

EMISSION SPECTROSCOPY OF A ρ -GEMINID METEOR. J.M. Madiedo^{1,2}. ¹Facultad de Ciencias Experimentales, Universidad de Huelva, Huelva, Spain. ²Departamento de Física Atomica, Molecular y Nuclear. Universidad de Sevilla. 41012 Sevilla, Spain.

Introduction: The poorly-known ρ -Geminid meteor shower was discovered by Southworth and Hawkins in the framework of the 1952-1954 Harvard Meteor Program [1]. Its activity extends from December 28 to January 28, peaking around January 8, and its parent body remains unknown. Data about this shower are scarce [1, 2, 3, 4], mainly because of its relatively low zenithal hourly rate (ZHR), which is of around 20 meteors h^{-1} [5], and typical bad weather conditions in the northern hemisphere during the above-mentioned activity period. Here I focus on the analysis of a double-station ρ -Geminid meteor and its emission spectrum, which was recorded in the framework of the SMART Project [6]. This is the first time that a ρ -Geminid spectrum is discussed in the scientific literature. Its analysis provides new clues about the chemical nature of ρ -Geminid meteoroids and their parent body.

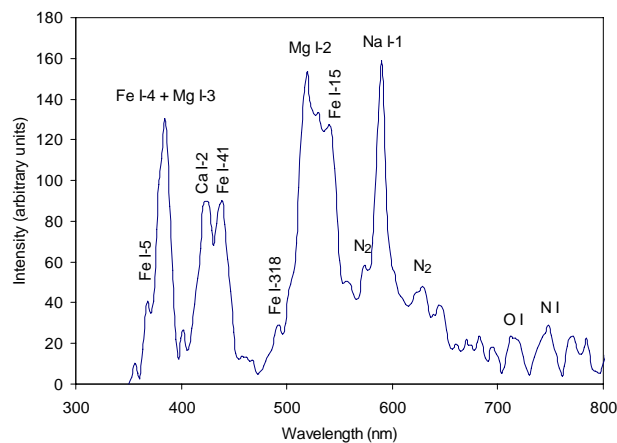


Figure 1. Calibrated emission spectrum.

Instrumentation and methods: Two meteor observing stations located in the South of Spain (Sevilla and El Arenosillo) recorded the meteor discussed here. These employ an array of low-lux monochrome CCD video devices (Watec 902H2 and 902H Ultimate) that work in an autonomous way by means of a software package developed for this purpose [7, 8]. Most of these CCD cameras are configured as video spectrographs by means of transmission diffraction gratings (1000 grooves/mm) attached to the objective lens. The atmospheric trajectory, radiant and meteoroid orbit have been obtained with the AMALTHEA software [9]. The fireball spectrum has been reduced with the CHIMET software [6].

Observations: A meteor with an absolute magnitude of -5.5 ± 0.5 was recorded from the above-

mentioned meteor observing stations on 13 Jan. 2013 at 23h09m59.9 \pm 0.1s UTC. Its emission spectrum was recorded by one spectrographs operating at El Arenosillo. The progenitor meteoroid struck the atmosphere with an initial velocity $V_{\infty} = 23.6 \pm 0.5$ km/s and the luminous phase of the event started at 92.3 \pm 0.5 km above the sea level. The terminal point of the atmospheric path could not be recorded since the meteor disappeared from the field of view of the cameras when it was located at a height of 67.3 \pm 0.5 km. The geocentric radiant was located at the equatorial coordinates $\alpha_g = 111.15 \pm 0.04$, $\delta_g = 30.61 \pm 0.02$. The orbital parameters are summarized in Table 1. The calculated value of the D_{SH} criterion [1] yields 0.09, which confirms that the meteoroid belonged to the ρ -Geminid stream. The value of the Tisserand parameter with respect to Jupiter yields 2.9, which means that the meteoroid was following a Jupiter family comet orbit before impacting Earth.

a (AU)	2.62 \pm 0.21	ω ($^{\circ}$)	257.26 \pm 0.04
e	0.750 \pm 0.022	Ω ($^{\circ}$)	293.78014 \pm 10 $^{-5}$
q (AU)	0.654 \pm 0.005	i ($^{\circ}$)	5.4 \pm 0.1

Table 1. Orbital data (J2000).

