bimonthly

wgn

15 – 4
august 1987

the international circular for meteor observers

This -2 Draconid was photographed by Hikaru Odagiri on October 8, 1985 at $09^h53^m50^s$ UT. The bright star in the upper left corner is Vega. The quadrangle of Hercules at the right side is prominent.

werkgroepnieuws - meteoren

tweemaandelijks tijdschrift 15de jaargang nummer 4 - augustus 1987

uitgave Vereniging voor Sterrenkunde

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WGN, volume 15, nr 4, august 1987, pp. 103–136

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

Bijdragen voor het oktobernummer moeten uiterlijk op *1 september* toekomen bij *Marc Gyssens* (adres op binnenzijde achterkaft).

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Editoriaal

Terwijl dit nummer in uw brievenbus valt, bent U waarschijnlijk al valop in de sfeer van de zomeracties. Ondanks de minder gunstige omstandigheden, wensen we iedereen (en natuurlijk ook onszelf!) goed weer voor het Perseïden-maximum.

Niet zonder enige trots kunnen we U aankondigen dat dit nummer ook een bijdrage bevat van een professionele astronoom, Dr. Olsson-Steel, momenteel werkzaam in de sterrenwacht van Lund te Zweden. Men heeft immers vaak de mond vol over samenwerking tussen beroepsmensen en amateurs in de sterrenkunde, maar in de praktijk loopt dit niet altijd even efficiënt als gewenst. Het is dan ook bemoedigend vast te stellen dat er in de meteoren-astronomie professionele sterrenkundigen zijn die belangstellen hebben voor het werk van de amateurs. Langs de andere kant hebben ook deze amateurs steeds gepoogd contacten te leggen. Een concreet resultaat hiervan was de aanwezigheid van Dr. I. Williams en Dr. B.A. Lindblad op het jongste Meteoren Weekend te Hingene in oktober 1986. We kunnen bovendien nu al zeggen dat het bij die ene professionele bijdrage in *WGN* niet zal blijven; verder in dit editoriaal hierover nog meer. Bovendien zullen we ook trachten de toegankelijkheid van de professionele literatuur voor de amateur te vergemakkelijken door geregeld abstracts van artikels uit vaktijdschriften te publiceren, afhankelijk van de beschikbare plaats. De "gewone" bijdragen voor *WGN* krijgen uiteraard voorrang.

Toch moeten we aan dit nummer ook een schaduwzijde vaststellen: de dikte (of beter het gebrek daaraan) van de nederlandstalige sectie. *WGN* tracht immers een dubbele functie te vervullen: enerzijds die van contactblad voor de Belgische en Nederlandse meteoorwaarnemers en anderzijds die van een internationaal meteorentijdschrift voor amateurs. Het nederlandstalige deel vervult die eerste functie en het engelstalige deel de tweede. De dikte van beide delen hangt echter af van de hoeveelheid copij die de redactie ontvangt. Daar we ervan uitgaan dat er na de zomerwaarnemingen zeker voldoende stof tot schrijven zal zijn, willen we dan ook alle groepen meteoorwaarnemers in België en Nederland oproepen een verslagje samen te stellen voor publicatie in *WGN*.

Tenslotte al even een vooruitblik voor het oktober-nummer, want daarvan zullen we iets speciaals proberen te maken. De grote toevloed van copij (en daar rouwen we heus niet om!) heeft immers de noodzaak doen voelen een extra-dik nummer uit te geven! In dit nummer zullen we ook een bijdrage publiceren van Dr. B.A. Lindblad; over de rest laten we U nog twee maandjes in het ongewisse.

Tenslotte nog een overzicht van de inhoud van dit nummer. In het nederlandstalige deel zijn we genoodzaakt geweest ons te beperken tot de visuele- en radio-actie-oproep voor augustus en september en nog verder nieuws over het Weekend der amateurs dat op 7 en 8 november zal doorgaan in de Borggraaf te Hasselt.

Het Engelse deel openen we met de bijdrage van Dr. Olsson-Steel. Hierin bespreekt hij de mogelijkheid dat de recent ontdekte komeet 1987c (Nishikawa-Takamizawa-Tago) het moederlichaam is van de ε-Geminiden, een normaliter zeer bescheiden zwerm die zichtbaar is medio oktober. Wanneer dit inderdaad het geval is - en vele aanwijzingen wijzen in die richting - dan is er kans op een sterk verhoogde activiteit of zelfs een storm tijdens dit najaar! Ten einde iedereen de kans te geven acties te kunnen voorbereiden om deze bewering al dan niet te kunnen bevestigen, publiceren we dit artikel reeds in dit nummer. Hopelijk komt er respons vanuit de amateur-gemeenschap. Iedere èchte samenwerking (dus ook die tussen beroeps en amateurs) impliceert immers tweerichtingsverkeer!

Daarna bespreekt Christian Steyaert de mogelijkheid om vooraf plottings te maken van de hemelgedeelten die zullen bestreken worden bij fotografische acties. Daarna volgen twee bijdragen over de duur van meteoor-reflecties bij radiowaarnemingen. Het eerste (van Christian) behandelt de nauwkeurigheid van de schatting van de duur ervan; het tweede (van Jeroen Van Wassenhove) gaat over het verband tussen deze duur en de visuele magnitude van de meteoor.

(wordt vervolgd op pagina 108)

Actie-oproep: augustus-september

Paul Roggemans

Tabel 1 --- Maanlicht augustus-september 1987

Datum	k	Datum	k
vrijdag 31 juli	0.23+	vrijdag 4 september	0.81+
vrijdag 7 augustus	0.91+	vrijdag 11 september	0.87-
vrijdag 14 augustus	0.74-	vrijdag 18 september	0.23-
vrijdag 21 augustus	0.11-	vrijdag 25 september	0.04+
vrijdag 28 augustus	0.11+	vrijdag 2 oktober	0.68+

Nieuwe Maan:	25 juli, 24 augustus, 23 september
Eerste Kwartier:	2 augustus, 1 september, 30 september
Volle Maan:	9 augustus, 7 september, 7 oktober
Laatste Kwartier:	17 juli, 16 augustus, 14 september

1. De Perseïden 1987

Helaas, helaas, ... dit jaar zijn de omstandigheden helemaal niet gunstig omwille van het storende maanlicht. De werkgroep bekwam een zeer volledige reeks waarnemingen voor de jaren 1985 en 1986, vrijwel geheel te danken aan de intensieve waarnemingen verricht in Zuid-Frankrijk. We vrezen nu dat in tegenstelling tot 1985 en 1986 bitter weinig waarnemingen zullen bekomen worden voor de Perseïden 1987. Dit is bijzonder jammer voor de lange-termijn-studie van de structuur van de Perseïdenzwerm. Daarom hopen we een maximum aan waarnemingen te kunnen bekomen ondanks de storende maan. Eind juli en de eerste augustusnachten leveren geen enkel probleem om de vroege Perseïdenactiviteit te volgen. Deze periode werd ook in 1986 nauwgezet gevolgd en een vergelijking met 1987 zou hoogst interessant zijn. In het algemeen is er van deze periode bitter weinig bekend, zodat 1987 belangrijke nieuwe informatie kan opleveren.

De volgende nachten moet men werkelijk gaan timen om de maan te vermijden. In Tabel 2 staan de gegevens over het maanlicht tijdens de dagen rond het Perseïdenmaximum.

Tabel 2 --- Perseïden en de maan in 1987

Datum	Opkomst	Ondergang	k
Aug 04-05	15^h26^m	22^h46^m	0.63+
05-06	16 48	23 33	0.74+
06-07	17 57	00 41	0.83+
07-08	18 48	02 08	0.91+
08-09	19 22	03 44	1.00+
09-10	19 46	05 19	0.99-
10-11	20 03	06 50	0.96-
11-12	20 17	08 17	0.91-
12-13	20 30	09 40	0.83-
13-14	20 43	11 02	0.74-
14-15	20 57	12 21	0.64-
15-16	21 14	13 40	0.54-

In de nachten 4-5, 5-6, en 6-7 kan men nog observeren na maansondergang. Nadien neemt de declinatie van de maan toe waardoor dit stuk lichtvervuiling nacht na nacht slechts weinig minuten later boven de horizon verschijnt. Zo gaan niet minder dan 8 nachten voorbij waarin men onmogelijk zonder de maan kan observeren. Van 7-8 tot 14-15 gaat zo nagenoeg heel de hoofdbrok van de Perseïden verloren. Het zou echter jammer zijn om in die periode helemaal geen waarnemingsmateriaal te verwerven. Vermoedelijk zal het maanlicht te fors hinderen in de nachten 7-8, 8-9, en 9-10. De maan staat echter laag en als men zich ergens in de schaduw installeert dan valt er beslist nog goed werk te doen. Pas vanaf 15-16 kan men de uitstervende Perseïdenactiviteit volgen tot rond 24 augustus zonder veel hinder van de vervelende maan.

Niettegenstaande de slechte omstandigheden dit jaar hopen we toch nog voldoende waarnemingen te hebben teneinde van enig idee te hebben van de Perseïdenactiviteit dit jaar. Dit geldt eveneens voor het maximum zelf dat voorzien is in de nacht van 12-13 omstreeks 0^h UT; dat zou ideaal zijn voor Europa, ware het niet dat de maan zo fel stoorde. Aangezien dat vele waarnemingen lang voor of na het maximum zullen doorgaan is het hoogst aangeraden om de radiantpositie op voorhand op te zoeken in het visuele handboek.

2. De δ en ι-Aquariden

Tijdens de waarnemingen van 1986 viel vooral eind juli en begin augustus de hoge activiteit op van de Aquaridenradianten. Tijdens de laatste week van juli en de eerste week van augustus overtroffen deze Aquariden de Perseïden in aantal. Door de minder goede omstandigheden in België is dit hier wellicht niet eerder opgevallen. Wat wel opvalt na de waarnemingen is dat de meeste waarnemers blijkbaar veel last hebben met de identificatie van hun meteoren als Aquariden. De complexe radiantstructuur staat laag aan de hemel in een gebied dat hier meestal nogal ster-arm is gezien door de nevelige lucht in onze contreien. Ofwel meldt men helemaal geen Aquariden, of anderen noemen alle meteoren uit zuidelijke richting Aquariden. Men moet zeer kritisch klassificeren, zeer goed weten waar de radiant staat en ook refereren aan de geometrische kenmerken van de Aquaride-meteoren : dit betekent dat men moet letten op de beweegrichting, de hoeksnelheid in (°)/s en dus ook op de spoorlengte in (°). Men kan dit jaar de aandacht een beetje verleggen naar deze Aquariden. Men mag echter niet nalaten dit goed voor te bereiden want onze waarnemers hebben onvoldoende ervaring met de Aquaridenradianten, leert de praktijk.

3. De κ-Cygniden

Een κ-Cygnide trekt de aandacht vooral door z'n uiterst trage beweging : een "snelle" meteoor kan dus nooit een κ-Cygnide zijn. Het aantal κ-Cygniden is gering, doch de radiant passeert bijna door het zenit. Sedert 1980 is elk jaar al aandacht gespendeerd aan deze zwerm. Er werden flink wat meteoren van deze zwerm gefotografeerd, twijfel over de echtheid van deze zeer bescheiden en vrij onopvallende zwerm is er dus niet. Dit jaar zijn de omstandigheden ideaal. Alhoewel de eerste twee weken van de κ-Cygnideactiviteit grondig verstoord worden door de gloed van het maanlicht, zal de beste periode voor deze κ-Cygniden, omstreeks 18 augustus, vrijwel ideaal zijn. Het is dus nuttig om dit jaar waarnemingen te plaatsen in de derde week van augustus. Het zou erg nuttig zijn voor de studie van de κ-Cygniden.

4. Het inzenden van waarnemingen

Aan de waarnemen alleen al kunt u veel plezier beleven. De voldoening wordt nog groter indien u behalve het werk ten velde ook een stuk van de voorbereiding tot verwerking onderneemt. Lever met uw waarnemingsformulieren een samenvattende tabel af met een uurfrequentietabel (zie jaarverslag 1986 in *WGN 15:3*), samen met de magnitudeverdeling per zwerm per nacht. Zend alles in aan de leider van de visuele sectie, Glenn Ticket (adres zie cover). Verzorg uw verslag en zend uw waarnemingen eind augustus aan Glenn Ticket zodat op korte termijn een activiteitenverslag kan worden voorbereid. De formulieren van september worden midden oktober verwacht.

Personen die een geslaagde actie achter de rug hebben, kunnen bij deze gelegenheid eens een verslagje schrijven voor *WGN*. Zend dit ter publicatie aan Marc Gyssens. Alvast veel succes met de zomeractie !

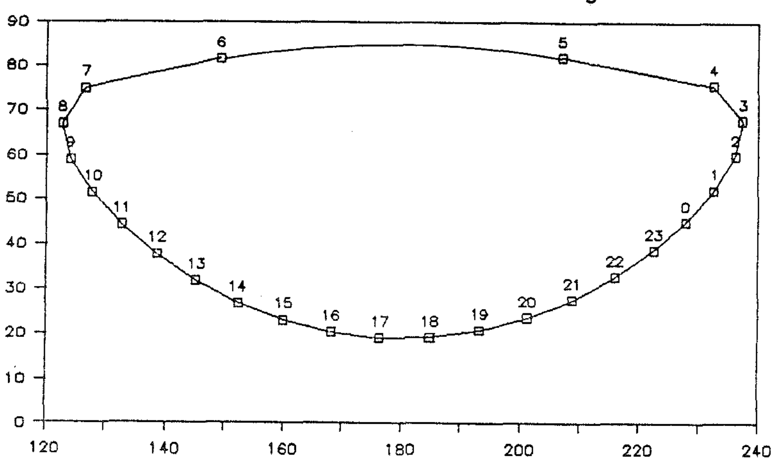
Actie-oproep: radiowaarnemingen

Jeroen Van Wassenhove

Begin augustus komen de ι-Aquariden aan bod, met een maximum rond 5 augustus. De radiant van deze kleine zwerm klimt maximaal 24° boven de horizon (α = 338°,0, δ = -15°). De waarnemingsomstandigheden worden nooit optimaal. Eén richting (noord) levert zelfs geen reflecties op! De waarnemingsperiodes zijn (alle tijdstippen in UT):

Z:	22^h-2^h-5^h	N:	—
ZW:	22^h-1^h-5^h	NO:	22^h-2^h
W:	22^h-3^h-5^h	O:	22^h-0^h-5^h
NW:	1^h-5^h	ZO:	22^h-1^h-5^h

Midden juli verschijnen de eerste Perseïden reeds; de laatste omstreeks 20 augustus. Het maximum valt rond 12-13 augustus. Onderstaande figuur toont de radiantbeweging van de Perseïden. Vergeet niet dat, éénmaal de radiant hoger komt dan 70°, de voorwaarde tot reflectie zeer moeilijk vervuld wordt. Het aantal reflecties per uur zal in die periode (4^h- 7^h) dan ook pijlsnel dalen.



