Session 2: Future Space Programs

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EARLY RESULTS FROM THE LOW-ENERGY CONCENTRATOR SPECTROMETER ON-BOARD BEPPOSAX

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1. Introduction

SAX, an acronym for "Satellite Italiano per Astronomia a raggi X", now renamed "BeppoSAX" in honor of Giuseppe Occhialini, is the first X-ray mission sensitive in the very broad energy range between 0.1 and 300 keV (Boella et al. 1997a). The Narrow Field Instruments (NFI) have approximately 1° fields of view and consist of the imaging low- and medium-energy concentrator spectrometers (LECS, 0.1–10 keV, Parmar et al. 1997; and MECS, 1–10 keV, Boella et al. 1997b), and the non-imaging high pressure gas scintillation proportional counter (HPGSPC, 3–120 keV, Manzo et al. 1997) and Phoswich detector system (PDS, 15–300 keV, Frontera et al. 1997). All the NFI are coaligned and are normally operated simultaneously. In addition, the payload includes two wide field cameras (WFC, 2–30 keV; Jager et al. 1997) which observe in directions perpendicular to the NFI. These allow the detection of X-ray transient phenomena, as well as long-term variability studies.

2. The LECS

In order to achieve the extended low-energy response the LECS has an extremely thin (1.25 μm) entrance window and, in contrast to conventional GSPCs, does not have separate drift and scintillation regions, since this would unacceptably compromise the low-energy response (see Parmar et al. 1997). The LECS operates in the energy range 0.1–10 keV, but it is

K. Koyama et al. (eds.), The Hot Universe, 71-74.

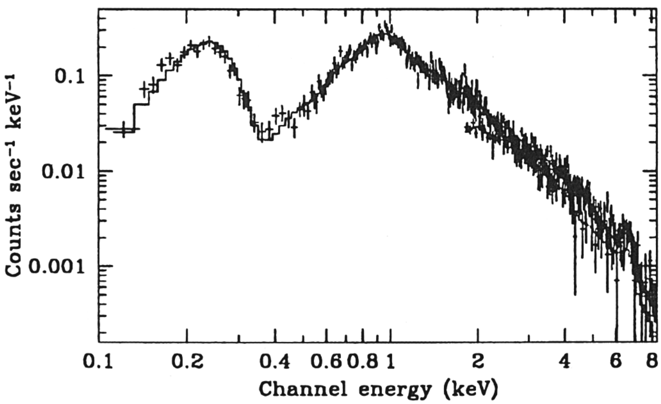

Figure 1. The observed LECS and MECS spectrum of VY Ari, together with the best-fit two temperature MEKAL spectrum.

$\lesssim$0.5 keV where the instrument really comes into its own. Here, it provides better energy resolution than previous non-dispersive instruments such as the PSPC on ROSAT (Trümper 1983), or the SIS on ASCA (Tanaka et al. 1994), as well as providing time resolution of up to 16 μs.

2.1. CORONAL PLASMA STUDIES

In the line-dominated spectra produced by optically-thin plasma in collisional ionization equilibrium, such as in coronal sources, much of the emission is concentrated around and below ~1 keV (which includes the Fe L complex). An example is the LECS spectrum of the active binary VY Ari obtained with a 37 ks exposure on 1996 September 4–6 (Fig. 1; Favata et al. 1997). The LECS, with its good spectral resolution and low-energy response is well suited to the study of such emission. Current CCD detectors such as the ASCA SIS have little response $\lesssim$0.5 keV, and thus miss the intense soft continuum of coronal sources. While proportional counters are generally used at low energies because of their good efficiency, they have significantly worse spectral resolution than the LECS. Thus, the combination of good spectral resolution and low-energy response is allowing the LECS to make a unique contribution to several areas of coronal physics. In particular, results from ASCA show evidence for low metal abundances in many coronal X-ray sources. LECS spectra will allow the accurate determination of metal abundances using different diagnostics than with ASCA.

