Impulse Picture of (d,p) Reactions

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1. Intermediate energy (d,p) reactions
2. Impulse approx. for the ^{3}He(d,p)^{4}He reaction
3. Comparison with 0degree observables
4. Discussion
5. Summary

Introduction

Transfer reactions at low energies
(*d*,*p*), (*p*,*d*), (*d*,^{3}He) . . . .

provide information on single-particle state.

J^π assignment

spectroscopic factor. . .

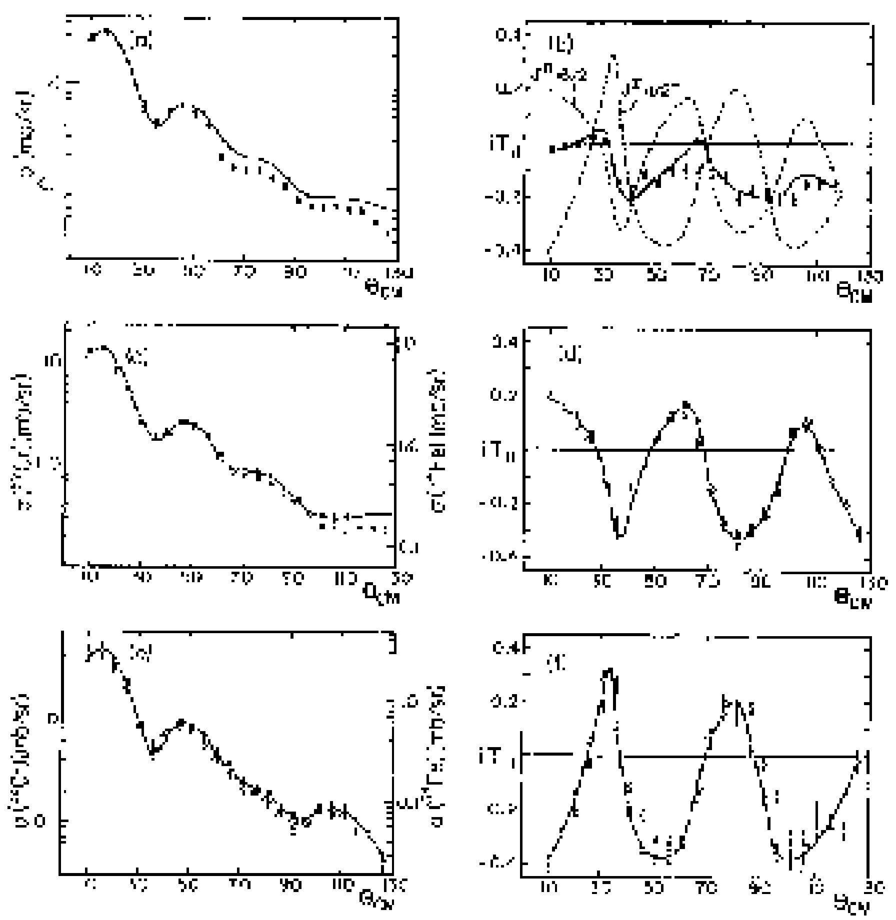
← ***Distorted Wave Born Approx.***

To intermediate and high energies

Larger momentum mismatch

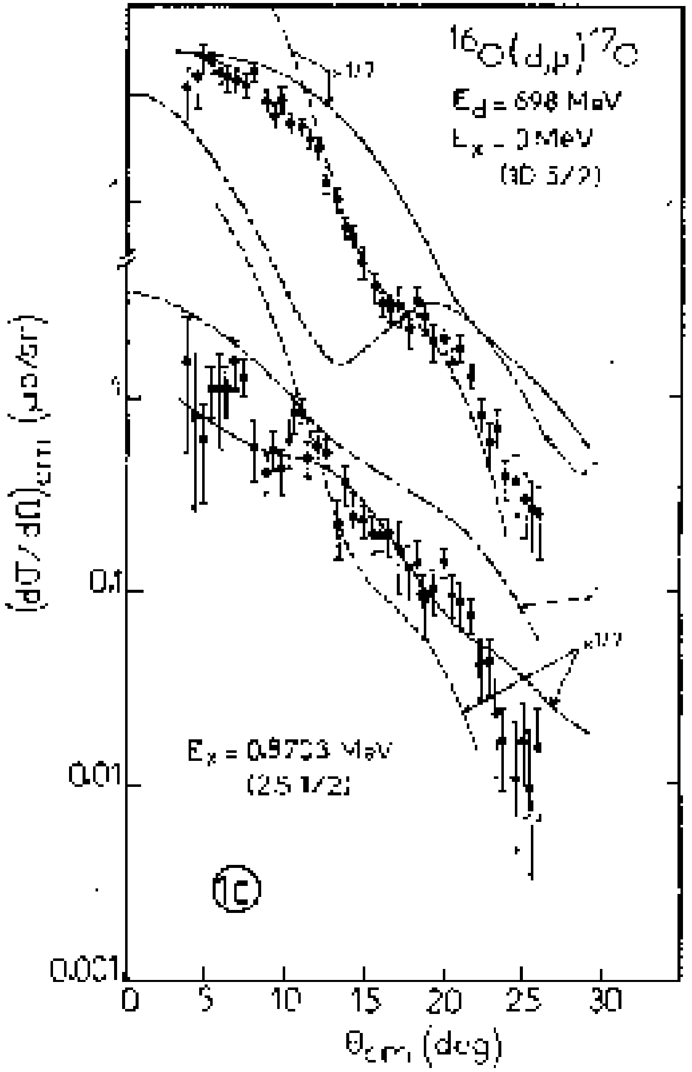
probing higher momentum component in nuclei

$^{53}Cr(d,p)^{54}Cr$



D.C.Kocher and W.Haeberli,
Phys. Rev. Lett. **23** (1969) 315.

