Meteor showers and sporadic spectra by AMOS-Spec

Tóth J. (1), Matlovič P. (1), Rudawska R. (2), Zigo P. (1), Kalmančok D. (1)
(1) Comenius University in Bratislava, Slovakia, (2) ESA/ESTEC, (toth@fmph.uniba.sk, +421 2 602 95 610)

Introduction

Meteor spectroscopy enables us to study the unaltered chemical composition of meteoroids in the Solar System. The primary aims of our research are focused on determining the spectral and physical differences between cometary and asteroidal bodies, the role of sodium abundance in meteoroids, and the spectral characteristics of different shower and sporadic meteors. We utilize the observations of the spectral All-sky Meteor Orbit System (AMOS-Spec), which provides systematic survey of meteor spectra since November 2013. The system is installed in the Modra observatory with the setup based on the standard AMOS system [1] equipped with 30 mm f/3.5 lens (FOV ~ 140° x 100°), and 1000 grooves/mm grating yielding spectral resolution of ~ 1.3 nm/pix. The absolute limiting magnitude of a meteor with spectrum is around -2.

First results [2] demonstrated the capability of the system and showed promise in pursuing our scientific goals. Here, we report on the results of 131 meteor spectra collected during 11/2013 - 04/2016.

Observations and reduction

Over the observation period of two and a half years, the AMOS-Spec collected 6531 meteors (zero-order), including 209 meteor spectra. Not all spectra were suitable for further analysis due to low S/N ratio, or other occurrences such as the moonlight interference, acute angle of the meteor, or missing part of the spectrum in the FOV. To prevent the saturation caused by the presence of the Moon, the center of the FOV was shifted 30° from zenith towards north. The analyzed spectral events were corrected for dark current, flat-fielded, and divided by the spectral response curve of the system. Before evaluating the relative intensities of studied emission lines of the meteoroid atoms and ions, the continuum radiation and atmospheric lines were subtracted from the spectrum.

