Proc. Sixth Int. Symp. Polar. Phenom. in Nucl. Phys., Osaka, 1985
J. Phys. Soc. Jpn. 55 (1986) Suppl. p. 670–671

1.59

Far-side Dominance of the Reaction Amplitude Observed in Large ℓ transfer (d,p) Reactions at Intermediate Energy

J.A. Tostevin, R.C. Johnson, E.J. Stephenson†, V.R. Cupps†, J.D. Brown†, C.C. Foster†, W.P. Jones†, D.W. Miller†, H. Nann†, P. Schwandt† and J.W. Seubert††.

University of Surrey, Guildford, Surrey, GU2 5XH, U.K.
†Indiana University Cyclotron Facility, Bloomington, IN 47405, U.S.A.
††Indiana University-Purdue University at Indianapolis, Indianapolis, IN 46223, U.S.A.

The experimental cross section angular distributions for the $^{116}Sn(d,p)^{117}Sn$ reaction at 79 MeV show a distinct change as a function of increasing orbital angular momentum transfer ℓ. In addition, the reaction vector (A_y) and tensor (A_{yy}) analysing powers reveal a very marked j-dependence at large angles[1]. As part of an analysis to understand these phenomena a decomposition of the transfer amplitude into near-side and far-side contributions has been performed.

To accomplish this we replace the associated Legendre function $P_L^M(\cos\theta)$ in the partial wave sum for the transfer amplitude by

$$P_L^M(\cos\theta) = Q_{LM}^{(+)}(\theta) + Q_{LM}^{(-)}(\theta) , \qquad (1)$$

$$Q_{LM}^{(\pm)}(\theta) = 1/2\ [P_L^M(\cos\theta) \pm 2i\pi\ Q_L^M(\cos\theta)] , \qquad (2)$$

where $Q_L^M(\cos\theta)$ is the irregular Legendre function. In the limit of large L the $Q_{LM}^{(+)}(\theta)$ and $Q_{LM}^{(-)}(\theta)$ correspond to travelling waves in the $+\theta$ and $-\theta$ sense,

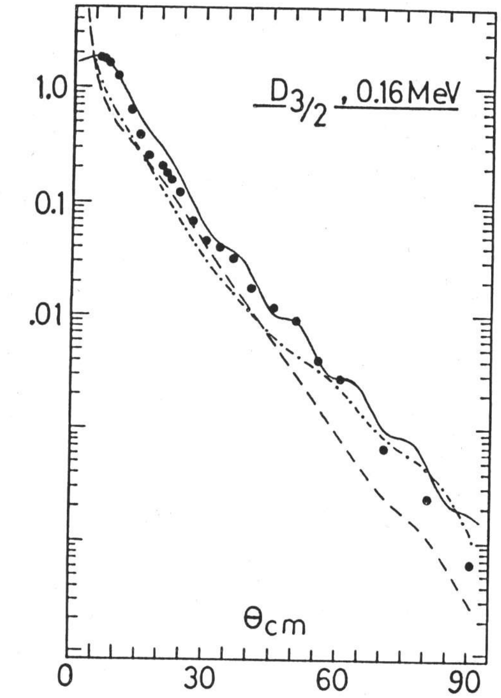

Fig. 1. Near-side (dashed) and far-side (dot-dashed) contributions to the full (solid) calculated cross section (in mb/sr) for the $^{116}Sn(d,p)^{117}Sn(3/2^+$, 0.16 MeV) transition at E_d = 79 MeV.

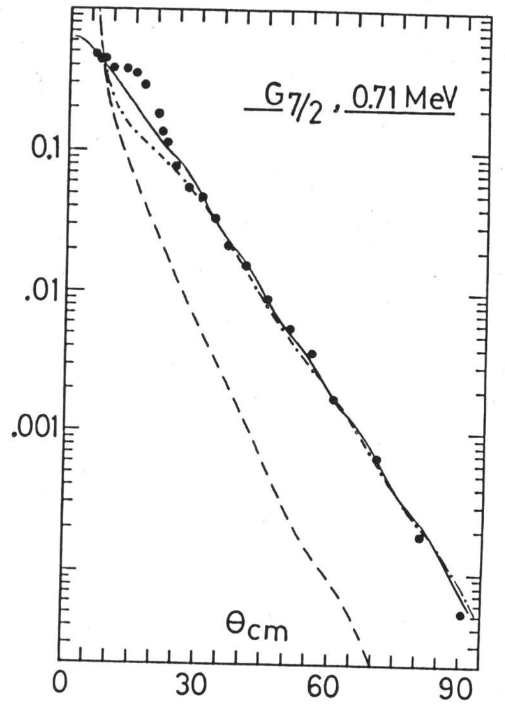

Fig. 2. As for Fig. 1 but for the $^{116}Sn(d,p)^{117}Sn(7/2^+$, 0.71 MeV) transition.

