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Automated High-Resolution Slow-Scan CCD Systems setup in the south of Spain for Meteor Spectroscopy

J.M. Madiedo (1, 2)
(1) Facultad de Ciencias Experimentales. Universidad de Huelva, 21071 Huelva, Spain. (2) Facultad de Física, Universidad de Sevilla, Departamento de Física Atómica, Molecular y Nuclear, 41012 Sevilla, Spain. (madiedo@uhu.es)

Abstract

This work presents a short description of the new high-resolution CCD spectrographs setup in Andalusia in the framework of the fireball spectroscopy campaign developed at the University of Huelva. Some preliminary results are presented.

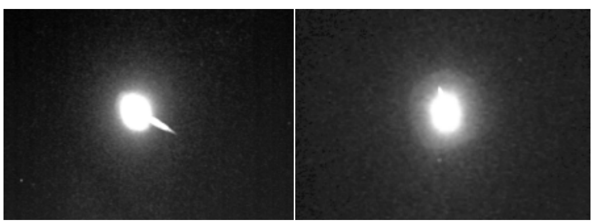

Figure 1. Composite image of the bolide analyzed here, as imaged from both recording stations.

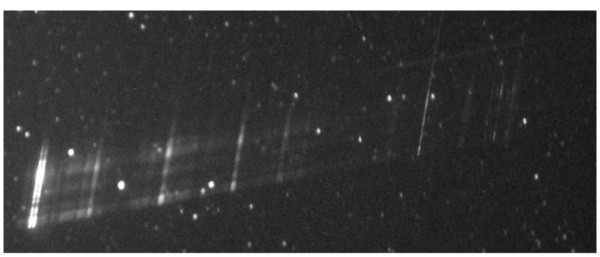

Figure 2. Emission spectrum registered by one of the new slow-scan CCD spectrographs.

1. Introduction

Meteor spectroscopy provides valuable data about the composition of meteoroids striking the atmosphere [1, 2, 3]. The results obtained from the analysis of meteor spectra can also be used to infer information about the chemical nature of the parent bodies of these particles of interplanetary matter. With this aim, we have employed since 2006 high-sensitivity CCD video cameras with attached holographic diffraction gratings (500-1000 lines/mm) to record the emission spectra produced during the ablation of meteoroids in the atmosphere [4, 5]. These devices allow for a precise recording of the evolution of the intensity of emission lines with time and, for multi-station events, with height also [6]. Since August 2012 additional efforts were made by setting up two new automated spectrographs, although these are based on slow-scan high-resolution CCD devices. These new systems are described here and some preliminary results are presented.

3. Description of the slow-scan CCD spectrographs

The new high-resolution spectral system consists of two slow-scan high-sensitivity CCD devices (models ATIK 4000LE and ATIK 16HR) that employ 1000 lines/mm diffraction gratings. They operate since August 2012 from our meteor observing station located in Sevilla, where an array of high-sensitivity CCD video cameras is also used for the monitoring of meteor activity. The new spectrographs generate imagery in FITS files which are sent to GPS synchronized computers. The exposition time is adjusted according to the conditions of the sky. These systems are currently covering an extension of about 50ºx50º degrees in the night sky. They provide a resolution of ~5 nm/pixel. Dead times between images is one disadvantage with respect to the operation of our video spectrographs, that can work continuously during the whole night. The slow-scan CCD spectrographs work in a fully autonomous way by means of software developed by myself. Thus, the devices are automatically started after the evening twilight and switched off just before the morning twilight. When the CCD video devices working from the same meteor station detect a bright event, our software takes the corresponding FITS images from the hard disk of the computers that control the slow-scan CCD spectrographs and sends them to our FTP server. These images are then inspected to check if they contain the spectrum produced by fireballs registered by our video cameras. Besides, I have also developed a software (CHIMET) to analyze the emission spectra recorded by these spectrographs.

3. Preliminary results

On August 13, 2012, at 1h23m33.4±0.1s UTC, a mag. -9 Perseid fireball was registered by SPMN video devices operating from Sevilla and Huelva (Fig. 1). Its spectrum was also recorded from Sevilla by one of our new high-resolution spectrographs (Fig. 2). The bolide began at 97.5±0.5 km above the ground level, with the terminal point located at 76.4±0.5 km. The preatmospheric velocity was 60.4±0.3 km/s. From the image shown in Figure 2 we obtained initially the emission spectrum as an intensity profile (pixel brightness, in arbitrary units, vs. pixel number). The signal was then converted to intensity versus wavelength by identifying typical lines appearing in meteor spectra. In this case, prominent lines produced by chemical species such as Mg, Ca and Na were also very helpful to accomplish this calibration. Then, the spectrum was corrected by taking into consideration the spectral response of the instrument. The result is shown in Figure 3. Although most lines correspond to Fe I multiplets, the most prominent features in the spectrum are the H and K lines of ionized calcium, which appear perfectly discerned as a result of the higher resolution of the spectrograph. Multiplet Ca I-2 (422.7 nm) was also identified. Other two important lines are due to multiplets Na I-1 (588.9 nm) and Mg I-2 (516.7 nm). The contribution of Mg I-3 (382.9 nm) is also seen, together with lines from Ni I (361.9 nm), Cr I (357.8 nm) and Ba II (413.0 nm). The contributions from atmospheric N_2 and O I are also seen.

6. Summary and Conclusions

The University of Huelva is setting up in Andalusia automated meteor spectrographs based on slow-scan CCD high-resolution devices. These significantly increase the resolution of the emission spectra obtained with our previous high-sensitivity CCD video devices. These systems, which are controlled by means of a software developed within this project, have been employed to obtain the emission spectrum of the Perseid fireball analyzed here.

Acknowledgements

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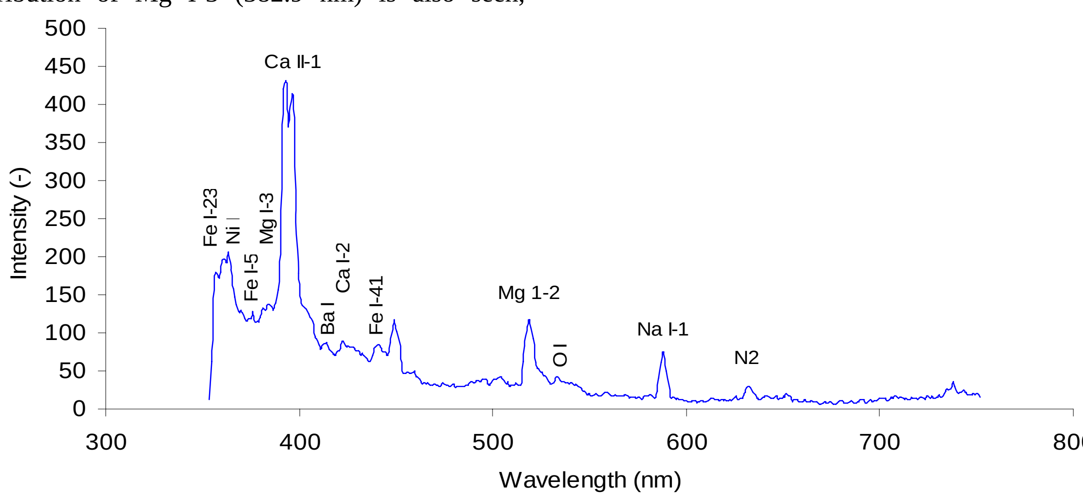

Figure 3. Main lines identified in the calibrated emission spectrum