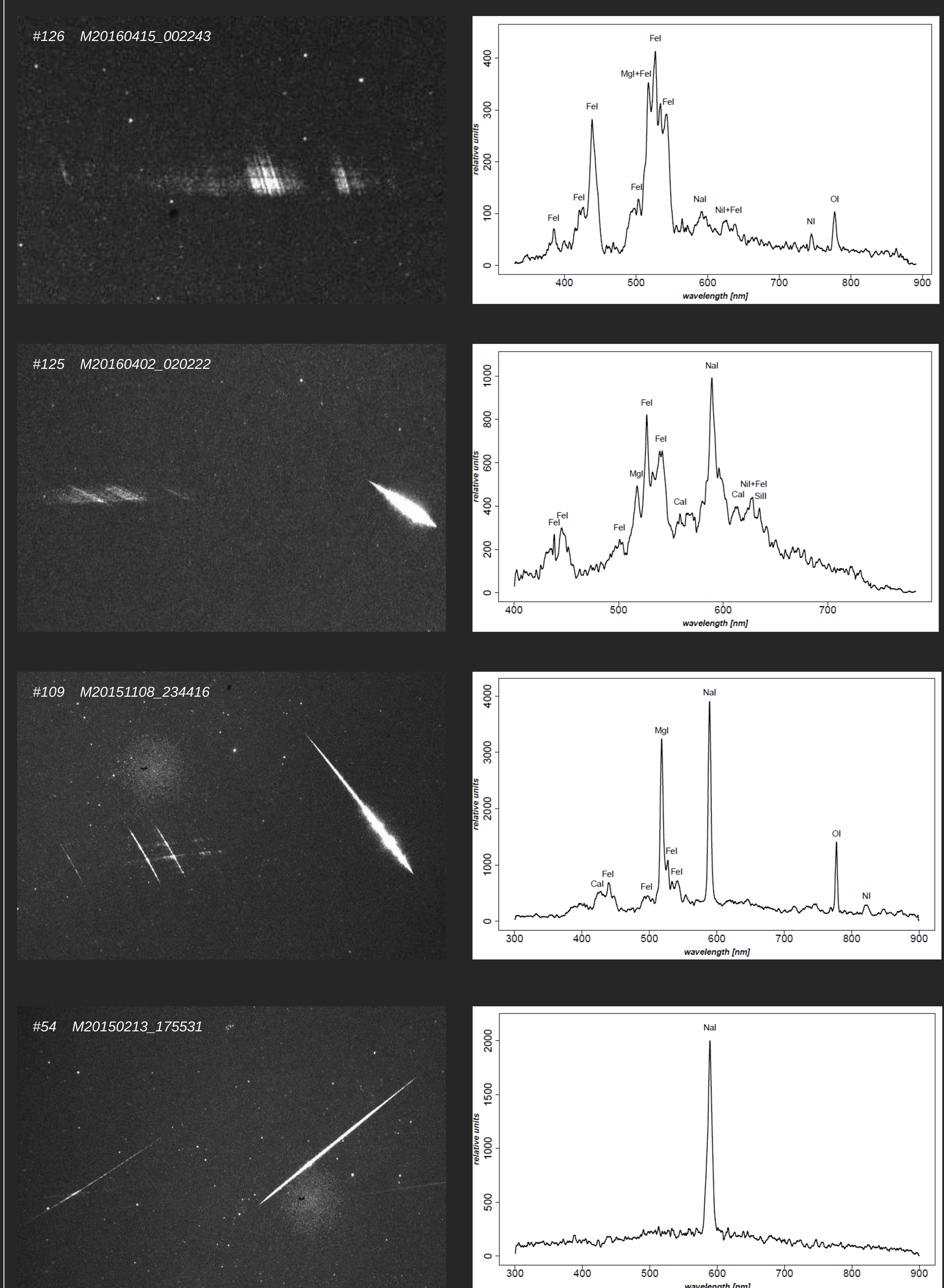

Figure 1. *Examples of spectral events captured by the AMOS-Spec system and corresponding spectral profiles before the correction for the spectral sensitivity of the system. Meteors #126, #125, #109 represent classes of various iron content: Irons, Fe rich and Fe poor meteoroids respectively. Spectrum of meteor #54 has one dominant line of sodium, representing Na-rich spectral class. Such high content of sodium suggests cometary meteoroid rich in volatile phases. Meteors #126 and #54 were sporadic, previously moving on Apollo orbits. Orbit of the meteor #125 is close to the April psi Ursae Majorids shower, while obviously originating in the Asteroidal Belt. Meteor #109 is a member of the Southern Taurids, formed by the debris of the comet 2P/Encke.*