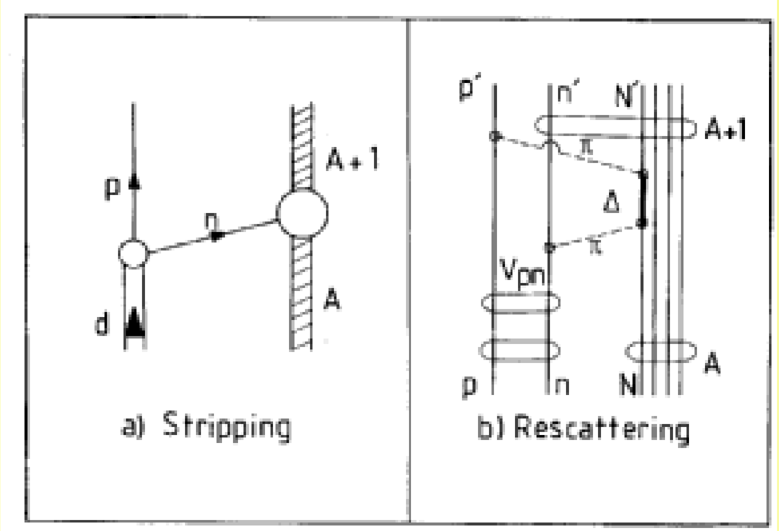
Failure of DWBA?



A.Boudard et al., Phys. Rev. Lett. **46** (1981) 218.

Δ excitation in the intermediate channel

A.Boudard et al., Phys. Rev. Lett. **46** (1981) 218.



Relativistic Effect

E.Rost et al., Phys. Rev. Lett. **49** (1982) 448.

Isobar Exchange

A.K.Kerman and L.S.Kisslinger,
Phys. Rev. **180** (1969) 1483.

^{3}He(d,p)^{4}He Reaction

Probe to the D-state admixture in deuteron

T. Uesaka et al., Phys. Lett B **467** (1999) 199.

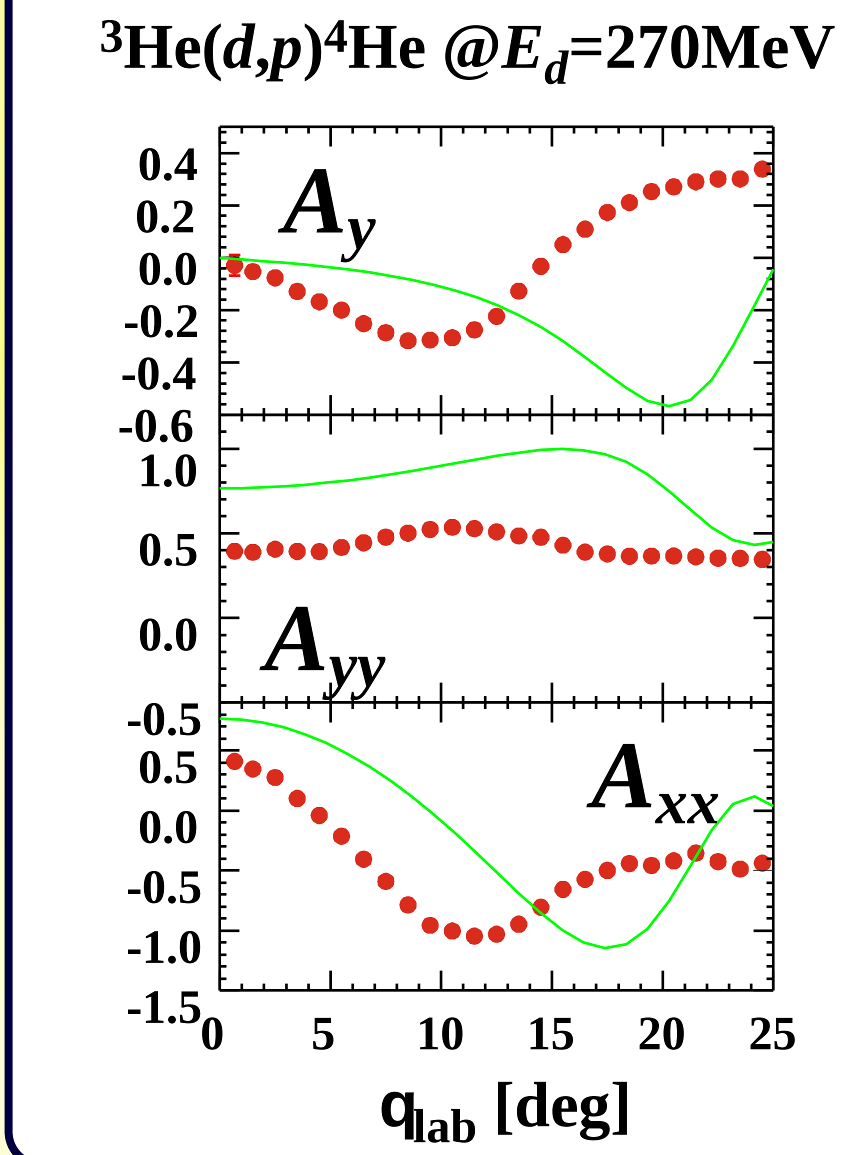
Strong spin-dependence in the n-capture process by ^{3}He

Spin correlation is less sensitive to ^{3}He and ^{4}He structures

DWBA calculations fail to reproduce polarization observables

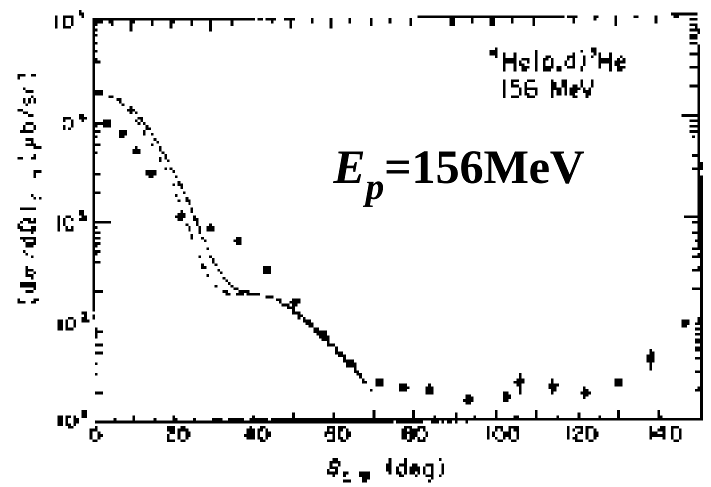
$$f_{fi} = \langle \Phi_f \vec{k}' | \underbrace{V_{pn}} | \Phi_i \vec{k} \rangle$$

