Probing the AC response of individual atoms serving as a platform for an atomic Boltzmann machine

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The concept of the atomic Boltzmann machine is based on the recently discovered idea of orbital memory [1,2]. Orbital memory is characterised by two stable states which are distinguished by two distinct magnetic moments [2,3]. Stochastic switching can be induced between the two states and probed by scanning tunneling microscopy (STM). The favorability of the individual states depends strongly on the bias voltage applied between STM tip and sample. Further, coupled atoms that exhibit orbital memory show multi-stability in their stochastic dynamics. This multi-well energy landscape serves as a basis for the Boltzmann machine and realizing multiple time scales.
In this poster, we will present how the stochastic behavior of individual orbital memory responds to time-dependent voltage signals [4]. Using scanning tunneling microscopy, we investigate individual Co and Fe atoms on the surface of black phosphorus. We characterize the frequency and amplitude dependence of the stochastic noise, illustrating how the lifetime and favorability of states are modified. We will give a perspective on how this can be used in hardware realizations of the Boltzmann machine.

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[3] B. Kiraly et al., Phys. Rev. Research 4, 33047 (2022).
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