Figuur --- De radiantbeweging van de Perseïden. Horizontaal staat het azimut en verticaal de hoogte van de radiant. De cijfers in de grafiek verwijzen naar de corresponderende data.

Vorig jaar leverde de Perseïden-actie 50% van al het waarnemingsmateriaal van 1986. Ik hoop dat iedereen dit jaar terug van de partij zal zijn.

Indien de uurfrequenties extreem hoge waarden bereiken, geef dan prioriteit aan de signaalsterkte en laat het tijdstip vallen. Beëindig ook uw waarnemingen niet onmiddellijk na het maximum van de Perseïden, maar luister nog enkele dagen langer (bijvoorbeeld tot 18 augustus). De waarnemingsperiodes zijn:

Z:	22^h-2^h en 9^h-14^h	N:	7^h-11^h-4^h
ZW:	7^h-11^h- 19^h	NO:	8^h-1^h-4^h
W:	7^h-10^h-0^h	O:	12^h-1^h-4^h
NW:	7^h-11^h-3^h	ZO:	16^h-5^h-3^h

Tot slot nog enkele waarnemingstips:

- Vraag tijdig uw waarnemingsformulieren (gratis) aan;
- Vooraleer je uw waarnemingen start, kijk uw opstelling nog eens grondig na;
- Vul steeds uw waarnemingsformulier *volledig* in;
- Vorig jaar werd er een vrij hoge activiteit geregistreerd op 8 augustus rond de middag (12^h UT). Luister als het kan ook even op die dag, rond 18^h UT.
- Laat uw waarnemingen niet in de kast liggen, maar stuur ze tijdig op (voor de 15de van de volgende maand).

Veel succes!

Weekend der Amateurs

Hasselt - 7–8 november 1987

Paul Roggemans

In het vorig nummer vonden de Belgische abonnees een inschrijvingsformulier voor het geplande weekend. Buitenlandse amateurs zijn evenzeer welkom. Zij kunnen een inschrijvingsformulier bekomen bij de werkgroep meteoren.

De laatste jaren is er een opvallende daling van het aantal deelnemers aan amateursbijeenkomsten. Slechts 10% van de leden van de VVS neemt af en toe deel aan een bijeenkomst, doch ook hierin blijkt jaar na jaar een dalende trend. Voor de meeste mensen is de verplaatsing te tijdrovend, als men 's morgens vroeg op moet om na een vervelende treinreis aan te komen halverwege een voordracht en dan na enkele uren weer op de loop moet gaan om de trein te halen. Men heeft nauwelijks de kans om met collega amateurs te spreken. Organisatorisch zijn de VVS-bijeenkomsten ook niet bepaald goede voorbeelden. Soms bleek de zaal onvindbaar, of was de zaal te klein, of men zit helemaal niet rustig en wordt gestoord door andere activiteiten. Na herhaaldelijke slechte ervaringen blijft men thuis. Bestaat er een andere formule die tegemoet komt aan de verwachtingen van de deelnemers?

Jarenlang kennen we de internationale meteorenweekends, een succes waar deelnemers van ver naar toe komen. In Nederland bestaat de bekende bijeenkomst in Roden in het voorjaar, een succesrijke weekendbijeenkomst waar velen naar uitkijken. Na het meteorenweekend in oktober vorig jaar stelde Ludwig Cluyse voor om een weekend der amateurs te organiseren i.p.v. een dag der amateurs. Dit initiatief werd inmiddels voorbereid en bij vele amateurs gunstig onthaald. We zijn ervan overtuigd dat het een succes zal worden. Wat zijn de voordelen van deze nieuwe formule?

- De verplaatsingskosten : het loont de moeite om geld tijd en moeite te spenderen om naar dit weekend te komen. Wie het hele weekend blijft heeft 30 uren tijdens dit weekend. Alle amateurs blijven samen, ook tijdens de maaltijden kan men van gedachte wisselen. 's Avonds is er tijd tot wanneer men zijn slaapvertrek wil opzoeken. Alles gebeurt in hetzelfde gebouw. Toevallig heeft de NMBS nu ook het weekendretourbiljet gereduceerd; je betaalt 60% van de normale prijs voor de eerste persoon en volgende medereizigers betalen 40% ! Bovendien proberen de organisatoren te bemiddelen om een soort van carpooling te organiseren. Verplaatsingskosten kunnen geen reden meer zijn om een gans weekend weg te blijven van een amateursbijeenkomst.
- Organisatie verblijf : je kunt overnachten aan een spotprijs, maaltijden zijn te bekomen aan een zeer redelijke prijs. Het gebouw waar de zaak doorgaat is modern en zeer goed ingericht. Restaurant, bar, vergaderlokalen en slaapkamers zijn volledig ter beschikking van de VVS. Men moet weliswaar op voorhand inschrijven (reserveren) voor de maaltijden en voor de overnachting, doch dit garandeert een vlotte organisatie. Er worden diverse mogelijkheden geboden : ruilbeurs, tentoonstelling van eigen werk, vergadering in afzonderlijke lokalen en natuurlijk het programma met voordrachten zoals men dit kent van de vroegere Dag der Amateurs. Wat dit laatste betreft wordt gestreefd naar een niet overladen programma met vooral 's avonds veel tijd voor informele contacten. Er zal ter plaatse gezorgd worden voor de bar en voor ruimte waar men gezellig kan zitten praten. Het hoofddoel is immers gericht op het verbeteren van de onderlinge contacten en samenwerking tussen amateurs. Elkeen zal een naamplaatje ontvangen zodat men weet wie wie is.

We hopen dat vele werkgroepleden zullen inschrijven. Schrijf nu in, want het weekend zou wel eens uitverkocht kunnen geraken. Dit is voor u misschien de goede gelegenheid om de bekende namen uit *WGN* persoonlijk te leren kennen en om uzelf beter te integreren in de werkgroep. We hopen u daar te kunnen ontmoeten. Tot ziens in Hasselt op 7-8 november !

Bij deze gelegenheid doen we ook een beroep op werkgroepleden die willen helpen bij de praktische organisatie. Neem contact op met de werkleider !

(vervold van pagina 103)

Vervolgens besteden we aandacht aan zuidelijke zwermen onder de vorm van drie bijdragen van Jeff Wood. Het btreft hier de κ-Pavoniden, de γ-Normiden en de δ-Pavoniden die van hieruit natuurlijk niet waarneembaar zijn. Terwijl de laatste twee een eerder zwakke activiteit vertonen, werd de eerste ontdekt tijdens routinewaarnemingen in 1986; dit onderstreept nogmaals het belang van dergelijke observaties - iets onverwachts is altijd mogelijk.

De hoofdbrok van dit nummer is een uitgebreide studie van Peter Brown over de Perseïden 1986 in Canada. Verschillende merkwaardige karakteristieken volgend uit de gedane waarnemingen worden vermeld en verklaringen voorgesteld. Opvallend aan de Perseïden 1986 vond Peter Brown het ontbreken van zeer heldere meteoren.

In de rubriek waarnemingsresultaten komt het jaarverslag 1986 van de Noorse Meteorengroep aan bod alsook nagekomen resultaten van de Geminiden en de Ursiden uit Finland.

In de rubriek met samenvattingen uit de vakliteratuur hebben we gekozen voor vijf artikels die verband houden met in dit nummer behandelde onderwerpen. Twee gaan over de verwantschap tussen bepaalde kometen en bepaalde zwermen, één over meteorenstormen en twee over de oorsprong van de Geminiden.

Tenslotte volgen enkele korte berichten, waaronder een belangrijke oproep van Paul Roggemans voor wie in 1988 de Perseïden wil waarnemen vanuit Zuid-Frankrijk!

Marc Gyssens

The Shooting Star

Across the darkened dome of night
Where sun-kings reign till break of dawn
A shooting star darts fast and bright,
Then like a spectral light is gone;
It fades from sight, and leaves behind
No more a trace than passing wind.

Yet, now and then, some shooting star
Remains much longer in the sky,
It gleams resplendent near and far,
But just the same its light must die;
Its splendor shines a little more,
Then like a breath its life is o'er.

Thus ev'ry man, both great and small,
Whate'er his wealth or mind or fame,
Must share the common lot of all,
And leave behind a fading name;
However grand his life may be,
It soon is just a memory.

Charles Nevers Holmes, 1921.

Bijdragen voor het oktober-nummer dienen Marc Gyssens (adres op binnenzijde achterkaft) te bereiken vóór 1 september.

While already editing this issue of WGN we received a contribution from Dr. Olsson-Steel in which the possibility of a strong meteor shower or even a storm in October of this year is discussed. In view of the importance of this article we chose to publish it still in this issue as to allow the various observing groups sufficient time to organize the necessary actions. At the same time we wish to thank Dr. Olsson-Steel of the Lund Observatory in Sweden for his interest in WGN and for communicating his findings to the amateur meteor astronomers.

Prospects for an Enhanced ε-Geminid Shower in 1987

Duncan Olsson-Steel (Lund Observatory)

It appears likely that comet Nishikawa-Takamizawa-Tago, a long-period comet which passed perihelion in March 1987, is the parent of the ε-Geminid meteor shower. If this comet is in fact the parent, then there is a good chance of a strong meteor shower or even a storm in October 1987.

1. Introduction

Comet Nishikawa-Takamizawa-Tago (1987*c*) was discovered in January 1987, about two months before it passed perihelion on March 17. The orbital elements of the comet were determined to be (1) (epoch 1950.0):

Perihelion distance	q = 0.869380 AU
Eccentricity	e = 0.995259
Inclination	i = 172°.2385
Argument of perihelion	ω = 200°.4009
Longitude of ascending node	Ω = 175°.3102

Calculating the theoretical radiant of this comet (i.e. the radiant with which meteors would appear if they intercepted the Earth moving in the same direction as the comet at the position of closest approach to the Earth's orbit (2,3,4)) one finds the following radiant:

Date	October 7
Right ascension	α = 93°
Declination	δ = +28°
Pre-atmospheric velocity	V_∞ = 71.8 km/s

This cometary radiant may be compared to the observed ε-Geminid radiant, as shown in the Table:

Table --- Observational data about the ε-Geminid radiant.

References	(5)	(6)	(7)
Date (Oct)	16-23	16-27	14-27
α	101°	102°	104°
δ	+27°	+27°	+27°
V_∞ (km/s)	71.9	70.9	70.3

The cometary radiant is apparently in excellent agreement with the observed radiant. The offset in the times of activity would be due to the meteoroid stream having slightly different orbital elements to those of the comet, such that the stream intersects the Earth about 10-15 days after the closest approach by the comet's orbit. The difference of about 10° in the values for the right ascension would be expected due to diurnal motion of the radiant just below $\Delta\alpha$ = 1°/day;

an observed motion of $\Delta\alpha = 0\overset{\circ}{.}7$/day has been reported, with $\Delta\delta = 0\overset{\circ}{.}0$ (7).

The October closest approach between the Earth and the comet's path occurs with a minimum geocentric distance of 0.048 AU. About July 21 there is another approach at a wider separation (0.117 AU). The theoretical radiant for that date is:

Perihelion distance	July 21
Right ascension	α = 35°
Declination	δ = +19°
Pre-atmospheric velocity	V_∞ = 72.2 km/s

2. The parentage of the ε-Geminid shower

Although a consideration of just the observed radiants given above and the cometary radiant in October might be thought to prove the genetic relationship between comet 1987*c* and the ε-Geminid meteor shower, in fact there is another comet which renders a similar radiant: this is comet 1964 VIII P/Ikeya (3). The theoretical radiant for that comet is:

Perihelion distance	October 23
Right ascension	α = 107°
Declination	δ = +27°
Pre-atmospheric velocity	V_∞ = 70.4 km/s

Thus considering only the radiants it would appear that 1964 VIII might be a better candidate as the parent.

In investigating the origin of meteor showers it is conventional to compare the stream orbit with that of the comet by means of the D-criterion invented by Southworth and Hawkins (8). On this basis, or using the revised discriminant of Drummond (9), there is little to choose between the two comets, although 1987*c* does give a slightly better fit (10). Similarly a direct comparison of the direction of perihelion of the ε-Geminid stream with that of each of the comets shows a slightly more favorable fit to the parameters of 1987*c* (10); nevertheless there is insufficient difference for one of the other to be definitely asserted as being the parent.

However comet 1987*c* has a conclusive advantage in its candidature in one very important aspect, as follows. The approach of the Earth to the orbit of 1964 VIII on October 23 is at a geocentric distance of 0.122 AU whereas on July 10 it makes a much closer approach: to within 0.044 AU. Thus a stronger shower would be expected in July, as has been previously pointed out (3,9,11). One possible reason for the non-observation of a shower in July is that the radiant transit is at about 07^h00^m local solar time, and hence it would not be easily observable in the Northern Hemisphere using visual or photographic techniques; however this does not explain the absence of radio observations, or visual detection from the Southern Hemisphere. In contradistinction to 1964 VIII, the path of 1987*c* makes its closest approach to the Earth in October when the ε-Geminid shower is seen and its more distant approach in July when no shower has been detected. It therefore appears that 1987*c* is the most likely of the two to be the parent of the ε-Geminids.

