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Instability of a Rotating Elastic Filament due to Viscous Stresses

BIAN QIAN, KENNETH S. BREUER, Brown University — The deformation of an elastic filament due to viscous stresses at low Reynolds number is important in the dynamics of flexible biological filaments such as bacterial flagella and DNA. Several theoretical and numerical works have reported that a twist-induced *writhing* instability or initial asymmetry with respect to the rotational axis may induce a shape bifurcation from a straight rotating elastic filament to a helical state. We present experimental results obtained using a macroscopic flexible rope rotating in a low-Re tank. The three-dimensional rope shape and torque-speed relationship are measured and characterized as functions of filament elasticity, fluid viscosity and system geometry. Transitions between different filament mode shapes, and the effect of the mode shape on the torque are quantified. In addition, the roles of bending and torsional stiffness is discussed.

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