Program for Nuclear Talent course on *Many-body methods for nuclear physics, from Structure to Reactions* at Henan Normal University, P.R. China, July 16-August 5 2018

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Motivation and introduction

To understand why matter is stable, and thereby shed light on the limits of nuclear stability, is one of the overarching aims and intellectual challenges of basic research in nuclear physics. To relate the stability of matter to the underlying fundamental forces and particles of nature as manifested in nuclear matter, is central to present and planned rare isotope facilities.

Important properties of nuclear systems which can reveal information about these topics are for example masses, and thereby binding energies, and density distributions of nuclei. These are quantities which convey important information on the shell structure of nuclei, with their pertinent magic numbers and shell closures or the eventual disappearence of the latter away from the valley of stability.

During the last decade, the study of nuclear structure and the models used to describe atomic nuclei are experiencing a renaissance. This is driven by three technological revolutions: accelerators capable of producing and accelerating exotic nuclei far from stability; instrumentation capable of detecting the resulting

===== Aims and Learning Outcomes =====

This three-week TALENT course on nuclear theory will focus on the Many-body methods for nuclear structure and reactions, focusing on nuclear shell model and/or coupled cluster theory and in-medium SRG with applications to structure and reactions. Via hands-on projects and series of exercise, the participants will have been exposed to the necessary tools and theoretical models used in modern nuclear theory.
Format: We propose approximately forty-five hours of lectures over three weeks and a comparable amount of practical computer and exercise sessions, including the setting of individual problems and the organization of various individual projects. The course starts July 16 (with arrival on July 15) and ends (the course) on August 3. A three days workshop will be organized from August 4 to August 6. The mornings will consist of lectures and the afternoons will be devoted to exercises meant to shed light on the exposed theory, and the computational projects. These components will be coordinated to foster student engagement, maximize learning and create lasting value for the students. For the benefit of the TALENT series and of

Teachers and organizers

The local organizers are

1. Chun-Wang Ma at Henan Normal University, Xinxiang, Henan 453007, P.R. China
2. Furong Xu at School of Physics, Peking University, Beijing 100871, P.R. China
3. Shan-Gui Zhou at the Institute of Theoretical Physics, Chinese Academy of Sciences, Beijing 100864, P.R. China

In addition Qiao Chunyuan will help with administrative matters. You can reach her at the email address qiaochunyuan919@126.com. Thomas Papenbrock and Morten Hjorth-Jensen will also function as student advisors and coordinators.
The teachers are

1. Kevin Fossez at National Superconducting Cyclotron Laboratory, Michigan State University, East Lansing, MI 48824, USA
2. Morten Hjorth-Jensen at National Superconducting Cyclotron

Course Content and detailed plan

Lectures are approximately 45 min each with a small break between each lecture. The morning sessions are scheduled to end around 1230pm. Every Friday we will have presentations from each group, where a summary of what has been achieved is presented.

Lectures and preparatory material on second quantization are all available at the Github address of the course, or go to `URL:`https://nucleartalent.github.io/ManyBody2018/doc/web/course.htm

for an easier read.

Furthermore, we strongly recommend that you read chapter 8 and 10 of Lecture Notes in Physics 936. This text contains also links to all codes we will discuss,

in addition to the codes we have placed in the "program folder of the course":"https://nucleartalent.github.io/ManyBody2018/doc/web/course.

The acronyms here stand for the different teachers:

1. KF: Kevin Fossez
2. MHJ: Morten Hjorth-Jensen
3. WJ: Weiguang Jiang

Teaching and projects

The course will be taught as an intensive course of duration of three weeks, with a total time of 45 h of lectures, 45 h of exercises, with the possibility to complete a final assignment if credits are needed. The organization of a typical course day is as follows:

Time	Activity
9am-1230pm	Lectures, project relevant information and directed exercises
1230pm-230pm	Lunch
230pm-6pm	Computational projects, exercises and hands-on sessions
6pm-7pm	Wrap-up of the day and eventual student presentations

Audience and Prerequisites

You are expected to have operating programming skills in in compiled programming languages like Fortran or C++ or alternatively an interpreted language like Python and knowledge of quantum mechanics at an intermediate level. Preparatory modules on second quantization, Wick's theorem, representation of Hamiltonians and calculations of Hamiltonian matrix elements, independent particle models and Hartree-Fock theory are provided at the website of the course. Students who have not studied the above topics are expected to gain this knowledge prior to attendance. Additional modules for self-teaching on Fortran and/or C++ or Python are also provided.