THE PHYSICAL PROPERTIES OF THE JUNE BOOTIDS AND THE JULY 23, 2008 SUPERBOLIDE.

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Introduction: Many cometary meteoroid streams crossing the Earth were formed from the continuous sublimation of the ice-rich regions in cometary nuclei [1,2,3]. Another mechanism of producing cometary meteoroid streams is the catastrophic disruption of cometary nuclei [4,5,6]. In that case the existence of cometary meteoroid streams containing meter-sized meteoroids capable of producing meteorites after atmospheric interaction is quite real. Their existence has important implications because they can be naturally delivering to the Earth different types of materials from comets. Establishing a link between meteorites and their parent bodies is a key issue in planetary sciences. The Orgueil cometary meteorite which has an orbit similar to that of Jupiter-family comets (JFCs) fell in southern France on May 14, 1864 [7]. Despite the very fragile and incoherent nature of the Orgueil stone, the recovered thrity-three stones are now present in several collections around the world. A cometary origin of the Orgueil meteorite-dropping bolide does not contradict cosmochemistry data on CII chondrites. The fall of the Tagish Lake carbonaceous chondrite meteorite on January 18, 2000 was caused by the already known μ–Orionid fireball stream [8] and also as in case of the Orgueil meteorite has a density 1.6 g/cm3. The initial fragmentation must have occurred under an aerodynamic pressure of about 0.3 MPa. We present here data on a recent superbolide event occurred over Tajikistan on July 23, 2008 (Fig. 1) associated with the 7P/Pons-Winnecke comet.

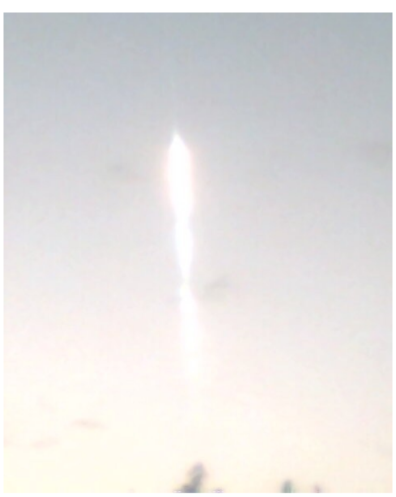

Fig. 1. The July 23, 2008 superbolide registered from HisAO (Tajikistan)

Methods: It is well known that the ablation behavior of meteoroids in the Earth's atmosphere shows the observed light curves that are reflecting important properties of the incoming meteoroids. The aim of the analysis of the June Bootid meteoroids is try to determine the strength and bulk density on the basis of their observed light curves. Our method consists in modeling the meteor light curve while taking into account a quasi-continuous fragmentation model [9] and analyzing the aerodynamic pressure on the meteoroid at the point of maximum brightness when the aerodynamic pressure exceeds the material's strength [10]. As a result of comparing the simulated and the observed light curve we obtain the density of the June Bootid meteoroids. On the other hand, the data on the height and velocity of the meteoroid at the moment of its maximum brightness becomes the basis for calculating the aerodynamic pressure, from which we infer the strength properties of the June Bootids and the type of extraterrestrial material that would fit such properties. On the basis of two available double-station records (baseline of 11.3 km) of extremely bright slow-moving fireball recorded on July 23, 2008. the astrometric calibration of the fireball apparent trajectory in reference to the stars was made. Measuring the rectangular coordinates of the positional stars and any feature point (beginning, terminal, and all flares and depressions) on the fireball trail, such measurements were converted to equatorial coordinates. The initial (pre-atmospheric) velocity, v_∞ =16 km/s was used for the meteoroid orbit computations. As a result of the astrometric measurements we were able to determine the fireball atmospheric trajectory, radiant, velocity, and orbit (Table 1, 2, 3)

Table 1 Atmospheric trajectory data

	Beginning	Max. light	Terminal
V (km/s)	14.3 ± 0.5	13.1 ± 0.5	5.8 ± 0.5
H (km)	38.2 ± 0.5	35.0 ± 0.5	19.6 ± 0.5
Abs. mag.	-	- 20.7	-

Table 2 Radiant data

Radiant	Observed	Geocentric	Heliocen
α_R (deg)	221.83 ± 2.1	219.52 ± 2.1	-
δ_R (deg)	+32.40 ± 2.1	+30.95 ± 2.1	-
v_∞ (km/s)	16.0	11.6	38.5

Table 3 Obital data

Orbit (J2000.0)	
Semimajor axis (AU)	3.32
Eccentricity	0.694
Perihelion distance (AU)	1.015
Aphelion distance (AU)	5.624

Argument of perihelion (deg)	176.76.
Ascending node (deg)	119.709
Inclination (deg)	11.95°

Results and discussion: We describe here one extremely bright slow-moving fireball recorded on July 23, 2008. The heliocentric orbit of this meter-sized meteoroid determined from the observation is very similar to the mean orbit of the June Bootids stream, whose parent body is comet 7P/Pons-Winnecke [11]. The June Bootids stream is a good example of relative dense cometary debris crossed by the Earth under low-velocity geometric circumstances and exhibiting a remarkable background of very bright fireballs [12]. To receive the data on the bulk densities of the June Bootid meteoroids we have analysed the smooth light curves of several the June Bootids [13, 14] within the framework of a quasi-continuous fragmentation model. The densities and energy of fragmentation data for different types of meteoroids [15] were used in the calculations. A range of the June Bootids density from 0.6 g/cm^3 up to 2 g/cm^3 was obtained as a result. Note, that according to the June Bootid fireballs EN270698 behavior in the atmosphere, this meteoroid belongs to the most fragle, typically cometary type III B [16]. Halliday at al. [17] presented data for 259 fireballs from the Canadian camera network among which cometary objects have typical densities near 1 g/cm^3. Only seven of the cometary group have values of density >1.6 g/cm^3 and six of these are at least 2.4 g/cm^3 or greater. Fragmentation of meteoroids in the Earth's atmosphere is produced when their tensile strength is reached. The meteoroid tensile strength is a fundamental physical property to understand meteoroid fragmentation and to improve our understanding of impact rates at Earth's surface. As a result of the estimated material strength in meteorites it was obtained a maximum strength of the fragmenting body of 44 MPa for iron and 15 MPa for stony impactors [18,19]. In the case of the June Bootid superbolide of July 23, 2008 the brightest flare was near the beginning of the visible trajectory at the height about 35 km when the first break-up must have occurred under an aerodynamic pressure of about 1.5 MPa. At the height in which two other small flares occured the aerodynamic pressure was 2.9 MPa and 3.1 MPa respectively. On the basis of this data we can conclude that the superbolide of July 23, 2008 was sufficiently large and exhibiting high enough tensile strength to produce meteorites.

Conclusions: The break-up of comet 7P/Pons-Winnecke has probably produced high-strength meteoroids capable to produce meteorites under determinate geometric circumstances. At least the July 23, 2008 event occurred over Tajikistan is a good candidate to recover meteorites from a comet. An international expedition should be set up in order to recover meteorites from this event.

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