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Observation of hard X-ray emission from extragalactic sources 3C 273 and NGC 5506 in 20-200 keV band

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Abstract. We report spectral measurements of the bright QSO 3C273 and the AGN source NGC 5506 made during a balloon flight experiment using high sensitivity scintillation counter telescope LASE, operating in the 20-200 keV energy band. The observations were made on Nov. 20, 1998 from Hyderabad, S. India. The observed spectrum for 3C 273 and is best fitted with a power law of the form $\frac{dN}{dE} = KE^{-\alpha}$ and the measure luminosity compares with earlier measurements by SIGMA and OSSE satellites. The observed spectra of NGC 5506 was found to be very hard although the total luminosity was much lower than the earlier observations and is consistent with the time variability of the AGN sources, Spectral data is discussed in terms of non-thermal emission models and X-ray emission geometry.

1. Introduction

The LASE hard X-ray telescope is a large area scintillation counter instrument with a modular design and is optimized to make spectral and fast temporal measurement of cosmic X-ray sources in the 20-200 keV energy band with very high sensitivity. In its present form balloonborne payload consists of three modules of scintillation detectors having both passive and active shielding and fitted on a fully steerable alt-azimuth mount. Each of the detector modules has a geometric area of 400 cm^2 and is specially configured in a back-to-back geometry consisting of a 3 mm thick single crystal placed above a similar detector of 30 mm thickness and the two crystals are optically decoupled by a thin aluminium foil. The thickness of the two components is carefully optimized to give better shielding with less detector volume and low dead time. The field of view of each module is 4.5° x 4.5° and is made with specially designed sandwiched material of tin, copper and lead. All modules have independent event-selection logic, and a 127 channel PHA analyzer and the arrival time of the accepted events is recorded with a time resolution of 25 μsec. The overall observed energy resolution for 60 keV photons from Am-241 is 35% in each module and the 3σ threshold sensitivity of the LASE telescope in the entire energy range upto 200 keV is ~ 1.5 x $10^{-6} cm^{-2} s^{-1} keV^{-1}$ for a source observation of 10^4 sec. The details of payload are given in D'Silva et al. (1998).

The LASE payload was launched successfully from the Hyderabad Balloon facility on Nov. 22, 1998 at 0531 IST and reached an altitude of 3.3 mbars. A number of X-ray sources were observed and detected during the 7 hrs float period at the ceiling altitude. In this paper, I present the spectral data for the two AGN X-ray sources namely 3C273 and NGC5506. The data on the other galactic sources observed during this experiment will be described elsewhere.

2. Results

The source observations in each case were preceded and followed by off-source measurement from a nearby source from region. An excess count rate spectrum was detected for each source

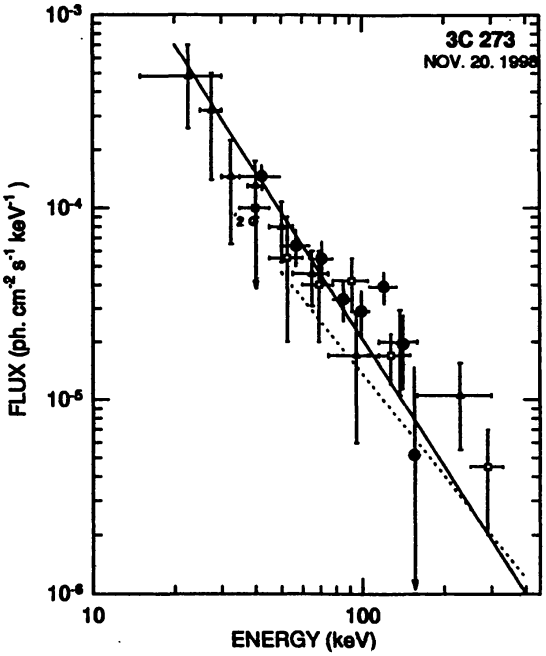

Figure 1. Hard X-ray spectrum of 3C 273. □, the SIGMA observations, △, the MIFRASO data and • represent the present observations. The dotted line represents the OSSE data at high luminosity state of the source. The solid line in the figure gives the best fit power law spectrum to the present data.

and corrected for the atmospheric absorption including multiple Compton scattering effects, window transmission and detector response functions. The spectra from all the three detectors were co-added to improve the statistics of the measured fluxes.

