Adiabatic model for e.g. (p,d) – breakup

$$T(p,d) = \langle \psi^{(-)}_{d,\vec{k}_d}(\vec{r},\vec{R}) | V_{np} | \chi^{(+)}_{p,\vec{k}_p}(\vec{r}_p)\phi_{n\ell j}(\vec{r}_n) \rangle$$

$$[T_R + \mathcal{H}_{np} + V_p(r_{pA}) + V_n(r_n) - E]\psi^{(+)}_{d,\vec{k}_d}(\vec{r},\vec{R}) = 0$$

Since to calculate the transfer amplitude we need the three body wave function only in regions where $V_{np} \neq 0$, $r \approx 0$

$$\mathcal{H}_{np} \to -\varepsilon_0, \;\; V_p(r_{pA}) \to V_p(R), \quad V_n(r_n) \to V_n(R)$$

So, with $E_0 = E + \varepsilon_0$

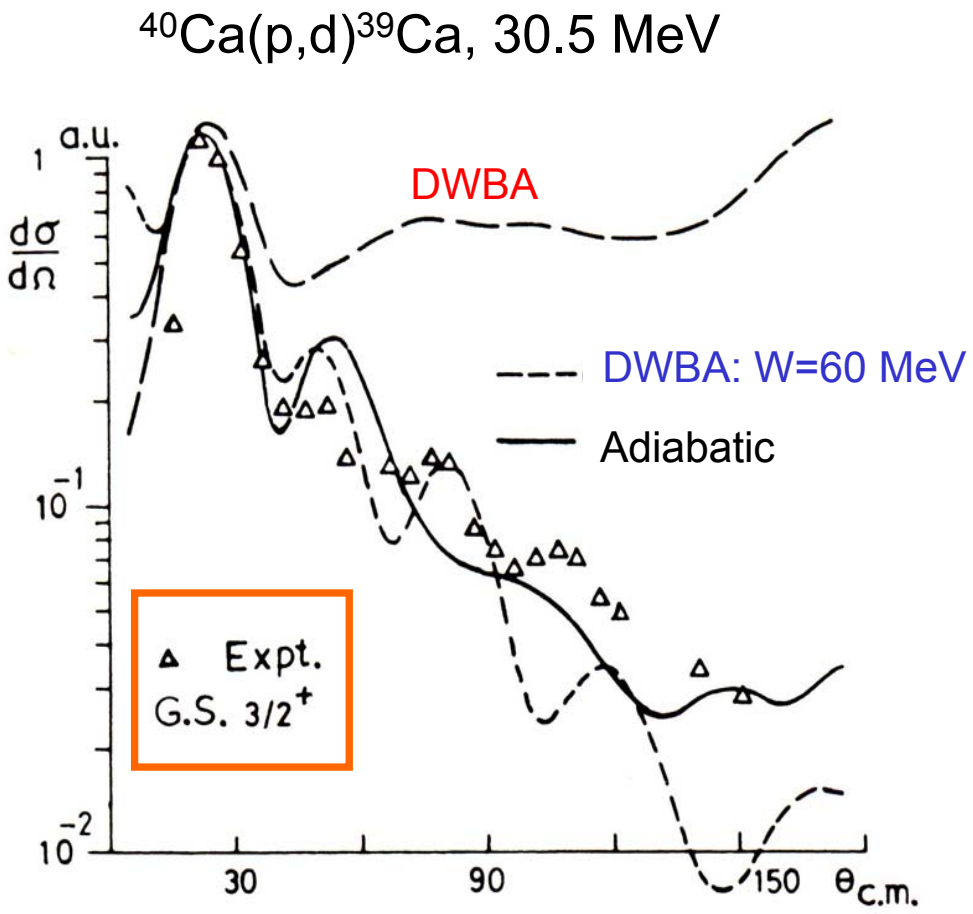
"ADWA"

$$\psi^{(+)}_{d,\vec{k}_d}(\vec{r},\vec{R}) = \chi^{Ad}_{d,\vec{k}_d}(\vec{R})\phi_d(r), \;\; \vec{r} \approx 0$$

$$[T_R + V_p(R) + V_n(R) - E_0]\chi^{Ad}_{d,\vec{k}_d}(\vec{R}) = 0$$

Compared with $[T_R + U_{dA}(R) - E_0]\chi^{(+)}_{d,\vec{k}_d}(\vec{R}) = 0$

Breakup on transfer reactions - geometry



Increased reflection at nuclear surface - less diffuse deuteron channel potential

