Exploring the Origins of Vorticity in Superfluid Helium Nanodroplets by Ultrafast X-ray Coherent Diffractive Imaging

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The X-ray diffraction patterns of isolated helium nanodroplets, obtained by femtosecond single shot coherent diffractive imaging (CDI) at the LCLS, offer direct access to sizes and shapes of these superfluid systems. Partly significant deviations from spherical shapes are observed and interpreted as centrifugal distortions of rotating droplets. The spheroidal contours are analyzed in terms of the underlying angular velocity and angular momentum distributions. Mechanisms are discussed to explain the creation and propagation of quantum vorticity in the finite superfluid systems upon their emergence from the directed flow and break-up of bulk liquid helium.