METEORITE-DROPPING SPORADIC FIREBALL WITH AN ASTEROIDAL ORIGIN AND ITS PARENT BODY. N. A. Konovalova[1], J.M. Madiedo[2,3] and J.M. Trigo-Rodríguez[4]. [1]Institute of Astrophysics of the Academy 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, 21071 Huelva, Spain, [3]Facultad de Física, Universidad de Sevilla, Departamento de Física Atómica, Molecular y Nuclear, 41012 Sevilla, Spain, [4]Institute of Space Sciences (CSIC-IEEC), Campus UAB, Facultat de Ciencies, Torre C5-parell-2a, 08193 Bellaterra, Spain.

Introduction: The detailed study of bright fireball events is important in the field of research of small bodies of the Solar system. Bright fireballs are produced by large meteoroids which are capable, under the right geometric conditions, of producing meteorites. The meteorites can help us to understand the solar system genesis and the processes that occurred after the formation of asteroids, the parent bodies of most meteorites. Meteor observations provide useful data for the determination of the velocity, radiant, orbit and luminosity data as well as the physical properties of meteoroids and creation a link between meteoroids, meteorites and their parent bodies. We present here the analysis of a slow moving sporadic fireball, observed in the past over the Hissar astronomical observatory and meteor station Kipchak (Tajikistan). This event was recorded during a systematic long-term observational photographic program on October 30, 1962 and had a maximal brightness corresponding to an absolute magnitude of -7.3.

Instrumentation: The two observing stations that imaged the event discussed here operate a meteor small-cameras MK-25 equipped with Uranus-9 (D/f = 1/2.5, f = 250mm) lenses which take one exposure per hour. The photographic plates, 19×19 cm with panchromatic emulsion have been applied. For the definition of the meteor velocity six small-cameras before the objective were equipped with rotating shutter creating 25 breaks/sec. These camera systems covering an area of the sky measuring approximately 40º ×50º can record meteors down to about visual magnitude +1 and brighter.

Observations and results: On October 30, 1962 at 17h 28m 10.5s UT, a bright fireball (abs. magnitude -7.3±0.2) was imaged by the Meteor Patrol of the Hissar Astronomical Observatory (Figure 1). The event was also recorded from meteor station Kipchak located 32 km from the Meteor Patrol. The parent meteoroid impacted the atmosphere with an initial velocity V_∞=13.7±0.1 km/s. The fireball started its luminous path at a height of about 77.4±0.2 km, reached its maximum brightness when the bolide was located at a height of 49.4±0.2 km and ended at 36.2±0.2 km over the ground level. The geocentric radiant of the fireball was located at α=332.6±0.3º, δ=-12.3±0.2º. Atmospheric trajectory, radiant data and orbital elements are shown on Tables 1, 2 [1]. The orbital elements of the meteoroid confirmed the sporadic nature and asteroidal origin (T_j = 3.3) of this event.

The fireball exhibited three strong flares including a very bright terminal flare which could point to sudden fragmentation of the body and numerous flickering in the second part of the trajectory. The light curve (Fig. 2) shows that maximal brightness was reached at an altitude of 49.5 km under an aerodynamic pressure of 0.2 MPa and terminal flare has occurred at about 37 km under an aerodynamic pressure of 0.3 MPa. This light curve has been used to infer the initial photometric mass of the meteoroid. A value of about 2.5 kg was obtained using the numerical value of luminous efficient provided by Ceplecha and McCrosky [2]. The terminal mass of the likely meteorite would vary from ~16 g (for a density d = 3.7 g/cm^3) to 47 g (for d = 2.2 g/cm^3).

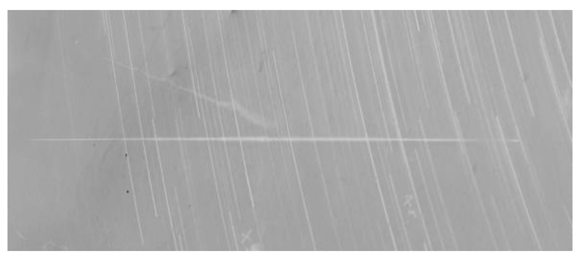

Figure 1. Image of the 062D3 (code 622215) fireball.

