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Direct numerical simulation of trefoil knotted vortices XINRAN ZHAO[1], CARLO SCALO[2], Purdue University — 3D viscous vortex reconnection has been a topic of strong interest for the fluid mechanics community over the past several decades. This paper investigates pre- and post-reconnection dynamics of a trefoil knotted vortex for Reynolds numbers up to Re = 20,000 by means of DNS with adaptive mesh refinement. The compressible Navier-Stokes equations are solved on the block-structured computational domain with compact-finite difference scheme. An overall high-order accuracy in space can be achieved with the combination of high-order compact restriction/prolongation operators. The test refinement function is given by a Coherent-vorticity-perserving (CvP) sensor (Chapelier, Wasistho, and Scalo, 2018. J. Comput. Physics., 359, 164-182) from our previous work. The simulation on the trefoil vortex problem has shown that this sensor is capable of capturing and refining the location where the reconnection occurs and local turbulence is produced. The complete flow evolution is resolved by the DNS simulation, including the turbulence production upon reconnection, subsequent separation into a smaller and a larger vortex ring, and, finally, the formation of Kelvin waves. The DNS simulation depicts the mechanism how helicity is produced due to small-scale vortical events during the bridging process. A qualitative comparison between the present simulations and existing experiments has also been conducted and an excellent match has been found in terms of flow topology.

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