Daytime Taurid complex meteor stream - Zeta Perseids and its potential parent bodies

Marek Bucek and Eva Schunova

Department of Astronomy, Physics of the Earth and Meteorology - Faculty of Mathematics, Physics and Informatics, Comenius University Bratislava, Slovakia

Abstract

Taurid complex crosses the Earth in the preperihelion arc in the form of meteor streams Taurids (Southern and Northern), Piscids and Chi Orionids in October – November. Because of its low inclination, the complex crosses the Earth also in postperihelion arc as daytime streams Beta Taurids and Dzeta Perseids in May – July. In this paper we deal only with Dzeta Perseid stream, which represents a continuation of two complex filaments related to the Southern Taurids. Our first step was to separate individual meteors of Harvard Radio Meteor Project catalogue using Southworth – Hawkins D-criterion and to find the mean orbit of the stream. For this orbit we made a search among the known NEO objects in order to find potential parent body of the stream. Relevance of discovered asociations was verified by a long-time orbital evolution. As a result of orbital similarity between the stream and found NEO objects, we consider asteroids 2007 TC_{14} and 2007 RU_{17} to be the most probable parents of the stream.

Introduction

The Taurid meteor complex is known since the beginning of the 20th century. Whipple made In 1940 analyses of Taurid orbits from photographic observation and supposed that, due the low orbit inclination of stream Earth crosses complex also in postperihelion arc (June, July). These meteors should be seen on daytime sky and were discovered at the Jordell Bank Radio observatory in 1947 as two separate streams, Zeta Perseids and Beta Taurids. Zeta Perseid stream represents a continuation of two complex filaments related to the Southern Taurids. As a parent of the complex, two objects: comet 2P/Encke and its related asteroid 2004 TG10, were suggested.

Meteor streams	q [AU]	a [AU]	e	i [deg]	ω [deg]	Ω [deg]	π [deg]	R.A. [deg]	Dec. [deg]	Vg [km/s]
Zeta PER	0,319	1,916	0,834	5,3	59,2	78,3	137,5	60	25	29
Beta TAU	0,325	1,853	0,825	2,2	239,2	275,2	163,1	80	22	28

Table 1: Main orbits of daytime Taurid streams

The number of discovered Near Earth Asteroids (NEAs) increased rapidly due to NEOs survey programs in recent years and possibility to find another parents increases as well.

Analysis

We have made a search for the Zeta Perseids among radio meteor orbits obtained from Harvard Radio Meteor observations in 1967 and 1969 consisting of almost 40 000 orbits (Sekanina (1973, 1976)), stored at the IAU Meteor Data Centre. We intended to perform an independent stream seach for which a computerized stream-search procedure based on an iteration process utilizing the Southworth-Hawkins D-criterion of orbital similarity was applied. The D-criterion is utilized to measure similarity of two orbits by means of their orbital elements (Southworth, Hawkins 1963). In our analysis, the members of the Zeta Perseids were search in the period from 1st of May to 30th of June and limiting value of D_{sh}=0,2 was used. From these individual stream members a new mean orbit was determined. There was also made a search among all known NEAs to find potential parent. For limiting value of D_{sh} = 0.3, asteroids were found and calculation of teoretical meteor radiants and geocentric velocities was made for them. Degree of relevance of these associations was verified by a long-term orbital evolution over 5000 years. The meteor stream was represented by 18 model particles uniformly distributed in mean anomaly.

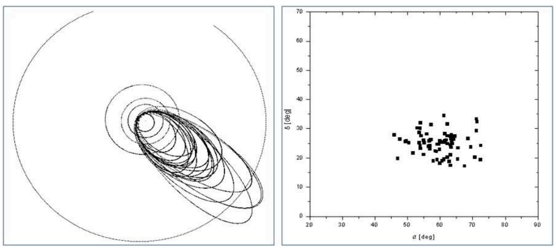

Figure 1: Orbits of Zeta Perzeids and reduced radiant positions

Main results

In the first step there were found 71 meteors for $D_{sh} \leq 0.2$ with respect to the Zeta Perseids mean orbit (observed in dates of stream activity: from 1st of May to 30th of June). These meteors were considered as Zeta Perseids and the new mean orbit was obtained. Search among 5818 to the Earth approaching asteroids was made in the next step. 15 asteroids for Southworth – Hawkins criterion limit up to D_{sh}=0.3 were found. Following theoretical meteor radiant, geocentric velocities (Svoreň, Neslušan and Porubčan, 1993 and 1994) and Tisserand's parameter were completed for these asteroids.

