Kyle A. Wendt

Graduate Institution: The Ohio State University Main Campus

Graduate Discipline: Nuclear Physics

Hometown: Rockford, IL

Relevant SC Research: Nuclear Physics

Research Interest:

My interest are centered around studying strongly interacting systems. In particular I am interested in understanding the properties of atomic nuclei, nuclear matter (stars), and ultra-cold fermionic systems from an ab-initio quantum many-body perspective. The majority of my work in centered on exploiting scale dependence to make solving the many-body problem easier. This is done by taking effective field theory interactions, and applying a Renormalization Group (RG) transform to soften the interaction, by tuning to the scales relevant to the nuclei being studied. These interactions can then be used to compute observables of interest to the structure of matter and reaction processes for fusion and astrophysics. While these soft interactions allow for precise calculations of properties of light nuclei, they can also extend the range of nuclei that can be computed, allowing for larger nuclei to be computed (compare to the bare interactions).

The RG method I study and use is known as the Similarity Renormalization Group (SRG). SRG allows for unitary transformations of high momentum strongly coupled potentials into low momentum decoupled soft potentials, at the cost of added non-locality to the potentials and more complicated many-body forces. The advantage of SRG is that it provides a consistent framework to soften two-, three-, and many-body forces, a to consistent compute observables, features not present in other forms of RG. I am working on understanding formally how SRG softens interactions as well as methods to extend SRG in manner that will let SRG softened potentials be useful in the calculation and understanding of long range (asymptotic) observables in light nuclei. An observable of great interest that I am developing tools to calculate is the asymptotic normalization coefficient (ANC). ANCs are critical to the calculation of many nuclear reactions that are relevant to understanding many fusion and astrophysical processes.

Additionally I am working on new methods for computing light nuclei, that will be designed to work better with SRG interactions for computing long range features. The issue with current modern approaches and low-momentum interactions is twofold. First is that modern Quantum Monte Carlo(QMC) methods, which are ideal for calculating asymptotic properties, are completely incompatible with softened non-local interactions. The second issue is that basis expansion/configuration interaction (CI) methods, which are compatible with these interactions, but cannot achieve the level of convergence needed to examine asymptotic properties. I am working on these problem in several different directions.

In an effort to use these potentials with QMC, as well as to understand the SRG "flow", I am developing the tools to separate two- and three-body potentials into a local effective potentials and purely non-local residual. Coupled to this is the extension of modern QMC methods to exploit this separation to allow for the accurate computation of light nuclie. Additionally I am working on using new forms of QMC to correct the asymptotic properties from the wave-functions from CI calculations. To augment both of these efforts, I am also developing a better formal understanding of the properties of the induced non-locality and many-body forces from SRG, and how these couple to and are driven by initial many-body forces.

Longer terms goals and interest involve using the data I can compute to aid in the construction of effective theories for larger systems (medium mass and heavy nuclei), advancing the reach of modern density functional theory calculations. Additionally I want to develop the methods and tools needed for full ab- initio calculations of complicated processes in medium mass nuclei, such as neutrinoless double beta decay, which are currently well outside the reach of current ab-initio methods. Another avenue I want to pursue is to too apply much of what am developing for nuclei to the accurate calculation of cold atomic gases.

About Me:

Currently I am a graduate student at the Ohio State University (OSU). I study low-energy theoretical nuclear physics, in particular I study phenomena related to the structure and reactions of atomic

Continued on next page

Continued from previous page
nuclei and to the properties of neutron stars. At OSU I have been afforded many opportunities to engage external academic pursuits. I have participated in the UNEDF collaboration (2010-2011). I have contributed talks and posters at many conferences such the American Physical Society(APS) April Meetings (2010,2011), APS Division of Nuclear Physics (2010,2011), International Nuclear Physics Conference 2010, UNEDF meeting 2011. I have been able to attend many external workshops, such as Triumf Summer Institute (2010), and the UiO-MSU-ORNL-UT series on solving the nuclear quantum many-body problem (2011,2012). These have permitted to build a broad picture of the field of nuclear physics, while also developing my skill set for solving the problems that are of interest to me. Locally at OSU I often have the chance to participate in physics outreach and scientific literacy activities such as running physics demonstrations in Ohio's state fair, and judging high-school science projects for the Ohio's State Science Day.

My long term goal as career physicist is to research and teach at a research institution or university. I want to be in a position where I can not only actively and vigorously pursue my research interest, but also be able to educate. I want to not only teach physics, but also be in a position to advocate scientific and mathematical literacy for general populace, a task I feel is of extreme importance in order for modern society to progress.

My personal life reflects much of research life. I am an avid explorer of the unknown. I spend much of time exploring mathematical oddities, solving complicated integral I find in my research (normally I only need them numerically, but in my nights I like to solve them analytically). I often write software to explore complex mathematical and numerical structures. I am also active in the free and open source software community, and spend time contributing to open source projects related to scientific computing. When exploring less academic pursuits in my leisure, I enjoy mastering the culinary arts and bird watching.