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Self-bound crystals of antiparallel dipolar mixtures

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Quantum fluctuations can stabilize bosonic mixtures and Bose-Einstein condensates with dipolar interactions against the collapse predicted by the mean-field theory. This stabilization mechanism allows for two new states of matter to arise: self-bound quantum droplets and dipolar supersolids. When dipolar interactions between the atoms are present, the droplets can self-assemble into arrays and form a supersolid, which presents both a crystalline structure and superfluid properties. The dipolar interaction between such droplets is repulsive, so these crystals unravel in the absence of external confinement.

On a binary mixture of antiparallel dipolar condensates, however, the attractive dipolar interaction between components allows for the formation of self-bound crystals with no transversal confinement. We explore the ground-state physics of the system, which includes three-dimensionally self-bound droplet-ring structures and, in the presence of only axial confinement, stripe/labyrinthic patterns and self-bound crystals of droplets surrounded by an interstitial superfluid.

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