

PARTICLE ACCELERATION BY SHOCKS

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Abstract. Astrophysical particle acceleration occurs on scales ranging from the heliosphere to clusters of galaxies. Particles can reach extreme energies measured in EeV. A number of different acceleration processes are possible but diffusive shock acceleration is widely invoked as the predominant mechanism. It operates on all these scales and probably to the highest energies. It is simple, robust and predicts a universal spectrum. However there are many unknowns and partial unknowns, especially regarding how acceleration operates in specific astrophysical contexts. Important questions are: what determines the maximum cosmic ray energy, how efficient is the acceleration, why does the observed spectrum not always match that predicted, how do cosmic rays escape the acceleration site, are protons accelerated beyond a few PeV in the Galaxy, what is the source of EeV cosmic rays, what is the balance between electron, proton and heavy ion acceleration? In this review I will show that the answers to these questions depend in large part on the detailed physics of diffusive shock acceleration. Much progress has been made in the past decade in confronting theory with observation and we now stand on the threshold of answering some of the most important questions.