Continuum extension of the NCSM: HORSE and ACCC

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TECHNISCHE UNIVERSITÄT DARMSTADT

TRIUMF Workshop 2019

SFB 1245

DFG

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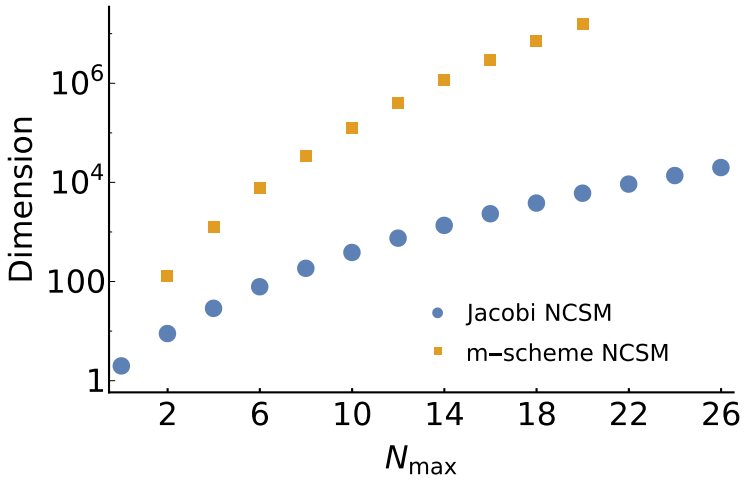
Motivation

- Describe possible resonance of the four neutron system from ab initio bound state calculations

  Kisamori et al. PRL **116**, 052501 (2016)

- Use existing Jacobi-NCSM framework with favourable model space scaling behaviour



- Single state HORSE calculations of 4n with large model spaces and different chiral interactions

  Shirokov et al. PRL **117**, 182502 (2016)

- Combine Jacobi-NCSM with analytic continuation in the coupling constant

  Kukulin et al. Theory of Resonances, Springer (1989)

HORSE

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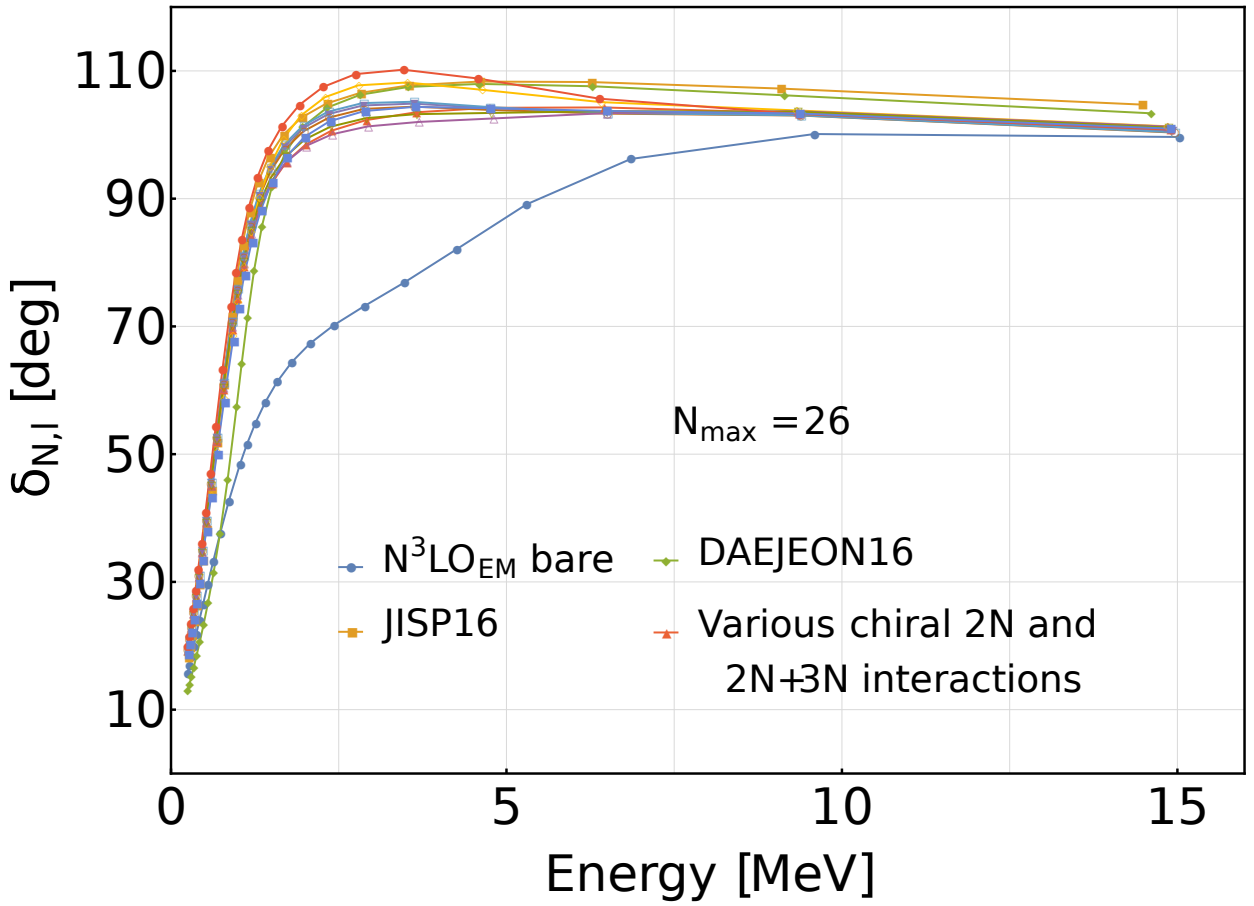
- **H**armonic **O**scillator **R**epresentation of **S**cattering **E**quation
- Single-state version
- Large model spaces
- Interactions consistent