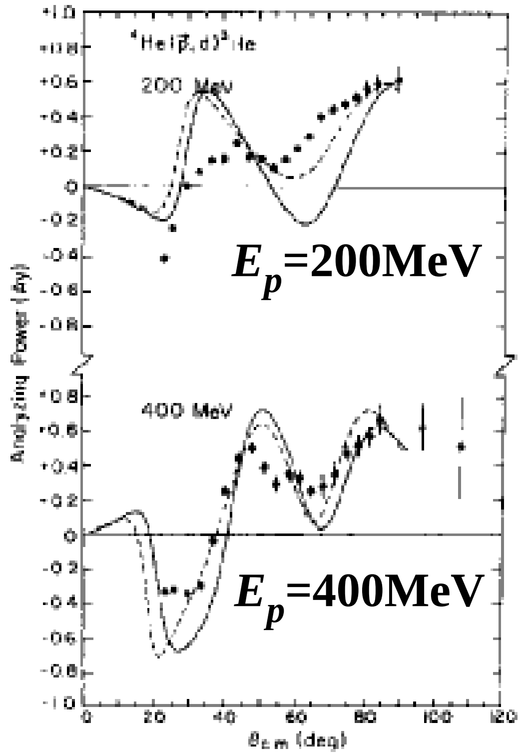
? $V_{pn} + V_{p^3\mathrm{He}} - U_{p^4\mathrm{He}}$

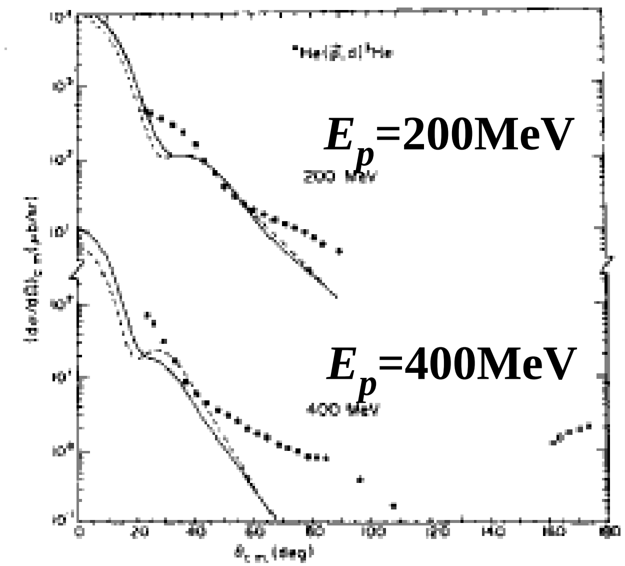


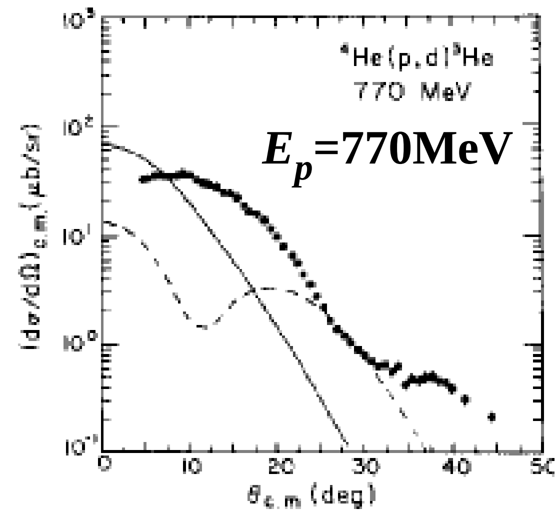
^{4}He(p,d)^{3}He Reaction

P.W.F.Alons et al., Phys. Rev. C **33** (1986) 406.