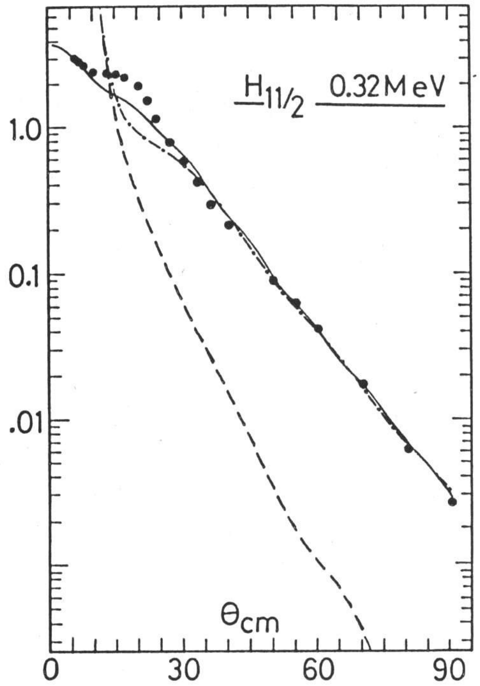

Fig. 3. As for Fig. 1 but for the $^{116}Sn(d,p)^{117}Sn(11/2^-$, 0.32 MeV) transition.

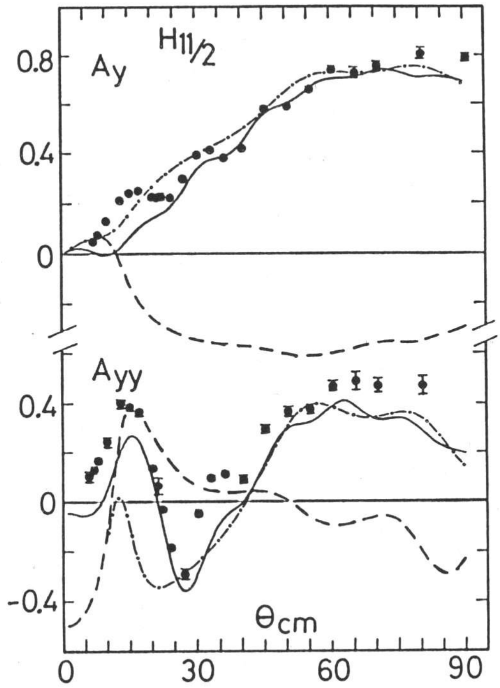

Fig. 4. Near-side (dashed) and far-side (dot-dashed) contributions to the calculated analysing powers in the $^{116}Sn(d,p)^{117}Sn(11/2^-)$ transition.

respectively. The $Q_{LM}^{(+)}$ and $Q_{LM}^{(-)}$ partial wave contributions are added independently and the resultant amplitudes are interpreted as the contribution to the full transfer amplitude from the far-side (-ve Madison Convention x-axis) and near-side of the nucleus[2], respectively.

In Figs. 1 to 3 we show the decomposition of the cross section into near (dashed curves) and far-side (dash-dotted curves) components. The figures are ordered in terms of increasing ℓ transfer for the states indicated in the $^{116}Sn(d,p)^{117}Sn$ reaction at 79 MeV. All calculations are exact finite range calculations which include the deuteron D-state and S-wave breakup effects through the Johnson-Soper adiabatic prescription for stripping[3]. The $d_{3/2}$ transition is oscillatory at all angles reflecting the interference of the comparably sized near- and far-side amplitudes. For the larger ℓ and better orbital angular momentum matched transitions the far-side amplitude is seen to completely dominate the reaction at large angles producing the required smooth fall off with angle. In Fig.4 we use the $11/2^-$ transition to show that the same far-side dominance applies in the consideration of the reaction analysing powers.

We have seen that realistic reaction calculations demonstrate, for the first time, the phenomenon of far-side dominance in large ℓ (d,p) transitions at intermediate energy. From this observation the j-dependence exhibited by the reaction vector and tensor analysing powers is understood[1]. In addition, far-side dominance implies strong constraints upon spin-dependent observables which when compared with data can be used to test the underlying reaction model.

References

1) E.J. Stephenson et al., The j-dependence of large ℓ transfer (d,p) reactions. Contribution to this conference.
2) See for example: R.C. Fuller, Phys. Rev. C12 (1975) 1561.
3) R.C. Johnson and P.J.R. Soper, Phys. Rev. C1 (1970) 976.