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Soft-phonon CDW formation in Kagome metals

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Kagome metals host van Hove points and flat bands, with the resulting nesting effects potentially leading to unconventional CDW states. Using inelastic X-ray scattering, we show that the CDW in KV3Sb5 forms via a continuous softening of phonons to zero energy, similar to transition metal dichalcogenides (such as NbSe2). The soft phonons exhibit a prominent in-plane anisotropy that mirrors the electron-phonon coupling (EPC) strength, suggesting that the CDW in KV3Sb5 is EPC-driven. While the bilayer Kagome metals ScV6Sn6 and LuNb6Sn6 exhibit first-order CDW transitions, soft phonons are also observed prior to their CDW transitions. However, the softest phonons occur at wavevectors distinct from the CDW ordering vector, suggesting the presence of competing ordered phases in these systems. These findings show that the EPC plays a prominent role in driving the CDW of Kagome metals, and should be considered in understanding their CDW and superconducting states.

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