

Non-linear dynamics of spinning bosonic stars

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We study the formation and stability of spinning bosonic stars (SBSs) through numerical-relativity simulations of the Einstein-Klein-Gordon and Einstein-Proca systems. SBSs can form from the gravitational collapse of a dilute cloud of scalar/Proca particles with non-zero angular momentum, via gravitational cooling. Spinning scalar stars are found to be transient due to a non-axisymmetric instability which triggers the loss of angular momentum. By contrast, no such instability is observed for the fundamental ($m = 1$) Proca stars. We relate the different stability properties to the different toroidal/spheroidal morphology of the scalar/Proca models. We find that unstable $m = 1$ scalar boson stars and $m = 2$ (toroidal) Proca stars exhibit a pattern of frequencies for the azimuthal density modes which crosses the angular velocity profile of the stars in the corotation point. This establishes a close parallelism with rotating neutron stars affected by dynamical bar-mode instabilities. We investigate the detectability of the gravitational waves emitted by SBSs affected by such bar-like deformations. Our results indicate that gravitational-wave observations of SBSs might be within the reach of future experiments, which might offer the possibility to prove the existence of such stars and to place constraints on the mass of the bosonic particle.