DOSSIER DE CANDIDATURE au LLR

Fast variability from extragalactic gamma-ray emitters as observed with the HESS and Fermi telescopes

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Context:

The extragalactic gamma-ray sky between 100 MeV to 10 TeV is dominated by a population of extremely energetic sources, thought to be galaxies in which powerful non-thermal emission is created by accretion of material onto a super-massive black hole. These objects are also among the best candidates of being the origin of the most energetic cosmic rays. Gamma rays are produced in relativistic jets of plasma which are launched from close to the black hole. Observationally, these so-called *active galactic nuclei* (AGN) are characterized by broad-band emission from radio to gamma-ray energies, extreme variability, with doubling-times as short as a few minutes, and a double-peaked emission spectrum which results from synchrotron and inverse-Compton emission from charged particles in the jet. Despite advances that have been made in our understanding of these objects over the past decade, many deep mysteries abide, in particular regarding the launching and collimation of the jet and the environment in which the radiation is produced.

Gamma rays are detected when they initiate cascades of charged particle, either directly using space-based particle detectors or indirectly by large ground-based optical telescopes using the atmospheric Cherenkov technique. The astrophysics group at LLR is a member of international collaborations that have built and operate both types of instrument, namely the Fermi large-area space telescope and the HESS array of five telescopes in Namibia. In particular LLR has played a large role in the construction of the HESS-II instrument, the largest gamma-ray telescope in the world, which was commissioned in September 2012 and promises to detect gamma rays from ever most distant AGN.

Figure 1: Left, artistic impression of jets in AGN. Right, the HESS array in Namibia.

Project outline:

The study of temporal variability with Fermi and HESS are complementary. Fermi has a large field of view but modest effective area allowing it to measure the full gamma-ray sky between 100MeV and 300GeV every 3 hours with (relatively) low sensitivity, while HESS has a small field of view and large effective area allowing it to make sensitive dedicated observations of single objects at energies larger than 50GeV. By combining observations with both instruments the variability spectrum of objects can be measured on timescales from years to minutes, which set strong constraints on the properties of the underlying emission mechanism.

A motivated PhD student wishing to join the LLR astrophysics group would have the opportunity to work with two state-of-the-art gamma-ray detectors. He or she would develop new and novel analysis algorithms that combine observations from both instruments with the aim of increasing sensitivity to objects detected by both instruments and of measuring the spectra of temporal variability in AGN.

The student would be expected to attend international collaboration meetings and to take an observation shift at the HESS telescope array in Namibia.

References:

"Fermi Observations of TeV-Selected Active Galactic Nuclei" http://arxiv.org/abs/0910.4881
The HESS array: http://www.mpi-hd.mpg.de/hfm/HESS/
The Fermi telescope: http://fermi.gsfc.nasa.gov/
The astrophysics group at LLR: http://astrollr.in2p3.fr