The Perseids 1995 in Poland

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Abstract

Visual observations of 1995 Perseid meteor stream made by Polish astronomy amateurs are reported. Using this material we obtained new accurate points in the activity profile during maximum. The Zenithal Hourly Rates (ZHRs) for the whole period of activity are presented. We also discuss the magnitude, the colour and the velocity distributions of Perseids.

Key words: Meteors

1 Introduction

Since 1988, when the new narrow and high peak of Perseids activity was first observed (Roggemans 1989), all meteor observers world wide are especially interested in watching this stream. The reason is high ZHRs noted in 1993 that reached 300 - 350 (Rendtel 1993) making Perseids the most active regular meteor stream of the sky. The 1994 observations gave maximum ZHR=250 $\pm$ 45 (Rendtel 1994). Calculations made by Williams and Wu (1994) suggested that in 1995 we can expect similar activity. Analysis given by Rendtel (1994) also indicated that the 1995 first and high peak should occur on August 12 at $17^h \pm 3$ UT. The old, more flattened and well known maximum should be observed on August 13 about 9^h UT.

The predicted time of the first maximum favoured observers in Eastern Europe and Asia. The second maximum time was very good for North-American observers. Unfortunately the Full Moon occurring on August 10 possibly could reduce maximal ZHRs values by factor even 10.

2 Observations and Data Reduction

The weather in Central Europe, unfortunately enough, does not coddle the sky observers. As a result it is very hard to obtain good observational data covering a long period of time. But such data are necessary for the analysis of the meteor stream behaviour during its activity. Fortunately the year of 1995 was different. There were many clear nights from the beginning of July to the end of August. Such good conditions allowed us to obtain a large number of Perseids 1995 observations.

In 1994, a group 32 Polish observers associated in Comets and Meteors Workshop (CMW) obtained 186.2 hours of observing time with 1981 meteors from Perseid stream observed (Olech and Woźniak 1996). In this paper we report the results of visual observations of Perseids 1995 made by CMW members. From July 16 to August 22, a group of 38 observers obtained 448.5 hours of observing time with 2503 meteors from Perseid stream, which were observed. The total number of hourly rate estimates is 430.

Although the number of observations is large, not all observations can be used for ZHR calculations. To obtain the most valuable conclusions we selected our data according to the following rules:

- the mean stellar limiting magnitude in the center of the field of view must be higher than 4.5 mag.,
- the effective time of observation must be equal to or longer than 30 minutes,
- the correction factor F resulting from clouds cover must be smaller than 2. We calculated F from equations given by Koschack (1991).

The observations satisfying these conditions accounted for 348.1 hours of observing time with 343 good hourly rate estimates. These data can be used for Zenithal Hourly Rate (ZHR) calculations. We adopted the formula given in Slančiková (1975) and Zvolánková (1983):

$$ZHR = \frac{N \cdot r^{6.5-LM}}{(\sin H)^{\gamma}}$$

where N is the number of meteors observed during one hour of the effective time, LM is the mean stellar limiting magnitude in the observed field, H is the altitude of the radiant point of Perseids, r is the apparent luminosity ratio between the meteors with magnitude $m+1$ and m (r is also called population index), and γ is the stream dependent constant. We took $r = 2.5$ and $\gamma = 1.41$ from Jenniskens (1994).

There is a problem with zero hourly rate detections. Except for the first two nights of activity, when all estimates had no meteors detected, we use such observations to compute mean ZHR only when the stream had nonzero detections during the same night. The second problem is the statistic error of the zero hourly rate detection. We assumed the formal error of 1.0.

The complete list of our observers, their location, the effective observing time, the numbers of total hourly rate estimates, total ZHR estimates and the observed meteors from Perseid stream is given in Table I.

Table 1: List of CMW observers.

