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Double-Station Meteor Observations in Ryazan, Russia

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Optical meteor observation methods and observation equipment characteristics are described. Results of CCD-meteor observations of 2011 and 2012 at two stations are presented. The results of wide-angle bright Perseids observations make it possible to estimate the average meteoroid risk over the period 2007–2012.

1 Introduction

Meteor research within the scope of circumterrestrial space ecology at the Ryazan State University astronomical observatory started at the beginning of the 21st Century (Murtazov, 2011):

1. investigating circumterrestrial space mechanisms that influence the terrestrial biosphere;
2. investigating near-space physical processes that are the basis of circumterrestrial space ecology;
3. monitoring meteors, artificial space objects, and space debris in order to assess the state of the circumterrestrial space ecologicy;
4. implementing the results of these investigations in higher education;
5. organizing research activities for students and pupils in the field of space ecology.

In addition, observations of bright meteors are necessary to assess the risk for natural impacts in space.

2 Observations and reductions

We use two observing sites for monitoring meteor activity: (1) the University Astronomical Observatory in Ryazan ($\varphi = 54°38'$ N, $\lambda = 39°45'$ E, $h \approx 125$ m) and (2) Sazhnevo, about 18 km from Ryazan ($\varphi = 54°28'$ N, $\lambda = 39°45'$ E, $h \approx 200$ m); see also Figure 1.

At both stations, observations were performed using a Watec 902H camera and a Computar T2314FICS lens with an effective field of view of $140° \times 100°$ directed towards the local zenith. The sky control and meteor detection were provided using a Pinnacle Media Center EN or Contrast as a grabber and an AMD Athlon™ 64 × 2 Dual Core processor 4200+, 2.21 GHz, 1 Gb RAM (Ryazan), or an Intel® Core™2 CPU processor, 1.83 GHz, 500 Mb RAM (Sazhnevo).

This equipment functioned in the mode assigned for registering bright meteors that present a danger for space hardware operating in the circumterrestrial space (Murtazov et al., 2008). A Watec 902H camera and a Com-

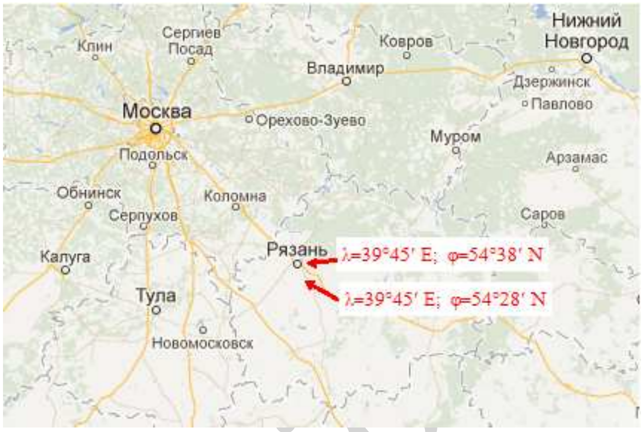

Figure 1 – Observing sites of the Ryazan State University Observatory.

putar HG0808AFCS-HSP lens (FOV = $34° \times 45°$) were used at both stations in 2012.

For meteor detection, we used free software: AMCap for making avi-files of all-sky images in continuous operation, and the SonotaCo UFOCapture software to capture meteor events. We next discuss some parameters of the system.

The distortion of the Computar lens according to our measurements is shown in Figure 2, where D is the true angular distance from the center of the frame, and R the same as measured with the stars. Thus, the cumulative distortion of the wide-angle Computar lenses amounts to up to 1°–1.°5 at a distance of 90° from the frame center.

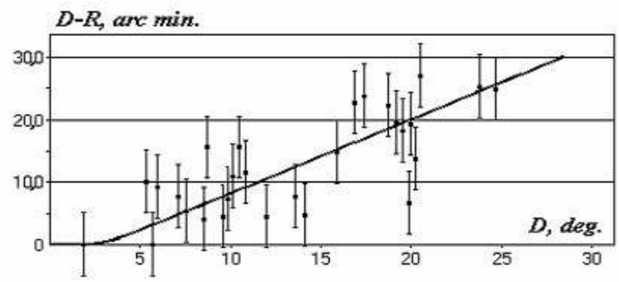

Figure 2 – Distortion of Computar lens.