ACCC – Introduction

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- Obtain resonance from unbound system by artificially binding system, e.g.

$$H(\lambda) = H + \lambda\, V_{\text{ext}} \quad \text{or} \quad \boxed{H(\lambda) = T + \lambda\, V_{\text{init}}}$$

- Generate set of binding energies $\{E_i, \lambda_i\}$

- Padé fit of wavenumber for analytic continuation

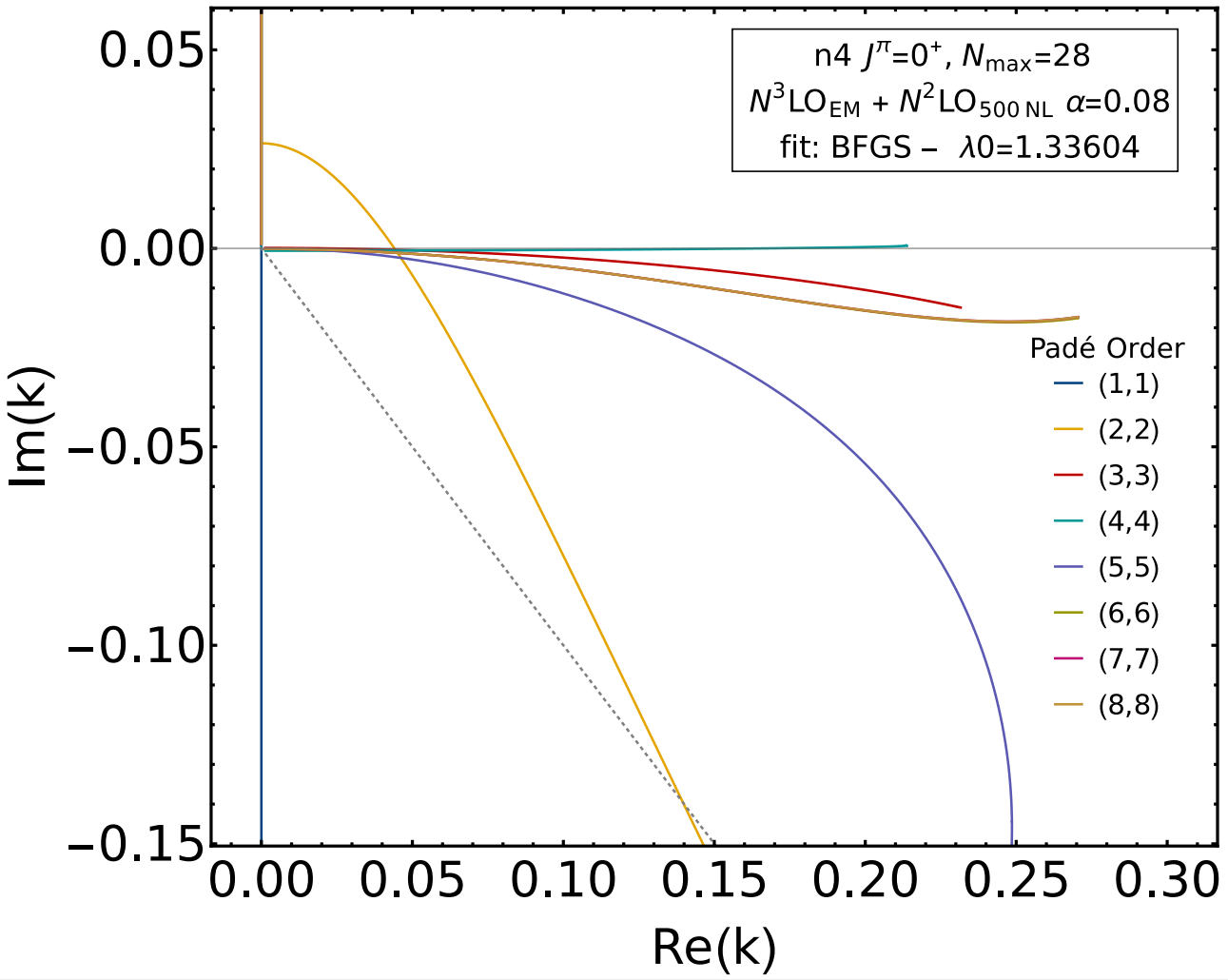
$$k^{[N,M]}(x) = i\,\frac{c_0 + c_1 x + \ldots + c_N\, x^N}{1 + d_1 x + \ldots + d_M\, x^M} \qquad x = \sqrt{\lambda - \lambda_0}$$

