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WITHIN A SINGLE PARTICLE MODEL

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NUCLEON NUCLEUS WEAK SCATTERING WITHIN A SINGLE PARTICLE MODEL

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Abstract - We discuss weak scattering of nucleon on nucleus in which the weak interaction has a single particle form (suggested by Michel) which is directly related to the parameters of the weak NN interaction. Numerical results are presented for n+ 40 Ca scattering.

After the neutron spin-rotation experiment at ILL, a lot of theoretical work has been done which focused mainly on the enhancement effects due to neutron resonances. However, neutron resonance is a complex many particle phenomena, and thus it is impossible to relate the evaluated results with the fundamental weak NN interaction parameters. One way out of this dead end is to concentrate (both in experiment and in theory) on light nuclei. Another way, which we suggest here is to construct crude but realistic models for weak neutron nucleus scattering which are simple enough and are directly related to the weak NN interaction parameters. Such models will not follow the fine details at the resonant energy but can serve as a reference result over wide energy, angle and mass ranges. Such a model has recently been suggested by the author (P.R. C28 (1983) 656) based on strong and weak nucleon-nucleus optical potential suggested by Michel. The weak potential is obtained by folding the NN weak interaction (whose non-relativistic form is taken from DDH-Ann. Phys. 124 (1980) 449) over the target density. The scattering amplitude for N+A scattering is then deduced from a two body Hamiltonian \( H = T + V + G' \langle p, r \rangle \) where \( V \) is the strong optical potential \( \rho(r) \) is the target nucleon density and \( \vec{p}, \vec{r} \) are spin and momentum of the projectile. The weak coupling constant \( G' \) is written as \( G' = A + B \) where \( A, B \) are linear combination of all the weak NN interaction parameters \( f, h \)'

As an example we have computed the spin rotation angle for n+ 40 Ca with the result \( d\phi/dz = -2.72 \times 10^{-5} \text{Rad/cm} \) and the asymmetries in the total (A) and differential \( I(\theta) \) cross sections which we show in the figure together with the pertinent cross-sections. In both calculations the "best value" of the weak parameters suggested by DDH is adopted. The vanishing of \( I(\theta) \) at 180° is a consequence of T invariance as implied in the \( \{ \} \) term in the Hamiltonian. Thus, if experiment finds \( I(180°) \neq 0 \) it implies P and T (hence CP) violation which is one of the puzzles raised by QCD.
FIG. 1. Results for $n + ^{40}$Ca at $2 < E < 8$ MeV. On the right side, the asymmetry $I(\theta)$ as a function of $\cos \theta_{\text{c.m.}}$. Also indicated is the asymmetry $A$. On the left side are the calculated differential and total cross sections.

A careful look at the figure reveals an interesting feature which may have important experimental consequences: As a function of energy, the asymmetry in the total cross-section $A$ changes sign at $E = 3.00$ MeV. However, this is not due to small asymmetry in the differential elastic cross-section $I(\theta)$. In fact, for $\theta > 90^\circ$ there is a large angular domain at which $|I(\theta)|/|A| > 1$. Hence, if experimental setting is possible, it appears that sometimes measuring $I(\theta)$ and not $A$ can save a substantial amount of beam time.