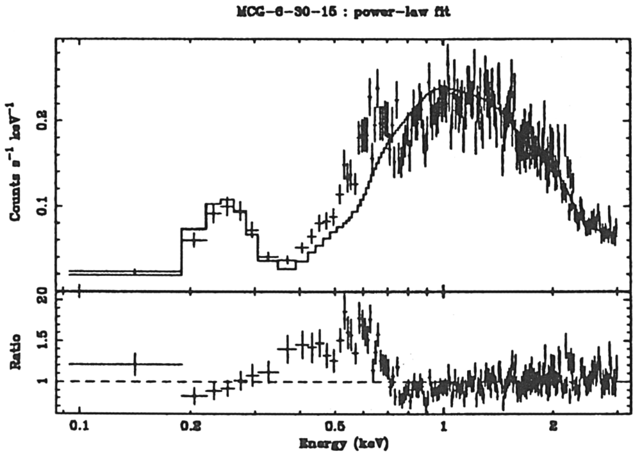

Figure 2. The LECS spectrum of MCG-6-30-15 fitted with an absorbed power-law model.

In particular, the ratio between the line-free continuum at low-energies and the strength of the Fe emission complex $\simeq$1 keV is a sensitive diagnostic of the metal abundance.

2.2. WARM ABSORBERS IN AGN

Figure 2 shows the LECS spectrum of the bright Seyfert 1 galaxy MCG-6-30-15 obtained during a 49 ks exposure on 1996 July 29 to August 3 (Orr et al. 1997). The X-ray spectrum of this object is complex and can be well studied by the good spectral resolution and broad-band coverage of BeppoSAX. An absorption feature due to partially ionized O (the "warm absorber") is visible. Studies of this feature can provide information about the location and properties of the material surrounding the active nucleus as well its relation to the ionizing continuum. The continuous line in Fig. 2 shows an absorbed power-law model. Large residuals due to a blend of O VII and O VIII. absorption edges are clearly seen below 1 keV.

2.3. COMETARY X-RAY EMISSION

The LECS detected low-energy X-ray emission from Comet Hale-Bopp on 1996 September 10–11 (Owens et al. 1997). While this may be unsurprising, given earlier ROSAT observations of X-ray emission from Hyakutake and at least four other comets (Lisse et al. 1996), the mechanism for producing cometary X-rays remains unclear. Two leading models are charge exchange

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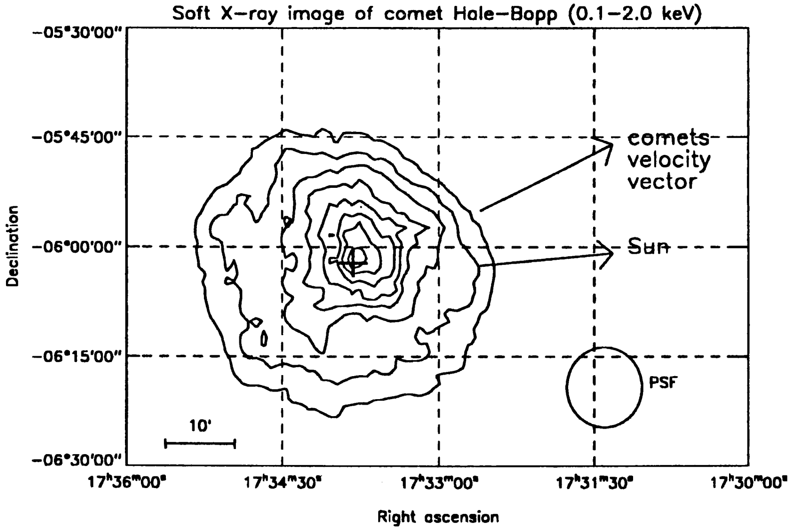

Figure 3. A contour plot of the X-ray emission observed from comet Hale-Bopp. The position of the nucleus is indicated by the cross.

excitations of highly ionized solar wind ions with neutral molecules in the comet's atmosphere and the scattering, fluorescence and bremsstrahlung of solar X-rays in attogram (10^{-18} g) dust particles.

The bulk of the emission detected by the LECS originates on the sunward side of the comet, in agreement with ROSAT images of comet Hyakutake. The extent of the emission is consistent with the LECS point spread function (PSF) of 9.5′ FWHM at the mean energy of the detected emission, although the width normal to the Sun-nucleus axis appears wider than in the direction of motion. The 68% confidence limit to any source extent is <6.5′. The LECS spectrum is equally well fit by a thermal bremsstrahlung with temperature 0.29±0.06 keV or a power-law with photon index $3.1\pm^{0.6}_{0.2}$.

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