EFFECTS OF QUANTUM DIFFRACTION IN DEEP INELASTIC HEAVY-IONS COLLISIONS

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The collective motions we describe in D.I.C. relax to equilibrium in a time larger than the one of the intrinsic degrees of freedom. One has to deal with low frequency modes and statistical assumptions can be made. The quantum effects we have introduced in our theory (1)(2) are quantum corrections to the classical description used for the relative motion in a statistical theory. No one of the usual statistical theories is able to introduce such quantum corrections. These effects are of diffractional type i) the interference effects near an inner rainbow ii) the Fresnel effects due to the limitation of the range of impact parameters which really contribute to D.I.C. (a fusion cut-off or a window-fusion can be taken into account). So, it appears that the nature of such effects has not to be compared to the quantum treatment of high frequency collective modes that Hofmann describes by mean of the harmonic approximation in a Fokker-Planck equation. By summing the microscopic cross-sections $(d\sigma_{\beta\alpha}^{D.I.})$ over all the microscopic channels β lying in a "coarse" interval of values a_i for observables Ω_i (angle θ, final kinetic energy, mass transfer, ...) we define the average macroscopic cross-section :

$$\frac{d^n\sigma^{D.I.}}{d\cos a_1 . da_2 \ldots da_n} da_1 . da_2 \ldots da_n = \frac{1}{\sin a_1} \sum_{\beta \in \{a_i\}_{i=1,n}} (d\sigma_{\beta\alpha}^{D.I.}) \quad (1)$$

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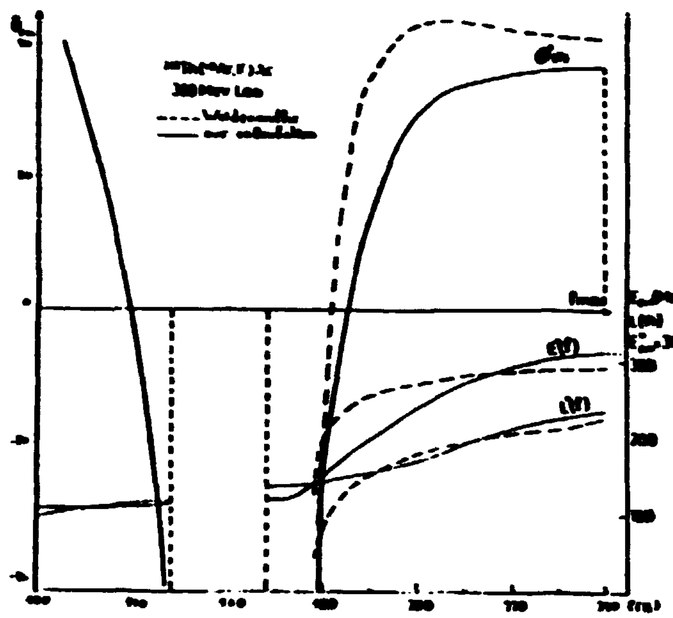
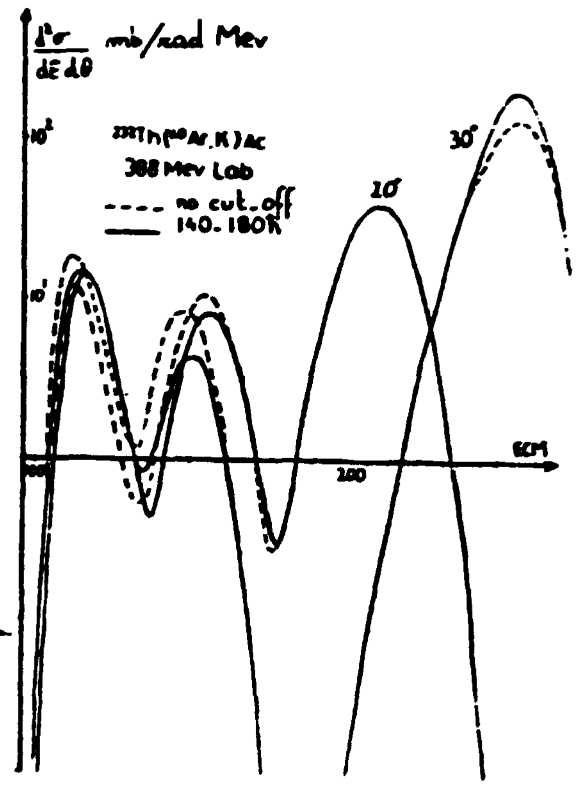
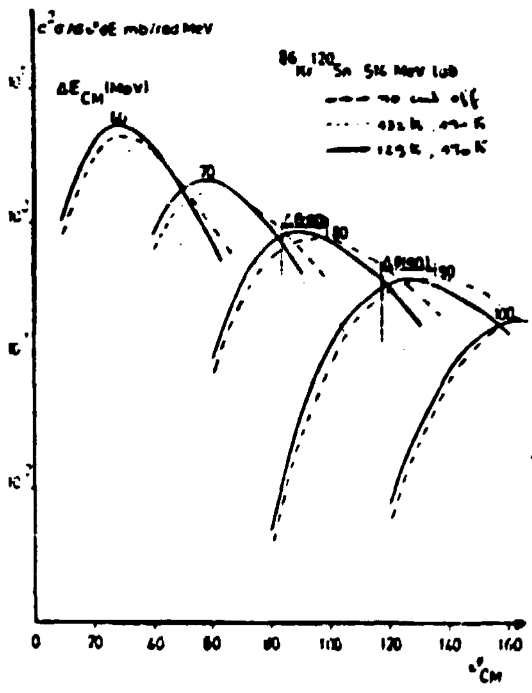