3. The prospects for October 1987

If comet 1987*c* *is* the parent of the ε-Geminid shower, then obviously there is a chance of enhanced activity this year. The comet passed the position in its orbit equivalent to the October close approach by the Earth on February 18, 1987: thus the comet preceded the Earth to that point by 230-240 days. At that point the heliocentric distance of the comet was 0.983 AU and that of the Earth will be 0.999 AU, so that the comet's path is 0.016 AU nearer to the Sun at the position of closest approach. Those meteoroids which strike the Earth will therefore be lagging *behind* the comet and *outside* of its orbit, and these conditions (behind and outside) have been shown by Yeomans (12) to result in spectacular showers or storms of the Leonids when the position of the parent comet (P/Tempel-Tuttle) is compared to that of the Earth at each shower. In view of this it appears likely that there will be an enhanced ε-Geminid shower in October 1987; for more details of the encounter conditions, see (10).

One final question which might be asked is when the presently-observed meteors were released by the comet? If one assumes that significant meteoroid release by a cometary nucleus does not begin until it comes within 3 AU of the Sun then such release by 1987*c* began about 190 days prior to perihelion passage, or about 160 days before the comet passed to position equivalent to the October close approach. Thus meteoroids released in the present apparition *cannot* lag the comet by 230-240 days, and *will not* be observed this year: any observed meteors must have been ejected by the comet on a previous passage through the inner solar system. From the values of q and e given in the Introduction, the period of 1987*c* is of the order of 2500 years, so that any observed meteors will have been on free orbits for at least that long.

4. Conclusions

It appears likely that comet Nishikawa-Takamizawa-Tago (1987*c*) is the parent of the ε-Geminid meteor shower. If this is the case then enhanced meteor activity would be expected this year. Although the closest approach by the Earth to the comet's orbit occurs on October 7, the shower has previously been observed in the period October 14-27. A meteor watch over this entire three-week period is therefore recommended: since many observers will be monitoring the sky for Draconid (also called Giacobinid) activity at the earlier date, and for the Orionids later in the month, it seems unlikely that any strong shower would be missed. The author would be pleased to receive any reports of ε-Geminid activity.

Acknowledgment

During 1987 the author is European Space Agency Fellow at the *Lund Observatory, Box 43, S-22100 Lund, Sweden*; from January 1988 his address will be: *Department of Physics, University of Adelaide, GPO Box 498, Adelaide, South Astralia 5001, Australia*. Discussions with Dr. B.A. Lindblad were appreciated.

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Photography: See what you will get

Christian Steyaert

A method is described to determine in advance which part of the sky will be covered by a camera during a photographical meteor watch. This is in fact the opposite of the astrometric problem.

In planning meteor photography, obviously the direction of the camera axis has to be selected. In the case of simultaneous photography, this direction will be determined by the commonly photographed area at the height of about 100 km. Otherwise, the photographer is free to direct his camera, but the following elements should be considered:

- the distance of the photographed field from the active radiant(s);
- the presence of the Milky Way, which can decrease the maximum exposure time;
- the elevation of the camera (loss in limiting magnitude and increased light pollution at lower elevation).

In order to make a choice,the photographer would like to see in advance which part of the sky he will obtain with a given camera. This is possible by now in using a micro-computer, a star catalogue on disk, and a printer/plotter or a graph.

The projection of a 35 mm camera with a commonly used lense (50 mm -28 mm) is of the geometric type, i.e. great circles are mapped as straight lines. The projection is fully determined by the 6 *plate constants*:

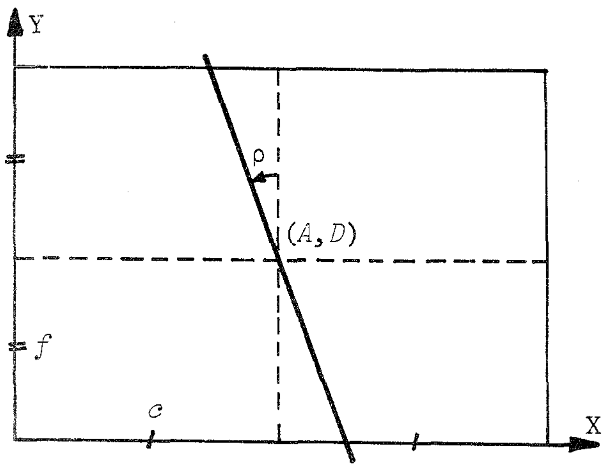

Figure 1 --- The plate constants.

A,D: right ascension and declination of the camera axis in degrees;

K: focal length in mm;

c,f: abscis and ordinate of the camera axis at the center of the frame (mm)

ρ: rotation angle in degrees.

Most of these constants are illustrated in Figure 1.

When the camera axis is fixed on a equatorial mount, A and D can be set directly and ρ = 0. More likely, a meteor camera is mounted alt-azimuth on a normal tripod. The X-axis is parallel to the horizon and the Y-axis is the vertical through the center of the plate. The azimuth Az and the elevation h will be set. Knowing place and time, A, D and ρ have to be calculated.

Formulae are readily available for converting (Az,h) into (A,D) and vice-versa, but ρ poses a problem. In fact, in the classical spherical triangle, this angle has not even been given a name!

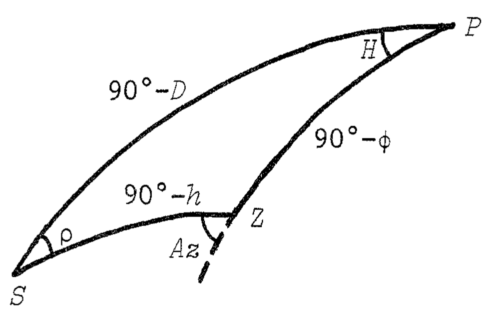

Figure 2 --- The elements of the sperical triangle:

P: North Pole
Z: zenith
S: object (plate center)
ϕ: latitude
H: hour angle

The sine law gives the answer:

$$\frac{\sin(-\rho)}{\cos\ \phi} = \frac{\sin Az}{\cos\ D} = \frac{\sin H}{\cos h}$$

The minus sign is due to the convention adopted in Figure 1. (The ambiguity about ρ from knowing only sin ρ can be avoided in using a vectorial procedure.)

Let us illustrate this with an example. We plan to photograph with a standard camera on July 20, 1987 from λ = 6° and ϕ = 44° (Provence, Southern France) around 23^h UT. During that period we can count on the activity of the α-Capri-

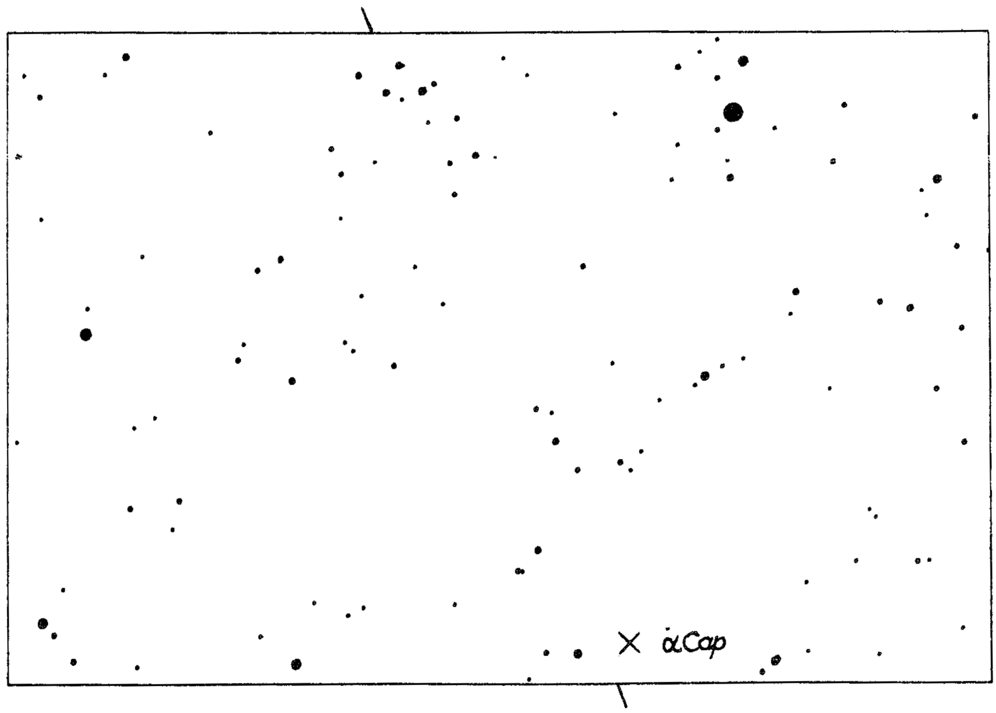

Figure 3 --- Plot of the sky for St.-Michel, July 20, 1987, 23^h UT with A = 309°.9, D = 2°.9, K = 180 mm, c = 65 mm, f = 43 mm and ρ = 21°.1

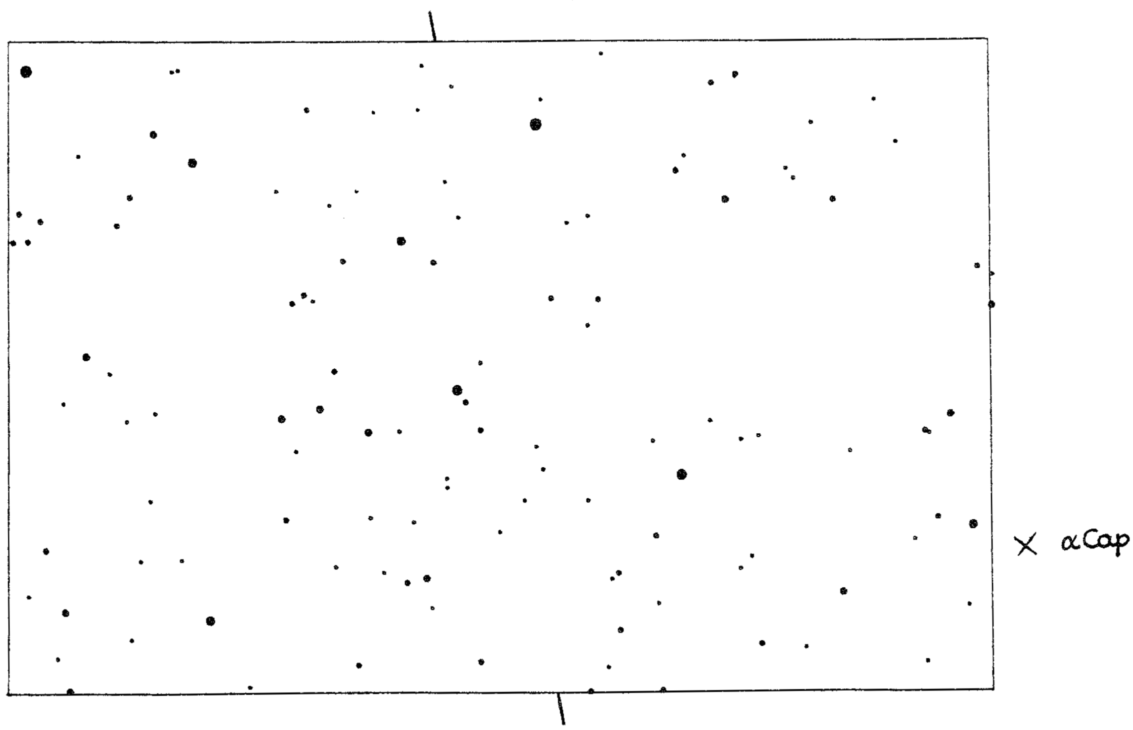

Figure 4 --- Plot of the sky for St.-Michel, July 21, 1987, 1^h UT with A = 328°.8 D = 0°.0, K = 180 mm, c = 65 mm, f = 43 mm and ρ = 10°.7

× δAqr

cornid and δ-Aquarid showers. In order to allow a good radiant determination, we would like to photograph not too far from the radiants. However, they are, even at culmination, not so high in the sky.

As a first attempt, we take Az = 330° and h = 45° for the camera direction. This yields: A = 309°.9, D = +2°.9 and ρ = 21°.1. A typical print of the full negative would measure 130 x 86 mm, compared to the 36 x 24 mm of the negative. This means a linear enlargement of 3.6, or an effective focal length K = 50 mm x 3.6 = 180 mm. Figure 3 shows the plot of what will be obtained. The Becvar star catalogue has been used. The "X" indicates the position of the α-Capricornid radiant. The two short lines at the bottom and top of the frame give the direction of the meridian through the center of the plate. The brightest star is Altair and the typical shape of Delphinus is easily recognized. The original choice turns out to be suitable.

Later on the same night, we can track more or less the radiants. The set-up for 1^h UT could be as in Figure 4: Az = 345°, h = 45°.

We also want to discuss the relation of the problem we discussed with astrometry. The astrometric problem is actually the opposite of the map drawing treated here. Given an exposure, astrometry is concerned with identifying the 6 plate constants. This is a longer, iterative process. The Photographic Meteor Data Base (PMDB) lists the plate constants of all exposures. Making a plot which overlays with the print is then straightforward.

The author is prepared to provide plots like Figures 3 and 4 to anyone interested in planning his or her photographic action.

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Reflection Duration Determination:

An Experiment

Christian Steyaert

In this article, the results of an experiment are discussed that was set up to determine the accuracy of reflection duration estimates in radio meteor observing.

1. Introduction

On the radio meteor observing form, audio observers of meteor reflections are asked to give an estimate of the duration of the reflection. The duration is very important (more important than the signal strength), as it relates to:

- the visual magnitude of a meteor;

- the population index of a stream.

There are more shorter duration reflections, as there are more fainter meteors. The purpose of the experiment described in this article is to find out if the reflection durations were sufficiently accurately estimated by various observers for allowing statistical calculations about the meteor population.

2. Setup

Three observers were asked to estimate the duration of "artificial"reflections, as generated by a computer loudspeaker. In order to come as close as possible to reality, both the time between the reflections and the duration were exponentially distributed.

