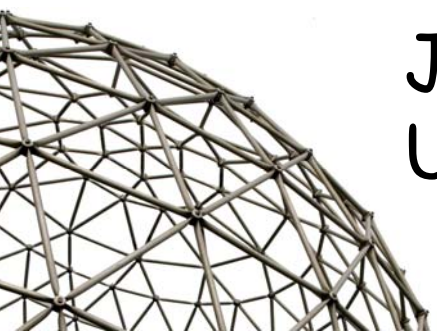
"Perspectives" - the state of one's ideas, the facts known to one, etc.

ECT* Workshop: "From nuclear structure to particle-transfer reactions and back",
Trento, 4-8 November 2013



Jeff Tostevin, Department of Physics,
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UNIVERSITY OF SURREY

Radioactive ion-beams – our future

RIKEN RI BEAM FACTORY

RIKEN

RIKEN NISHINA CENTER

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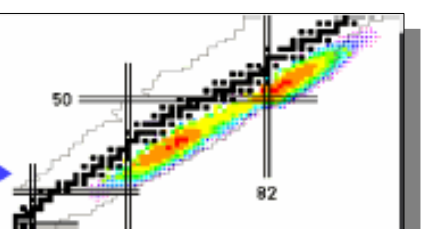
TRIUMF ARIEL
ADVANCED RARE ISOTOPE LABORATORY

ISOLDE

HIE-ISOLDE

---A Dream Factory for Particle Beams---

Spiral2



ATLAS

NSCL

FRIB

Some issues: Transfer – structure interaction

1. Interactions for exotic species (optical, SRG etc.)
2. Independent particles and “correlations”
3. Reaction challenges (manpower for the future)
   Making the new generation tools available
4. Interface with shell/microscopic/mean field models
   – 1N, 2N overlaps from other than SM
5. Spectroscopy (data that challenges theory)
6. Understanding of reaction sensitivities
7. Thanks and close

Interactions for exotic species (optical, SRG etc.)

Issues:

Optical potentials for exotics. Will form part of May 2014 workshop. Mainly a low-energy problem.

Implications of use of ‘soft NN interactions’ for ab-initio-derived overlap functions and SF for use in direct reactions – in context of ‘non-observable’ discussions of SF?

Spectroscopic Factors as ‘non-observables’

Furnstahl and Schwenck **[J. Phys. G 37 (2010)]**

- The general structure is that a measured quantity such as a cross section is decomposed as a convolution of subsidiary pieces, usually based on a factorization principle.
- The quotes are intended to soften the implication that it is improper to talk about them; nevertheless, unless the conventions (e.g., scale and scheme dependence) are controlled and specified, there will be ambiguities that will be entangled with the structure and reaction approximations.
- The challenge is to formulate and carry out experimental extractions and theoretical calculations of non-observables systematically and consistently.

Absolute SF would be nice but are not a prerequisite for obtaining detailed structure information in exotic nuclei

Independent particles and “correlations”