In order to find a likely parent body for the meteoroid we have employed the ORBEX software (ORbital Association Software) with the information contained in the NeoDys database. By using the Southworth and Hawkings D_{SH} dissimilarity criterion [3] 77 NEOs were identified as potential parents, but the best match was obtained with the near-Earth object 2011SL189, with D_{SH}=0.05. However, the orbital elements of most of these bodies, including 2011SL189, were determined from observations performed during just 1 or two days, and so their accuracy is too low. We have found that Asteroid 2011VB provided a low D_{SH} value (0.07) with an orbit determined with a sufficiently high data-arc span (31 days). But, as Figure 3 shows, when the orbit of this NEO is integrated in the past the dissimilarity function increases very fast, and the usually adopted cut-off value of 0.15 is reached in about 1,200 years. So, the link between the meteoroid and this asteroid is too weak. We are currently performing additional analysis to identify a likely parent body among the sample of 77 NEOs provided by ORBEX.

HisAO Code	M_v	H_b (km)	H_e (km)	α_g (º)	δ_g (º)	V_∞ (km/s)	V_g (km/s)	V_h (km/s)
622215	-7.3 ±0.2	77.4 ±0.2	36.2 ±0.2	332.6 ±0.3	-12.3 ±0.2	13.7 ±0.1	8.0 ±0.1	37.6 ±0.1

Table 1: Radiant (J2000) and trajectory data for the 062D3 (code 622215) fireball.

HisAO Code	a (AU)	e	i (º)	Ω (º)	ω (º)	Q (AU)	T_J
622215	2.36	0.583	0.29	36.66	15.47	3.74	3.3

Table 2: Orbital data (J2000) for the 062D3 (code 622215) fireball.

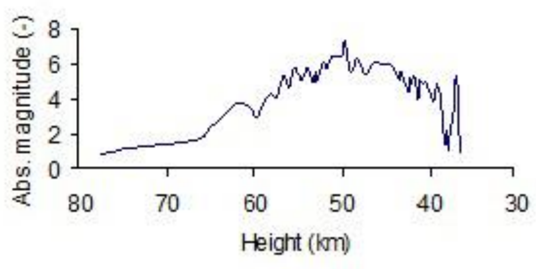

Figure 2. Light curve of the 062D3 fireball imaged from HisAO.

Summary and Conclusions: Because of terminal height and mass, the event analyzed here falls into the category of meteorite-dropping meteoroids. The calculated radiant and orbital data confirm the sporadic nature of event and the likely asteroidal origin of meteoroid. The derived value of the aerodynamic pressure at the heights of maximal brightness and terminal flare used to estimate the bulk density of the meteoroid by using the graphical fit of the meteoroid bulk density versus the compressive strength shown in [4]. As result a value of about 1.2 g cm^{-3} is obtained and confirms the fragility of meteoroid.

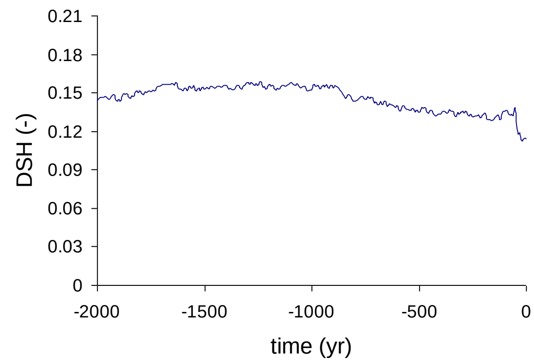

Figure 3. Evolution in the past, since current epoch, of the DSH criterion for the meteoroid and Asteroid 2011VB.

References: [1] Summary catalogue of orbital elements and light curves of the meteors photographed in the Institute of Astrophysics, Tajik Academy of Sciences (Dushanbe). Editor P.B. Babadzhanov, (2006), Dushanbe, "Donish". [2] Ceplecha Z. and McCrosky R.E., (1976), *Journal of Geophys. Res.*, *81*, 6257. [3] Southworth, R.B., Hawkins, G. S. *Smithson Contr. Astrophys.*, *7*, 261–285, 1963. [4] ReVelle D.O., (2002), *Proceedings of Asteroids, Comets, Meteors*, (ESA-SP-500, 127).