PhD project in ASTROPHYSICS

Title: The life-cycle of relativistic jets in compact objects: from transient to stable phenomena

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Scientific case – Understanding how radio emission originates and evolves in extragalactic radio sources is one of the greatest challenges faced by modern astrophysics. Radio-loud (jetted) active galactic nuclei (AGN) represent only a small fraction of the total population of their host galaxies, suggesting that radio emission may be a transient phase in the lives of these systems. A peculiar aspect of jetted AGN is the possibility to identify and date their evolutionary stages: from the trigger of the radio emission to its halt. It is also possible that after the period of quiescence the radio emission turns on again. Cosmological simulations require recurrence of nuclear activity to regulate the growth of supermassive black holes (SMBHs) and star formation in massive galaxies. The discovery of remnants among young radio galaxies suggests that the injection of relativistic plasma may be as short as a few thousands years. The theoretical motivation behind the short lives of these sources and the duration of the active phase is still unclear. The connection with the accretion process is a further ingredient that we need to understand. Both radiation pressure instability of the accretion disk and stellar tidal disruption events may be viable scenarios.

Outline of the Project – This project aims to assess for the first time the incidence of remnants among a complete sample of young radio sources. Results will be compared with the outcome of current evolutionary models and numerical simulations. In addition, the link among accretion and ejection processes will be investigated. While focusing on SMBHs, the candidate will have the chance to extend the analysis also to their stellar counterparts, whose evolution takes place on faster timescales, opening to the possibility to investigate the formation and evolution of the radio phenomenon on month-to-year timescales. To achieve the goal, the candidate will have access to: 1. proprietary multi-frequency radio data to discriminate between active and remnant sources by determining their radio structure and spectral index, 2. multi-wavelength observations at high (X-to-gamma-ray) energies in systems powered by BHs.
A complete characterization of the life cycle of the radio emission from relativistic jets will be crucial for the exploitation of the data from the next-generation facilities, like SKA and ngVLA. The candidate will be part of the VLBI high-energy group at IRA-INAF which includes experts in compact objects, from stellar to supermassive BH, from the observational and theoretical standpoint.

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