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

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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 $^{11}$Li, its nucleus has a cross section that is roughly the same size as that of $^{208}$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 HeH$^+$, BeH, and 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$^{a,b,c,d}$ for the low-lying states of $^{6,6}$Li$_2$, $^{6,7}$Li$_2$ and $^{7,7}$Li$_2$ to predict potentials and various properties of the halo nucleic molecule $^{11,11}$Li$_2$, along with isotopologues containing $^3$Li, $^4$Li, $^5$Li, $^6$Li, $^7$Li, $^8$Li, $^{10}$Li, and $^{12}$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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