

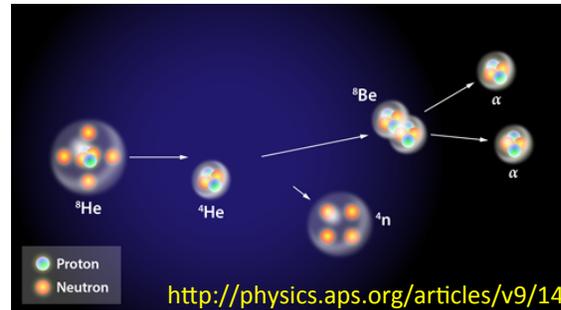
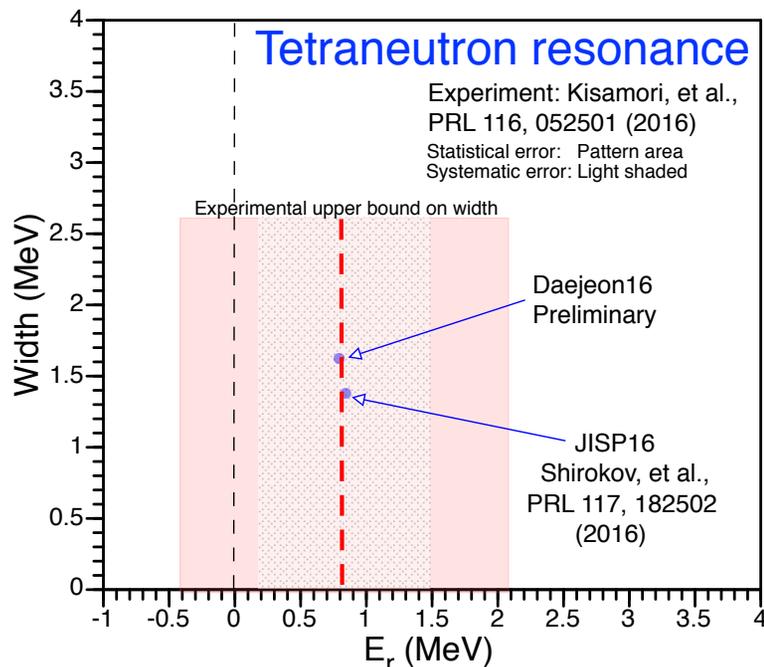
# Prediction of a Tetraneutron

## Objectives

- Predict properties of neutron-rich systems which relate to exotic nuclei and nuclear astrophysics
- Develop and apply new methods for deriving scattering properties from *ab initio* nuclear structure simulations
- Produce accurate predictions of nuclear resonances with quantified uncertainties

## Impact

- Guides experimental programs searching for tetraneutron resonances
- Demonstrate the predictive power of *ab initio* nuclear theory for nuclear resonances
- Establishes foundation for precision determination of new trineutron and tetraneutron interactions



**Above:** illustration of the experiment by Kisamori, et al, reporting the detection of the tetraneutron. **Left:** comparison between theory and experiment for the tetraneutron resonance. The statistical and systematic errors of the experiment are shown separately with the width determined only as a upper bound. The results of the NCSM are employed in the SS-HORSE method to produce the phase shifts leading to the resonance parameters.

## Accomplishments

1. Development of SS-HORSE, a new *ab initio* scattering formalism extending the No-Core Shell Model (NCSM) into the continuum
2. Demonstrated predictive power of *ab initio* nuclear theory for scattering observables
3. Provided resonance predictions for future experimental searches
4. Introduced new element to the chart of the nuclides
5. Provided a stepping-stone to possible heavier multi-neutron systems



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**References:** A.M. Shirokov, G. Papadimitriou, A.I. Mazur, I.A. Mazur, R. Roth and J.P. Vary, Phys Rev Lett 117, 182502 (2016); A.M. Shirokov, et al, Phys Rev C 94, 064320 (2016)  
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