INDEPENDENT PARTICLE DESCRIPTION OF MASS TRANSFER IN DEEP INELASTIC COLLISIONS

by

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Among the several theoretical approaches to heavy ion collisions which have been proposed so far, Time Dependent Hartree-Fock theory (TDHF) is the most fundamental one. In principle it should give good estimates for all quantities described by one body operators. This indeed turns out to be the case for e.g. the energy loss; however TDHF results for the mean number of transferred nucleons in deep inelastic collisions (DIC) are very poor[1,2].

In the present contribution we want to investigate how much this discrepancy is due to the well known spurious coupling between different channels, inducing a spurious coupling between relative motion and internal degrees of freedom. Our analysis will also allow us to isolate the effects of this spuriousity on the mass distribution variance from those due to the two body nature of the corresponding operator.

The physical picture underlying our model is essentially the same as that of the Time Dependent Single Particle Model (TDSPM) introduced by G. Bertsch and R.Schaffer[3], differing from it in the following points:

i) the method of solution allows to give explicit expressions for both $N(t)$ and $\sigma(t)$ as functions of time and it is particularly simple for numerical calculations;

ii) we fix the classical trajectory of the relative motion by using potential and friction terms such that the energy and angular momentum losses are typical of a deep inelastic process;

iii) our model allows the use of experimental single particle energies, so that realistic potential wells and Fermi energies are implicitly introduced.

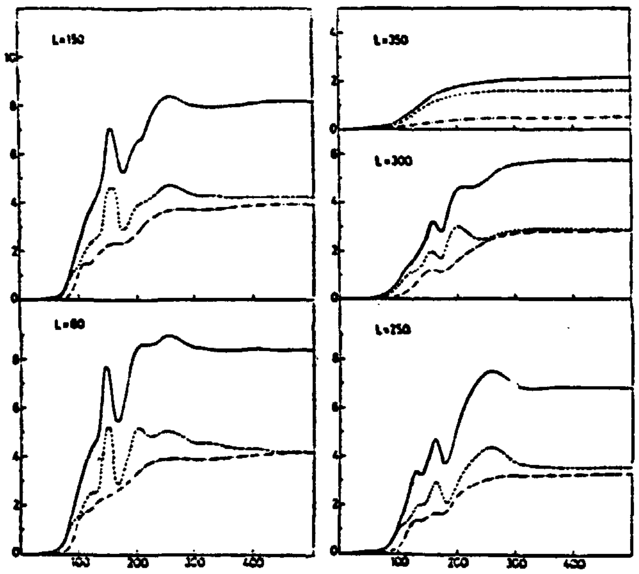

Fig.1. Mean value of transferred neutrons (dashed line), protons (dot-dashed line) and nucleons (full line) for different values of the relative angular momentum for the reaction $^{84}Kr(714\ MeV)+^{209}Bi$. In abscissa we report the time along the trajectory in units fm/c.

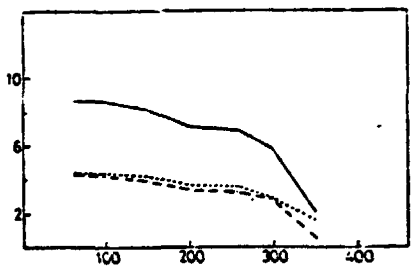

Fig.2. Transferred neutrons, protons and total nucleons as a function of initial relative angular momentum. Notation as in fig.1.

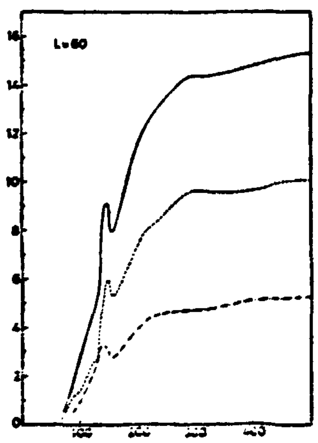

Fig.3. The same as in fig.1, for $L_{rel}=$ 60 $\hbar$, but with the modified spectrum (see text).

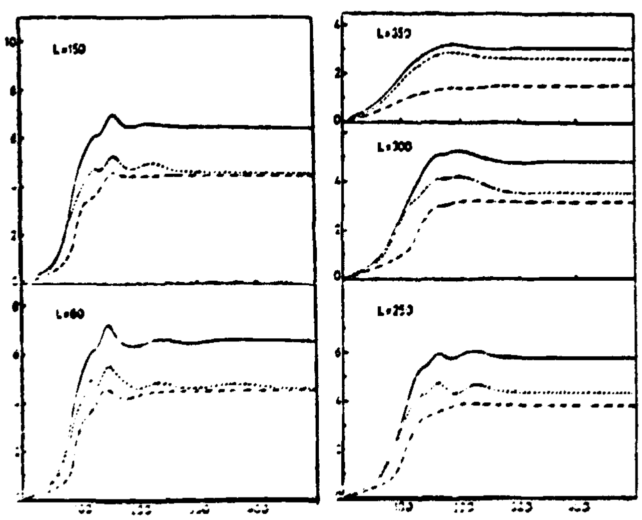

Fig.4. The same as in fig.1 for the full widths at half maximum Γ. The initial value of Γ has been quadratically subtracted. This is necessary since we use the filling approximation.

In this contribution we report the calculations[4] for the reaction ^{84}Kr(714 MeV) + ^{209}Bi. From Eqs.(4) and (5) one can get the average transferred mass and charge as well as the corresponding widths, along the trajectory as functions of time. The results for $N(t)$ are reported in Fig.1 for different angular momenta of the relative motion. After an initial stage in which it displays oscillations, $N(t)$ increases steadily up to its asymptotic value, the only observable one.

The total number of transferred nucleons reported in Fig.2 as a function of the angular momentum, is larger than the corresponding TDHF one[1] by a factor of about two. The experimental value[5] in the deep inelastic region is around 24. Thus it seems that at least part of the discrepancy of the TDHF results with respect to experiments can be ascribed to the above mentioned spurious coupling. In order to analyze the relevance of the single particle spectra, we have made a calculation neglecting spin-orbit coupling. The result is reported in Fig.3. The asymptotic value of $N(t)$ increases up to about 16, approaching the experimental value. The latter result could be also an indication of the relevance of the deformation degree of feedom to which the single particle spectra are rather sensitive.

In Fig.4 the calculations for the mass width are reported. In comparison with TDHF the values appear only slightly improved (the experiment gives a value around 30 in the DIC region). This result holds true even with the degenerate single particle spectrum, indicating the essential role of the correlations for the mass width, as expected according to the two-body nature of the quantity.

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