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Nuclear Structure and alpha radioactivity

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Nuclear systems display a huge diversity of properties, proving the complexity of their structure. This complexity has multiple causes, the first one being the inner structure of protons and neutrons. Since they are constituted of quarks, the underlying theory of Quantum ChromoDynamics (QCD) plays an important role in the description of nuclei. However, at the energies involved in nuclear systems (~1 to 10 MeV), QCD is known to be non-perturbative, leading to many difficulties to obtain a reliable description of the interaction.

Another important aspect of atomic nuclei lies in their composition, in terms of multiple nucleons bound in a very complex way. The resulting quantum many body problem is extremely hard to tackle. Its solution cannot be obtained without approximations and the mean-field framework turns out to be a very powerful framework. Additionally, it can be coupled to many "beyond mean field"techniques allowing for a broader and better description of nuclear properties. However, as often in physics, many particles being involved in a coherent system gives rise to collective features. A nucleus does not circumvent this rule and many interesting aspects emerge from collectiveness (rotation, vibration, superfluidity, clustering, deformation, ⋯).

Among the many properties studied in nuclear structure, radioactivity is of particular interest. More precisely, alpha decay remained, until last year, the only kind of radioactivity which was not entirely understood from the microscopic point of view. Its first description has been achieved using a covariant EDF framework in mid-mass nuclei, namely in the ^{108}Xe decay chain.

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