22.01
The Advanced X-ray Astrophysics Facility (AXAF): An Overview

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The AXAF is the next major step in NASA's continuing program in X-ray Astronomy. The AXAF will be built around a high resolution (0.5 arc-second), large area (1700 cm² geometric area) Wolter Type I grazing incidence X-ray telescope. The AXAF will be a major national facility and is being developed for 15 years. The majority of the observing time will be available to the entire community through an AXAF Observer Program. The AXAF will be described in detail including the recent results of the AXAF Technology Program.

Supported in part by NASA Grant NAG8-525.

22.02
Energy Balance in Stellar Coronae

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The AXAF will provide an enormous increase in sensitivity for spectroscopy at low and high resolution for soft point sources like stars and binary systems. This capability, which is several orders of magnitude more powerful than previous spacecraft, will permit AXAF to probe physical conditions in the hot plasmas of stellar coronae by measuring temperatures, densities, line widths, and flow velocities. Examples will be given of how AXAF will be able to address the following important questions:

- What is the relative importance of radiation, conduction, and wind expansion on the coronal energy budget, and what are the heating rates for different types of stars?
- What is the distribution of material at different temperatures for different types of stars? Can a simple two-component model (closed magnetic loops and open coronal holes) explain these data, or are coronae more complex?
- How do the coronae of young, rapidly rotating stars differ from older stars? Are the coronae of premain sequence stars just scaled-up versions of solar active regions?
- What are the evolutionary time scales of coronal loops, and do they depend on the convective zone properties?
- Are coronae heated by steady state mechanisms (i.e., MHD waves) or rapid field reconnection (i.e., microflares)?
- What is the time evolution of flaring plasmas on M dwarfs, T Tauris, and RS CVn systems? Is the energy deposited impulsively or gradually? How are flares cooled?
- What are the coronal structure and physical parameters for rapidly rotating (synchronous) binary systems? Do loop structures interconnect stars that do not fill their Roche lobes? Eclipsing systems should provide valuable input.

These questions provide some insight into the impact AXAF can have on our understanding of stellar coronae and their physical processes.

22.03
The MIT X-Ray Spectroscopy Investigation on AXAF

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Two complementary instruments will provide the capability of performing high resolution X-ray spectroscopy on point and extended sources. The High Energy Transmission Grating Spectrometer (HETGS) operates over the range 0.4–8 keV with resolving powers of 100-1000 and effective areas of 10-200 cm². The Bragg Crystal Spectrometer (BCS) gives resolving powers of 200-2000 over the range 0.5-8 keV and 50-70 over 0.14-0.5 keV, with effective areas of 5-50 cm². The HETGS is most effective for studying point or slightly extended sources whereas the BCS operates equally well for point and extended sources. These instruments will make possible the application of plasma diagnostics to the study of optically thin sources. Example of diagnostics for temperature, abundance and ionization state will be given. Such diagnostics can be applied to supernova remnants in our Galaxy and in nearby galaxies, and to gas in galaxies and clusters of galaxies.

22.04
Studies of Isolated Neutron Stars, Pulsars and Pulsar-Driven Nebulae with the AXAF

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Neutron stars may emit X-rays through thermal emission from the surface, magnetospheric (nonthermal) processes, or accretion from the interstellar medium or a companion star. No firm cases of surface thermal emission have been recorded, but the Einstein Observatory detected X-rays from a number of compact objects in supernova remnants: 4 isolated pulsars (including 1 in the LMC), 2 accretion powered sources, and 4 spatially unresolved X-ray sources (neutron star candidates). Centrally brightened, presumably synchrotron nebulae have been found in some 16 supernova remnants (including 3 in the LMC) and around about 3 radio pulsars. The high sensitivity and spatial and spectral discrimination of the AXAF allow important programs in this area including: 1) Detection of surface thermal emission from any neutron stars left by historical supernovae. This observation can provide unique data regarding the early cooling rate of neutron stars and the relation of their formation to supernova type f; 2) Measurements of the temperature and field surface variation in older neutron stars/pulsars. This work will constrain continuing energy sources, such as polar cap heating from magnetospheric discharges, frictional heating from the crust-core interface, and heating in glitches. 3) Searches for accretion-driven binaries in supernova remnants, in order to constrain the statistics of the break up of binaries in supernova explosions. 4) Studies of the magnetic X-ray emission through discovery of more isolated X-ray pulsars. 5) Detailed investigations of the morphology and particle acceleration in X-ray synchrotron nebulae. 6) Surveys for Crab Nebula-like remnants and X-ray pulsars in external galaxies. Such programs, in which the objects studied have the same, known distance, allow more reliable determinations of birthrates and evolution than in our Galaxy.

22.05
The AXAF CCD Imaging Spectrometer Experiment (ACIS)

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The ACIS experiment consists of an array of charge coupled devices (CCD) chips placed at the focus of the AXAF x-ray mirror assembly. The instrument offers an incredible combination of the best qualities of the entire previous generation of Einstein Observatory detectors. The 20 μ pixel size is ideally matched to the 0.5" = 20 μ resolution of the telescope, while the non-dispersive spectroscopy capability means every object image will also produce a spectrum with ΔE/E ~ 50, and quantum efficiency above 50%. In conjunction with the objective gratings the energy resolving power increases to ΔE/E ~ 10⁴ with a loss of efficiency of 50%.

While the great capability of ACIS will naturally make it attractive for a wide variety of AXAF investigations, ACIS has a particular advantage in fields where it can simultaneously acquire imaged spectra of many objects. Examples of rich fields which fit into the 180 sq. min ACIS field include compact star clusters, star formation regions, the nuclear region of M31, Virgo Cluster galaxies and the entire Coma Cluster.

To illustrate I cite a few examples: a single 3 x 10⁴ s observation of Pegasus would measure X-ray emission from every star as bright as the Sun, studying 50 clusters. A similar observation of M31 would find every pulsar, burst