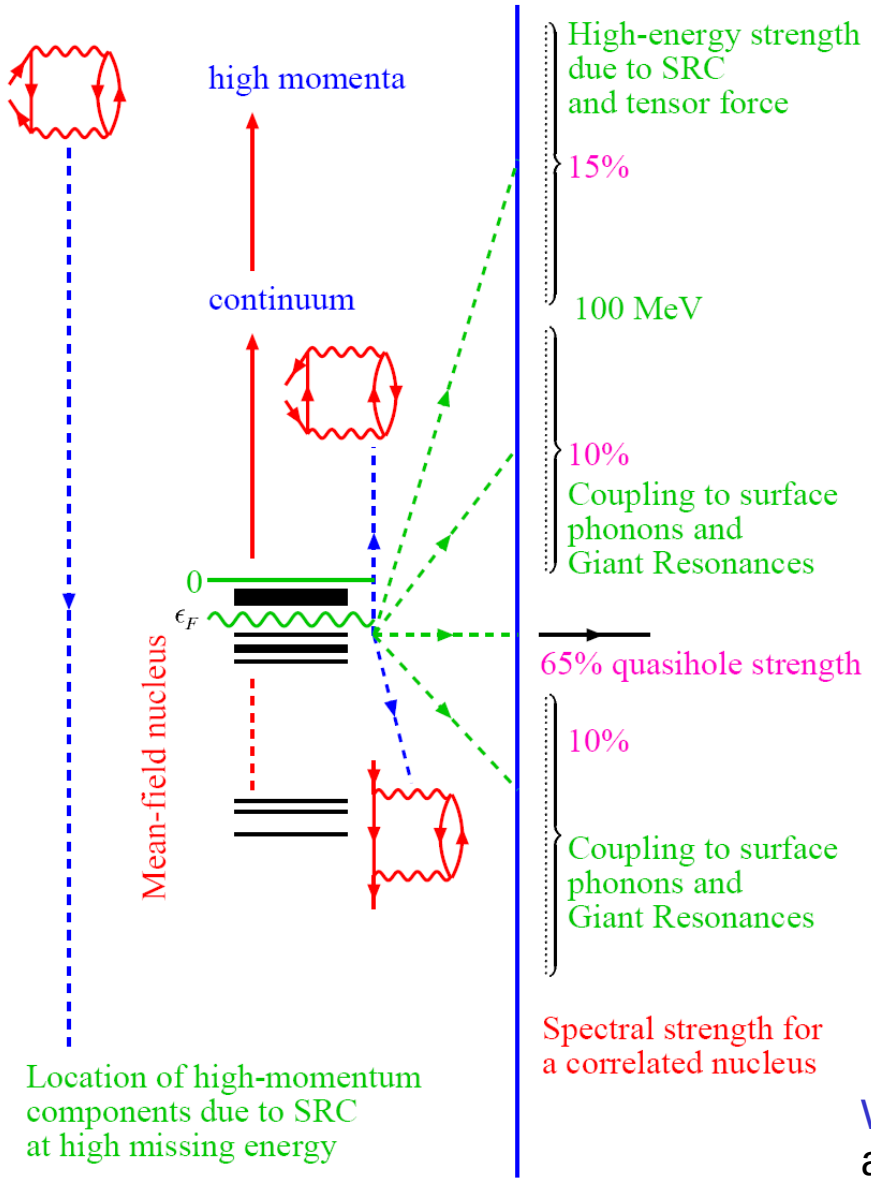
Issues:

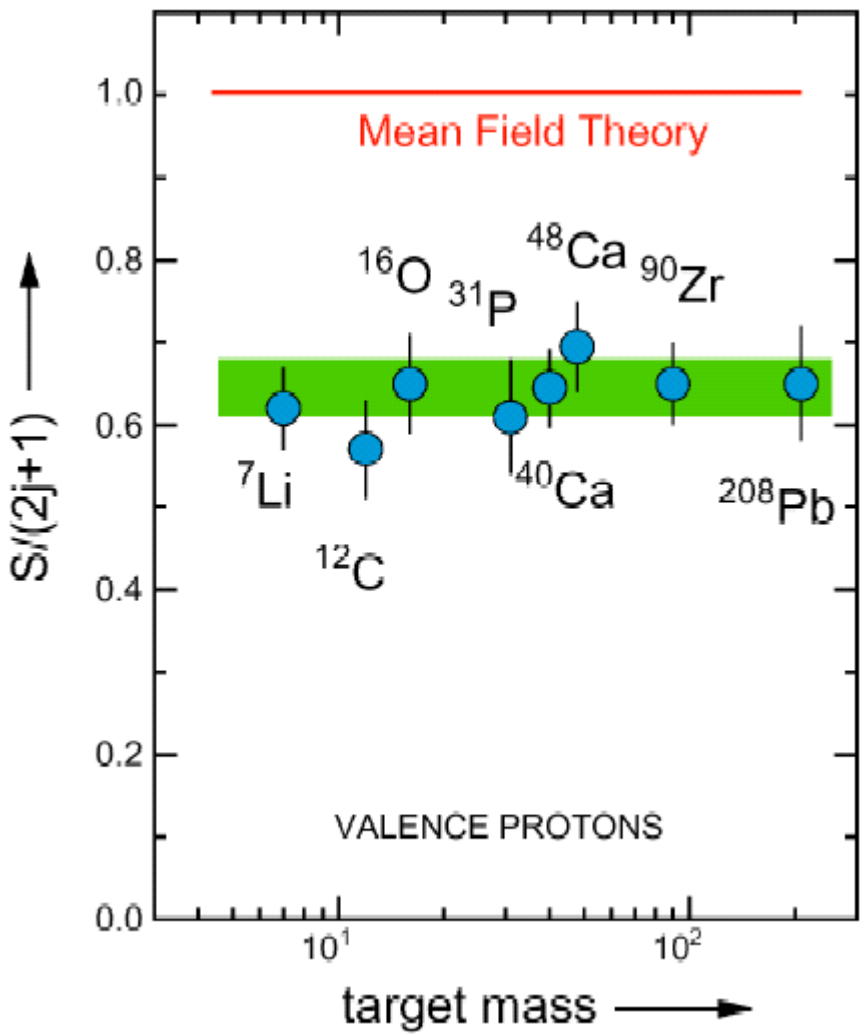
Extent to which correlations are included in SM.

