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ANALYSIS OF THE SPECTRAL ENERGY DISTRIBUTION FROM A RUNAWAY STAR BOW SHOCK

C. S. Peri,[1,2] A. T. Araudo,[1,2] P. Benaglia,[1,2] G. E. Romero,[1,2] and J. Martí[3]

The bow shock produced by the high-mass runaway star BD +43° 3654 (Comerón & Pasquali 2007) has been detected as a non-thermal radio source ($S_\nu \propto \nu^{-\alpha}$, $<\alpha>=0.5$) and it is the first one of that type ever observed (Benaglia et al. 2010). The non-thermal detection provides evidence of the presence of a magnetic field and relativistic electrons. This population of relativistic particles can produce high-energy (HE) emission.

• Model of the source. The combination of the stellar wind terminal velocity ($v_\infty \sim 2300$ km s^{-1}) and the movement of the star produces the bow shock observed in many runaway stars. This structure is composed of two shocks: a forward (radiative) shock in the interstellar medium (ISM) and a reverse (adiabatic) shock (RS) in the stellar wind. The shocked material of the ISM is accumulated into a dense thin layer whereas the shocked wind forms the most extended part of the bow shock. In the surface discontinuity between these two regions, hydrodynamical instabilities can grow up and mix the ISM and wind materials.

In the presence of a magnetic field and a shock wave charged particles can be accelerated up to relativistic energies by Fermi mechanism. We considered that electrons (e^-) and protons (p) are accelerated in the RS. These particles are injected in the bow-shock region following a power-law energy distribution. We used the spectral index derived from radio observations, $\Gamma=2\alpha+1=2$. We assumed equipartition between the magnetic and relativistic particles energy densities. The magnetic field in the bow-shock region results $B_{\rm eq} \sim 10^{-4}$ G.

• Bow-shock non-thermal emission. Relativistic particles interact with matter, magnetic and photons fields, and produce non-thermal emission. In the case of synchrotron radiation we used the value $B_{\rm eq}$. Infrared photons emitted by the dust heated by the radiative shock are the most important target for inverse Compton (IC) scattering. To estimate relativistic Bremsstrahlung and proton-proton (pp) emission we fixed the density of the shocked medium in the bow-shock region in $n = 100$ cm^{-3} (Kobulnicky et al. 2010). We found that the most important losses are due to the convection of particles from the emitting region. Thus, the maximum energy of e^- and p has been derived comparing the acceleration and escape losses, getting $E_{\rm max} \sim 10$ TeV.

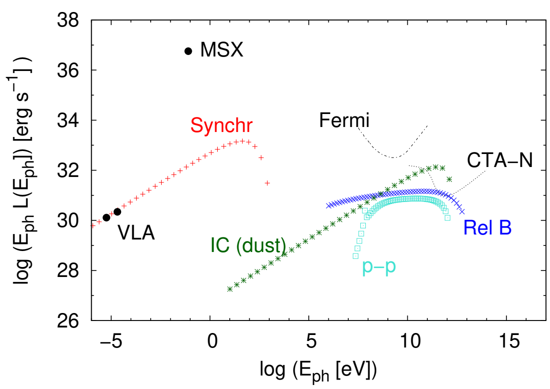

Fig. 1. Spectral energy distribution. The measured flux densities (VLA and MSX) and the sensitivity of Fermi and CTA-North are also plotted.

• Results and discussion. We calculated the spectral energy distribution considering the radiative processes mentioned above (Figure 1). At HE the spectrum is dominated by IC emission. The detectability of the source at HE, by instruments like Fermi, depends on the medium density n and the contribution of secondary $e^\pm$. The pp contribution extends into the TeV regime, but is weak and it will be dificult to observe with ground-based telescopes like VERITAS or MAGIC II. Radio polarization data can provide additional information on the magnetic field. X-ray observations can be useful to determine the cutoff of synchrotron spectrum and the maximun value of the e^- energy. This value would help us to test the correctness of the equipartition hypothesis.

[1]Instituto Argentino de Radioastronomía, CCT-La Plata, CONICET, C.C.5, (1894) Villa Elisa, Buenos Aires, Argentina (cperi@fcaglp.unlp.edu.ar).

[2]Facultad de Ciencias Astronómicas y Geofísicas UNLP, Paseo del Bosque S/N, B1900FWA La Plata, Argentina.

[3]Departamento de Física (EPS), Universidad de Jaén, Campus Las Lagunillas s/n, 23071 Jaén, Spain.

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