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Collective modes of a helical liquid[1] SRINIVAS RAGHU, SUK BUM CHUBG, Stanford University, XIAO-LIANG QI, Microsoft Station Q, SHOU-CHENG ZHANG, Stanford University — We study low energy collective modes and transport properties of the "helical metal" on the surface of a topological insulator. At low energies, electrical transport and spin dynamics at the surface are exactly related by an operator identity equating the electric current to the in-plane components of the spin degrees of freedom. From this relation it follows that an undamped spin wave always accompanies the sound mode in the helical metal – thus it is possible to 'hear' the sound of spins. In the presence of long range Coulomb interactions, the surface plasmon mode is also coupled to the spin wave, giving rise to a hybridized "spin-plasmon" mode. We make quantitative predictions for the spin-plasmon in Bi_2Se_3, and discuss its detection in a spin-grating experiment.

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