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Using magnetic helicity to diagnose wave vector direction in solar wind turbulence.

Robert Wicks (1), Daniel Verscharen (1), Lloyd Woodham (1), and Miriam Forman (2)
(1) MSSL, UCL, London, UK (r.wicks@ucl.ac.uk), (2) Department of Physics and Astronomy, Stony Brook University, USA

One of the central open questions in solar wind physics is how energy is transported from large scale flows to micro-scales where it can be dissipated. Previous work (Horbury, PRL, 2008, Wicks MNRAS, 2010) has shown that the amplitude of fluctuations at scales from roughly 1,000,000 km to 1000 km increase in anisotropy about the magnetic field direction as the scales get smaller. Understanding this anisotropy is made complicated by typically only having a single spacecraft observation and thus having to use the Taylor hypothesis and so all measurements of anisotropy are integrated over the plane perpendicular to the solar wind flow (Wicks et al., ApJ, 2012). Here we show that the magnetic helicity is the only property of the magnetic field to have a simple dependency on wave vector k when measured by a spacecraft. After deriving this dependence we then use different projections of the helicity to separate different populations of waves, both in angle with respect to the magnetic field direction, and by dominant direction of k. We then use this new analysis technique to test different models of the anisotropy of turbulent fluctuations generated from Alfven wave dispersion relations from a linear Vlasov solver.