Short report

ANALYSIS OF PERSEIDS SHOWER METEOR CHARACTERISTICS ON THE BASIS OF PHOTOGRAPHIC OBSERVATION DATA

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Introduction

Arago considered astronomy the lucky science that does not need any embellishment. Astronomy is one of the most ancient and fascinating sciences. It dates back to the old times when the written language did not exist. Observing the stars and noting the regularities of celestial body apparent motions, man learned measuring time and created the prototype of the first calendar.

Throughout the whole human history the man tried to realize the mystery of the universe and create the consistent world view. The spyglass that was invented in Holland in 1609 and laid the conceptual basis for the modern giant telescopes, greatly facilitated the considerable extending of the Universe frontiers by the scientists.

However, in spite of the grand-scale scientific and technical revolution that also involved astronomy, it is practically the only science where the observations of the Universe phenomena are still urgent, spectacular and fascinating.

The present paper describes the characteristics of Perseids shower meteor basing upon the data of the photographic observations performed on August 13, 2007. The observations were performed with the application of ZENIT-EM camera featuring MIR-1B objective lens.

Perseids Meteoric Shower

The name Perseids comes from Perseus constellation that makes a source of these falling stars for the careful observer. If we plot the visible traces of meteors on the celestial map and draw the straight lines backward, we will see that for the most of the observed meteors these lines converge in Perseus. And their point of convergence is called the radiant. Thus, the meteors fly away in the various directions from the radiant. Actually the meteors of the shower move in parallel with each other, and the visual scatter from a single point of the coelosphere can be compared with the rails in the tangents. For the observer they seem to radiate from the far-off single point, but in fact they are laid strictly in parallel.

In summer 146 years ago a beautiful, previously unknown comet appeared in the sky. It was discovered in mid-July by American scientists L. Swift and H. Tuttle. During the rest of the summer this comet was seen high in the sky from the Northern hemisphere of the Earth. And during the last week of August the comet radiance reached its peak – the second stellar magnitude, moreover the comet had a long bright tail. While examining this comet through the telescope one could see luminous nebulous jets radiating from the dense nucleus of a comet like the flower lobes. It was not by chance that Camille Flamarion, the greatest astronomy popularizer ranked Comet Swift-Tuttle among the ten most beautiful comets of the nineteenth century. Others called it simply the Great Comet of 1862. But it was the appearance of this comet that made the scientists notice the relation between the comets and meteoric showers. Thus, in 1867 Giovanni Skiaparelli, a well-known Italian astronomer stated that the comet orbit almost coincided with Perseids orbit and the comet itself had ejected the finest fragments of the particles generating Perseids meteoric shower. Nowadays the relation of most of the meteoric showers with comet remnants is proved.

In 2007 the radiance peak of Perseids meteoric shower - that is the most popular among amateur astronomers - fell on August 13. The bright meteors of this intensive shower (the hour number of meteors visible with the unaided eye amounts to 60) could hardly be mixed with any other shower or sporadic meteors.

Photographic Observations of Meteors

Photographic observations present one of the most important methods of studying meteors. They provide the maximum information scope for each meteor including its position, velocity and luminosity at any point of the visible trajectory.

Meteors can be photographed practically by any camera. It is not only the number of photographed meteors but also the image quality and the scale that matters.

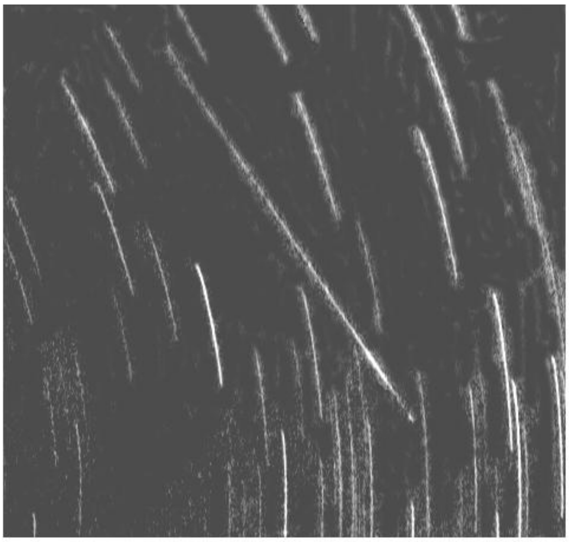

Figure 1. The processed snapshot of the meteor

In 2007 the conditions for Perseids observation from Samara were very favorable: clear sky during the whole period of the meteoric shower action (mid-July – mid-August), meteoric shower peak coincided with the interlunar period. The photographic observations were performed with the application of ZENIT-EM camera featuring MIR-1V objective lens (37mm focal distance, 60^0 viewing angle, 1:2.8 relative aperture). Academia 200 film was used for photographing. The exposure was 2 hours. Fig. 1 presents the processed photograph of one of the shower meteors observed at 20^h25^m Universal Time on August 12, 2007.

