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Rogue waves in Alfvénic turbulence

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An equation for Alfvén waves propagating in the solar wind at a small angle with respect to the ambiant magnetic field is numerically integrated in one space dimension. This equation takes the form of the classical integrable Derivative NonLinear Schrödinger (DNLS) equation with the addition of a random force modelling energy injection due to ions reflected from the Earth bow shock and of a dissipative term orginating from ion Landau damping and/or the presence of weak collisions. Global energetic properties as well as spectral energy transfer are analyzed. Energy dissipation displays highly intermittent events associated with the breaking of large solitonic structures (giant breathers). These very high amplitude "rogue waves" form by merging of quasi-solitons followed by a viscous quasi-collapse (Laveder et al. Phys. Letters A **375** (2011) 3997-4002). The latter phenomenon also takes place in the unforced case where an initial DNLS oblique breather is perturbed by a weak dissipation (Sánchez et al., Phys. Rev. E **82** (2010) 016406). The distribution of the instantaneous global maxima of the Alfvén wave intensity fluctuations is seen to be accurately fitted by power laws, which contrasts with the integrable regime (absence of dissipation and forcing) where the behavior is rather exponential. As the dissipation is reduced, freak waves form less frequently but reach larger amplitudes. These events are possibly related to SLAMS (Short Large Amplitude Magnetic Structures) observed upstream of quasi-parallel shocks.