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Television meteor observations in INASAN

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The results of TV observations of meteors during the period 18 July–19 August (activity period of the Perseid meteor shower) in 2011 and 2012 are presented. The wide field-of-view cameras "PatrolCa" were used for the observations. Observations were carried out by the single-station as well as the double-station method. The double-station observations were aimed at determining the individual orbits of the observed meteors. The principle of Index Meteor Activity (IMA) calculations can be used for all meteor showers active during the observing period. We can use the IMA parameter to estimate the influx of meteor particles to the Earth per hour, both for shower and sporadic meteors. The distribution of the influx rate (IMA) for the Perseids to the Earth for the observing periods in 2011 and 2012 is given. Distributions of Perseid meteors by stellar magnitude are also presented.

1 Introduction

The Perseids are one of the most active and most interesting meteor showers. The stream is active in the period 17 July–24 August. It normally reaches a broad maximum on 12-13 August. The Perseids radiant at the time of maximum activity is $\alpha = 48°$, $\delta = +58°$. The velocity is 59 km/s. An interesting feature of the Perseid shower is its suggested association with Comet 109P/Swift-Tuttle.

TV observations of meteors were carried out at the INASAN stations (Zvenigorod Observatory) and the "Istra" station, from 18 July to 19 August (within the activity period of the Perseids), both in 2011 and 2012. "PatrolCa" cameras were used for observations. These cameras have a field of view of $50° \times 40°$ and the limiting magnitude for meteors is above +4.0.

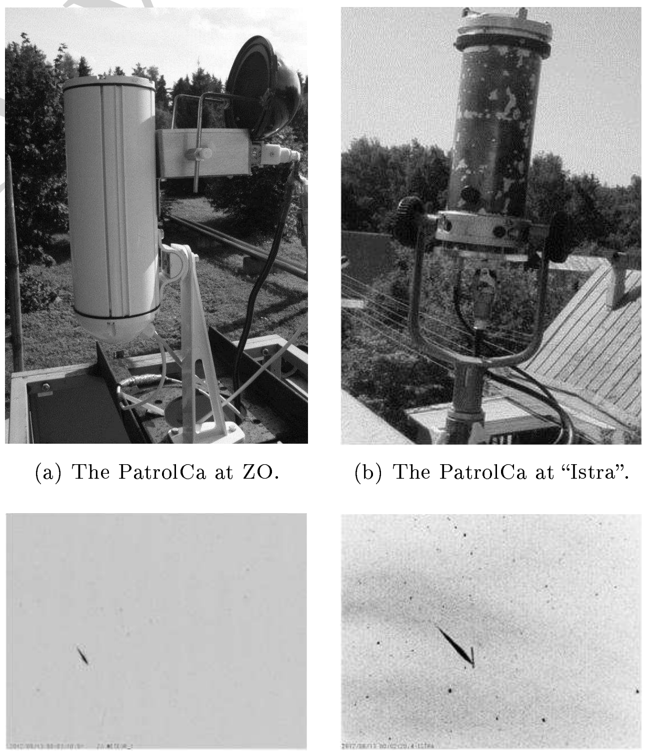
2 Observations and data

The main task of our meteor observations was to clarify the picture of low-mass particle migration inside the Solar System. A number of individual meteor orbits seems to be representative data for this phenomenon, so we began double-station meteor monitoring. The PatrolCa camera (Watec LCL-902H Ultimate with a 6 mm $f/0.8$ Canon lens) has a similar design as the cameras used by other meteor observers and has been adapted to the Russian climate (the camera has a cover and is heated). The parameters of the PatrolCa are summarized in Table 1.

Double-station observations were carried out from the INASAN's Zvenigorod Observatory (ZO) and "Istra" station. The cameras of both stations are shown in Figure 1, (a) and (b). The first camera is permanently oriented to the zenith area; the second one observes over 90% of the first camera's field of view at the heights where meteors occur. The distance between the cameras is 25 km. For both cameras, an example of a frame with a meteor is shown in Figure 1, (c) and (d).

Table 1 – Parameters of the PatrolCa meteor camera.

Type of CCD	CCD 1/2″ Watec LCL-902H Ultimate
Size of CCD	720×576 pixels
Frequency	25 frames/s
Field of view	$50° \times 40°$
Stellar limiting magnitude (initial estimate)	+5.5
Meteor limiting magnitude (moonless night)	+4.0



(a) The PatrolCa at ZO. (b) The PatrolCa at "Istra". (c) A frame from (a). (d) A frame from (b).

