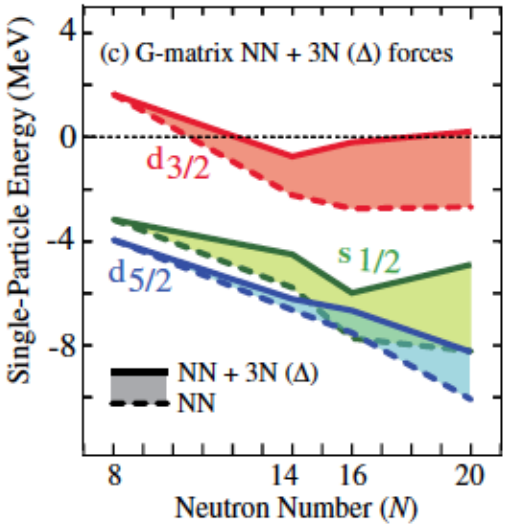
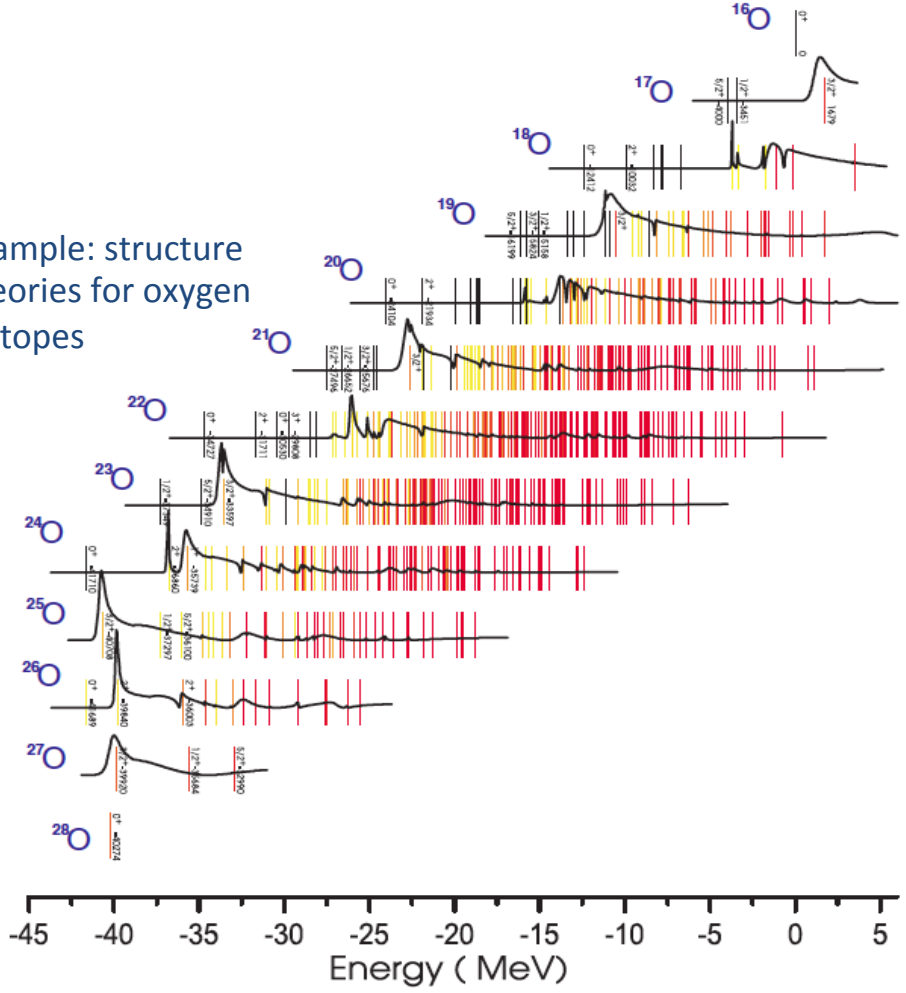
Transfer reactions populating continuum states (resonances and non-resonant continuum)