- Resonance energy and width

$$E_R = \frac{\hbar^2\left(k_{\text{Re}}^2 - k_{\text{Im}}^2\right)}{2m} \qquad \Gamma = \frac{2\,\hbar^2}{m}\, k_{\text{Re}}\, k_{\text{Im}}$$

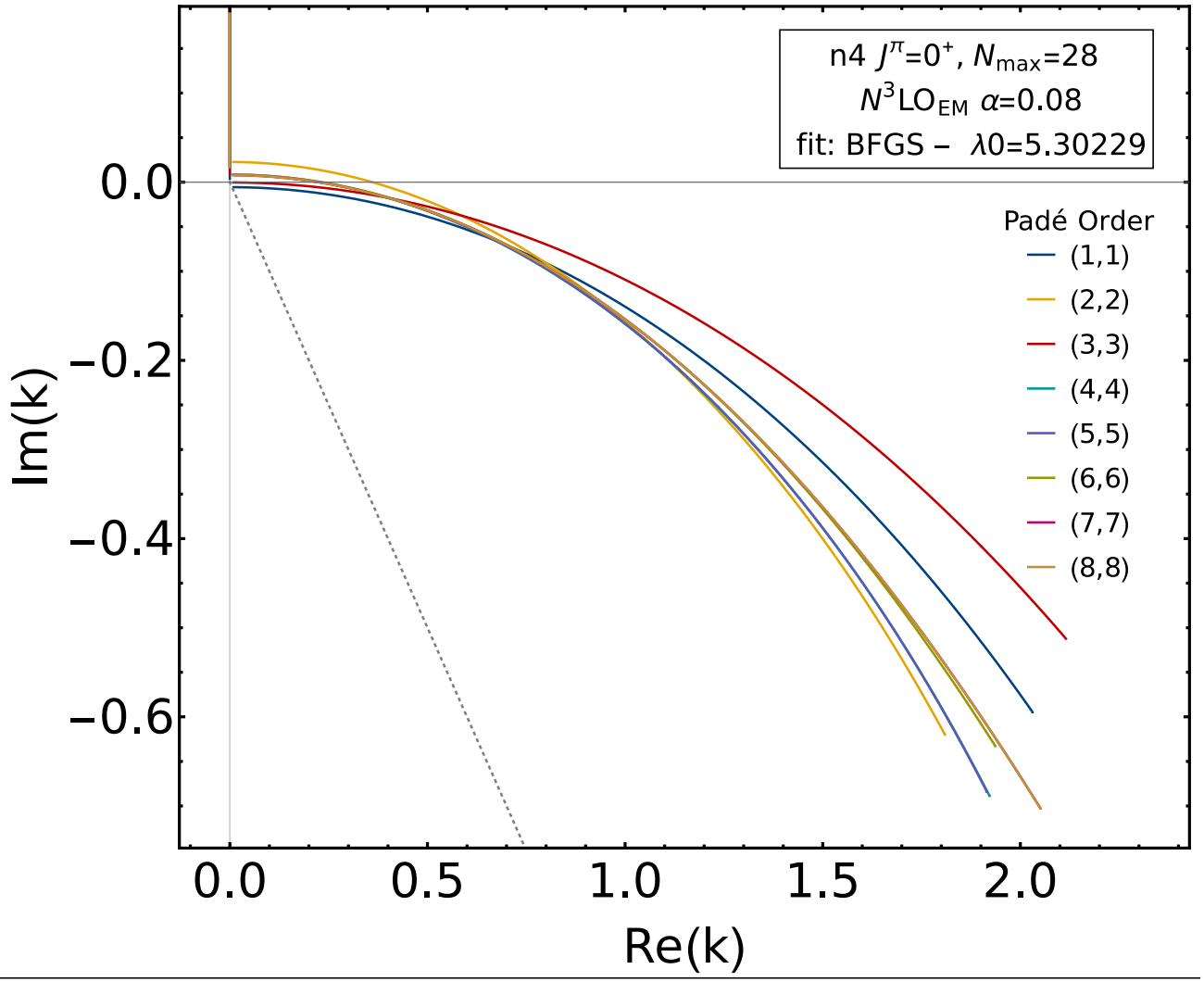
ACCC – 4n

- Modification: $H(\lambda) = T + \lambda V_{2\mathrm{N}} + V_{3\mathrm{N}}$
- Di-neutron not accounted for
