Laser cooling of an interacting atomic gas

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Laser sideband cooling allows us to cool single particles to nanoKelvin temperatures. Its discovery opened the way for experiments, which test the foundations of quantum physics and have applications ranging from quantum metrology to quantum computing. Moreover, motivated by the imminent quantum technological applications of ultra-cold many-body quantum systems, quantum thermodynamics recently became a very active area of research. Nevertheless, applying laser cooling to large ensembles of particles is still not straightforward.

This project aims to enhance the cooling process of many particles through interactions. A quantum coherence with the ability to induce collective dynamics in an atomic gas has already been identified [1]. This coherence plays the same role as entropy in classical physics and would be strongly affected by interactions between particles. Linking thermodynamics and quantum physics and estimating efficiencies, we will establish more efficient approaches to cooling many particles than currently available.

[1] Cavity-mediated collective laser-cooling of an atomic gas inside an asymmetric trap, O. Kim, P. Deb and A. Beige, arXiv:1506.02910 (2016).