

Abstract Submitted
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Quantifying polymer deformation in viscoelastic turbulence: the geometric decomposition and a Riemannian approach to scalar measures¹
ISMAIL HAMEDUDDIN, CHARLES MENEVEAU, TAMER ZAKI, DENNICE GAYME, The Johns Hopkins University — We develop a new framework to quantify the fluctuating behaviour of the conformation tensor in viscoelastic turbulent flows. This framework addresses two shortcomings of the classical approach based on Reynolds decomposition: the fluctuating part of the conformation tensor is not guaranteed to be positive definite and it does not consistently represent polymer expansions and contractions about the mean. Our approach employs a geometric decomposition that yields a positive-definite fluctuating conformation tensor with a clear physical interpretation as a deformation to the mean conformation. We propose three scalar measures of this fluctuating conformation tensor, which respect the non-Euclidean Riemannian geometry of the manifold of positive-definite tensors: fluctuating polymer volume, geodesic distance from the mean, and an anisotropy measure. We use these scalar quantities to investigate drag-reduced viscoelastic turbulent channel flow. Our approach establishes a systematic method to study viscoelastic turbulence. It also uncovers interesting phenomena that are not apparent using traditional analysis tools, including a logarithmic decrease in anisotropy of the mean conformation tensor away from the wall and polymer fluctuations peaking beyond the buffer layer.

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