Observer	**Place**	**Tot. hours**	**Tot. HR estimates**	**Tot. ZHR estimates**	**Tot. meteors**
Maciej Reszelski	Szamotuły	105^h	105	105	388
Arkadiusz Olech	Pruszcz Gd.	61^h50^m	63	63	577
Marcin Gajos	Opole	32^h	32	25	213
Krzysztof Gdula	Brodnica	20^h	23	9	122
Sylwia Hołowacz Agnieszka Kaczorowska	Pasłęk Pasłęk	$\}19^h35^m$	14	0	136
Wojciech Jonderko	Rybnik	19^h30^m	13	4	15
Tomasz Dziubiński	Szamotuły	19^h	19	12	54
Konrad Szaruga	Telatyn	17^h	17	11	53
Łukasz Sanocki	Wola Dębowiecka	15^h	15	14	70
Krzysztof Kamiński	Poznań	14^h10^m	13	3	58
Adam Grzeszuk	Szóstka	12^h25^m	13	11	82
Jerzy Zagrodnik	Krosno	12^h10^m	13	13	88
Krzysztof Socha	Piórków	11^h	11	11	9
Izabela Solica	Pasłęk	9^h20^m	8	0	27
Urszula Bąk Joanna Hibowska Katarzyna Hibowska	Namysłów Namysłów Namysłów	$\}9^h15^m$	4	3	149
Paweł Gembara	Warszawa	7^h38^m	7	7	43
Janusz Płeszka	Kraków	6^h45^m	7	7	92
Krzysztof Wtorek	Grudziądz	6^h	6	6	16
Michał Marek	Zawiercie	5^h40^m	6	6	19
Karol Zwilling	Katowice	5^h05^m	5	2	37
Maciej Kwinta	Kraków	5^h	5	4	21
Michał Jurek	Polska Nowa Wieś	4^h22^m	4	3	23
Grzegorz Bonikowski	Warszawa	4^h20^m	3	3	42
Tomasz Ramza	Świebodzin	4^h	4	4	13
Krzysztof Zurek	Kraków	3^h55^m	3	3	25
Urszula Majewska	Chełm	3^h30^m	4	4	28
Piotr Grzywacz	Łódź	3^h	3	3	16
Michał Kopczak	Sanok	2^h30^m	2	2	4
Sebastian Nieznaj	Czechowice-Dziedzice	2^h	1	1	21
Łukasz Pośpieszny	Ostroróg	2^h	2	1	4
Jacek Burda	Kraków	1^h30^m	1	1	8
Elzbieta Brembor	Wielichowo	1^h	1	0	2
Marcin Nowakowski	Starogard Gd.	1^h	1	1	5
Tomasz Piotrowski	Gdańsk	1^h	1	0	0
Józef Wianowski	Lublin	1^h	1	1	3
ALL		448^h30^m	430	343	2503

3 Results

3.1 Activity profile

Figure 1 shows the activity of Perseids stream from July 16 (JD 2449915.5) to August 22 (JD 2449952.5). There was only one night without ZHR estimate (August 16). We also removed one single observation point of July 22 which had the error comparable with the value of ZHR itself.

