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Optimal Reynolds-stress Decomposition of the Velocity Field in a Channel Flow ANDRE FERNANDO DE CASTRO DA SILVA, KENZO SASAKI, ANDRE VALDETARO GOMES CAVALIERI, Instituto Tecnologico de Aeronautica — Using a novel methodology, referred to as cross proper orthogonal decomposition (CPOD), cross-covariances of flow fluctuations (such as Reynolds stresses) are decomposed into modes that are optimal in representing an appropriately chosen inner product. This framework is applied to the representation of Reynolds shear stress in turbulent channel flow with friction Reynolds numbers of 179, 550, and 1000. Leading modes are shown to comprise streamwise vortices and streaks with phase opposition between streamwise (u') and wall-normal (v') velocities, representing ejections and sweeps, and higher-order modes show similar structures, but with u' and v' in phase. A combination of such structures leads to an accurate reconstruction of the Reynolds stress, and consequently of the mean flow, with a reasonable near-wall reconstruction with the leading CPOD mode pair (even and odd modes) for each considered wavenumber, and a close match of the profiles with the five leading CPOD mode pairs. For the Reynolds numbers of 550 and 1000, the leading modes for the wavenumber spectral peak present a self-similar behavior when scaled in outer units, highlighting the large-scale structures that determine the bulk of Reynolds stress.

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