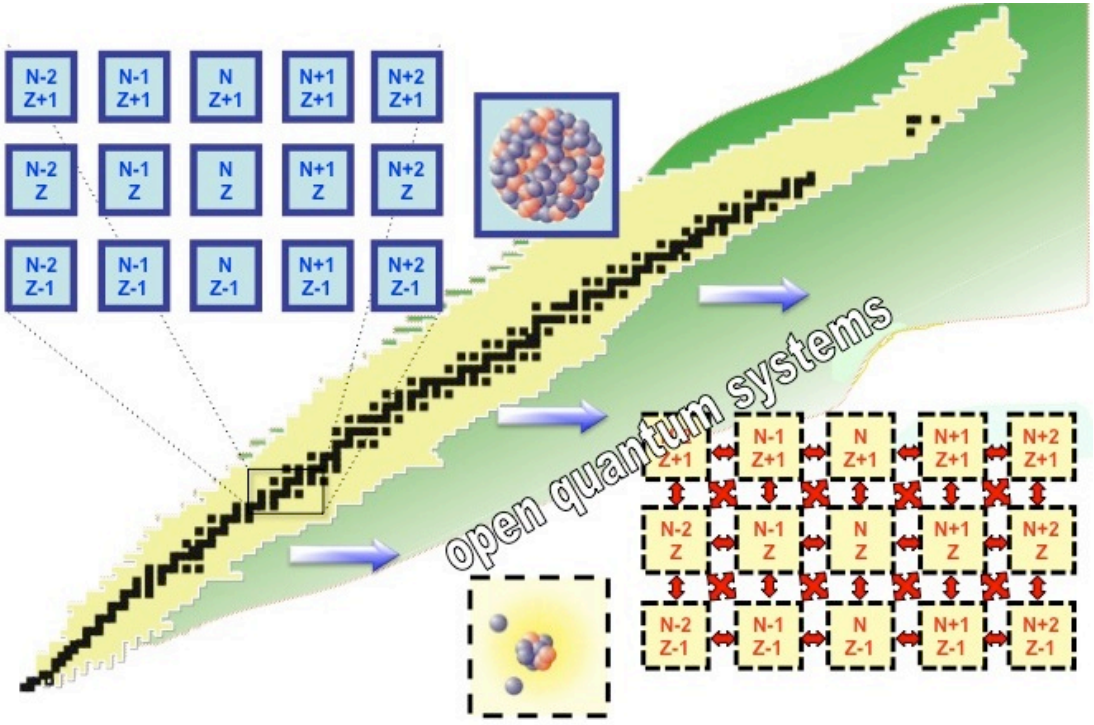
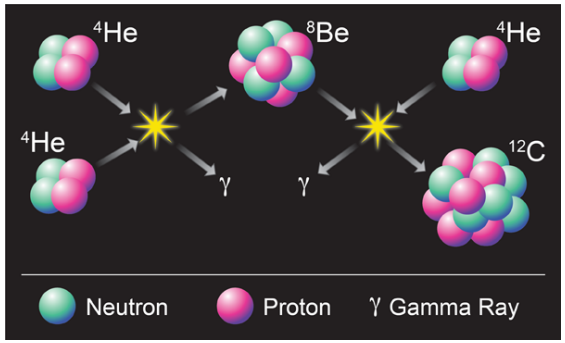
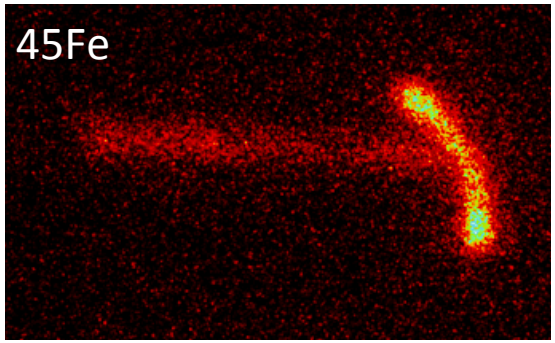
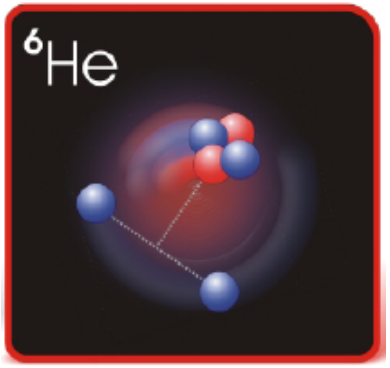
Atomic Nuclei: Many-Body Open Quantum Systems



- Facts: (i) nuclear structure is impacted by couplings to reaction and decay channels; (ii) reaction dynamics is impacted by nuclear structure
- Challenge: clustering, alpha decay, and fission still remain major challenges for theory
- Answer: unified picture of structure and reactions







Current Status

A suite of powerful approaches developed to open nuclear systems:

- Real-energy continuum shell model
- Complex-energy continuum shell model
  - Gamow Shell Model
  - Complex Scaling
- Ab-initio methods
  - Coupled Cluster Method
  - No-core Shell Model
- DFT (and beyond DFT) descriptions (fission, fusion, strength functions)
- Time-dependent approaches (HI fusion, fission…)

Profound interdisciplinary connections:

- resonance trapping and super-radiance
- threshold anomalies and channel coupling effects
- spectral fluctuations and statistics of resonances
- clusterization
- spatially extended halos and Efimov states

Future Prospects and Needs

Open problems in the theory of nuclear open quantum systems:

- What is the interplay between mean field and correlations in open quantum systems?
- What are properties of many-body systems around the reaction threshold?
- What is the origin of cluster states, especially those of astrophysical importance?
- How to understand tunneling of complex systems?
- What should be the most important steps in developing the theory that will treat nuclear structure and reactions consistently?
    - What is Quantum Mechanics of open quantum systems?
    - How are effective interactions modified in open quantum systems?

Needs:

- Workforce
- Large-scale computing