Quantum sensing using imbalanced counter-rotating Bose-Einstein condensate modes

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A quantum device for measuring two-body interactions, scalar magnetic fields and rotations is proposed using a Bose-Einstein condensate (BEC) in a ring trap. We consider the situation in which the BEC is prepared in an imbalanced superposition of the two counter-propagating Orbital Angular Momentum (OAM) $l = 1$ modes. Due to quantum interference, a line of minimal atomic density appears and in the presence of non-linear interactions, this nodal line rotates. We derive an analytical expression that relates the angular frequency of the rotation of the minimal density line to the strength of the non-linear atom-atom interactions and the difference between the populations of the counter-propagating modes. Additionally, we propose a full experimental protocol based on direct fluorescence imaging of the BEC that allows to measure all the quantities involved in the analytical model and use the system for sensing purposes.

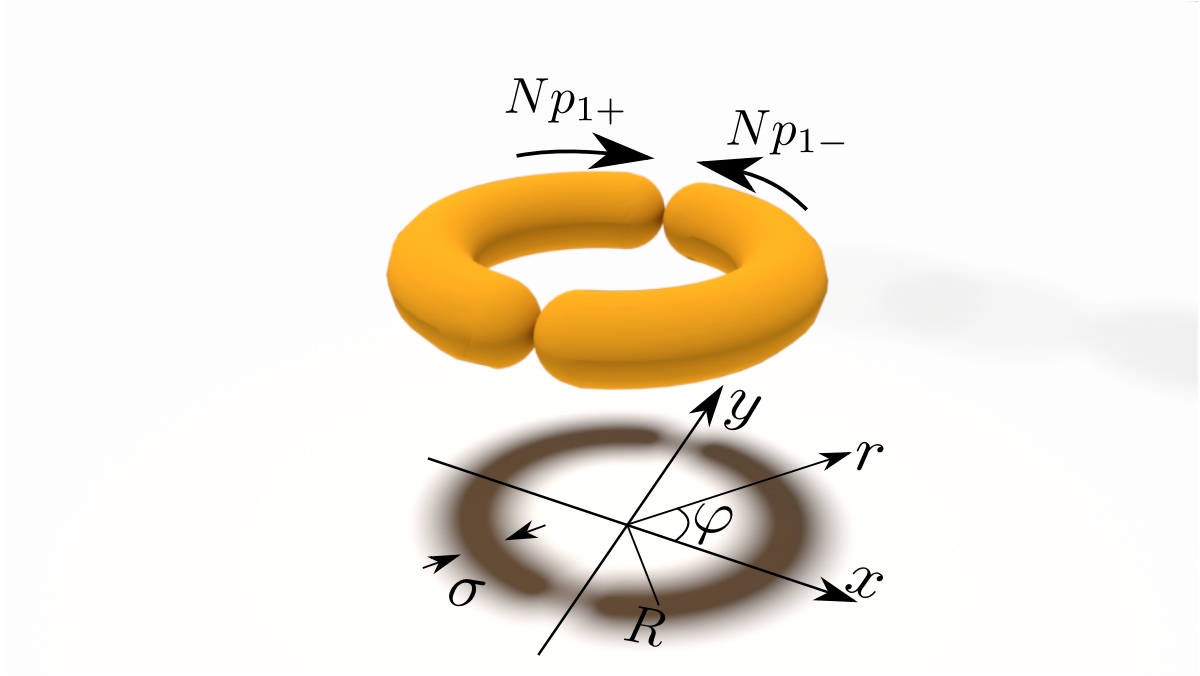

Figure 1: Sketch of the imbalanced superposition of counter-rotating OAM modes of a BEC in a ring trap considered in this work.