Quasi-particle versus nucleonic nature of low-energy degrees of freedom and interpretation of SF.

Reactions sensitivity to formfactors – radial forms, WS shapes adequate? radius parameter choice and determination, transfer and knockout reaction sensitivities to detail versus rms

Strength from e-induced knockout – stable nuclei





W. Dickhoff and C. Barbieri, Progress in Particle and Nuclear Physics **52** 377 (2004)

Stable nuclei – can be made consistent

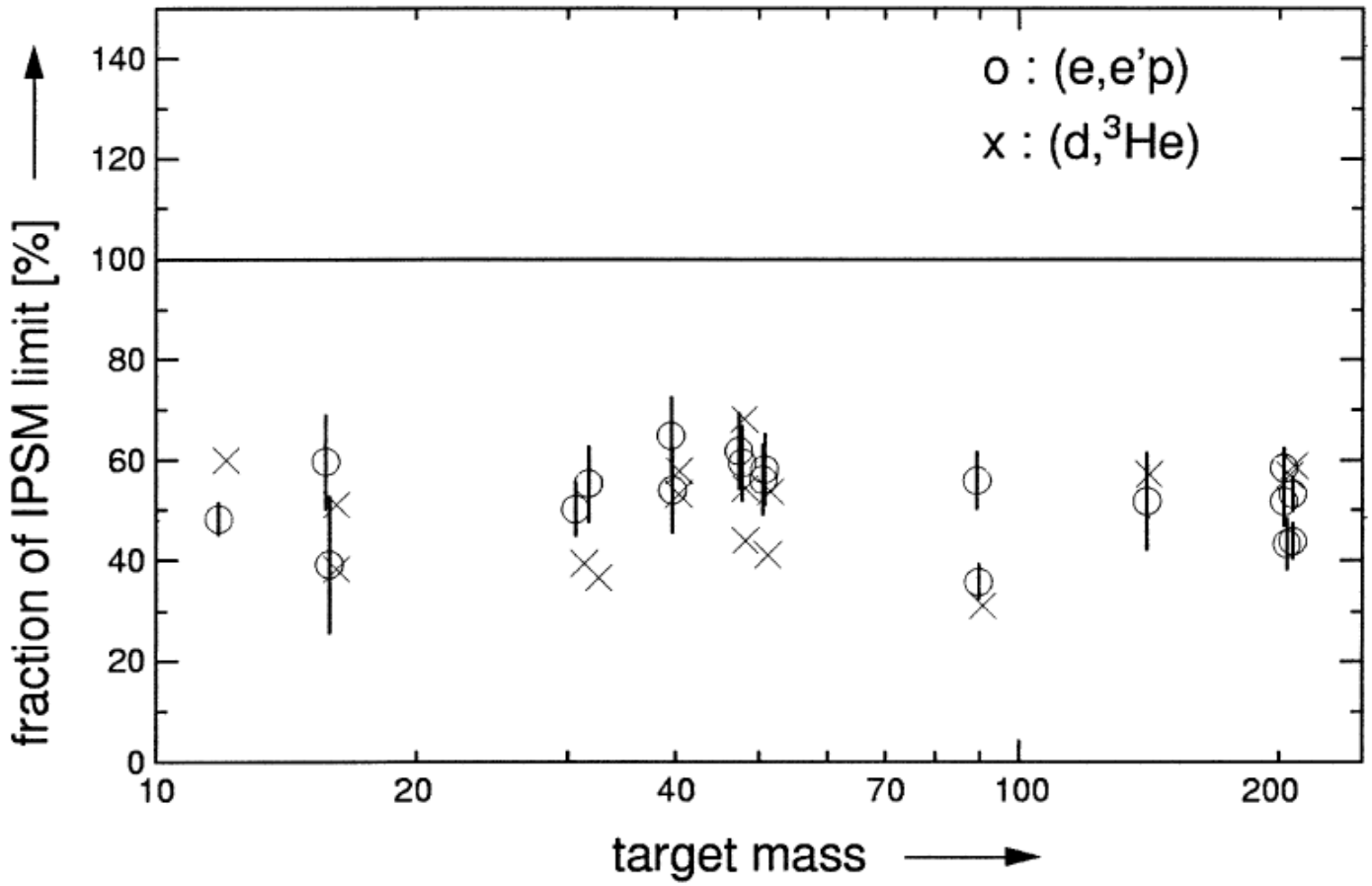


Fig. 7. Summed spectroscopic strength of the valence orbit as function of the mass number normalized to the independent-particle shell-model limit according to literature values from (e,e′p) experiments and from a reanalysis, as discussed in the text, of the (d,^{3}He) data presented in Fig. 1.

G.J. Kramer et al. / Nuclear Physics A 679 (2001) 267–286

Radius parameter is not fixed in (e,e′p)

Spectroscopic factors for proton pick up from ^{48}Ca deduced from (e,e′p) and from (d,^{3}He) experiments

E_x [MeV]	J^π	r_0 [fm]	r_{rms} +) [fm]	S(e,e′p)	S(d,^{3}He) [16] LZR	NLFR	S(d,^{3}He) [17] NLFR
0.00	$1/2^+$	1.228(47)	3.58(10)	1.07(7)	1.55	0.96	0.94(25)
0.36	$3/2^+$	1.254(48)	3.54(10)	2.26(16)	4.16	2.39	2.31(65)
3.42	$5/2^+$	1.128(44)	3.39(9)	0.683(49)	1.02	1.28	1.07(31)
3.85	$1/2^+$	1.294(51)	3.59(10)	0.167(14)	0.28	0.12	
3.95	$3/2^+$	1.288	3.54	0.323(27)	0.70	0.32	
5.24	$5/2^+$	1.192(48)	3.49(8)	0.288(21)	0.32	0.27	
5.49	$5/2^+$	1.182(46)	3.47(9)	0.746(52)	0.94	0.84	
6.51	$5/2^+$	1.265(56)	3.62(12)	0.160(14)	0.22	0.11	
6.87	$5/2^+$	1.162(65)	3.41(14)	0.070(7)	0.14	0.14	
7.81	$5/2^+$	1.243(49)	3.56(9)	0.434(32)	0.71	0.42	
8.13	$5/2^+$	1.299(54)	3.46(12)	0.228(19)	0.33	0.26	

plus a bound state (Perey-Buck) non-locality.

