METEORITE-DROPPING BODIES FROM COMETARY METEOROID STREAMS AND THEIR PHYSICAL PROPERTIES. N. A. Konovalova[1], J.M. Madiedo[2] and J.M. Trigo-Rodriguez[3]. [1]Institute of Astrophysics of the Academy of Sciences of the Republic of Tajikistan, Bukhoro, str. 22, Dushanbe 734042, Tajikistan. (**nakonovalova@mail.ru**), [2]Facultad de Ciencias Experimentales, Universidad de Huelva, Spain, (madiedo@cica.es), [3]Institute of Space Sciences (CSIC-IEEC), Campus UAB, Sciences Faculty, tower C-5 even, 2ond floor, 08193 Bellaterra (Barcelona), Spain (trigo@ieec.es).

Introduction: Until recently it was considered that the sources of meteorite-dropping bodies are asteroidal fragments mostly delivered by main belt resonances crossing the Earth's orbit. Such source may include a considerable fraction of meteorites falling at a given time [1]. Wetherill initially discarded comets as a probable source of meteorites [2], but recent results seem to indicate that they could also contribute [3, 4]. The terrestrial collections of meteorites include the ordinary chondrites meteorites represented by ~85% of meteorite falls and finds, but only ~40% of the total meteorite mass. Iron meteorites account for 50% of the mass but only ~4% of meteorites. Carbonaceous chondrite meteorites forming ~9% of the mass are underrepresented due to their fragility and low density [5]. It has been estimated that ~24,000 meteorites with masses from 100 g to 10 kg fall to the Earth each year and amongst them a few ones might have a cometary provenance. Some Near Earth Objects (NEOs) supports the notion that dormant nuclei of periodic comets can have asteroidal appearance, and that some fraction of the NEOs have a cometary origin and are potentially delivering meteorites to the Earth.

From 46 meteorite-dropping events recognized from the MORP network survey [6] about 10% fireballs appear to belong to cometary type of orbits according to Tisserand's parameter ($2 < T_j < 3.1$). The carbonaceous chondrite meteorite Orgueil has a deduced orbit from visual historical records similar to that of Jupiter-family comets (JFCs), although a Halley-type comet cannot be excluded, has very fragile and incoherent nature [7]. The Tagish Lake carbonaceous chondrite meteorite was caused by the already known μ-Orionid fireball stream [8] and also as in case of the Orgueil meteorite this ungrouped carbonaceous chondrite has a density of 1.6 g/cm^3. We think that all this available evidence is clearly pointing out that cometary sources are also capable to produce meteorite-dropping bodies as a result of the catastrophic disruption of cometary nuclei [4,9,10].

The presence of large meteoroids in cometary meteoroid streams of cometary origin is a key to understand the nature and evolution of comets. Thermally processed short-period comets evolve towards dormant phases that evidence the accumulation of a rubble mantle in their surfaces [11]. In order to provide additional evidence to our claims we are here including new results obtained by the Spanish Meteor Network (SPMN). We identify here some meteoroids with orbits clearly associated with two cometary meteoroid streams o-Draconid and June Bootid. First one is associated with C/1919Q2 Metcalf and the second one to 7P/Pons-Winnecke.

Methods: In this work we made the analysis of the observed light curves that are reflecting important physical properties of the several o-Draconid and June Bootid meteoroids. The aim of this analysis is try to determine the strength and bulk density of these meteoroids. The density of each meteoroid is estimate by simultaneously fitting the observed light curve using a model based on quasi-continuous fragmentation [12]. The aerodynamic pressure on the meteoroid is estimate at the point of maximum brightness or flares when the aerodynamic pressure exceeds the material's strength [13]. By comparing the simulated and the observed light curves we obtain the density of the studied o-Draconid and June Bootid meteoroids. On the other hand, the data on the height and velocity of the meteoroid at the moment of its maximum brightness or flares becomes the basis for calculating the aerodynamic pressure, from which we infer the strength properties of the studied o-Draconids and June Bootids and the type of material that would fit such properties.

