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Linear fractional stable motion as a time series model for space physics applications

N. W. Watkins (1)

British Antarctic Survey, Cambridge, UK (nww@bas.ac.uk/Fax: +44 1223 221226)

Fractional equations are a promising modern method for going beyond the Brownian motion which is associated with thermodynamic equilibrium. They have seen at least two areas of application in space physics. They are needed to model fractional kinetics in plasmas, and also to model magnetospheric activity as measured for example by auroral indices. It is not so obvious that it needs to be the **same** equation in both contexts i.e. reversible microphysical processes versus time evolving macroscopic dynamics. We here illustrate this point by deriving a new equation for time series applications, with a fractional derivative in space but a power law time dependence in the diffusion coefficient: $\partial P/\partial_t = \mu H t^{\mu H-1} \partial^\mu P/\partial x^\mu$.

We show how this process, the well-known linear fractional stable motion, differs from that governed by the fully fractional diffusion equation where the time derivative is also fractional. We show an application to modelling the scaling of burst sizes and durations in the indices. Finally we discuss extensions to multifractal processes.

Work done in collaboration with Dan Credgington (BAS/UCL), Sandra Chapman (Warwick) and Raul Sanchez (Oak Ridge).