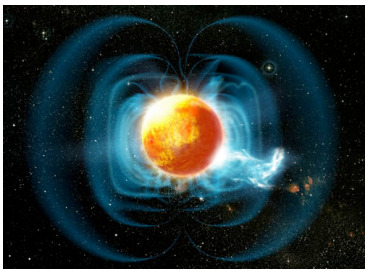
EXIST: Surveying the birth and evolution of Black Holes

Transient *Science Working Group*

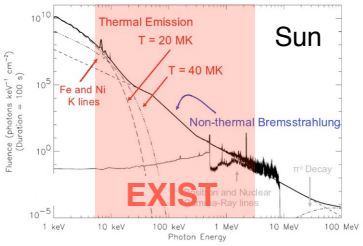
Chair: *Alicia M. Soderberg (Harvard/CfA)*

SUMMARY:
The *EXIST* satellite (PI Grindlay - NASA AMCS) will revolutionize our understanding of X-ray transients in the local Universe with its high sensitivity, arc second localizations, triggering capability, and on-board NIR follow-up. Supernova shock breakout, tidal disruption events, magnetar superflares, and black hole systems are among the sources that *EXIST* will reveal.

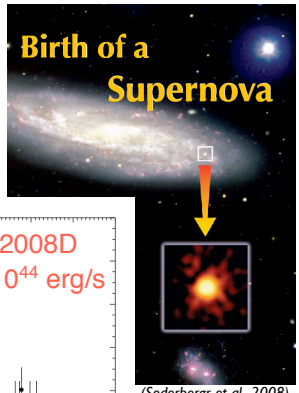
Stellar Magnetic Activity

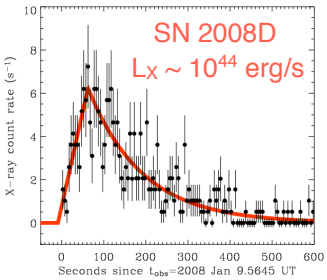


In the Sun, magnetic reconnection leads to strong X-ray emission with two components: a high energy non-thermal component (due to particle acceleration) and a lower energy thermal component (due to plasma heating). Extending from 5 keV to 3 MeV, *EXIST's* High Energy Telescope (HET) will finally enable such two component X-ray studies of magnetic activity for a large sample of flare stars.



Supernova Shock Breakout

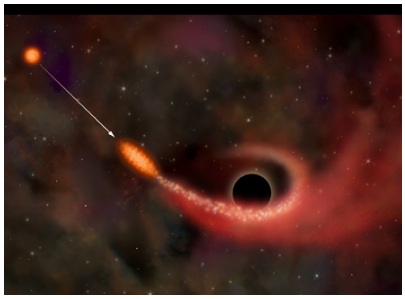




(Soderbergr et al., 2008)

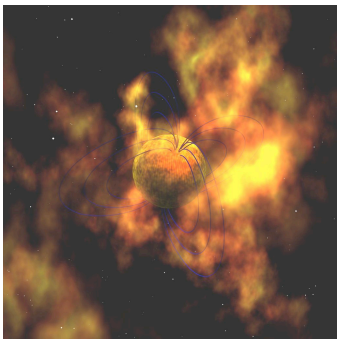
With the serendipitous discovery of an extremely luminous X-ray outburst from SN 2008D came the observational realization that core-collapse supernovae may be discovered *at the exact moment of explosion* thanks to their shock breakout emission. *EXIST's* wide FOV (90 deg), soft X-ray response, and triggering capability will uncover dozens of nearby (d < 200 Mpc) supernovae each year at the exact moment of shock breakout. Moreover, the rise-time of the X-rays provides a direct estimate of the progenitor star radius and a "time-stamp" to aid the search for coincident gravitational waves.

Tidal Disruption Events

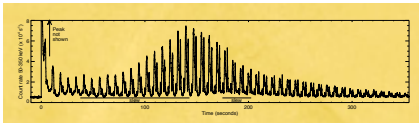


The disruption of a star by a massive black hole leads to prompt X-ray flash (due to compression of star) followed by a long-lived soft X-ray/UV fall-back phase. While such events are rare, the observable signal can provide a direct estimate of the BH mass. *EXIST's* HET will detect ~100 nearby tidal disruption events each year enabling follow-up with the IR Telescope from 0.3 to 2.2 μm. Through this effort *EXIST* can extend the M-σ relation to larger distances.

Magnetar Superflares

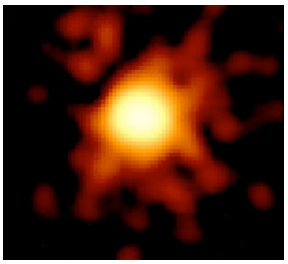


Soft-Gamma Repeaters (SGRs) mark the most dynamic class of isolated neutron stars, giving rise to giant X-ray flares. While their persistent emission is attributed to superstrong magnetic fields, the nature and cause of the flares remains unknown and hotly debated. With only a few SGR giant flares seen to date, progress requires a larger sample. *EXIST's* HET will trigger on a dozen extragalactic SGRs each year and precisely localize the source with its sensitive and high-resolution IRT.



(SGR 1806-20: Palmer et al., 2005)

The Transient Universe



EXIST will serve as an X-ray transient workhorse and factory, opening new discovery space by patrolling the skies for new flavors of high energy transients while also following up ground-based optical transients from large ground-based surveys (e.g. LSST).

Black Hole Populations

EXIST's HET is a poweful black hole (BH) finder that will provide a full census of the local BH population including stellar-mass BHs (through their accretion history), intermediate mass BHs (through their Ultra-luminous X-ray emission), and also supermassive BHs (through tidal disruption events). Moreover, EXIST will reveal the birth cries from newly formed BHs in cosmological gamma-ray bursts. In turn, EXIST will shed light on BH formation channels and map the mass function of the local BH population.

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