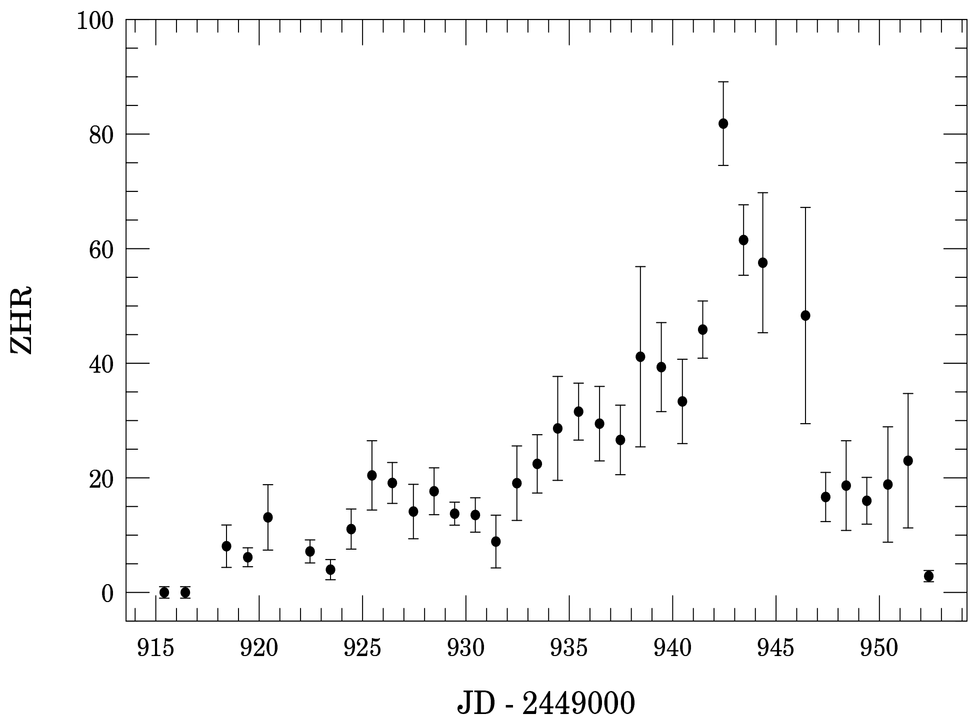

Figure 1: The graph of Perseids 1995 activity from July 16 to August 22.

This graph differs slightly from that of the previous year (Olech and Woźniak 1996) especially in the wings of activity profile. The ZHRs noted at the end of July and at the beginning of August are higher than the counts of the previous year. It suggests more uniform distribution of meteor bodies in the whole ribbon of Perseid meteoroids.

The maximum value presented in Figure 1 is the mean value of 20 good ZHR estimates. We tried to divide these estimates into five bins and added them to the graph given by Rendtel (1995). The resulting diagram is shown in Figure 2. The filled triangles are International Meteor Organization (IMO) observations and the filled circles are CMW points. Only the first two of our points have large errors because of small number of observations being averaged. However these errors are similar to IMO estimates. Our next three points are more precise and show nice monotonic decrease of activity. There is also good conformity of IMO and CMW results.

