Bayesian methods for extrapolations to stellar energies

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Since the 2015 Long-Range Plan

- Several forefront analyses of solar-fusion cross sections adopted a Bayesian approach to the extrapolation of experimental data to solar energies
- Done with EFT; R-matrix; polynomial; ab initio parameterizations of S(E)
- Permits: discovery of non-gaussian (including multi-modal) solutions for parameters; straightforward propagation of parameter uncertainty to predicted quantities; modeling of systematic experimental uncertainties

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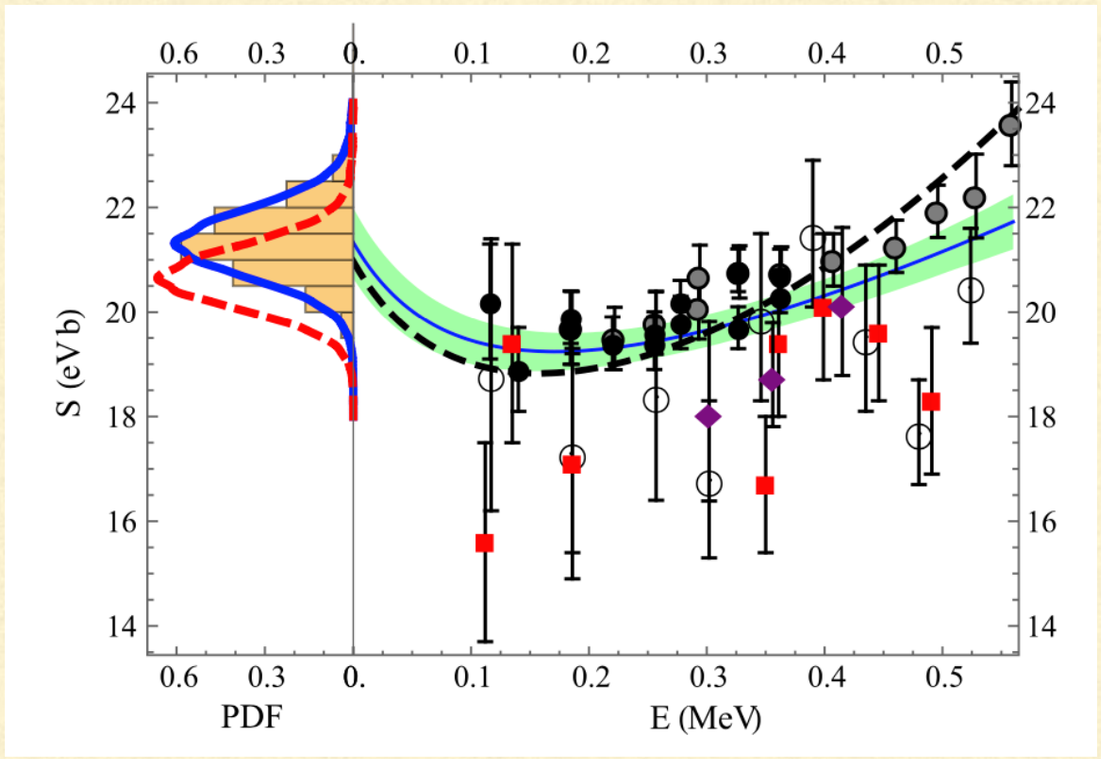

Zhang et al., PLB 751, 535 (2015)

