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Dark Matter as a condensed phase of generic bosons

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We analyze the rotation curves that correspond to a Bose–Einstein Condensate (BEC) type halo surrounding a Schwarzschild–type black hole to confront predictions of the model upon observations of galaxy rotation curves. We model the halo as a BEC in terms of a massive scalar field that satisfies a Klein–Gordon equation with a self–interaction term. We also assume that the bosonic cloud is not self–gravitating. To model the halo, we apply a simple form of the Thomas–Fermi approximation that allows us to extract relevant results with a simple and concise procedure. We find that in the centre of galaxies we must have a supermassive compact central object, i.e., supermassive black hole, in the range of $\log_{10} M/M_{\odot} = 11.08 \pm 0.43$ which condensate a boson cloud with average particle mass $M_{\Phi} = (3.47 \pm 1.43) \times 10^{-23}$ eV and a self–interaction coupling constant $\log_{10}(\lambda\ [\mathrm{pc}^{-1}]) = -91.09 \pm 0.74$, i.e., the system behaves as a weakly interacting Bose–Einstein Condensate. We compare the Bose–Einstein Condensate model within the Thomas–Fermi approximation, with the Navarro–Frenk–White (NFW) model, concluding that in general the BEC model using the Thomas–Fermi approximation is strong enough compared with the NFW fittings. Moreover, we show that BECs still well–fit the galaxy rotation curves and, more importantly, could lead to an understanding of the dark matter nature from first principles.

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