

Toshi Fumi A. Konuma, Jeff Wood and Japanese high school and university students at Mt. Magnet, Australia, in 1986.

Dutch Video Observations of a Leonid Fireball in 1987

Klaas Jobse

A description is given of a Leonid fireball on November 17, 1987, that was registered on video by the author.

In the mornings of and around November 17, I had planned some hours of Leonid watch. The alarm was set for 02^h UT and I am sure it did its job, but for some reason, I woke up only at 04^h UT. One glance through the window told me the sky was clear. I hurried into my clothes and - remembering the 1985 Leonid show - went out for the remaining hour of observing. It was then that, within the hour, two fireballs appeared.

I entered the observatory and directed BETSY (my image intensifying video camera) to the Leonid radiant while I installed myself in the armchair. I started observing visually at 04^h30^m UT and determined the limiting magnitude in Ursa Major. $04^h31^m13^s$! A giant flash temporarily made any further star count impossible. From the corner of my eye, in southern direction and about 15° above the horizon, I saw a very bright train pointing away from the Leonid radiant. This magnitude -10 event certainly chased away any remainders of sleepiness!

Figure 1 --- The author is operating the computer connected to the Photo Multiplier Tube - system, which is visible at the bottom left.

I recorded the time myself, because the Photo Multiplier Tube (PMT) was not active that night (see Figure 1). Then I realized BETSY was prepared for action, and I quickly pointed her in the direction of the train, which by now had been visible for about 30 seconds in Puppis. Its length was about 4°. It took more than 2 minutes before nothing was left of it for the naked eye. Yet BETSY filmed the train to about *13 minutes* after first appearance, and the slow spread of the train due to high altitude winds could be clearly followed. Figure 2 on the next page shows some of that. After three minutes, the train started to fold and break up, always slowly fading away. Within the 13 minutes BETSY filmed the trail, it moved over 8°.

Later, while looking at the video tape, it was possible to redetermine the precise time of first appearance, since the entire sky was illuminated by the fireball, while BETSY was looking in another direction.

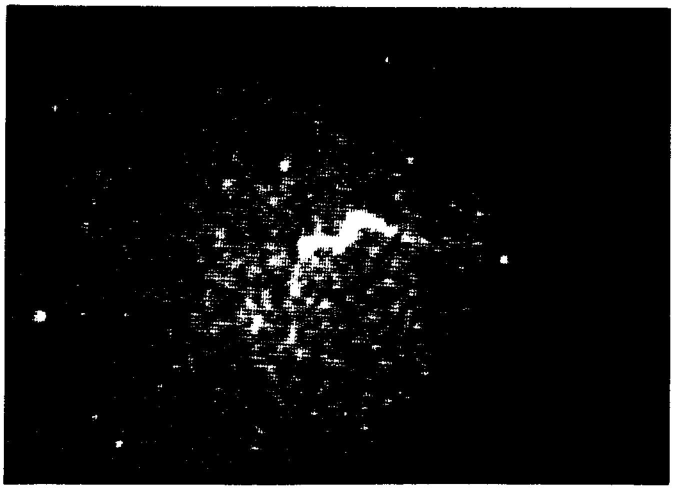


Figure 2 --- The train of the Leonid fireball of November 17, 1987 at $04^h31^m13^s$ UT, after 30 seconds (top left), 1 minute (top right) and 6 minutes (right).

After all these emotions, I stayed out till 5^h30^m UT to observe visually, and saw about 12 Leonids (among which a -2), in spite of the Moon.

The enthusiasm was lessened a bit when I discovered that only five instead of six all-sky shots were taken, due to a flat battery of the command panel. So the all-sky stopped about half an hour before the appearance of the fireball... Yet the magnificent video images make up for this a great deal!

Remarkable Meteor Activity on Sep 23–24, 1987

George Spalding

A special night of interest was September 23-24, when I was using my new microcasette recorder for the first time. My first watch was 21^h40^m-22^h40^m, during which time I saw 12 meteors. Curiously, all 12 were in the hectic phase 21^h47^m-22^h19^m. This was an unusually good sporadic activity, but I took it as a mere statistical fluke. However, Noel White rang next night to report that he too had been observing on September 23-24, and had 9 meteors between 21^h47^m-22^h14^m. We both had clear sky, his with a limiting magnitude of 5.0, mine with a limiting magnitude of 5.5. These rates are about three times what both of us were typically seeing in similar periods around that date.

