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Linear response theory for one point statistics in the log-law region of wall bounded turbulence[1] YUKIO KANEDA, Aichi Institute of Technology, YOSHINOBU YAMAMOTO, University of Yamanashi, YOSHIYUKI TSUJI, Nagoya University — The idea of linear response theory developed in statistical mechanics for irreversible phenomena is applied to one-point statistics in the so-called log-law region, or strictly speaking the constant Reynolds stress region, of wall bounded turbulence. The one-point statistics include the Reynolds stress and the r.m.s's of the velocity fluctuations in the stream wise, span wise and wall normal directions. In the application of the idea, a similarity between (i) the Karman-Howarth equation for homogeneous isotropic turbulence and (ii) the conservation equation of the Reynolds averaged momentum in turbulence with parallel mean flow plays a key role. Both of (i) and (ii) are exact, and they respectively represent the energy-transfer from large to small scales, and the momentum-transfer in the wall normal direction. In the limit of infinite Reynolds number, (i) reduces to Kolmogorov's 4/5–law in the inertial subrange, while (ii) results in the constancy of the Reynolds stress in a certain range. The theory gives an estimate on the influence of finite Reynolds number on the statistics. The theoretical conjectures are compared with data of a series of direct numerical simulations of turbulent channel flow with Re_tau up to 8000.

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