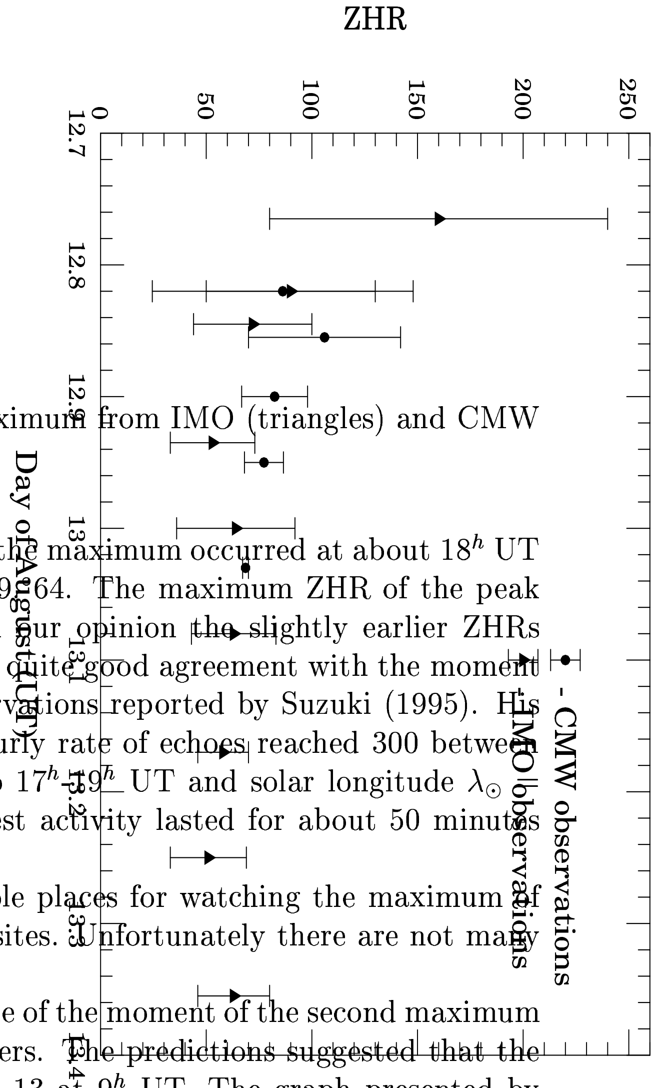

Figure 2: ZHR graph of the Perseids 1995 maximum from IMO (triangles) and CMW (circles) observations.

From the Figure 2, it is clearly visible that the maximum occurred at about 18^h UT on August 12, which corresponds to $\lambda_\odot = 139.^\circ64$. The maximum ZHR of the peak given by Rendtel (1995) was 160±80, but in our opinion the slightly earlier ZHRs could have been even higher. This would be in quite good agreement with the moment of maximum activity derived from radio observations reported by Suzuki (1995). His observations suggested that the maximum hourly rate of echoes reached 300 between August 12.71-12.79 UT, which corresponds to 17^h-19^h UT and solar longitude $\lambda_\odot =$ $139.^\circ6$ (equinox 2000.0), and that the strongest activity lasted for about 50 minutes (from 17^h50^m UT to 18^h40^m UT).

It is clearly visible that the most favourable places for watching the maximum of Perseids 1995 were Eastern Europe and Asia sites. Unfortunately there are not many meteor observers there.

We are also waiting for more precise estimate of the moment of the second maximum and its ZHR made by North-American observers. The predictions suggested that the second maximum can be expected on August 13 at 9^h UT. The graph presented by Rendtel (1995) (see Figure 2 in this paper) strongly suggests that the actual maximum occurred slightly later in comparison to the above predictions.

3.2 Magnitude distribution and brightness estimates

The apparent brightness was estimated for 2061 events. The magnitude distribution (without a correction for the altitude of the event) is given in Table II. From this distribution we can derive the mean population index r for the whole period of activity of the stream. The value of r for the meteors brighter than 2 mag becomes 2.11 ± 0.44. It is in quite good agreement with the value of r reported by other authors (Jenniskens 1994). We also tried to investigate the changes of r during the stream activity (see Figure 1 in Rendtel 1994 for comparison), but the errors of our measurements were too large for such analysis and no sensible trend was obtained.

Nevertheless we tried to plot the average brightness of meteors from Perseid stream for each night versus time. The result of this operation is shown in Figure 3. It is clearly visible that the brightness increases from the beginning of activity to the maximum and drops after this moment. However, the points in the vicinity of August 10, when the Full Moon caused the drop of the stellar limiting magnitude, can be artificaly overestimated. On the other hand the point corresponding to the maximum of activity is the highest point of the graph. This fact suggests the presence of increased density of bigger particles in the central part of the stream.

Table 2: Magnitude distribution for Perseids 1995

-5^m	-4^m	-3^m	-2^m	-1^m	0^m	1^m	2^m	3^m	4^m	5^m	6^m
5	8	14	40	86	210.5	386	514	469.5	239	85	4

3.3 Velocity and colour distributions

The angular velocity of the meteor event on the sky was estimated using 0-5 scale. There were 1817 such estimates in total. The velocity distribution is given in Table III. The average velocity of all Perseid meteors in this scale becomes 4.3. Knowing that true velocities of meteoroids in atmosphere vary from 11 km/s to 72 km/s this value corresponds to 61 km/s. The result differs from the real Perseids velocity which is equal to 59 km/s (Koschack 1991). The difference between our estimates and the real velocity can be a result of the small number of our counts.

We also computed the mean velocity as a function of Julian day. No systematic trends were visible, and the points were uniformly spread around the average value 4.3.

