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Rydberg atom mediated polar molecule interactions¹

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Manipulating Rydberg interactions in ultracold ensemble is currently in vogue due to the long-range nature of forces and large dipole moments. Interactions between ultracold Rydberg and ground state atoms lead for formation of exotic classes of Rydberg molecules with peculiar properties. A particular class of such homonuclear molecules was recently observed to exhibit linear Stark shifts, pointing to significant permanent electric dipole moments. The symmetry-breaking in these molecules is explained. Rydberg atom mediated coupling with polar molecules leads to formation of ultralong range polyatomic molecules, which can be employed to dramatically enhance the range of controlled interaction between polar molecules, to coherently control molecular orientation, and to individually address polar molecules in optical lattices. A number of scenarios are described.

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