The activity did not seem to be from any particular radiant as I saw it. It is still, of course, quite possible that the good activity was merely a chance fluctuation, but I would be interested to have any details from any Belgian or Dutch observations secured on the same night around this period (21^h45^m-22^h15^m UT) on September 23-24.

(People having observed that night are kindly requisted to contact the author. His address is on the inside of the back cover - editor)

Observational Results

Finnish Observations — Spring 1987

Teemu Hankamäki

An account is given of the Finnish visual meteor observations during January, February, March and April 1987. Special attention was given to the Virginids and the Lyrids.

The spring weather was rather fair in Finland, we often had clear skies and we enjoyed good limiting magnitudes. In brief, we observed 495 sporadic meteors, 86 Lyrids and 46 Virginids, or a total of 627 meteors after the Quadrantids 1987. The mean magnitude of all the sporadics is 3.48.

Virginids have been observed during spring. The 46 Virginids that were seen had an average magnitude of 2.72, so the difference in mean magnitude between the sporadics and the Virginids is 0.76. 10.7% of the Virginids showed a train and 8.7% a color.

The Lyrids were rather active in 1987. Lyrids were well observed during the nights of April 19-20, 20-21 and 21-22. The mean magnitude of the Lyrids we saw was 3.08, or 0.40 magnitudes brighter than that of the sporadic background. 1.2% of the Lyrids showed a train and also 1.2% of these meteors were reported to have a color.

Table 1 --- Finnish observations during the spring of 1987.

Date	Obs	Period (UT)	T_{eff}	Lm	F	Vir	Lyr	Spor
Jan 22-23	LR	$16^h30^m-18^h30^m$	1.25	6.27	1.00	0	0	13
21-22	LR	21 40 -22 40	0.83	6.00	1.09	0	0	22
22-23	LR	20 55 -23 00	2.00	6.46	1.00	0	0	18
28-29	LR	23 40 -02 10	2.33	6.53	1.00	0	0	36
31-32	LR	23 50 -03 00	2.92	6.70	1.00	0	0	46
Feb 08-09	LR	16 10 -17 30	1.28	5.45	1.12	0	0	8
15-16	LR	16 30 -17 40	1.13	5.98	1.00	0	0	8
23-24	LR	20 50 -23 00	2.00	6.42	1.00	0	0	17
26-27	LR	22 05 -23 30	1.33	5.81	1.00	0	0	11
28-29	MR	18 02 -21 02	1.82	6.30	1.18	1	0	13
Mar 05-06	LR	23 45 -03 05	3.20	6.45	1.03	6	0	33
09-10	LR	21 10 -22 10	0.82	5.42	1.22	1	0	2
10-11	LR	21 30 -23 35	2.02	5.70	1.11	1	0	9
12-13	LR	21 55 -00 05	2.13	5.10	1.00	1	0	11
16-17	LR	21 50 -23 00	1.15	4.60	1.25	0	0	4
17-18	LR	20 35 -22 35	1.97	5.10	1.11	1	0	4
18-19	LR	18 40 -20 10	1.47	6.20	1.00	3	0	11
30-31	LR	21 00 -23 00	1.93	6.46	1.11	2	0	12
31-32	JH	18 24 -21 29	0.98	6.90	1.11	3	0	13
31-32	LR	21 40 -01 00	3.17	6.72	1.00	6	0	27
Apr 03-04	TK	21 46 -22 52	0.83	4.85	1.11	1	0	7
04-05	LR	02 30 -03 30	0.97	5.71	1.00	0	0	8
08-09	LR	22 20 -01 00	2.57	5.93	1.01	4	0	22
16-17	IL	22 03 -22 30	0.48	6.20	1.52	0	1	1
17-18	LR	21 55 -22 55	0.97	6.55	1.11	3	2	8

Table 1 (continued)

