INVESTIGATION OF HIGH ENERGY AND PLASMA ASTROPHYSICS PHENOMENA: THEORY, NUMERICAL SIMULATIONS, OBSERVATIONS, AND INSTRUMENT DEVELOPMENT FOR THE CHERENKOV TELESCOPE ARRAY (CTA)

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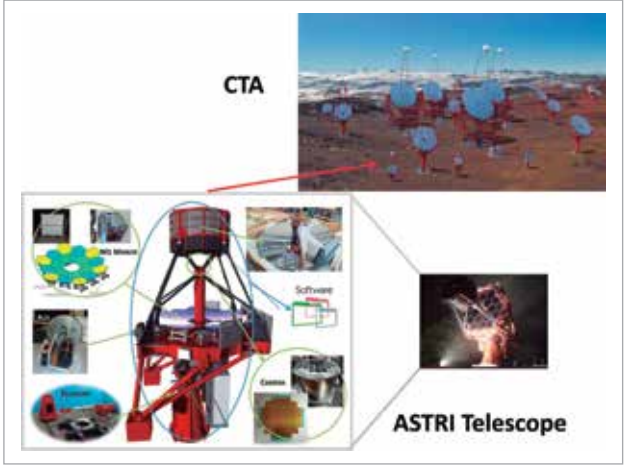

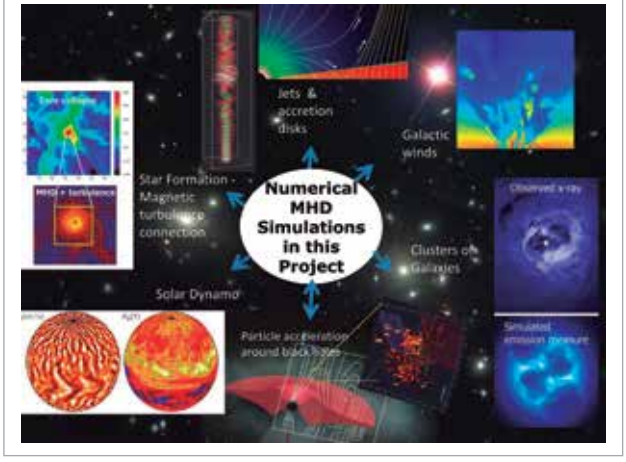

Most of the visible matter in the Universe is in a plasma state, or more specifically is composed of ionized or partially ionized gas permeated by magnetic fields.

The goals of this Thematic Project are two-fold:

• The investigation of plasmas and high energy phenomena in Astrophysical systems by means of multi-dimensional magneto-hydrodynamical (MHD) studies employing high performance computing (HPC) and sophisticated codes. The studies include: astrophysical jets; black holes; acceleration and propagation of cosmic rays; galactic and stellar winds; role of turbulence and magnetic fields in star formation; solar and stellar dynamos; turbulent intra-cluster medium of galaxies and the origin of cosmic magnetic fields; and gamma ray astrophysics.

• The construction of the ASTRI – a Mini-Array of 9 Cherenkov telescopes – in partnership with Italy and South Africa. The MINI-ARRAY will be the (Cherenkov Telescope Array) CTA PRECURSOR. The CTA, is an international collaboration aiming at the construction of the largest gamma ray observatory – an array of ~100 Cherenkov telescopes – which will provide the deepest insight of the non-thermal high-energy Universe ever reached, with significant contributions to cosmology, astrophysics, astroparticle physics, and physics beyond the standard model. ASTRI is planned to be deployed by 2018, around which the big array will grow later.

Currently, the following main results have been achieved:

• Performance of numerical/theoretical studies of cosmic ray acceleration and production of gamma-ray radiation around black holes and relativistic jets with pioneerinig results on particle acceleration by magnetic reconnection, a process that can extract magnetic energy from the plasma of the system very efficiently and lead to stochastic particle acceleration and non-thermal high energy radiation.

• Performance of three-dimensional magneto-hydrodynamical simulations of the evolution of relativistic jets; galactic winds; turbulent intra-cluster medium of galaxies; and solar dynamo.

• The ASTRI telescope prototype testing is almost concluded and Brazilian engineers of this Thematic Project have participated in its development, and in particular, of the silicon photomultiplier camera (see figure).

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