Nonlinear particle reacceleration by successive shocks

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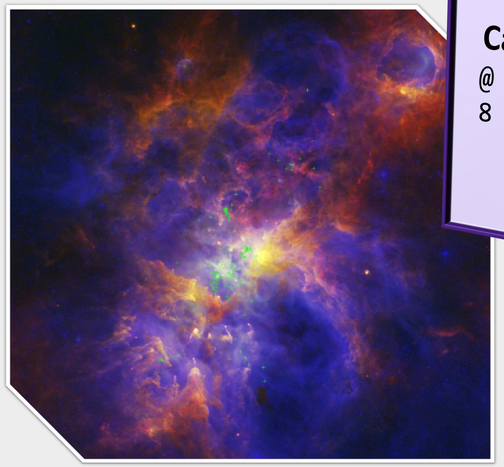
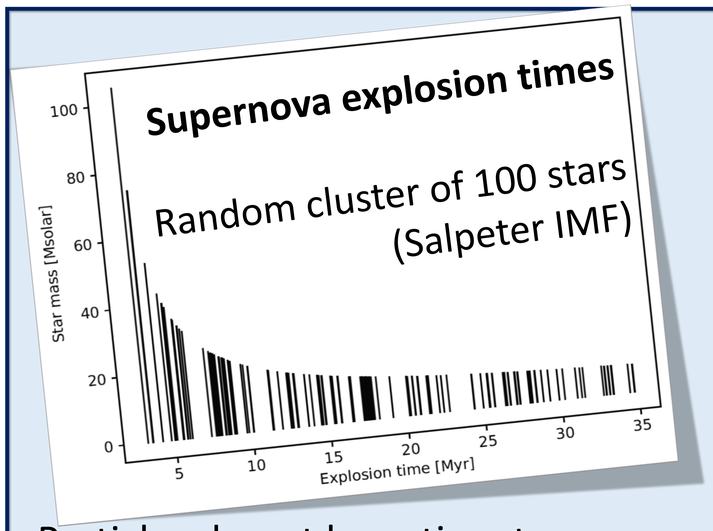


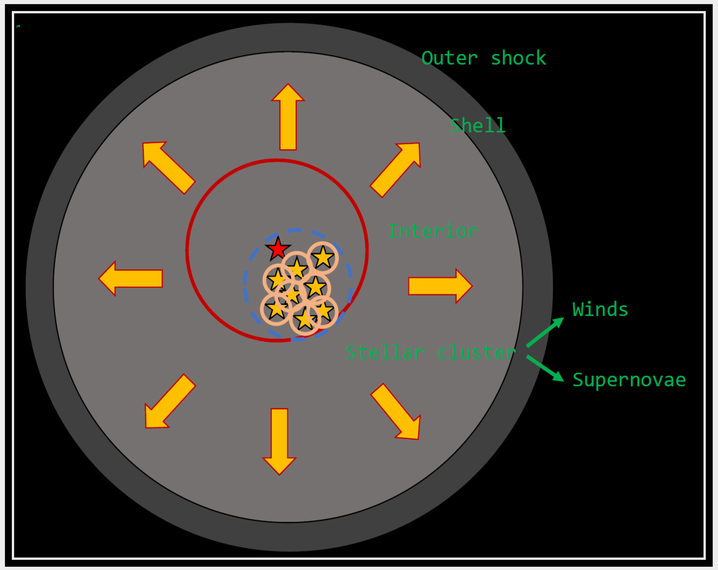
Carina nebula
@ 2.3 kpc
8 clusters
- 100 stars
- Cavities

