

Quantum degenerate erbium atoms

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Application Note

Introduction

Our experiments investigate the behavior of an ensemble of neutral erbium atoms at ultralow temperatures of around 100 nK. Erbium belongs to the lanthanide series and has a large magnetic moment of 7 Bohr magneton. The primary purpose of our experiments is to observe the impact of large magnetic dipole-dipole interaction in quantum degenerate gases. Low noise imaging is crucial in our experiments because our experiments rely solely on the measurement of the density distribution of atomic clouds via absorption imaging.

Experiments

In our experiment, atomic gases are imaged as a shadow of a probing laser beam onto a back-illuminated EMCCD detector, iXon3 -ECS-QBB, from Andor Technology. Figure 1 shows the density distributions of an ensemble of erbium atoms, exhibiting a transition from a thermal gas to a Bose-Einstein condensate (BEC) [1]. Initially atoms are trapped in an optical trap. Atoms are exposed to a resonant light at 401 nm for 150 μ s after they are released from the trap. Additionally, two images, one only with the probing beam and one for a background image, are taken for obtaining a picture indicating the optical density of an atomic cloud.

We typically work on a gas containing about 10^5 atoms, giving a peak optical density of about 0.5. The large electron counts and the low noise counts available with iXon3 enable us to achieve a picture with a low noise of well below 0.1 in optical density. In addition, the high quantum efficiency at 401 nm obtained with iXon3 (about 80 %) is beneficial for achieving clear pictures with a low intensity for the probing beam.

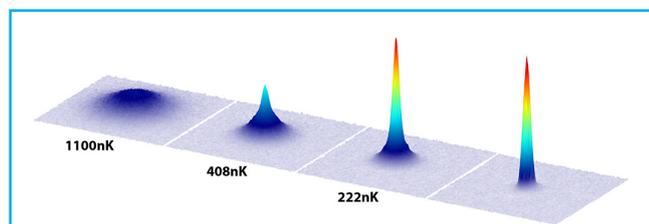


Figure 1. A BEC phase transition in a gas of erbium atoms. By cooling a gas of erbium atoms down to a few 100 nK, we can populate a significant fraction of atoms in the lowest vibrational level of an optical trap, which form a Bose-Einstein condensate (BEC). The narrow peaks in the momentum distribution are the signature of a BEC.

Acknowledgements

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References

- [1] K. Aikawa, A. Frisch, M. Mark, S. Baier, A. Rietzler, R. Grimm, and F. Ferlaino, Phys. Rev. Lett. 108, 210401 (2012).

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