Contacts: eva.schunova@fmph.uniba.sk; mbucek@fmph.uniba.sk

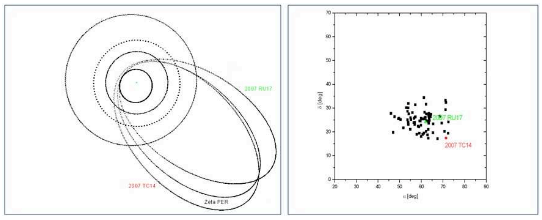

Figure 2: Orbits and radiant positions of Zeta Perseids and their potential parents

Only two asteroids have D_{sh} lower than 0.2: 2006 SO_{198} (D_{sh} = 0.188) and 2007 RU_{17} (D_{sh} = 0.196). With respect to Zeta Perseids, asteroids 2007 RU_{17} and 2007 TC_{14} seem to be the best fitted (Table 2).

	a [AU]	e	i [deg]	ω [deg]	Ω [deg]	π [deg]	Dsh	Tj	R.A. [deg]	Dec. [deg]	Vg [km/s]	H [mag]	D [km]
Zeta PER	1,994	0,820	6,7	78,7	59,6	138,3	-	3,33	60,0	25,0	28,0	-	-
2007 TC14	2,090	0,807	4,6	268,7	224,6	133,3	0,195	3,24	71,4	17,4	26,5	18,13	1,57
2007 RU17	2,044	0,826	8,9	128,3	18,9	147,2	0,215	3,23	61,9	24,2	28,0	22,13	0,25

Table 2: Orbital elements, the value of Southworth-Hawkins criterion, Tisserand's parameter, absolute magnitude, estimated diameter (for A = 0, 04) and geocentric velocity of Zeta Perseids and their most probable parent bodies.

Orbital evolution indicates possible relation of these objects. Similar trend of evolution in all orbital elements during the integration can be seen in figure 3.

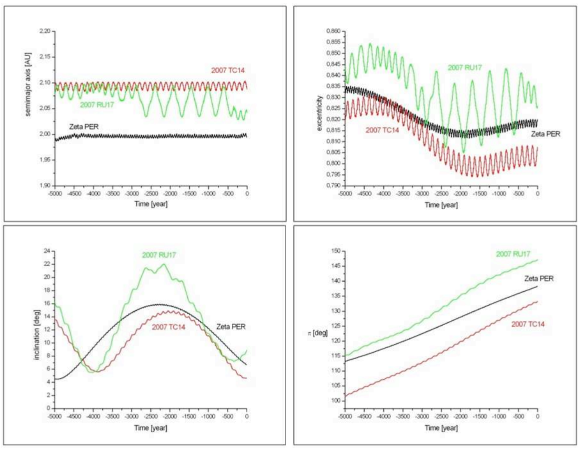

Figure 3: Orbital evolution of Zeta Perseids a potential parent asteroids

Significant change in trend of semimajor axis and eccentricity evolution of 2007 RU_{17} (250, 700 and 3000 years ago) was possibly made by very close Mercury encounters (minimal distance of 0.005 AU). Asteroid 2007 TC_{14} suffered very close Mars encounter in 4300 years ago, also. Diameters of these asteroids are approximately 1.5 km for 2007 RU_{17} and 250 meters for 2007 TC_{14} (for A=0.04). Escape velocity from such small objects is low. Probably a stream of dust particles in an asteroid orbit could be a result of very close approaches to the planet.

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