The colour was estimated for 1885 meteors. 80.2% of them were white, 10.4% were yellow, 2.3% were white-blue, 2.1% were orange, 1.8% were red and 1.6% were blue. Other colours were white-yellow, white-red, green and pink. About 21.3% of meteors had a trail and 0.6% were finished with a flash or fragmentation. These results are similar to the last year results, and only the number of trails seems to be two times greater than during last apparition of Perseids (see Olech and Woźniak 1996).

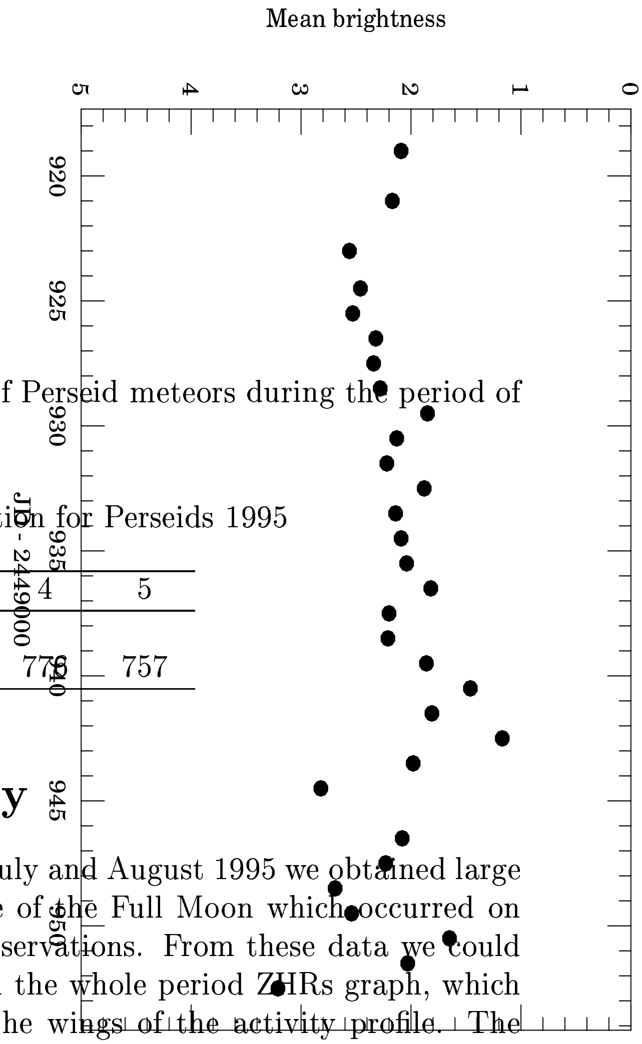

Figure 3: The changes of the mean brightness of Perseid meteors during the period of activity.

Table 3: The velocity distribution for Perseids 1995

0	1	2	3	4	5
6	0	18	269	776	757

4 Conclusions and Summary

Thanks to the good weather conditions during July and August 1995 we obtained large number of Perseids 1995 observations. In spite of the Full Moon which occurred on August 10, we obtain quite numerous set of observations. From these data we could derive some valuable conclusions. We presented the whole period ZHRs graph, which differs from previous years data especially in the wings of the activity profile. The ZHRs in these points of the graph are slightly higher than on the plots from previous years, which suggests the evolution of the swarm towards the more uniform distribution of meteor bodies.

Our ZHR estimates during the night of the maximum are accurate points and confirm precisely the results presented by Rendtel (1995). We agree with Rendtel

(1995) and Suzuki (1995) conclusions concerning the moment of the maximum and its ZHRs. We regret only that the moment of the maximum occurred too early to be well observed in Poland.

We also presented the figure of mean brightness versus Julian day, and we noted the highest mean brightness of meteors during the night of the maximum. It suggests that the large particles are more numerous in the center of the meteoroids ribbon.

We also discussed the velocity and the colour distributions, and we conclude that the results do not differ strongly from the measurements of the previous year (Olech and Woźniak 1996).

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