Two intervals of 10 minutes, the first with on average 5 reflections per minute, the other with 10 reflections per minute were recorded on tape with a simple condensor microphone. These rates were told to the observers up front. There was also some background noise, due to the computer fan and activity in the room. The artificial reflections were of constant amplitude and the tone varied randomly between 600 and 1000 Hz. Hence, the duration was sharply defined, better than in the case of real meteor reflections. A computer listing with the time interval duration up to 0.01 s was generated for checking afterwards. The participants were asked to observe as usually, noting time and duration.

3. Results

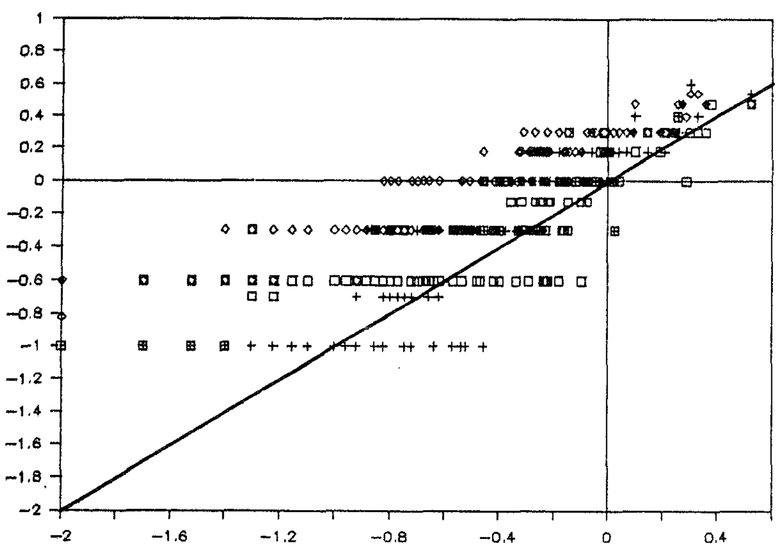

Figure 1 --- Results of the reflection duration experiment. On the horizontal scale is the logarithm of the true duration and on the vertical one the logarithm of the estimated duration.

At first, the observers remarked that the fastest reflection rate (10 per minute) gave problems in noting down the required details. Due to this, some reflections were missed. Each observer has established classes for the short durations. The relevant values are: 0.1 s, 0.25 s, 0.5 s, 0.75 s, 1 s, 1.5 s, 2 s, 2.5 s and 3 s. Still longer durations were rounded to the second. The figure shows the results on a logarithmic scale, as the statistical calculations are based upon the logarithms of the durations. Accordingly, an error of 0.5 s on a 3 s reflection is relatively less important than 0.1 s on 0.5 s. It turns out that all three candidates systematically *overestimate* the duration. In Table 1 below, the results are listed (LG = Luc Gobin, MD = Maurice Demeyere, JV = Jeroen Van Wassenhove).

Table 1 --- Comparison between true and estimated duration.

Obs.	N	true dur. (s)		est. dur. (s)	
		avg.	st.dev	avg.	st.dev
LG	128	0.53	0.57	0.63	0.58
MD	141	0.52	0.54	0.54	0.72
JV	143	0.52	0.54	1.08	0.74

Unfortunately the errors cannot be reduced to a simple shift or constant factor between the true and estimated duration. The regression lines on logarithmic scales given by:

$$\log T_{\mathrm{est}} = a + b \log T_{\mathrm{true}}$$

were determined as in Table 2, below.

Table 2 --- The parameters of the regression lines.
ρ: correlation coefficient
σ^2: unexplained variance after the regression

Obs.	a	b	ρ^2	σ^2
LG	-0.06	0.546 ± 0.033	0.686	0.199
MD	+0.06	0.772 0.034	0.791	0.128
JV	+0.21	0.523 0.021	0.814	0.139

Only when coefficient b would be sufficiently close to 1, further calculations can be based upon the results without needing empirical corrections.

4. How to improve

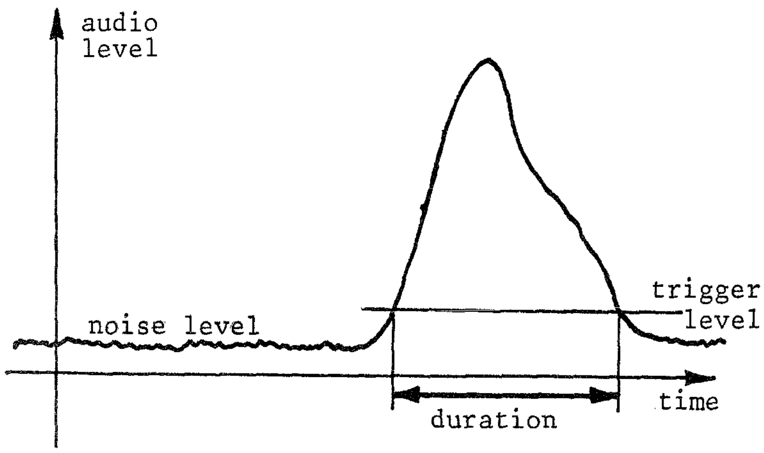

Figure 2 --- Electronical timing of the reflection duration.

Most people have a bad perception of short durations (not above 1 s), as they have no reference duration in mind; a duration of 1 s is quite long.

The way to overcome this problem is training, listening to and memorizing durations of a specific length. Hence a tape will be made were first the duration is spelled out, followed by the reflection, and this for the whole range of durations. Next, some reflections of unknown duration will be given, followed by the correct duration.

The duration of a reflection can also be timed electronically, and displayed to the observer (e.g. to 0.01 s). (See Figure 2.)

The Relation between Visual Magnitude and Echo Duration

Jeroen Van Wassenhove

In this article, the relationship between the echo duration and the visual magnitude of a simultaneous radio-visual meteor is examined. A linear relationship between the visual magnitude and the logarithm of the echo duration seems to fit rather well.

1. Introduction

In 1931, Schafer and Goodall suspected a relation between the so-called "night time E-region abnormalities" and meteoritic ionization, but they could not prove it conclusively due to magnetic disturbances (1). One year later, by observing the Leonid shower, they were able to confirm it.

The following years, other observers also invistigated this subject, e.g. Minohara and Ito in Japan; Mitra, Syan and Ghox in India; Quäck and Pickard... After World War II, Hey and Stewart also noticed this relation (2).

In the early fifties, several workers treated the relation between visual magnitude and echo duration of a meteor in detail. Extensive investigations, by means of simultaneous radio and visual observations, were carried out by Lindblad (3), Millmann and McKinley.

2. Observational results

In 1986, two observers were able to to carry out simultaneous work. In August, Jeroen Van Wassenhove made radio observations (forward scatter) of the Perseids

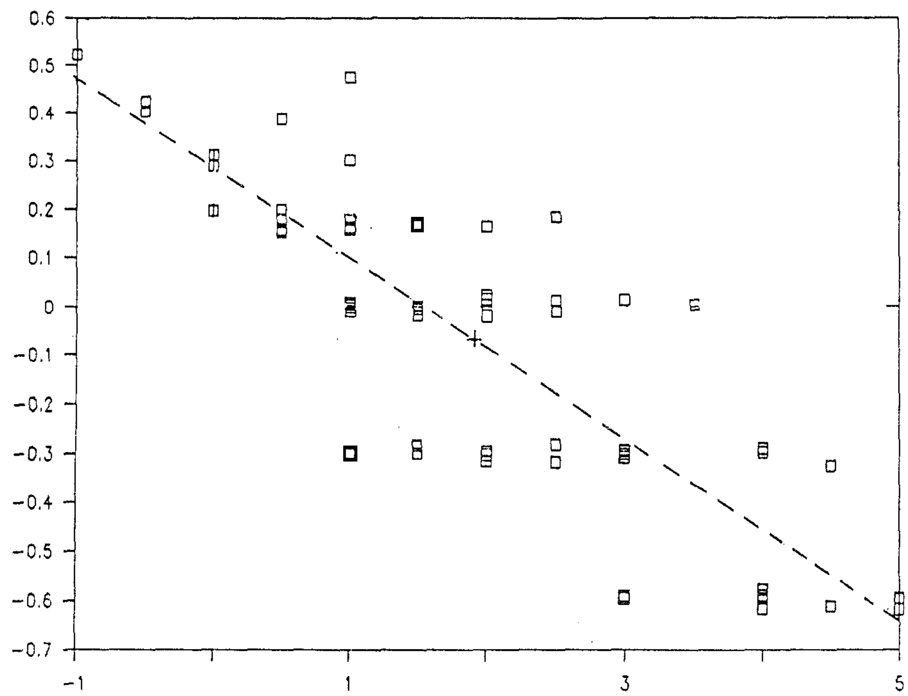

Figure 1 --- Visual magnitude - echo duration relationship for Jeroen Van Wassenhove (Puimichel, France, August 1986). On the horizontal axis is the (uncorrected) visual magnitude, on the vertical the logarithm of the echo duration.

at Puimichel, France. He looked for visual coincidences. In this way, 64 radio-visual meteors were obtained. This resulted in the following relation, obtained by linear regression analysis:

$$\log T = -0.182\ Mv + 0.288$$

with correlation coefficient $\rho = -0.83$, where T is the echo duration and T the uncorrected estimated visual magnitude of the meteor. T is expressed in seconds.

In October, Christian Steyaert went to Puimichel and carried out radio observations (forward scatter) of the Taurids. He also estimated the magnitudes of the visual coincidences. This yielded 26 simultaneous meteors. The estimated magnitudes were corrected for the zenithal distance with the formula:

$$Mz = Mv - 5 \log \cos z$$

Mz is the zenithal magnitude, i.e. the magnitude the meteor would have when seen in the zenith.

With this corrected data, we found the following relationship:

$$\log T = a.Mz + b$$

with:

$$a = -0.228 \pm 0.047$$
$$b = +0.331$$

No corrections were applied to the echo durations for both cases. The results of Christian Steyaert's observations are shown in Figure 2.

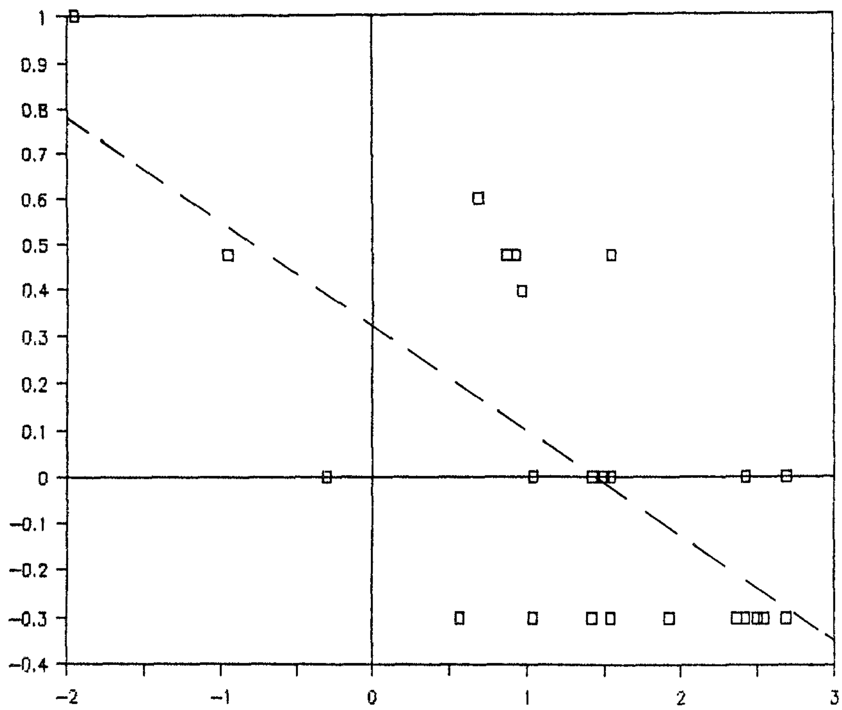

Figure 2 --- Zenithal magnitude - echo duration relationship for Christian Steyaert (Puimichel, France, November 1986). On the horizontal scale is the zenithal magnitude, i.e. the observed visual magnitude after zenithal correction and on the vertical one the logarithm of the echo duration.

The greatest number of echo durations are situated between 1 and 5 seconds. The longest echo duration is 10 seconds.

3. Conclusion

In spite of the small number of data and few corrections applied, the obtained relationships seem to fit rather well. In the future we hope to obtain such results more regularly.

Acknowledgment

The author wishes to thank Christian Steyaert for his support.

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On the Perseids of 1986

Peter Brown

In 1986 members of the Alberta Meteor Group, Canada, observed the Perseids. In all 651 Perseids and 517 sporadic meteors were recorded. Peak rates were seen during August 13.2–13.4 UT, with an integrated ZHR of 48.2. An analysis of the magnitude distribution was made. The average particle size is found to gradually increase from the beginning of the activity to 3–5 days before maximum. Thereafter the particle size falls off. A proposal is made to account for unusually bright peak nights. No substantial variation from past years is found, with the exception of an unusual absence of bright meteors.

1. Introduction

The Perseid meteor shower is one of the strongest and most reliable showers of the year. Peaking each year on or about Aug 11-12 the shower offers a unique opportunity to study over a long term, the evolutionary processes of a well-established meteor stream. With the possible return of the Perseids parent comet, Swift-Tuttle during the 1980's, a very careful watch has been kept on the shower. Very strong displays were seen in the mid-1970's culminating in the spectacular 1980 Perseid display, undoubtly the best return of a meteor shower since the 1966 Leonid display. A typical example would be the 1980 observations of this shower by Roggemans who managed to obtain ZHR's as high as 170, (Meteor News, 52, Jan 1981). 1982 was the expected return date of Swift-Tuttle, but so far no major outburst seems to have occurred. The last truly rich return appears to have occured in 1981, (Meteor News, 56, Jan 1982). In fact, the shower is apparently getting progressively weaker since the 1980 and the 1981 displays, suggesting that one of these years may have been the maximum.

This paper describes observations carried out by members of the Alberta Meteor Group, (hereafter AMG), during the 1986 return of the Perseids and the results of those observations. In all, 651 Perseids and 517 sporadic meteors were observed and given magnitude estimates on 12 nights from July 30 to August 30, 1986. Magnitude estimates were made to the nearest whole magnitude. As well meteors from other showers active during this period, such as the δ-Aquarids, were recorded and separated from the sporadic background. In all, well over 1200 meteors were seen and recorded.

