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A Self-regulating Stochastic Acceleration Model of Pulsar Wind Nebulae

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Pulsar wind nebulae (PWNe) are clouds of the magnetized relativistic electron/positron plasma supplied from the central pulsar. Broadband emission from radio through PeV gamma-rays is produced by high-energy particles accelerated at the termination shock of the relativistic pulsar wind. However, the number of radio-emitting particles inside a PWN is larger than the expectation from the study of pulsar magnetospheres and then their origin is still unclear. In this presentation, we discuss the stochastic particle acceleration by the turbulence inside the PWN (particle diffusion in momentum space). A stochastic acceleration of externally injected particles by a turbulence inside the PWN is proposed by our previous studies [1,2]. The previous stochastic acceleration model of the PWN broadband spectra is improved by considering the time evolution of the turbulent energy and then the total energy balance inside a PWN is maintained. The turbulent energy supplied from the central pulsar is wasted by the backreaction from the stochastic particle acceleration and the adiabatic cooling according the PWN expansion. The model is applied to the Crab Nebula and reproduce the current broadband emission spectrum, especially the flat radio spectrum (Fig. 1) although time evolution of the turbulent energy (diffusion coefficient) is a bit complicated compared with our previous studies (Fig.2), where we assumed an exponential behavior of the diffusion coefficient.

References
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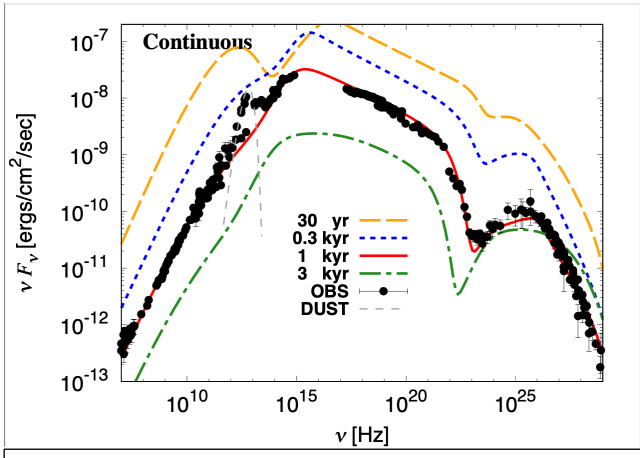

Fig. 1. The spectral energy distribution of the Crab Nebula are plotted for different ages, 30 yr (yellow dashed), 300 yr (blue dotted), 1 kyr (red solid) and 3 kyr (green dot-dashed), respectively. The current age of the Crab Nebula is 1 kyr and the black points are the observed flux of the Crab Nebula.

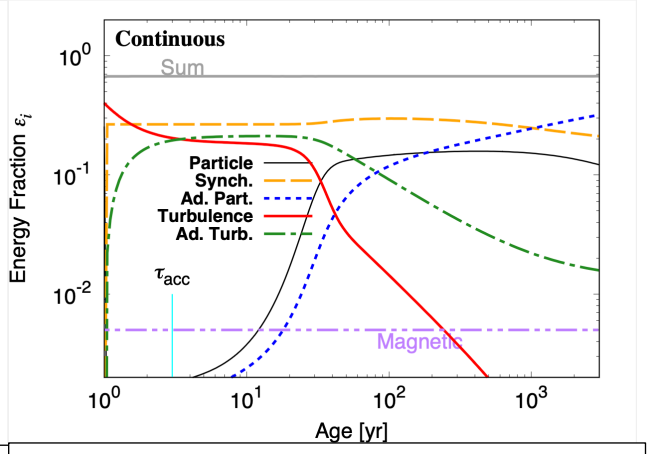

Fig. 2. Evolution of the fraction energy (the energy is normalized by the total injected rotational energy from the Crab pulsar) inside the Crab Nebula are plotted for different components. The red line is the turbulent energy.