After the chemical processing of the film with D-76 developer and acid fixer, the photographic image of the meteor was scanned with the help of Epson Perfection 1260 scanner slide-adapter featuring 2400 dpi resolution with subsequent Photoshop processing of the image.

Correlation of the meteor visible path with the horizontal frame dimension (60^0) results in the following path length estimation:

$$l \cong 12^{\circ}.5$$

The comparison of the meteor photographic brightness with the stellar brightness of the stars observed in the same snapshot afforded plotting the approximate light curve (Fig.2).

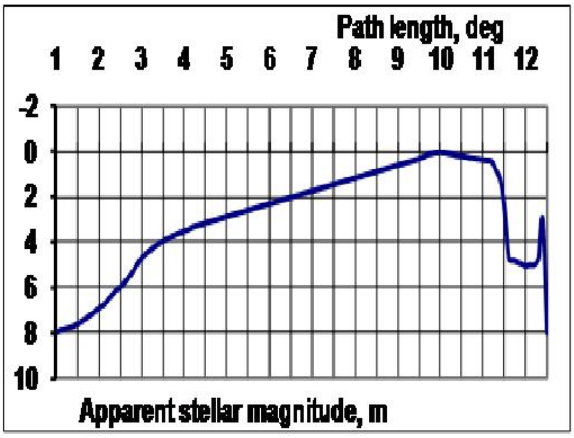

Figure 2. The meteor light curve

The maximum brightness was estimated as follows: $m_{\max} = 0^m.0$ (practically the same as for Vega (α Lyra, $m = +0^m.03$ [1]) also observed in the snapshot). Extra-atmospheric mass is defined basing upon the approximate functional connection for Perseids meteoric shower [2]:

$$m_{\max} = -4.5 - 2.35 \lg M_{\infty} - 2.31 \lg(\cos Z_R), \quad \textbf{(1)}$$

where M_{∞} is meteoroid extra-atmospheric mass, Z_R - its coaltitude at the moment of maximum brightness. The value of the extra-atmospheric mass at $Z_R = 30^0$ is as follows: $M_{\infty} \cong 0.014 g$.

The meteoroid mass at the moment of maximum brightness was equal to the following value:

$$M_{\max} = \frac{8}{27} M_{\infty} \cong 0.004 g.$$

The following equation is used for defining the meteoroid velocity at the maximum brightness moment:

$$M = M_{\infty} e^{-\frac{\sigma}{2}\left(v_{\infty}^2 - v^2\right)}, \quad \textbf{(2)}$$

where $\sigma \cong 3 \cdot 10^{-12} s^2 / cm^2$ is ablation coefficient (meteoroid surface mass loss). Substituting $M_{\max}$ instead of *M*, and 61 km/s [2] instead of v_{∞} into (2), we get the following:

$$v_{\max} = \sqrt{v_{\infty}^2 + \frac{2}{\sigma} \ln \frac{M_{\max}}{M_{\infty}}} = \sqrt{61^2 + \frac{2}{0.03} \ln \frac{8}{27}} \cong 60.332 \, km/s$$

Thus, the meteoroid practically preserved its initial velocity.

Luminous intensity curve is plotted basing upon Fig.2 data with application of the following approximate functional relation:

$$\lg I = 9.72 - 0.4 m$$

This ratio is presented in Fig. 3.

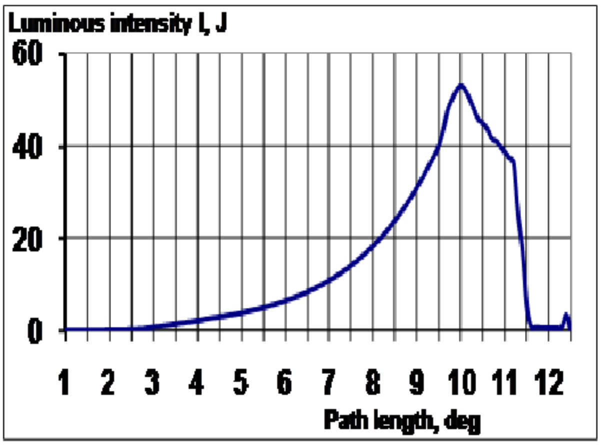

Figure 3. Meteor luminous intensity curve

Thus, within the scope of this work the photographic image of Perseids shower meteor was used for plotting the light curve and the luminous intensity curve, and for estimation of the meteoroid extra-atmospheric mass as well as its mass at maximum brightness and its velocity. The present study presents interest for investigation of shower meteors and background meteors.

References:

1. P.G. Kulikovskiy, *Stellar Astronomy*, Nauka, Moscow, 1985, p. 272.

2. P.B. Babadjanov, *Meteors and their Observation*, Nauka, Moscow, 1987, p. 202.