Supplementary materials for "Distinct switching of chiral transport in the kagome metals KV$_3$Sb$_5$ and CsV$_3$Sb$_5"$

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Supplementary Note 1: Angular dependence of magnetoresistance

The angular dependence of magnetoresistance is measured with a rotation from c to a’-axis for both CsV$_3$Sb$_5$ and KV$_3$Sb$_5$ (Supplementary Figure 1). Here $\theta$ stands for the angle between c-axis and field direction, and a’ is defined as the in-plane direction perpendicular to a-axis. For the longitudinal configuration with the field applied approximately parallel to the current direction, a negative magnetoresistance (MR) is observed in CsV$_3$Sb$_5$. This is possibly due to the reduction of boundary scattering in magnetic field, as commonly seen in clean metals where the transport mean free path is comparable to the size of the microstructure. For KV$_3$Sb$_5$, the longitudinal magnetoresistance also tends to saturate at high magnetic field yet no negative MR is observed. This suggests an enhanced scattering rate in KV$_3$Sb$_5$ likely due to K-vacancies. Therefore, the quantum oscillation amplitude is also smaller in K- compared to Cs-compound, yet clear quantum oscillations can still be observed up to 75 deg for both materials.

Supplementary Note 2: FFT analysis of quantum oscillations

By subtracting the third-polynomial function as a MR background, we have obtained the SdH oscillations for various angles. After having identified all peaks in the Fast Fourier Transform analysis (Supplementary Figure 2) with the field window of 5 to 35 T, the full angular dependence of the high oscillation frequencies ($F > 500$ T) is presented in Fig. 2.

Supplementary Note 3: Angular dependence of $V_{2\omega}$

The angular dependence of the second harmonic response in CsV$_3$Sb$_5$ displays a strong spike and its sign switches when the magnetic field rotates across the Kagome plane (Supplementary Figure 3). Such enhancement is consistently observed in previous measurements and provides direct evidence of a field-switchable electronic chirality in CsV$_3$Sb$_5$. Such behavior is absent in KV$_3$Sb$_5$ as $V_{2\omega}$ as a consequence of minimized chiral transport. These results consistently demonstrate the distinct switching of chiral transport in CsV$_3$Sb$_5$ and KV$_3$Sb$_5$. 
Supplementary Note 4: Heating-induced extrinsic second harmonic generation in KV$_3$Sb$_5$

To verify the possible extrinsic origin of the second harmonic voltage generation, we have measured the device at the same temperature and field configuration yet with different thermal conditions (Supplementary Figure 4). By adding a slight amount of He$^4$ exchange gas to the sample chamber, the thermal link between the microstructure and the sample space is enhanced. If the second harmonic voltage we measured is completely intrinsic, this change of thermal condition shall not alter the signal at all$^1$. However, a change of the signal can be observed which suggests the existence of extrinsic second harmonic voltage, most likely due to the thermal gradient across the device. This is likely due to the contact resistance difference between the two current leads. Consistently a field-symmetric component is readily observed and the signal measured at ± 35 T is differed by about 20 % for $\theta = -1$ deg.

SUPPLEMENTARY REFERENCES

Supplementary Figure 1. **Angular dependence of magnetoresistance.** The angular magnetoresistance is measured with a field rotation from c to a’-axis and θ here stands for the angle between the field direction and c-axis. Clear quantum oscillations are readily observed in both materials, yet the amplitude is comparatively small for KV₃Sb₅ due to the reduced sample quality.
Supplementary Figure 2. **Angle-dependent FFT spectrum.** The Fast Fourier Transform (FFT) analysis of quantum oscillations at various angles allows us to identify the angular evolution of each peak. The corresponding frequencies are summarized in Fig. 2.
Supplementary Figure 3. **Angular dependence of $V_{2\omega}$.** The angular dependence of the second harmonic voltage in CsV$_3$Sb$_5$ displays a clear spike only when the field direction is close to the Kagome planes, consistent with the previous reports$^1$. Such behavior is not observed in KV$_3$Sb$_5$ as the second harmonic signal remains unchanged with varying $\theta$. 

![Graph showing angular dependence of $V_{2\omega}$]
Supplementary Figure 4. Origin of extrinsic second harmonic voltage generation. The field-dependence of $V_{2\omega}$ has been measured with two different thermal conditions. By adding more exchange gas to the sample space, the signal is significantly altered, suggesting Joule heating as the origin of the observed second harmonic signal.