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THE HARD X-RAY TELESCOPES FOR MIRAX AND PROTOMIRAX

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The **MIRAX** experiment is a wide-field coded-aperture hard X-ray imager which will be the first Brazilian-led space astronomy project; **protoMIRAX** is a balloon-borne experiment developed to test several MIRAX subsystems in a near-space environment and to demonstrate technological developments. Here we describe both experiments and highlight their main expected contributions.

The Monitor e Imageador de Raios X (MIRAX), under development at the National Institute for Space Research (INPE), Brazil, is a hard X-ray astronomy experiment that is expected to be launched in low-Earth orbit (650 km altitude, 15° inclination) onboard the Lattes satellite mission in 2018 for a lifetime of 3+ years (see Figure 1).

The hard X-ray band is particularly important to study accretion onto black holes and neutron stars, including non-thermal processes of emission such as the ones occurring on jets and other hot relativistic astrophysical plasmas. MIRAX main goals include the characterization, with unprecedented depth and time coverage, of a large sample of transient and variable phenomena on accreting neutron stars and black holes, as well as Active Galactic Nuclei (AGNs) and both short and long GRBs (Braga 2006). This will be achieved by the combined operation of a set of two coded-aperture telescopes that will operate in scanning mode in a near-Equatorial circular LEO.

MIRAX consists essentially in two coded-aperture imaging telescopes equipped with cadmium-zinc-telluride (CZT) solid-state room-temperature semiconductor detectors. One telescope (T1) is being developed at INPE’s Astrophysics Division and will fly in a high altitude (~43 km) balloon in 2014 for testing and demonstration; this development is called the *protoMIRAX project*. T1 uses an array of 13×13 CZT planar detectors with dimensions 10mm×10mm×2mm and a 1 mm-thick lead coded mask with 20 mm openings and an extended 13×13 Modified Uniformly Redundant

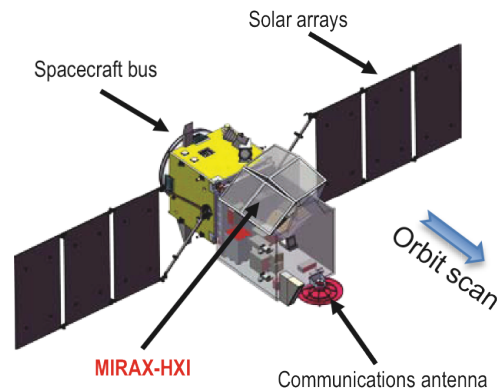


Fig. 1. Representation of the the MIRAX experiment onboard the payload module of the Lattes satellite.

Array (MURA) basic pattern for “perfect” (no intrinsic noise, no ambiguities) imaging. It will have a $20^\circ \times 20^\circ$ field-of-view (FOV), fully coded by the mask, and an angular resolution of 1.5° . T1 will be mounted in a balloon gondola with an attitude control and pointing systems as well as a 500 kbps telemetry and command capability for real-time operation and data acquisition.

The imaging CZT detectors for the second telescope (T2) are being developed at the Harvard Smithsonian Center for Astrophysics (CfA) (Rodrigues et al. 2013). The detector plane for T2 will have a 0.6 mm spatial resolution and an area of 250 cm^2 . A 0.3mm-thick tungsten mask with a random pattern will provide images with $6'$ angular resolution with a $20^\circ \times 20^\circ$ FWHM FOV.

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