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Classical Scaling Symmetry Implies Useful Nonconservation Laws

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Scaling symmetries of the Euler-Lagrange equations are generally not variational symmetries of the action and do not lead to conservation laws. Nevertheless, by an extension of Noether's theorem, scaling symmetries lead to useful {\em nonconservation} laws, which still reduce the Euler-Lagrange equations to first order in terms of scale invariants. We illustrate scaling symmetry dynamically and statically. Applied dynamically to systems of bodies interacting via central forces, the nonconservation law is Lagrange's identity, leading to generalized virial laws. Applied to self-gravitating spheres in hydrostatic equilibrium, the nonconservation law leads to well-known properties of polytropes describing degenerate stars and chemically homogeneous nondegenerate stellar cores.

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