Nuclear TALENT:perspectives and future plans

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What is Talent

The TALENT initiative aims at providing an advanced and comprehensive training to graduate students and young researchers in low-energy nuclear theory and experiment.

The network aims at developing a broad curriculum that will provide the platform for a cutting-edge theory for understanding nuclei and nuclear reactions. These objectives are being met by offering intensive three-week courses on a rotating set of topics, commissioned from experienced teachers in nuclear theory and experiment. The educational material generated under this program will be collected in the form of web-based courses, textbooks, and a variety of modern educational resources. No such all-encompassing material is available at present; its development will allow dispersed university groups to profit from the best expertise available.

Motivations and aims

- Develop structured modules which will provide our students with a modern education in nuclear physics
- Help smaller university groups which cannot cover the whole range and breadth of nuclear physics
- Modules/courses should contain a high-level of synchronization
- A computational perspective is essential
- plus many other aspects

Present Talent board

- Northern American Board members:
  - Dick Furnstahl (Ohio State University), heading the board
  - Chuck Horowitz (Indiana University)
  - Filomena Nunes (Michigan State University)
  - Martin Savage (University of Washington)
- European Board Members:
  - Jacek Dobaczewski (Poland, Finland, and UK)
  - Christian Forssen (Chalmers, Sweden)
  - Francesca Gulminelli (Caen and GANIL, France)
  - Morten Hjorth-Jensen (MSU, USA and University of Oslo, Norway)
  - Jeff Tostevin (Surrey, UK)

Board members serve for periods up to six years. With the strong interest in China, the board should be extended to include members from Asian countries

Nuclear Talent courses offered 2012-2017

In total we have organized 12 courses at several different places

1. Nuclear forces (**INT 2013**)
2. Many-body methods (**GANIL 2015** and **Henan 2018**)
3. Few-body methods for nuclear physics (**ECT 2015**)
4. Density functional theory and self-consistent methods (**ECT 2014** and **York 2016**)
5. Theory for exploring nuclear structure experiments (**GANIL 2014** and **ECT 2017**)
6. Theory for exploring nuclear reaction experiments (**GANIL 2013**)
7. Nuclear theory for astrophysics (**MSU 2014** and **INT 2015**)
8. Theoretical approaches to describe exotic nuclei (**planned for 2019/2020, INT**)
9. High-performance computing and computational tools for nuclear physics (**ECT 2012** and **North Carolina State University 2016**)
10. Fundamental Symmetries (**INT in the summer of 2018**)

2017 and plans for 2018/2019 Nuclear Talent courses

For all courses (till this year) we have had on average more than 40 applicants per course. The Shell-model course held this year had 52 applicants and we accepted 31 students. They came from 16 different countries and 20 different institutions/laboratories.

1. Theory for exploring nuclear structure experiments, **ECT 2017**
2. Many-body methods for nuclear structure and reactions (courses 5 and 6), July-August 2018 at Henan Normal University, Xin-Xiang with Chung-Wang Ma as local host
3. The first edition of Course 10 on Fundamental Symmetries will be offered at the INT in the summer of 2018. Contact: Michael Ramsey-Musolf (mjrm@physics.umass.edu)
4. The first edition of Course 8 on Theoretical approaches to describe exotic nuclei will be titled Atomic Nuclei as Open Quantum Systems: Unifying Nuclear Structure and Reactions. It will be offered in the summer of 2019/2020 at the **INT**. Contact: Christian Forssen (christian.forssen@chalmers.se)

The 2018 course at Henan Normal University, Xin-Xiang.

The aim is to run a three-week Talent course at Henan Normal University in Xin-Xiang. Professor Chung-Wang Ma is the local host.

The Chinese community had a course on Reaction theory for nuclear experiments (course 6) as their first choice. It has however been difficult to set up this course and a possibility is to rather organize a course on

- Many-body methods for nuclear structure and reactions (a mix courses 2, 5 and 6), July-August 2018.

The 2018 course at Henan Normal University, Xin-Xiang. Possible paths

We have already a group of potential organizers and teachers and the following possibilities could be

1. Focus on two central (and partly new) many-body methods like Coupled Cluster theory and In-medium Renormalization group theory with applications to nuclear structure studies and reaction theory studies.
2. Focus more on shell-model studies and for example coupled-cluster theory with applications to nuclear structure studies and inputs to reaction theory studies

The 2018 course at Henan Normal University, Xin-Xiang, China

The first path

- Many-body methods like Coupled Cluster theory and In-medium Renormalization group theory with applications to nuclear structure studies and reaction theory studies

would favor more theoretically inclined students while

- Shell-model studies (with perhaps an additional many-body method) as basis for applications to nuclear structure studies and inputs to reaction theory studies

could be of interest for both theorists and experimentalists since the shell-model approach has a lower level of complexity than the other two many-body methods. Quantities like spectroscopic factors and one-body densities which enter reaction theory studies are easier to study within a shell-model framework.

