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Double-station video observations of the Quadrantid meteor shower in 2012

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Abstract

Optimal weather conditions in Spain during January 2012 favored the analysis of the activity of the Quadrantids. For this purpose, multi-station meteor trails were recorded from different video observing stations operated by the SPanish Meteor Network (SPMN). This allowed us to obtain precise radiant and orbital information for this stream. Some preliminary results are presented here.

1. Introduction

The Quadrantid meteor shower is unusual for its strong but brief maximum. Its main activity is confined to a 12 to 14 h window near maximum, although some extended activity is visible for about ±4 days centered around this date.

One NEO, 2003 EH1, has been identified as the parent body of the Quadrantid meteoroid stream [1]. The dynamical evolution of this swarm has been studied by several authors. Hamid & Youssef [2] found large changes in both eccentricity and inclination to the ecliptic with a period of about 4000 years. More recent studies performed by Hughes et al. [3], Froeschlé and Scholl [4, 5], Babadzhanov and Obrubov [6], as well as Wu and Williams [7] revealed rapid and large changes in all orbital elements within the periods of a few thousand years. So, the determination of precise orbital and radiant information can be very useful to improve our knowledge about the Quadrantids. Usually this shower is very difficult to observe because of frequent bad weather in early January in the northern hemisphere. This was the case for previous SPMN meteor observing campaigns, although despite of this we could successfully register over 100 double-station Quadrantid events between 2008 and 2011 [8]. However, optimal weather in Spain during January 2012 allowed us to monitor the Quadrantids from several meteor observing stations under very favourable conditions. In this way, multiple-station meteors were recorded and analyzed.

2. Instrumentation

The SPMN meteor observing stations involved in the imaging of the Quadrantids meteors employ high-sensitivity Watec CCD video cameras (models 902H and 902H Ultimate from Watec Corporation, Japan) to monitor the night sky. The cameras are arranged in such a way that the whole sky is monitored from every station and, so, this maximizes the common atmospheric volume recorded by the different systems. These devices are equipped with a 1/2" monochrome Sony interline transfer CCD image sensor with their minimum lux rating ranging from 0.01 to 0.0001 lux at f1.4. Aspherical fast lenses are used for the imaging objective lens. A detailed description about how these video stations are operated has been given elsewhere [9, 10, 11].

3. Data reduction and results

Over 200 meteor trails were imaged from several SPMN meteor observing stations operating during the activity period of this shower in 2012. The magnitude distribution index, calculated from 20 meteors brighter than mag. 3, yields r=1.8±0.6. The averaged apparent radiant was located at R.A.: 229.7 ± 0.6 º, Dec: 48.2 ± 0.5º and a value of the ZHR of 105±20 was obtained.

To calculate orbital and radiant data for multi-station meteors we use our Amalthea software [12]. This package employs the method of the intersection of planes to reconstruct the trajectory of the meteors in the Earth's atmosphere. Velocity values along the meteor path are calculated from the video frames by obtaining the variation of the trajectory length as a function of time. Then, the preatmospheric velocity V_∞ is found by extrapolating the velocities measured at the initial part of the trajectory by using a fitting model. In this way, a value V_∞=42.9±0.3 km/s was obtained for this parameter. The mean orbital parameters calculated from 15 multi-station Quadrantid meteors can be found on Table 1. By using our ORAS software (ORbital Association Software), this orbit confirms that asteroid 2003 EH1 is the likely parent body of the Quadrantid meteoroid stream. Thus, by using the Southworth and Hawkings dissimilarity criterion, a value of the D_{sh} parameter of 0.18 was obtained [13].

Table 1: Averaged radiant and orbital data (J2000) for 15 Quadrantids.

Radiant data			
	Observed	**Geocentric**	**Heliocentric**
R.A. (º)	229.7±0.6	231.1±0.6	-
Dec. (º)	48.2±0.5	48.3±0.5	-
V_∞ (km/s)	42.9±0.5	41.2±0.5	38.8±0.5
Orbital parameters			
a (AU)	3.1±0.3	**ω (º)**	167.8±1.7
e	0.67±0.06	**Ω (º)**	282.954±0.006
q (AU)	0.97±0.05	**i (º)**	72.1±1.2

6. Summary and Conclusions

Favorable weather conditions in Spain during January 2012 allowed us to monitor the activity of the Quadrantids by means of high-sensitivity CCD video devices. In this way, mutilple-station events were imaged. These have provided precise radiant and orbital information about this meteoroid stream. The data also confirm 2003 EH1 as its likely parent body.

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