



Mathematical Physics

Applications of Classical Scaling Symmetry

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Any symmetry reduces a second-order differential equation to a first-order equation: variational symmetries of the action (exemplified by central field dynamics) lead to conservation laws, but symmetries of only the equations of motion (exemplified by scale-invariant hydrostatics), yield first-order non-conservation laws between invariants. We obtain these conservation laws by extending Noether's Theorem to non-variational symmetries, and present a variational formulation of spherical adiabatic hydrostatics. For scale-invariant hydrostatics, we directly recover all the published properties of polytropes and define a core radius, a new measure of mass concentration in polytropes of index n . The Emden solutions (regular solutions of the Lane-Emden equation) are finally obtained, along with useful approximations. An appendix discusses the special $n=3$ polytrope, emphasizing how the same mechanical structure allows different thermostatic structures in relativistic degenerate white dwarfs and zero age main sequence stars.

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