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NEO/Fireball accociations and the origin of Chelyabinsk meteorite

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The Southworth-Hawkins (1963) D_sh criterion was used to quantify the similarity between current known Near-Earth Objects (NEOs) and the orbit of Chelyabinsk bolide (Borovicka et al. CBET 3423, 2013), same for current known fireball orbits. Apollo asteroid 2011 EH and a meteorite fireball (1996/Oct/8.248) were identified as possible associations. However, it is surprisingly difficult to prove that similar orbits are statistically significant within a near-Earth population. Here, I checked the statistically significant level using a method modified from Schunova et al. (2012) based on Fu et al. 2005 and Gladman 2005. Bottke et al. model (2002) enabled us to compute that a Chelyabinsk fragment has a 90% probability to have been reached the Earth collision orbit that escaped through the nu_6 resonance, a 10% probability through the 3:1 mean-motion resonance with Jupiter. This result is consistent in explaining of the origin of Chelyabinsk meteorite (LL5 chondrite) evolved from the inner-main-belt region where chondritic asteroids are dominant.

Another example of an Earth-grazing orbit of a carbonaceous fireball will be introduced which was observed by Japanese meteor observation network (SonotaCo Network Japan). Hayabusa-2 (JAXA/ISAS) will explore a near-Earth asteroid (162173) 1999 JU3 which is also thought to be a parent body of carbonaceous chondrites.

Figure; Pairs between Chelyabinsk meteorite and current known NEOs, Chelyabinsk meteorite and Meteorite fireballs using D_sh criterion.

Keywords: meteorites, asteroids, near-Earth objects, orbits