

Education

The big bang, the fuel of stars and supernovae, the source of power to run our homes and factories; these are all examples of how nuclear physics plays an important role in understanding the universe around us. The nucleus is a unique laboratory in which the interplay between the fundamental forces can be studied in detail. The next few years, driven by experimental and theoretical advances, will see a revolution in our understanding of the quantum world that is the nucleus. The advent of many new facilities will allow an unprecedented number of new nuclei to be studied with their properties giving us a new insight across the whole chart of nuclei from light to heavy nuclei. It is vital that there is an education programme to ensure that the new nuclear physicists of the future are ready to take on the challenge.

An important aspect of education and training in nuclear physics is the PhD (or DPhil) doctoral degree. Normally students entering these programmes will already have achieved an excellent degree qualification at bachelor or master's level in a science degree, usually physics. A PhD requires the student to perform and document novel research of publishable quality. It is assessed through the writing of a substantial thesis, c. 30,000 – 50,000 words or a collection of published papers, and an oral examination in which two or more experts discuss the work in detail with the candidate. The format of the oral examination varies from country to country and is designed to test the expertise of the student. The topic for the thesis usually originates from an academic, aware of an area that is in need of exploration, with precise title and content evolving through the period of the doctoral work. The student progressively takes more leadership of the work, and by the end of the PhD the student should have developed sufficient technical expertise, practical know-how, and transferrable skills, to be recognised as an independent research scientist. Typically, associated to the doctoral work would be a number of peer-reviewed scientific papers, with the student first- (or corresponding-) author.

Nuclear Scientists are also involved with delivering education programmes at master's level specifically tailored for those who are seeking a career in nuclear related industries and for those already in industry who are developing their careers and skills. In the UK for example over 100 students per year obtain master's degrees in such nuclear topics which often have a substantial practical and computation basis

as well as a research project. In addition more than 50 industry based scientists per year attended master's level nuclear programmes as part of their career development.

The excitement of nuclear physics is easily communicated and recognised, such that the field has an extremely healthy public outreach component. An example of this is the theoretical nuclear physicist Prof Jim Al-Khalili who has made a number of programmes broadcast on main stream television channels. Examples of this work include

- The Beginning and End of the Universe, two-part documentary series
- The Secrets of Quantum Physics, two-part TV documentaries
- Horizon: Fukushima: Is Nuclear Power Safe?, one-hour TV documentary.

Nuclear Physics researchers also provide input to outreach activities targeted at the key school age audience, 11-18 as well as the wider public. These interactions bring nuclear physics to wide range of people through for example:

- Public talks at local science societies
- Exhibitions and open days at universities, national laboratories and those places more generally open to the public such as museums
- Web-based resources including games and teaching resources
- Use of Lego bricks to demonstrate the chart of nuclides and the valley of stability
- School talks, summer internships and work experience
- Undergraduate projects involving students in research

These activities are essential for inspiring and attracting young people to study STEM subjects and promoting nuclear physics. This in turn is essential to underpin the future workforce in the role of inspirational science.

NuPECC sponsors the NUPEX resource which can be found online at <http://nupex.eu/>. This provides information on nuclear physics suitable for a wider audience covering topics including the material world, nuclear energy and applications of nuclear physics and its techniques.