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Magnetoelectric effects and valley dependent spin resonances in transition metal dichalcogenide bilayers ZHIRUI GONG, Department of Physics, The University of Hong Kong, Hong Kong, China, GUI-BIN LIU, School of Physics, Beijing Institute of Technology, Beijing 100081, China, HONGYI YU, Department of Physics, The University of Hong Kong, Hong Kong, China, DI XIAO, Department of Physics, Carnegie Mellon University, Pittsburgh, Pennsylvania, 15213, USA, XIAODONG CUI, Department of Physics, The University of Hong Kong, Hong Kong, China, XIAODONG XU, Department of Physics, University of Washington, Seattle, Washington, 98195, USA, WANG YAO, Department of Physics, The University of Hong Kong, Hong Kong, China — In addition to spin, valley is an internal degrees of freedom of carriers in monolayer group-VI transition metal dichalcogenides (TMDCs). In bilayer, carrier is also characterized by the layer pseudospin, which is associated with the electrical polarization. Here we show in TMDC bilayers, the spin, valley and layer pseudospins of carriers are strongly coupled to each other. Because of this coupling, most of the spin physics in TMDC monolayer such as the spin Hall effect and spin-dependent selection rule for optical transitions are inherited in TMDC bilayers. The strong coupling between spin and layer pseudospin also gives rise to a variety of magnetoelectric effects that make possible quantum manipulation of these electronic degrees of freedom. For example, electric polarization will oscillate in a magnetic field, while electric field can be used to tune the spin precessions. Moreover, the coupling between spin, valley and layer pseudospins makes possible valley dependent spin resonances such that spin rotations can be selectively addressed in the two valleys.

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