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Helical instability of a rotating viscous liquid jet J.P. KUBITSCHEK, P.D. WEIDMAN, University of Colorado — Experimental results are presented for a rotating viscous liquid jet showing a clear preference for helical instabilities that evolve from initially planar disturbances at large rotation rates. In the ideal case of a uniformly rotating viscous liquid column with stress-free boundaries in the absence of gravity, the preferred modes of linear temporal instability are theoretically known over the entire physical domain. The relevant physical parameters are $L = \gamma/\rho a^3\Omega^2$ and $Re = a^2\Omega/\nu$, where a is the column radius, Ω the uniform angular velocity and ρ, ν, and γ are fluid density, kinematic viscosity and surface tension, respectively. The theoretical results suggest that instability in different regions of L-Re parameter space is dominated by three modes: the axisymmetric mode, $n \geq 2$ planar modes, and the first $n = 1$ spiral mode. For the rotating viscous liquid jet, experiments reveal that planar disturbances of the same mode numbers ($n \geq 2$) spontaneously arise in the same regions of parameter space predicted by uniformly rotating viscous liquid column theory. However, these planar disturbances do not persist, but instead rapidly evolve into helical instabilities. Although fundamental differences exist between the rotating liquid jet and the uniformly rotating liquid column, some remarkable similarities associated with initial growth rates, disturbances frequencies, and mode transitions between the two systems are found.

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