G.J. Kramer et al. / Nuclear Physics A 679 (2001) 267–286

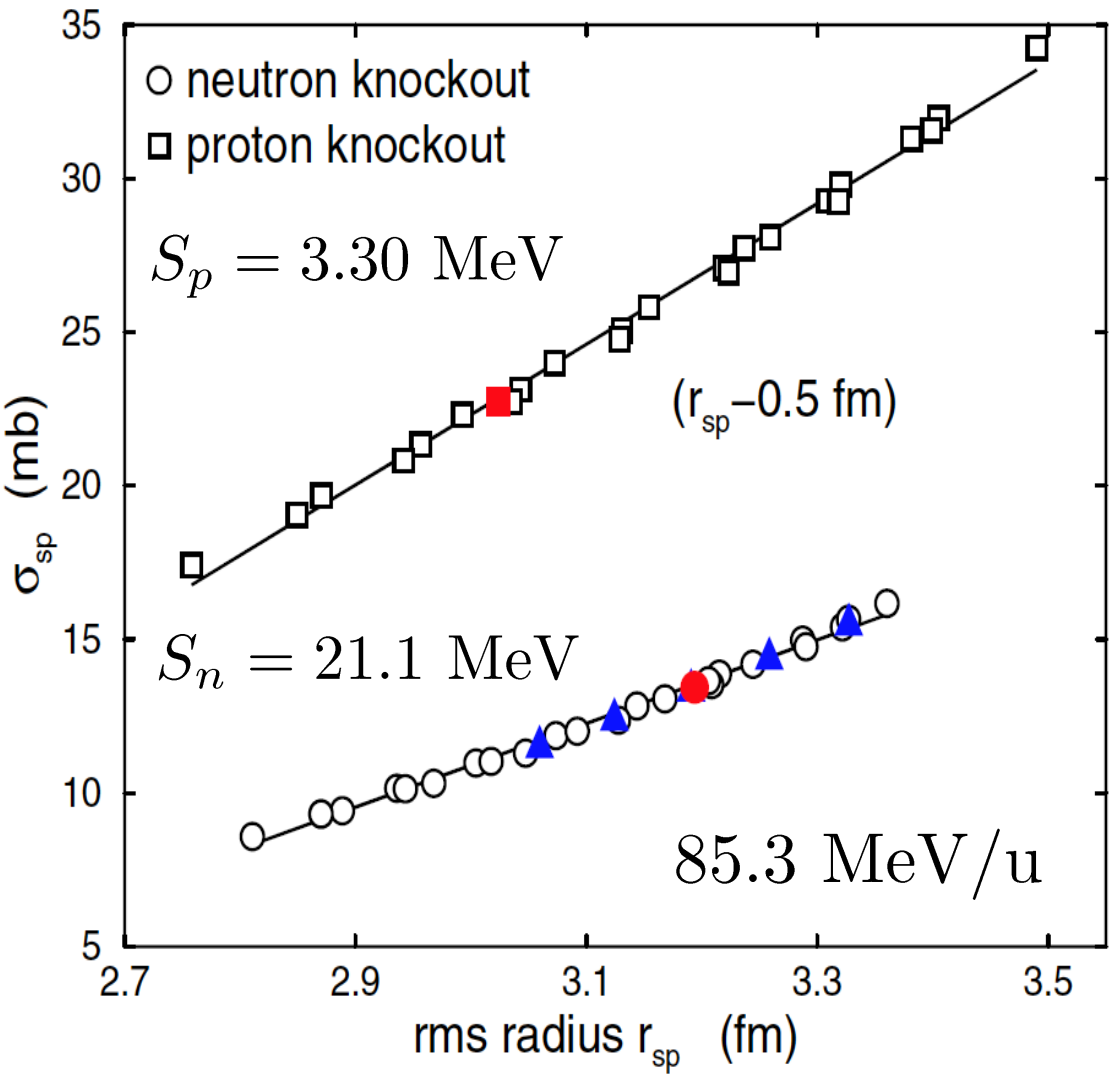
Overlap function sensitivity: knockout

