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Electron screening in laboratory experiments-an unresolved effect

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Energy production, evolution and neutrino emission in stars are governed by fusion reactions. The influence of surrounding electrons that inevitably surround interacting nuclei is very poorly understood in still experimentally unachievable stellar plasmas. Therefore, it is of significant importance to measure the bare cross sections as well as possible. The probability for tunnelling through the Coulomb barrier depends on its height exponentially and even small changes to the barrier caused by electrons surrounding the reactants in laboratory experiments have a significant effect on the fusion cross section. As a result, the measured cross sections are enhanced compared to cross sections for bare nuclei. Experimental studies of various nuclear reactions in metallic environments have shown the expected cross section enhancement at low energies [1-4]. However, the enhancements in metallic targets were significantly larger than expected from the adiabatic limit, which is thought to provide the theoretical maximum for the magnitude of electron screening. The electron screening is an effect far from being understood in the laboratory conditions and consequently it cannot be deduced theoretically. Moreover, its size has to be measured for each metallic environment and each target separately. Recently, we performed an extensive experimental campaign, with an aim to study the electron screening in the laboratory for various nuclear reactions and involving both low and high Z targets. The 1H(7Li,α)4He fusion reaction was studied for hydrogen implanted Pd, Pt, Zn and Ni targets. Large electron screening, of a few keV was observed in all targets. On the contrary, no large electron screening was observed in the following proton induced reactions: 55Mn(p,γ)56Fe, 55Mn(p,n)55Fe, 113Cd(p,n)113In, 115In(p,n)115Sn, 50V(p,n)50Cr and 51V(p,γ)52Cr. Moreover, no shift in resonance energy for metallic compared to insulator environment was observed for the studied (p,n) and (p,γ) reactions. In a continuation of our experimental campaign, we further investigated the 1H(7Li,α)4He reaction in W, Pd and C environments. In addition, we also focused on studies of electron screening in the 1H(19F,αγ)16O reaction in the same targets (in both normal and inverse kinematics). Preliminary results showed unexpectedly large electron screening values (of the order of 10 keV), pointing to a dependence of the electron screening potential on the position of the target nuclei in metallic lattice as well as to a non-linear scaling (instead of widely accepted linear one) of electron screening potential with the charge number of the target. These hypotheses, if correct, would have a profound effect on the understanding of the "laboratory"electron screening effect and would eventually lead to the more correct bare cross sections extracted from laboratory measurements. Untill plasma experiments become feasible in the laboratory, the study of electron screening in a metal - the plasma of a poor man [2], is the only means of study that will hopefully successfully point towards the correct interpretation of the electron screening and further understanding of immensely important fusion processes in stellar environments. A review of previous results, as well as newly obtained ones will be presented.

[1] J. Cruz et al., Phys. Lett. B624, 181 (2005).
[2] C. Rolfs, AIP Conf. Proc. 847, 245 (2006).
[3] F. Raiola et al., Eur. Phys. J. A 19, 283 (2004).
[4] K. U. Kettner et al., J. Phys. G 32, 489 (2006).

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