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Nucleus as an Open System: New Effects and Theoretical Challenges[1]

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As nuclear science moves in the direction of nuclei far from stability, the studies of nuclear structure and nuclear reactions become more and more interrelated. The main theoretical challenge is to find a consistent description of the nucleus as an open mesoscopic system coupled with continuum through real decay channels and through virtual excitations. The method using the effective non-Hermitian Hamiltonian [see review article: N. Auerbach and V. Zelevinsky, Rep. Prog. Phys. 74, 106301 (2011)] is one of the most promising theoretical approaches; it can be strictly derived from quantum many-body theory, it allows for calculating bound states, resonances and reaction cross sections in the unified framework, and it is quite flexible in practical applications. After explaining the main features of this theory, I will show the method at work (continuum shell model with predictions recently confirmed by the experiments with exotic oxygen isotopes, phenomenon of super-radiance, relation to the idea of doorway states, quantum signal transmission through mesoscopic systems) and discuss new theoretical challenges.

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