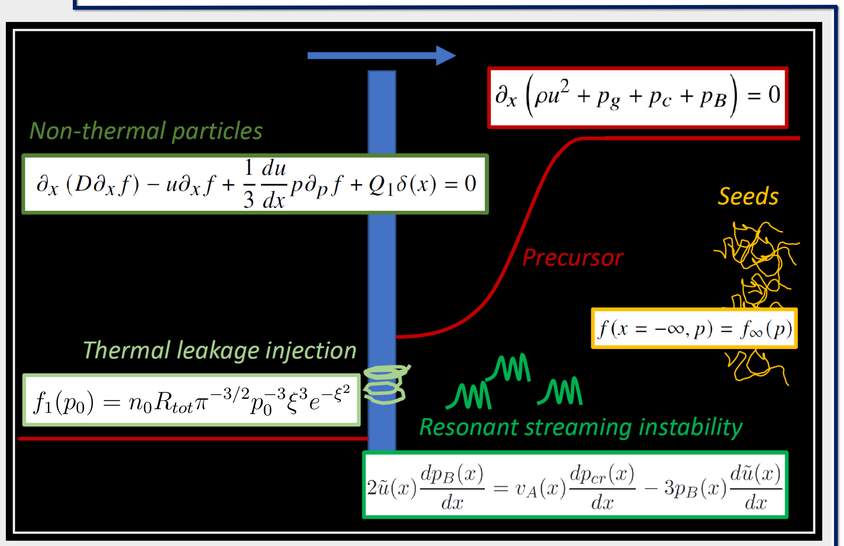
Blue: red optical
Green: Hershel 70 µm
Red: Hershel 160 µm
Preibisch et al. 2012

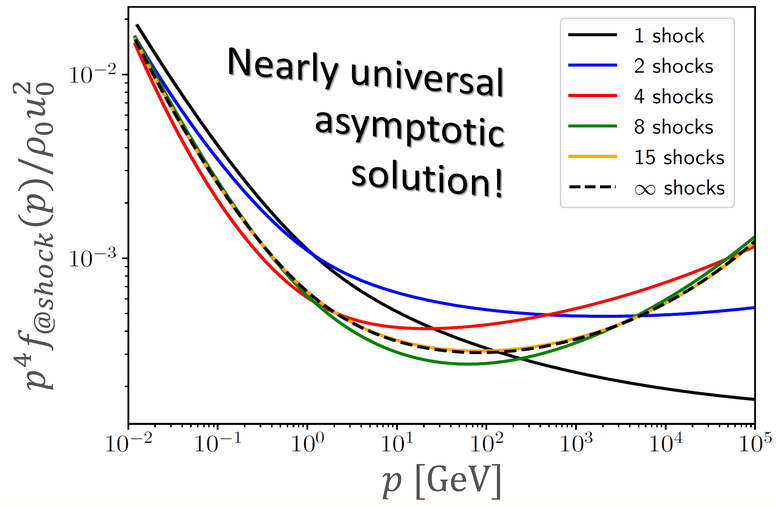
Superbubble: Low density expanding cavity

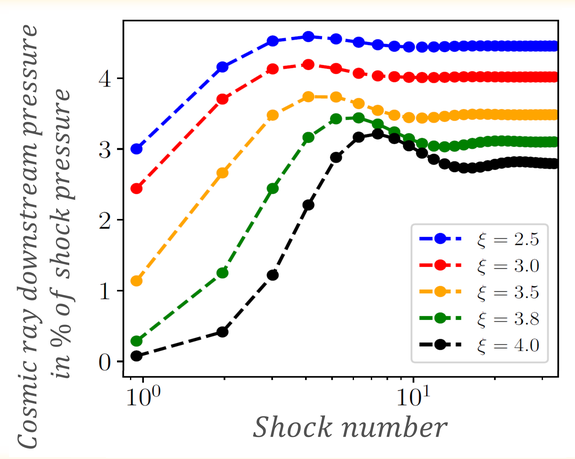


Particles do not have time to escape
➢ **reacceleration**!









Saturation downstream at few % ∀ efficiency

Leakage upstream

CONCLUSION: To respect the energy balance between shocks and cosmic rays, nonlinearities must be tackled when solving shock reacceleration. The spectrum is nearly universal after a few successive shocks, with a concave shape (p^{-5} at low energy, $p^{-3.5}$at high energy).