The linearity of the magnitude-light flux relation for CCD-systems is very high. This relationship between comparing stellar magnitudes and the light flux obtained for them in every single frame is linear within a wide flux range of 10^4. This relationship for the Watec 902H and Computar HG0808AFCS lens is shown in Figure 3. Here, "*Lg I*" is the relative brightness of the comparison stars measured by means of IRIS aperture photometry (Buil, 2010). Different inclinations of straight lines are the result of different contrast frames measurements. Magnitudes of comparison star magnitudes are taken from Nesterov et al. (1995). The atmospheric extinction was obtained for every frame from avi-files containing meteors.

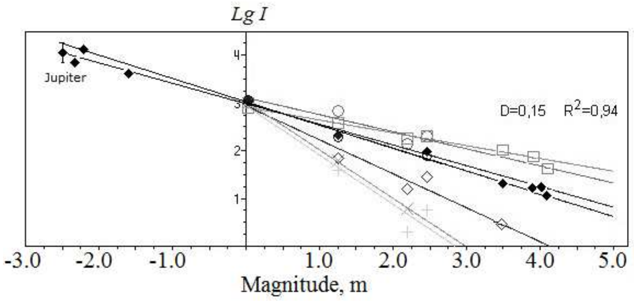

Figure 3 – Linearity of magnitude-light flux relation.

3 Results

We continued our observations at the country station. As usual, our young astronomers took part in them. The 2011 results of wide-angle bright Perseids monitoring are shown in Figure 4 as compared to the IMO visual data.

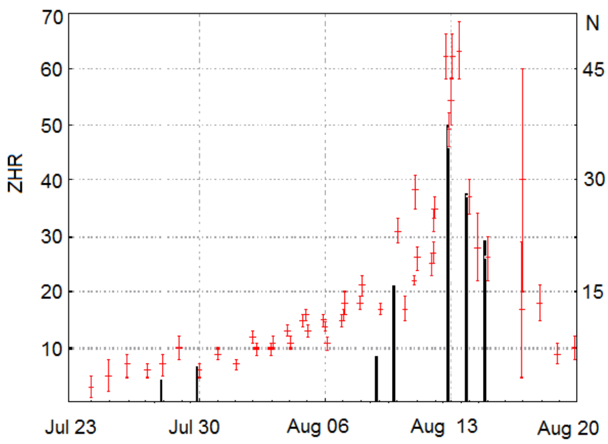

Figure 4 – Number of 2011 bright Perseids as compared to IMO visual data (the latter with error margins).

Haze and fog prevented us from conducting good-quality observations of the 2012 Perseids in the period of the shower maximum with the wide-angle equipment. However, we conducted both visual observations and observations using our TV camera (though we did not manage to measure TV meteor magnitudes). The results of these observations are shown in Figure 5. The limiting magnitude of visual observations is +4, that of TV observations brighter than 0.

Long-time observations of bright (and hazardous) Perseids allow us to calculate the meteoroid impact risk in

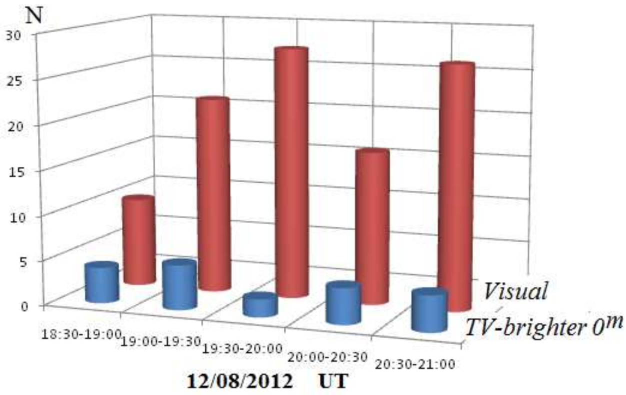

Figure 5 – Comparison of visual and wide-angle TV observations of the 2012 Perseids.

near-space. Figure 6 shows the average values of the bright meteor spatial density for the period 2007–2012. The maximum of this distribution is around solar longitude $\lambda_\odot = 140°–141°$, and practically coincides with the maximum of all IMO Perseid meteors.

