Program the Nuclear Talent course at the ECT* in 2017: Theory for Exploring Nuclear Structure Experiments

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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 interpretation of data on the structure of nuclei using the Nuclear shell model as main tool.
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 mornings will consist of lectures and the afternoons will be devoted to exercises meant to shed light on the exposed theory, the computational projects and individual student 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 the community, material (courses, slides, problems and solutions, reports on students' projects) will be made publicly available using version control software like *git* and posted electronically on github.
As with previous TALENT courses, we envision the following features for the afternoon sessions:

Course Content and detailed plan

Week 1. Lectures are approximately 45 min each with a small break between each lecture. There is also a coffee break of 30 min in the morning sessions.

Day		Lecture Topics and lecturer
Monday	9am-930am	Registration at the ECT
	930am-10am	Introduction and welcome (BAB, MHJ and GJ)
	10am-12pm	Survey of data (BAB)
	12pm-2pm	Lunch +own activities
	2pm-6pm	More survey of data (BAB)
Tuesday	9am-10pm	Mean-field and shell-model basics (MHJ)
	10am-12pm	Single-particle potentials and shell-model basics (BAB)
	12pm-2pm	Lunch+ own activities
	2pm-6pm	Single-particle potentials
Wednesday	9am-11am	Shell-model basics (MHJ)
	11am-12pm	Shell-model dimensionalities (BAB)
	12pm-2pm	Lunch+ own activities
	2pm-6pm	
Thursday	9am-11am	Shell-model basics (MHJ)
	11am-12pm	Proton-neutron formalism and isospin (BAB)
	12pm-2pm	Lunch+ own activities
	2pm-6pm	
Friday	9am-12pm	Effective interactions for shell model (GJ)

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 and a final assignment of 2 weeks of work for those of you wish to receive 7 ECTS credits for the course. The total load, with the additional project to be handed in later, will be approximately 160-170 hours, corresponding to **7 ECTS** in Europe.
The final assignment will be graded with marks A, B, C, D, E and failed for Master students and passed/not passed for PhD students.
A course certificate will be issued for students requiring it from the University of Trento. This certificate states that you have completed the equivalent of 7 ECTS at the graduate level. We plan also to issue a certificate for those of you who have attended the course but did not want to do the final project. This certificate will most likely correspond to 4 ECTS at the graduate level.
The organization of a typical course day is as follows:

Time	Activity
9am-12pm	Lectures, project relevant information and directed exercises
12pm-2pm	Lunch
2pm-6pm	Computational projects, exercises and hands-on sessions

Teachers and organizers

The organizers are

1. Alex Brown, National Superconducting Cyclotron Laboratory and Department of Physics and Astronomy, Michigan State University, East Lansing, MI 48824, USA
2. Morten Hjorth-Jensen, National Superconducting Cyclotron Laboratory and Department of Physics and Astronomy, Michigan State University, East Lansing, MI 48824, USA and Department of Physics, University of Oslo, N-0316 Oslo, Norway

Morten Hjorth-Jensen will also function as student advisor and coordinator.
The teachers are

1. Alex Brown, National Superconducting Cyclotron Laboratory and Department of Physics and Astronomy, Michigan State University, East Lansing, MI 48824, USA
2. Alexandra Gade National Superconducting Cyclotron

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.