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Hidden Roto Symmetries in Crystals and Handed Structures[1]
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Symmetry is a powerful framework to perceive and predict the physical world. The structure of materials is described by a combination of rotations, rotation-inversions and translational symmetries. By recognizing the reversal of static structural rotations between clockwise and counterclockwise directions as a distinct symmetry operation, here we show that there are many more structural symmetries than are currently recognized in right- or left-handed handed helices, spirals, and in antidistorted structures composed equally of rotations of both handedness. For example, though a helix or spiral cannot possess conventional mirror or inversion symmetries, they can possess them in combination with the rotation reversal symmetry. Similarly, we show that many antidistorted perovskites possess twice the number of symmetry elements as conventionally identified. These new symmetries, referred to as "roto" symmetries, predict new forms for roto properties that relate to static rotations, such as rotoelectricity, piezorotation, and rotomagnetism. They also enable a symmetry-based search for new phenomena, such as multiferroicity involving a coupling of spins, electric polarization and static rotations. This work is relevant to structure-property relationships in all material structures with static rotations.

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