

Superbubbles as Galactic PeVatrons: The Potential Role of Rapid Second-Order Fermi Acceleration

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Superbubbles are now one of the few remaining potential PeVatron candidates in the Galaxy, based on the identification of the Cygnus Cocoon as a LHAASO identified PeVatron and Westerlund 1 as a very powerful TeV gamma-ray source with a large shell-like morphology. At the moment, it is not clear how superbubbles accelerate particles to PeV energies. Recent focus has been on the role of the collective cluster wind termination shock which could accelerate particles through first order Fermi acceleration. However, it is not clear whether the termination shock is powerful enough or even always existent. A termination shock may explain the shell-like morphology of Westerlund 1, but then requires a leptonic origin of the gamma-ray emission. In this talk I will argue that second-order Fermi acceleration in the tenuous region outside the termination may be fast enough to accelerate particles to the PeV domain. What is required is a large Alfvén velocity ($V > 500$ km/s), caused by the tenuous density, and a high level of magnetic-field turbulence. For the latter cosmic-ray containment estimates based on gamma-ray observations provide evidence.

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Session Classification: Particle acceleration and propagation