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Near Earth Object 2012XJ112 as a Source of Bright Bolides of Achondritic Nature

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Abstract

We analyze the dynamical link between the recently discovered NEO 2012XJ112 and a bright sporadic fireball observed over Spain on Dec. 27, 2012. The emission spectrum produced by this event was also recorded. The bulk chemistry of the parent meteoroid is consistent with a basaltic achondrite.

Figure 1. Composite image of the SPMN271212 fireball imaged from Sierra Nevada.

Table 1: Radiant and orbital data (J2000).

Radiant data				
	Observed		Geocentric	Heliocentric
R.A. (º)	266.5±0.4		277.3±0.4	
Dec. (º)	-6.9±0.3		-16.8±0.3	
V_∞ (km/s)	16.1±0.3		11.2±0.3	32.5±0.3
Orbital parameters				
a (AU)	1.18±0.01	**ω (º)**	95±1	
e	0.37±0.01	**Ω (º)**	275.7841±10^{-4}	
q (AU)	0.73±0.01	**i (º)**	2.3±0.3	

1. Introduction

The SPanish Meteor Network (SPMN) is involved in the identification of the parent bodies of bright bolides. The standard way of linking meteoroids with a potential parent body is through the similarity of their orbits [1]. For this purpose we have developed a software package which searches the NeoDys and the MPC databases in order to establish such links [2]. Here we again employ this software tool together with the Mercury 6 orbital integrator [3] to identify likely parent body of a mag. -9 sporadic fireball recorded over the south of Spain on Dec. 27, 2012. The emission spectrum produced by this event is also discussed.

2. Instrumentation

Two SPMN observing stations recorded the bolide discussed here: Sierra Nevada and Molina de Segura. These operate an array of low-lux CCD video cameras manufactured by Watec Co. Their operation is explained in [4, 5]. For meteor spectroscopy we employed holographic diffraction gratings (1000 lines/mm) attached to some of these devices. In this way we can infer information about the composition of meteoroids ablating in the atmosphere.

3. Data reduction and results

The fireball shown in Fig. 1 (SPMN code 271212) was recorded under twilight conditions on Dec. 27, 2012 at 6h45m47.8±0.1s UTC. The absolute magnitude of this event was -9±1. The atmospheric trajectory and radiant were calculated with our AMALTHEA software, which employs the method of planes intersection [6]. In this way, we obtained that the luminous phase started at 80.5±0.5 km above the ground level. The bolide disappeared behind a tree appearing in the field of view of one of the cameras when it was located at a height of 47.0±0.5 km. So, the exact location of the terminal point could not be established, but as the bolide was not observed beyond that tree this is constrained to a height of about 40 km. The estimated initial mass of the meteoroid was 3.9±0.5 kg. For this calculation it was assumed that the final part of the light curve can be extrapolated by means of the parabola. On the other hand, the parent meteoroid struck the atmosphere with an initial velocity V_{∞}=16.1±0.3 km/s. With this information the orbit of this particle was calculated. Radiant and orbital parameters are summarized on Table 1.

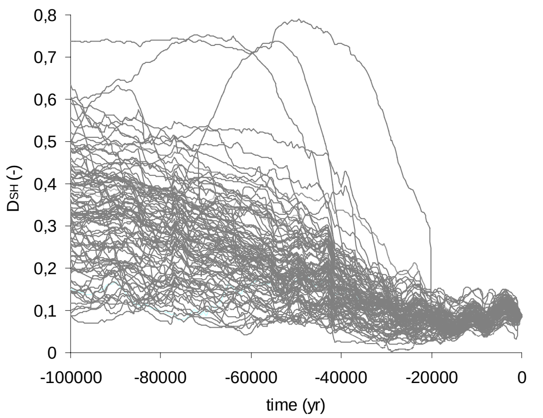

Figure 2. Evolution of the D_{SH} criterion for the SPMN271212 fireball and 100 clones of NEO 2012XJ112.

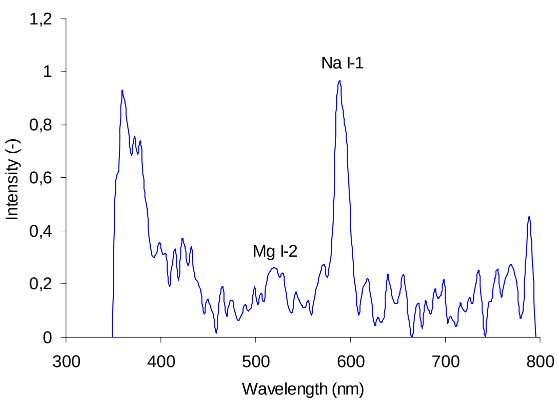

Figure 3. Calibrated emission spectrum of the SPMN271212 fireball.

We investigated the potential parent body of the SPMN271212 fireball with our ORAS software. The Southworth and Hawkins dissimilarity criterion was used and the best result was obtained for NEO 2012XJ112 (D_{SH}=0.08). A numerical integration backwards in time of the orbital parameters of the fireball and this NEO was performed in order to test a link between them. These calculations were performed with the Mercury 6 symplectic integrator [3]. The gravitational influence of Venus, the Earth-Moon system, Mars, Jupiter and Saturn were taken into account for these calculations. The orbits were integrated back for 100,000 years. A cloud of 100 clones was created around the orbit of the NEO to take into account the uncertainty in the orbital elements of the asteroid. This analysis revealed (Figure 2) that the D_{SH} criterion remains ≤0.15 during at least 20,000 years for 100% of clones, confirming the dynamical link with the SPMN271212 meteoroid.

On the other hand, the derived elemental abundances from the emission spectrum (Figure 3) are pointing towards an achondrite as likely nature of the SPMN271212 meteoroid. In particular, the derived low Mg/Si and Na/Si ratios are consistent with an achondrite of basaltic nature.

6. Summary and Conclusions

We have calculated the atmospheric trajectory, radiant and orbit for a double-station mag. -9 sporadic fireball recorded in the framework of the SPMN. The parent meteoroid could have penetrated the atmosphere down to a height of about 40 km. The orbital analysis confirms that NEO 2012XJ112 is the parent body of the meteoroid. Besides, the analysis of the emission spectrum of the bolide allows us to predict a basaltic (achondritic) nature for this particle.

Acknowledgements

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