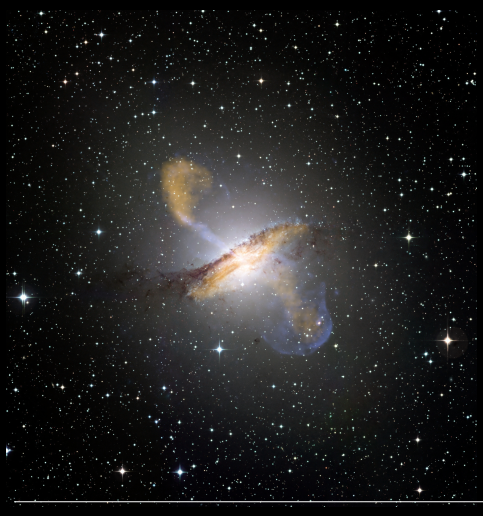
Active galactic nuclei and star formation in galaxies



SUMMARY.
Supermassive black holes residing in the nuclei of massive galaxies are considered key for regulating the growth of their host galaxies and the formation of large-scale structure. Accretion of matter leads to an immense energy output from these black holes, in particular through radio jets. If only a small fraction of the kinetic energy carried by these jets can be efficiently deposited in the ambient gas (AGN "feedback"), then this might be enough to terminate the rapid growth of massive galaxies in the early Universe, and to keep these galaxies devoid of gas and star formation until the present day. In this METEOR we will discuss why AGN feedback is one of the central ingredients of galaxy evolution and cosmic structure formation today. We will also examine the interplay of the AGN energy output, gas properties, and star formation in nearby galaxies, to follow the distribution of kinetic energy in the interstellar gas, and to investigate what impact this has on the formation of stars.

OBJECTIVES

The students will carry out a scaled-down version of a state-of-the art research project combining VLT imaging spectroscopy, ALMA millimeter radio interferometry, and VLA cm radio interferometry with results from relativistic hydrodynamical simulations.

Depending on the number of students, we will split the program into several intertwined parts. Each student will learn how to extract information on either gas kinematics, gas heating processes, or star formation histories from imaging spectroscopic or interferometric data cubes for the same galaxy. Subsequently, we will compare the results for each aspect, and interpret all elements together in the context of AGN feedback models.

PREREQUISITES

Fundamental courses: General Astrophysics (required).

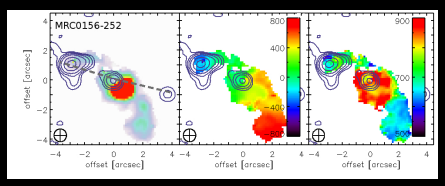
A basic understanding of astrophysical spectroscopy would be highly appreciated, but is not a strict requirement.

Basic computing skills (Python) are mandatory for this project.

THEORY

by Nicole Nesvadba

Physics of radio-jet driven AGN feedback in galaxies and role for galaxy evolution. Multi-wavelength imaging spectroscopy of gas in galaxies and spectral line fitting. Emission-line kinematics and diagnostics of star formation and AGN. Gas energetics and regulation of star formation in galaxies.



APPLICATIONS

by Nicole Nesvadba

Analysis of imaging spectroscopic (or interferometric) data cubes from leading ground-based observatories in the optical (VLT) and radio (ALMA, VLA): Fitting of emission and absorption lines, mapping of the gas kinematics (line widths, velocities) or gas heating, and comparison with cm radio imaging to extract information about how the radio jet affects the gas motion, e.g., through injecting turbulence and driving outflows. Comparison of different gas phases, with the star-formation histories derived from the optical spectra, and with the results of numerical simulations.

MAIN PROGRESSION STEPS

- First week : General introduction into the topic, and study of the relevant literature.
- From the 2nd week on: Data analysis and interpretation, in parallel to a continuing study and discussion of the relevant literature.
- Last week : Synthesis of the final results, and preparation of the oral presentation.

EVALUATION

- Several short talks discussing salient papers (30%). • A written report of the scientific context and results (30%). • Final oral defense (40%).

BIBLIOGRAPHY & RESSOURCES

- Cattaneo et al. (2009), Nat, 460, 213
- Best et al. (2014), ARA&A 26, 52
- Nesvadba et al. (2021), A&A in press

CONTACT

☎ +33 4 92 00 39 73
✉ nicole.nesvadba@oca.eu