LnSb$_x$Te$_{2-x-\delta}$ ($Ln= $ Lanthanide) is a family of square-net-derived magnetic topological semimetals that exhibits an evolving charge density wave (CDW) distortion, in which $q_{\text{CDW}}$ is controllable by $x$ and the distortion of the structure is localized within the square net[1]. Control of band filling by substitution allows for access to different topological states[2], making LnSb$_x$Te$_{2-x-\delta}$ an interesting system to study the interplay of crystal symmetry, band topology, magnetism, and electronic correlation. Previous studies on Gd[3] and Ce[4] members displaying CDW have shown complex magnetic phase diagrams which imply the interaction of the CDW with spins localized on Ln, but a dearth of magnetic structures have been solved within the CDW regime for this family of compounds. Herein, we report on the interaction of the CDW with magnetism in NdSb$_x$Te$_{2-x-\delta}$ via comparison of the undistorted square net member NdSb$_{0.94}$Te$_{0.92}$ with the CDW-distorted phase NdSb$_{0.48}$Te$_{1.37}$, using single-crystal x-ray diffraction, magnetometry, heat capacity, and neutron powder diffraction[5]. NdSb$_{0.94}$Te$_{0.92}$ is a collinear antiferromagnet with $T_N \sim 2.7$ K, where spins align parallel to the plane of the square net, but antiparallel to each other. NdSb$_{0.48}$Te$_{1.37}$ exhibits a CDW with a near-five-fold structural modulation ($q_{\text{CDW}} = 0.18b$), isostructural to previously studied LnSb$_x$Te$_{2-x-\delta}$ at similar $x$. The magnetic phase diagram of NdSb$_{0.48}$Te$_{1.37}$ is significantly more complex, with $T_N = 2.3$ K, additional metamagnetic transitions, and an elliptical cycloid magnetic structure ($q_{\text{mag}} = -0.41b$) determined by neutron diffraction. The magnitudes of $q_{\text{CDW}}$ and $q_{\text{mag}}$ fit to an integer relationship $1+2q_{\text{mag}} = 2q_{\text{CDW}}$, indicating a coupling relationship between the CDW and the spin cycloid. Finally, preliminary neutron diffraction on Ce analogue CeSb$_{0.57}$Te$_{1.4}$ indicates that the spin alignment of the undistorted parent may determine if the same coupling occurs in other Ln.

References

Figure 1