A-STAR

Observing the transient Universe

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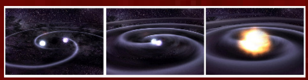
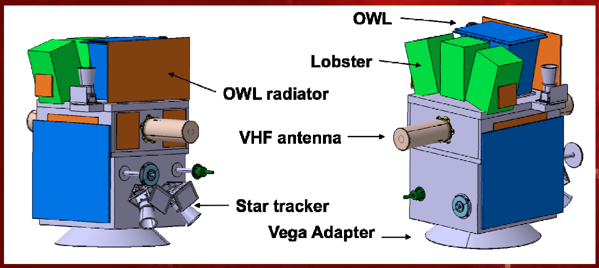
The universe is a highly dynamic place in which stars evolve and die, matter gets accreted onto compact objects and matter gets ejected from stars and galaxies. All of these processes can result in large, sometimes explosive, release of energy. Thus, monitoring the sky is a requirement if we are to understand the universe. Many of the most powerful transient sources emit mostly in X-rays and γ-rays. We propose a joint CAS-ESA small mission to provide sensitive, broad-band, high-energy monitoring of all the visible sky using wide-field X-ray microchannelplate (MCP) telescopes (Lobster).

Science Objectives:

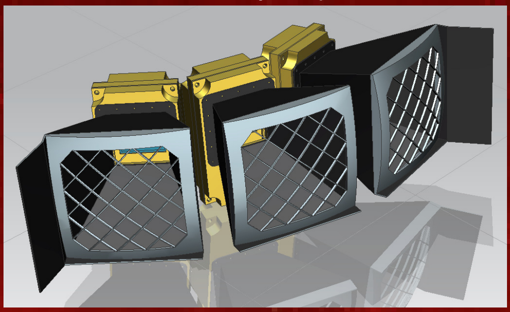
1. Precisely locate the high-energy photon sources of gravitational-wave and neutrino transients and transients located by the new generation of astronomical facilities
2. Reveal the physics underlying the variety in the population of gamma-ray bursts, including high-luminosity high-redshift bursts, low-luminosity bursts and short bursts
3. Discover new high-energy transient sources over the whole sky, including supernova shock break-outs, black-hole tidal disruption events, magnetar flares and monitor known X-ray sources

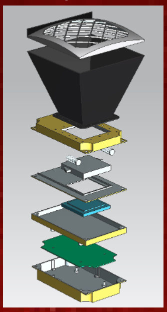




An example mission concept (A-STAR) is shown opposite which used MCP (Lobster) telescopes and a γ–ray coded mask telescope (OWL). Developed for the ESA S-class mission AO in 2012, a modified version of this concept using only Lobster telescopes can be accommodated on a small spacecraft bus for a Vega, Soyuz or Long March launch into LEO. 20 minute exposures would provide all-sky coverage with 2 observations per field day^{-1} and an exposure of 1 Msec per field yr^{-1}.

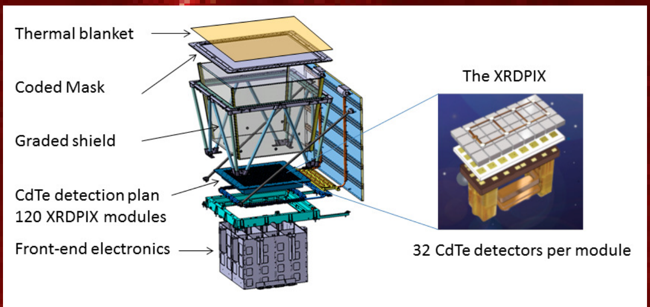
Lobster MCP optics (Leicester + B/I/DK/PL/CH)



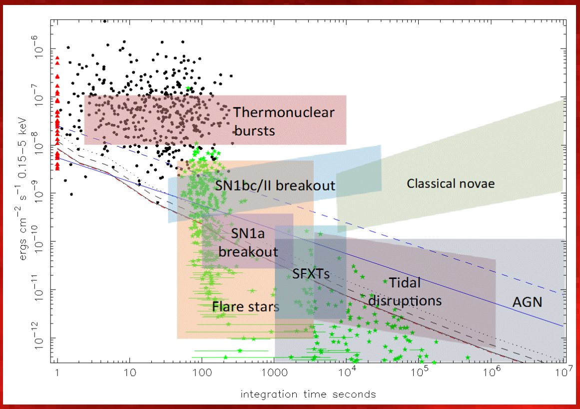


FOV	17° x 52°
Energy band	0.15-5.0 keV
Positions	50% <30″localisation
Sensitivity	4x10^{-11} erg/cm^{-2}/s in 10^{3} sec

Owl coded-mask optics (IRAP, Toulouse & CEA, Saclay)



FOV	60° x 88°
Energy band	4-150 keV
Positions	2-10′ localisation
Sensitivity	2x10^{-10} erg/cm^{-2}/s in 10^{3} sec



A-STAR sensitivity: Blue curves show the Owl 6σ limit for AGN (dashed) and E_{peak}=30 keV GRBs (solid), the lower curves show the Lobster 6.3σ limits for power law spectra of photon indicies 1, 1.5 & 2 (black) and for a 2 keV thermal spectrum (red). Black points are Swift long GRB prompt emission (short GRBs are shown in red without durations), with afterglows shown as green stars. The shaded boxes represent various source types, all of which can be studied in detail using Lobster telescopes.

This type of mission is of great interest to the Chinese and ESA communities. Payload contributions can be provided by both sides (cf. the Lobster telescopes are similar to those proposed for the Chinese Einstein Probe concept). A high-energy transient finder mission will enable sensitive searches for a wide variety of object types over the entire visible sky in the era of multi-messenger transient astronomy.

The background image is a simulated Lobster 1 Msec exposure of the sky around the Crab