Energy Dependent Barrier Penetration Model for Heavy - Ion Fusion at Deep Sub-Barrier Energies

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Nuclear fusion at extreme sub - barrier energies has been revisited recently [1, 2]. Jiang et al.[1] have observed that the Wong model analysis fails to reproduce the data at low energies and the logarithmic slope L(E) increased with decrease of energy in contrast to a constant value expected at these energies. Hagino et al. [2] have pointed out that the failure of the Wong model analysis is partly due to the parabolic shape of the fusion barrier assumed in the model. Further, they noted that the increase in L(E) at sub - barrier energies is consistent with the large diffuseness parameter required to fit the fusion data. We have invesitgated the unusual behaviour of the fusion cross section at deep sub - barrier energies using the energy and angular momentum dependent barrier penetration model (ELDBPM) [3]. The fusion data spanning a large range of energies(for 25 systems) have been fitted using the six parameters of the ELDBPM (V_1,E_1,V_2,E_2,R_B and $\hbar\omega$). The fits to data for ^{58}Ni + ^{58}Ni and ^{60}Ni + ^{89}Y systems are shown in fig.1. While the highest barrier V_2 values are similar to the sudden barrier values, the lowest barriers V_1 are very close to the adiabatic barriers determined using Ref.4 [4] prescription with modified radius parameter and surface tension coefficient values. To sum up, the unusual behaviour for fusion cross sections observed at deep sub - barrier energies can be described using the ELDBPM.

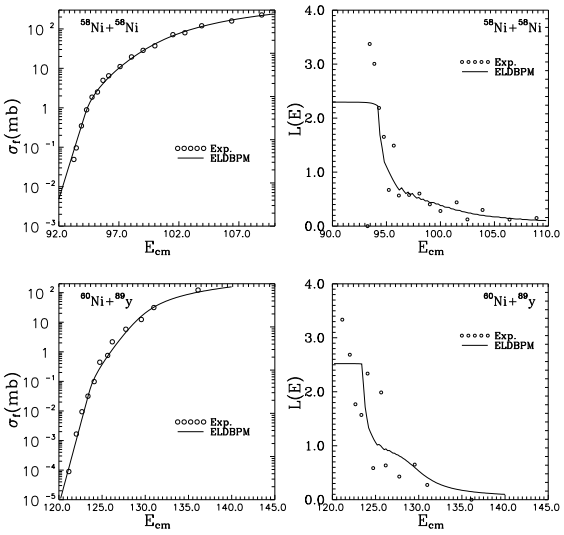

Figure 1: Fusion excitation function and L(E) fits for Ni+Ni and Ni+Y systems

[1] C. L. Jiang et al. Phys. Rev. Lett. **89** 052701 (2002)

[2] K. Hagino, N. Rowley and M. Dasgupta, Phys. Rev. **C67** 054603 (2003)

[3] A. K. Mohanty et al. Phys. Rev. Lett. **65** 1096 (1990); Phys. Rev. **C46** 2012 (1992)

[4] K. Siwek - Wilzynska and J. Wilzynski Phys. Rev. **C64** 024611 (2001)