Bull. Astr. Soc. India (2000) **28**, 271-273

Hard X-rays and gamma rays from the Be star LSI +61° 303

Krishna M. V. Apparao
Department of Physics, University of Bombay, India

Abstract. The hard x-ray flux resulting from inverse Compton scattering of photons from the Be star by the high energy electrons responsible for the radio emission, is calculated and compared with observation.

1. Introduction

LSI +61° 303 is a binary system containing a Be star and a compact star (neutron star?). The binary period is 26.5 days. It emits radio radiation and also x-rays and gamma rays. The strength of x-ray and gamma ray emission is given below (Tavani et al., 1996)

Soft x-rays (0.5-4 keV) with energy $E_{SX} \sim 10^{34}$ ergs s^{-1}

Hard x-rays (20-200 keV) with energy $E_{HX} \sim 5 \times 10^{34}$ ergs s^{-1}

Soft γ-rays (1-30 MeV) with energy $E_{S\gamma} \sim 10^{35}$ ergs s^{-1}

Hard γ-rays (>30 MeV) observed but association with source doubtful.

The x-ray emission is correlated with radio emission. The soft x-rays originate from accretion of gas from the Be star envelope on to the compact object. However since the hard x-ray luminosity is larger than that of the soft x-rays, its origin is different, and here we suggest that it is from the inverse Compton scattering of the photons from the Be star, by the high electrons responsible for the radio emission.

2. Inverse Compton scattering calculation

The Radio emission from the source is attributed to an expanding cloud of high energy electrons accelerated near the periastron of the compact object orbit and released in the polar direction. The observed radio flux spectrum is of the form $N=K\nu^{-\alpha}$, where K and α are constants and ν is the radio frequency in units of Hz; N is in units of ergs s^{-1} cm^{-2} Hz^{-1}. The spectrum of electrons responsible for the radio emission by the synchrotron process is $N_e=K_eE^{-p}$, where E is in units of erg and N_e is number per cm^3. $p=2\alpha+1$. K_e is then given by

$$K_e = \frac{4\pi K(6.26\times10^{18})^{(1-p)/2}}{1.17\times10^{-22}\,\alpha(p)\,B^{(p+1)/2}} \tag{1}$$

where B is the magnetic field in Gauss and $\alpha(p)$ is a slowly varying function given by Lang(1980). The surface temperature of the Be star (B0V) T=31500°k. The power in the inverse Compton scattered photons (Rybicki and Lightman 1979) is given by

$$\frac{dE^{IC}}{dVdtd\bar{\varepsilon}_s} \quad \frac{C\ 8\pi^2 r_0^2 (kT)^{(p+5)/2}\ F(p)\ \varepsilon_s^{-(p-1)/2}}{h^3c^2} \tag{2}$$

where h is the Planck constant, k is the Boltzman constant, c is the velocity of light and r_0 is the classical radius of the electron. V is the volume of emission and C is given by

$$C = K_e/(mc^2)^{p-1}\ V \tag{3}$$

F(p) is given by Lang (1980). The peak radio flux at 10 ghz is ~250 mJy (Tavani et al. 1996). The inverse Compton photon spectrum is calculated using these values and B=1G (Paredes et al.,1991) and is

$$N_{HX}\ (\varepsilon_s) = 2.7\times10^{-5}\ \varepsilon_s^{-2}\ \text{photons cm}^{-2}\text{s}^{-1}{}_{\text{MeV}}{}^{-1} \tag{4}$$

Here the photon energy ε_s is in MeV and α=1. This spectrum is plotted in Fig. 1. The spectrum

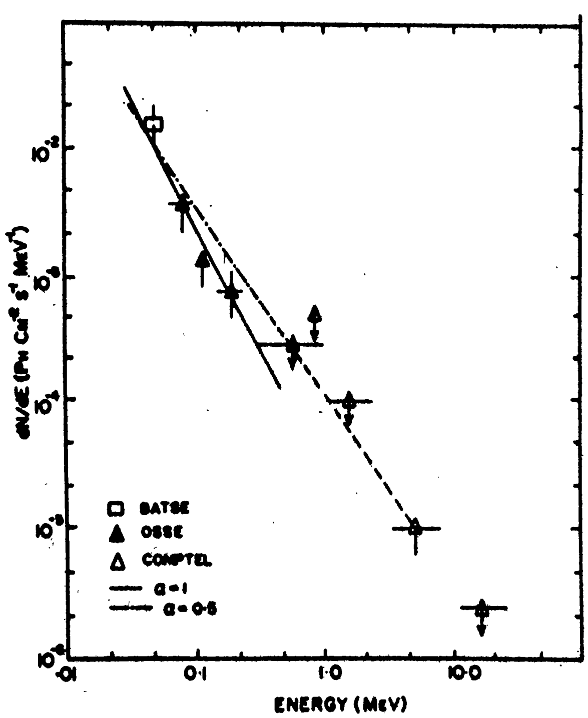

Figure 1. The hard x-ray and gamma ray spectrum of LSI +61°303. The lines correspond to the calculations of the inverse Compton scattering of the Be star photons by the radio electrons. The two lines correspond to two values of spectral index of the radio electron spectrum as indicated.

for α=0.5 is also calculated in Fig. 1. It is seen that the spectrum obtained for α =1 agrees with the hard x-ray observations. It is interesting that the extension of the α=0.5 spectrum explains the soft gamma ray observations. However electrons with $E/mc^2 > 150$ cannot survive the Be star photon field. These electrons are however accelerated and live for a time; the calculation incorporating this aspect appears elsewhere.

The hard gamma rays observed may not be from LSI +61° 303 as the quasar 0241+62 is quite close and within the error circle of the gamma ray instrument. However hard gamma rays can be produced in the system. The compact object passes through the Be star gas envelope at supersonic speed in its binary motion, and the shock can accelerate high energy protons. These protons in turn can produce hard gamma rays by nuclear interactions. This flux need to be calculated.

References

Lang K. R., 1980, Astrophysical Formulae, Springer Verlag, New York.

Tavani M. et al., 1996, Astr. Astrophys. Suppl. Ser., 120, 243.

Rybicki G. B., Lightman A. P., 1979, Radiative Processes in Astrophysics, John Wiley and Sons, New York.

Paredes J. M., Marti J., Estella R., Sarrate J., 1991, Astr. Astrophys, 248, 124.