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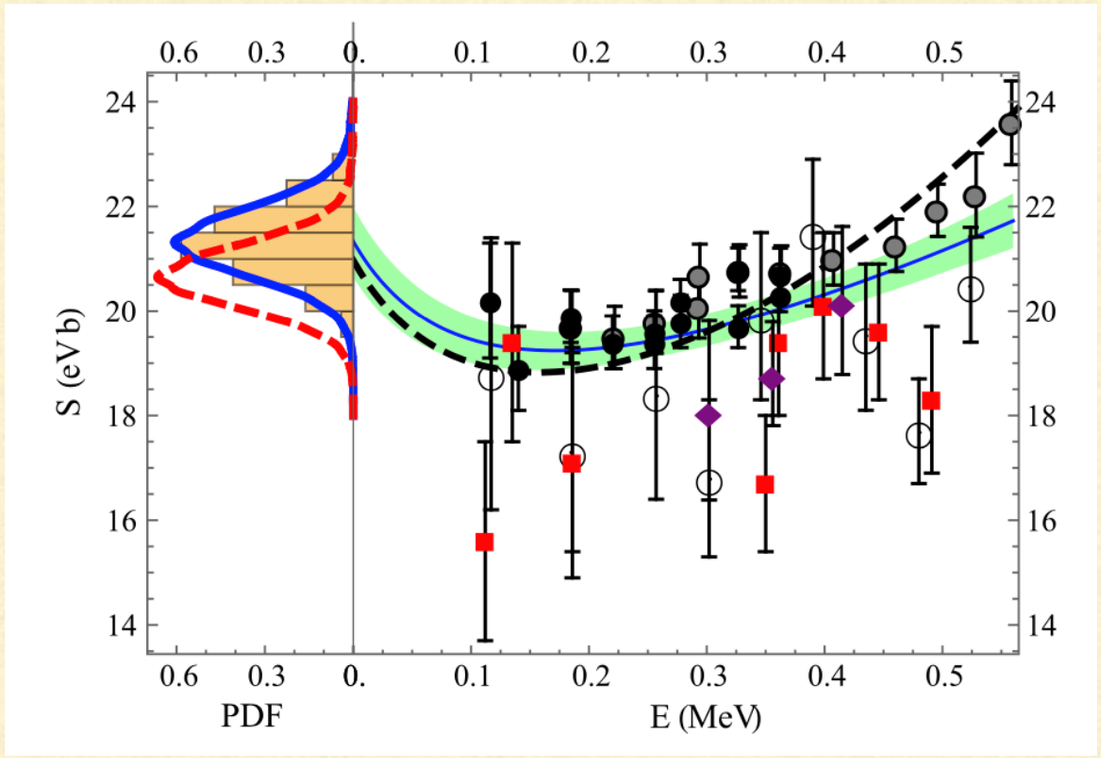

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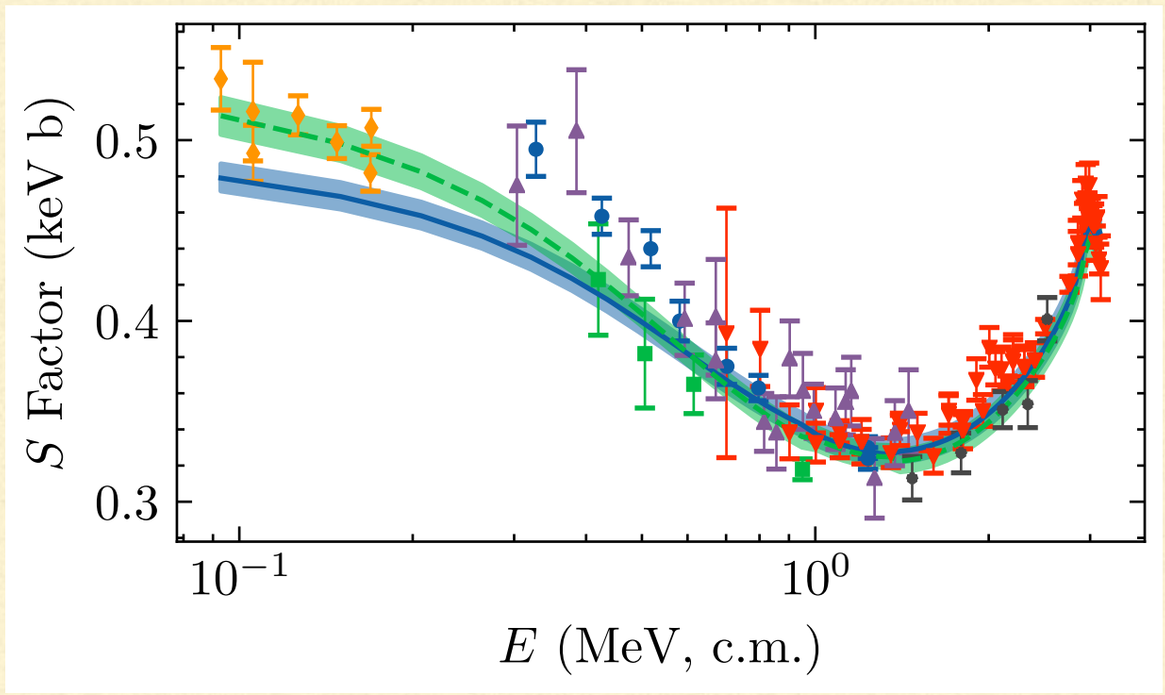

