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Using Gaia spectrophotometric data for the purposes of asteroid taxonomy

Alberto Cellino[1], Paolo Tanga[2], Marco Delbo[2], Laurent Galluccio[2], Philippe Bendjoya[2] and Francesca De Angeli[3]

[1]INAF-Osservatorio Astrofisico di Torino, strada Osservatorio 20,
I-10025, Pino Torinese, Italy
email: cellino@oato.inaf.it

[2]Université Côte d'Azur, Observatoire de la Côte d'Azur, CNRS, Laboratoire Lagrange,
Bd de l'Observatoire, CS 34229, 06304 Nice Cedex 4, France
email: paolo.tanga@oca.eu, marco.delbo@oca.eu, laurent.galluccio@oca.eu,
philippe.bendjoya@oca.eu

[3]Institute of Astronomy, University of Cambridge,
Madingley Road, Cambridge CB3 0HA, UK
email: fda@ast.cam.ac.uk

Abstract. A new asteroid taxonomy will be an important result of Gaia observations of Solar System objects. Since Gaia observes asteroids in observing conditions and in an interval of wavelength which are slightly different with respect to normal ground-based observations, a dedicated observing campaign has been carried out at the Telescopio Nazionale Galileo in La Palma (Canary Islands, Spain). The obtained spectra have been used to generate a large number of synthetic clones, each one having slight changes with respect to its parent spectrum. These synthetic spectra are then used to feed the algorithm of taxonomic classification developed to reduce Gaia asteroid spectra. Processing of these data is in progress.

Keywords. minor planets, asteroids, methods: data analysis

1. Introduction

Using its BP/RP detector, Gaia observes asteroid spectra extending from blue to red for a number of targets of the order of 10^5. This is a much larger number with respect to currently available reflectance spectra obtained from the ground. Moreover, Gaia spectra are not obtained close to solar opposition, but at larger phase angles, between about 12 and 25 degrees†. Some reddening effects can therefore be expected. In order to use such big data-base of asteroid spectra to obtain a new taxonomic classification, an algorithm has been developed and will be used to process Gaia data. In order to test the algorithm, a spectroscopic survey aimed at obtaining spectra of asteroids of different taxonomic classes, preferentially observed at large phase angles, and in the same interval of wavelengths covered by Gaia, has been done using the 3.6-m Telescopio Nazionale Galileo (TNG) in La Palma (Spain). Some examples of the obtained spectra are shown in Fig. 1 (left panel). The TNG reflectance spectra have then been used to create a large number of synthetic spectra, each one exhibiting some realistic random variations with respect to its parent spectrum. These clones can be be used to feed to the algorithm of Gaia taxonomic classification.

† The phase angle is the angle between the directions to the Sun and to the observer, as seen from the asteroid.

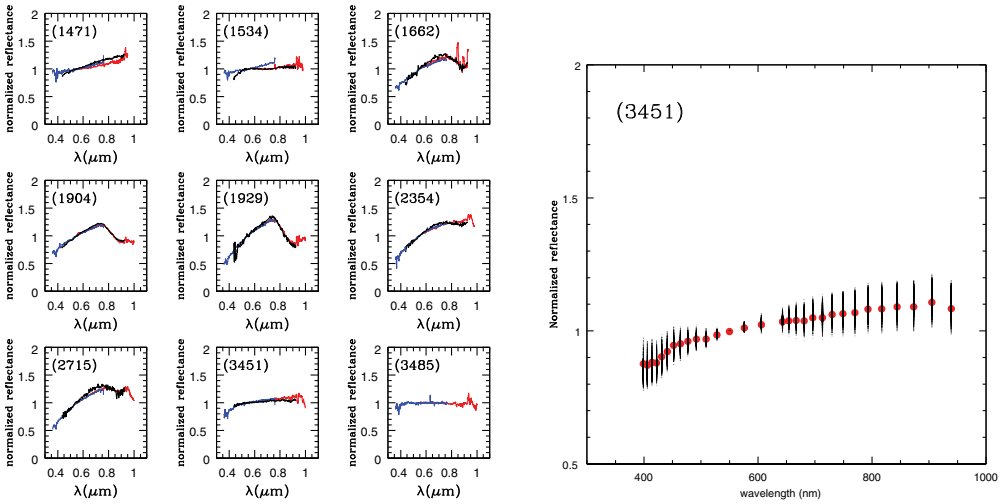

Figure 1. Left panel: a small subset of the asteroid reflectance spectra obtained during our observing campaign at TNG. The blue and red parts of the spectra have been measured separately for each object by using two different grisms. Superimposed black curves represent, when available, spectra previously obtained by the SMASS survey (Bus and Binzel (2002). Right panel shows, in the case of the reflectance spectrum of the Jupiter Trojan asteroid (3451) Mentor, the total variation exhibited by the full set of its clones at each of the discrete values of wavelength used in our analysis. Note that all spectra are normalized at the wavelength of 550 nm.

2. Spectral clones

The continuous TNG spectra have been discretized and used to generate a synthetic population of 100,000 "clone" spectra. The number of clones of asteroids belonging to different classes has been chosen according to the currently known relative abundances of different classes. Each clone represents a realistic random variation of its parent TNG spectrum. Fig. 1 (right panel) shows the total range of variation at different wavelengths of the generated clones of asteroid (3451) Mentor, a Jupiter Trojan. All the spectra are normalized at the wavelength of 550 nm. We are currently working to use the generated spectra to optimize the algorithm of taxonomic classification developed for Gaia.

3. Work in progress

Asteroid taxonomic classes are generally interpreted in terms of differences in surface composition. A great advantage of a Gaia-based taxonomy will be that of being based on a wider interval of wavelengths with respect to the most recent ground-bases classifications. As an example, we expect to be able to recover the old F class, which has been lost in modern taxonomies based on data not covering the blue spectral region, but are known to be well distinct in terms of polarimetric properties. Polarimetric data also suggest for the F class a possible cometary origin. A paper is currently in preparation.

Reference

Bus, S. J. & Binzel, R. P. 2002, *Icarus*, 158, 146