The spatial density of the meteoroid flux here defines the highest possible value of the meteoroid risk for space vehicles in near-space. So, these results give evidence for the fact that the predictable risk increased several times in the period of Perseids' main maximum.

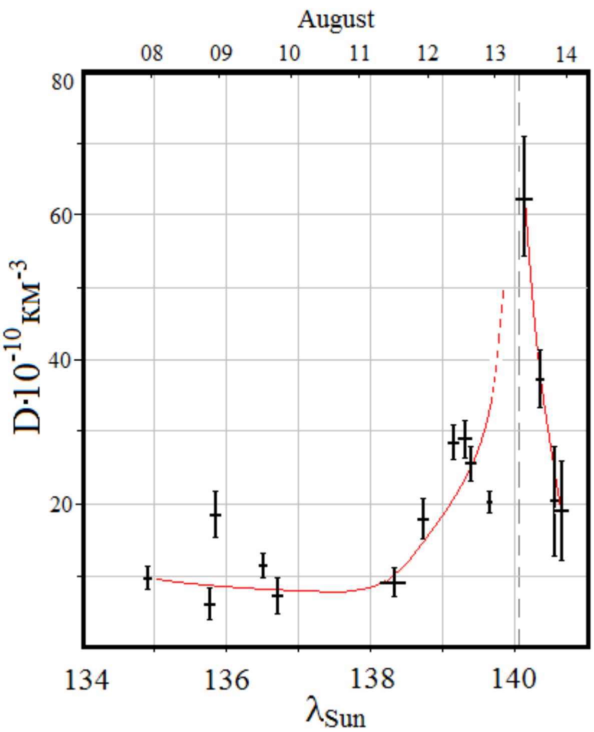

Figure 6 – Average 2007–2012 bright Perseids maximum for the Sazhnevo station. Dates shown correspond to the solar longitudes in 2007 and 2011.

In 2011, we began meteor observations at the Astronomical Observatory. Wide-angle observations in the center of the city are impossible, because of the bright street lights. So we used the system of Watec 902H and Computar HG0808AFCS lens with field of view $34° \times 45°$. This system was used for the observations of

Table 1 – Results of meteor monitoring in Ryazan, Russia, in 2011 and 2012.

Shower	Site	Date	Field of view	Meteor lm	Meteors
S δ-Aquariids (SDA)	Sazhnevo	2011, Jul 30	$140° \times 100°$	+1	6
α-Capricornids (CAP)	Sazhnevo	2011, Jul 30	$140° \times 100°$	+1	2
Perseids (PER)	Sazhnevo	2011, Aug 9–13	$140° \times 100°$	+1	80
Draconids (DRA)	Ryazan	2011, Oct 8	$45° \times 34°$	+4	36
Orionids (ORI)	Ryazan	2011, Oct 23	$45° \times 34°$	+4	27
Perseids (PER)	Sazhnevo	2012, Aug 11	$140° \times 100°$	+1	9
Perseids (PER)	Sazhnevo	2012, Aug 12	$45° \times 34°$	+3	21
Perseids (PER)	Ryazan	2012, Aug 11–14	$45° \times 34°$	+3	92

