Adding hair to Kerr black holes: theory and phenomenology

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Kerr black holes with scalar hair [1] are, likely, the conceptually simplest non-electrovacuum, asymptotically flat, regular on and outside an event horizon, black hole model. We shall review their construction [2], some physical properties that distinguish them from the Kerr solution [1,2] -- in particular their shadows [3] -- and their astrophysical feasibility. We will also address the effect of including self-interactions for the scalar field, which makes these black holes hairier, but not heavier [4]. Finally, we note that the recently discovered Proca Stars [5] imply also the existence of Kerr black holes with Proca hair.

[1] Kerr black holes with scalar hair
Carlos A. R. Herdeiro, Eugen Radu
Phys.Rev.Lett. 112 (2014) 221101

[2] Construction and physical properties of Kerr black holes with scalar hair
Carlos Herdeiro, Eugen Radu
Class.Quant.Grav. 32 (2015) 14, 144001

[3] Shadows of Kerr black holes with scalar hair
Pedro V. P. Cunha, Carlos A. R. Herdeiro, Eugen Radu, Helgi F. Runarsson
e-Print: arXiv:1509.00021 [gr-qc]

[4] Kerr black holes with self-interacting scalar hair: hairier but not heavier
Carlos A. R. Herdeiro, Eugen Radu, Helgi Rúnarsson
e-Print: arXiv:1509.02923 [gr-qc]

[5] Proca Stars: gravitating Bose-Einstein condensates of massive spin 1 particles
Richard Brito, Vitor Cardoso, Carlos A. R. Herdeiro, Eugen Radu
e-Print: arXiv:1508.05395 [gr-qc]