Enormous entropy enhancement revealed in linked nuclear and atomic Li + D fusion in metallic Li liquid

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Deuterons in the energy range 10 – 30 keV have been implanted on a surface of metallic Li liquid just above the melting point (181C). Alpha particles produced in the fusion reaction 7Li + d 8Be + n 2 + n were detected and identified using an SSD and thin foil energy loss method. A telescope consisting of a *E* and *E* detector was also used. The rate of alpha particles normalized to the full solid angle was about one million per second at 1 A of deuterons. This is a factor 1010 - 1015 higher than what is expected based on available cross sections for the nuclear fusion at low energy 1). Since we do not observe any alpha particles when the Li sample is at room temperature the enhancement must be connected with the thermodynamic force in the liquid.

In fact this enhancement was predicted two years ago based on a thermodynamic argument similar to the theory of irreversible chemical reactions in liquids 2). In the nuclear stopping or buffer energy range of collision of ions or atoms, their electrons adjust continuously and smoothly to the nuclear fusion reforming electronic configuration state. In this case the irreversible atomic Li + D Be process is linked with the nuclear fusion process in liquids and governed by the Gibbs energy change ($G < 0$) in the atomic process revealing the enormous entropy enhancement, $\exp(-G/k_B T) >> 1$.

In any irreversible process, the reaction rate is proportional to the rate of entropy increase. This general thermodynamic relation is accurate regardless of nature of microscopic inter-particle interactions (A. Einstein) 3). One aspect is, common to all irreversible processes, the appearance of long-range coherence. Here macroscopically distinct parts of liquid become correlated and result in the thermodynamic force 3). This is consistent with our observation of alpha energies up to the full Q-value of 15 MeV implying the break up of 8Be into unidirectional coherent alpha particle pair 1).

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