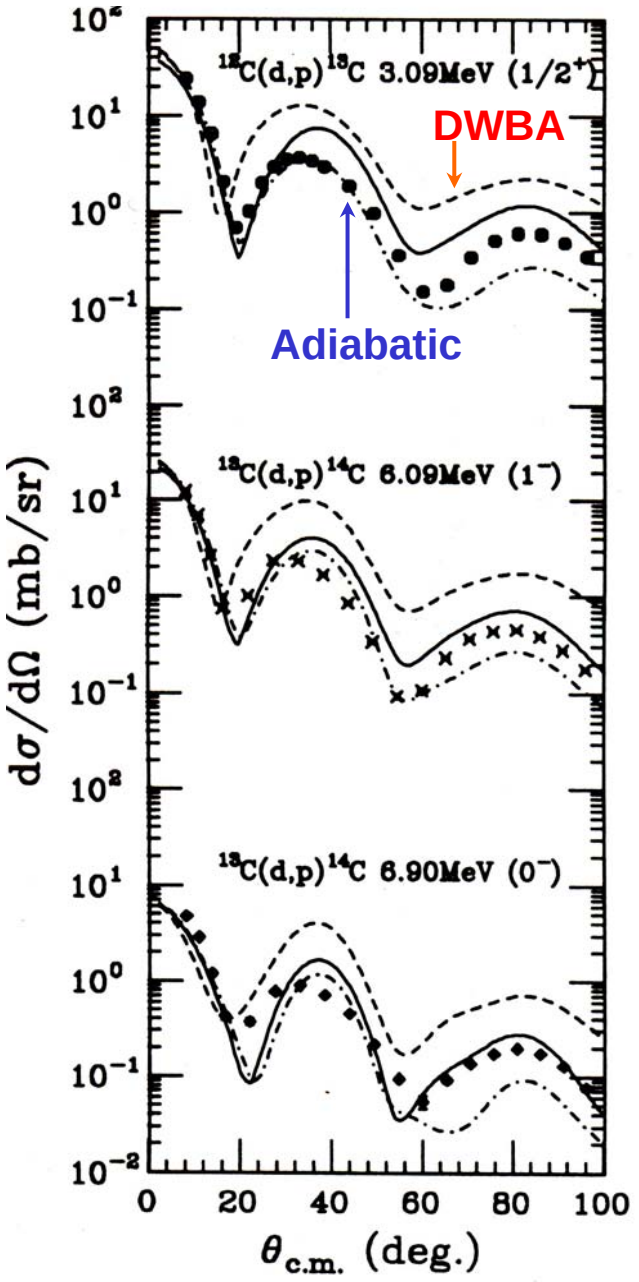
Greater surface localisation - L-space localisation

Less nuclear volume contribution and less sensitivity to optical model parameters

More consistent sets of deduced spectroscopic factors

J.D. Harvey and R.C. Johnson, Phys. Rev.C **3** (1971) 636

Spectroscopic factors in the adiabatic limit



Excitation energy (MeV)	J^π	Transferred nl_j	Spectroscopic factor DWBA	ADBA	CCBA	Shell Model
0.00	$1/2^-$	$0p_{1/2}$	1.0	0.7	0.8	0.61
3.09	$1/2^+$	$1s_{1/2}$	1.8	0.8	0.9	—
3.68	$3/2^-$	$0p_{3/2}$	0.14	0.14	0.14	0.19
3.85	$5/2^+$	$0d_{5/2}$	0.7	0.6	0.6	—

Table 16. Spectroscopic factors obtained from the ^{12}C$(d,p)^{13}$C reactions and the shell model calculations.

Way to systematically improve the adiabatic approximation to transfer reactions (Weinberg states)