2. Historical

The Perseids are not only rich in number and annual returns but are also rich in history, and have a large number of meteoritic firsts attached to their name. The shower was first to be noticed to recur on an annual basis, this fact being ascertained by the Belgian, A. Quetelet in 1836. The first established radiant points, though, were given by the American Prof. John Locke in 1834 followed by G.C. Shaffer in 1836. In popular literature the Irish may be given credit for noting them as the 'Tears of St. Lawrence', with St. Lawrence having been killed at or near the date of maximum of the shower.

In 830, ancient Chinese chronicles give what appear to be the first record of the shower. As well there are a number of records suggesting that the shower was quite active in the 10th and 12th centuries.

The Perseids were also the first shower in which the radiant was observed to 'wander' with respect to the background stars. A.C. Twinning published his observations in 1861, (Am. Jour. Sci. Vol. 32, p. 444), and showed conclusively that the radiant point changed its position with respect to the stars throughout the period of visibility. Denning in England reached the same conclusion based on his observations shortly thereafter.

The Perseids were identified in 1866 as occupying the same orbit as 1862 III, (or comet Swift-Tuttle), by the brillant Italian scholar Schiaparelli, although it appears the American H.A. Newton came to the same conclusion a year or two before. This apparent connection between comets and meteor streams is one of the most important, historically, in meteor science, having been first suggested, though not proven, as early as 1837.

The Perseids have been regularly observed since the mid-19th century and thus offer an unprecedented look at the dynamic behaviour of a reasonably evolved meteor stream.

3. Data reduction methods.

Before describing and analyzing the observations it might be worthwhile to describe the methods used to compute various values, such as the ZHR and the population index. All corrections applied to obtain the ZHR from the observations will be described here.

3.1 Computation of the population index (r).

One of the important physical quantities that describe a meteor stream is the population index. This index tells us the value that one theoretically observed magnitude distribution must be multiplied by, or divided by, (depending on whether you are going to fainter or brighter magnitudes respectively), to obtain another. Of course there is no one number that perfectly describes this relation, but instead we must try to find a least squares fit, using linear regression to compute the best value for the observed data. An excellent description of this method was given in *WGN 14:2* by Paul Roggemans, but the method will be described here again.

First we must assign a perception function for each magnitude, i.e. how many of the total number of meteors visible in the entire observer's sky the observer actually sees. From this correction a theoretical observed magnitude distribution is obtained and a cumulative distribution is found by adding the total theoretical number of observed meteors to the total theoretical observed number of meteors in the next faintest magnitude class. Then this number is taken and added to the next faintest class, and so on until by the time the faintest magnitude distribution is reached, we have effectively added all numbers for all the theoretical magnitude distributions obtained. The magnitude range over which the calculation of r is to made depends on the observed distribution, and it is up to each analyst to decide what magnitude range is best for his data. This will be discussed in greater detail later.

All these parameters have been listed in table 1. $N(m)$ is the number of meteors

Table 1 --- Parameters for calculating r

Mv	−4	−3	−2	−1	0	+1	+2	+3	+4	+5
$N(m)$	2	4	16	29	65	110	155	155	87	28
$P(m)$	.95	.87	.76	.64	.53	.42	.31	.19	.08	.01
$T(m)$	2.1	4.6	21.1	45.3	122.6	261.9	500	815.8	1087.5	2800
$C(m)$	2.1	6.7	27.8	73.1	195.7	457.6	957	1773	2861	5661

observed in each magnitude class. $P(m)$ is the perception coefficient for each magnitude, and is derived from observing tests and experiments, comparing, as best as can be done, the number of meteors of a given magnitude the observer sees to the actual numbers seen over the entire sky. $T(m)$ is the theoretical number of meteors observed in each magnitude class, obtained by dividing $N(m)$ by $P(m)$. $C(m)$ is the cumulative distribution. Care must be exercised in evaluating $P(m)$ as it certainly varies from observer to observer and the values of $P(m)$ become very uncertain in the fainter magnitude classes. The data listed in table 1 is from the 1986 observations of the Perseid stream by the AMG.

This is all the information necessary to compute r. First we will assign the variables x and y to the magnitude, and log $C(m)$ of each class respectively. We also must compute the values x^2 and xy and now use the general formula :

$$\log r = \frac{n(\Sigma xy) - (\Sigma x)(\Sigma y)}{n(\Sigma x^2) - (\Sigma x)^2} \quad (1)$$

where n is the number of data points, (or the number of magnitudes) overwhich the calculation was done; in our case this was 10 in the range $-4 < Mv < +5$, and Σxy is the sum total of the values of xy in this range; in our case 42.4324, and Σx is the sum of the values of x; in our case 5. Also Σy is the sum total of the values of y; in our case 22.8495 and Σx^2 is the sum of the values of x^2; in our case this value is 85. If these numbers are put into eq. (1) and solved for $\log r$ so as to obtain r we arrive at 2.38 over the entire observed magnitude range, (-4 - +5). This will be discussed in more detail later.

3.2 Corrections applied to the observations

It is inevitable when attempting to derive a realistic picture of any one shower's activity that numerous corrections for obstructions, clouds,etc. will be applied in order to 'standardize' a set of observations. Of course, for every correction applied the uncertainty in the final number increases. Unfortunately there is, as yet, no one universal set of corrections applied to all observations in meteor work from the many different groups around the world, thus making intercomparisons very difficult. The corrections applied to our observations will be described in order to obtain a final standard value.

First, only observations that had an effective observing time, (T_{eff}), of 1 hour were used, any others were rejected. In all the observations only one half-hour interval was dropped because it did not meet this criterion.

Secondly, corrections for any obstructions of the sky, be it from terrestrial objects or from clouds, were found from the formula :

$$F = 1 / (1 - k) \quad (2)$$

where F is the correction factor and k is the amount of the sky being obscured, expressed as a decimal. If more than .3 of an observer's sky was covered the observation was not accepted.

Next, and most importantly for the shower data, a zenith correction was applied for the altitude of the radiant of the Perseids from :

$$\mathrm{ZHR} = 1 / \sin h \quad (3)$$

where ZHR is the Zenithal Hourly Rate and h is the altitude of the radiant expressed in degrees from the horizon. The value h, further, is derived from :

$$\sin h = \sin \delta \sin \phi + \cos \delta \cos \phi \cos (t - \alpha) \quad (4)$$

where δ is the declination of the radiant, ϕ is the latitude of the observer, t is the local mean sidereal time and α is the right ascension of the radiant.

In order to correct for the brightness of the sky background the Lm, or Limiting Magnitude, was determined by counting the number of stars in a specified region of sky and then consulting the appropriate F.E.M.A. star region tables in order to determine the Lm based on starcount. F.E.M.A. stands for the Federation of European Meteor Astronomers. Measurements were made at half-hour intervals and then weighted to derive the final hourly average. Lm's brighter than 5.0 were not accepted. It should be noted that on numerous nights during the observations the Aurora was present and thus greatly reduced the Lm. This, however, will be discussed in more detail later. To apply a final correction our group must first adopt an r value for the Perseid stream and the sporadics. We have adopted what we feel are the most realistic of these values from the literature. For the Perseids we use $r = 2.5$ (1) and $r = 3.5$ for the sporadics from Zvolankova (2). These values are higher than those found in this paper, (when the analysis is done over the entire magnitude range), and this, as well, will be discussed in more detail later.

Once the r values are obtained, correction for the Lm applied to the Perseids is

$2.5^{(6.5 - Lm)}$ and $3.5^{(6.5 - Lm)}$ for the sporadics. Thus a perfect sky is defined, in this paper, as one having Lm of 6.5. Once these values are obtained the uncertainties are found from $1/\sqrt{n}$ where n is the observed number of meteors. However this simple formula assumes that all errors are random, a situation rarely occuring in meteoric astronomy, and this estimate may be a very conservative one. Table 2 lists the Lm and the final corrected values for the ZHR of the Perseids and the Hourly Rate of the sporadics, as a comparison , as well as their respective uncertainties for every hourly observation.

Table 2 --- Hourly breakdown of observations. Observer codes are listed in text.

Date	Obs.	Period (UT)	Lm	N_p	ZHR_p	HR_s
Jul 30-31	PB	05^h26^m-06^h26^m	6.1	3	7.7 ± 4.4	3.3 ± 1.4
30-31	PB	06 26 -07 26	6.2	3	11.3 6.5	8.7 3.6
31-01	MZ	05 29 -06 29	5.8	1	3.2 3.2	13.3 5.0
Aug 01-02	PB	05 25 -06 25	6.0	3	7.7 4.4	13.1 5.0
01-02	BC	05 25 -06 25	6.0	1	2.6 2.6	18.7 5.9
01-02	PB	06 25 -07 25	6.0	7	15.9 6.0	20.6 6.2
01-02	BC	06 25 -07 25	6.0	4	9.1 4.6	11.2 4.6
01-02	PB	07 25 -08 25	6.0	3	6.1 3.5	11.2 4.6
01-02	BC	07 25 -08 25	6.0	3	6.1 3.5	13.1 5.0
02-03	BC	05 30 -06 30	5.5	3	11.9 6.9	10.5 6.1
02-03	PB	05 30 -06 30	5.5	0		21.0 8.6
02-03	BC	06 30 -07 30	5.0	1	5.6 5.6	58.9 19.6
02-03	PB	06 30 -07 30	5.0	2	11.1 7.8	39.3 16.0
02-03	BC	07 30 -08 30	5.0	5	25.1 11.2	19.6 11.3
02-03	PB	07 30 -08 30	5.0	5	25.1 11.2	45.8 17.3
04-05	PB	05 25 -06 25	6.0	9	23.2 7.7	5.6 3.2
04-05	MZ	05 29 -06 29	6.3	5	10.2 4.6	10.3 3.6
04-05	PB	06 25 -07 25	6.0	5	11.4 5.1	16.8 5.6
04-05	MZ	06 29 -07 29	6.3	4	9.4 4.7	6.4 2.9
04-05	PB	07 25 -08 25	6.0	9	18.5 6.2	16.8 5.6
04-05	MZ	07 29 -08 29	6.2	4	7.0 3.5	16.0 4.8
05-06	PB	06 05 -07 05	6.0	14	34.2 9.1	11.2 4.6
05-06	PB	07 05 -08 05	6.0	13	24.5 6.8	9.4 4.2
06-07	PB	05 45 -06 45	6.2	14	28.9 7.7	14.6 4.6
06-07	PB	06 45 -07 45	6.2	9	18.2 6.1	18.9 5.2
06-07	PB	07 45 -08 45	6.2	9	22.4 7.5	13.1 4.4
09-10	PB	04 31 -05 31	6.1	9	27.4 9.1	9.9 4.0
09-10	MZ	04 31 -05 31	6.1	6	18.3 7.5	14.9 5.0
09-10	SK	04 31 -05 31	6.1	7	21.3 8.1	6.6 3.3
09-10	PB	05 31 -06 31	6.35	14	28.9 7.7	14.5 4.2
09-10	MZ	05 31 -06 31	6.35	8	16.5 5.8	12.1 3.8
09-10	SK	05 31 -06 31	6.35	8	16.5 5.8	14.5 4.2
09-10	PB	06 31 -07 31	6.3	13	24.4 6.8	20.6 5.2
09-10	MZ	06 31 -07 31	6.3	9	16.8 5.6	20.6 5.2
09-10	SK	06 31 -07 31	6.3	11	20.6 6.2	3.9 2.3
09-10	PB	07 31 -08 31	6.4	15	22.5 5.8	15.9 4.2
09-10	MZ	07 31 -08 31	6.4	11	16.5 5.0	19.1 4.5
09-10	PB	08 31 -09 31	6.45	25	32.2 6.5	13.8 3.8
09-10	MZ	08 31 -09 31	6.45	12	15.5 4.5	22.4 4.9
09-10	MZ	09 31 -10 31	6.4	7	8.7 3.3	14.7 4.1
12-13	PB	06 36 -07 36	6.3	39	90.8 14.5	9.0 3.4
12-13	MZ	06 37 -07 37	6.3	24	44.7 9.1	9.0 3.4
12-13	SK	07 07 -08 07	6.3	24	42.4 8.7	7.7 3.1
12-13	MZ	07 37 -08 37	6.1	18	35.3 8.3	9.9 4.0
12-13	MZ	08 37 -09 37	6.3	19	27.8 6.4	8.1 3.1

Table 2 (continued)

Date		Period (UT)	Lm	N_p	ZHR_p	HR_s
Aug 13-14	PB	06^h00^m-07^h00^m	6.25	25	53.1 ± 10.6	9.6 ± 3.6
13-14	MZ	06 00 -07 00	6.25	16	34.0 8.5	13.7 4.3
13-14	SK	06 54 -07 54	6.25	27	50.6 9.7	12.3 4.1
13-14	PB	07 00 -08 00	6.3	30	53.0 9.7	24.4 5.6
13-14	MZ	07 00 -08 00	6.3	16	28.3 7.1	23.1 5.4
13-14	SK	07 54 -08 54	6.3	8	12.7 4.5	18.0 4.8
13-14	PB	08 00 -09 00	6.35	32	52.9 9.4	16.9 4.5
13-14	MZ	08 00 -09 00	6.35	16	24.0 5.8	25.3 5.5
13-14	SK	08 54 -09 54	6.35	12	16.4 4.7	15.7 4.4
13-14	PB	09 00 -10 00	6.3	27	47.8 9.2	12.8 4.0
13-14	MZ	09 00 -10 00	6.3	20	35.4 7.9	21.8 5.3
16-17	MZ	09 21 -10 21	6.0	7	12.7 4.8	26.2 7.0
25-26	PB	04 32 -05 32	6.1	2	5.3 3.7	6.6 3.3
25-26	PB	05 32 -06 32	5.7	1	3.5 3.5	10.9 5.5

4. Observations

4.1. Overview

The observation period for this paper ran from July 31 - August 31. An examination of Table 2 reveals that the majority of observation time was during the pre-maximum and maximum nights with very little post-maximum coverage. This was in part due to the moon's unfavorable phase (full on August 18), as well as poor weather which set in during mid-August.

