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Vorticity Alignment with Local and Nonlocal Strain Rate Eigenvectors in Turbulent Flows PETER E. HAMLINGTON, University of Michigan, JOERG SCHUMACHER, Technische Universitat Ilmenau, WERNER J.A. DAHM, University of Michigan — The anomalous alignment of vorticity $\omega_i(\mathbf{x})$ with the strain rate eigenvectors in turbulent flows is examined using a decomposition of the strain rate $S_{ij}(\mathbf{x})$ into the sum of local $S_{ij}^R(\mathbf{x})$ and nonlocal (background) $S_{ij}^B(\mathbf{x})$ contributions. Unlike previous work where alignment properties have been examined using the coupled differential transport equations for the vorticity and strain rate, we here consider instead the integro-differential equation for the vorticity that results when the strain rate is represented by a Biot-Savart integral over all vorticity in the flow. The decomposition of the strain rate as $S_{ij}(\mathbf{x}) = S_{ij}^R(\mathbf{x}) + S_{ij}^B(\mathbf{x})$, which is achieved by splitting the integration domain into local ($r \leq R$) and nonlocal ($r > R$) domains, clearly distinguishes the linear (nonlocal) and nonlinear (local) contributions to the vorticity dynamics. The calculation of $S_{ij}^R(\mathbf{x})$ and $S_{ij}^B(\mathbf{x})$, including an operator method involving laplacians of $S_{ij}(\mathbf{x})$, is demonstrated. Using data from highly-resolved direct numerical simulations of statistically-stationary homogeneous, isotropic turbulence, we show that while vorticity tends towards anomalous alignment with the intermediate eigenvector of the *combined* strain rate $S_{ij}(\mathbf{x})$, it aligns with the most extensional eigenvector of the *background* strain rate $S_{ij}^B(\mathbf{x})$, resulting in a significant linear contribution to the vorticity dynamics.

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