The 2018 course at Henan Normal University, important sides of the Talent courses

Important aspects of the Talent courses have been

- students aquire skills and konwledge that would have been difficult or almost impossible to aquire while following traditional courses
- most Talent courses have computational elements where students write code that have many of the elements of codes used in nuclear physics research.
- close contact between teachers and students.

The 2018 course at Henan Normal University, questions to think of

The nuclear shell-model is an example of codes which can be written and developed for simpler systems during a Talent course of three weeks. Combined with a professional research code like NushellX or similar nuclear structure tools, it is easier to understand the input and the theory which the analysis of nuclar structure and reaction experiments.

The hands-on aspects of the Talent courses is highly appreciated by the participants. We may need to think of

- which skills and learning outcomes do we want our students to aquire? See the 2017 course as an example
- and what is pedagogically possible to achieve?
- and what is desirable and useful to the Chinese community?

Nuclear Talent v2.0, questions

- Is it possible to integrate material developed in different Talent courses, offering thereby a coherent source for educating the next generation of nuclear physicists? Keyword: Modularization of topics.
- How many basic courses can an institution offer, and which courses should be offered?
- How can we coordinate an advanced training in nuclear physics?
- Can we integrate the (*ad hoc*) Nuclear Talent courses/initiative in our education?
- Can we use efficiently version control tools like git and Github or other modern tools?

Nuclear Talent v2.0, technicalities: Scientific writing and publishing for the future

Scientific writing = LaTeX

1. Pre 1980: handwriting/typewriting + publisher
2. Post 1985: scientists write LaTeX
3. Post 2010: a few scientists explore new digital formats
4. Big late 1990s question: Will MS Word replace LaTeX? It never did!
5. LaTeX PDF is mostly suboptimal for the new devices
6. The book will survive (LaTeX is ideal)
7. The classical report/paper will survive (LaTeX is ideal)
8. But there is an explosion of new platforms for digital learning systems!
9. How to write scientific material that can be easily published through old and new media?

Can one assemble lots of different writings to a new future document (or even a book)?

Suppose I write various types of scientific material

1. LaTeX document,
2. blog posts (HTML),
3. web pages (HTML),
4. Sphinx documents,
5. IPython/Jupyter notebooks,
6. wikis,
7. Markdown files, ...

and later want to collect the pieces into a larger document, maybe some book - is that at all feasible?

Popular tools anno 2017 and their math support

1. LaTeX: de facto standard for math-instensive documents
2. pdfLaTeX, XeLaTeX, LuaLaTeX: takes over (figures in png, pdf) - use these!
3. MS Word: too clicky math support and ugly fonts, but much used
4. HTML with MathJax: "full" LaTeX math, but much tagging
5. Sphinx: somewhat limited LaTeX math support, but great support for web design, and less tagged than HTML
6. reStructuredText: similar to Sphinx, but no math support, transforms to lots of formats (LaTeX, HTML, XML, Word, OpenOffice, ...)
7. Markdown: somewhat limited LaTeX math support, but minor tagging, transforms to lots of formats (LaTeX, HTML, XML, Word, OpenOffice, ...)

More popular tools anno 2017 and their math support

1. IPython/Jupyter notebooks: Markdown code/math, combines Python code, interactivity, and visualization, and is becoming a standard in many courses
2. Confluence: Markdown-like input, with limited LaTeX math support, but converted to XML
3. MediaWiki: quite good LaTeX math support (cf. Wikipedia/Wikibooks)
4. Other wiki formats: no math support, great for collaborative editing
5. Wordpress: supports full HTML with LaTeX formulas only
6. Google blogger: supports full HTML with MathJax
7. and more...

DocOnce: one file to rule them all

DocOnce offers minimalistic typing, great flexibility wrt format, especially for scientific writing with much math and code. Developed by Hans Petter Langtangen, University of Oslo and Simula Research lab

1. Can generate LaTeX, HTML, Sphinx, Markdown, MediaWiki, Google wiki, Creole wiki, reST, plain text
2. Made for large science books and small notes
3. Targets paper and screen
4. Many special features (code snippets from files, embedded movies, admonitions, modern LaTeX layouts, extended math support for Sphinx/Markdown, ...)
5. Very effective for generating slides from ordinary text
6. Applies Mako: DocOnce text is a program (!)
7. Much like Markdown, less tagged than LaTeX, HTML, Sphinx