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Many–body physics of ultracold doublet sigma molecules in optical lattices[1] GAVRIIL SHCHEDRIN, DANIEL JASCHKE, WEI HAN, LINCOLN CARR, Colorado School of Mines, Golden, Colorado, USA, DERMOT G. GREEN, Durham University, Durham, UK, JESUS ALDEGUNDE, Universidad de Salamanca, Salamanca, Spain, JEREMY M. HUTSON, Durham University, Durham, UK — The creation of ultracold polar molecules provides a unique opportunity to discover and explore new regimes in strongly interacting many–body quantum systems. Polar molecules have strong long–range dipole–dipole interactions that allow one to realize exotic phenomena such as topological phases and quantum magnetism. We explore quantum many–body systems formed by molecules in doublet sigma ($^2\Sigma$) states, with both electric dipole moments and electron spin $S = 1/2$, but without electronic orbital momentum. The Hamiltonian for doublet sigma molecules includes molecular rotation terms, spin–rotation interaction, hyperfine terms including both spin–spin and nuclear electric quadrupole interactions, and molecular dipole–dipole interactions. The complete control of the molecular quantum states can be accomplished by applying electric and magnetic fields to molecules trapped in optical lattices. We provide the complete theoretical treatment for experimentally relevant doublet sigma molecules such as SrF and CaF and discuss the associated single–body and many–body physics.

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