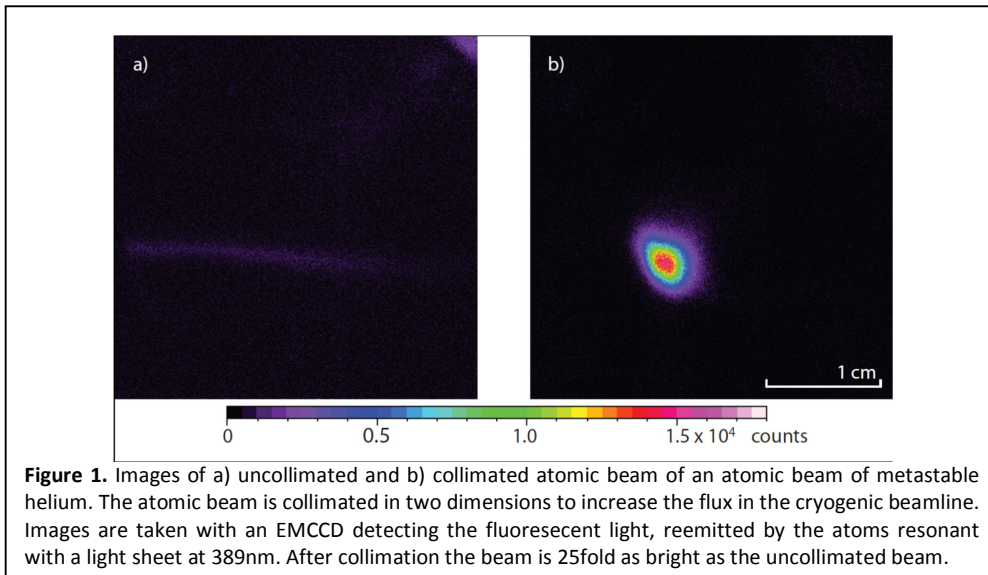


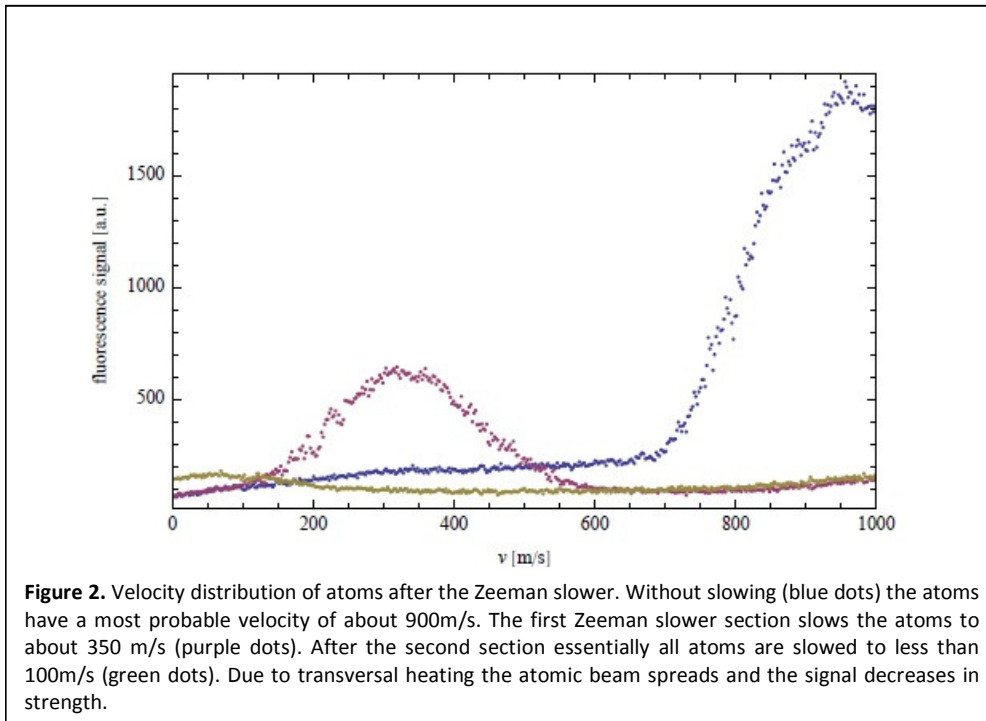
On the Road to Entangled Matter Waves in a Metastable Helium BEC

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In the 1930s Einstein, Podolsky, and Rosen (EPR) [1] initiated a fervent discussion about quantum mechanics by challenging its discrepancy with classical understanding of reality and thus stressed quantum mechanics relevance even to philosophy. After Bell's seminal paper [2], multiple experiments have verified the validity of quantum mechanics. However, most experiments up to date discussed and discuss the problem in terms of the spin-formalism of Aharonov and Bohm [3]. More closely linked to the original EPR Gedankenexperiment, we plan on investigating the entanglement of matter waves created by a Four-Wave-Mixing (FWM) process in a Bose-Einstein-Condensate (BEC) [4].



To address this problem of momentum entangled particles, we will make use of the high single atom detection efficiency of metastable helium at a Micro Channel Plate (MCP). The high internal energy of the atoms eject electrons at the plate and make them individually detectable, a necessary requirement to show their entanglement. To prepare the state, we will start with indistinguishable particles in a BEC and subsequently have them collide in a FWM process.



On the way to achieve this we have realized a source for an atomic beam of metastable helium which is then collimated (fig. 1) and slowed down (fig. 2) to be eventually trapped. The system will now be extended to implement a Magneto-Optical Trap (MOT) and magnetic trap, which lead the way ultracold atoms in the degenerated state of a BEC.

[1] A. Einstein, B. Podolsky, and N. Rosen, Phys. Rev., **47**, 777, (1935)

[2] J.S. Bell, Physics **1**, 195 (1964)

[3] D. Bohm and Y. Aharonov, Phys. Rev. **108**, 1070 (1957)

[4] A. Perrin, H. Chang, V. Krachmanicoff, M. Schellekens, D. Boiron, A. Aspect, and C. I. Westbrook, Phys. Rev. Lett., **99**, 150405 (2007)