Predictions of inverse Compton radiation from PSR B1259−63

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1. Introduction

Unpulsed high energy (TeV) emission has been detected from several isolated pulsars (Aharonian 1999) and presumably results from relativistic electrons accelerated at the termination shock of an MHD wind driven by the pulsar itself. These electrons inverse Compton scatter target photons from either the cosmic microwave background, or from their own synchrotron radiation.

The rotation-powered binary pulsar PSR B1259−63 (Johnston et al. 1996) is also thought to drive an MHD wind, and the synchrotron radiation of electrons accelerated at its termination shock is probably the source of the unpulsed X-rays seen from this object by ROSAT, OSSE and ASCA (Tavani & Arons 1997). Compared to the isolated pulsars, however, the the pulsar's Be-star companion provides an energy density of target photons available for inverse Compton scattering which is some 11 orders of magnitude larger. Using delta-function approximations to the emissivities and a monochromatic approximation to the spectrum of the target photons, we modelled the observed X-ray synchrotron emission and predicted the TeV emission in a recent paper (Kirk et al. 1999). In this contribution we improve these calculations in two respects – by treating the target spectrum more precisely, as described in the companion paper (Ball & Kirk 1999), and by relaxing the approximations made in the emissivities.

2. Results

A typical model spectrum is shown in Fig. 1. Here, it is assumed that the shocked electrons cool by radiating before expansion losses have a chance to intervene. A magnetic field at the shock of 0.32 G is taken, so that the energy density of the target photon field exceeds that of the magnetic field by a factor of 100. Nevertheless, because most of the scattering events lie in the Klein-Nishina region, the energy radiated in gamma-rays only slightly exceeds that emitted
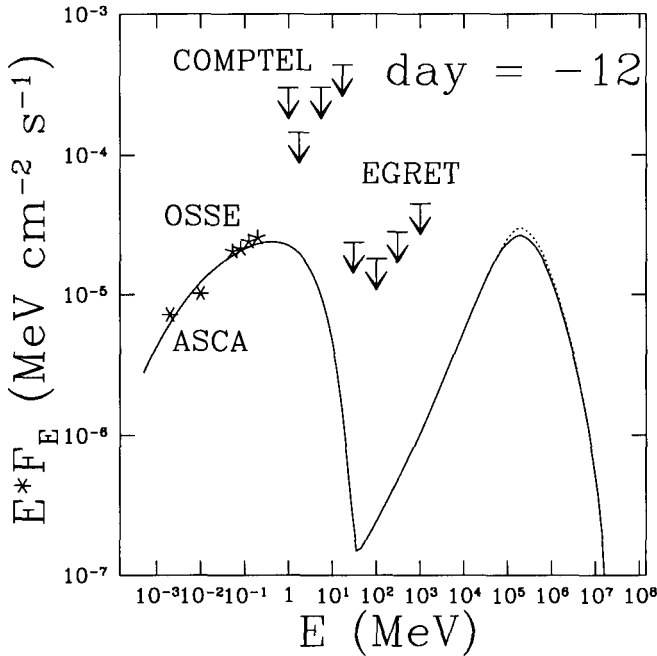
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Figure 1.   The predicted spectrum 12 days before periastron.

as synchrotron radiation. The Lorentz factor of the electrons and positrons in the cold pulsar wind is assumed to be 5×10^6, which is spread out at the shock amongst isotropically directed electrons with a power law distribution $(n_e \propto \gamma^{-1.4})$ over a range of Lorentz factors up to $\gamma_{max} = 4 \times 10^7$. It is interesting to note that if electrons of such a high Lorentz factor are indeed present in the source, the EGRET upper limits imply a modest magnetic field strength, which guarantees a substantial gamma-ray (TeV) flux. The predicted flux level lies well above the sensitivity of the new CANGAROO imaging Čerenkov telescope (Matsubara 1997).

References

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