3C 273

The total number of excess counts in all detector correspond to 12418 during a source observation of 3540 sec and corresponds to a statistical significance of 20σ in the 35 to 160 keV energy band. The observed photon spectrum is shown in Figure 1. The best fit power law is given as; $dN/dE = 0.94\ E^{-2.26\pm0.07}$ with a reduced χ^2 value of 0.2 corresponding to 7 degrees of freedom The power law fit is shown in the figure with solid line. Other data shown in the figure corresponds to the observations by SIGMA-Granat mission (Bassani et al., 1989) and OSSE

(Johnson et al., 1995) detector on-board Compton/GRO observatory. It is seen from the figure that present values of spectral flux in various energy bins has one-to-one match with the SIGMA and MIFRASO data (Bassani et al., 1992). The present data is also consistent with the high-state observations from OSSE data shown in dotted line in the figure. The figure also indicates that normal luminosity state of the source is generally 'high' and the low X-ray flux is observed only on rare occasions. The best spectrum obtained from the present observations is also consistent with the data in the gamma ray energy up to 1000 GeV (Manchanda - *in preparation*).

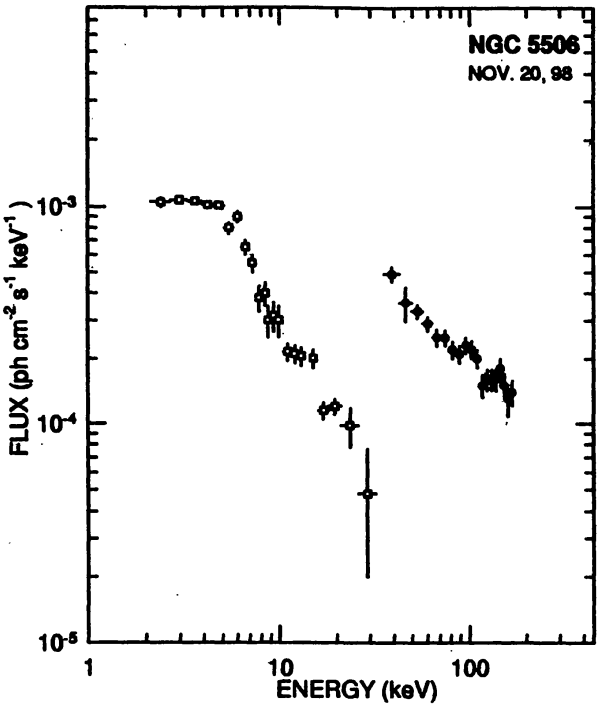

Figure 2. Hard X-ray spectrum of NGC 5506. □ HEAO-A2 and • LASE observations.

NGC 5506

NGC5506 is a bright Seyfert 2 galaxy and is the very first AGN to be observed in the 15-180 keV energy band in 1969 (Manchanda et al., 1971). The source is also classified as NELG, due to the presence of narrow emission line. Unlike many Seyfert 1 members like NGC4151, MCG8-11-11 for which the hard X-ray variations have been studied in detail, the total available hard X-ray data on the this source is limited. This is mainly due to the fact that in general, the hard X-ray emission in the Seyfert 2 galaxies is much lower than the Seyfert 1 type AGNs. The low energy observations of NGC 5506 below 3 keV and in the 2-18 keV band by Ginga data indicate a variable intensity from the source with a occasional soft excess and a hard tail. It has also been noted that unlike classical Seyfert 2 galaxies, NELG members also exhibit the Seyfert 1 type variable luminosity consistent with the partial covering model for these sources.

The combined total excess from the source during present observation in all the detectors was 72000 counts in 4200 sec on source tracking and corresponds to a statistical significance of 117 σ signal above the background. The combined spectrum of the source is shown in figure 2. The data in figure is best fitted to a power law photon spectrum with a spectral index $\alpha \sim 1.1 \pm 0.2$ and is shown in the figure with a solid line. This data is in complete contrast with the earlier spectral measurement by HEAO-A2 made in 1978 and Ginga in 1988 shown in the figure for comparison. No other spectral data is available for comparison. The light curve from the ASM data on board RXTE satellite show that the source intensity in the 2-10 keV was a factor of 3-4 higher on the day of present observations and is seen in the figure 3a. The epoch corresponding to our observation is marked by an arrow in the figure. The X-ray source fiux in the 2-10 keV from the archival data between 1972 and 1991 is also shown in the figure 3b. The data is taken from Polleta et al., 1996. It is clearly seen from these observations that NGC 5506 exhibits intensity variations similar to Seyfert 1 and which is generally explained on the basis of partial covering model (Mushotzky, 1982).

