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Bright Perseids 2007-2012 statistics. Estimation of collision risks in circumterrestrial space

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Bright meteors are of serious hazard for space vehicles. In the Persieds shower these are the meteors brighter than 0m [2].

During 2007-2012 we conducted wide-angle CCD observations of bright Perseids [3-5].

Observations were performed near Ryazan, Russia, (φ= 54.467 N, λ=39.750 E, H=200 m) using a Watec 902H camera and a Computar T2314FICS lens with the effective FOV of 140×100 arc degrees directed towards the local zenith. The sky control and meteor detection were provided using a Pinnacle Media Center EN or the Contrast as a grabber and an Intel Core.2 CPU processor, 1.83GHz, 500Mb RAM.

Our results as compared to the visual meteors total number (IMO) are shown in Fig. 1.

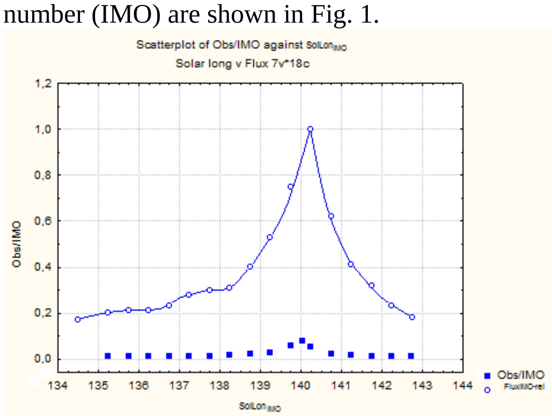

Figure 1: 2007-2012 bright Perseids (blue squares) in comparison with total shower data (IMO)

The averaged Perseids maximum lies within the solar longitudes 140.00-140.25 and here the average total shower spatial density is $(80\pm6)\cdot10^{-9}$km^{-3}. The bright Perseids average spatial density maximum is about (6±2) 10^{-9}km^{-3}. The bright Perseids average percentage in the shower is calculated as the integrals ratio under the curves in Fig. 1 and is equal to 5% for the presented range of solar longitudes.

It is natural to expect that the space densities of meteoroids decrease exponentially from the maximum [1]:

$$D = D_0\exp\{-B|\lambda-\lambda_0|\}, \qquad (1)$$

where: D_0 is the maximum meteor spatial density near the solar longitude λ_0 and B – the factor determined empirically from observations.

The meteoroid flux F is equal to the number of particles passing through the elementary area per time unit:

$$F(\lambda) = D(\lambda)\cdot v, \qquad (2)$$

where: v – is the meteor shower velocity.

During the Perseids' maximum ($D_0=6\cdot10^{-9}$km^{-3} and v=59km/s) the bright meteoroid flux was equal to $F = (3.8\pm1.1)10^{-7}$km^{-2}s^{-1}, which corresponds to the hour rate $HR\approx15$ for our camera FOV.

The collision risk R here amounted to one collision per month on average with a 1 sq. km plane located normal to the meteor shower.

An artificial space object rotating around the Earth constantly changes its orientation relative to the meteor shower, the Sun, and a ground-based observer. From time to time, the Earth occults the satellite from meteoroids.

The number of collisions between this meteor shower's dangerous meteoroids and the satellite during the time ΔT of its flight around the Earth is [6]:

$$N = K_1\cdot K_2\cdot K_3\cdot S\cdot F(\lambda)\cdot\Delta T. \qquad (3)$$

Here K_1 accounts for the Earth's geliocentric position in the current season relative to the meteor shower radiant. K_2 accounts for the satellite's plane surfaces relative to the meteor shower radiant.

K_3 is defined by the satellite's orbit parameters.

Calculations are done in the ecliptic reference system (Fig. 2), wherein a satellite can be considered as located in the ecliptic plane. In this figure: **N** is the normal to the satellite's surface; ♈, ⊙, ***E*** – directions to the vernal equinoctial point, the Sun and the Earth; λ_R, $\lambda_{\odot}$ – ecliptic longitudes of the meteor radiant and the Sun; λ_E – the ecliptic satellite-centric Earth longitude; b_R and b_E – consequent ecliptic latitudes of meteor shower radiant and the Earth.

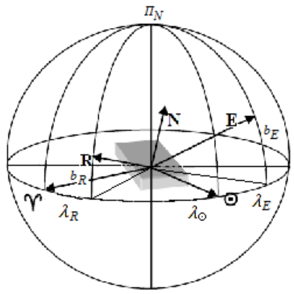

Figure 2: Ecliptic reference system for meteoroid risk calculation

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