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Spin-dependent superfluidity in ultracold BECs

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The exquisite control available in ultracold quantum gas experiments has enabled the emulation of many different quantum systems and allowed us to better understand the many-body states of quantum matter. Using the technique of artificial gauge fields, a spatially- and spin-dependent gauge potential $A_\sigma(\vec{r})$ can be engineered in a BEC, in which the kinetic energy is modified from the free-particle value to create spin-dependent artificial magnetic field, B. In the limit of strong-enough B, vortices should enter the system, but will have opposite circulation for each spin. This raises several questions: Can vortices of opposite rotation be introduced into the same condensate? Is the threshold for vortex nucleation the same as a single-component system? What are the stable spatial configurations of vortices? How do inter-spin interactions affect all of these? This talk will discuss the theoretical simulations of a spin-dependent artificial magnetic field, and discuss our progress towards realizing these gases using ultracold ^{87}Rb atoms in our laboratory.

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