The spontaneous symmetry breaking in Ta_2NiSe_5 is structural in nature

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The excitonic insulator is an electronically driven phase of matter that emerges upon the spontaneous formation and Bose condensation of excitons. Detecting this exotic order in candidate materials is a subject of paramount importance, as the size of the excitonic gap in the band structure establishes the potential of this collective state for superfluid energy transport. However, the identification of this phase in real solids is hindered by the coexistence of a structural order parameter with the same symmetry as the excitonic order. Only a few materials are currently believed to host a dominant excitonic phase, Ta_2NiSe_5 being the most promising. Here, we test this scenario by using an ultrashort laser pulse to quench the broken-symmetry phase of this transition metal chalcogenide. Tracking the dynamics of the material's electronic and crystal structure after light excitation reveals surprising spectroscopic fingerprints that are only compatible with a primary order parameter of phononic nature. We rationalize our findings through state-of-the-art calculations, confirming that the structural order accounts for most of the electronic gap opening. Our findings conclusively rule out any substantial excitonic character in this instability of Ta_2NiSe_5.