Figure 1 – Cameras used and example frames from these cameras.

The UFOCapture software (SonotaCo, 2009) was used for the detection of the video signal in 2012. The observations were performed during the activity of the Perseids (from 18 July to 19 August) in 2011 and 2012. In total, 247 and 680 meteors were detected in both years, respectively. From the observations, 16 double-station meteors (5 of them being Perseids) were obtained from the 2011 observations , and 120 double-station meteors (65 of them being Perseids) from the 2012 observations.

The distributions of the number of meteors (the total number of meteors, the number of Perseids, and the number of sporadic meteors) in 2011 and 2012 (from both stations) are presented in Figures 2–5. The ground projection of individual Perseid trails obtained from the double-station observations is shown in Figure 6.

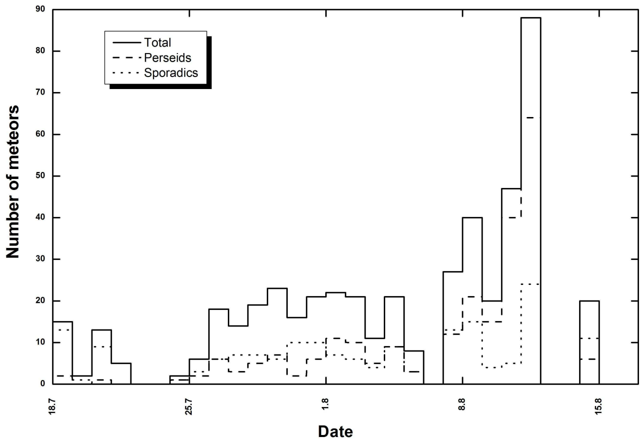


Figure 4 – Distribution of the number of meteors detected at ZO in 2012.

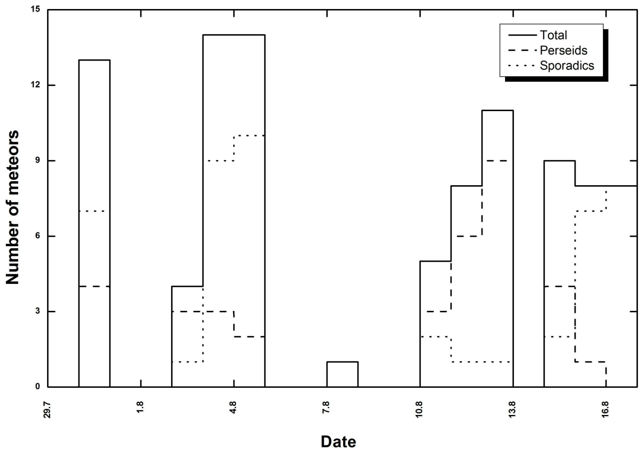


Figure 2 – Distribution of the number of meteors detected at ZO in 2011.

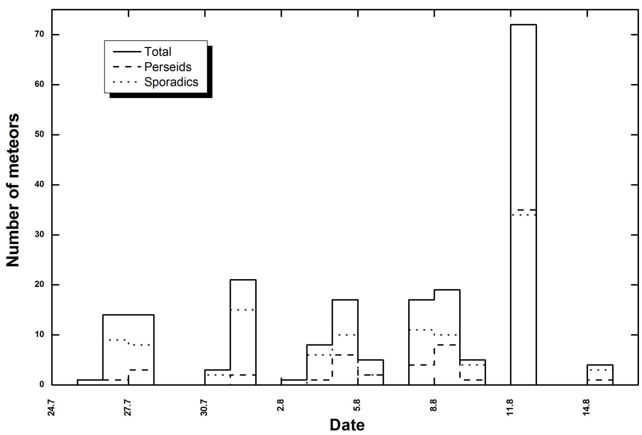


Figure 5 – Distribution of the number of meteors detected at "Istra" station in 2012.

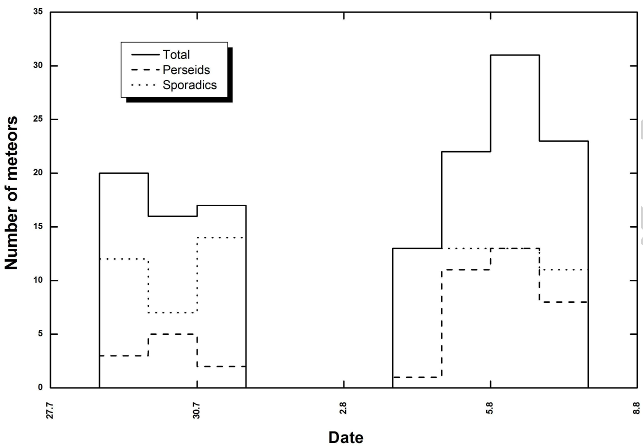


Figure 3 – Distribution of the number of meteors detected at "Istra" station in 2011.

