A new-old way to split matter-waves: putting Stern-Gerlach, Zeeman, Ramsey and Rabi, in one dish.

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The splitting of matter-waves into a superposition of spatially separated states is a fundamental tool for studying the basic tenets of quantum mechanics and other theories, as well as a building block for numerous technological applications.

I will describe the realization of a matter-wave beam splitter based on magnetic field gradients on an atom chip, which can be used for freely propagating or trapped atoms in a Bose-Einstein condensate or a thermal state. The beam splitter incorporates several fundamental quantum processes such as Rabi Oscillations, Ramsey fringes, first and second order Zeeman splitting and Stern-Gerlach interactions.

As the beam splitter is "classical" in the sense that it is run by classical currents, it is interesting to see how far can technology take us in terms of coherence or more precisely, in terms of phase and momentum stability. I will describe the current situation as well as what are the fundamental limits.

The beam splitter has a wide dynamic range of momentum transfer and operation time. Differential velocities exceeding 0.5 m/s can be achieved in a few microseconds. It may enable a wide range of applications, such as, fundamental studies of many-body entanglement and dephasing processes, probing classical and quantum properties of nearby solids, and metrology of rotation, acceleration and gravity on a chip scale.

S. Machluf et al., arXiv:1208.2526 (2012).