Search for Superconductivity in Alkali Metals under High Pressure

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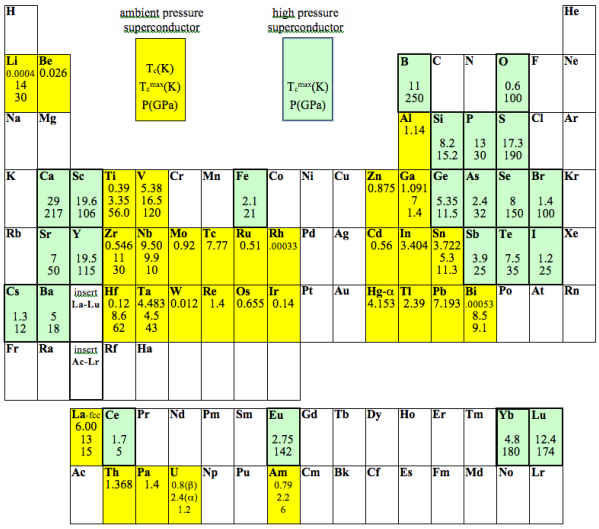
The alkali-metal column begins with the most abundant element in the universe, hydrogen (H), and ends with perhaps the rarest element on earth, francium (Fr), with lithium (Li), sodium (Na), potassium (K), rubidium (Rb), and cesium (Cs) lying in-between. Hydrogen reportedly becomes metallic at low temperatures under the enormous static pressure 495 GPa [1], but the anticipated high-temperature superconductivity [2] has yet to be demonstrated.

By virtue of their extremely high compressibility [3], the other alkali metals display under pressure the most dramatic variation of properties of any group of elements in the periodic table, ranging from textbook nearly-free-electron behavior at ambient pressure to exotic highly correlated electron properties under extreme pressure whereby the conduction band narrows and the Fermi surface becomes multi-connected, as for the transition metals [4]. The conventional bcc-to-fcc phase transition in all alkali metals is followed by a transition to more exotic low-symmetry structures at higher pressures [5], structures that for the most part are retained in the ground state of K, Rb, and Cs at low temperatures [6]. In fact, at these Mbar pressures the alkali metals actually turn into electrides as the conduction electrons are forced into interstitial lattice sites [7]. Li even undergoes a metal-semiconductor transition above 80 GPa [8], reverting to a metal again for pressures exceeding 120 GPa [9].



Periodic Table of Superconductivity. All data from [10] except for Ca [11], Yb [12], and, at ambient pressure, Bi [13].

As seen in the *Periodic Table of Superconductivity*, the only alkali metal known to superconduct at ambient pressure is Li at 0.4 mK, T_c rising to 14 K at 30 GPa, whereas Cs becomes superconducting near 1.3 K at 12 GPa. The search for superconductivity in the alkali metals until 2006 has been reviewed [3].

In this talk I will report the results of a more recent search for superconductivity under extreme pressure in Cs and other alkali metals [14].

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