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DBS measurements of turbulence spectra in *Bouncing Ball* DIII-D plasmas

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Understanding turbulent transport is key for optimising future fusion power plants. This requires measurements of turbulent fluctuations. We measured turbulent density fluctuations over a range of wavenumbers: $2.0\ \mathrm{cm}^{-1} < k_\perp < 12.0\ \mathrm{cm}^{-1}$, or $0.9 < k_\perp \rho_s < 5.5$, using Doppler backscattering (DBS). Here $k_\perp$ is the wavenumber of the turbulent density fluctuations and ρ_s is the ion sound gyroradius. The DBS diagnostic is one of the few diagnostics which can measure density fluctuations of intermediate length scales, $1 \lesssim k_\perp \rho_s \lesssim 10$. To vary the measured wavevector of the fluctuations, the DBS probe beam is typically steered poloidally shot-to-shot, with the shots being repeated with as similar properties as possible [1]. Such measurements are key for validating simulations of turbulence.

In this work, we moved a limited circular DIII-D [2] plasma vertically up and down within a single shot, attempting to keep the density profile and magnetic geometry as similar as possible during this process (within 20%). The DBS launch position remained fixed, measuring the backscattered power as a function of plasma position and thus different fluctuation wavevectors. We then assume turbulent density fluctuations of the form given in previous work [3], which has five fitting parameters. By accounting for instrumentation effects [4] with the Scotty beam-tracing code [5] to predict the backscattered power for a given set of fitting parameters. By solving the inverse problem, we determined sets of fitting parameters for that best account for the measured backscattered power, shedding light on the nature of the turbulence spectra.

Our approach enabled measurements of density fluctuations across a range of wavevectors, within a single shot. With the 8 DBS channels, we measured different radial locations (normalised radial coordinate ρ between 0.3 and 0.7) over a range of wavenumbers: $2.0\ \mathrm{cm}^{-1} < k_\perp < 12.0\ \mathrm{cm}^{-1}$, or $0.9 < k_\perp \rho_s < 5.5$. We found that for higher $k_\perp$, the density fluctuations vary like $\sim k_\perp^{-\gamma}$, where $\gamma = 3.3 \pm 1.0$ for all radial locations.

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