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The Geminids as a potential meteorite-producer meteoroids stream

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Abstract

The SPanish Meteor Network (SPMN) is performing a continuous monitoring of meteor and fireball activity over Spain and neighboring countries. One of the goals of out network is the identification of potential meteorite-producer events. The asteroidal origin of the Geminids suggests that this meteor stream could give rise to meteorites. We present here the analysis of a Geminid fireball imaged by our systems that supports this idea.

1. Introduction

The Geminids is the densest annual meteoroid stream, with a maximum activity about December 14. Its generally accepted parent body is asteroid (3200) Phaethon, which is considered by some researchers as an extinct cometary nucleus rather than a regular asteroid [1]. However, on the basis of spectral and dynamical similarities, it has been recently proposed that asteroid 2 Pallas is the likely parent body of asteroid (3200) Phaeton [2, 3] The asteroidal origin of the Geminids suggests that this stream could be a potential meteorite producer. Several Geminid fireballs observed from Spain on 2009 and 2010 supports this idea. The preliminary results of this research are presented here.

2. Instrumentation and methods

The observation of the Geminids was made on 2009 and 2010 from several video stations operated by the SPanish Meteor Network (SPMN) in Spain. These employ high-sensitivity 1/2" black and white CCD video cameras (Watec Co., Japan) endowed with fast aspherical optics (f0.8). A detailed description of these devices has been given elsewhere [4, 5]. On the other hand, a low-scan high-resolution resolution all-sky CCD was operated from La Mayora [6].

For data reduction we used our Amalthea software [4]. This package uses the method of the intersection of planes to reconstruct the trajectory of the meteors in the atmosphere. It also provides radiant and orbital parameters for meteor trails that are simultaneously recorded from at least two observing stations. From the analysis of the position of the meteor on every video frame, the velocity of the bolide along its path was obtained. The preatmospheric velocity was found by fitting to a suitable model the velocities measured at the earliest part of the trajectory.

3. Preliminary results

A mag. -15 fireball (SPMN151209) was imaged on Dec. 15, 2009 at 04h20m09±1s UT (Fig. 1). From the apparent trajectory on the sky recorded by our observing stations in Sevilla and La Mayora (Fig. 2), the atmospheric trajectory was obtained. In this way, we could calculate the velocity and acceleration profiles as a function of height and time. The estimated preatmospheric velocity V_∞ was of 34.76 km/s and the geocentric radiant was located at R.A.: 114.6º, Dec: 30.6º. With these values, the heliocentric orbital parameters could also be calculated (Table 1). On the other hand, as can be noticed in Figure 1, the fireball exhibited a bright flare at 39.5 km over the ground level, which indicates that a fragmentation event took place at this stage, when the fireball velocity was 23.5 km/s. By using the atmospheric density calculated from the US standard atmosphere model [7] we have obtained an aerodynamic strength at which the meteoroid suffered the break-up of about 9.4MPa. The terminal point of the trajectory was located at a height of 24.2 km and the dynamic mass obtained at the end of the luminous trajectory, by assuming a meteoroid density of 2.9g/cm^3 [8], is of about 10 g. Despite this value is small, the fact that the Geminids can produce fireballs with low terminal height and non-zero terminal mass indicates that this is a potential meteorite-producing stream. On the other hand, the analysis of Geminid fireballs suggests a chondritic nature for surviving meteorites [9].

Another mag. -15 Geminid fireball was observed by our network on 2010 (Fig. 3). However, in this case the bolide was imaged from just one station and no trajectory data could be obtained to confirm if this might be also a meteorite-dropper.

Figure 1: Mag. -15 Geminid fireball imaged from Sevilla on Dec. 15, 2009, at 04h20m09±1s UT.

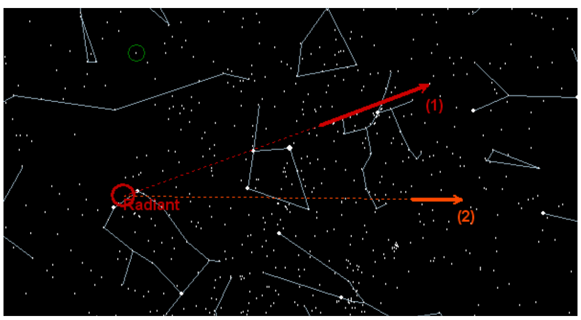

Figure 2: Apparent trajectory on the sky of the SPMN151209 fireball as seen from Sevilla (1) and La Mayora (2) SPMN stations.

Figure 3: Mag. -15 Geminid fireball imaged from Santiago de Compostela on Dec. 13, 2010, at 20h00m16±1s UT.

Table 1: Radiant and orbital data (J2000) for the SPMN141209 fireball

Radiant data			
	Observed	Geocentric	Heliocentric
R.A. (º)	115.9±0.2	114.2±0.2	55.9±0.8
Dec. (º)	30.6±0.05	29.83±0.05	8.1±0.1
V_∞ (km/s)	34.7±0.5	33.0±0.5	33.1±0.5
Orbital parameters			
a (AU)	1.25±0.04	**ω (º)**	325.1±0.7
e	0.886±0.007	**Ω (º)**	263.1900 ± 10^{-4}
q (AU)	0.14±0.05	**i (º)**	17.3±0.6
Q (AU)	2.34±0.07		

4. Summary and Conclusions

We are performing a continuous monitoring of fireball activity over the Iberian Peninsula and neighboring areas. By measuring the properties of meteor events at the terminal point of the atmospheric trajectory we can identify potential meteorite dropping fireballs. The fireball imaged by the SPMN on Dec. 15, 2009 show that the Geminids meteor stream is producing events with a low terminal height (of about 20 km) and a non-zero terminal mass. This, together with the asteroidal origin of this stream, indicates that the Geminids is a candidate to produce meteorites.

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