Geophysical Research Abstracts
Vol. 19, EGU2017-17862, 2017
EGU General Assembly 2017

Comparing particle acceleration rates of different astrophysical environments

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Energetic particles, with energies much larger than thermal energies, are observed in most astrophysical environments, but a full understanding of the acceleration processes is still missing.
Here, we make a comparison of the observed acceleration rates at various astrophysical environments like solar flares, Crab nebula flares, Earth's magnetotail energetic particles, supernova remnants and heliospheric shocks. We try to cross the borders between different astrophysical fields by looking for common acceleration mechanisms: in particular we consider acceleration at the reconnection outflow jet and shock Fermi acceleration in the cases of either diffusive or superdiffusive particle transport.
We make order-of-magnitude estimates of the acceleration rates in solar flares, Crab nebula flares, Earth's magnetotail, supernova remnants (SNRs) and heliospheric shocks, and compare the observations with predictions from acceleration models related to magnetic reconnection and Fermi acceleration at shocks. In details, we consider the results of numerical simulations of particle acceleration in the presence of moving magnetized plasmas, i.e. reconnection jets or transient random perturbations which model fluctuations observed
in the Earth's magnetotail.
Such measurements may help MMS mission as well as other future missions currently under study, e.g., THOR.
We find that magnetic reconnection can explain the fastest acceleration rates observed both in solar flares and Crab flares, while shock acceleration is generally slower and requires magnetic field amplification in the SNR environment and anomalous transport at heliospheric shocks.