Far out-of-equilibrium spin populations trigger giant spin injection into atomically thin MoS_2

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Efficient spin injection into semiconductors remains a formidable and elusive challenge even after almost three decades of major scientific effort, studded by obstacles and only partial workarounds.

Few years ago I predicted the possibility of injecting massive ultrashort spin current pulses across a ferromagnetic metal/semiconductor interface [M. Battiato, K. Held, Phys. Rev. Lett. 116, 196601 (2016)]. We have now proved experimentally the prediction.

By injecting strongly out-of-equilibrium sub-picosecond spin current pulses across a bare ferromagnet/semi-conductor interface, we have overcome the crippling problem of impedance mismatch and obtained a massive spin transfer. We demonstrated this by producing ultrashort spin current pulses into cobalt and injecting them into monolayer MoS2. The semiconducting MoS2 layer also acts as a selective converter of the spin current into a charge current, whose THz emission is then measured. As predicted, we measured a giant spin current, orders of magnitude larger than typical injected spin current densities in modern devices.