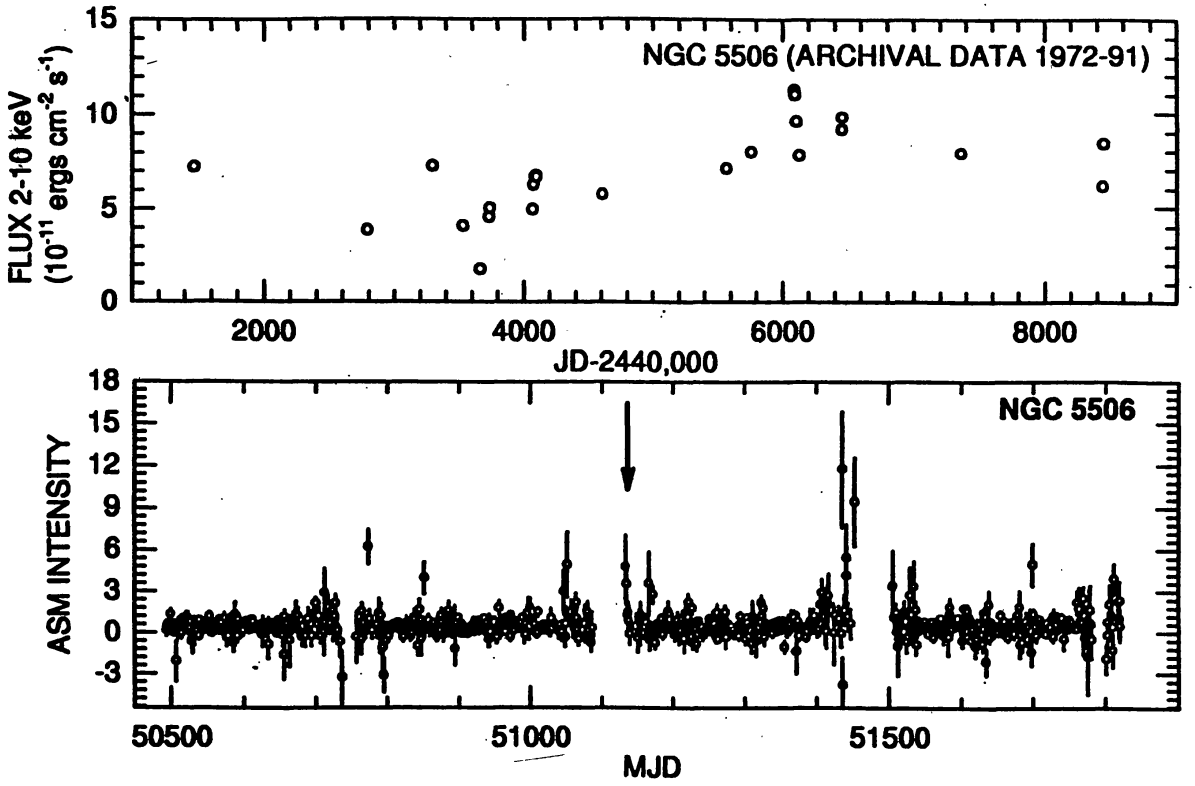

Figure 3. a. ASM light curve of NGC 5506. b. Observed flux variation of NGC 5506 in the archival data.

The observations of a clear extremely hard power law spectrum in the 30-180 keV energy band in the present measurements, coupled with the increased activity of the X-ray source as seen in ASM data suggests that hard X-ray observations may be better explained by the Comptonized spectrum from seed photons as proposed by Maraschii et al. (2000). In a tenuous plasma, multiple scattering controls the energy exchange between electron and photon, since the bremstrahlung and recombination losses are $\propto \rho^2$ and Thompson scattering goes as $\propto \rho$; where

ρ is the number density. If $4kT_e > h\nu$, the seed photons will be upgraded in energy and the emergent spectrum develops into a unified power law from the ensemble of spectra produced by photons scattered by differing number of times. For example, with kT_e ~27 keV, and input seed photon with 1 keV energy requires about 20 scatterings to reach the maximum value of $3kT_e$ ~81 keV. A small change in the energy of seed photons and the electrons can radically shift the spectra to higher energies.

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