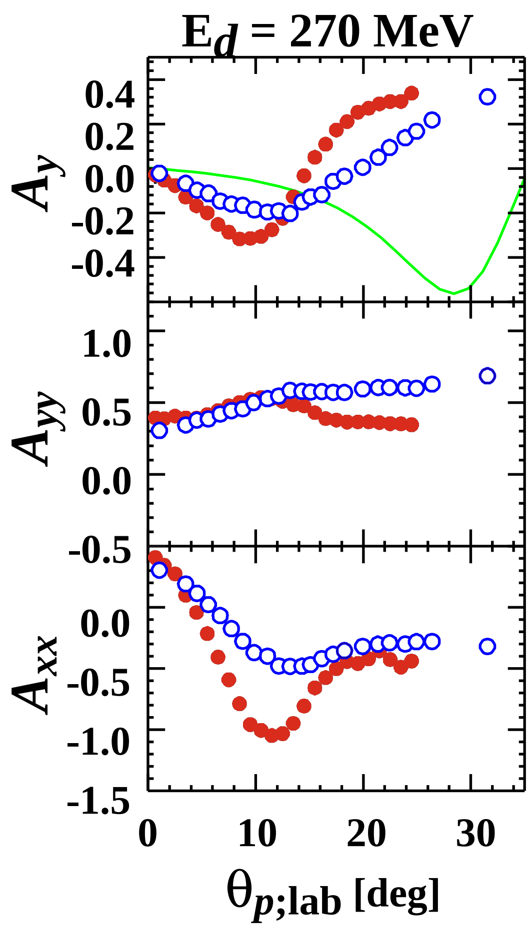




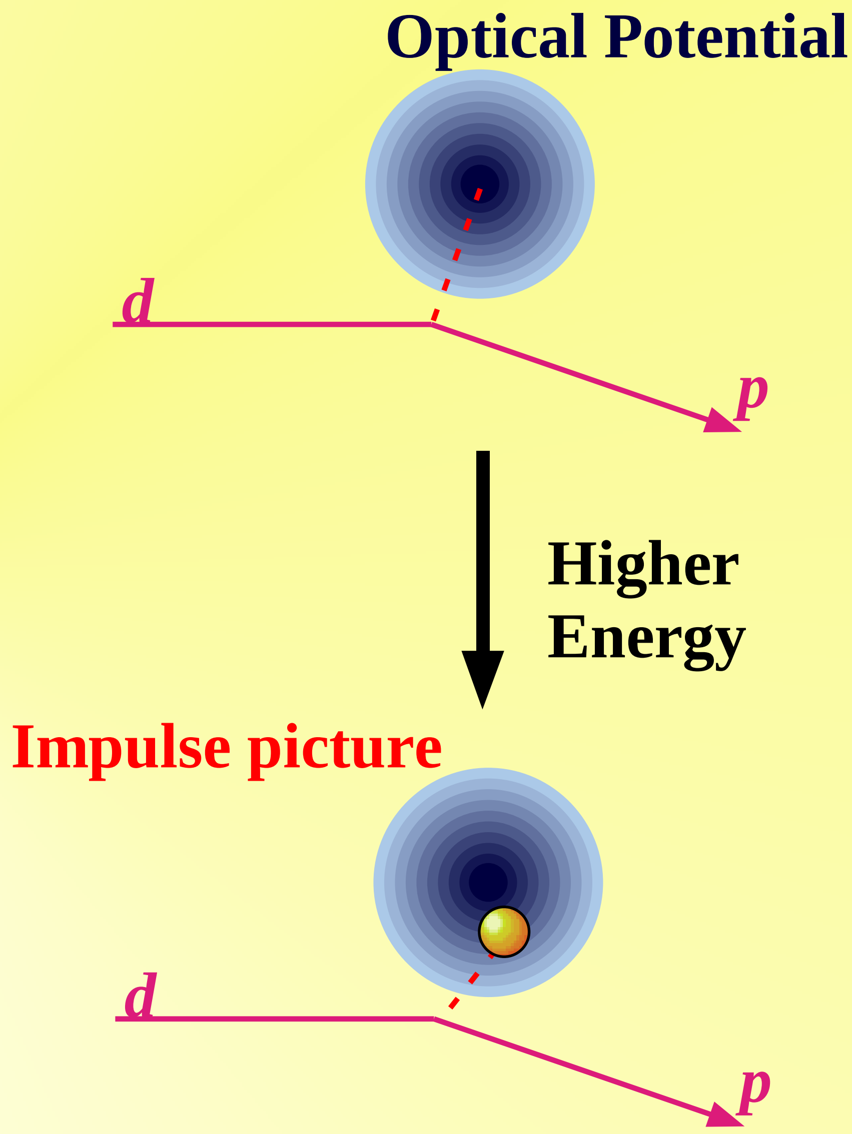




Motivation to IA



^{3}He(d,p)^{4}He reaction
DWBA calculation for ^{3}He(d,p)^{4}He
d+p backward scattering
Sekiguchi et al.,
Phys. Rev. C **65** (2002) 034003.

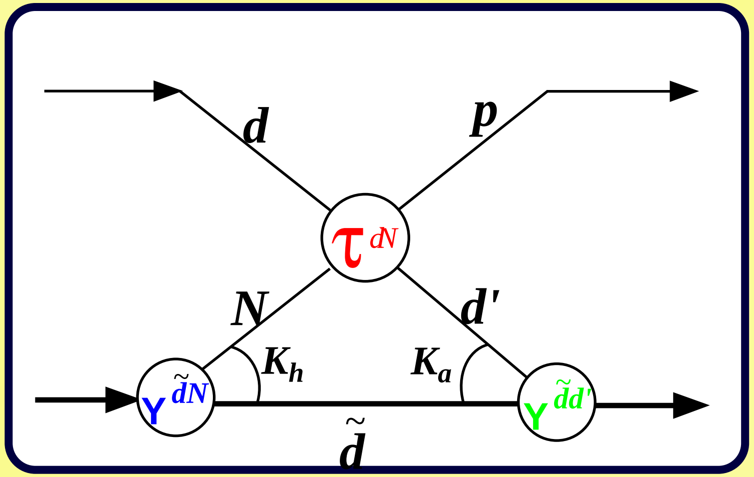


H.Kamada et al.,
Prog. Theor. Phys. **104** (2000) 703.

IA for the (d,p) Reactions

^{3}He(d,p)^{4}He Reaction

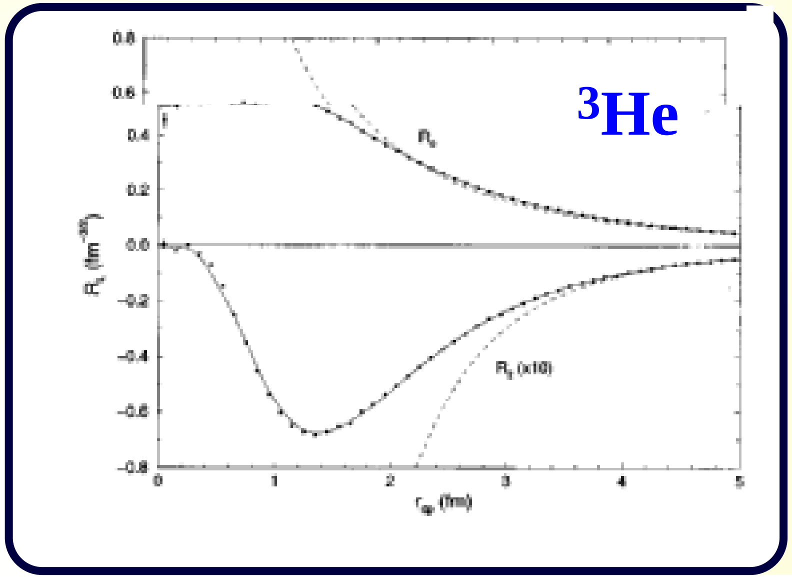
$$T_{\nu_p;\nu_h\nu_d} = \sum_{(N,\tilde{d})} \langle \Psi^{\tilde{d},d'}(K_\alpha) | \tau^{dN}_{\nu_p\nu_{d'};\nu_N\nu_d}(E_{dN}) | \Psi^{\tilde{d},N}_{\nu_h}(K_h)\varphi_{\nu_d} \rangle$$

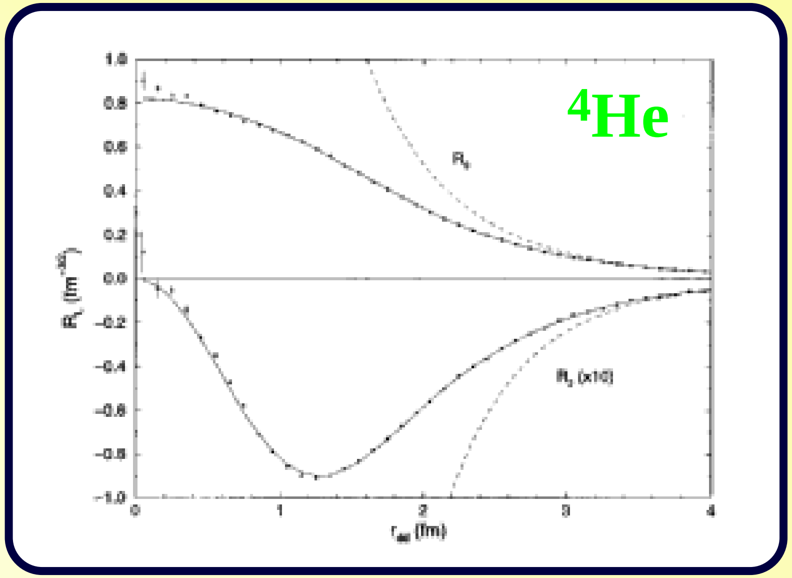


Elementary process : **d+N backward scattering τ^{dN}**

Wave functions of ^{3}He, ^{4}He: **Green's function Monte Carlo**

J.L.Forest et al., Phys. Rev. C **54** (1996) 646.