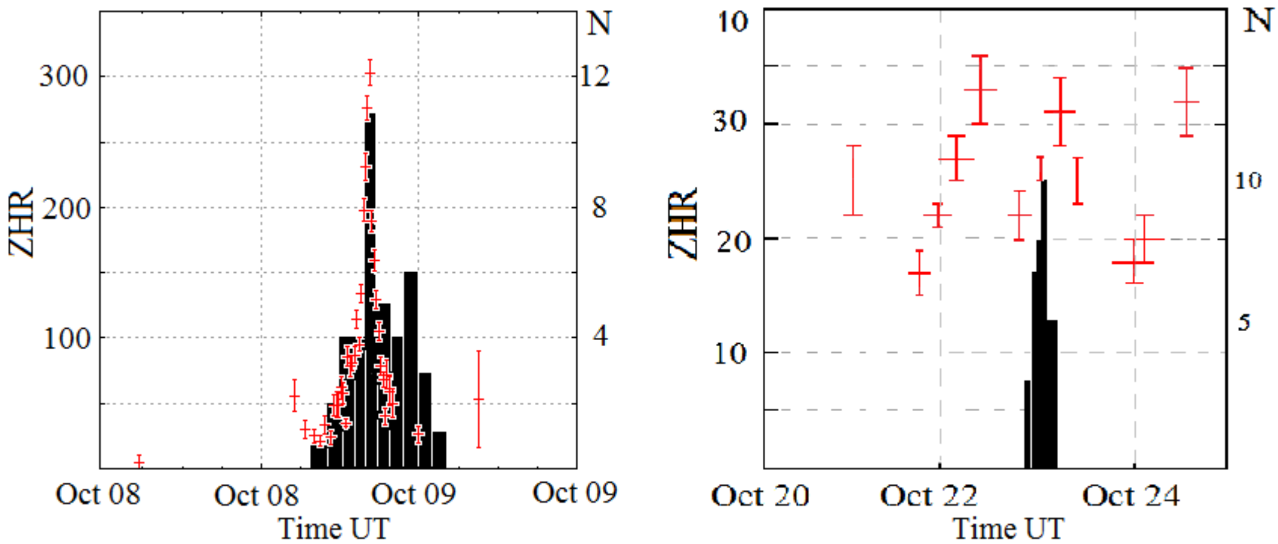

Figure 7 – Results of 2011 Draconids and Orionids observations versus IMO data (the latter with error margins).

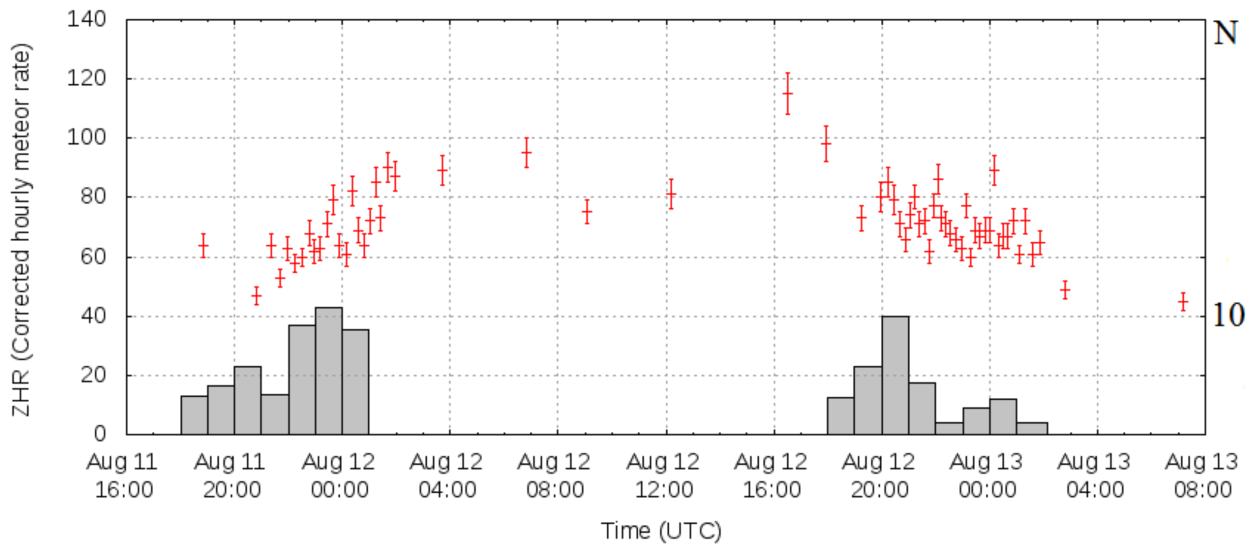

Figure 8 – 2012 TV Perseids in Ryazan. The field of view is $34° \times 45°$ and the limiting +3.

