Area deficit of geodesic balls and gravitational energy

José M M Senovilla

Física teórica, Universidad de País Vasco, Apartado 644, 48080 Bilbao, Spain
josemm.senovilla@ehu.eus

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ABSTRACT

Gravity manifests itself as curvature of spacetime, and its strength can be measured by considering the deficit of the volume of small geodesic balls with respect to their counterparts in flat spacetime. The area *deficit of the enclosing boundaries can actually be put in relation, via the Einstein field equations, with the energy density of matter at the ball's centre, and this led Jacobson to propose a novel "maximal entanglement hypothesis", establishing a thermodynamic principle for quantum gravitational theories [1].*
In this contribution we consider what happens when the matter energy density vanishes. The area still feels the effect of pure gravity, and this change should be related to the gravitational strength, or in simple words, to the gravitational energy density with respect to the mentioned observer. The area deficit now involves terms quadratic in the curvature related to classical quantities [2], but there arise some subtleties and ambiguities to be resolved.

Work based on a collaboration with Ted Jacobson and Antony Speranza.

References

[1] T. Jacobson, Entanglement equilibrium and the Einstein equation, *Phys. Rev. Lett.* **116** (2016) 201101

[2] J.M.M. Senovilla, Super-energy tensors, *Classical and Quantum Gravity* **17** (2000) 2799.