PhD title: Unveiling the secrets of blazars through the study of multifrequency observations

Abstract

The extreme variability of blazars, in both timescale and amplitude, is generally explained as the effect of a relativistic jet closely aligned to the observer's line-of-sight. Due to causality arguments, variability characteristics translate into spatial information about the blazars' emitting region. Since 2005 the IRA radio telescopes are involved in the Blazar Monitoring Program, a project for the systematic observation of an important number of blazars; thousands of data points, at different radio bands, have been collected so far. Aim of this PhD thesis is the exploitation of the wide archive of the Blazar Monitoring Program, together with other available interferometric data (e.g., ALMA, EHT, EVN), for a deeper understanding of the blazars' physics through the analysis of their multifrequency variability.

Project description

Blazars are the most extreme sources among Active Galactic Nuclei (AGNs). Their emission, which covers the entire electromagnetic spectrum, is characterised by strong variability on a wide range of timescales, from minutes to many years. According to a well-established paradigm, the blazar engine is a rotating supermassive black hole which, fed by a surrounding accretion disc, powers a relativistic jet closely aligned to the observer's line-of-sight. While this picture seems generally confirmed by the observations, a more thorough comprehension of the physical mechanisms at the base of the blazar phenomenon is still missing. Many competing models have been proposed in the course of several decades of research, but the problem is still unsolved.

An essential contribution to the solution of the blazar enigma comes from the study of their variability, which, for causality arguments, constrains the size of the emitting regions at different frequencies. Since 2005, the IRA radio telescopes of Medicina and Noto have been collecting a large amount of data at several radio frequencies, within a long-term program for the monitoring of blazars that is still ongoing. These data are already available and ready to be analysed; they can be combined with public data from other projects (e.g. the F-gamma project, and the ALMA Calibrator Source Catalogue, which provides flux density measurements at mm wavelength) and facilities (e.g. the NASA satellite FERMI GST), or with proprietary data collected within the framework of large collaborations (such as the Whole Earth Blazar Collaboration) to exploit a multifrequency archive that can provide new important insights in our understanding of blazars.

For most of these blazars also very long baseline interferometric (VLBI) data (e.g., EHT, GMVA) is available which provides a high-angular resolution view of the mass accretion onto supermassive black holes and the formation and acceleration mechanisms of relativistic jets. Combining the VLBI with interferometric data (e.g., ALMA, VLA), a large range of angular scales of the emitting regions can be explored and compared with the variability analysis.

The PhD student would be involved in all the steps of the study --- from the observations with the radio telescopes to the data calibration, from the time series analysis to the theoretical interpretation of the results --- gaining a solid expertise in all the relevant aspects of astrophysical research.

Supervisors:
Nicola Marchili, INAF-IRA & Italian ALMA Regional Centre, nicola.marchili@inaf.it
Elisabetta Liuzzo, INAF-IRA & Italian ALMA Regional Centre, elisabetta.liuzzo@inaf.it

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