PhD project in ASTROPHYSICS

Title of the Project: ***The variable and multi-messenger sky with CTA***

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Scientific Case: The Cherenkov Telescope Array (CTA), will be the major observatory for very high energy gamma-ray astronomy over the next decade and beyond. The scientific potential of CTA is extremely broad, exploring the extreme universe, from the origin and role or relativistic cosmic particles to the frontier of physics (dark matter, quantum gravity), to the study of extreme environments and, connected with them, the transients phenomena. Wider field of view, improved sensitivity makes CTA a powerful instrument for time-domain astrophysics. The CTA Observatory will be capable of issuing alerts on variable and transient phenomena and will closely interact with complementary astrophysical facilities, accepting triggers from them, enabling multi-wavelength and multi-messenger approaches that will lead to a deeper understanding of the broad-band non-thermal properties of target sources. To capture these phenomena during their evolution and for effective communication to the astrophysical community, the speed is crucial and can be achieved using the Science Alert Generation system for the fast identification of flaring events, from targeted observation to serendipitous discoveries during surveys. INAF is deeply involved in the development of CTA with the responsibility of developing the Science Alert Generation (SAG) system. INAF/OAS researcher are participating in different scientific CTA scientific working groups from extra-Galactic surveys to transients, have substantial experience on gamma-ray real-time domain astronomy, in the definition of strategies and systems for fast reaction to transients in the multi-messenger and multi-wavelength context.

Outline of the Project: The proposed activity can be divided into two main topics:
1) Follow-up of external science alerts. The candidate contributes to set strategies for CTA reaction to external transients (i.e. gravitational waves, neutrinos, GRB, gamma-ray binaries, Radio-Loud AGN, etc.); in particular, the purpose is to consider the potential variable sources that CTA may detect, how to identify them with the CTA Science Alert Generation system and their likelihood, and how to select science alerts for the follow-up strategies based on scientific ranking and observatory constraints.
2) Serendipitous identification of gamma-ray transients. The ability to rapidly issue science alerts is another key aspect of the SAG. Extragalactic surveys will cover 25% of the total sky, with the primary objective to construct an unbiased very high-energy extragalactic source catalogue. In this context, a potential discovery field could be serendipitous detection of flaring sources. The candidate can contribute to consider the potential variable sources that CTA may discover during surveys, and define key strategies for their identification with the CTA Science Alert Generation system. One of the focuses could be the serendipitous discovery of blazars in the transient state.
During the work the candidate will learn high-energy data analysis techniques and will use the state-of-the-art of gamma-ray analysis tools. The candidate will also gain experience in transient follow-up using the data of the current gamma-ray space missions. The candidate will analyse also the data of the first CTA telescope, LST1 located in La Palma. Based on the interests of the candidate, application of machine-learning techniques for the definition of observational strategies could be an additional benefit.

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