

HALO NUCLEIC MOLECULES: MOLECULES FORMED FROM AT LEAST ONE ATOM WITH A HALO NUCLEUS. EMPHASIS ON  $^{11,11}\text{Li}_2$  ALONG WITH OTHER EXOTIC ISOTOPOLOGUES.

NIKE DATTANI (dattani.nike@gmail.com), STASZEK WELSH, *Physical and Theoretical Chemistry Laboratory, Oxford University, Oxford, United Kingdom.*

Atoms whose nuclei have an exotic number of nucleons can have a ‘core nucleus’ surrounded by a ‘halo’ formed by a nucleon orbiting the core nucleus. For example, due to the two halo neutrons orbiting the core nucleus of  $^{11}\text{Li}$ , its nucleus has a cross section that is roughly the same size as that of  $^{208}\text{Pb}$ . Halo nucleic atoms have been studied extensively both in theory and in experiments, however halo nucleic molecules have not been studied in either. We first show, using  $\text{HeH}^+$ ,  $\text{BeH}$ , and  $\text{MgH}$  as examples, that with measurements of any two isotopologues of a molecule, we can determine crucial properties of a third isotopologue well within spectroscopic accuracy. We then use the extremely precise empirical information available<sup>a,b,c,d</sup> for the low-lying states of  $^{6,6}\text{Li}_2$ ,  $^{6,7}\text{Li}_2$  and  $^{7,7}\text{Li}_2$  to predict potentials and various properties of the halo nucleic molecule  $^{11,11}\text{Li}_2$ , along with isotopologues containing  $^3\text{Li}$ ,  $^4\text{Li}$ ,  $^5\text{Li}$ ,  $^8\text{Li}$ ,  $^9\text{Li}$ ,  $^{10}\text{Li}$ , and  $^{12}\text{Li}$ . We believe that our predictions of the ro-vibrational energies are reliable for experiments for the first detection of a halo nucleic molecule.

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<sup>c</sup>M. Semczuk, X. Li, W. Gunton, M. Haw, N. S. Dattani, J. Witz, A. Mills, D. J. Jones, K. W. Madison, *Phys. Rev. A* **87**, 052505 (2013)

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