Results and discussion: To receive the data on the bulk densities of the o-Draconid and June Bootid meteoroids we have analysed the smooth light curves (Fig. 1 – 3) of several meteors from both streams. Our results provide the modeled range of bulk densities (Table 1) was obtained as a result. This result is consistent with work [14] which suggest bulk density of meteoroids with orbits belonging to Jupiter family comets (JFCs), have an average density of 3.1± 0.3 g cm^{-3}. In the case of the Bejar bolide appeared on July 11, 2008 (Spain) and the July 23, 2008 Tajikistan bolide the orbital information and preliminary fall data was obtained [4,15,16]. The brightest ending flare of Bejar was at the height 26.8 km and the brightest first flare of fireball of July 23, 2008 was at the height 35.0 km when the first break-up must have occurred under an aerodynamic pressure of about 14 Mpa and 1.5 Mpa respectively.

Stream	N	ρ (g/cm^3)
o-Draconid	M20070714	1.2 ± 0.2
o-Draconid	D830251	2.2 ± 0.4
o-Draconid	D592351	2.4 ± 0.1
June Bootid	MO 4117	0.6 ± 0.1
June Bootid	MO 4121	2.0 ± 0.1

Table 1. Bulk density modeled values of the studied events. N is the number of meteors studied.

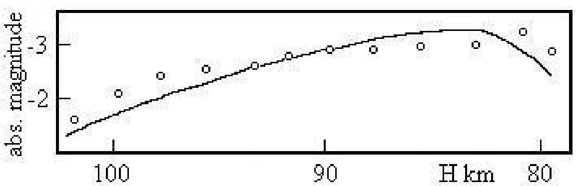

Figure 1. Observed (circle) [17] and simulated (line) light curve of a July 12, 1959 o-Draconid.

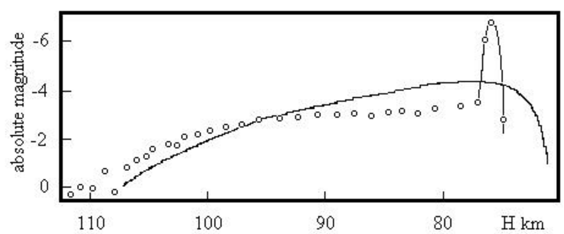

Figure 2. Observed (circle) and simulated (line) light curve of a o-Draconid recorded on July 14, 2007.

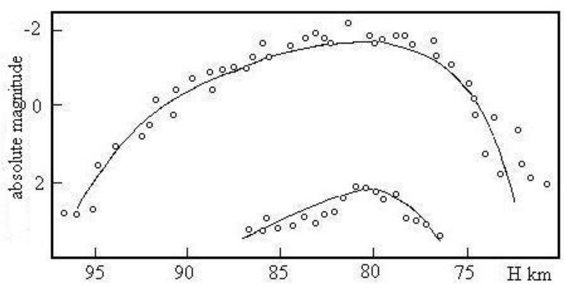

Figure 3. Observed (circle) [18] and simulated (line) light curve of June Bootids recorded on June 23, 2004.

Conclusion: Our modelling approach allow to estimate the bulk density of o-Draconid and June Bootid meteoroids. On the basis of aerodynamic pressure derived values we can conclude that the meteorite-dropping fireballs of July 11, 2008 and of July 23, 2008 were sufficiently large and exhibited high enough strength to produce meteorites. Except for two fragile cases, M20070714 and MO 4117, the determined bulk densities are characteristic of C1 or CM carbonaceous chondrites [19, 20]. Consequently, associated comets C/1919Q2 Metcalf and comet 7P/Pons-Winnecke are producing high-strength meteoroids capable to produce meteorites under determinate geometric circumstances. When compared to the dynamic strengths to which meteorite-dropping bodies break up in the atmosphere [21], our sample exhibit similar values.

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