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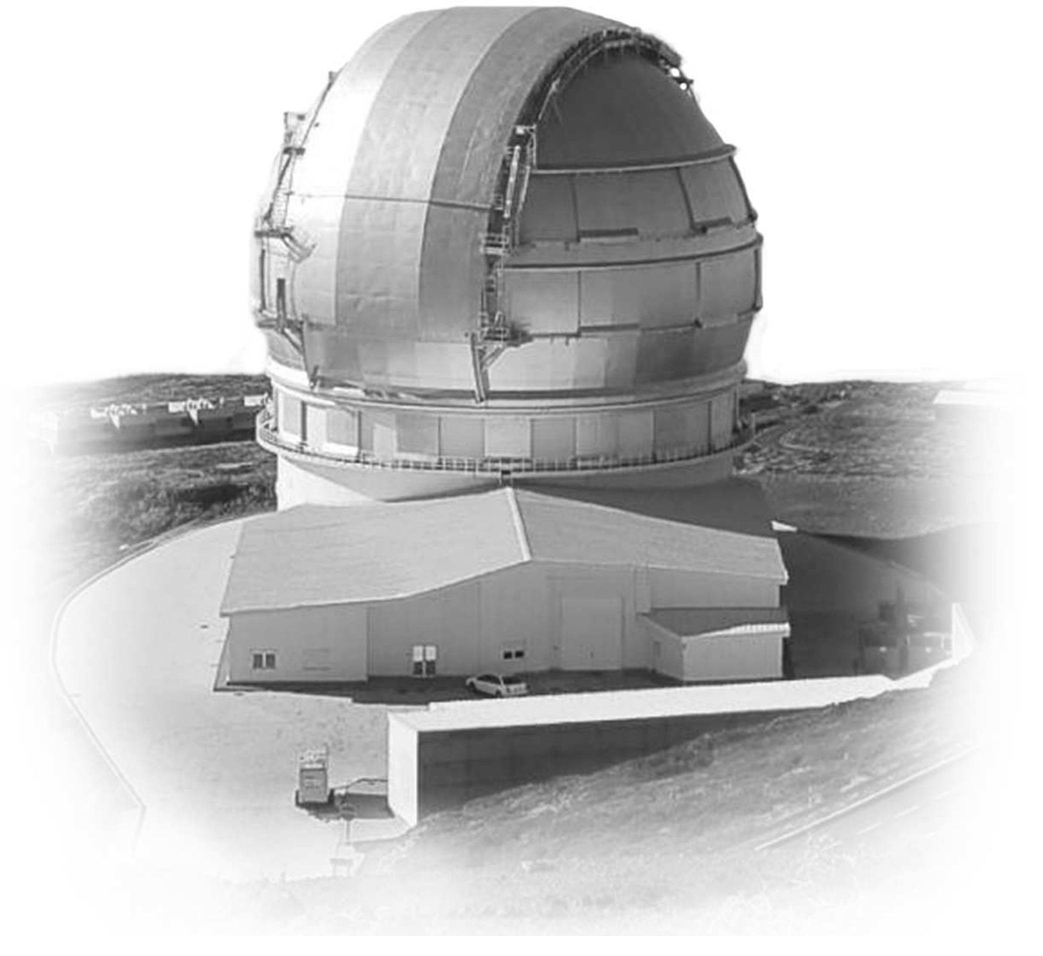

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On short-perihelion meteor streams related to comets and asteroids

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The relationship between short-perihelion meteor streams and comets and asteroids was investigated. Out of over 400 meteor and fireball showers (from both photographic and TV observations), 20 had perihelion distances of $q \leq 0.26$ AU. The research showed that 8 of these 20 meteor streams displayed a relationship with small bodies. No such relationship with either comets or asteroids was found for the remaining 12 streams.

1 Introduction

Our knowledge about the origin of meteor streams with a small perihelion distance remains problematic. It concerns in particular meteor streams on small-sized orbits (of the Arietid and Geminid types). V. N. Lebedinets (1985) proposed and mathematically substantiated a mechanism for the formation of short-period meteor streams of this type. He showed that large-sized comet orbits might transform into small-size meteor-type orbits during the evaporation of their icy nuclei by the action of reactive drag. An alternative mechanism for the formation of small-sized meteor orbits was considered based on close encounters with inner planets (Terent'eva and Bayuk, 1991; Andreev et al., 1990). A source of additional information for the solution of this problem may be in the recent discovery of SOHO comets, as part of these may be short-period ones (Hönig, 2006).