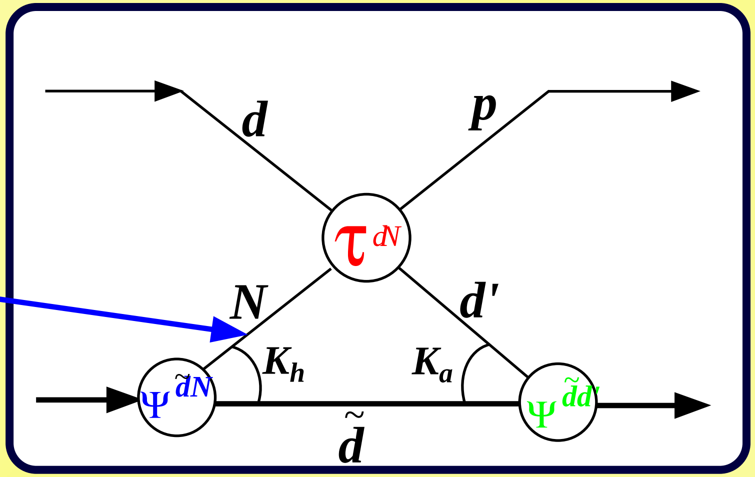


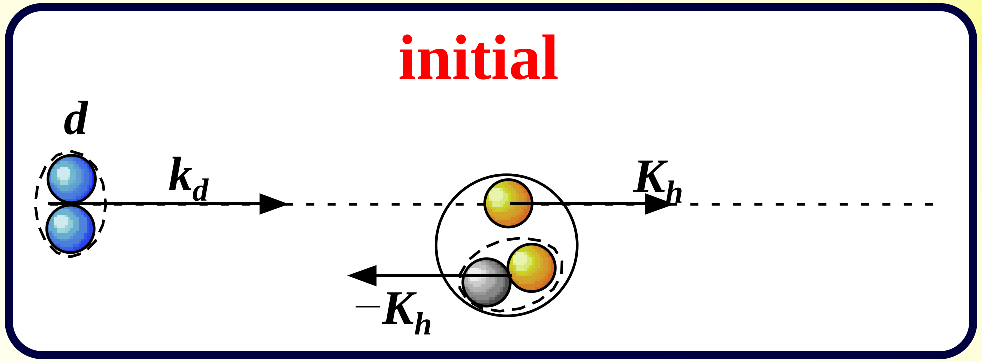
Fermi motion in Target

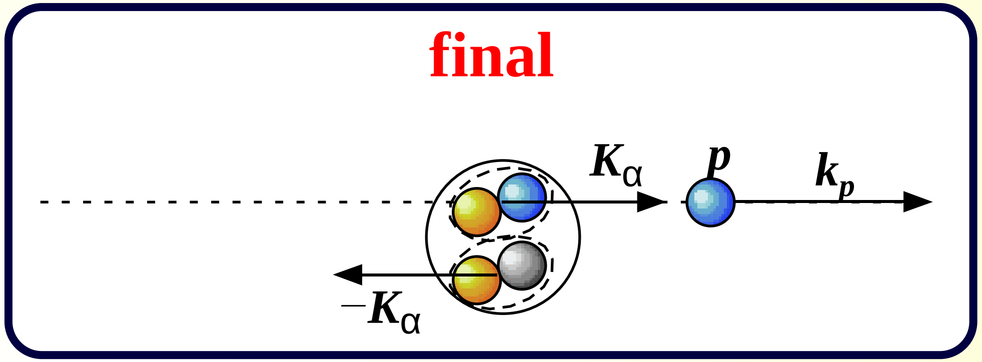
Integration for momentum of participant nucleon

