Theoretical basics and modern status of radioactivity studies

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Within four lecture hours the following topics will be discussed:

- Historical notes. Discovery of radioactivity. Types of radioactive decays. Importance of radioactivity phenomenon in the development of quantum physics. Radioactivity vs. reactions in the studies of nuclear properties.

- General issues of resonance phenomena in quantum mechanics, particle emission and particle radioactive decays. Geiger–Nuttall law. Gamow theory. Formalism: scattering vs. reactions vs. decays. Formalisms for studies of particle emission and particle radioactive decays.

- Alpha-decay. Nuclear structure and alpha-decay. Fine structure of alpha decay spectra.

- Cluster radioactivity. Cluster radioactivity vs. fission.

- Fission. Spontaneous vs. induced fission. Ternary fission. Superheavy element synthesys.

- Beta-delayed particle emission. Beta decay basics: phase space, Fermi and Gamow-Teller type transitions. Beta decay and nuclear structure. Types of beta-delayed particle emission. Importance for astrophysical applications.

- Recently discovered types of radioactivity. Proton radioactivity.

- Recently discovered types of radioactivity. Two-proton radioactivity. Modes of 2p emission. Decay mechanisms and correlations in 2p decays. Nuclear structure effects on correlations in 2p decays. Three-body Coulomb problem in continuum and 2p decay. Transitional dynamics between modes of 2p decays. Importance of 2p decays for astrophysical applications.

- Prospects to discover n, 2n and 4n radioactive decays.

- Studies of 2n decays in the light nuclear systems beyond the neutron dripline.

Review paper:

- M. Pfutzner, L.V. Grigorenko, M. Karny, K. Riisager, *Radioactive decays at limits of nuclear stability*, Rev. Mod. Phys. 84 (2012) 567.