DETERMINATION OF AVERAGE MAXIMUM OF ORIONIDS METEOR SHOWER FROM VISUAL OBSERVATION

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Abstract:
This article deals with a method of investigation of Orionid meteor shower ZHR profile. The collected data were fitted with Gauss-like functions in order to determine the maximum of this meteor shower activity. This peak was found at solar longitude $\lambda = 208.554° \pm 0.156°$. The activity date range of Orionids stream, determined from our data, starts approximately on September 26 and ends on November 9.

Key words: Orionids, visual meteor observations, Zenithal Hourly Rate, meteor shower, population index

1 Introduction

The Orionids are the most active meteor shower in late October. The discovery of the Orionids should be credited to E. C. Herrick (Connecticut, USA). In 1839, he made the ambiguous statement that activity seemed to be present during October. A similar statement was made in 1840, when he commented that the "precise date of the greatest meteoric frequency in October is still less definitely known, but it will in all probability be found to occur between the 8th and 25th of the month". The first precise observation of this shower was made by A. Herschel on 1864 [1] when meteors were found to radiate from the constellation of Orion. Thereafter, interest in this stream increased very rapidly, because Orionids are one of best observed annual showers.

The exact determination of the maximum of Orionid meteor shower is difficult because this meteor shower has a filamentary structure. In this article we focused on the determination of the center of maximal activity. The Earth crosses the path of Orionid filaments from 18-th to 26-th October every year. The average frequency (ZHR) is up to 35 meteor per hour (without outbursts).

The parent body of this shower is the famous comet 1P/Halley [2]. The resonance affects the comet 1P/Halley and therefore enhances the chances of meteoroid particles getting trapped in resonance, leading to meteor outbursts in some particular years. The comet 1P/Halley liberated itself in the 2:13 resonance with Jupiter from 240 B.C. to 1700 A.D., and in the 1:6 resonance from 1404 B.C. to 690 B.C., while the stream of the particles can survive for the time scales of the order of 10,000 year and 1,000 year in the 1:6 and 2:1 resonance, respectively [3]. Outburst of this meteor shower related to the resonance of meteoroids/comet 1P/Halley from this comet with Jupiter was observed in 1436-1440, 1933-1938, and 2006-2010, the latest with Zenithal Hourly Rate up to 70 meteors per hour [4].

The second shower from 1P/Halley meteor shower family is Eta Aquarids. Eta Aquarids shows similar filamentary structure as well. This shower is active from April to May and its observation conditions from northern hemisphere are not suitable. We can observe only rare meteors from our geographical latitudes.

The center of Orionids activity is expected at about $\lambda = 208°$ (21/22th October). The radiant coordinates during Orionids activity peak are as follows: right ascension 75°, declination +16°. The shower is active from 2.10 to 7.11 [5]. The population index of Orionids in maximum date is about r = 2.5.

This shower is often studied by visual and camera observations [6]. The radiant drift of the Orionids (ORI) and the Epsilon Geminids (EGE) drift are shown in Figure 1. The meteor shower Epsilon Geminids has a similar period of activity as Orionids. The radiant drift of Epsilon Geminids is shown in the figure to avoid confusion of Geminid shower observers [7]. Southern a Northern Taurids have a similar period of activity. The parent body of both showers is the comet 2P/Encke. Radiant of these showers lies nearby the above mentioned radiants. Taurids produce relatively high amount of fireballs.

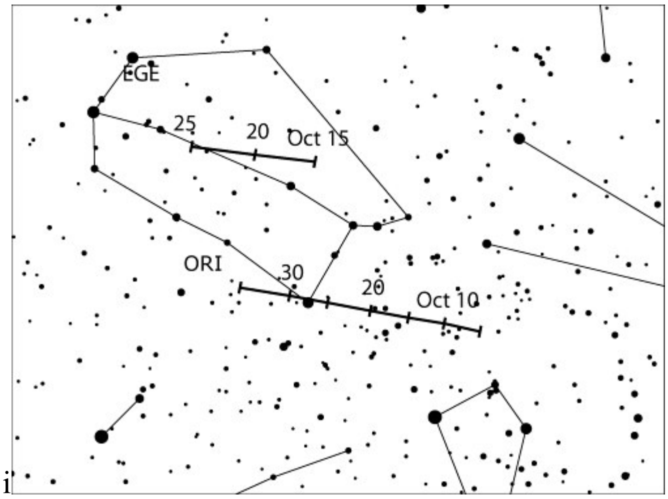

Fig. 1 *Radiant drift of the Orionids (ORI) and epsilon Geminids (EGE).*

2 Description of the approach

We use our model [8], equation (3) for description of ZHR curve to obtain the maximum solar longitude and period of activity. The data for this analysis were downloaded from the Visual Meteor Database of the International Meteor Organization. We used the data from years 2007, 2008, 2009, 2010, 2011 and 2012. The analysis is based on the fact that the maximum of meteor showers occurs every year at the same solar longitude. In our analysis, 18 125 meteors were identified as Orionids in 2 659 intervals.

