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Ultra-long-range molecules and ultracold heavy Rydberg systems FREDERIC HUMMEL, PETER SCHMELCHER, Center for Optical Quantum Technologies, University of Hamburg, Luruper Chaussee 149, 22671 Hamburg, Germany, HERWIG OTT, Research Center OPTIMAS, Technische Universitt Kaiserslautern, 67663 Kaiserslautern, Germany, HOSSEIN SADEGHPOUR, ITAMP, Harvard-Smithsonian Center for Astrophysics 60 Garden St., Cambridge, Massachusetts 02138, USA — Ultralong-range Rydberg molecules (ULRMs) are bound states between a Rydberg atom and one or more ground-state atoms with bond lengths on the order of thousands of Bohr radii. The binding originates from electron-atom scattering and leads to exotic oscillatory potential energy surfaces that reflect the probability density of the Rydberg electron. Heavy Rydberg systems (HRS) are highly excited, binary atomic systems, which consist of a positive and a negative ion. The large reduced mass leads to high principal quantum numbers up to several thousand, which can be achieved in ultracold samples. We here propose an experimentally feasible and efficient protocol to create HRS via photoassociation to an intermediate ULRM. The Rabi coupling is typically in the MHz range and the permanent electric dipole moments of the HRS can be as large as one kilo-Debye. We identify specific transitions which place the creation of the heavy Rydberg system within immediate reach of experimental realization.

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