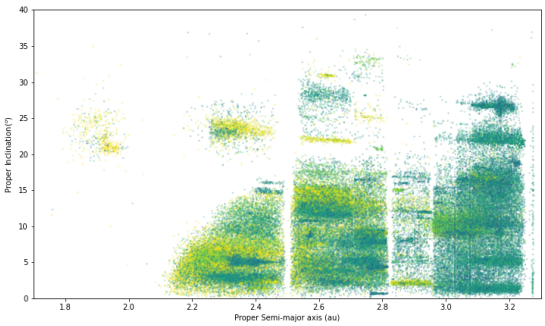
Distribution of asteroid compositions



The asteroid belt, color-coded by albedo

SUMMARY.
Asteroids are the remnants of the original building blocks that formed the terrestrial planets. The early events of planetary migrations that occured in our Solar System left their prints in the distribution of asteroid orbits and compositions. While detailed compositions are determined from spectroscopy, multi-filter photometry from large surveys such as the SDSS or the LSST can be used to classify asteroids into compositional groups and study their distribution into orbital elements (see Figure on the left).
This METEOR combines theoretical knowledge with practical work (applicable to other research fields). It includes lectures on the composition of asteroids, their links with meteorites, their surface aging due to space weathering, and experimental work on the links between spectroscopy and photometry, and methods of classification

OBJECTIVES

- Acquire fundamental knowledge on asteroid compositions and their biased sampling by meteorites, space weathering, reflectance spectroscopy, and Solar System formation.
- Convert spectra into photometry. Classify large samples into coherent groups. Develop codes in python. Extract essential information from articles.

PREREQUISITES

☒ S1. Data Sciences

THEORY

by B. Carry, G. Libourel, P. Tanga

The theoretical part of the METEOR covers both fundamental knowledge on asteroids and on photometry/spectroscopy in astronomy.

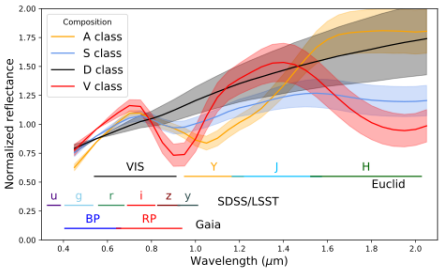
- Solar system formation. Accretion of planetesimals. Planetary migrations.
- Classification and composition of meteorites.
- Compositions, classification, distribution of asteroids.
- Surface aging by space weathering.
- Definition of the magnitude systems in astronomy. Convertion between spectra and magnitudes.
- Extraction of asteroid signal in sky surveys.
- Measurement of asteroid reflectance. Solar analogs.
- Clustering of data in high-dimension space wih machine learning.

APPLICATIONS

by B. Carry

Three projects are possible, reproducing all the steps used nowadays to conduct large scale study of asteroid compositions from sky surveys. You will

- retrieve the photometry from on-line repositories,
- compute reference colors from templates for comparison,
- reduce the dimensions of the sample while minimizing information loss,
- classify asteroid in groups from their observed properties,
- interpret their orbital distribution.



Examples of asteroid spectra

MAIN PROGRESSION STEPS

- `Tier 1`: Courses on photometry and Solar system, exercices on spectra.
- `Tier 2`: Courses on meteorites and machine learning. Start of the project.
- `Tier 3`: Project.

EVALUATION

- `Theory grade [30%]`
  - Written exam (70%): theoretical questions from lectures
  - Presentation of an article (30%): critical spirit, applied knowledge from lectures
- `Practice grade [30%]`
  - Exercice (30%): structure of the solution, precision of results.
  - Project (70%): initiative, autonomy, curiosity, results, critical analysis of results.
- `Defense grade [40%]`
  - Oral and slides quality
  - Context
  - Project / Personal work
  - Answers to questions

BIBLIOGRAPHY & RESOURCES

- DeMeo & Carry 2014
- Mahlke et al. 2022
- Raymond et al. 2020
- https://scikit-learn.org

CONTACT

☎ +33.4.92.00.39.64
✉ benoit.carry@oca.eu