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Hadronic acceleration and obscuration in η Carinae at TeV energies

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Abstract content

The η Carinae binary system hosts one of the most massive stars and has the highest known mass-loss rate. This dense wind encounters the much faster wind expelled by the stellar companion, dissipating mechanical energy in the shock. In these regions, particles are accelerated to very-high-energies via diffusive shock acceleration and subsequently cooled via inverse-Compton and photo-pion production, emitting γ-rays already detected by the Fermi-LAT satellite. The low-energy spectrum cuts off at 10 GeV and can be explained with a pure leptonic or mixed lepto-hadronic model. The presence of a second component, clearly visible around periastron 2009, can likely be explained via hadronic photo-production. Particle-in-cell hydrodynamic simulations predict a proton spectra variability along the orbit, with a cut off of few 100 TeV at periastron and few TeV at apastron. The intrinsic π_0 decay spectrum is a complex convolution of the maximum energy, luminosity, particle drift and obscuration. The out going TeV photons interact with the huge pool of anisotropic UV photons, emitted by the two luminous stars, creating $e^+ - e^-$ pairs. This effect is maximized at periastron, due to the higher particle density and the higher intrinsic cut off, and it heavily modifies the observed γ-ray spectrum. Quick variations of the optical depth are expected due to the moving shape and position of the shock with respect to the two stars along the orbit, and the changing density structure of the gas along the line of sight. The predicted γ-ray spectrum is consistent with the recent HESS detection. Thanks to its deep sensitivity, CTA could monitor the high-energy flux variations starting from > 30 GeV with an unprecedented resolution of few days. Furthermore, the wide energy range that CTA can probe could help to disentangle the intrinsic high-energy cut off of the π_0 spectrum from the $\gamma - \gamma$ absorption, expected to play an important role at lower energies, providing unique additional constrains on the model parameters, geometry and magnetic field configuration, that will help unveil the nature of the high-energy component and its acceleration mechanism.

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