Latex guid

Application to Graduate with Honors

Student ID: ____

I plan to defend in: FALL / (SPRING) of 2011

Personal Information:

Name: Sam Bein

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I am an: (IN-STATE) / OUT-OF-STATE student

Academic Information:

☑ I plan to graduate with *Departmental Honors* in: Physics

☐ I plan to graduate with *General Honors*

Cumulative GPA:

Please attach a brief **PROSPECTUS, BIBLIOGRAPHY,** and **TIMELINE** of your thesis project to this application. When summarizing your work, consider the following:

- What is the problem you are investigating?
- What is the hypothesis you are testing?
- What is the focus of your study?
- What is your goal in this study?

Primary thesis advisor:	Name: Jim Shepard	Dept: PHYS
List the other members of your committee:	Name: Bud Coleman	Dept: Theatre
	Name: John Cumalat	Dept: PHYS
	Name:	Dept:
	Name:	Dept:

Departmental and General Honors Committee Checklist:

Applicant has a total of at least three committee members. ✓
At least one Honors Council Representative is included on committee. ✓
At least one committee member from an outside department. ✓

APPLICATION CONTINUED ON BACK OF THIS SHEET

Please initial if you are pursuing Departmental Honors:

SB I have consulted with my department and have completed (or am completing) the requirements they have established.

For Honors Council Representative:

I have met with applicant and approve him/her for departmental honors.

Printed Name: John P Cumalat Signature: John P. Cumalat

Please initial if you are pursuing General Honors:

_____ I have completed (or am completing) the requirements for graduating with General Honors. Please list the courses you have or are taking toward General Honors:

_____________________ _____________________

_____________________ _____________________

For General Honors Council Member:

I have met with applicant and approve him/her for general honors. I agree to be on his/her defense committee.

Printed Name: _____________________ Signature: _____________________

For the Thesis Advisor:

I have met with the applicant to discuss the proposed work and agree to provide the necessary help and direction for this thesis project.

Printed Name: James R. Shepard Signature: James R. Shepard

For the Student:

I have read the requirements for graduating with honors at the University of Colorado. I also understand that my designation will be sent to the CU email address that I have provided and will not be given out over the phone.

Signature: Samuel Bum Date: 12/3/10

For additional graduation information including requirements, guidelines and deadlines, you can download them online at www.colorado.edu/honors

Prospectus
Sam Bein
Advisor: James Shepard

Effective Potentials and Infinite Nuclear Matter

Background:

Understanding the atomic nucleus is one of the oldest outstanding problems in physics. Since the early days of quantum mechanics, physicists have assembled the Standard Model to explain phenomena on the atomic level, but the model has not shed enough light on many interesting properties of nuclei. Many such properties, like the binding energy of nucleons, are known through experiment, but are not readily accounted for by theory. Perhaps the two largest obstacles preventing the success of theory arise from difficulties of renormalization associated with the strong force, and the mathematical complexity associated with the 3-particle problem. Many techniques have been solve or circumnavigate these problems, development of which remains very much alive today. My research is involved with a method of characterizing the nucleus and predicting its properties, part of which is a model of infinite nuclear matter (explained later).

My research:

My research explores the use of simple effective potentials that approximate the long-range nucleon potential to characterize the two-particle nucleon-nucleon interaction. These effective potentials are the key ingredient to the model of nuclear matter, which amalgamates the interactions of all constituent nucleons.

The first hope is that an acceptable two-particle interaction can account for the overall nucleus behavior, and that a 3-particle interaction is not necessary to include. The second hope is that the quantities I want to calculate (binding energy and saturation of nucleons in a nucleus) can be obtained by treating the low-energy properties of nucleons and ignoring the close-range, high-energy physics of the strong force. If this is true, simple effective potentials will be acceptable.

My goals:

My goal is to apply a simple effective nucleon potential to a model of nuclear matter (infinite nuclear matter), and calculate the symmetry energy, binding energy, and saturation energy of its constituent nucleons. I will be able to test the model against finite nuclei by examining historical data.

The question remains: What effective potential should be used to approximate the nucleon-nucleon interaction? My advisor has shown how a certain breed of effective potentials, separable potentials, have delightfully elegant mathematical advantages over generic potentials, allowing one to solve the Schrodinger equation for scattered particles exactly. Another benefit of separable potentials is that with as few as two parameters, they can be cooked to fit experimental nucleon-nucleon scattering data in the low-energy regime. For these reasons I will apply separable potentials to the model of infinite nuclear matter.

What is infinite nuclear matter? Invented in the 1960s, Infinite nuclear matter is essentially a toy model of heavy atomic nuclei used to test for nuclear properties. In the model, a nucleus is constructed of infinitely many protons and neutrons, equal in number. Because of translational invariance, one can treat the nucleus initially as a free Fermi gas. Perturbation theory is then applied to the system where H', the perturbation, is the effective separable potential that was cooked to fit experimental, nucleon-nucleon scattering data. From there, the saturation can be calculated, along with binding energy and symmetry energy. Results coming...

Timeline

September: I will use the remainder of this month to complete the program I'm writing to computing scattering lengths and shape parameters of 1-dimensional, unbound scattering states, given an inputted potential. I will obtain any graphing software I might need to generate the plots I need. I will install and learn to use xmgrace, which my advisor says is a lengthy and difficult process.

October: A time of literature reviewing, I will study Fetter and Walecka chapters, especially the chapter on many-body scattering and Green's functions. Simultaneously, I'll develop my program to compute energy states of bound states of the 1-d scattering potential. My goal here is to be able to calculate scattering parameters associated with any potential, and find any bound state that might exist.

November: Here, I will focus my understanding of scattering theory into the theory of many body systems. Also, the deuteron bound state. Potentials will be fit to match experimental scattering data. These potentials will be the backbone of the model of infinite nuclear matter. By now I should have my defense panel picked out.

December: I will apply for honors. Likewise, I'll work toward creating a model of the nucleus, and calculate the symmetry energy of infinite nuclear matter. I hope to be reading as much as a possibly can on the subject. Also, I'll be taking another honors seminar class.

Jan: I will at this point have a good idea of what I'll be writing about. I will be discussing my paper with Jim Shepard (advisor), Debrah Biasca, and others. Over break I hope to make headway on the model of nuclear matter.

Feb: I'll continue writing my thesis. I'll will discuss it with as many faculty members as possible. Most likely, I'll still be involved in some research at this point.

March:I'll finish writing my thesis. I will redraft, get peer critiques, faculty critiques, and redraft. I want to know the subject inside out.
April: Defend

Bibliography

Shankar, Ramamurti. "Chapter 19: Scattering Theory." *Principles of Quantum Mechanics*. New York: Plenum, 1994. Print.This section covers the basics of quantum Scattering theory and introduces Green's functions. It builds and develops of a model of 2-body scattering. 2-body scattering theory is essential to the theories of many body scattering.

Fetter, Alexander L., and John Dirk Walecka. *Quantum Theory of Many particle Systems*. San Francisco: McGraw-Hill, 1971. Print .Fetter and Walecka is a comprehensive documenton many-body systems. The book covers everything from deuteron scattering to cooper pairs in an electron sea.