The AMG had planned a full observing campaign from August 09-13, covering the maximum at a dark site in southern Alberta. Three of the five nights turned out to be clear: August 09-10, 12-13 and 13-14. This allowed a great deal of data to be acquired for analysis. Observations outside of this main campaign were made as well by different observers, thus adding more light to the overall picture of the Perseid stream. Although quite a few observers participated, only the four most experienced observers' results were used in this analysis. The participating observers were Bill Crochane, Fort McMurray (BK), Marc Zalcik, Edmonton (MZ), Peter Brown, Fort McMurray (PB) and Sid Klushin, Edmonton (SK).

4.2. Nightly observations

The night of August 12-13 was the expected maximum and the qualitative impressions of the observers (as well as the quantitative) certainly proved this. On this night, individual ZHR's ranged from 91 to 28, a threefold difference in rates over a few hours. Certainly some of these deviations were from the internal structure of the stream itself, but perceptional differences also played a role. The integrated ZHR was 48.2, the highest of the observation period. In the past many observers have claimed that the night of maximum has a high percentage of bright and medium bright meteors, and our observations support this to some degree; however a complete interpretation of this will be made in the section dealing with magnitudes.

Figure 1 (on the next page) lists the ZHR curve derived from observations of the AMG. A reasonably well pronounced peek is seen on August 12-13 followed by another strong night of activity on August 13-14. The error for the integrated ZHR's was found from the standard deviation of the individual ZHR's during each night of observation. Near the beginning of August the Perseids are quite weak and rates remain below the sporadic background from late July until about August 5. After August 5, the curve gradually begin to increase in slope until the maximum on August 12-13 is reached. After the maximum the shower fades fairly quickly until by the 20th it is well below the sporadic background once again.

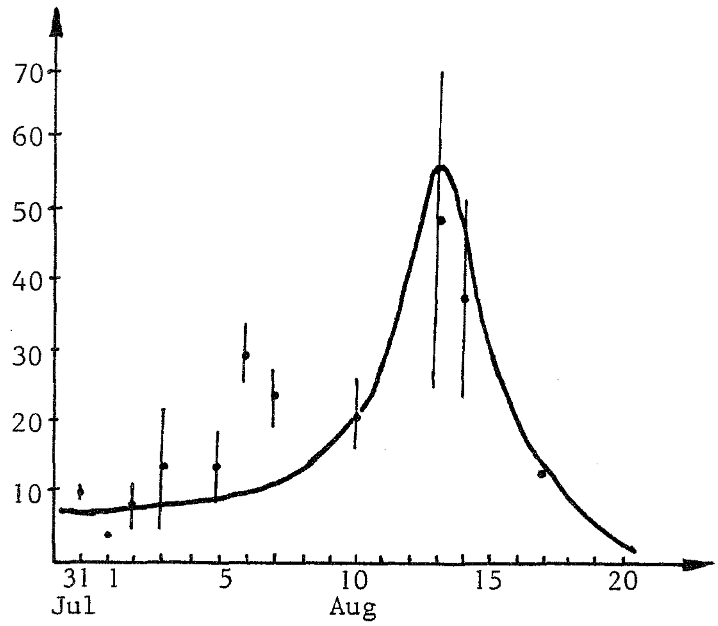

Figure 1 --- Perseid ZHR curve obtained by Alberta Meteor Group in 1985.

The fact that the Perseids can be seen for such a long period of time indicates that the stream has fanned out to a large degree from its primeval dimensions, with the stream width on the order of 100 million km in diameter. This suggests that the Perseids are a very old and evolved stream and the extreme regularity of its returns further suggests that the stream undergoes very little perturbations from the planets, mainly due to its high inclination to the ecliptic.

Referring back to Figure 1 one sees that on August 05-06 and 06-07 the computed ZHR's are extremely high. The ZHR actually appears to decline between August 06-07 and 09-10. In fact, these two nights (August 05-06 en 06-07) were dominated by aurora which in turn led to low *lm* values. Much of the discrepancy is accounted for by the reduced *lm* and if there is no correction made for the *lm* on this night the rates seem to fit the curve well. The main reason why the aurora creates the illusion of enhanced rates stems from its non-uniform appearance in the sky. At certain times the aurora may be extremely bright and block almost all observations, while at other times it may remain quiet for many minutes and in doing so allows rates to pick up dramatically. Thus for meteor observers living in or near the Auroral Oval, the aurora, with its complex distribution in the sky and short-term evolution, creates a very complicated extremely non-linear function to fully account for. This I believe is why the rates on the 05-06th and 06-07th are so hight. The nights near the shower's maximum were virtually aurora free with only a faint glow on the northern horizon on all three nights. Thus our observations give a very general appearance of the Perseid stream's activity (with respect to ZHR's) in 1986.

4.3. Magnitudes

During the observational run covered by this paper, 651 Perseids were given magnitude estimates as were 517 sporadics. The magnitude distribution through a stream is very important as it gives a good idea as to the sizes of the particles at various points in the stream.

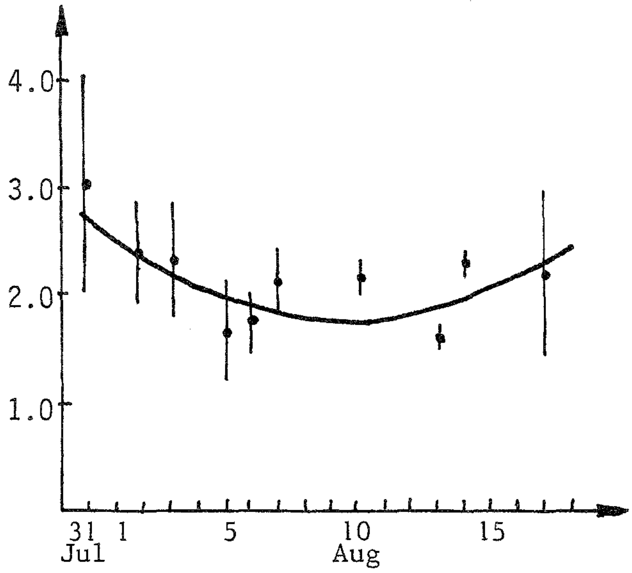

Figure 2 gives the mean magnitude of the Perseid stream on a night by night basis, as well as the standard deviation of each night's observation. It can be seen that the stream starts out fairly faint and gradually grows in brightness, until sometime between August 07 and August 10 the maximum brilliance of the stream is reached. If this is interpreted in terms of particle size, it is clear that the outer parts of the stream generally consist of small particles while the region several degrees of solar longitude before maximum, has the greatest particle size.

Figure 2 --- Perseid mean magnitudes by date.

After this point is encountered, the stream's particle size begins to dwindle, once again.

This trend was also found by Roggemans in his 1985 analysis of over 24 000 meteors (1). He addresses the popularly held belief that the night of maximum of the Perseids corresponds to its night of peak brilliance by saying that during the peak nights of the Perseids many inexperienced observers try to observe them and typically overestimate their brightness. However, many experienced observers have reported the same phenomenon (4), and therefore it may be worthwhile to investigate this possibility further. Our own observations indicate that, this year at least, the peak night does show a tendency to be brighter than might be expected.

This might be accounted for with the following hypothesis: on the peak night meteor rates are typically as high as one or even two a minute. An observer who is trying to record this, even with a tape recorder, may find himself spending a great deal of time looking at his watch or perhaps his report form. He may find it hard to concentrate on observing, and meteors, especially faint ones, may be easily overlooked. As well the high velocity of the Perseids, both geocentric and angular, make the fainter meteors additionally hard to detect. This does not mean that the observer is underestimating the magnitude but rather that for every bright, easily perceived meteor, there may be easily two or three faint ones which are missed. Of course, this is only a hypothesis and other ideas might be equally valid. This hypothesis however could offer a solution to the problem especially if individual group rates are examined. With group rates more and more observations are being dealt with and the tendency of the peak night to stick out as a bright one would be lessened. As more and more observations are accumulated the effect would become smaller until the deviation from the expected curve would be minimal. Therefore we can see why individual or small group observations might show this tendency with their small data bases.

For the 1986 return of the Perseids, the AMG obtained an average magnitude of 1.98 for the Perseids and 2.65 for the sporadic background. The distribution of magnitudes for the Perseids can be found in Table 4, in the following subsection. Clearly, the Perseids are much richer in medium bright meteors (magnitude -2 to +1), but show many fewer meteors in the 4th and 5th magnitude categories than do the sporadics. Clearly almost half of all the Perseids fall in the 2nd or 3rd magnitude category, while the sporadic meteors are more evenly distributed in the 2nd-4th magnitude category. From this it can readily be seen that a typical Perseid meteor is, on average, much brighter than its sporadic counterpart. The only true abnormal characteristic of the Perseid magnitude distribution comes to light when compared to previous years.

This year's display showed the typical bright -3 and -4 Perseids, but in far fewer numbers than in previous years. For example the AMG's own results from 1985 show the same number of Perseids of magnitude -4 and brighter, but this is taken from a sample of less than one third the size of this year's observations. If the number of bright meteors remained roughly in the same ratio one would expect two to three times as many bright meteors in 1986 than in 1985; this expectation is further strengthened by pointing out that much more observing time was spent at and near the maximum than in 1985. It is possible that this is only a statistical fluctuation, and verification will have to wait until other groups report their observations.

One method that can be used to check how well an observer separates the sporadic background from the shower background is through use of the value $\Delta\bar{m}$. This value has been obtained empirically from the comparison of mean Perseid magnitudes and mean sporadic magnitudes. When taken on a nightly basis this value should be in the order of +0.6 to +0.8. It is found by simply substracting the mean magnitude of the Perseids from the mean magnitude of the sporadics. Table 3, on the following page, lists these values for each observer during every night observations took place. Generally the data set is quite homogeneous, this being further

Table 3 --- Nightly values of $\Delta\bar{m}$

Date	Obs.	$\bar{m}_p$	$\bar{m}_s$	$\Delta\bar{m}$
Jul 30-31	PB	3.00	3.25	+0.25
Aug 01-02	PB	2.54	2.96	+0.42
01-02	BC	2.63	2.30	-0.33
02-03	PB	2.57	2.58	+0.01
02-03	BC	2.89	2.20	-0.69
04-05	PB	1.61	2.90	+1.29
05-06	PB	1.70	2.36	+0.66
06-07	PB	2.06	2.94	+0.88
09-10	PB	2.09	2.67	+0.58
09-10	MZ	2.08	2.77	+0.69
09-10	SK	1.85	2.42	+0.57
12-13	PB	1.43	2.00	+0.57
12-13	SK	1.67	1.33	-0.34
12-13	MZ	1.33	2.65	+1.32
13-14	PB	2.35	2.96	+0.61
13-14	MZ	2.00	3.05	+1.05
13-14	SK	2.23	1.64	-0.59
25-26	PB	1.67	2.75	+1.08
Mean		1.98	2.65	+0.67

strengthened by comparing the overall mean magnitudes of the Perseids and the sporadics, which yields $\Delta\bar{m}$ = +0.67. This indicates that the Perseids were generally well distinguished from the sporadic background.

The population index for the Perseids, found by the method of linear regression (which was previously described) from our observations in 1986 yields an r value of 2.38 when taken over the entire observed magnitude range (-4 - +5). For reference Roggemans finds an r value of 2.68 (1) from an analysis of observations in 1985, and Zvolankova (2) gives an r value of 2.6 found from observations made from 1944 to 1953. However, as pointed out by Millman et al. (1951) significant deviations occur from a straight line graph in the magnitude range above +2 or +3. These deviations are caused by the large uncertainties involved in the values of $P(m)$ for the fainter magnitude classes. In fact, the curve deviates in some cases to such a degree that inclusion of the fainter magnitudes when doing a regression analysis leads to highly spurious results. This phenomena can be seen in Figure 3 where the values of log $C(m)$ and Mv are compared graphically for our observations. It is obvious that above magnitude 2 the graph begin to significantly deviate from a straight line. As well, looking at the bright end of the graph we see that the -4 and -3 magnitude categories tend to be slightly scattered, suggesting that more data in these categories should be obtained before reliable data points can be obtained. In fact these two magnitude categories combined have only 6 observed meteors out of a total population of 651, a value less than 1%. It can then be seen why it is more logical to give these points little or no weight in the final analysis.

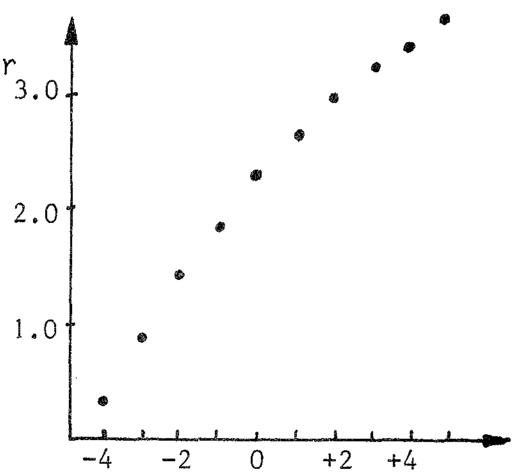

Figure 3 --- Relationship between log $C(m)$ and Mv.

Applying this to the observations, we can see that a combination of the most reliable $P(m)$ and most substantial data base is obtained in the magnitude range of (-2 - +2). Indeed, a regression analysis over this range yiels an r value of 2.44, much more representative of values obtained in the past. Thus using our most reliable data we obtain a value of r very much in line with that found by other authors.