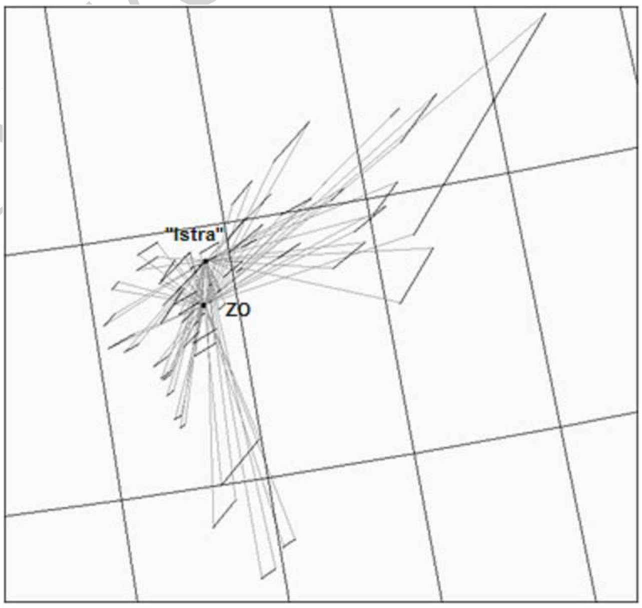


Figure 6 – Ground projection of the meteor trails detected by ZO and "Istra" station in 2012.

3 Results

3.1 Magnitude distribution of Perseids

Our cameras detected meteors brighter than magnitude +4.0. The magnitude distribution of the Perseids for 2011 and 2012 is shown in Figure 7. In 2011, our cameras worked in test mode, explaining the low number of meteors. The data for 2012 show that most Perseids are of magnitude between +0.0 and +2.0.

3.2 Distribution of meteor radiants

As reported above, 120 double-station meteors were detected in 2012. The radiant was calculated for each meteor. The radiant distribution is shown in Figure 8.

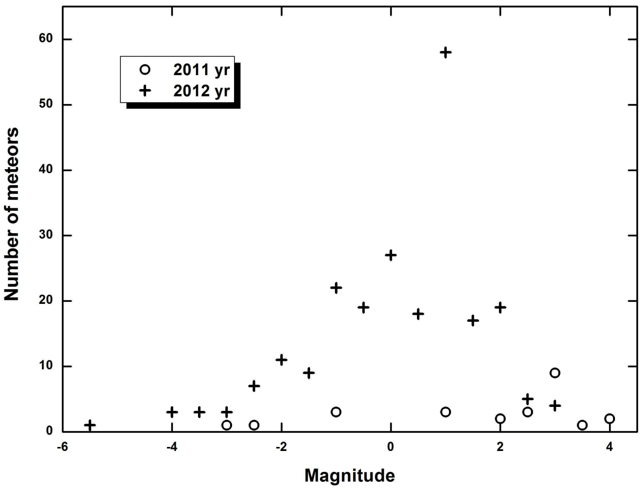


Figure 7 – Magnitude distribution of the Perseids in 2011 and 2012 (18 July–19 August).

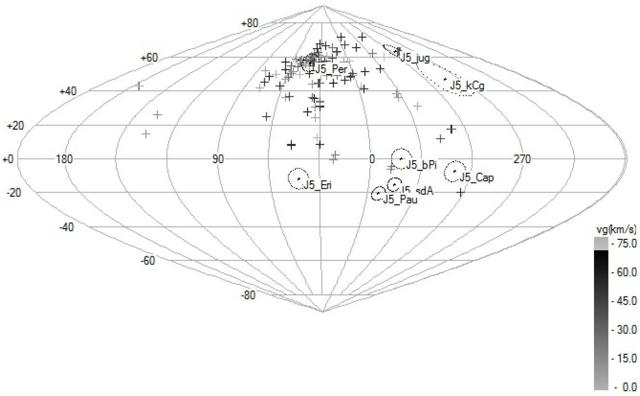


Figure 8 – Radiants of double-station meteors.