$^{24}\mathrm{Si}\ (-1\mathrm{N})\ \ 1d_{5/2}$

$\sigma(r_0, a_0, V_{so}, \beta_{NL})$

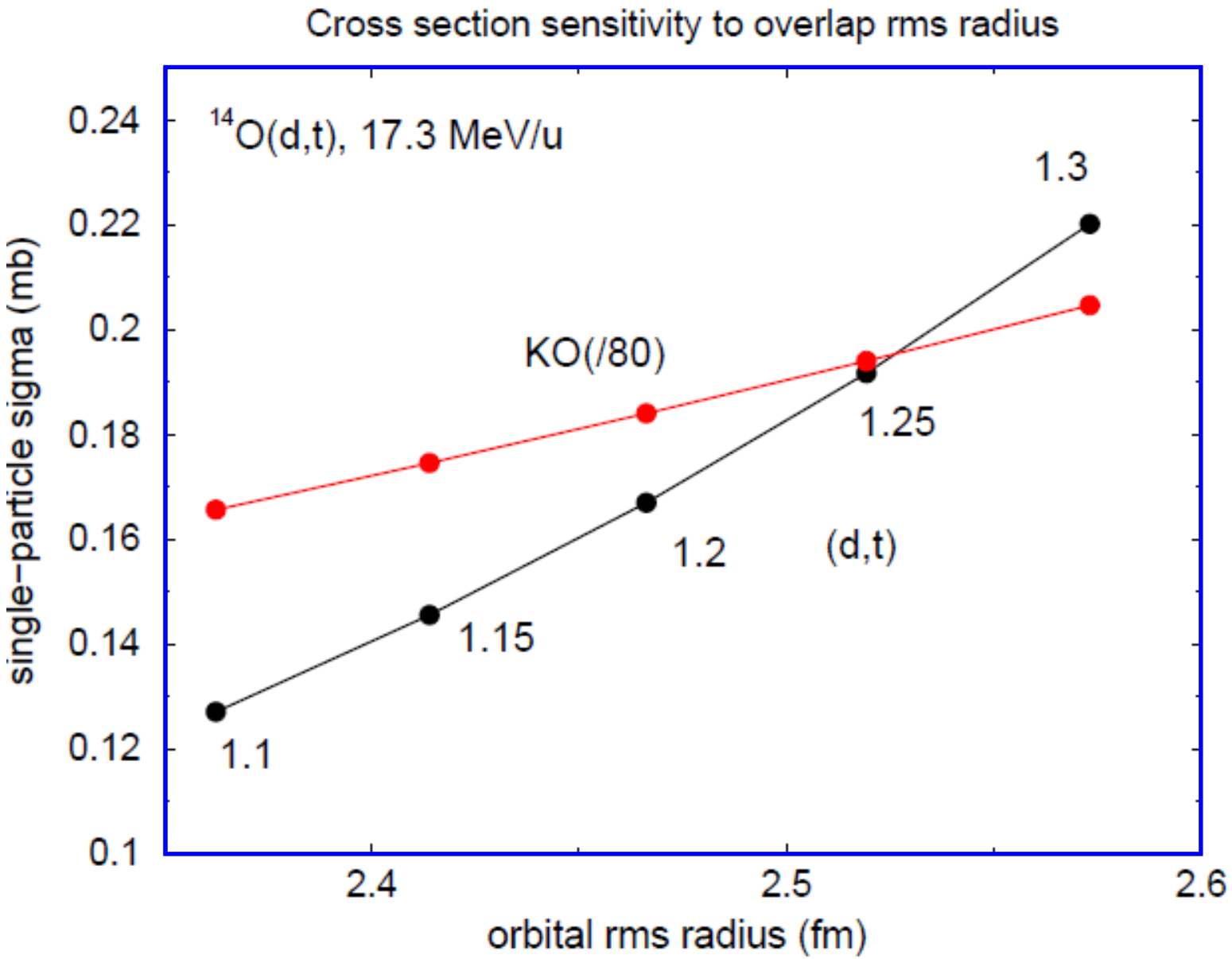
$\sigma(r_{sp} = \langle r^2 \rangle^{1/2})$

