Annual occurrence of meteorite-dropping fireballs

N.A. Konovalova (1), T.J. Jopek (2)
(1) Institute of Astrophysics of the Academy of Sciences of the Republic of Tajikistan (nakonovalova@mail.ru),
(2) Institute Astronomical Observatory, Faculty of Physics, A.M. University, Poznan, Poland

Introduction

The event of Chelyabinsk meteorite has brought about change the earlier opinion about limits of the sizes of potentially dangerous asteroidal fragments that crossed the Earth's orbit and irrupted in the Earth's atmosphere making the brightest fireball. The observations of the fireballs by fireball networks allows to get the more precise data on atmospheric trajectories and coordinates of predicted landing place of the meteorite. For the reason to search the periods of fireball activity is built the annual distribution of the numbers of both meteorites with the known fall dates and of the meteorite-dropping fireballs versus the solar longitude. The resulting profile of the annual activity of meteorites and meteorite-dropping fireballs shows several periods of increased activity in the course of the year.

Data processing and analysis

The analysis of the atmospheric trajectories of sporadic meteorite-dropping fireballs observed in Tajikistan by instrumental methods [1] in the summer–autumn periods of increased fireballs activity has been made. The physical properties of fireballs in terms of different methods (beginning velocities and heights, initial mass, dynamic pressures at the height of fragmentation or bright flare) were calculated. As a result the structural strength, the bulk density and terminal mass of the studied fireballs that can survive in the Earth atmosphere and can be meteorites was determined.
From the photographic IAU MDC_2003 meteor database and published sources based on the orbit proximity as determined by D_{sh}-criterion of Southworth and Hawkins [2] the fireballs that could be the members of group of meteorite-dropping fireballs, was found. Among the near Earth's objects (NEOs) the searching for parent bodies for meteorite-dropping fireballs was made on the base of D_{sh}-criterion of Southworth and Hawkins. As orbits evolve rapidly in the solar system, just a similarity of orbits at the present time is not sufficient to prove a relationship [3]. The evolution of orbits of these objects in the past on a long interval of time was investigated to show that the evolution is similar.

Conclusions

From statistics of recorded meteorite-dropping fireballs and meteorites we have found four major and two minor increases in fireball activity within a year. The major ones occur around dates 1st August, 24th October, 4th December, and 7th January and the minor ones around 16th April, and 9th February. Histogram of numbers of both meteorites with the known fall dates and of the meteorite-dropping fireballs is shown in the figure below.

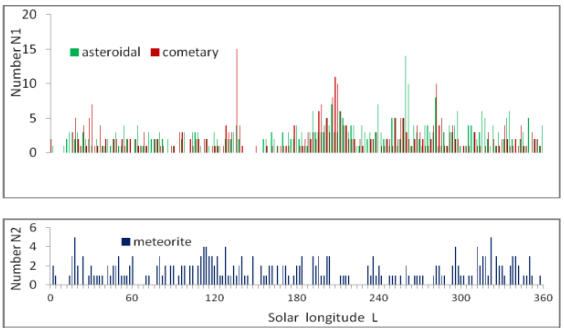

Figure. Annual activity profiles of meteorite-dropping sporadic fireballs (top) and meteorites (bottom).

References

[1] Summary catalogue of orbital elements and light curves of the meteors photographed in the Institute of Astrophysics, Tajik Academy of Sciences (Dushanbe). Editor P.B. Babadzhanov, (2006), Dushanbe, “Donish”, 207 p.
[2] Southworth, R.B., Hawkins G.S, Smith. Contrib. Astrophys., Vol.7, pp. 261-285, 1963.
[3] Jopek, T.J., Williams, I.P. Highlights of Astronomy, Vol. 16, pp. 143-145, 2015.