the 2011 Draconids and Orionids, and the 2012 Perseids (Figures 7 and 8). In 2012, we attempted to make basic meteor observations from both of our sites using the system of the Watec 902H camera and HG0808 AFCS-HSP lens (field of view $34° \times 45°$). Figure 9 shows some typical images. The left picture is the result of adding 100 bmp-frames from the avi-file (Sazhnevo) and the right one from 100 frames captured and added by SonotaCo software (Ryazan).

Some statistics of the observations conducted in 2011 and 2012 are summarized in Table 1.

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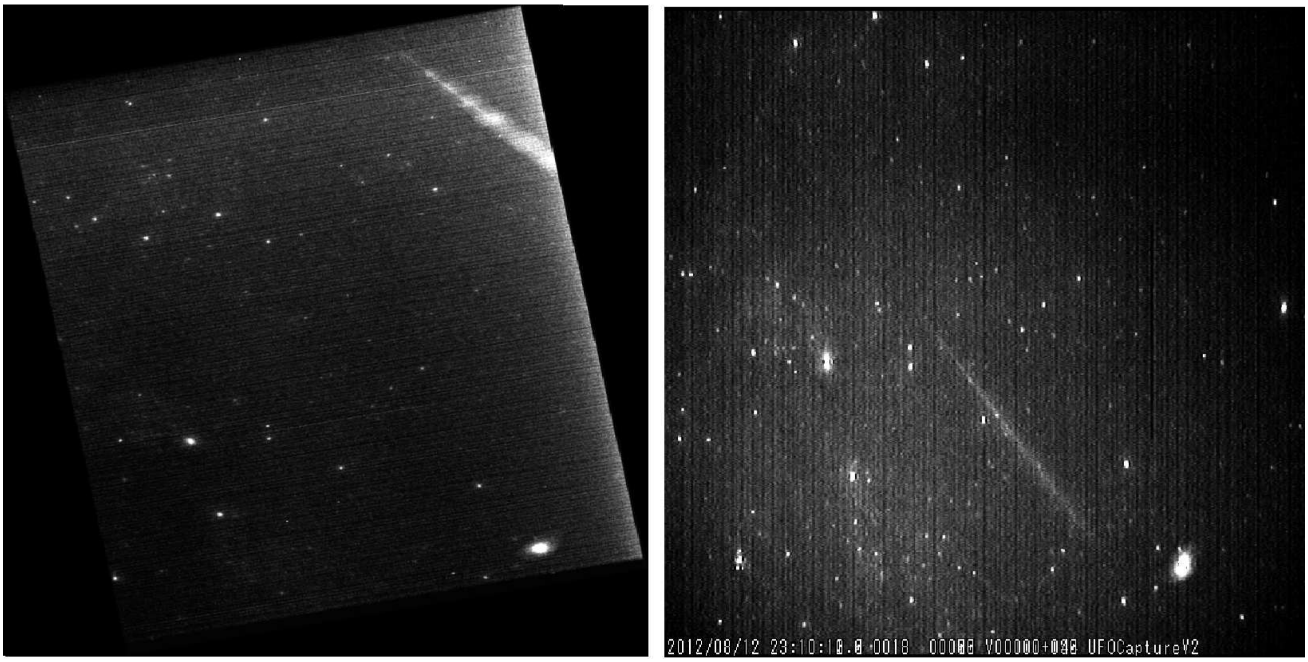

Figure 9 – Typical Perseid meteors.

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