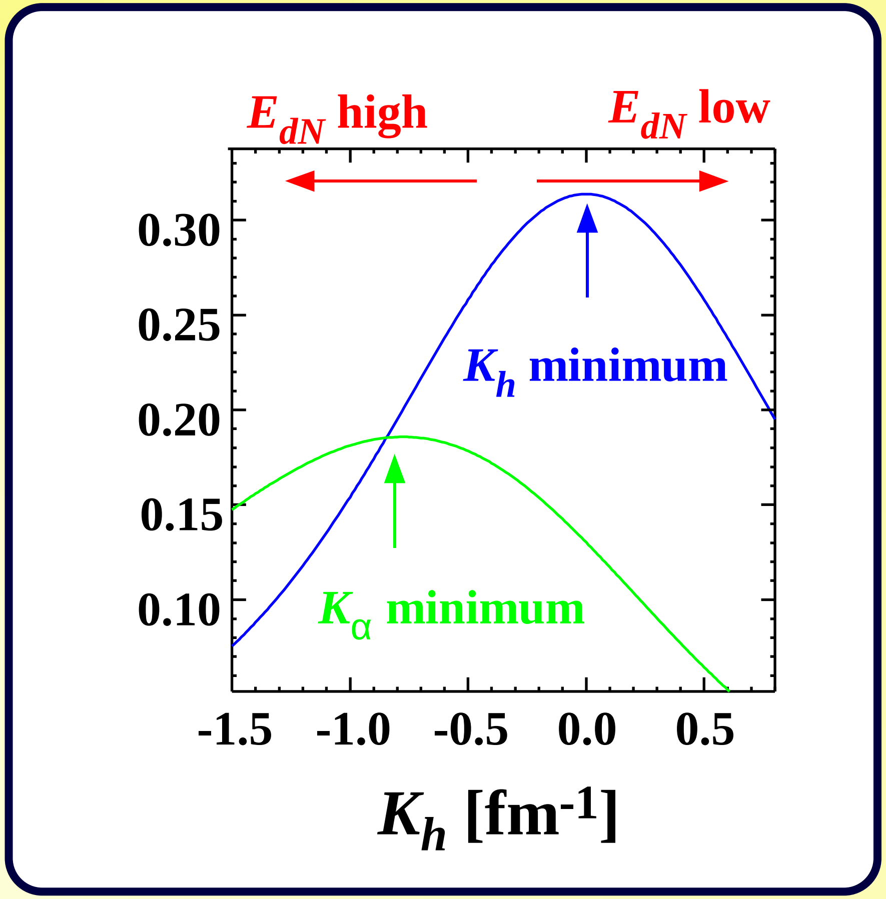
K_α Internal momentum in ^{4}He

E_{dN} dN center-of-mass energy









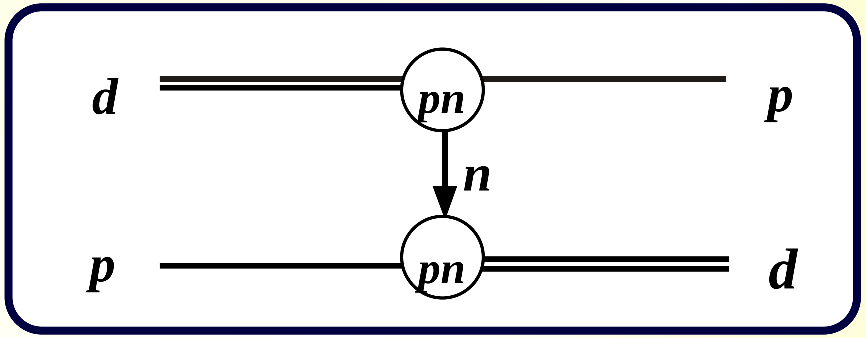
3N Amplitude

Faddeev solution

H.Kamada et al., Prog. Theor. Phys. **104** (2000) 703.

One-nucleon exchange approximation

$$\begin{aligned}\tau^{dN}_{\nu_p \nu_{d'};\nu_N \nu_d}(E_{dN}) &= \tilde{t}\langle \Psi_{d'}|\chi_{\nu_N}\chi_{\nu_p}|\varphi_{\nu_d}\rangle \\ &= \tilde{t}\sum_{\nu_n}\langle \Psi_{d'}|\chi_{\nu_n}\chi_{\nu_N}\rangle\langle \chi_{\nu_n}\chi_{\nu_p}|\varphi_{\nu_d}\rangle\end{aligned}$$