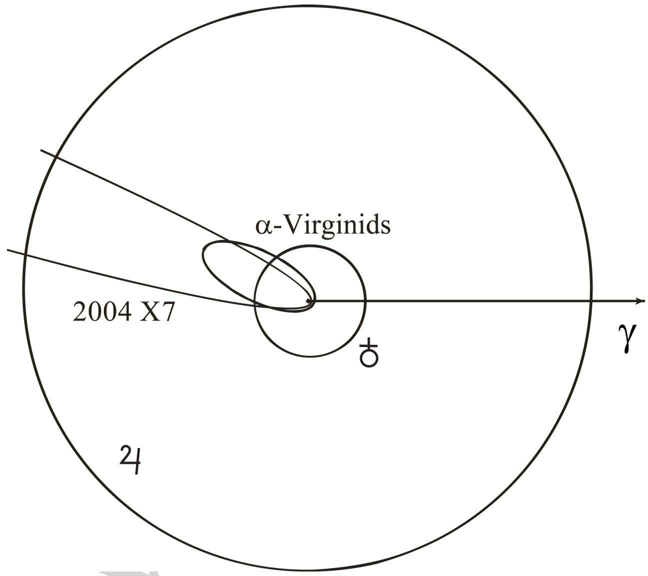

Figure 1 – The α-Virginid meteor stream and SOHO Comet C/2004 X7 (orbital planes are superposed on the ecliptic plane).

2 Results and conclusions

Out of over 400 meteor and fireball showers (from photographic and TV observations), 20 had perihelion distances of $q \leq 0.26$ AU. Further research showed that 8 out of these 20 streams displayed a relationship with small bodies. For 4 streams, this relationship was with comets (including SOHO comets). One of these, the Scorpionids, may alternatively be related with an asteroid of the Apollo group (see Table 1). The other 4 streams could be associated with asteroids, one of which from the Aten group, and the other ones from the Apollo group. No relationship with either comets or asteroids was found for the remaining 12 streams.

Thus, meteor streams with a small perihelion distance may originate equally well from comets as from asteroids, no matter what the nature of these objects is. Indeed, short-period streams may be formed on quasi-parabolic comet orbits with small perihelion distances in the vicinity of the perihelion. This is, for example, the case for the α-Virginids (see Table 1 and Figure 1).

A decrease in size of the orbit occurs as a result of very moderate drag of particles when these are released from the comet nucleus. This can be a significant change, as much as from a parabolic orbit to such small-size orbit that its aphelion turns out to be approximately 2 AU (maybe, even less). Using the well-known formula

$$V_{\rm per}^2 = GM_\odot \left(\frac{2}{q} - \frac{1}{a} \right),$$

it can be found that a decrease in velocity during release into the perihelion compared to the velocity of the parent body will be between 470 m/s to 740 m/s (for a parabolic orbit with $q = 0.002$–0.005 AU), about 1 km/s ($q = 0.01$–0.02 AU), and 3.4 km/s($q = 0.1$ AU).

For the μ-Virginid meteor stream (Table 1, Figure 2) the theoretical radiant of Comet C/1737 C1, according to our calculation, refers to the southern (S) branch of the stream, if the μ-Virginids represent its northern (N) branch. We found that a similar situation occurs for the 31-Pegasid meteor stream and its parent, Comet 1995 LG (Table 1).

Table 1 – Relation of meteor streams with comets and asteroids. Orbital elements of meteor streams are given for Equinox 1950.0; all other orbital elements are given for Equinox 2000.0. The comets C/2004 X7 and C/2001 D1 are SOHO comets.