The distribution of individual radiants of Perseid meteors (for 2012) is presented in Figure 9. Their geocentric velocity in indicated with a grey scale.

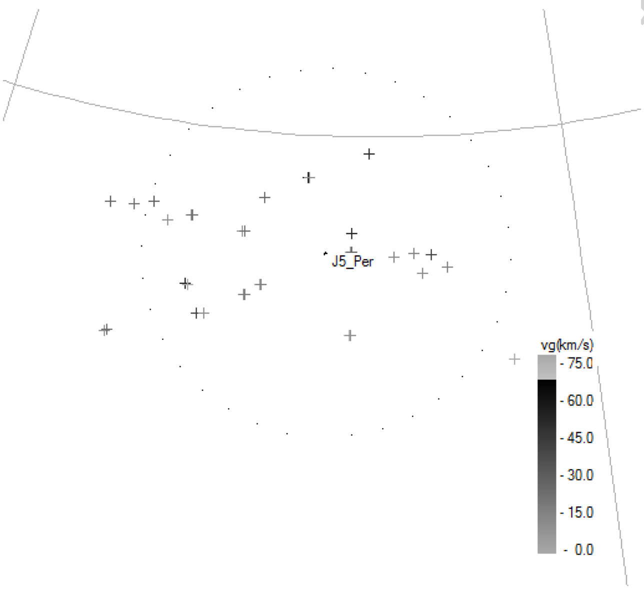


Figure 9 – Individual radiants of Perseids. The radiation area shown corresponds to 12-13 August)

It is clearly seen that both the group of points corresponding to high geocentric velocities and the group of points corresponding to low geocentric velocities are concentrated around the Perseids orbital plane. A possible explanation for this observation is that it is a result of non-gravitation drift of lighter particles to orbits with decreased eccentricity. However, both distributions are mixed, which points to a multi-stream structure of the Perseids.

3.3 Index meteor activity (IMA)

The index meteor activity (IMA) is used for the determination of meteor influx (Bagrov et al., 2007; Kartashova, 2011). The IMA was calculated for meteors associated with the Perseid meteor shower (Figure 10).

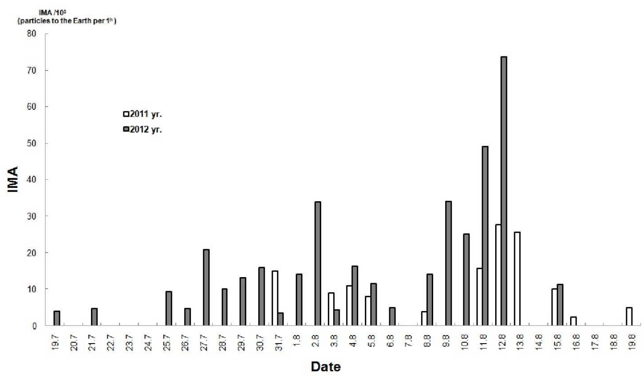


Figure 10 – Index meteor activity (IMA) for the 2011 and 2012 Perseids.

We used unfilled bars for the IMA of the 2011 Perseids, and filled bars for the 2012 Perseids. The maximum IMA was 28×10^3 (particles to the Earth per hour) in 2011 and 74×10^3 (particles to the Earth per hour) in 2012 during the maximum activity (August 12-13).

4 Conclusions

The simple design and low-cost aspect of TV meteor systems allow us to monitor meteor activity at almost all small observatories. Observations of meteors from several locations in a single observing program provides essential information for the study of various aspects of meteor astronomy.

Unfortunately, weather conditions did not allow us to monitor the meteor activity in a systematic way, and we also observed under conditions of partial cloudiness. This circumstances makes it difficult to calculate the total IMA, but we can get the IMA for different solar longitudes step-by-step. In order to obtain the distribution of meteoroids in space, knowledge of their orbits is required. Our double-station observations are intended to reveal this distribution. However, a small number of meteor stations in Russia cannot provide the quantity of observational material required for this endeavor, and, therefore, we need the help of the International Meteor Organization.

Investigations of the meteoroid matter influx to the near-Earth space should be supported by the study of its physical properties (mass and density). Double-station observations can provide the necessary basic information. The Meteor Group in INASAN plans to perform such observations in the nearest future. The Meteor Database of INASAN includes more than 1500 meteor records. Observations are carried out using a standardized methodology under INASAN supervision in Moscow and Irkutsk, allowing us to get objective information about meteoroid streams in the Solar System and the inflow of meteoroid matter to the Earth.

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