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Magnetic field effects on Bose-Einstein condensate stars

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We study magnetic field effects on the Equations of State (EoS) and the structure (mass-radius relation) of Bose-Einstein Condensate (BEC) stars, i.e. a compact object composed by a gas of interacting spin one bosons formed up by the pairing of two neutrons. To include magnetic field in the star description we suppose that particle-field and particle-particle interactions are independent, and consider two situations, one where the magnetic field is constant, and another where it is produced by the bosons. Magnetic field presence splits the pressure of the boson gas in two components, one parallel and the other perpendicular to field direction. At low densities and/or strong fields the smaller pressure might be negative, making the boson system unstable. This imposes a lower limit to the central mass density of the star in a way that, the stronger is the magnetic field, the denser has to be star to support its mass against collapse. Since the anisotropy in the pressures implies that the resulting star is not spherical, to compute the mass-radius relation we use the recently found γ-structure equations that describe axially symmetric objects provided they are spheroidal. The obtained BEC stars are, in general, less massive and smaller than in the non-magnetic case, being magnetic field effects more relevant for low densities. When the magnetic field is produced by the bosons, the inner profiles of the fields are determined self consistently as a function of the star inner radii, its values being in the orders expected for compact stars.

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