Sub-ion scale intermittency and topological transitions in solar wind turbulence

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We present a survey study to investigate, over a broad range of solar wind plasma conditions, the intermittent properties of sub-ion scale magnetic field fluctuations in a turbulent collisionless plasma as seen in the solar wind. We use measurements from instruments on-board the Cluster spacecraft quartet to sample a range of different plasma parameters such as ion and electron plasma beta, fast and slow wind regimes, spatial sampling directions (wavevectors) etc. In particular, special care is taken to ensure approximate stationarity of the plasma parameters in each of the intervals. We find that all the intervals, regardless of the values of the plasma parameters or the scaling exponents involved, show a.) a monoexponent scaling at scales smaller than the characteristic ion scales, thus firmly establishing this sub-ion scale scaling that earlier studies have seen with single intervals; and b.) possess non-Gaussian heavy-tailed statistics of their magnetic fluctuations indicating the presence of large but frequent extreme events which can be interpreted as the presence of `coherent' structures. Importantly, these intervals show appreciable trends of the scaling exponents with total plasma beta and solar wind speed. To explore further the nature of this scaling we investigate, via Electron MHD simulations, the nature of the structures which are responsible for this scaling. We find that these are of filamentary nature -- a consequence of the magnetic Beltrami fields which arise when the J X B Hall term in EMHD, and hence nonlinearity, vanishes.