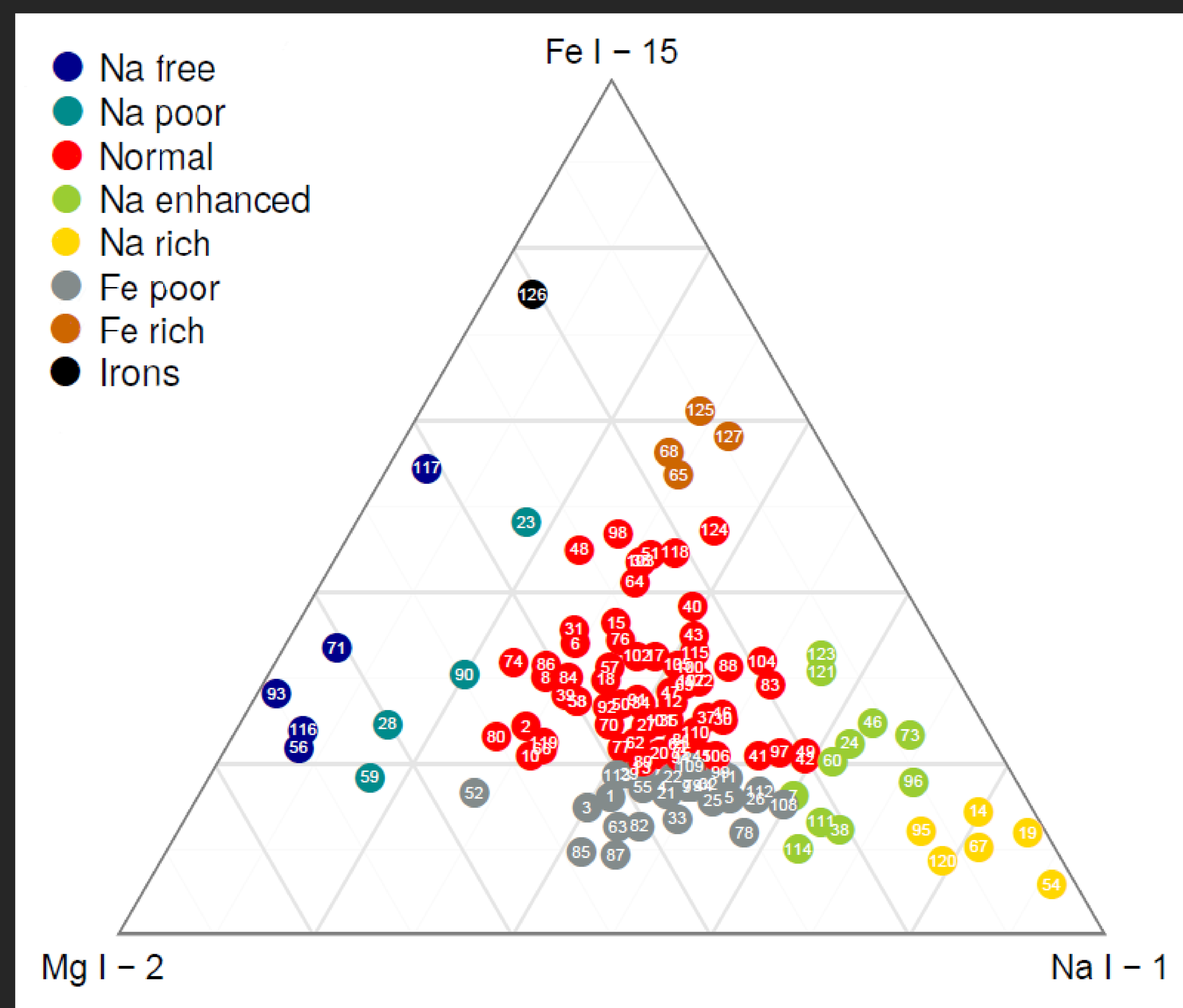

Figure 2. *Spectral classification of 127 meteor spectra observed during 11/2013 - 04/2016. New spectral class of Fe rich meteors is proposed to supplement the spectral classes introduced by Borovička [3]. Meteor spectra of purely atmospheric content were excluded.*

The presence of the Slovak Video Meteor Network (SVMN) consisting of 4 additional AMOS stations in Slovakia enabled multi-station observations of studied meteors. Additional observations were kindly provided by Pavel Spurný (European Fireball Network) and Jakub Koukal (Central European Meteor Network). Of the 131 meteors captured with spectra, 103 were observed by multiple stations, which allows us to determine heliocentric orbits and additional physical properties of meteoroids such as the photometric mass, material strength parameters Kb and PE [4] and dynamical pressure causing the meteoroid fragmentation [5].

Summary: the spectral classification

By comparing the relative intensities of the three most dominant multiplets in the visual spectrum of meteors (Fe I - 15, Mg I - 2 and Na I - 1), we are able to define the spectral classification of the studied meteoroids (Fig. 2). The intensities of the three main multiplets are similar for a typical meteor, with Na/Mg and Fe/Mg ratios close to the values observed in standard chondrites. This is defined by a normal class spectrum, which contained the majority of our sample. However, we also identified numerous cases of distinct meteor classes.

Generally, we observe lower number of iron meteoroids compared to the work of Borovička [3] (~10% of the sample), and higher content of sodium in a large part of our sample. We argue that this is mainly caused by the different size range of studied meteoroids. Our system observes spectra of meteors from -2 to -10 magnitude (corresponding to meteoroid sizes of app. few mm to tens of cm), compared to to the population of +3 to -1 magnitudes observed by Borovička (sizes app. 1 to 10 mm). Smaller particles are more effectively affected by solar and cosmic radiation and thus more likely to be depleted in volatile phases including sodium. The reason for the high number of iron particles observed among fainter meteors by Borovička remains unknown. Furthermore, we propose a new class of meteor spectra: Fe rich. This type of spectrum is defined by Fe/Mg ratio significantly higher than chondritic, while (unlike irons) emission multiplets of Na I and Mg I are still present and have considerable intensity. Meteoroids with such spectra could be related to stony-iron meteorites (siderolites), or simply fragments with high content of iron, which were not yet depleted in volatiles.

Acknowledgement

This work was supported by grant APVV-0517-12 and VEGA 1/0225/14.
(http://www.daa.fmph.uniba.sk/agonews)

References

[1] Tóth et al., (2015), *P&SS*, 118, 102-106
[2] Rudawska et al., (2016), *P&SS*, 123, 25-32
[3] Borovička et al., (2005), *Icarus* 174, 15-30
[4] Ceplecha Z., (1988), *BAICz*, 39, 221-236
[5] Popova et al., (2011), *MAPS,* 46, Nr. 10, 1525-1550