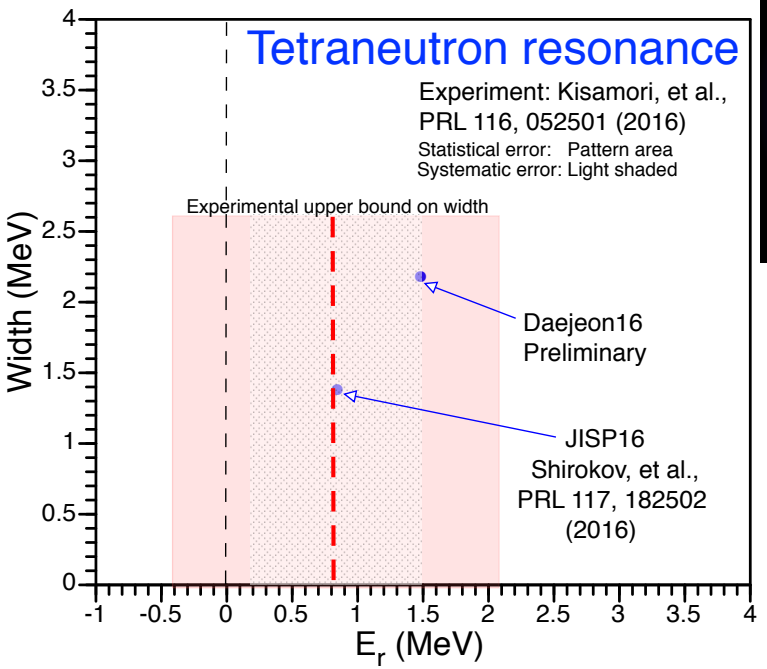
Prediction of a Tetraneutron

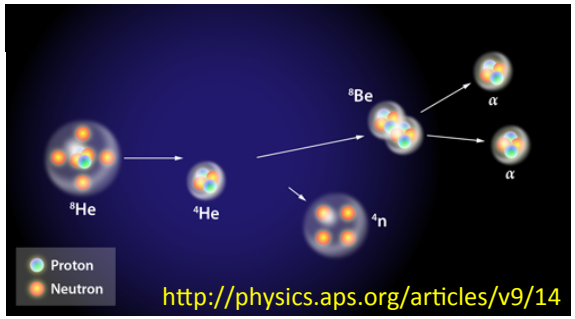
Objectives

- 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
- Demonstrates 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 theoretical results employ the SS-HORSE method with realistic neutron-neutron interactions.

Accomplishments

1. Development of SS-HORSE, a new *ab initio* scattering formalism
2. Demonstrated predictive power of *ab initio* nuclear structure theory
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, in press; arXiv: 1698.05885;

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