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Dynamical formation of Proca stars and quasi-stationary solitonic objects.

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The dawn of gravitational-wave astronomy opens up an observational window to probe the true nature of astrophysical black hole candidates. These are widely believe to be well described, when near equilibrium, by the Kerr metric. But more exotic theoretical possibilities have been put forward, including horizonless compact objects. Such objects have the theoretical appeal of avoiding conceptual issues related to event horizons and spacetime singularities and could, in some circumstances, mimic the phenomenology of black holes. A notable example of these exotic compact objects are boson stars (BSs), which are self-gravitating, everywhere non-singular, horizonless Bose-Einstein condensates of massive scalar (scalar boson stars) or vector field (Proca stars). Two important questions can be raised about their dynamics. We may ask if they are stable, and more fundamentally if they may form dynamically. We perform fully non-linear numerical simulations within the spherically symmetric Einstein-(complex)Proca system. Starting with Proca field distributions that obey the Hamiltonian, momentum and Gaussian constraints, we show that the self-gravity of the system induces the formation of compact objects, known as Proca stars.

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