Odell et al., Front. Phys. 10 (2022) 888476

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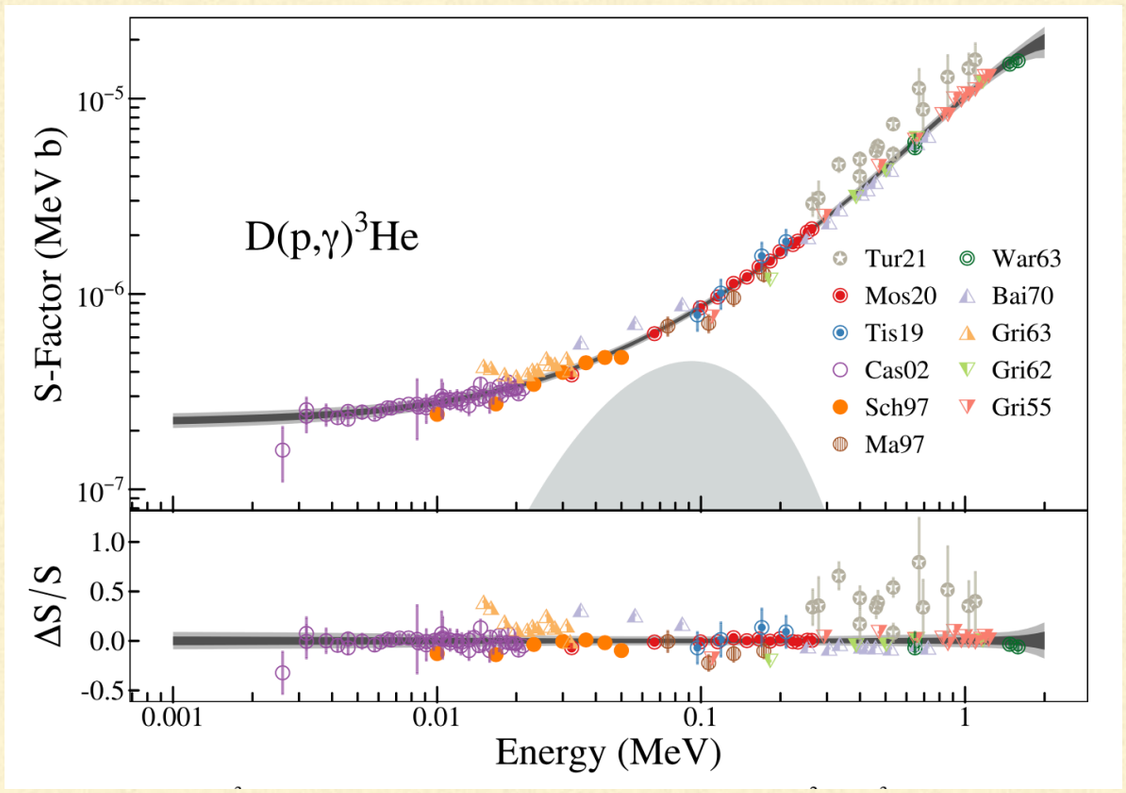
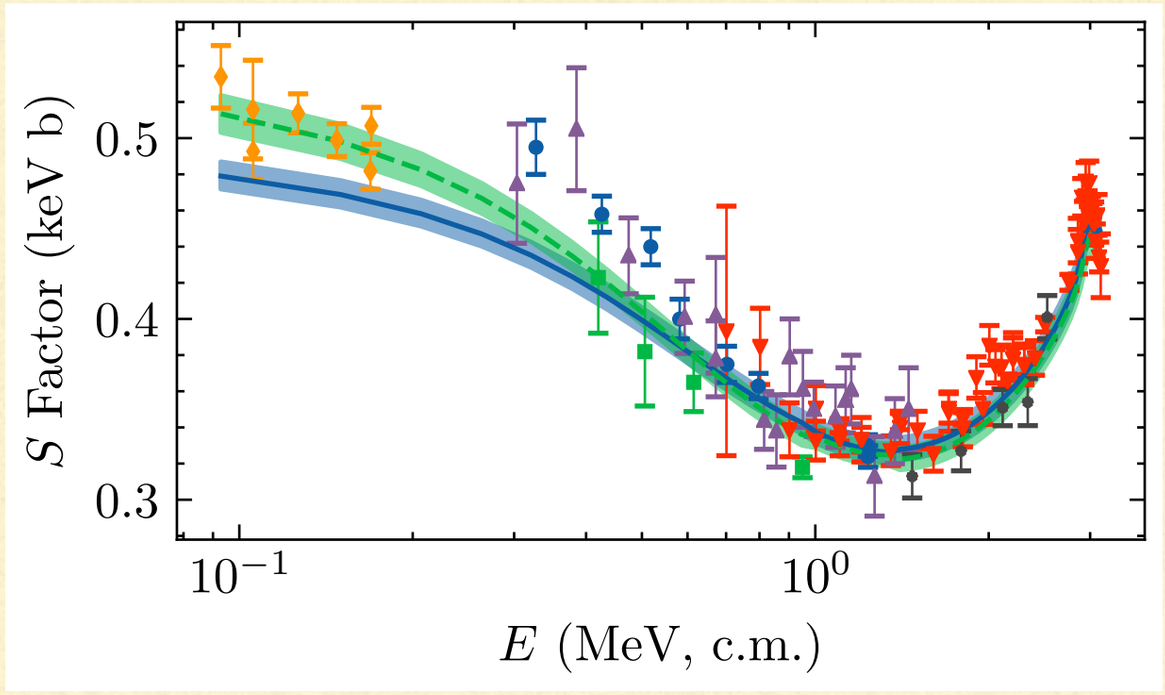