3 Definitions

It is possible to determine the quantity Zenithal Hourly Rate (ZHR) from visual observation. This quantity is related to visible meteor rate per hour with respect to ideal observing conditions: radiant in zenith, no observation field limitations and limiting magnitude is M = 6.5. The ZHR is given by the formula:

$$\mathrm{ZHR} = \frac{\mathrm{N\,F\,r^{6.5-M}}}{\mathrm{T_{eff}\,sin(h)}} \tag{1}$$

where N is the number of observed meteors, F is the factor of observation field limitations, T_{eff} is effective time of observation. M is the limiting magnitude and h is the radiant altitude. Various techniques were used for determining the limiting magnitude M. One of them is counting the observable stars in defined areas in the sky. The parameter of limiting magnitude is individual for each observer and was used for standardization of observations. The population index r is obtained from the relation:

$$\mathrm{r} = \frac{\mathrm{N(m+1)}}{\mathrm{N(m)}} \tag{2}$$

where N(m) is the number of meteors with magnitude m and N(m+1) is the number of meteors with magnitude m+1. The solar longitude λ is the angular distance along Earth's orbit measured from the intersection of the ecliptic and celestial equator (spring point); it gives the position of the Earth in its orbit.

4 Results and discussion

The fitting function of our data is based on Gauss–like distribution [8]:

$$\mathrm{ZHR} = \mathrm{A(x-B)^2 + C + De^{-\frac{1}{2}\left(\frac{x-\mu}{\sigma}\right)^2}} \tag{3}$$

This formula enables us to determine the maximum and the duration of meteor shower activity. For detailed analyses for older part of shower we suppose the parabolic distribution. The final ZHR profile is shown in Fig. 2. In this profile, the population index r = 2.1 was used.

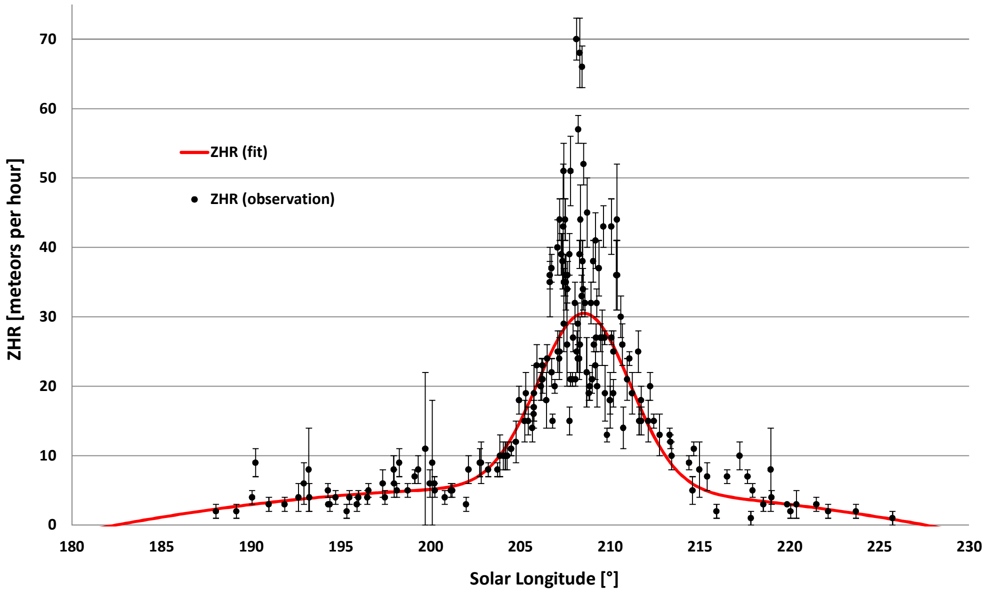

Fig. 2. *The ZHR profile of Orionids (years 2007 – 2012).*

The obtained ZHR parameters are presented in Table 1. Parameter values are shown in the second column, standard errors are in the last column.

Parameters	**Value**	**Error**
A	-0.01041	0.00411
B	205.0072	1.68327
C	5.32415	0.78823
D	25.32606	1.26345
σ	2.56691	0.17825
μ	208.5544	0.15604

Table 1 *Parameters of the fitting function.*

The position of the peak of meteor shower activity was found at solar longitude λ = 208.554° ± 0.156°. The maximum of visually observable meteors occurs approximately a 0.61 day later than reported in [5] .The activity of Orionids may have a longer duration than presented in [5]. The activity date range of Orionid stream was found to start approximately on September 26 and end on November 9.

5 Conclusions

We determined the average position of Orionids maximum at 208.554° ± 0.156°. This computation is in a good agreement with the position of the maximum given in literature [5], the difference being 0.61 day. The duration of Orionids meteor shower activity is longer than reported in [4]. The Orionids are an attractive meteor shower for visual observers and are studied with various techniques (cameras, radio). The visual observation method is undemanding and therefore suitable for students and amateur astronomers. The information collected from Orionids observations contribute to our knowledge about the behavior of comet 1P/ Halley in the past. For detailed information you can visit the page www.imo.net.

6 References

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