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Some words about gravitational entropy and Penrose's Weyl curvature conjecture

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Many notions of entropy have been formulated in Physics, from thermodynamics to statistical mechanics and information theory. Bekenstein and Hawking, relying on completely different physical arguments than each other's, pioneered the idea of *gravitational* entropy claiming that the gravitational field of an empty space black hole as Schwarzschild comes with an entropy equal to one fourth of its horizon area. In the cosmological context, Penrose has instead conjectured that the Weyl curvature should serve as a measure of gravitational entropy proposing the so-called Weyl curvature hypothesis. However, implementing consistently all those ideas is not a trivial task, with drawbacks in the literature proposal of considering the square of the Weyl tensor as an appropriate entropy density being identified. In my talk, I will propose a solution to this issue by introducing an appropriate combination of curvature quantities based only on the Weyl curvature, which therefore is not sensitive to the matter content and really constitutes a measure of the *pure gravitational field*, exhibiting a general applicability to all static and spherically symmetric black holes in general relativity independently of the matter field in their exterior. Physical insights about the nature of black hole entropy will be provided, also putting our results in the perspective of modified gravity theories. My talk will be based on PRD 105, 104017 (2022).

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