Clusters in Atomic Nuclei

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Teaching staff

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Program of the course:

1 – Modern view of particle decay of nuclear states. α-decay: Coulomb and centrifugal barrier effects. Hindrance factors. Decay towards excited states of the daughter nucleus. Odd-nuclei and α - decay. Geiger-Nuttal law and fine-tuning problems. Electron screening effects. Selection rules in α - decay. Test of parity violation in strong interactions. Semi-classical calculations of α spectroscopic factors. Rose & Jones experiment and cluster radioactivity.
2 – A summary of decays and reactions useful to test clustering in nuclei. Beta decay and electron capture. Nuclear Fluorescence resonance. Resonant elastic and inelastic scattering of α particles. α -transfer reactions. Sequential break-up of nuclei. Analysis methods to extract nuclear structure properties from experimental data.
3 - α - clustering in light nuclei. Self-conjugate nuclei: their peculiar properties. Lifetime of 8 Be states and Coulomb barrier effects. Isotopes of Be and nuclear dimers. Nuclear Orbitals. σ and π bonding in nuclei. Coriolis effect on molecular rotational bands. The ^{12}C case. The "Hoyle state": its properties and mysteries. The anthropic principle. Signatures of Bose-Einstein condensation in nuclei. A novel view of light nuclei structure: the Algebraic Cluster Model (ACM). Symmetries and Group theory in light nuclei. n-rich and p-rich isotopes of carbon. Nuclear molecules. Effects of α clustering on nuclear astrophysics.

Bibliography:

[1] A.S. Davydov, Theory of Atomic Nucleus, Nauka
[2] I.E. McCarthy, Introduction to Nuclear Theory, Wiley
[3] L. Valentin, Noyaux and Particules, Hermann
[4] C. Beck (Ed.), Clusters in Nuclei, Springer
[5] I. Lombardo, Problemi di Fisica Nucleare e Subnucleare, CEA Zanichelli