The rms radius of the single particle wfn is the key requirement for accurate values of the removal cross sections. We choose to constrain these by Hartree-Fock.



A. Gade et al., Phys Rev C **77**, 044306, (2008)

Overlap function sensitivity: transfer



Reaction challenges

Issues:

New developments 3-body (Faddeev, AGS: Lisboa) and (p,t) (simultaneous/sequential/ orthogonality terms: Milano) and codes now appear to offer major improvements and tools for use by potential/trained experimenters .

Few codes seem to be being made available leaving analysis tools lacking. There is need to encourage publication of codes as they become stable.

Interface with shell/microscopic/mean field models

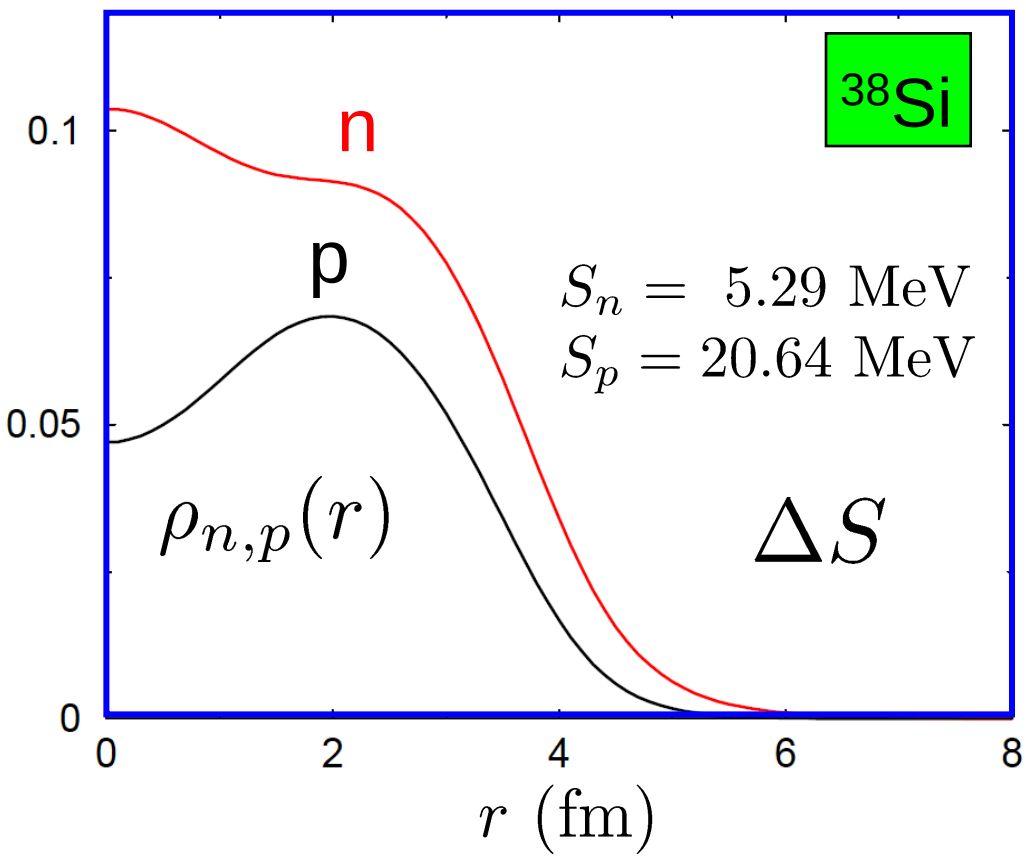
Issues:

