Hall effect of neutral spin excitations

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The Lorentz force causes a charged particle moving in a magnetic field \( \mathbf{B} \) to describe a cyclotron orbit (Fig. A). The curved trajectory also leads to the Hall effect. Can neutral particles or “spin excitations” called magnons exhibit the Hall effect in a magnetic field? In Fig. B, a magnon is depicted as a packet of reversed spins moving in a sea of “down” spins. Theory has predicted that mobile magnons in certain quantum magnets can be deflected left (or right) by \( \mathbf{B} \). Hirschberger et al. recently observed this “thermal” Hall effect in two materials at cryogenic temperatures. In a kagome lattice (Fig. C), the magnons display a sizeable thermal Hall signal with a rich pattern of behavior [1]. In the pyrochlore \( \text{Tb}_2\text{Ti}_2\text{O}_7 \), the spins do not order even at 50 mK (a state called the spin liquid). Nonetheless, the spin excitations also display a thermal Hall effect [2]. The two results confirm that neutral “particles” do experience a novel type of Lorentz force despite lacking a charge.