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Software tools for the analysis of video meteors emission spectra

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Abstract

One of the goals of the SPanish Meteor Network (SPMN) is related to the study of the chemical composition of meteoroids by analyzing the emission spectra resulting from the ablation of these particles of interplanetary matter in the atmosphere. With this aim, some of the CCD video devices we employ to observe the nigh sky are endowed with holographic diffraction gratings, and a continuous monitoring of meteor activity is performed. We have recently developed a new software to analyze these spectra. A description of this computer program is given, and some of the results obtained so far are presented here.

1. Introduction

The SPMN is currently operating 25 meteor observing stations in Spain. These perform a continuous monitoring of the night sky and some of them work in a fully autonomous way [1]. One of the main systems we employ is based on high-sensitivity CCD video cameras that reach a limiting stellar magnitude of about +4 without using any additional image intensifying devices [2]. Some of these cameras have attached holographic diffraction gratings (500-1200 lines/mm) to record the emission spectra produced during the ablation of meteoroids in the atmosphere [3]. In this sense, recent studies show that applying a physical model of chemical equilibrium in the meteor column can yield information above the chemical composition of the meteoroids [4, 5]. These video devices can be used to study the temporal evolution of these spectra for meteors brighter than mag. -5 and they have already proven to be very useful to provide useful information about the chemical composition of these particles of interplanetary matter [6].

On average, about 5 emission spectra per month are being obtained by our automated observing stations. A software called CHIMET (Chemical Information of Meteoroids) has been developed in the framework of the SPMN to analyze them. A brief description of this program is given below.

2. The spectra analysis software

CHIMET is an MS-Windows compatible application developed under C++ programming language which is able to analyze meteor spectra recorded by CCD video devices on AVI video files. The software can also process FITS files containing spectra recorded by high-resolution slow-scan CCD cameras.

In general, the source AVI files need to be processed before analyzing the spectrum in order to address some issues that may interfere during the lines identification process. Thus, for instance, in some cases video noise needs to be reduced and the image background must be removed. Besides, our CCD video cameras generate interlaced video and these must be deinterlaced. Several video processing filters have been implemented in the software in order to accomplish these and other related tasks.

The spectrum is initially obtained as an intensity profile (pixel brightness, in arbitrary units, vs. pixel number) by specifying which area in the image must be scanned by the software. This is then converted to intensity vs. wavelength by identifying typical lines appearing in meteor spectra. At this stage, the spectral resolution is also calculated. Most lines are produced by neutral Fe, but prominent lines produced by chemical species such as Mg, Ca and Na can also be used for this identification. On the other hand, the spectra need to be calibrated in order to take into account the spectral response of the detection device. This calibration is automatically performed by the software once the corresponding spectral response is

provided. The thermal continuum is also removed. The software is currently being improved in order to obtain the relative abundance of the chemical species appearing in the spectrum.

3. Preliminary results

We are using our new software to obtain chemical information about meteoroids ablating in the atmosphere. For instance, fig. 1 shows a mag. -7 fireball imaged from La Hita station on Jan. 14, 2011, at 0h44m41±1s UT together with its raw spectrum. The processed spectrum obtained by using the deinterlacing and the background removal filters implemented in CHIMET is also shown. Most prominent lines correspond to Ca II-1 (396.8 nm), Mg I-2 (516.7 nm), Na I-1 (588.9 nm) and Ca II-2 (854.2 and 866.2 nm). Atmospheric oxygen and nitrogen lines can also be noticed.

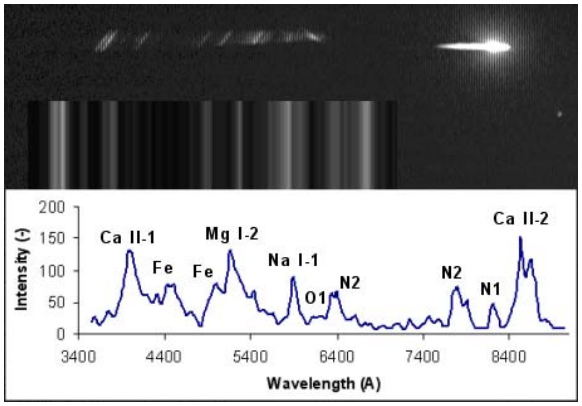

Figure 1: spectrum of a mag. -7 fireball recorded on Jan. 14, 2011, at 0h44m41±1s UT.

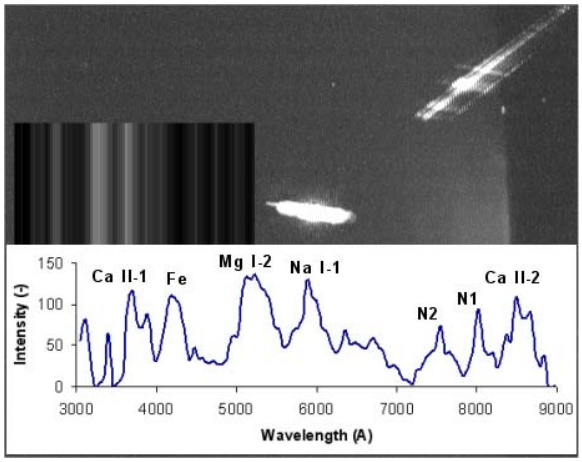

Figure 2: spectrum of a mag. -6 fireball recorded on Apr. 27, 2011, at 22h11m32±1s UT.

Another example can be seen in fig. 2, where the spectrum of a mag. -6 fireball recorded from the same station on April 27, 2011, at 22h11m32±1s UT is shown. As in the above mentioned example, most prominent lines correspond to Ca II-1, Mg I-2, Na I-1 and Ca II-2. When compared to the previous case, it is obvious that the meteoroid that gave rise to this fireball was richer in moderately volatile elements, such as Na.

4. Summary and Conclusions

We are performing a continuous monitoring of meteor and fireball activity by means of high-sensitivity CCD video devices. These have been proven to be also very useful to record the emission spectra generated during the ablation of meteoroids in the atmosphere. Our meteor observing stations are currently obtaining, on average, about 5 spectra per month. The CHIMET software has been developed to analyze these spectra and, so, chemical information about meteoroids is being obtained. Further development is being performed on this package in order to obtain also the relative abundances of the corresponding chemical species.

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References

[1] Madiedo, J.M. and Trigo-Rodriguez, J.M., abstract # 1504, 41st Lunar and Planetary Science Conference, 2010.

[2] Madiedo, J.M. and Trigo-Rodríguez, J.M. Earth, Moon, and Planets 102, pp. 133-139, 2007.

[3] Madiedo, J.L., Trigo-Rodriguez, J.M., Ortiz, J.L., Morales, N. Adv. in Astronomy, Vol. 2010, pp.1-5, 2010.

[4] Borovicka, J. Astron. Astrophys, 279, pp. 627-645, 1993.

[5] Trigo-Rodríguez, J.M. et al. Meteoritics & Planetary Science 38, n. 8, pp. 1283-1294, 2003.

[6] Trigo-Rodriguez, J.M, Madiedo, J.M.m Williams, I.P. Mon. Not. R. Astron. Soc. 392, pp. 367–375, 2009.