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Quasi-one dimensional dipolar bosonic systems: from gas to droplet formation

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We study a tightly trapped one-dimensional dipolar gas of bosonic atoms for which we derive the equation of state using a variational approximation based on the Lieb-Liniger gas Bethe ansatz wave function. We test our results by computing the breathing mode after solving the stationary generalized Gross-Pitaevskii equation, finding very good agreement with experiments.

When the strength of the dipolar interaction becomes sufficiently attractive compared to the contact one, the incipient formation of droplets is signalled by a steep increase of the breathing mode and a change in sign of the chemical potential. Eventually, on increasing the number of particles in the cloud, the density profile shows the typical droplet flat-top shape.

Upon a sudden release of the trap, varying the number of trapped atoms and the scattering length, the numerical solution of a time-dependent generalized Gross-Pitaevskii equation shows either an evaporation of the cloud, the formation of a single self-bound droplet, or a fragmentation in multiple droplets. Finally we extend the analysis of the breathing modein the region of stability of the droplets.

Orateur: DE PALO, Stefania