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Nonlinear interactions and their scaling in the logarithmic region of turbulent channels[1] RASHAD MOARREF, Caltech, ATI S. SHARMA, University of Southampton, JOEL A. TROPP, BEVERLEY J. MCKEON, Caltech — The nonlinear interactions in wall turbulence redistribute the turbulent kinetic energy across different scales and different wall-normal locations. To better understand these interactions in the logarithmic region of turbulent channels, we decompose the velocity into a weighted sum of resolvent modes (McKeon & Sharma, J. Fluid Mech., 2010). The resolvent modes represent the linear amplification mechanisms in the Navier-Stokes equations (NSE) and the weights represent the scaling influence of the nonlinearity. An explicit equation for the unknown weights is obtained by projecting the NSE onto the known resolvent modes (McKeon et al., Phys. Fluids, 2013). The weights of triad modes -the modes that directly interact via the quadratic nonlinearity in the NSE- are coupled via interaction coefficients that depend solely on the resolvent modes. We use the hierarchies of self-similar modes in the logarithmic region (Moarref et al., J. Fluid Mech., 2013) to extend the notion of triad modes to triad hierarchies. It is shown that the interaction coefficients for the triad modes that belong to a triad hierarchy follow an exponential function. These scalings can be used to better understand the interaction of flow structures in the logarithmic region and develop analytical results therein.

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