Geophysical Research Abstracts
Vol. 16, EGU2014-11231, 2014
EGU General Assembly 2014

Superdiffusive transport in space and laboratory plasmas

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In the last few years it has been shown that the transport of plasma particles in the presence of electric and magnetic turbulence can be superdiffusive rather than normal diffusive (Gaussian). The term 'superdiffusive' refers to the mean square displacement of particle positions growing superlinearly with time, as compared to the normal linear growth. The so-called anomalous transport, which in general is comprising both subdiffusion and superdiffusion, has gained growing attention during the last two decades in many fields including laboratory plasma physics and space physics. Both anomalous regimes, i.e. sub- and superdiffusion, are found in such plasmas by a number of techniques. In parallel, it has been found, both by data analysis and by numerical simulations, that the transport of energetic particles in the presence of solar wind magnetic turbulence can be superdiffusive.

The theoretical description of anomalous transport in the cases of both sub- and superdiffusion involves the use of a variety of tools. In this presentation we will discuss the most common theoretical approaches to superdiffusion, that is the one based on fractional transport equations, and the one based on a non Guassian jump probability corresponding to Levy walks. The two approaches are compared, and we discuss which tool is most appropriate to each plasmas system. Examples of superdiffusive transport and of the corresponding particle acceleration for astrophysical plasmas will be given.