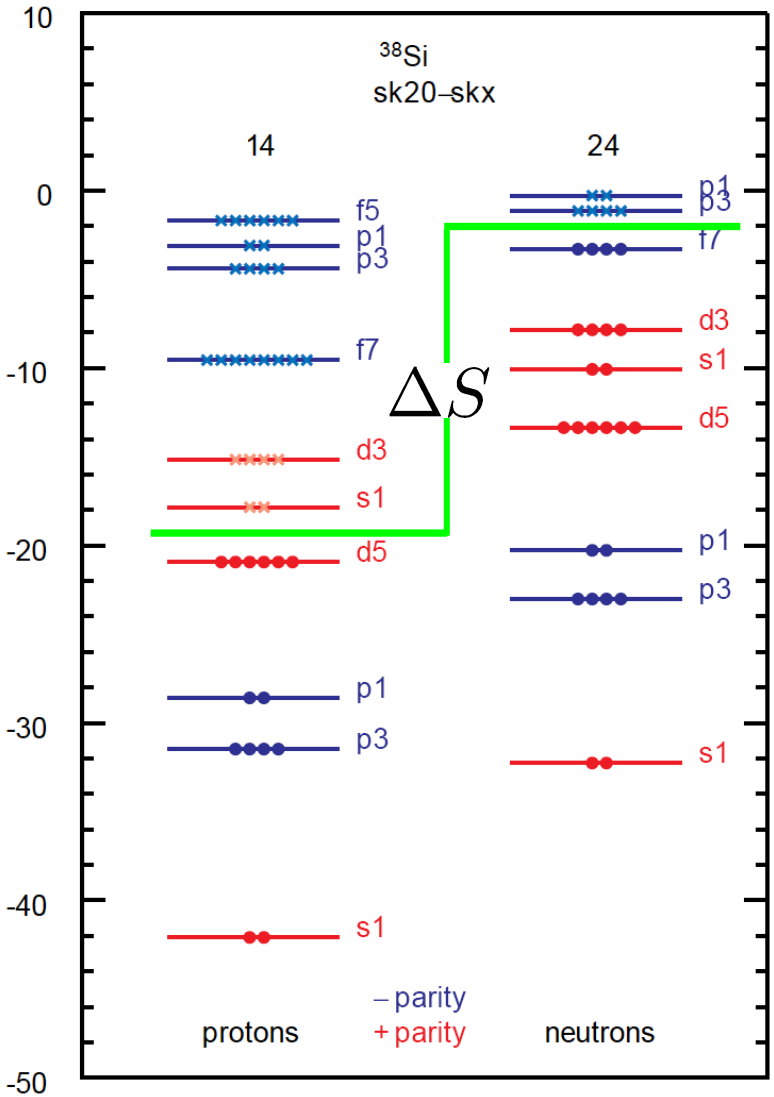
Overlap availability is increasing from ab-initio approaches – but little from other structure approaches.

How can we improve/test the description of well-bound nucleon states in asymmetric systems? What are the likely changes of these from WS descriptions, SM spectroscopic strengths, etc. as are currently used?

What is the role of the continuum in e.g. proton removal from n-rich and vice-versa?

Two displaced Fermi surfaces – and densities





Spherical Hartree Fock density (SkX)

Measurements at the two Fermi surfaces