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Evaluation of reduced power spectra from three-dimensional k-space

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We present a new tool to evaluate one dimensional reduced power spectral densities (PSD) from arbitrary energy distributions in k-space. This enables us to calculate the power spectra as they are measured in spacecraft frame for any given measurement geometry assuming Taylor's frozen-in approximation. It is possible to seperately calculate the diagonal elements of the spectral tensor and also to insert additional, non-turbulent energy in k-space (e.g. mirror mode waves). Given a critically balanced turbulent cascade with $k_\parallel \sim k_\perp^\alpha$, we explore the implications on the spectral form of the PSD and the functional dependence of the spectral index κ on the field-to-flow angle θ between plasma flow and background magnetic field. We show that critically balanced turbulence develops a θ-independent cascade with the spectral slope of the perpendicular cascade $\kappa(\theta{=}90^\circ)$. This happens at frequencies $f > f_{max}$, where $f_{max}(L, \alpha, \theta)$ is a function of outer scale L, critical balance exponent α and field-to-flow angle θ. The resulting spectra resemble the θ-independent spectral form reported by *Grappin & Müller* (2010). We also discuss potential damping terms acting on the k-space distribution of energy and their effect on the PSD. Further, we show that the functional dependence $\kappa(\theta)$ as found by *Horbury et al.* (2008) can be explained with a critically balanced turbulence model.