Object	Date (UT)	Radiant (Corr. geoc.) α	δ	V_∞ (V_g) (km/s)	a (AU)	e	q (AU)	i	ω	Ω	π
μ-Virginids (N)[1]	Apr 06–24	218°	−10°	44.0	56.8	1.01	0.16	12°	314°	20°	333°
C/1737 C1 (S)[2]	Apr 17	218°.3	−24°.5	(39.9)		1	0.22282	18°.3	99°.5	230°.1	329°.6
α-Virginids[3]	Mar 02–26	210°	−10°	35.2	1.16	0.91	0.10	10°	334°	0°	334°
C/2004 X7[2]	Mar 22	208°.6	−14°.4	(46.8)		1	0.0412	21°.3	160°.6	180°.1	340°.7
Scorpionids (N)[4]	May 01–19	249°	−17°	38.4	2.13	0.93	0.14	12°	323°	46°	9°
Scorpionids (S)		250°	−28°	38.0	1.64	0.93	0.12	16°	146°	225°	12°
2005 HC_4[5]	Apr 29	241°.6	−20°.9	(35.6)	1.818	0.961	0.0708	8°.4	309°.0	63°.8	12°.8
C/2001 D1[2]	May 08	254°.2	−25°.0	(47.5)		1	0.0326	14°.8	214°.0	173°.8	27°.8
θ-Taurids[6]	Mar 11–21	213°	−31°	55.3	61.40	1.00	0.16	105°	133°	181°	314°
C/1439 F1[2]	Mar 31	219°.0	−32°.4	(50.2)		1	0.12	81°	140°	192°	332°
η-Librids[7]	Apr 11–21	230°	−19°	29.5	0.87	0.84	0.14	2°	152°	201°	353°
1999 FK_{21}[5]	Apr 07	236°.4	−19°.8	(24.6)	0.7388	0.703	0.219	12°.6	172°.3	180°.5	352°.9
β-Leonids[8]	Feb 03–20	174°	+11°	36.0	1.50	0.90	0.16	16°	322°	324°	286°
1996 BT[5]	Jan 27	155°.2	+18°.2	(29.8)	1.195	0.830	0.204	11°.9	327°.8	297°.1	264°.9
31-Pegasids (N)[9]	Jul 15–19	334°	+12°	28.0	0.73	0.79	0.16	36°	338°	115°	93°
1995 LG (S)[5]	Jul 10	336°.7	−36°.9	(29.8)	1.064	0.791	0.222	43°.5	160°.1	276°.5	76°.6
δ-Piscids (N)[10]	Sep 10–13	10°.2	+08°.3	(34.6)	2.1	0.92	0.17	7°.3	317°.5	170°.7	128°.2
δ-Piscids (S)		13°.7	+01°.1	(35.7)	2.2	0.93	0.15	10°.9	140°.2	349°.7	129°.9
1984 QY_1[5]	Sep 15	5°.7	+12°.6	(33.6)	2.963	0.917	0.246	15°.5	335°.4	144°.1	119°.5
2000 SG_8[5]	Sep 23	24°.3	−05°.0	(32.7)	2.461	0.902	0.242	24°.1	151°.8	338°.3	130°.2

[1] Terentjeva, 1963; 1966. No. 52
[2] http://ssd.jpl.nasa.gov/dat/ELEMENTS.COMET
[3] Terentjeva, 1967. No. 27
[4] Terentjeva, 1963; 1966. No. 71
[5] http://neo.jpl.nasa.gov/cgi-bin/neo_elem
[6] Terentjeva, 1967. No. 28
[7] Terentjeva, 1967. No. 45
[8] Terentjeva, 1963; 1966. No. 23
[9] Terentjeva, 1967. No. 228
[10] Ueda et al, 1997

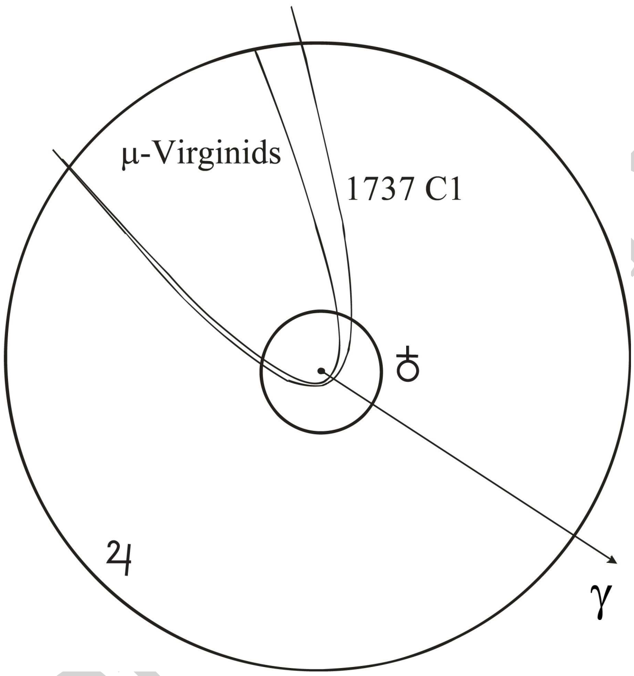

Figure 2 – The μ-Virginid meteor stream and Comet C/1737 C1 (orbital planes are superposed on the ecliptic plane).

We (Terentjeva and Barabanov, 2008) discovered vast streams of meteor bodies related with large streams of SOHO comets or with separate SOHO comets.

Therefore, we may conclude that the SOHO comets represent a rich source of both small and large meteor bodies, which may generate meteor streams with small perihelion distances, and, in particular, short periods. SOHO comets may also form vast comet-meteor complexes.

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