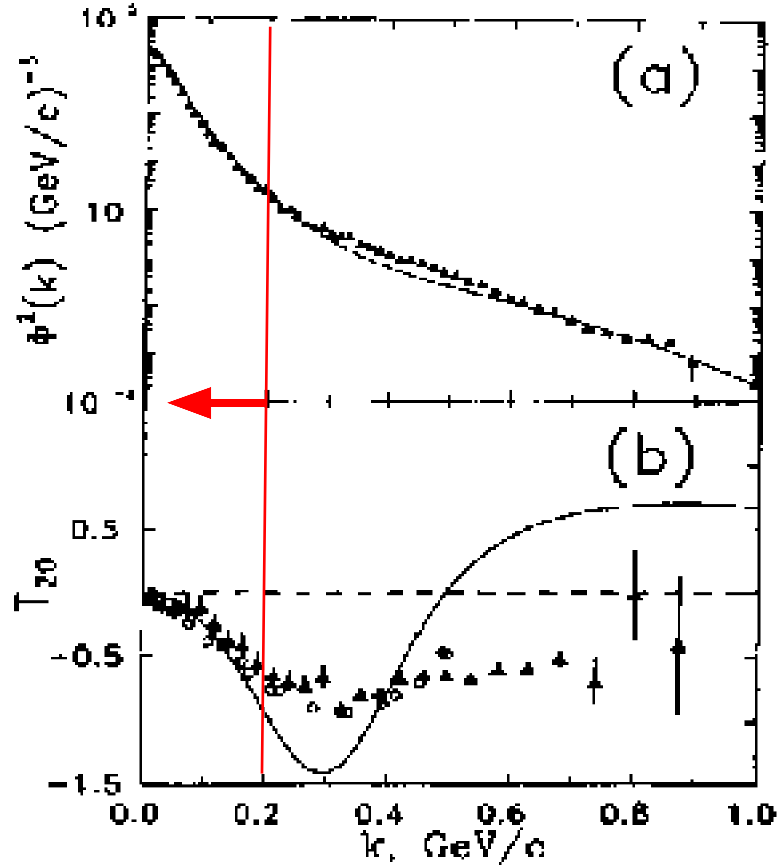


~~Vector Analyzing Power~~

~~Absolute Value of Cross Section~~

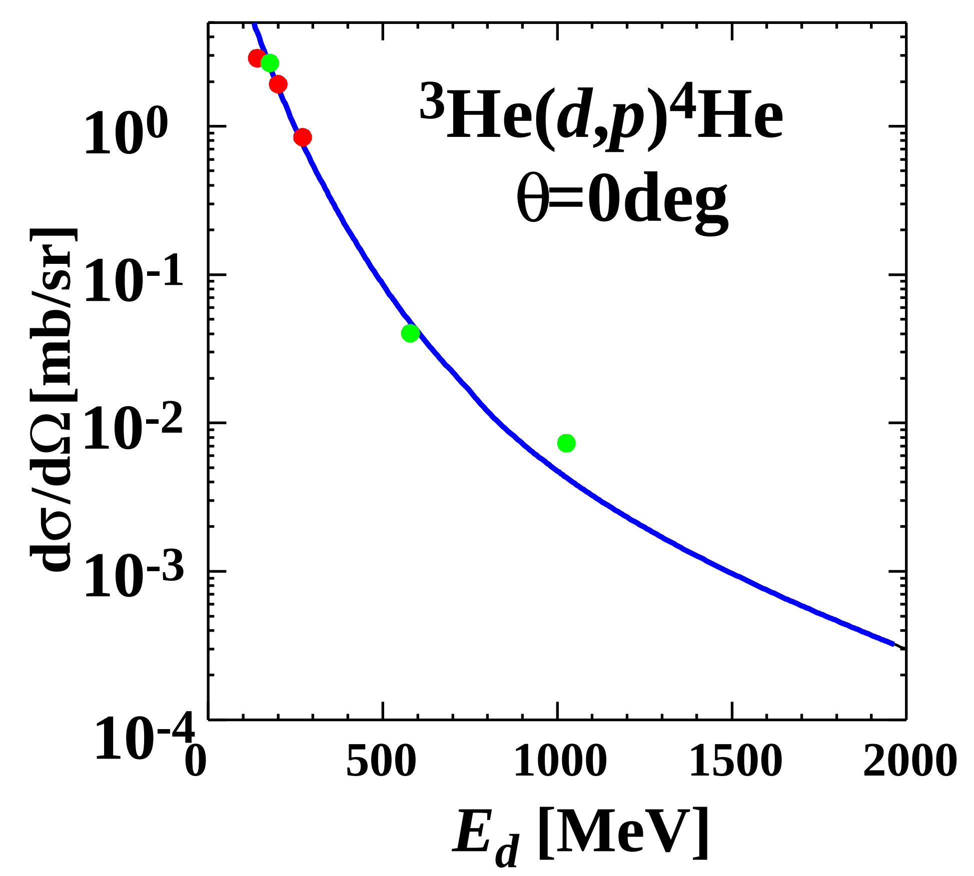
Deuteron Inclusive Breakup

B. Kuehn et al.,
Phys. Lett. B **334** (1994) 298.



Cross Section

Absolute value is arbitrarily normalized.



Energy dependence is well reproduced.

Polarization Observables

Observables sensitive to D-state admixture

T_{20} tensor analyzing power

decrease with energy

$$T_{20}(0^\circ) = \frac{\underline{2uw} - \frac{1}{\sqrt{2}}w^2}{u^2+w^2}$$

$C_{y,y}$ vector spin correlation

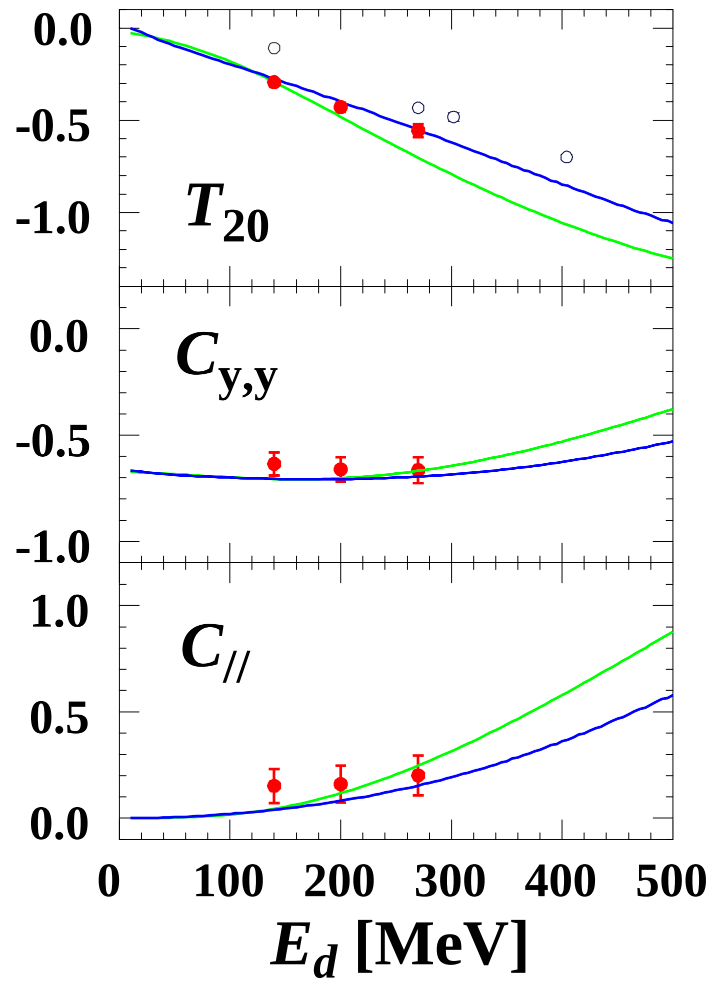
$C_{y,y} \sim -2/3$

$$C_{y,y}(0^\circ) = \frac{\frac{\sqrt{2}}{3}uw - \underline{\frac{2}{3}u^2} + \frac{2}{3}w^2}{u^2+w^2}$$

