

New Insights on the Origin of Cosmic Rays

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I present the results of large kinetic (particle-in-cells) plasma simulations of particle acceleration at non-relativistic collisionless shocks, which in particular allow a first-principles investigation of diffusive acceleration at the blast waves of supernova remnants, the most prominent sources of Galactic cosmic rays (CRs). Ion acceleration efficiency and magnetic field amplification are obtained as a function of the shock properties and compared with theoretical predictions, multi-wavelength observations of individual remnants, especially Tycho and SN1006.

Finally, I outline an original mechanism (the “espresso mechanism”) for the acceleration of nuclei up to $\sim 10^{20}$ eV in the relativistic jets of powerful active galactic nuclei. The combination of the “supernova-remnant paradigm” for the origin of Galactic CRs and the “espresso” mechanism provides a unified description of the spectrum and the chemical composition of CRs over more than 11 orders of magnitude in energy.

Summary

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