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Recently there has been much interest in the spatial distribution of light scalar dark matter, especially axions, throughout the universe. When the local gravitational interactions between the scalar modes are sufficiently rapid, it can cause the field to re-organize into a Bose-Einstein condensate of gravitationally bound clumps. These clumps are stable when only gravitation is included, but the picture becomes more complicated when the presence of the axion's attractive self interactions is considered. We perform a detailed stability analysis to determine under what conditions the clumps are stable. We focus on spherical configurations, leaving aspherical configurations for future work. We identify branches of clump solutions of the axion-gravity-self-interacting system and study their stability properties. We find that clumps that are (spatially) large are stable, while clumps that are (spatially) small are unstable and may collapse. In both cases, there is a maximum number of particles which can be in a clump. The stable branch is mainly ruled by gravity and could comprise a significant component of dark matter in the galaxy. The unstable branch connects to a relativistic branch, which is quasi-stable because of the emission of relativistic axions. We clarify how a recent claim in the literature of a new ultra-dense branch of stable solutions rests on an invalid use of the non-relativistic approximation. We also consider repulsive self-interactions that may arise from a generic scalar dark matter candidate, finding a single stable branch that extends to arbitrary particle number. This may have interesting astrophysical consequences.

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