However, when the sporadic magnitude distribution is examined, severe deviations begin to turn up if we use linear regression over the entire observed magnitude range, in this case (-2 - +5). The previously cited authors derived 3.55 and 3.5 respectively as r values for the sporadics. From this paper the r values for the sporadics is 2.79 over the entire magnitude range, much lower than the values found in the literature. It is obvious that this large deviation is a result of the poorly known $P(m)$ values, especially for the fainter magnitude classes, a problem already discussed. If we do a regression analysis over the same magnitude range as that adopted for the Perseids as being the most reliable, namely (-2 - +2), then we arrive at an r value of 3.32, in much better agreement with other authors, though a small deviation is apparent. This small deviation from other values might be accounted for if poor skies were prevalent in the data, but most of the observations were made in skies with limiting magnitudes between 6.2 and 6.5. Poor perception might also be responsible and this factor cannot be fully ruled out. The best suggestion might be that although the the sporadics were observed throughout the observation period, the majority of the Perseids were obtained in the space of a few nights at maximum. The nights near maximum had limiting magnitudes of 6.0 or better. Therefore, the majority of the data used to find the Perseid r value would have been obtained in near optimum conditions, while the previously mentioned problem of the aurora would play a larger role in deriving the sporadics' r value, since a larger percentage of the sporadic data (relative to the Perseid data), was obtained with the aurora present.

4.4. Trains

One of the trademarks of the Perseid stream is its high percentage of train leaving meteors. Generally values on the train percentages range from 25 to 35% with a typical value of 33% (see Meteor News 38, Oct. 1977). The percentage of Perseids that left trains in 1986 as observed by the AMG was 34.9%, a very typical value.

Table 4 --- Train percentage by magnitude for the Perseids

Magnitude	−4	−3	−2	−1	0	+1	+2	+3	+4	+5
Total number seen	2	4	16	29	65	110	155	155	87	28
Number with trains	2	4	13	23	46	69	52	19	1	0
% with trains	100	100	81	79	71	63	34	12	1	

Table 4 lists the number of meteors in each magnitude interval showing a train, as well as the percentage of all the meteors in each magnitude class which showed trains. Generally the train percentages this year closely followed those of previous years. The only unusual occurence was the number of extremely long persistent trains (of over 10 seconds). While Olivier states that one meteor in a thousand has a train duration of 10 seconds or over on average, our findings show that one in 100 Perseids show a train of 10 seconds or over on average. This is about twice as high as last year. It is very likely though that this is simply a statistical fluctuation rather than a true stream characteristic for 1986. Most notable was a train from a -2 à -3 Perseid which had a duration of about 30 seconds, and showed some contortions from upper atmospheric winds.

4.5. Colors

One of the most outstanding features of meteors in a stream is their ability to display different colors. The colors usually reflect a chemical difference between shower members, with blue for example indicating high iron content. However a meteor color tends to be a very hard physical characteristic to accurately determine, with many factors contributing to the uncertainties. For example sometimes especially when the meteor appears close to the horizon, atmospheric absorption can play a major role, and turn what should be a white meteor into a red or orange one. As well the human eye is subject to a wide variety of physiological effects, making any observed color variation open to question. It would be desirable to confirm color variations with many other observers in order for a statistical smoothing to occur, and reveal the true variations within the stream. With this in mind we can look at the AMG's color data.

Table 5 on the following page lists the AMG's color breakdown for the Perseids and the sporadics. The table also lists the pre-maximum, maximum and post-maximum colors for the Perseids. The pre-maximum nights seem to have the highest percentage of colors with one in four Perseids showing a color other than white. Orange followed by yellow dominates the pre-maximum nights. The night of maximum shows

Table 5 --- Color distribution

Color	White	Orange	Yellow	Blue	Green	Red
Number of sporadics	451	23	15	23	2	3
Number of Perseids	517	64	34	30	1	5
% of sporadics	87.2	4.5	2.9	4.5	0.4	0.6
% of Perseids	79.4	9.8	5.2	4.6	0.2	0.8
% of pre-max Pers.	75.0	12.5	6.8	4.6	0	1.4
% of max Perseids	78.6	7.9	2.1	11.0	0.7	0
% of post-max Pers.	85.7	7.8	5.2	0.8	0	0.4

nearly as many Perseids colored as in the pre-max; about 21% show a color other than white. The post-max nights show the Perseids with the least amount of color, with only 14% of the members showing color. The color variations throughout the stream, seem to be more or less the same, with the color percentage remaining the same for almost all colors, the one big exception being blue. In pre-max nights about 4% of the Perseids show up as blue, while on the nights of maximum this percentage nearly triples to 11% and correspondingly falls to less than 1% in post-max nights. No other color shows this extreme variation. Without a complex evolutionary model it is difficult at best to suggest reasons why this variations occur. As our chemical models of comets improve, and our understanding of how the internal chemical makeup of comets is passed onto meteor streams, a more complete understanding of why the colors, and therefore the chemical makeup of a stream, changes in the way observed.

5. Conclusions

The first, and probably most important conclusion derived from our observations is that the 1986 return was a fairly normal return of the Perseid meteor stream. No high hourly counts such as wereobserved in 1980 and to some extent in 1981 were noted. Nor was the return a weak one, with activity showing that the Perseid stream can still put on one of the best displays of any of the meteor streams. The only marked difference from past years was the notable lack of bright meteors in the magnitude range brighter than -4.

Secondly, by looking at the magnitude data, it can be stated that the average size of a Perseid stream particle is small at the very beginning of the stream, reaches a maximum average size three to five days before maximum and then gradually dwindles in size near the end of the stream. It is unclear whether the average magnitude on the peak night is, in fact, due to a concentration of large-medium sized particles near the core of the stream, or whether it is due, perhaps, to the previously mentioned problem of observer concentration. The best fit curve seems to support the idea of the largest particles being encountered three to five days before maximum (assuming the stream is relatively linear on a large scale, which, due to its age, seems reasonable).

It can also be concluded, fairly accurately, that linear regression analysis, even with large data bases, will lead to poor values of r if fainter magnitude classes are not omitted. Alternatively if better $P(m)$ values for the fainter magnitude classes could be obtained, it might be possible to derive a very accurate r value over the entire observed range.

I would also like to apply the observations to a problem that has been suggested with respect to the ZHR correction factor. Some analysts have found (2) that when the correction applied to the altitude of the Perseid radiant is used, a notable drop in ZHR occurs when the radiant is near the horizon, with the ZHR picking up as the radiant climbs higher in the sky, an effect most notable near shower maxima when rates are the highest. Unless this is a feature reflecting the spatial separation of meteoroids within the core of the Perseid stream (which seems unlikely to show such a periodic variation), it would appear that this is due to undercorrection near the horizon , and that an exponential factor of 1.4 applied to the ZHR correction factor would give more realistic results. From the AMG observations at maximum we have concluded that the opposite effect is true, with the correction near the horizon leading to what appear to be artificially high ZHR's and low ZHR's appearing when the radiant is near the zenith. We would suggest that this tentative conclusion be taken along with other observations, before any firm conclusion be made.

The validity of all these conclusions should be gauged on the quantity and quality of the observations. We are careful when drawing generalizations about the Perseid stream, knowing that our observations can give only a broad picture of the stream. We, therefore have made reasonably broad conclusions and in the process addressed specific questions about some of the problems which are encountered in trying to characterize the Perseid meteor shower.

Acknowledgment

I would like to thank all the observers who participated in this study, without whom it could not have taken place. As well I would like to sincerely thank Dr. Ian Halliday of the Herzberg Institute of Astrophysics for his helpful comments and suggestions, particularly regarding the derivation of the population index. I would also like to thank Mr. Steven Gallagher and Mr Duncan McDougall for their help and suggestions.

References

(1) P. Roggemans, "On the Perseid Meteor Stream 1985", *WGN 14:4*, 1986, pp. 108-125.

(2) J. Zvolankova, "Changes in the Activity of the Perseid Meteor Shower 1944-1953", *Contr. of the Astron. Obs. Skalnate Pleso, vol. XII*, 1984.

(3) D.W.R. McKinley, "Meteor Science and Engineering", McGraw Hill, New York, 1961.

(4) E.M. Moya, "Perseidas 83, estudio de la corriente meteorica asociada al cometa Swift-Tuttle 1862 III, durante el ano 1983", *WGN 13:4*, 1985, pp. 118-123

(5) P. Roggemans, "On the Geminid Meteor Stream in 1985", *WGN 14:2*, 1986, pp. 48-63.

Meteor Streams of the Southern Hemisphere

Under this title we publish three contributions from Jeff Wood about meteor streams not observable from the Northern Hemisphere, where most of the readers of WGN live. One of these three streams was discovered during a routine meteor watch, proving once again the importance of such observations as to the detection of unusual meteor activity.

The κ-Pavonid Meteor Stream in 1986

Jeff Wood

During routine observations an usual activity was recorded on July 17 shortly before noon UT from a radiant near κ Pavonis.

While carrying out a routine meteor watch on the evening of July 17-18, 1986, N.A.P.O.M.S. observers Neil Ingwood and Paul Stacey started noticing a number of bright yellow-orange meteors radiating out from a point near the star κ Pavonis. The meteor shower was of a very short duration starting at 10^h50^m UT and finishing by 12^h00^m . During this time Neil and Paul saw 26 and 30 κ-Pavonids respectively. Their average magnitude was +0.73 and 14.3% had a train. In Table 1, their magnitude distribution is listed.

Table 1 --- Magnitude distribution of the 1986 κ-Pavonids

Magnitude	−3	−2	−1	0	+1	+2	+3	+4	Tot	$\bar{m}$
Number	2	6	6	9	13	11	7	2	56	0.73

A nationwide meteor alert saw several other observers out watching after 12^h00^m UT. None of these saw any sign of activity from the κ-Pavonid radiant, though most were severely to moderately handicapped by interference from cloud. The latter observers included Robert McNaught at Coonabarabran (New South Wales), Peter Brown and Brendan Page at Richmond (NSW) and Shane Sullivan at Busselton (West Australia). In Table 2 are the orbital ements being derived using the information supplied by Neil and Paul, under two assumptions for the geocentric velocity.

Table 2 --- Orbital elements for the κ-Pavonids

Name of the stream	κ-Pavonids	
Date of maximum	1986 July 17.60 UT	
Geocentric velocity	20 km/s	25 km/s
Observed radiant position	$\alpha = 275^\circ$ $\delta = -67^\circ$	
Corrected radiant position	$\alpha = 277^\circ.9$ $\delta = -68^\circ.0$	$\alpha = 280^\circ.6$ $\delta = -68^\circ.9$
Period	216.4 y.	3.9 y.
Semi-major axis	36.04 AU	2.48 AU
Eccentricity	0.98	0.63
Perihelion distance	0.89 AU	0.91 AU
Argument of perihelion	$41^\circ.58$	$43^\circ.10$
Longitude of the ascending node	$294^\circ.5$	$294^\circ.5$
Inclination	$24^\circ.6$	$20^\circ.0$

The γ-Normid Meteor Stream in 1986

Jeff Wood

During six nights the γ-Normids, also called Corona Australids, were observed. Only a weak activity was recorded.

The γ-Normid or also incorrectly named Corona Australid meteor stream was the subject of close scrutiny by Australian meteor observers. Watching over 6 nights from March 07-08 to March 21-22, a total of 113 man-hours of observations were made. The participating observers were as follows:

Chris Natoli, Karen Morrissey, Alison Skelly, Anita Skelly, Kirsty Craven , Natalie Longman, Natasha Clark, Kirsten Lee, Jeff Wood, Martin Coroneos, Glen Blencowe, Robert Mc Laughlin, Andrew Whitney, Paul Rawlings, David Cake, John Goldsmith, Jason Tame, Lisa Woolridge, Michelle Cockeram, Michelle Treasure, Justin Whitney, Maria Ingram, Hoh-Ann Burrows, Brian Macauley, Peta Fitzgerald, Jeremy Nelson, Mick McMullen, Peter Minogue, Kevin Storer, Colin Shepherd, Prue Webb, Graham Pooley, Graeme Sutton, Katrina Mitchell, Neil Ingwood, Louise Cockeram, Guy Harvey, Meeghan Clay, Laurie Ahearn, Craig Hinton.

The γ-Normids did not display a great amount of activity in 1986, as can be seen from Table 1. The best ZHR-recorded was on the night of March 14-15 when it was around 3.5 meteors per hour.

Table 1 --- γ-Normid rates in 1986

Date	Nr. Obs.	ZHR
Mar 07-08	1	no γ-Nor seen
12-13	2	2.57 ± 0.08
14-15	65	3.49 1.54
15-16	8	1.96 0.61
20-21	5	1.35 1.66
21-22	2	no γ-Nor seen

The magnitude distribution of the γ-Normids is shown in Table 2. Using the correction factors described by Kresakova (1966), an r value of 2.29 was derived for the magnitude range (-3 - +5).

Of the 122 γ-Normids of magnitude +2 or brighter, 2.46% were orange, 44.26% were yellow, 3.28% were green, 1.64% were blue and the remainder were white in color. 19.78% of the γ-Normids seen had a train.

Table 2 --- Magnitude distribution of the γ-Normids in 1986

Magnitude	-4	-3	-2	-1	0	+1	+2	+3	+4	+5	+6	Tot	m
Number	2	2	5	11	16	30	56	73	59	17	2	273	2.41

The δ-Pavonid Meteor Stream in 1986

Jeff Wood

During the second half of March and the first half of April an observing campaign was set up for the δ-Pavonids, a stream associated with comet P/Grigg-Mellish. In all, 884 δ-Pavonids were recorded by 35 people in 369 man-hours.

The δ-Pavonid meteor stream which was formed from the debris of comet P/Grigg-Mellish can be seen each year in the early morning skies of late March and early April. Due to the poor weather that frequently occurs at this time as well as the fact that the stream can only be seen in the Southern Hemisphere, has meant that the δ-Pavonids have been poorly observed over the years.

In 1986 as part of the Comet Halley Project, Australian meteor observers participated in a comprehensive project to monitor the δ-Pavonid meteor stream. The δ-Pavonid Watch commenced on March 12-13 and concluded on April 11-12. During this period of time, data were collected on 17 nights including eight straights from April 04-05 to April 11-12 when most of our observers were on a camp under the dark skies at Meeline Sheep Station which is near the Western Australian town of Mt Magnet. During the δ-Pavonid Watch, a total of 369 man-hours of observations were made by 35 people. The names of the participating observers were as follows:

Jeff Wood, Martin Coroneos, Glenn Blencowe, Lisa Woolridge, Chris Natoli, Colin Shepherd, Prue Webb, Mick McMullen, Graeme Sutton, Darren Ferdinando, Andrew Whitney, John Goldsmith, Louise Cockeram, Simon Evans, Jason Tame, Michelle Treasure, Meeghan Clay, David Cake, Shane Sullivan, Justin Whitney, Maurice Clark, Lance Taylor, Neil Ingwood, Robert McLaughlin, Katrina Mitchell, Michelle Cockeram, Brian Macauley, Paul Rawlings, Peta Fitzgerald, Aaron Sheppard, Darren Anthony, Jeremy Nelson, Joh-Ann Burrows, Guy Harvey, Kim Ladhams.

