The cosmic ray content of superbubbles

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Most massive stars are believed to be clustered. Their feedbacks (stellar winds and supernova explosions) carve superbubbles in the surrounding medium.

We model particle acceleration in superbubbles, including diffusive shock acceleration at wind termination shocks, expanding supernova remnants, as well as the stochastic acceleration in turbulence.

The reacceleration mechanisms efficiently transfer the mechanical energy of the stars into non-thermal particles. The energy density of cosmic rays in superbubbles is expected to be high and the feedback of the particles onto the shock and the turbulence must be taken into account.

The spectra display a typical hard/soft transition with a bump around 1 GeV. Low energy bands are shaped by the stochastic reacceleration in turbulence while high energy bands are modulated by the escape of the particles from the superbubble. The supernovae are generally not frequent enough to sustain these physical processes and the production of cosmic rays is intermittent.

The average escaping fluxes tend to be steeper than that of isolated supernova remnants ($E^{-2.2}$).