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Quantum Corrected Spherical Collapse: A Phenomenological Framework

A phenomenological framework is presented for incorporating quantum gravity motivated corrections into the dynamics of spherically symmetric collapse. The effective equations are derived from a variational principle that guarantees energy conservation and the existence of a Birkhoff theorem. The gravitational potential can be chosen as a function of the areal radius to yield specific non-singular static spherically symmetric solutions that generically have two horizons. For a specific choice of potential the effective stress energy tensor violates only the dominant energy condition. The violations are maximum near the inner horizon and die off rapidly. A numerical study of the quantum corrected collapse of a spherically symmetric scalar field reveals that the modified gravitational potential prevents the formation of a central singularity and ultimately yields a static, mostly vacuum, spacetime with two horizons. The matter "piles up" on the inner horizon giving rise to mass inflation at late (Vaidya) times. The Cauchy horizon is transformed into a null, weak singularity, but in contrast to Einstein gravity, the absence of a central singularity renders this null singularity stable.

Joint work with J. Ziprick, University of Waterloo and Perimeter Institute.