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Emission spectrum and orbital elements of two Quadrantid fireballs

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Abstract

The activity of the Quadrantid meteor stream in 2011 has been monitored in the framework of the SPanish Meteor Network (SPMN). For this purpose, an array of high-sensitivity CCD video devices endowed with holographic diffraction gratings has been employed. Despite unfavorable weather conditions, we could image several bolides and their corresponding emission spectrum during the maximum activity period of this shower. We analyze here two of these Quadrantid fireballs.

1. Introduction

Although the Quadrantids has one of the highest ZHR of all annual showers (above 100 meteors/hour), it is very difficult to observe because of frequent bad weather in early January in the northern hemisphere. Besides, it is unusual for its strong but brief maximum. Thus, its main activity is confined to a 12 to 14 h window near this maximum, although some extended activity can be noticed for about ±4 days centered around this date.

The near-Earth object 2003 EH1 has been identified as the parent body of the Quadrantid meteoroids stream [1]. Several studies have revealed changes in the orbital elements of this stream within a period of a few thousand years [2-6]. So, the determination of precise orbital and radiant information can be very useful to improve our knowledge about the Quadrantids. For this purpose, we have monitored the activity of this stream from several video meteor observing stations operating in Spain. Despite the unfavorable weather conditions during early January 2011, we have successfully imaged several multiple-station fireballs, together with their emission spectrum.

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 [7].

3. Observations and results

The two Quadrantid fireballs analyzed here (SPMN040111a and SPMN040111b, respectively) were imaged on Jan. 4, 2011. Their radiant and orbital parameters are shown on table I. Their emission spectrum was recorded from our meteor observing station operating from El Arenosillo. The signal obtained in the spectrum was corrected by taking into account the instrumental efficiency, and then calibrated in wavelengths by using typical metal lines (Ca, Fe, Mg, and Na multiplets). Raw spectra are shown on Figs. 1 and 2, where the processed spectra obtained by using the deinterlacing and the background removal filters implemented in our recently developed CHIMET software are also included. Most prominent lines correspond to Fe I-5 (374.5 nm), Ca I-2 (422.6 nm), Fe I-41 (440.4 nm) Mg I-2 (516.7 nm) and Na I-1 (588.9 nm). Atmospheric lines can also be noticed. Additional improvements are currently being made on this software to calculate also the relative abundances of

the corresponding chemical species from these spectra.

Table 1: Radiant and orbital data (J2000) for the SPMN040111a and SPMN040111b Quadrantid fireballs.

Radiant data (SPMN040111a)			
	Observed	Geocentric	Heliocentric
R.A. (º)	233.1±0.2	234.9±0.2	
Dec. (º)	48.2±0.1	47.9±0.1	
V_∞ (km/s)	42.3±0.5	40.5±0.5	39.0±0.5
Orbital parameters (SPMN040111a)			
a (AU)	3.17±0.2	**ω (º)**	296.7±0.2
e	0.695±0.02	**Ω (º)**	283.2210 ± 10^{-4}
q (AU)	0.9662±0.0002	**i (º)**	70.16±0.1
Radiant data (SPMN040111b)			
	Observed	Geocentric	Heliocentric
R.A. (º)	227.8±0.2	228.1±0.2	
Dec. (º)	51.3±0.1	51.8±0.1	
V_∞ (km/s)	42.5±0.5	40.8±0.5	39.1±0.5
Orbital parameters (SPMN040111b)			
a (AU)	3.23±0.02	**ω (º)**	181.6±0.1
e	0.695±0.002	**Ω (º)**	283.3559 ± 10^{-4}
q (AU)	0.98313±0.00003	**i (º)**	70.84±0.04

6. Summary and Conclusions

By using high-sensitivity CCD video devices we have recorded several double-station Quadrantid fireballs during the maximum activity period of this meteor shower in 2011. These cameras employ holographic diffraction gratings to obtain several physico-chemical parameters about meteoroids ablating in the Earth's atmosphere. Our monitoring has provided useful information about the Quadrantids. Thus, we have obtained radiant, orbital and chemical information for two Quadrantid fireballs imaged from several of our meteor observing stations.

Acknowledgements

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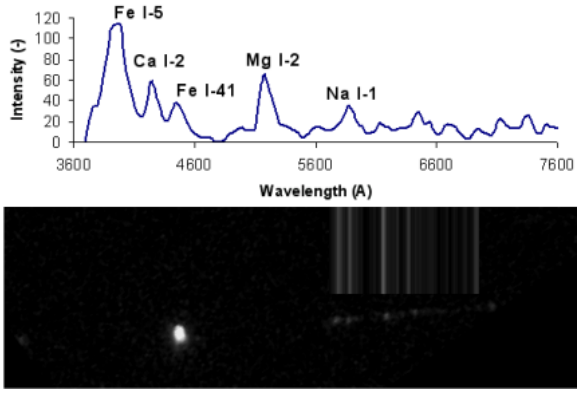

Figure 1: Emission spectrum of the SPMN040111a Quadrantid fireball.

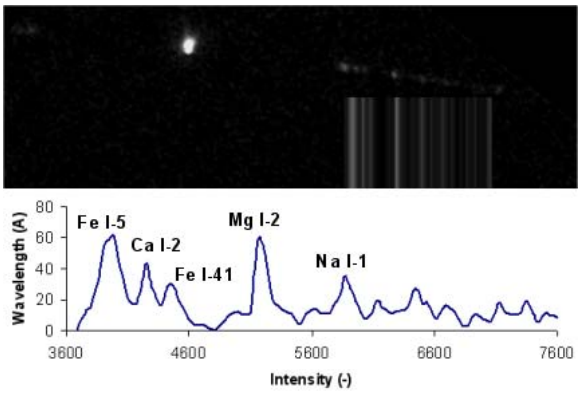

Figure 2: Emission spectrum of the SPMN040111b Quadrantid fireball.

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