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A case for photoassociative production of long-range tetramers in the ultracold regime[1] MARKO GACESA, Bay Area Environmental Research Institute and NASA Ames Research Center, Moffett Field, CA 94035, USA, JASON BYRD, ENSCO, Inc., 4849 North Wickham Road, Melbourne, FL 32940, USA, ROBIN CÔTÉ, Department of Physics, University of Connecticut, Storrs, CT 06269-3046, USA — We theoretically demonstrate the feasibility of the optical formation of cold long-range tetramers in the ground electronic state from ultracold pairs of polar diatomic molecules in a planar geometry. Based on the relative orientation of two interacting dimers, we find that a tetramer can be formed either as a loosely bound "dimer-dimer" complex in a very extended halo state or as a true long-range tetramer molecule. The latter is of particular interest because it constitutes a specific type of bond between two polar molecules with possible significant consequences for quantum emulation of long-range planar Hamiltonians similar to those found in high-temperature superconductivity models. Our numerical studies were conducted for ultracold molecular gases of KRb and RbCs, resulting in production of $(KRb)_2$ and $(RbCs)_2$ complexes. However, the proposed approach is based on universal properties of polar molecules and the conclusions can be generalized to formation of polyatomic molecules with five or more atoms that have favorable ratio of dipole and quadrupole polarizabilities.

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