

# Oxford University Summer School for Adults



**Title:** 130 Years of Discovery: Nuclear and Particle Physics from Becquerel to Gianotti

**Dates:** Week 2, 18-25 July 2026

**Tutor:** Susan Bigge

## Course Overview

We will embark on a journey through time as we follow the trail of discovery forged by some of the greatest minds in physics. Over the past 130 years, explorers of the subatomic world have reshaped our understanding of matter, energy, and the universe. Our journey will take us from Henri Becquerel's discovery of radioactivity in 1896 to the cutting-edge experiments led by physicists such as Fabiola Gianotti today. Along the way, we will delve into key breakthroughs including Rutherford's atomic model, the discovery of the neutron, the development of the Standard Model, and the identification of the Higgs boson. We will also explore the tools that physicists have used to detect and identify particles, and consider how this quest has impacted our daily lives - from advances in medicine to the development of nuclear technology. As we arrive in the present day we will examine contemporary experiments, including state-of-the-art particle detection techniques in ATLAS at the Large Hadron Collider and DUNE at Fermilab.

## Course Outline

<b>Seminar 1</b> Sun, 9.00 am – 10.30am	Radioactivity. Late 19 <sup>th</sup> century scientific discoveries of ionizing radiation by Becquerel and Marie and Pierre Curie
<b>Seminar 2</b> Sun, 11.00 am – 12.30pm	Early models of the atom, including the work of J. J. Thomson and Rutherford
<b>Seminar 3</b> Mon, 9.00 am – 10.30am	Detecting particles. Scintillations, cloud chambers and Geiger counters
<b>Seminar 4</b> Mon, 11.00 am – 12.30pm	The confirmation of the neutron by James Chadwick and Fermi's proposition of the neutrino
<b>Seminar 5</b> Tue, 9.00 am – 10.30am	The beginning of Quantum Theory. Einstein's photoelectric effect and Bohr's model of hydrogen
<b>Seminar 6</b> Tue, 11.00 am – 12.30pm	Fission and Fusion. Understanding the energy stored in the nucleus.
<b>Seminar 7</b> Wed, 9.00 am – 10.30am	The Particle Zoo. Pions, muons and lambda particles are discovered.
<b>Seminar 8</b> Wed, 11.00 am – 12.30pm	Particle Accelerators. Linear, synchrotrons and synchrocyclotrons
<b>Seminar 9</b> Thu, 9.00 am – 10.30am	The Standard Model – how physicist organized and explained the Zoo.
<b>Seminar 10</b> Thu, 11.00 am – 12.30pm	Particle Interactions and Feynman Diagrams Beyond the Standard Model – limitations and questions
<b>Seminar 11</b> Fri, 9.00 am – 10.30am	Student Presentations
<b>Seminar 12</b> Fri, 11.00 am – 12.30pm	Current Experiments. Including the Large Hadron Collider at CERN and DUNE at FermiLab

## Tutor

Susan Bigge has taught physics on both sides of the Atlantic for 30 years. She was awarded the Presidential Award for Excellence in Math and Science Teaching in 2007 and is currently teaching electromagnetism at St. John's School in Houston.

## Course Aim

This course aims to introduce nuclear and particle physics following a historical timeline, examining the people and concepts that have shaped our understanding of the universe.

## Course Objectives

This course will enable students to appreciate the development of an area of science in a historical context and the underlying physics concepts.

## Learning Outcomes

By the end of this course, students will be expected to understand:

- Early models of the atom
- Alpha, beta and gamma decay
- The processes of nuclear fission and fusion.
- Classification of particles including leptons, quarks, bosons, hadrons (baryons and mesons)
- Methods of experimentation and detection in particle physics

## Recommended Reading

Author(s)	Year	Title	Publisher
Gino Segrè & Bettina Hoerlin	2016	The Pope of Physics Enrico Fermi and the Birth of the Atomic Age	Henry Holt
Richard Feynman (with R Leighton and M Sands)	2011	Six Easy Pieces: Essentials of Physics Explained by Its Most Brilliant Teacher	Basic Books
Daniel Whiteson and Jorge Cham	2018	We Have No Idea: A Guide to the Unknown Universe	John Murray

## Assessment

Students are required to submit pre-course and on-course assignments as follows:

### *Pre-course assignment (c. 1500 words):*

Scientists often develop classification models/systems to organize information. Choose one (not related to nuclear and particle physics) and explain its development, use and limitations (possible examples include the periodic table in chemistry, taxonomy in biology and several rock classification systems in geology).

**Please note that the submission for the pre-course essay is Monday 8<sup>th</sup> June 2026 and should be submitted as Word format to [oussa@conted.ox.ac.uk](mailto:oussa@conted.ox.ac.uk).**

**Also complete the Declaration of Authorship or the Assignment Cover Sheet form and add it at the beginning of your essay.**

### *On-course assignment (c. 1000 words):*

To be agreed upon with your tutor on arrival.