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New conserved integrals for Euler's equations in $n > 1$ spatial dimensions

Euler's equations are the governing equations of inviscid fluid flow. In this talk, new conserved integrals generalizing Kelvin's circulation are presented for Euler's equations in $n > 1$ spatial dimensions. Circulation is defined by the integral of the fluid velocity around any closed curve and is known to be a constant of motion when the curve is transported by the fluid in the case of either incompressible or compressible flows in $n \leq 3$ dimensions. The new conserved integrals hold for both incompressible and compressible fluids in $n > 1$ dimensions and are defined similarly to helicity in terms of the fluid velocity and its curl on any closed surface of odd dimension less than n which is transported by the fluid. These integrals yield new circulatory constants of motion for inviscid fluid flow in all dimensions $n > 3$ and reduce to the circulation in $n = 2$ and $n = 3$ dimensions. The corresponding local conservation laws are shown to have an equivalent formulation as differential p-forms (with $p = 1,3,...,2[n/2] - 1$) whose convective Lie derivative along the fluid streamlines is equal to a closed p-form when evaluated for all solutions of Euler's equations.