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Resonance and nonlinear effects in a turbulent coronal loop

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The energy balance at large scales in a coronal loop is investigated, using an analytical approach based on the reduced magnetohydrodynamic equations and a simplified model of the loop. The dynamics is regulated by two phenomena: the resonance excited by motions at the loop basis, that stores energy within the loop; nonlinear couplings, that move energy towards smaller scales. The properties of resonant modes are derived and the input energy flux is found to be independent of dissipation. The spectral energy flux to small scales is determined by interactions among fluctuations at the same order of resonance and the zero-frequency (DC) velocity fluctuation. The DC magnetic field fluctuations does not influence the spectral flux, though it dominates the large-scales fluctuations. An estimation for the velocity fluctuation in the loop is derived from the energy balance, finding an agreement with measures of nonthermal velocity in the solar corona. A peculiar form of the fluctuation spectrum is inferred, formed by an injection range at large scales, a pre-inertial range where magnetic energy dominates kinetic energy, an inertial range where the turbulence behaves as in an unbounded system, and a dissipative range. These analytical results are compared with those of a numerical model, finding a good agreement.