Energization of charged particles in the Saturn's magnetosphere

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The acceleration of charged particles to suprathermal energies appears to occur in every diffuse plasma of astrophysical interest. Mechanisms like the direct electrostatic acceleration, the stochastic acceleration, the diffusive shock acceleration, the shock drift acceleration, the resonant acceleration by MHD waves, the resonant acceleration by Alfven and Langmuir waves, the runaway acceleration, the acceleration by potential double layers and the acceleration during magnetic reconnection are observed in a wide variety of astrophysical sites ranging from the terrestrial aurorae to the most distant quasars.

The simplest type of acceleration is the systematic acceleration in an electrostatic field parallel to the magnetic field. Consequently, one is lead to the concept of stochastic acceleration (or second order Fermi acceleration). The main idea is that the electric field is random in some sense, and that, although particles both gain and lose energy in elementary interactions, they gain energy on average. The essential requirements of a stochastic acceleration mechanism are: 1) elementary interactions which cause the energy of the particles to change due to the betatron effect, reflection of moving magnetic inhomogeneities or transit damping; 2) effective scattering attributed to wave-particle interactions and, 3) a random process (statistical treatment) usually based either on a Fokker-Planck approach or on a quasilinear approach implying that stochastic acceleration may be regarded as a diffusion in momentum space.

We propose a different stochastic acceleration model in which the equation of motion includes the force due to a stochastic field (electric for charged particles and gravitational for neutral particles), the Lorentz force, the corotational electric field force and the gravitational force. To simulate the stochastic behavior of such field we employ a Monte Carlo simulation. Taking different initial conditions, like the source of charged and neutral particles and the distribution function of their velocities, we find that charged particles injected with very low energies ($\sim$0.1 eV to $\sim$6 keV) can be strongly accelerated to reach much higher energies ($\sim$20 eV to $\sim$10 keV) as a result of 200,000 hitting events. The components of the final velocity in the perpendicular direction to the corotation velocity (*z-axis*) show a bimodal behavior in their distribution. A possible consequence of this acceleration is the radial transport of the particles due to their gain of kinetic energy. It is, when the particle's final energy surpasses the escape energy (in Saturn it ranges from $\sim$7 eV for protons to $\sim$90 eV for N^{+}) the particle is able to be radially transported to the outer regions of the magnetosphere.