Stability and Collapse of a dipolar Bose-Einstein Condensate in an optical lattice

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Abstract

The stability conditions as well as the collapse dynamics of bosonic quantum gases are strongly modified in the presence of dipolar interactions [1, 2], mainly due to its anisotropic character. In addition, in quasi-2D geometries, like those produced by one-dimensional optical lattices, roton features are expected to emerge and be enhanced in the dipolar BEC. In this work, we investigate both the stability diagram and the collapse dynamics of a strongly interacting dipolar Bose-Einstein condensate of ^{52}Cr atoms loaded in an one-dimensional optical lattice. The stability diagram was measured as a function of the lattice depth with remarkable agreement with fully-numerical simulations [3]. We have observed that in the regime of deep optical lattices, there exist a strong influence of the intersite long range dipolar interactions on the stability threshold of the system. In the same regime, we were able to produce a strongly interacting BEC with attractive short-range interactions, stabilized by the dipolar interactions. We also investigate the collapse of such quantum gas. In contrast to non-dipolar BEC, where the collapse is induced by a sudden change in the interaction energy, in this work, we investigate the collapse of the dipolar BEC induced by a sudden change in the confining potential. Only a dipolar BEC offers this possibility since its stability threshold strongly depends on the confinement geometry due to the anisotropic character of the dipolar interaction. In addition, we observe, for shallow lattices, that a stable BEC in-trap can collapse in free expansion when the trapping potential is completely switched-off. This is a unique feature of dipolar systems. [4]

References

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