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Surveying the higher dimensions of the aperiodic composite nonadecane/urea

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We recently observed for the first time that there exist phase transitions where the structural changes correspond just to degrees of freedom hidden in the internal (super)space of an aperiodic material, here the composite nonadecane/urea [1]. A key factor in the discovery of this type of transition [2] was the examination of the diffraction pattern in 3D, only possible at the time on a four-circle triple-axis neutron spectrometer, the analyzer used in zero-energy transfer to reduce the background and improve resolution. Despite the greater accessibility in reciprocal space, the weak intensity of the superlattice reflections limited the volume of reciprocal space that could be explored. Modern neutron Laue diffractometers with large image-plate detectors permit rapid and extensive exploration of reciprocal space with high resolution in the two-dimensional projection and a wide dynamic range with negligible bleeding of intense diffraction spots [3]. Surveying nonadecane/urea with neutron Laue diffraction from 300K to 4K reveals further detail of the superspace-driven phase transition, notably an increase in misorientation in the plane perpendicular to the composite misfit axis, as well as a first-order transition to a new phase at lower temperature. These new observations shed further light on how nature can use the degrees of freedom hidden in the internal superspace to form states that cannot be envisaged in the usual 3D real space.

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