Date	Obs	Period (UT)	T_{eff}	Lm	F	Vir	Lyr	Spor
Apr 18-19	LR	22^h15^m-01^h15^m	2.75	6.31	1.00	3	9	29
19-20	LR	21 50 -00 30	2.50	6.45	1.00	1	12	20
19-20	IL	23 15 -00 30	1.23	6.36	1.11	1	4	7
19-20	PCW	00 10 -00 36	0.43	?	1.00	1	0	2
20-21	PP	23 05 -01 10	2.00	6.30	1.11	0	4	8
20-21	LR	22 00 -00 05	2.02	6.52	1.00	1	11	18
21-22	IL	22 29 -00 17	1.78	6.28	1.11	1	7	9
21-22	PP	22 00 -01 06	2.77	6.30	1.11	0	11	6
21-22	TK	23 18 -00 34	1.22	5.70	1.05	0	2	6
21-22	LR	21 20 -01 00	3.50	6.32	1.33	5	22	25
22-23	PR	21 25 -21 55	0.50	4.30	1.00	0	1	1

The following observers took part in the observations that are summarized in Table 1, above:

Leo Rajala (LR), Marko Riikonen (MR), Jussi Holopainen (JH), Timo Kinnunen (TK), Ismo Luukkonen (IL), Paul-Christer Wirtanen (PCW), Pekka Parviainen (PP), Pentti Ramberg (PR).

In Table 2 and 3, magnitude distributions are given for the sporadics, the Virginids and the Lyrids.

Table 2 --- Magnitude distributions for the sporadics, the Virginids and the Lyrids as seen from Finland in 1987.

Magnitude	-4	-3	-2	-1	0	+1	+2	+3	+4	+5	+6
Virginids	0	0	1	3	2	3	1	19	14	3	0
Lyrids	0	0	0	1	6	7	9	21	28	14	0
Sporadics	1	2	2	6	3	15	53	158	140	100	15

Table 3 --- Magnitude distributions, percentage-wise, for the sporadics, the Virginids and the Lyrids as seen from Finland in 1987.

Magnitude	Virginids	Lyrids	Sporadics
-4	00.00	00.00	00.20
-3	00.00	00.00	00.40
-2	02.17	00.00	00.40
-1	06.52	01.16	01.21
0	04.35	06.98	00.61
+1	06.52	08.14	03.03
+2	02.17	10.47	10.71
+3	41.30	24.42	31.92
+4	30.43	32.56	28.28
+5	06.52	16.28	20.20
+6	00.00	00.00	03.00

As mentioned, the mean magnitudes are:

Virginids:	2.72
Lyrids:	3.08
Sporadics:	3.48

Norwegian Observations — Spring 1987

Trond Erik Hillestad

An account is given of the Norwegian visual meteor observations during February, March and April 1987. Apart from several minor showers, special attention was given to the Virginids and the Lyrids.

Our visual efforts were much higher than normal during the spring of 1987. After the Quadrantids, 63 Lyrids have been recorded as well as meteors from several minor showers, all in all 808 meteors, including sporadics.

Table 1 --- Observers and observing sites, Norway, spring 1987.

Abb.	Observer	Site	λ	φ
KG	Kai Gaarder	Roa	10°36' E	60°10' N
LTH	Lars Trygve Heen	Kristiansand	07°56!2 E	58°08!0 N
ETH	Trond Erik Hillestad	Kongsberg	09°35!8 E	59°42!3 N

All showers are according to Cook's working list of radiants (1). The following abbreviations are used in Table 2:

V	Virginids	A	η-Aquarids
DL	δ-Leonids	SL	σ-Leonids
C	Camelopardalids	FB	φ-Bootids
D	δ-Draconids	AB	α-Bootids
L	Lyrids		

Table 2 --- Norwegian observations during the spring of 1987.

