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Continuum e ects in nuclear transfer reactions

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Abstract. We develop a semiclassical calculation for nuclear transfer reactions where the continuum is treated in an exact way, and compare the results with those of a treatment in which the continuum is neglected. We conclude that the influence of the continuum is very important for weakly bound reactants.

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We study neutron transfer reactions considering that the neutron jumps from an inert donor core to an inert acceptor one [1]. The motion of the transferred particle is restricted to the line that joins the centers of the projectile and target cores. Only two degrees of freedom are needed for its description: the distance between the centers of the two cores, r, and the position of the transferred neutron, x. The neutron wavefunction satisfies the equation

$$i\hbar\frac{\partial\Psi(x,b,t)}{\partial t} = -\frac{\hbar^2}{2m}\,\frac{\partial^2\Psi(x,b,t)}{\partial^2 x} + [\, V_1(x, r_b(t)) \, + \, V_2(x, r_b(t))]\;\Psi(x,b,t) \;\;, \quad (1)$$

where m is the neutron mass and the r coordinate considered as classical and approximated by a Rutherford trajectory with impact parameter b is named $r_b(t)$. V_1 and V_2 are the interactions of the neutron with the projectile core and the target, respectively. The initial wavefunction corresponds to the neutron bound to core 1. Transfer and breakup cross sections are found from appropriate projections of the

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final wave function.

For comparison purposes we have developed a procedure based in that of Breit and Ebel [2], which involves the restriction of the wavefunction space to a linear combination of adiabatic functions, defined as the eigenfunctions of the instantaneous Hamiltonian.

In Fig. 1 we show results for the ^{27}F + ^{26}F system. The transfer cross sections obtained with and without consideration of the continuum are in qualitative agreement at low E_{cm}, but that the difference between both curves increases with energy.

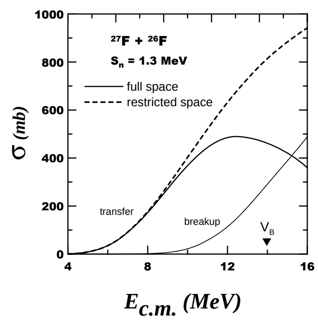

Fig. 1. One-neutron transfer and breakup cross sections, for the ^{27}F + ^{26}F system for the two calculations described in the text. The arrow indicates the position of the Coulomb barrier V_B.

In conclusion, we have shown strong indications that the inclusion of the continuum in transfer reactions involving weakly bound systems leads to large deviations with respect to calculations which do not include it. The effects are most noticeable in the high end of the subbarrier region studied, where the breakup process has a large cross section. Therefore, neglecting the continuum may only be justified at very low collision energies, where the breakup probability is very small.

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References

1. R.A. Broglia and Aa. Winther, *Heavy Ion Reactions*, (Addison-Wesley, Reading, MA, 1991).
2. G. Breit and M.E. Ebel, Phys. Rev. **103**, 679 (1956); M.E. Ebel, Phys. Rev. **103**, 958 (1956).