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Helicity Dynamics in Unknotting and Unlinking Events of Topologically Complex Vortex Flows XINRAN ZHAO[1], CARLO SCALO[2], Purdue University — In this study, we address the question of whether helicity is conserved through viscous reconnection events in vortical flows. To answer this question, we performed direct-numerical-simulations (DNS) focused on two topologically complex vortex flow cases: (1) a trefoil knot, and (2) a two-ring linkage, for various vortex core radii. The adopted DNS framework relies on a block-structured Adaptive Mesh Refinement (AMR) technique. A third, a companion simulation of the collision of two unlinked vortex rings is also performed to serve as a baseline case for trivial helicity dynamics. The results show that a well-defined helicity jump occurs during the unknotting/unlinking events of cases (1) and (2), and is initiated after the complete annihilation of the local helicity density magnitude in certain flow regions. Similar helicity dynamics are observed for various core radii explored for cases (1) and (2), while they are not present for the third topologically trivial colliding-ring case. Further analysis of the simulation results suggests that the integral of helicity density in a volume surrounding the reconnection region can be used as an estimator for the magnitude of the helicity rise during the reconnection event. Finally, a mechanistic model is provided to explain the local helicity annihilation, which relates the helicity annihilation rate to circulation transfer rate and local helicity content.

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