- Padé extrapolation unstable
- Effect of modification?



ACCC – 4n

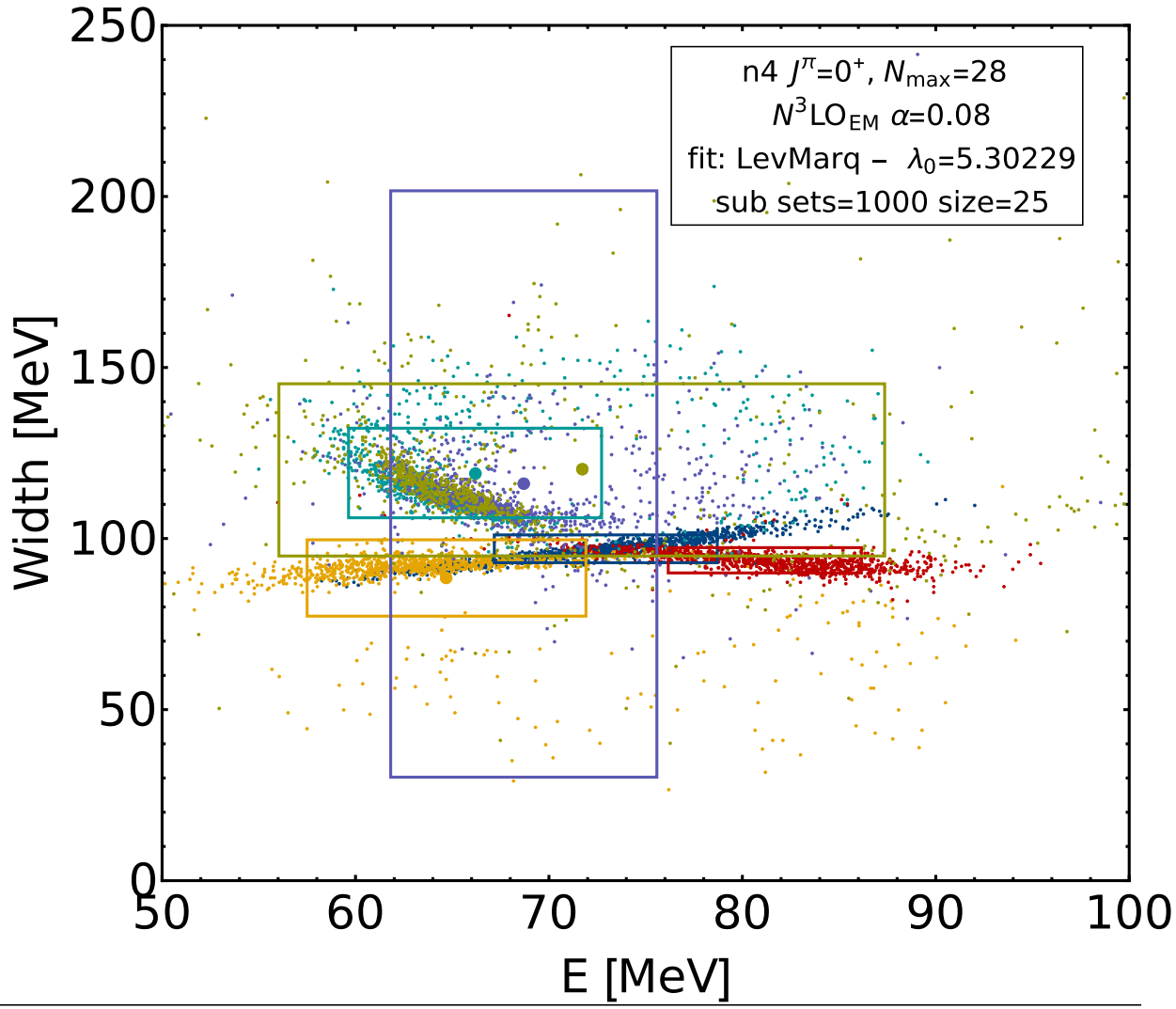
- Modification: $H(\lambda) = T + V_{2\mathrm{N}}({}^1S_0) + \lambda\, V_{2\mathrm{N}}$
- Di-neutron unbound
- Padé orders “better behaved”
- Far extrapolation due to large λ_0
- Modification too strong?