$C_{//}$ spin correlation

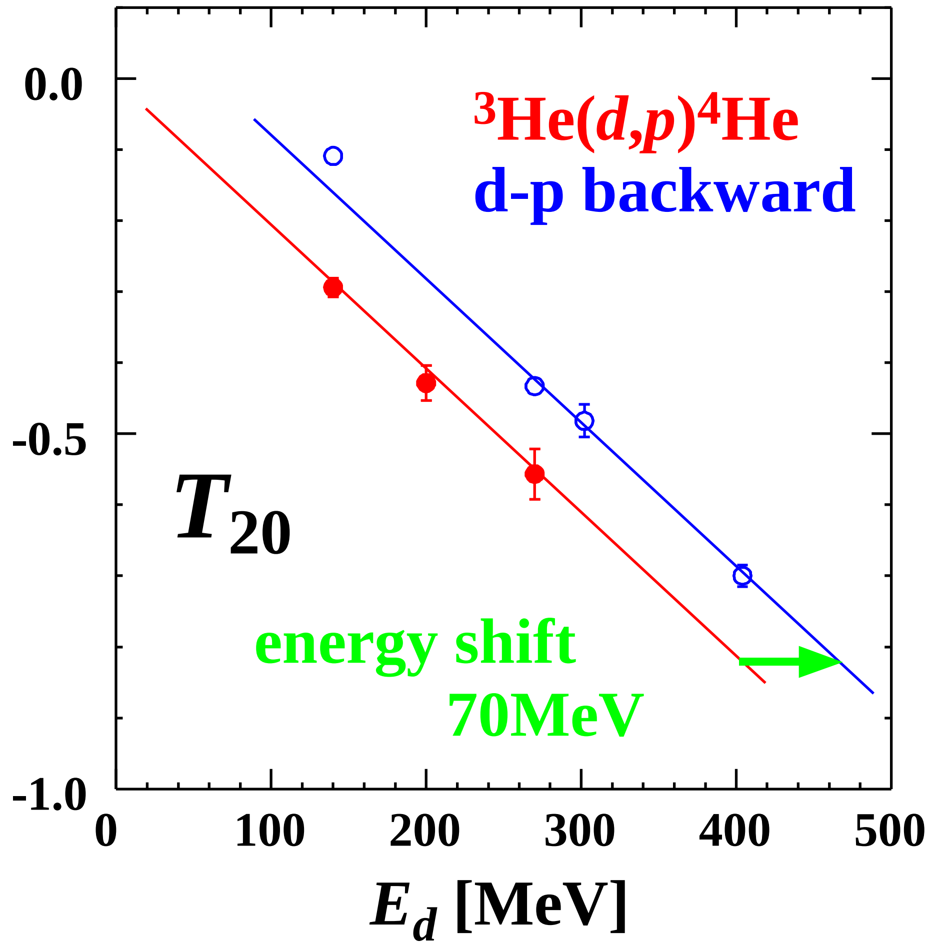
small positive value

$$C_{//}(0^\circ) = \frac{9}{4}\frac{\underline{w^2}}{u^2+w^2}$$

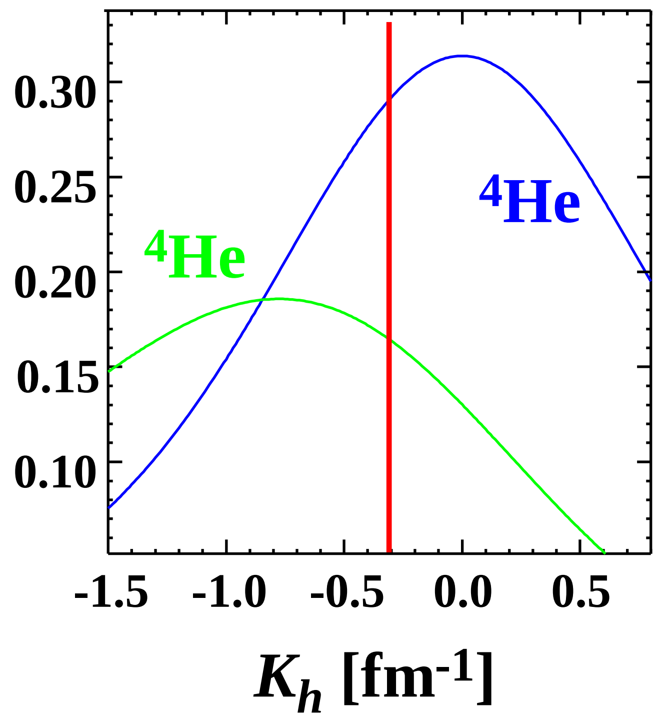


magnitude
energy dependence
well reproduced

^{3}He(d,p)^{4}He ⇔ d-p

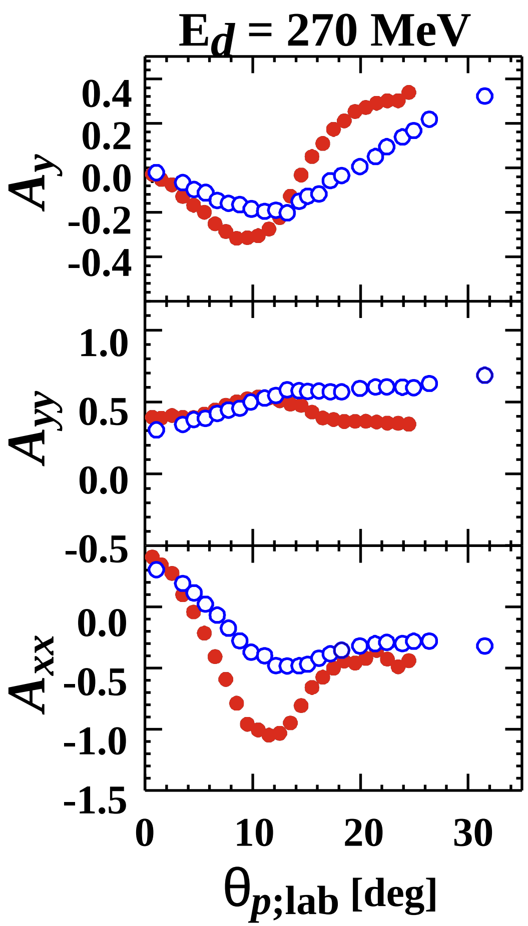


main contribution
from $K_h \sim -0.3$ fm^{-1}



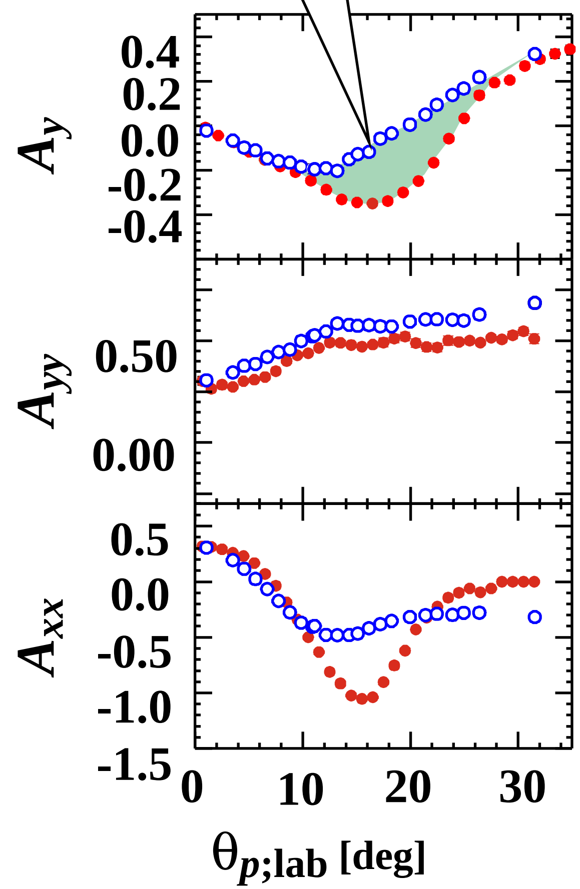
consistent with 70MeV shift

^{3}He(d,p)^{4}He ⇔ d-p (*cont.*)



^{3}He(d,p)^{4}He reaction
***d*+*p* backward scattering**
Sekiguchi et al.,
Phys. Rev. C **65** (2002) 034003.

distortion effect?



^{3}He(d,p)^{4}He reaction @200MeV

70MeV

***d*+*p* backward scattering** @270MeV

Summary

A model of (*d*,*p*) reactions alternative (?) to DWBA

Impulse Approximation

Reproduces energy dependence of polarization observables for the ^{3}He(*d*,*p*)^{4}He reaction at E_d=140 —270MeV

Theoretical basis?

large momentum transfer

large energy (or momentum) dependence in elementary amplitudes.

Future development

introduce Faddeev amplitudes

introduce distorted wave

→ absolute value of $d\sigma/d\Omega$

vector analyzing power