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Toward rotation sensing using a trapped single ion

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Abstract

Matter-wave interferometers typically exploit entanglement between the internal state and the motional state of matter. The development of a gyroscope using an ion trap is being pursued because of the high sensitivity to rotation and insensitivity to translational acceleration. Here we aim to realize a rotation measurement using a trapped single ion based on a matter-wave Sagnac interference by exciting the motion of the ions to form a two-dimensional circular orbit. Although the matter-wave interference of ions in multi-dimensional motion is essential for gyroscopes using circular orbits, only one-dimensional interference was realized before our achievement. Our experiment has succeeded in observing matter-wave interference of ions in three-dimensional motion by exciting the motion of 171Yb+ ions using a mode-locked laser. To realize a large interferometric area, we have developed a technique to significantly increase the ion orbital area by moving the ion trap center in a short time scale. We have also constructed a whole experimental setup on a rotatable optical table, such that we can rotate the entire system with an angular velocity up to 2 degrees per second.