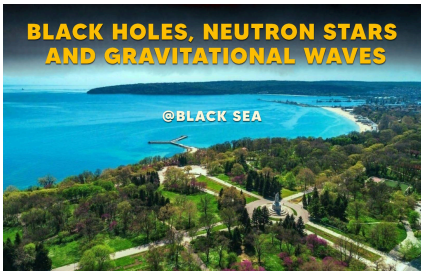

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A new model of spontaneous scalarization induced by curvature and matter

Friday 20 June 2025 16:05 (15 minutes)

We present a model of black hole scalarization where a scalar field couples simultaneously to the Gauss–Bonnet invariant and the electromagnetic Maxwell field. This combined interaction broadens the conditions for spontaneous scalarization. We track how the electric charge and the two coupling constants control the onset of the scalar field and uncover new solution branches with non-trivial scalar profiles. Scalarization occurs across a wide range of parameters and even with negative Gauss–Bonnet coupling at sub-extremal charge (q). Scalar clouds and fully scalarized black holes form above several mass thresholds; varying the Maxwell coupling or the charge makes the highest threshold mass almost three times the lowest. Multiple branches of scalarized solutions converge to the same final state, indicating non-unique growth of scalar hair. The model also produces overcharged black holes ($q > 1$) while the Gauss–Bonnet coupling remains positive. Several examples show horizon areas larger than those of the Reissner–Nordström solutions with the same mass and charge.

The Maxwell term shifts the scalarization onset and tends to stabilize the solutions, as seen from the evolution of the scalar charge and horizon quantities. These results provide an alternative route to scalarization, may avoid the instabilities of curvature-only or matter-only models, and open new possibilities for testing strong-gravity effects in upcoming observations.

Author: BELKHADRIA, Zakaria (Université de Genève & Università di Cagliari & GWSC & INFN)

Presenter: BELKHADRIA, Zakaria (Université de Genève & Università di Cagliari & GWSC & INFN)