Emission spectrum: The calibrated spectrum of the meteor is shown in Figure 1, where the most important contributions have been highlighted. The most significant contributions correspond to the Mg I-2 triplet at 516.7 nm and the Na I-1 doublet at 588.9 nm. The emission from Ca I-2 (422.6 nm), Fe I-41 (441.5 nm) and Fe I-15 (526.9 nm) are also very noticeable, together with the signal from Fe I-4 (385.6 nm) and Mg I-3 (383.8 nm), although these two are not individually resolved. In addition, the emission of atmospheric nitrogen around 573.0 nm and in the red region of the spectrum can also be seen.

In order to get an insight into the chemical nature of ρ -Geminid meteoroids, the emission from multiplets Na I-1, Mg I-2 and Fe I-15 has been analyzed [10]. These contributions were measured frame by frame in the corresponding videospectrum, and then corrected by means of the spectral response of the recording device. For each multiplet, these contributions were then added frame by frame to obtain their integrated intensity along the atmospheric path of the fireball. Then, the Na/Mg and Fe/Mg intensity ratios were calculated. From this analysis the ratios Na/Mg = 1.03 and Fe/Mg = 1.57 were obtained. As shown in Figure 5 in [10], the Na/Mg intensity ratios fit fairly well the result expected for meteoroids with chondritic composition for a meteor velocity

of about 23 km/s. To confirm this result, the Na I-1, Mg I-2 and Fe I-15 relative intensities were plotted in the ternary diagram shown in Figure 2, where the solid curve indicates the expected relative intensity as a function of meteor velocity for chondritic meteoroids [10]. As can be seen, the value corresponding to the emission spectrum fits fairly well the expected relative intensity for a meteor velocity of about 23 km/s, which again suggests a chondritic nature for ρ -Geminid meteoroids.

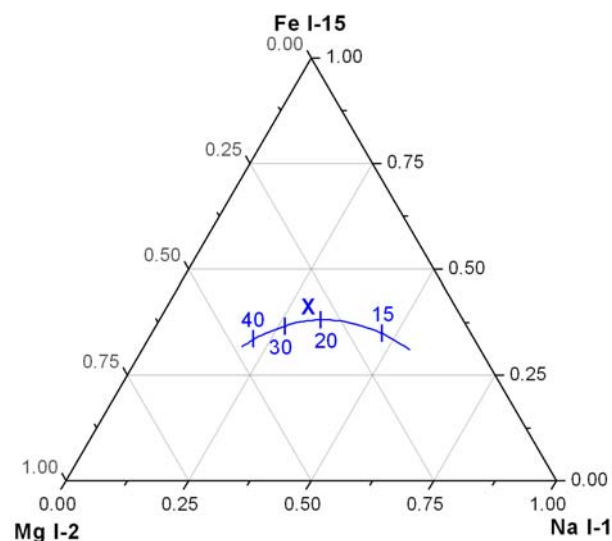


Figure 2. Expected relative intensity (solid line), as a function of meteor velocity (in km/s), of the Na I-1, Mg I-2 and Fe I-15 multiplets for chondritic meteoroids [10]. The cross shows the experimental relative intensity obtained for the meteor.

Conclusions: We have analyzed a mag. -5.5 ρ -Geminid meteor simultaneously imaged from two meteor observing stations operating in the framework of the SMART project. The orbital elements reveal that the meteoroid followed a Jupiter family comet before impacting Earth. The emission spectrum recorded for this bolide exhibited the contributions from different lines belonging to neutral Fe, Mg, Ca and Na. Several emissions from atmospheric nitrogen and oxygen were also identified. The analysis of this spectrum reveals a chondritic nature for meteoroids belonging to the ρ -Geminid stream.

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