Angular Bloch Oscillations and their applications

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To advance precise inertial navigation, we present a compact quantum sensor which is based on novel quantum phenomenon of the angular Bloch oscillations [1] and measures solely the angular acceleration of slow external rotation. We investigate the dynamics of ultra-cold atoms confined in a toroidal trap with a ring-lattice along the azimuth angle, realized with the superposition of two copropagating Laguerre-Gaussian beams. In the presence of external rotation of small angular acceleration, or prescribed linear chirp between the two beams, the measured angular momentum of trapped atoms displays a specific periodic behaviour in time, which we name as the angular Bloch oscillations. This discovered quantum phenomenon is shown to be a key element of fruitful applications for (i) an efficient transfer of quantized angular momentum from light field to atoms, and (ii) realization of compact quantum sensor to measure exclusively the angular acceleration of external rotation.

[1] Bernd Konrad and Maxim Efremov, Angular Bloch Oscillations and their applications, arXiv:2402.12826 (2024)