MHD Turbulence in the solar wind

Solar wind (SW) is a complex non-equilibrium plasma emitted from the Sun and propagating till the end of the heliosphere, roughly 100 AU away. Detailed measurements in the SW confirmed the existence of the turbulent cascade. It appears, the bulk of the perturbations belong to the anisotropic Alfven mode, the dynamics of which has lately been a subject of intense theoretical and numerical scrutiny. The theory of Alfvenic turbulence arrived at a relatively simple picture which predicts k^-2 parallel spacial spectrum and Kolmogorov perpendicular spectrum, it also predicts the constant ratio of magnetic to kinetic energy, scale-wise. Comparison of this simple theory with numerics have largely confirmed the predictions. Comparison with the SW have been successful in most basic quantities, such as spectra, anisotropies and the energy transfer, while showing deviations in a number of a less straightforward measurements. I will point to some of these deviations and explain why it is important to understand them. Despite the concordance picture outlined above, the number of open questions remain. First, what is the nature of the rest (non-Alfvenic) perturbations, in particular the ones perturbing the magnitude of B. Classic collisional fast and slow modes do not exist in the SW due to its very low collisionality. Second, what is the effect of discontinuities. Third, what is the effect of non-uniform density on the cascade. Fourth, how the cascade is driven, if at all. Fifth, can we somehow localize the effect of non-uniform particle distributions, e.g. showing that it is produced in situ, or that we should always consider the global picture where the Sun is the source of such distributions. Despite I posed these five questions in the fluid range of scales (above the ion Larmor radius, rho_i), the answer to some of them, for example question one, the mode content, will drastically affect the predictions of the theory regarding transition to the so-called dispersive range (below rho_i).