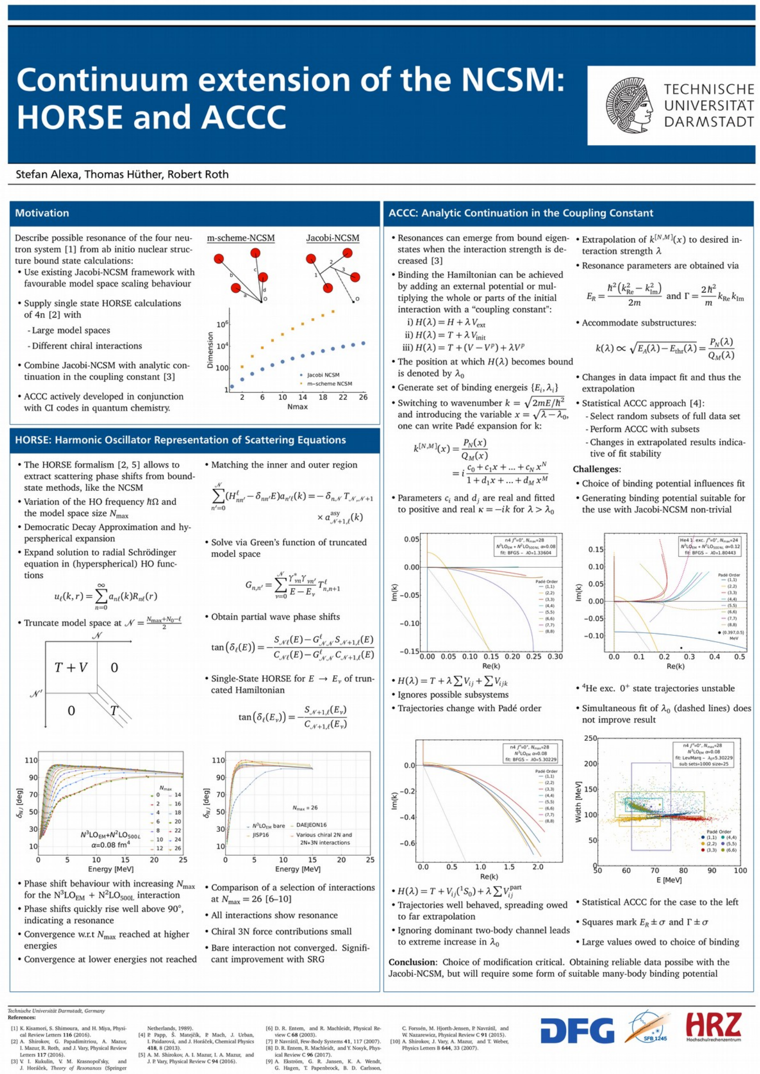
ACCC – 4n – Statistical ACCC

- Modification: $H(\lambda) = T + V_{2N}(^1S_0) + \lambda V_{2N}$
- Statistical approach

  Papp et al. Chem.Phys 418 (2013)
- Number of data points impact fit
- Modification generates unphysical state?
- External potential necessary?



See you at the poster



Thank you for your attention!

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- **Thanks to my group and collaborators**

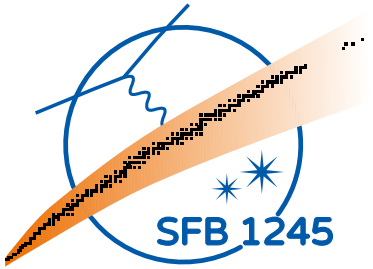
  M. Deuker, T. Hüther, P. Käse, M. Knöll, L. Mertes, T. Mongelli, J. Müller, R. Roth, K. Vobig, C. Walde, T. Wolfgruber

  Institut für Kernphysik, TU Darmstadt

  - **Special thanks**

    R. Wirth

    Michigan State University



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