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Ultracompact stars in semiclassical gravity

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We present evidence that semiclassical gravity can give place to ultracompact stars, indistinguishable from black holes up to current observations. We integrate the semiclassical equations of (spherically symmetric) stellar equilibrium for a constant-density classical fluid. The semiclassical contribution is modelled by a quantum massless scalar field in a genuinely-static vacuum state compatible with asymptotic flatness (Boulware vacuum). The Renormalized Stress-Energy Tensor (RSET) is firstly approximated by a cut-off version of the analytic Polyakov approximation. This approximation reveals a crucial difference with respect to purely classical solutions: stars whose compactness is nearing that of a black hole exhibit bounded pressures and curvatures up to central core of a very small relative size. For a subfamily of these ultracompact configurations, their mass can be made arbitrarily close to zero at the boundary of the core, just before the solution enters a singular regime. Our analysis suggests the absence of a Buchdahl limit in semiclassical gravity, while indicating that the cut-off regularized Polyakov approximation must be improved to describe equilibrium configurations of arbitrary compactness that remain regular at the center of spherical symmetry.

Primary authors: ARRECHEA, Julio (Institute of Astrophysics of Andalusia (IAA-CSIC)); Dr BARCELÓ, Carlos (Institute of Astrophysics of Andalusia (IAA-CSIC)); Dr CARBALLO-RUBIO, Raúl (Florida Space Institute); Prof. GARAY, Luis J. (Complutense University of Madrid)

Presenter: ARRECHEA, Julio (Institute of Astrophysics of Andalusia (IAA-CSIC))

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