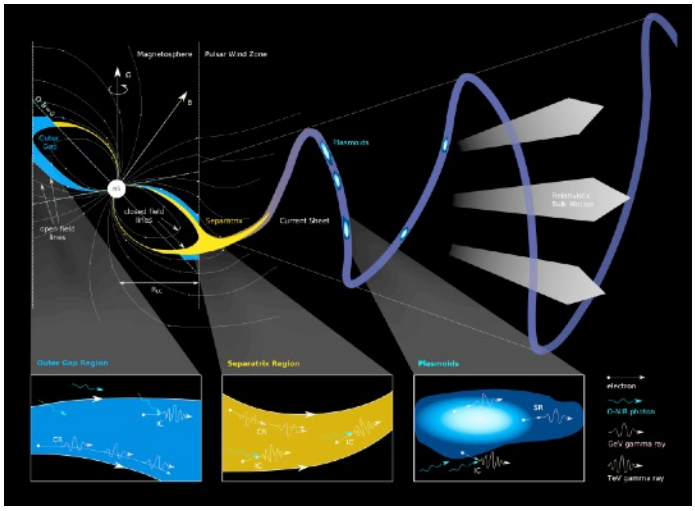
High Energy Astrophysics

Probing pulsars with TeV gamma-rays



Pulsars are extremely magnetised spinning cosmic objets which emit beams of electromagnetic radiation from the radio band up to high-energy (HE; <100 GeV) and very-high-energy (VHE; >100 GeV) gamma-ray domain. While about 10% of the ~3000 radio pulsars are known to emit gamma-rays in the HE range, only three pulsars have up to now been detected in the VHE domain. The discovery (2022-23) of pulses reaching **an unprecedented energy of 20 TeV** from **the nearby (280 pc)** and young **Vela pulsar**, challenged strongly our understanding of the acceleration and radiation processes at play in pulsars' magnetosphere and wind zone. **The very recent discovery of a very luminous multi-TeV emission from a pulsar much further than Vela** has opened definitively the domain of TeV pulsar astrophysics.

The proposed thesis project consists of two complementary parts:

I) The observational part consists of analysis of data obtained with the H.E.S.S. gamma-ray observatory (in Namibia) and the satellite-based Fermi-LAT instrument, in view of producing the first H.E.S.S pulsar catalog. This will be a major legacy of H.E.S.S. and will pave the way for TeV pulsar astronomy with the forthcoming major observatory CTAO (two sites, La Palma/Spain and Atacama/Chile), of which the partial exploitation of data has already begun at the northern site.

II) The phenomenological part: due to their very-high energies, TeV photons probe the acceleration and emission mechanisms at their extreme limits. One can expect with great confidence a significant progress in models of high-energy emission from pulsars using more and more precise gamma-ray measurements, but also thanks to new sources discoveries. In this part of the thesis, the PhD

candidate will take part in the modelling work, of course in a multi-wavelength (radio, X-ray, HE and VHE) perspective.

In summary, the PhD subject could be formulated as “Current Landscape and Prospects in TeV Pulsar Astronomy with CTAO” . The center of gravity of the work could range from data analysis (H.E.S.S., Fermi-LAT) to detailed modelling, depending on the skills and personal tastes of the candidate.

This proposal can naturally be started with a Masters internship period.

[Python programming language skills are highly recommended !].

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M2 Internship

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