Spin-polarized tunable photocurrents

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Circular dichroism, a distinct response to left and right-handed circularly polarized light, is an example of a phenomenon involving light-matter interaction that has been heavily exploited to control valley polarization in two-dimensional materials [1]. In most studies, light-matter interaction enters perturbatively and does not modify the electronic properties. But beyond this weak-coupling regime, Floquet-engineering [2-4] has shown that we can use light to change the band-structure of a material [5-7] and even its topology [2-4, 8], generating a Hall response [9].

Light can also be used to generate directed currents even in the absence of an applied bias voltage, a phenomenon called quantum pumping, and recently it has been shown that by tailoring a selective environment one can take this to the limit of a perfect isolator effect [10], where currents flow in one direction but not the opposite.

Here, we go a step further and show how the rich interplay between electron-photon processes (and the additional synthetic dimension), stacking order, spin-orbit coupling, and the topology of a two-dimensional material can be harnessed to control spin, charge, and valley currents in two-dimensional materials, beyond the weak-coupling regime [11].

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FIGURES

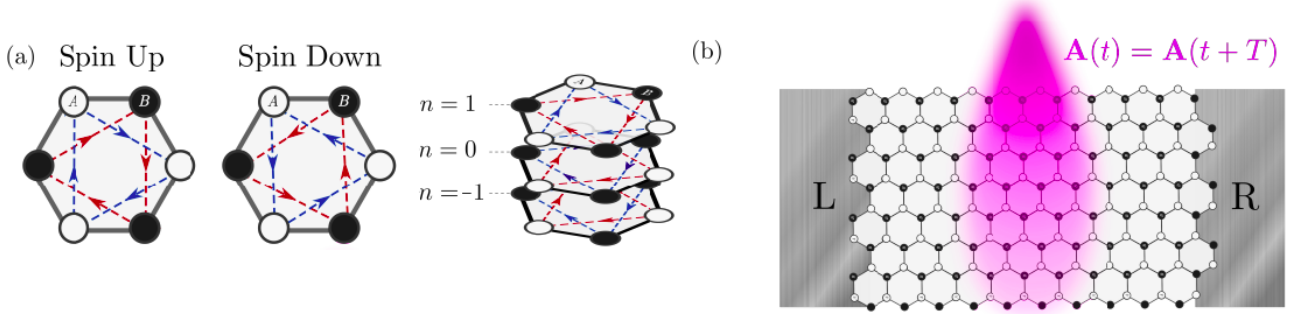

Figure 1: Under the light spot, the system develops the replica scheme unfolding itself into several copies which represent photon dressed processes (a, right). In (b) a schematic representation of the device we will consider in the transport setup. Under particular conditions, the transport of one spin might be suppressed while the remaining is perfectly unaffected.