388 Mev Lab
no cut.off
ECM
200
10'
10²
20'
30°


ΔE CM (MeV)
Sn 516 MeV Lab
no cut off
θ CM

When the collective degrees of freedom are treated as classical variables, this expression can be connected to the classical probability :

$$P^c(a,b) = \int dQ_\mu dP_\mu d(Q_\mu,P_\mu,\infty) \prod_{i=1}^{n} \delta(\Omega_i,(Q_\mu,P_\mu) - a_i) \quad ,$$

the distribution function d being solution of a Fokker-Planck equation. The D.I.C. cross-section (1) can take different forms according to the cut-off effects and to the pattern of the mean defection function $\bar{\Theta}(a,b) = \int d\theta\, \theta P^c(\theta,\ldots b) / \int d\theta\, P^c(\theta,\ldots b)$. Near an inner rainbow, we use the uniform approximation in the lit region and the Airy one in the dark region. For a single-valued $\bar{\Theta}(a,b)$, we have the simpler expression

$$\frac{d^n \sigma^{D.I.}}{da_1 \ldots da_n} = \frac{\mu_f}{\mu_\alpha} \int P^c(a,b) v(a,b) \bar{\Theta}'(a,b) db$$

with

$$v(a,b) = \frac{\mu_\alpha}{\mu_f} \frac{b}{|\bar{\Theta}'(a,b)|} \frac{1}{2} [(C(x_o) - C(x_g))^2 + (S(x_o) - S(x_g))^2]$$

C and S are the Fresnel integrals of arguments

$$x_{o,g} = (|\bar{\Theta}'(a,b)|/\pi)^{1/2} (\ell_{o,g} - \ell)$$

where $\ell_{o,g}$ are the lower and upper angular momentum cut-off. Quantum diffractional effects due to cut-off are defined for the reactions Kr on Sn, calculated with two degrees of freedom (r,θ) and Ar on Th, calculated with four degrees of freedom $(r,\theta,\theta_1,\theta_2)$ and conservative forces which are different in the in and out channels to simulate the deformations of the outgoing ions.

(1) K.Dietrich and Ch.Leclercq-Willain. Nucl.Phys. A359 (1981) 201

(2) Ch.Leclercq-Willain, M.Baus-Bagndikian and K.Dietrich Nucl.Phys. A359 (1981) 237