A New Type of Molecule

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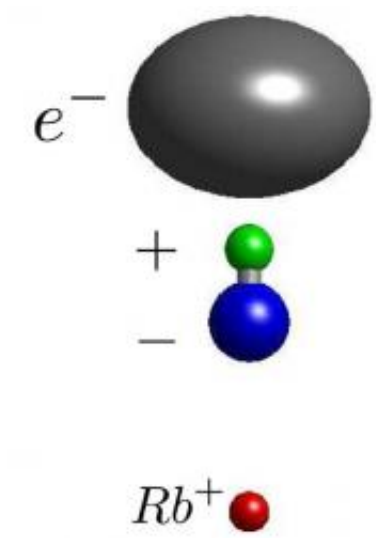

A schematic drawing of a new type of molecule with relatively gigantic dimensions, designed in theory by CfA scientists. The new molecule could be made in ultra-cold situations when a normal molecule is bound to an atom in a large excited state, for example as shown here with potassium-rubidium (KRb; the blue and green spots) joined to an excited large atom of rubidium (the red spot and gray electron cloud). Credit: S. Rittenhouse and H. Sadeghpour

(PhysOrg.com) -- A Rydberg atom is one with an electron that spends most of its time far from the nucleus. Rydberg atoms, which are normally artificially produced, can have dimensions thousands of times larger than typical atoms or simple molecules.

Because these giants push the envelope of our understanding of atomic physics they are interesting in their own right, but scientists also wonder

whether their extreme properties might be useful.

Two CfA scientists, Seth Rittenhouse and Hossein Sadeghpour, used the known properties of Rydberg atoms to "invent," theoretically, a new kind of gargantuan molecule and to predict its properties.

They paired a giant rubidium Rydberg atom with a normal molecule of potassium-rubidium. Like most molecules, the potassium-rubidium molecule has a slight internal charge separation induced by the different charges in its two nuclei.

That charge structure enabled the scientists to show that it should bind to the Rydberg atom to produce a molecule even larger than the giant atom.

Moreover, this amazing new form of matter should have an internal structure that retains information about the charge separation of both the Rydberg atom and its molecular partner, a property that could be useful in making a quantum "bit" that might someday be used in quantum computers.

Although this invention now needs to be realized in a laboratory, the research has already demonstrated that a new class of molecules might in principle result from combining giant atoms in carefully tailored configurations.

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