The activity of the δ-Pavonids is shown in Table 1, below:

Table 1 --- δ-Pavonid rates in 1986

Date	Nr. Obs.	ZHR
Mar 12-13	2	no δ-Pav
14-15	43	0.9 ± 1.0
15-16	7	0.4 0.5
20-21	4	3.7 1.4
21-22	2	5.0 0.8
22-23	3	2.3 2.1
28-29	2	2.4 2.4
29-30	3	7.3 4.7
Apr 02-03	2	4.4 1.3
04-05	3	1.8 0.7
05-06	27	2.4 0.8
06-07	56	3.2 1.6
07-08	61	4.7 2.3
08-09	42	1.4 0.7
09-10	57	2.3 1.1
10-11	36	0.6 0.1
11-12	19	0.4 0.5

The magnitude distribution of the δ-Pavonids can be found in Table 2. For the magnitude range from -4 to +5 an r value of 2.61 was obtained.

Table 2 --- Magnitude distribution of the δ-Pavonids in 1986

Magnitude	-4	-3	-2	-1	0	+1	+2	+3	+4	+5	+6	Tot	m
Number	3	2	9	20	36	71	117	212	234	141	39	884	3.12

The following color distribution was derived from 258 δ-Pavonid meteors of magnitude +2 or brighter:

Red:	1.2%	White:	60.1%	Blue:	21.6%
Orange:	4.7%	Green:	0.8%	Violet:	0.4%
Yellow:	11.2%				

δ-Pavonids often have a train. This year, 12.9% of the meteors seen had a train. All of these were of short duration with none of them lasting for more than 6 seconds after the meteor itself had disappeared.

We can now already announce that the October-issue of WGN will be a special one! Not only will this issue contain a number of additional pages, but also it will contain a contribution from Dr. B.A. Lindblad from the Lund Observatory, Sweden! We hope that with this and the following issue a tradition will grow of regular contributions from professionals in WGN! Good contacts between professionals and amateurs can provide to the former group potentially valuable data and to the latter one a chance to see what their work is used for.

We also want to remind contributors that all the stuff for the October-issue must reach the editor (address on inside of back cover) no later than September 1st! We can imagine that many amateur groups all over the world will set up meteor observing campaigns during July and August. Please send us a report of your observations!

Observational Results

Finland - Geminids and Ursids in 1986

Teemu Hankamäki

Below are the Finnish observations of the Geminids that were not yet published in the previous issue as well as those of the Ursids.

Below are the Finnish observations of the Geminids, which did not yet appear in the previous issue of *WGN* as well as observations of the Ursids. The observers were:

Aki Parviainen (AP), Pekka Parviainen (PP), Ismo Luukkonen (IL), Jussi Holopainen (JH), Markku Nousiainen (MN), Timo Kinnunen (TK).

Table 1 --- Finnish observations of the Geminids and Ursids in 1986.

Date	Obs	Period (UT)	T_{eff}	Lm	F	Gem	Urs	Spor
Dec 11-12	AP	20^h15^m-04^h01^m	7.40	5.70	1.00	75	0	36
11-12	PP	20 20 -21 25	0.83	5.00	1.33	4	0	2
13-14	IL	19 01 -21 00	1.73	5.16	1.11	11	0	7
13-14	JH	22 38 -23 29	0.82	4.20	1.25	10	0	3
13-14	MN	18 03 -19 49	1.20	3.90	1.43	6	0	1
13-14	IL	18 08 -19 50	1.48	5.00	1.11	9	0	3
14-15	PP	19 30 -23 10	2.60	4.50	1.18	19	0	1
14-15	LR	21 00 -00 00	2.88	5.56	1.00	22	0	17
15-16	TK	22 28 -23 32	1.07	4.00	1.25	4	0	2
19-20	LR	15 15 -16 20	1.03	6.10	1.03	0	4	8
21-22	IL	18 35 -20 45	1.75	6.09	1.11	0	2	7
24-25	LR	22 20 -22 50	0.48	5.26	1.18	0	1	3

Of the 234 Geminids mentioned in (1) and the 160 Geminids listed above, the following magnitude distribution was obtained:

Table 2 --- Magnitude distribution of the Geminids 1986 in Finland.

Magnitude	-4	-3	-2	-1	0	+1	+2	+3	+4	+5	Tot	$\bar{m}$
Number	1	1	4	16	38	58	108	113	50	5	394	2.05

The mean magnitude of the seven Ursids that were observed is 3.34.

Reference

(1) T. Hankamäki, "Observational Results, Finland - November and December 1986", *WGN 15:3*, 1987, pp. 97-98.

On April 6, 1987 at 19^h15^m UT a daylight fireball has been seen in the United Kingdom. It was reported by observers from Hampshire, Essex and South Wales. They saw the object in the north-north-west. Two experienced observers estimated the magnitude of the fireball as -8. This estimate must be considered as a conservative one because it wass still daylight.

(from BAA Newsletter 24)

Norway - Annual Report 1986

Trond Erik Hillestad

In 1986, 14 members of the Norwegian Meteor Section saw over 6000 meteors during 48 nights. A brief account of these observations is given.

The Norwegian Meteor Section had a very successful year in 1986. More then 6000 meteors were seen by 14 observers. In 1985, some 4000 meteors were observed, and less than 1000 in each previous year. The number of visual observers increased three-fold during 1986, and the number of Meteor Section members rose from 15 to 21.

A meteor camp (Norway's first) was arranged during the Perseids, yielding about 60% of the total number of meteors seen in 1986. Few of our members ever had the chance to meet before. The possibilities of such a stay, together with the informal atmosphere, proved to be highly advantageous for the participants at the camp. For more details, see (1).

Two independant observers were lucky to see the Ursid outburst in 1986 under good sky conditions, the observations thus being of an extremely large value on world basis. See also (2).

Our photographic Perseid campaign netted 21 meteors, a good result. One meteor was photographed simultaneously from two different places, for the first time ever in the history of the Norwegian Meteor Section.

Presenting detailed results of our observations in *WGN* will take up a lot of space, but a copy of our Annual Report 1986 is available on request (author's address on inside of back cover). We would welcome a payment of 10 NOK (about 1 Pound St.) to the postal giro account 4 20 66 29 of NAS-Meteorgruppen, N-3600 Kongsberg, Norway. The 54-page report contains rate data, magnitude distributions and total results for all showers, and color/train data for the Perseids, κ-Cygnids, Taurids and Ursids.

The following people contributed during our visual meteor watches in 1986:

> Torbjørn Fredriksen, Øyvind Grandum, Robert Gibala, Finn Gundersen, Kai Gaarder, Lars Trygve Heen, Trond Erik Hillestad, Terje Hotte, Terje Larsen, Tor Vidar Lian, Thorbjørn Løvik, Olaf Skjæraasen, Kai Stokkeland, Magne Svanemsli.

The following table gives a global idea of the 1986 results of the Norwegian Meteor Section:

Number of participants	14
Number of meteors	6186
Number of observed showers	19
Number of nights covered	48
Total man-hours	$7^d14^h40^m$

References

(1) T.E. Hillestad, "The First Norwegian Meteor Camp", *WGN 15:3*, 1987, pp. 100-101

(2) T.E. Hillestad, "The 1986 Ursid Outburst in Norway", *WGN 15:2*, 1987, pp. 59-60

We wish all the readers of WGN very nice observing conditions during August and September!

In this section, we shall regularly publish abstracts of articles that appeared in professional journals, as to keep the readers of WGN informed of what is going on in the professional world of astronomy. People interested in papers whose abstracts are reprinted in this section of WGN should contact Paul Roggemans (address on inside of back cover).

The Meteor Library

collected by Paul Roggemans

B.A. Lindblad, "The Meteor Stream Associated with Comet Grigg-Skjellerup" Proceedings of the 20th ESLAB Symp. on the Exploration of Halley's Comet, ESA, SP-250 vol. III, 1986, pp. 399-400.

A 1964 Jupiter approach of P/Grigg-Skjellerup perturbed the comet'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 meteoroid stream.

M. Simek, P. Pecina, "Possiblilty of a Meteor Shower Associated with Comet Sugano-Saigusa-Fujikawa 1983e"
Asteroids, Comets, Meteors II, C.I. Lagerkvist and H. Rickman (eds.), Uppsala, 1968, pp. 541-545.

The comet 1983*e*, discovered in May 1983 was suggested as a source of meteors with a theoretical radiant at $\alpha = 21°$, $\delta = +42°$. The closest approach of the Earth to the comet's orbit occured on June 14.7, 1983, when the Earth passed 0.048 AU inside the comet's orbit, only 2.9 days after the comet has passed this point. Radio meteor observations were carried out using the 25 kW Ondrejov pulsed radar in 1983 and 1984. A small increase of the meteor rate was observed in the appropriate range interval. Results of the radar observations are described.

I.P. Williams, C. Johnson, K. Fox, "Meteor Storms"
Asteroids, Comets, Meteors II, C.I. Lagerkvist and H. Rickman (eds.), Uppsala, 1986, pp. 559-564.

Meteor showers are generally seen as annual events, with the number of meteors seen per hour not varying dramatically from year to year. In contrast meteor storms, where the number of meteors seen per hour reaches values of the order of 10 000 occur far less frequently. We develop a simple model for the rate of spreading around the mean orbit and apply this theory to the best known of the streams associated with a storm, namely the Leonids. Interesting constraints on the size of the parent comet are obtained.

J. Hunt, K. Fox and I.P. Williams, "Asteroidal Origin for the Geminid Meteor Stream"
Asteroids, Comets, Meteors II, C.I. Lagerkvist and H. Rickman (eds.), Uppsala, 1986, pp. 549-554.

In previous papers, the authors have demonstrated that most of the characteristics of the Geminid meteor stream can be explained in terms of a model where the stream particles are ejected from a cometary nucleus. It now seems fairly certain that object 1983*TB* is associated with the Geminid stream but recent observations suggest that 1983*TB* is not the nucleus of a comet. A model for the formation based on a collision between two rock like bodies is described. It is found that this model can explain two of the major observed characteristics but has more difficulty in explaining the observed distribution of aphelion distances.

J. Jones, R.L. Hawkes, "The structure of the Geminid meteor stream - II. The combined action of the cometary ejection process and gravitational perturbations" Monthly Notices of the R. Astr. Soc. 223, 1986, pp. 479-486.

We have extended the theory of Fox, Williams and Hughes for the evolution of the Geminid meteor stream under the perturbing influence of the gravitation attraction of the planets. Whereas the original theory allowed for the planetary perturbations by ascribing to each particle the rates of change of orbital elements appropriate to the mean orbit we note that the motions of e orbital elements are themselves functions of the orbital energy and angular momentum. Since the ejection velocity from the comet depends on particle mass, the spread in orbital size and shape and hence the precession and nutation rates are also mass-dependent. We have shown that the inclusion of this effect causes the duration of the shower to increase with time so offering hope of a reconciliation of theory and observation and it also predicts a very low apparent rate of retrogression of the ascending node as is observed.

Short Notes

About Observing in Southern France

Paul Roggemans

This is an important note for people who want to observe the Perseids 1988 in the Haute Provence, France. In order to rent a house for a sufficiently large number of observers in the period July 30 to August 20, 1988, we ask interested observers to write us to reserve a place. Depending upon the respons, we shall make our choice as soon as possible in September. Then the number of participants will be fixed. The price for a forthnight will be about 9000 BEF, for three weeks about 11 000 BEF (including travel costs from Belgium to France, the rent of the house and meals). If paricipants are prepared to pay an extra 1500 BEF, we can pay someone to run the kitchen for us, freeing us from housekeeping and cooking. Please write to Paul Roggemans (address on inside of back cover) about your desires!

The 1986 Taurids in the United Kingdom

compiled from BAA Newsletter 24

In Newsletter 24 of the BAA, some interesting comments on their 1986 Taurid observations were published. In spite of the popularly held believe that the Taurids produce many bright fireballs, they obtained a mean magnitude of 2.05 compared with 2.52 for the sporadics; not such a big difference! They also noted that it is very difficult to distinguish North and South Taurids. As far as their magnitude is concerned, they found on the average 2.16 and 1.98 respectively, not a significant difference.

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tel. 03/455 68 18

Tijpwerk - Typesetting: Volkssterrenwacht Urania Public Observatory

Drukwerk - Printing: André Gabriël

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Weekend der Amateurs

Hasselt - 7–8 november 1987

- 30 uren verblijven te midden van amateurastronomen;
- een heleboel voordrachten;
- tentoonstelling eigen werk;
- ruilbeurs;
- ruime gelegenheid tot informele contacten;
- maaltijden gedurende het ganse weekend en overnachting voor slechts 1050 BEF, alles inbegrepen;
- gemakkelijk bereikbaar met minimale verplaatsingsonkosten; ...

... dit lijkt wel het gedroomde evenement om vele collega's amateurastronomen te ontmoeten, voor jong en oud. Op 7-8 november wordt je te Hasselt verwacht in de Borggraaf, om deel te nemen aan het eerste weekend der amateurs. Het belooft een succes te worden; schrijf dus spoedig in voordat het uitverkocht geraakt. Dit weekend kan voor velen een nieuwe start worden als amateur! Aarzel niet en neem deel; de afwezigen zullen het grootste evenement uit de VVS-geschiedenis missen!

P.S. Reservatie is verplicht voor het gebruik van maaltijden en overnachting; bezoekers zijn welkom zonder reservatie, doch zij kunnen geen maaltijd gebruiken en evenmin overnachten.

Doe mee!