# Stability of $\ell$-boson stars under linear perturbations

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(Dated: March 16, 2019)

$\ell$-boson stars are solutions to the static, spherically symmetric Einstein-Klein-Gordon system for a collection of an arbitrary odd number $N$ of complex scalar fields with an internal $U(N)$ symmetry and no self-interactions [1]. These solutions are parametrized by an angular momentum number $\ell = (N-1)/2$, an excitation number $n$, and a continuous parameter $u_c^l$ rlated to the central amplitude of the fields $\phi(r=0) = u_c^\ell r^\ell$. They are regular at every point and possess a finite total mass. For $\ell = 0$ the standard spherically symmetric boson stars are recovered. For $\ell \neq 0$, as in the case of boson stars, $\ell$-boson stars exhibit a mass profile against $u_c^\ell$ with a maximum for a specific value of $u_c^\ell = u_c^{\ell *}$. In this work we investigate, using linear perturbation theory, the stability against small radial perturbations of $\ell$-boson stars. We compute the eigenfrequecies of the perturbations for different values of $u_c^\ell$ and we found that configurations with values of $u_c^\ell$ to the right of $u_c^{\ell *}$ are unstable under such perturbations while configurations with values of $u_c^\ell$ to the left of $u_c^{\ell *}$ are stable.

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[1] M. Alcubierre, J. Barranco, A. Bernal, J. C. Degollado, A. Diez-Tejedor, M. Megevand, D. Nunez and O. Sarbach, Class. Quant. Grav. **35**, no. 19, 19LT01 (2018) doi:10.1088/1361-6382/aadcb6 [arXiv:1805.11488 [gr-qc]].