Unusual thermal Hall effect in the 3*d* cobalt Kitaev system $Na_2Co_2TeO_6$

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Kitaev physics has recently attracted attention in condensed matter for its anticipated novel quantum spin liquid state. The thermal transport measurement is crucial for probing the novel features of charge-neutral quasiparticles. In this letter, we report a significant thermal Hall effect in $Na_2Co_2TeO_6$ (NCTO), a Kitaev spin liquid candidate, when the magnetic field is applied along the out-of-plane direction of the honeycomb plane. The thermal conductivity (κ_{xx}) and thermal Hall conductivity (κ_{xy}) in NCTO reveals distinct magnetic field dependences below and above the Neel temperature (T_N) of 27 K. For $T>T_N$, κ_{xx} has a monotonic decrease in the field dependence, while κ_{xy} persists up to T^* = 150 K. On the other hand, both κ_{xx} and κ_{xy} exhibit complex field dependence for $T<T_N$. We found that the experimental κ_{xy} data are inconsistent with reported magnon or phonon Hall scenarios. Comparing the similar thermal properties of NCTO and α-$RuCl_3$, we suggest that both NCTO and α-$RuCl_3$ would share the origin for thermal Hall effect.