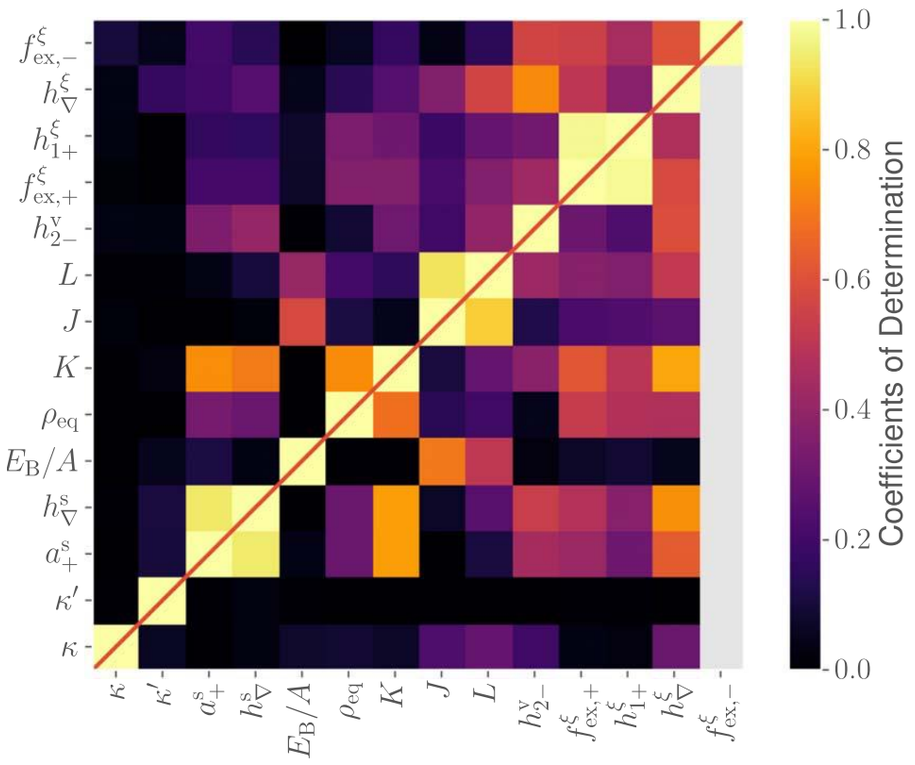
Extended Fayans energy density functional: optimization and analysis

Objectives

- Extend a 13D study of the Fayans functional to 14D by adding the isovector pairing term.
- Use sensitivity analysis, correlation analysis, and theoretical prediction of nuclear properties to compare 13D and 14D calibration results obtained with derivative-free optimization and assess importance of isovector pairing.



Coefficients of determination between model parameters demonstrate a reduction of correlations for 14D (upper triangle) compared to 13D (lower triangle).

Impact

- Allowing for different pairing strengths resulted in an ~30% improvement in the fit to the dataset with the fit to neutron gap data improving the most.
- The 14D result shows decreased correlations between model parameters and enhanced sensitivity of the calibration to data.
- The calibrations yield good theoretical predictions across a large set of nuclear observables not included in the calibration dataset.
- The Fayans code was extended to allow for approximating with ECNoise the derivatives needed for the statistical and sensitivity analyses, which informed the current effort to develop a universal framework that couples simulation codes with less effort to a set of pre-existing tools such as ECNoise and POUNDerS.

Accomplishments

- Published in Journal of Physics G (2024)