Date	Obs	Period (UT)	T_{eff}	Lm	F	Showers	Spor
Jan 31-32	KG	$19^h00^m-21^h00^m$	1.74	6.14	1.05		26
Feb 01-02	KG	19 00 -20 00	1.00	6.25	1.00		8
01-02	KG	20 00 -21 00	1.00	6.30	1.00		12
21-22	KG	20 00 -21 10	1.11	6.07	1.01	4DL	9
21-22	KG	21 10 -22 20	1.13	6.23	1.02	2DL	12
22-23	KG	20 00 -21 15	1.21	6.12	1.00	3DL	10
22-23	KG	21 15 -22 30	1.19	6.24	1.00	4DL	14
22-23	KG	22 30 -23 30	0.99	6.25	1.00	1V,2DL	11
23-24	KG	20 00 -21 15	1.18	6.16	1.00	3DL	12
23-24	KG	21 15 -22 30	1.21	6.20	1.00	4DL	14
23-24	TEH	21 05 -22 05	0.98	5.95	1.00	4V,3DL	17
23-24	TEH	22 05 -23 05	0.98	6.10	1.00	4V,4DL	19
26-27	KG	00 00 -01 05	1.04	6.15	1.00	1V,4DL	12
26-27	KG	01 05 -02 10	1.04	6.20	1.03	1V,2DL	14
27-28	TEH	20 38 -22 03	1.39	6.17	1.00	3V,9DL ?	15?
28-29	TEH	21 00 -22 00	0.97	6.20	1.00	3V,7DL	11
28-29	TEH	22 00 -23 00	0.97	6.30	1.00	6V,4DL	13
28-29	TEH	23 00 -00 00	0.97	6.20	1.00	3V,7DL	12
Mar 02-03	KG	21 00 -22 05	1.04	6.10	1.00	4DL	13
04-05	KG	23 00 -00 05	1.04	6.10	1.00	2V	9
30-31	TEH	19 45 -20 45	0.99	6.05	1.00	1V	17
30-31	TEH	20 45 -21 45	0.99	6.13	1.00	1V	12

Table 2 (continued)

Date	Obs	Period (UT)	T_{eff}	Lm	F	Showers	Spor
Mar 30-31	TEH	$21^h45^m-22^h45^m$	0.99	6.20	1.00	1V	16
30-31	TEH	22 45 -23 45	0.99	6.25	1.00	2V	16
Apr 01-02	KG	20 00 -21 30	1.49	6.23	1.03	3V,2C,2D	14
02-03	KG	21 10 -22 50	1.62	6.25	1.01	4V,1C,4D	15
04-05	KG	20 45 -21 45	0.99	6.00	1.00	3D	7
04-05	KG	21 45 -22 45	1.00	6.10	1.00	1V,1C,1D	5
15-16	KG	20 45 -21 45	1.00	6.05	1.18	1AL	7
16-17	KG	21 45 -22 45	0.99	6.25	1.11	8SL,5FB,3AL	9
16-17	KG	22 45 -23 45	0.99	6.30	1.11	5SL,2FB,3AL	15
17-18	KG	21 15 -22 35	1.22	6.22	1.11	5SL,3FB,2AL	11
17-18	KG	22 35 -00 00	1.29	6.30	1.11	2SL,3FB,2AL	19
17-18	TEH	21 00 -22 00	0.99	6.30	1.00		12
17-18	TEH	22 00 -23 00	0.99	6.35	1.00		13
18-19	TEH	21 30 -21 55	0.41	6.30	1.00		6
21-22	TEH	21 20 -22 45	1.23	6.21	1.05	6L	12
21-22	KG	21 15 -23 00	1.56	5.96	1.03	13L,2FB,4AL	23
21-22	KG	23 55 -00 40	0.74	6.30	1.02	9L	12
22-23	TEH	21 15 -22 15	0.98	6.28	1.00	5L	13
22-23	TEH	22 15 -23 15	0.97	6.30	1.00	10L	12
22-23	TEH	23 15 -00 16	0.99	6.20	1.00	7L	12
23-24	TEH	22 15 -23 15	0.98	6.30	1.04	7L	18
23-24	TEH	23 15 -00 25	1.14	6.30	1.08	6L,1A	12
24-25	LTH	23 00 -00 00	0.97	6.05	1.04	1FB,3AL	6
25-26	KG	23 30 -00 45	1.24	6.00	1.01	1FB,5AL	20

The following remark must be made about the night of February 27-28: TEH had a failure of his cassette recorder. The rates presented in Table 2, above, are very uncertain, as they are remembered the day after the observation.

References

(1) Cook A.F., "A Working List of Meteor Streams", *Evolutionary and Physical Properties of Meteoroids*, 1973, pp. 183-191.

The Meteor Library

compiled by Paul Roggemans

B.A. Lindblad, " The meteor stream associated with comet P/Grigg-Skjellerup Astronomy and Astrophysics, 187, 1987, pp. 931-932

A 1964 Jupiter approach of P/Grigg-Skjellerup perturbed the comit's orbit so that very close approaches to the Earth's orbit now occur. A recently observed southern hemisphere meteor shower, the σ-Puppids, is associated with P/Grigg-Skjellerup. Observations of this meteor shower now provide us with a unique opportunity to observe the birth and evolution of a meteor stream.

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