Many-body physics of superfluid dipolar filaments

Fabio Cinti

National Institute for Theoretical Physics (NITheP), Stellenbosch University, Stellenbosch, South Africa

Recent experiments on BECs with dipolar interactions have observed a clear stabilisation of the gas (typically dysprosium or erbium) in a three-dimensional setup. Such remarkable results rekindled interest in systems characterised by anisotropic dipolar-interactions. Yet the microscopic mechanisms that cause these interesting quantum regimes is still under debate. Along these lines, we are undertaking an investigation of cluster phases made up of dipolar bosons. Employing quantum Monte Carlo techniques, we can clearly identify regions where the attractive part of the dipolar interaction dominates and the system forms an ordered array of parallel filaments, and a quantum-mechanical one, wherein filaments are destabilised by zero-point motion, and eventually the ground state becomes a uniform cloud [1]. Most interestingly, by computing the local superfluid fraction in a relevant set of experimental parameters, we conclude that coherence is preserved up to strong interactions. Our calculations at finite temperature also confirm the stability of such filaments against thermal fluctuations [2].

[1] F. Cinti, M. Boninsegni, arXiv:1703.10291.
[2] F. Cinti, A. Cappellaro, L. Salasnich, and T. Macrì, arXiv:1610.03119.