High Resolution Spectroscopy of Long-Range "Trilobite-like" States of Ultracold $^{85}Rb_2$ Molecules*

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Abstract

We observe long-range "trilobite-like" states of ultracold 85Rb2 molecules in which a novel form of chemical bonding occurs: an ultracold ground state atom is bound by the attraction of the Rydberg electron, with its Rydberg electronic wavefunction in np Rydberg atomic levels with n = 7-12 [1]. Unlike earlier work by others at much higher n formed by photoassociation, our observations involve bound-bound transitions excited in the ultraviolet where the upper state autoionizes to produce Rb2+, which is detected by time-of-flight mass spectroscopy. The lower state in these observations is primarily v''= 35, J''= 1 of the metastable a $^3\Sigma_u^+$ state. The important upper electronic states are calculated to be a $^3\Pi_g$ and a $^3\Sigma_g^+$ state, each with a deep short range well and a shallow long range well and an intermediate barrier between the two wells [2]. Recently we have improved our resolution by over a factor of 100 and now see well-defined structure in lines that were unresolved in ref. [1]. Our latest data and analysis will be discussed.
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[1] M.A. Bellos, *et al.*, Phys. Rev. Lett. **111**, 053001 (2013).
[2] M.A. Bellos, et al., Phys. Rev. A **87**, 012508 (2013).