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Symmetry analysis of phosphorene: electronic structure with spin-orbit interaction PENGKE LI, IAN APPELBAUM, Univ of Maryland-College Park, APPELBAUM'S GROUP TEAM — We present a symmetry analysis of electronic band structure including spin-orbit interaction close to the insulating gap edge in monolayer black phosphorus ("phosphorene"). Expressions for energy dispersion relation and spin-dependent eigenstates for electrons and holes are found via simplification of a perturbative expansion in wave vector k away from the zone center using elementary group theory. Importantly, we expose the underlying symmetries giving rise to substantial anisotropy in optical absorption, charge, and spin transport properties, and reveal the mechanism responsible for valence band distortion and possible lack of a true direct gap. We discovered that, spin flip processes are decoupled by symmetry from flexural phonons, allowing us to predict a spin lifetime comparable to bulk Si, vastly greater than graphene.

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