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Space-Time Crystals of Trapped Ions TONGCANG LI, University of California, Berkeley, ZHE-XUAN GONG, University of Michigan, Ann Arbor, ZHANG-QI YIN, Tsinghua University, H. T. QUAN, University of Maryland, College Park, XIAOBO YIN, PENG ZHANG, University of California, Berkeley, L.-M. DUAN, University of Michigan, Ann Arbor, XIANG ZHANG, University of California, Berkeley — Spontaneous symmetry breaking can lead to the formation of time crystals, as well as spatial crystals. Here we propose a space-time crystal of trapped ions and a method to realize it experimentally by confining ions in a ring-shaped trapping potential with a static magnetic field. The ions spontaneously form a spatial ring crystal due to Coulomb repulsion. This ion crystal can rotate persistently at the lowest quantum energy state in magnetic fields with fractional fluxes. The persistent rotation of trapped ions produces the temporal order, leading to the formation of a space-time crystal. We show that these spacetime crystals are robust for direct experimental observation. We also study the effects of finite temperatures on the persistent rotation. The proposed space-time crystals of trapped ions provide a new dimension for exploring many-body physics and emerging properties of matter.

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