# A century after the discovery of the nucleus : shapes and shells through the nuclear chart

S. Courtin and F. Haas
IPHC-UDS
Sandrine.Courtin@iphc.cnrs.fr
Florent.Haas@iphc.cnrs.fr

The atomic nucleus was discovered by Ernest Rutherford a century ago in an experiment of alpha scattering through a gold foil. It was established later that the nucleus is composed of neutrons and protons, the nucleons. Since then, the behaviour of the nucleons inside the nuclear matter has been the object of a realm of theoretical and experimental studies.
In a very simple view, neutrons and protons each would form a series of concentric shells leading to a spherical shape for the nucleus. We shall see in this course that the picture is a bit more complex and we shall present the interplay between shapes and shells across the nuclear chart.

**I** In a first part, we will discuss the main nuclear models describing the spherical and deformed nuclear system. Special attention will be devoted to the classical *nuclear shell model* and the associated magic numbers 8, 20, 28, 50, 82, 126, i.e. how shells develop from the lightest to superheavy nuclei.

**II** In a second part, we will discuss in details experimental evidences of shapes and shells. Key experiments such as transfer reactions will be presented. The measurement of experimental observables for the nuclear shapes like quadrupole moment of inertia and nature of electromagnetic transitions will be discussed.

**III** In the recent years, state-of-the-art experimental techniques have allowed the study of exotic proton or neutron rich nuclei hitherto unreachable. As a consequence, the idea of permanent magic shells has evolved, due to the fact that in these nuclei, protons and neutrons may occupy very different orbits.
We will discuss how these new experiments have changed our view of the magic numbers.

**Dates :** **16 to 20 april 2012, 4 pm to 6pm + 18 april 2012, 9 am to 11 am**

**Place :** **Amphithéâtre M. Grünewald, IPHC, 23 rue du Loess, Campus CNRS, Strasbourg Cronenbourg.**