

THE SIMBOL-X HARD X-RAY MISSION

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Abstract. The SIMBOL-X mission, operating in the 0.5–70 keV range, is proposed by a consortium of European laboratories for a launch in 2011. Its sensitivity will be two to three orders of magnitude better than those of INTEGRAL below 40 keV, and its angular resolution will be comparable to that of XMM-Newton on all the energy range. The scientific objectives, the baseline mission, and the status of the project are shortly presented here.

1 Scientific rationale of the mission

The study of the non-thermal component in high energy astrophysics sources is presently hampered by the large gap in spatial resolution and sensitivity between the X-ray and gamma-ray domains. Below ~ 10 keV, astrophysics missions like XMM-Newton and Chandra are using X-ray focusing mirrors based on grazing incidence reflection properties, while at higher energy hard X-ray and gamma-ray imaging instruments, such as those on the recently launched INTEGRAL are using the non focusing technique of coded masks. This transition of techniques, and consequently of instrument performances, unfortunately happens roughly at the energy above which the identification of a non-thermal component is unambiguous with respect to thermal emission. Considered from the low energy side, this obviously strongly limits the interpretation of the high quality X-ray measurements, and particularly that related to the acceleration of particles. Considered from the high energy side, this renders impossible the mapping of the gamma-ray emission of extended sources to the scales needed to understand the emission mechanisms by comparing with lower energy data; this also limits the class of objects studied to very bright ones only. Examples of these limitations are given in the Galactic Centre region, as detailed in Ferrando *et al.* in this volume.

SIMBOL-X is designed to bridge this gap by extending the X-ray focusing technique to much higher energies, up to at least ~ 70 keV. In addition to that,

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with an energy range starting at ~ 0.5 keV SIMBOL-X covers the transition from thermal to non-thermal emissions, as well as the Iron line region, two important characteristics for the study of the highly variable accreting sources which are prime targets of this mission.

The scientific goals of this mission, which will be a pointed observatory, can be classified in two major categories which are the understanding of accretion / ejection processes onto Black Holes, and the understanding of particle acceleration and its limits. In the first category are the study of AGNs, including Compton thick, with strong links to the problem of the X-ray diffuse background, the study of Sgr A*, and that of binary systems in our Galaxy and in our local group. The second category includes the physics of acceleration in Supernovae Remnants, as well as in extended jets of quasars and microquasars.

2 Mission concept and performances

SIMBOL-X is built using a classical Wolter I optics focusing X-rays onto a focal plane detector system. The gain in maximum energy, compared to the present X-ray telescopes, is achieved by having a long focal length, of 30 metres. This is obtained by mounting the mirror module and the detectors on two separate spacecraft in a formation flying configuration. The orbit presently studied, and demonstrated to be feasible, is a high altitude ($\sim 90,000$ km) circular orbit. The mirror system will be using the same technology as for XMM-Newton mirrors. The focal plane detector system will combine a Silicon low energy detector, efficient up to ~ 20 keV, on top of Cd(Zn)Te high energy detector. They will be surrounded by an active anticoincidence shield.

The main scientific characteristics are an energy range from 0.5 to 70 keV, an effective area of > 550 cm² up to 35 keV, 150 cm² at 50 keV, an energy resolution of 130 eV at 6 keV, 1 % at 60 keV, an angular resolution better than 30'', a localization capability of better than 3'', for a field of view of 6'. The continuum sensitivity (5σ , $\Delta E = E/2$, 100 ks) will be of $5 \cdot 10^{-8}$ ph/cm²/s/keV for energies less than 40 keV.

3 Mission status

SIMBOL-X is a multi-lateral mission led by France, and involving a major participation of laboratories from France and Germany for the focal plane, and Italy for the mirror system. A United Kingdom participation is also envisioned. The SIMBOL-X proposal, with a launch date around 2010, was presented to the CNES French space agency in 2002 in the context of its former quadri-annual selection process, and was recommended then for a start of phase A study.

A detailed scientific case, as well as a full technical description can be found in : Ferrando, P., Arnaud, M., Cordier, B., *et al.* 2003, Proc. SPIE 5168, *in press*, astro-ph/0309424.