- Resonance properties give insights into nuclear structure, complementary to information obtained from bound states in weakly-bound systems.
- Stringent tests for theories that predict positions and widths of resonances



Example: structure theories for oxygen isotopes

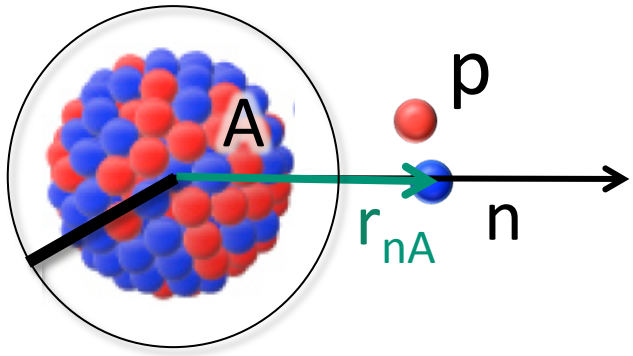


- Resonance often dominate astrophysical reaction rates: Resonance positions and widths in range of stellar energies are needed.

Suitable reaction theory is required to extract resonance properties from experiments, understand interference between resonant and non-resonant structures.

Current Status

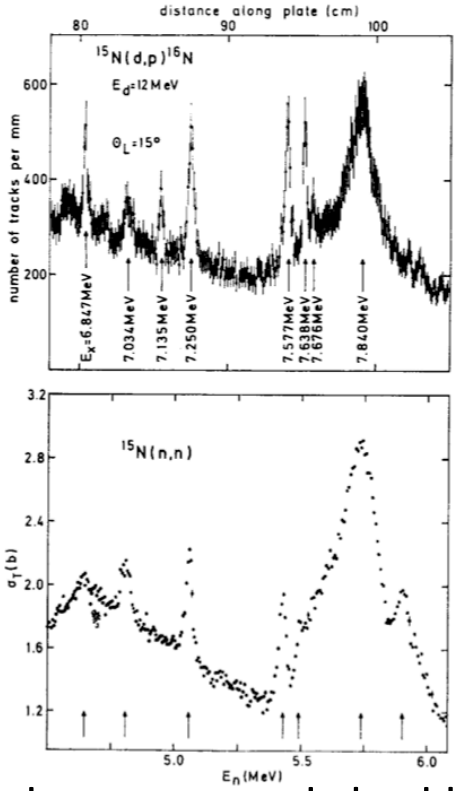
- Transfers to continuum typically described with tools developed for bound states.
- Theoretical formulations rely heavily on overlap functions, which are not well know in nuclear interior and typically approximated rather crudely:
  - interference effects are not described properly
  - measured peak shapes are not reproduced
  - multichannel effects are neglected
  - breakup is not treated on same footing
- Nuclear physics community is moving away from 'spectroscopic factors' to asymptotic quantities:
  - for bound states, ANCs are used
  - for resonances, widths and partial widths should be used
- In analogy with R-matrix descriptions of binary reactions, a 'surface formalism' is being explored:
  - transfer cross section can be expressed in terms of asymptotic parameters
  - dominant part of transfer cross sections can be reproduced, but corrections still needed



Surface formalism for transfer reactions

Future challenges

- Fully develop theory to express transfer cross sections in terms of R-matrix parameters for resonances and their backgrounds:
  - Incorporate both surface and relevant non-surface contributions
  - Properly include breakup effects
  - Expand formalism to cover 'cluster' transfers (n, p, α, γ, etc.)
  - Implement multi-channel version of the approach
  - Develop user-friendly code for easy comparison with experiment, providing option to fit to experiment or to make use of information from advanced structure theories



Transfer: Data from (d,p) exp.

Challenge: establish relation-ship

Binary reaction: direct neutron data

- Apply theory to measurements for weakly-bound systems and shed light on the reaction mechanisms, to understand resonance profiles
- Extract quantities needed for astrophysics (resonance energies and widths) from indirect (transfer) measurements

Requirements: Additional faculty/staff effort, postdoc and student involvement, close collaboration with experimentalists