Moscoso et al., Astrophys.J. 923 (2021) 49



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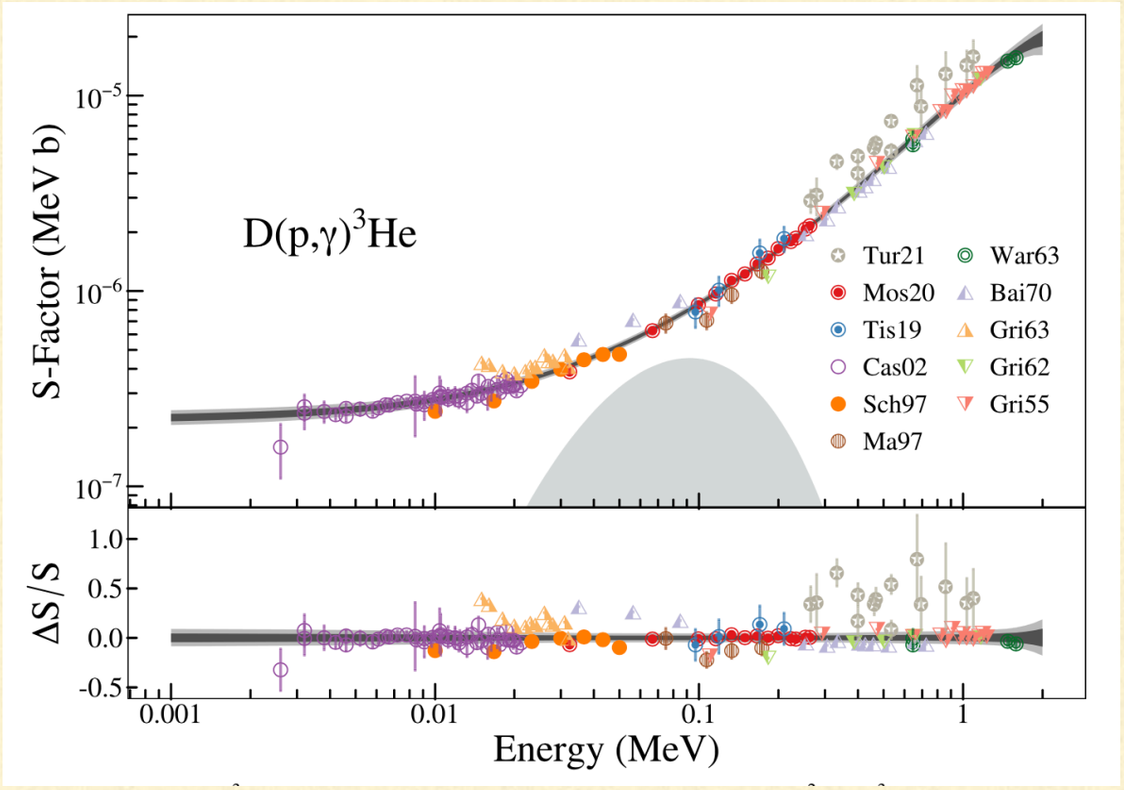

