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Helmholtz's third theorem in numerical general relativity[1] CHARALAMPOS MARKAKIS, DAMTP, Univ of Cambridge & NCSA, Univ of Illinois — The motion of strongly gravitating fluid bodies is described by the Euler-Einstein system of partial differential equations, combining fluid dynamics with general relativity. Centuries after their advent, the solution to these equations remains mathematically and computationally difficult, and the break-down of well-posedness on the boundary interface between fluid and vacuum remains a challenging open problem. The problem manifests itself in numerical simulations of binary neutron-star inspiral. This work focuses on formulating and implementing well-posed, acoustical and canonical hydrodynamic schemes, suitable for inspiral simulations and gravitational-wave source modelling, with promising mathematical and computational applications. The scheme uses a variational principle by Carter-Lichnerowicz stating that barotropic fluid motions are conformally geodesic, Helmholtz's third theorem stating that initially irrotational flows remain irrotational, and Christodoulou's acoustic metric approach adopted to numerical relativity, in order to evolve the canonical momentum of a fluid element via Hamilton's equations. The recent observation of the inspiral of binary neutron stars by the LIGO-Virgo collaboration makes this work timely.

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