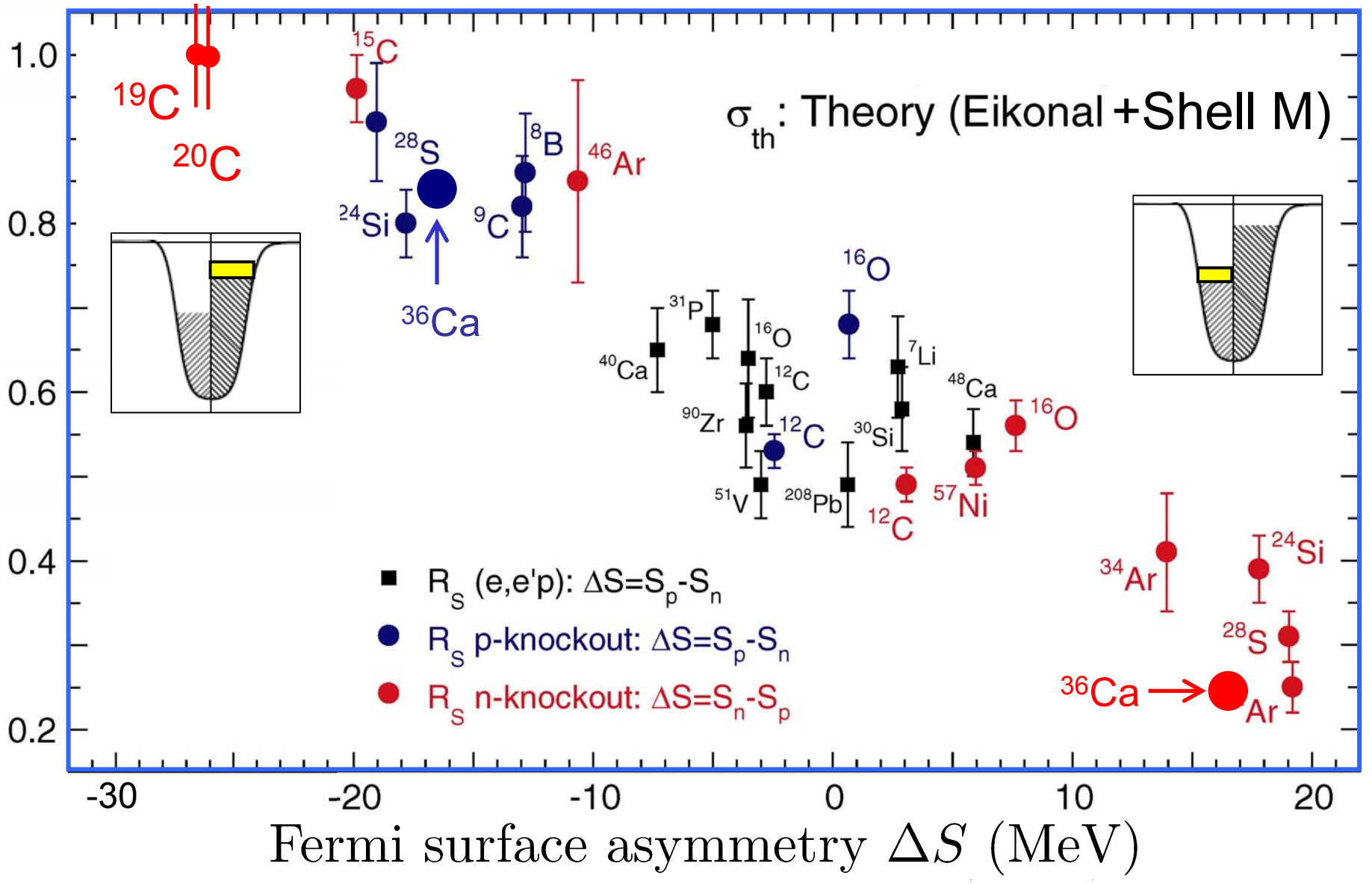
R.C. Johnson and P.C. Tandy, Nucl. Phys. A 235 (1974) 56

implemented for practical calculations

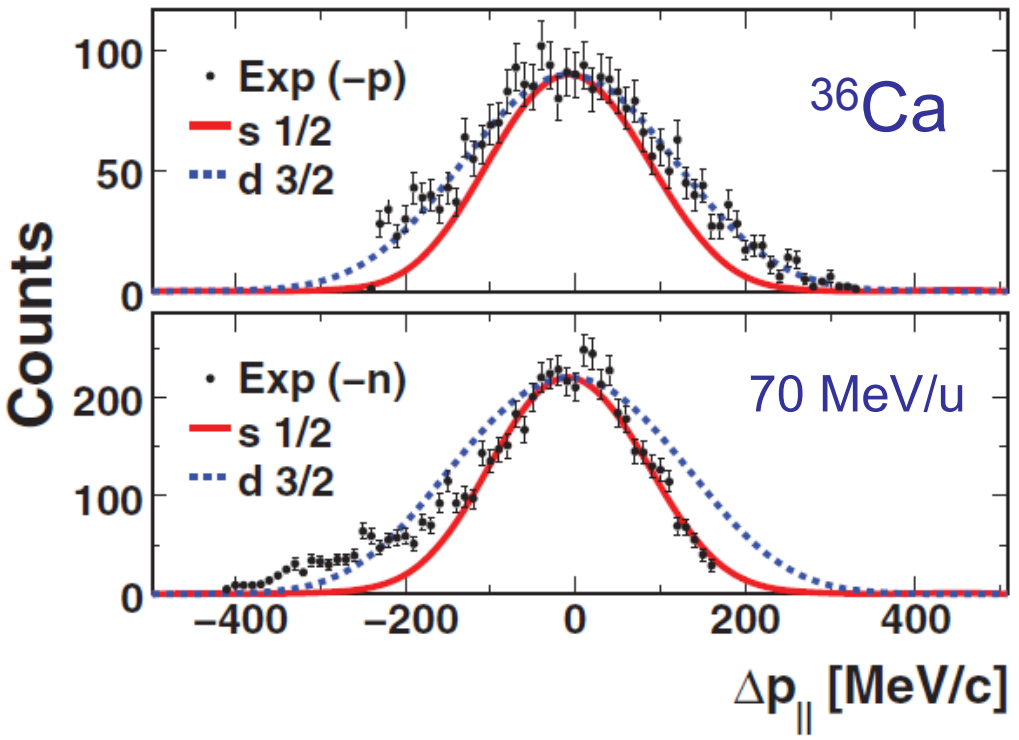
A. Laid, J.A. Tostevin and R.C. Johnson, Phys. Rev. C **48** (1993), 1307

H. Toyokawa, PhD Thesis, RCNP, Osaka University 1995

Measurements at the two Fermi surfaces



Recent data added to the plot



R. SHANE *et al.*
PHYSICAL REVIEW C **85**, 064612 (2012)

N. KOBAYASHI *et al.*
PHYSICAL REVIEW C **86**, 054604 (2012)