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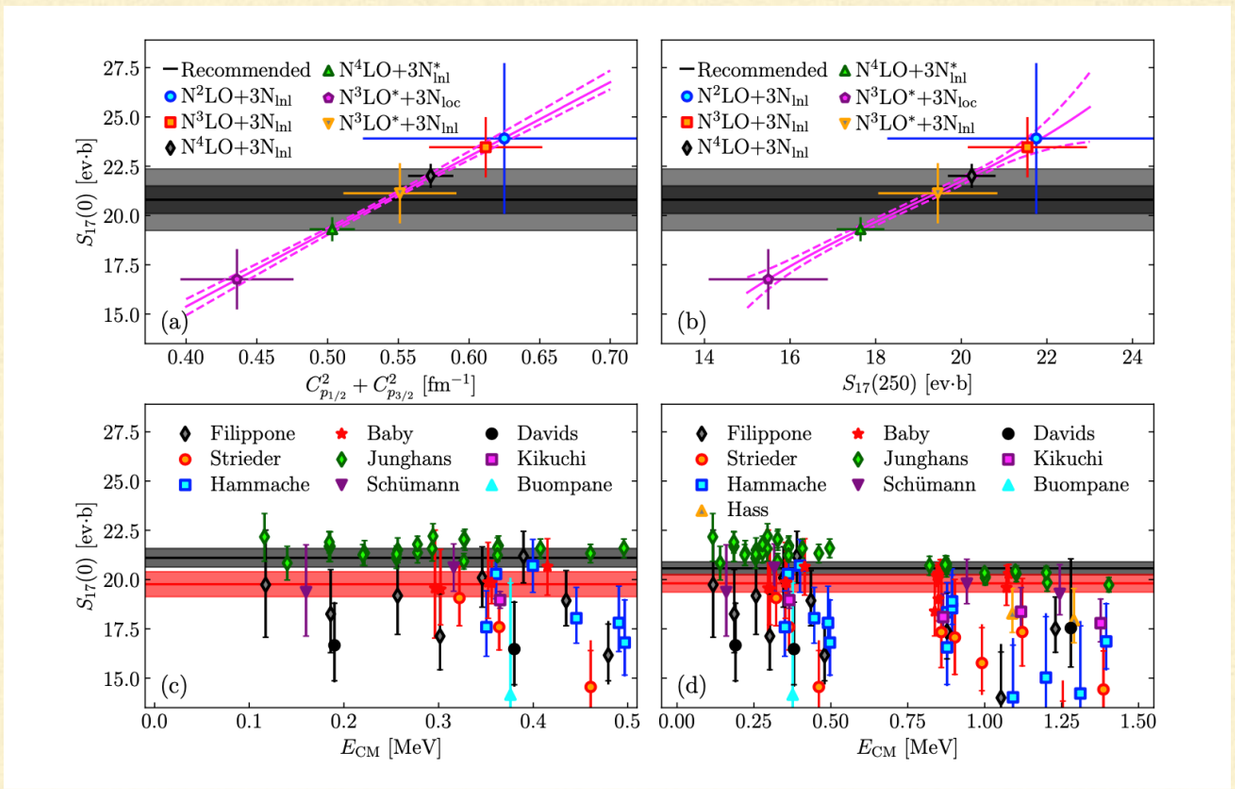

Kravvaris et al., arXiv:2202.11759

Needs

- Detailed discussion of systematic uncertainties, ideally with covariance matrices, in experimental publications; theory-experiment collaborations
- Collaboration with statisticians (e.g., through ISNET series of meetings, funding for inter-disciplinary collaboration) on forefront statistical approaches for these problems
- High-performance computing and/or emulators to run models and MC sampling of parameters
- Inter-model comparisons and Uncertainty Quantification

Disclaimer

- Focus is on extrapolations for S(0) here; similar issues arise in other extrapolations from nuclear data, although modeling issues can be larger
- Important work on neutron-spectrum unfolding, experimental design, ….