Bose-Einstein Condensate of Thulium Atom

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Bose-Einstein condensation (BEC) is a powerful tool for a wide range of research activities, a large fraction of which is related to quantum simulations. Various problems may benefit from different atomic species. Thulium atoms possess a dipole moment of 4 Bohr magneton in the ground state, allowing long-term interactions. It also has a number of non-chaotic low-field Feshbach resonances, allowing fine control of the near-field interactions. It also has a relatively simple level structure compared to the other magnetic lanthanoids and thus is a quite promising subject for applications in quantum simulations. Nevertheless, cooling down novel species interesting for quantum simulations to BEC temperatures requires a substantial amount of optimization and is usually considered to be a difficult experimental task. Specifically, previous attempts of cooling thulium atom to Bose-Einstein condensation temperature at 532 nm dipole trap were not successful.

Here we report on the implementation of the Bayesian machine learning technique to optimize the evaporative cooling of thulium atoms and achieved BEC in an optical dipole trap. The developed approach could be used to cool down other novel atomic species to quantum degeneracy without additional studies of their properties.