Decay of “stretched” states in the continuum

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The first part of the talk will concentrate on the studies of “stretched” single-particle states, which are presently ongoing at CCB IFJ PAN. The stretched states, arising from the promotion of one particle across the shell gap and possessing the highest possible spin which such configuration offers, are the simplest nuclear excitations in the continuum. Their properties are poorly known, even though they are of key importance for the physics of unbound system. In light nuclei, stretched excitations appear as high-lying (in energy) resonances and direct measurement of their decay should provide data, which will be used as a very demanding test of state-of-the-art theory approaches, from Shell Model in the Continuum to *ab-initio* type, shedding as well light on details of the nuclear force. Here, we will initially focus on investigating the decay of the so-called M4 stretched state located at 21.47 MeV in ^{13}C. Next, the studies will be extended to similar cases in other light nuclei, i.e., C, N and O isotopes.

The information on the decay of M4 resonances in light nuclei will be obtained by measuring inelastically scattered protons (which excite the resonance) in coincidence with charged particles, from the resonance decay, and gamma rays from daughter nuclei. In particular, the emitted gamma rays will give a precise knowledge of the feeding to specific states, even in the case of neutron decay from the resonance state. Measurements will be done by employing inelastic scattering of a proton beam from the cyclotron at the Cyclotron Centre Bronowice (CCB) in Kraków (Poland) on a ^{13}C target and detecting emitted gamma rays and light charged particles. A detection setup consisting of: i) a thick position-sensitive Si detector, ii) an array of $LaBr_3$ detectors (3”x3”), iii) two clusters of the PARIS scintillator array, and iv) the KRATTA telescope array, will be used. The experimental results will then be compared with the theoretical calculations provided by the theory group in Krakow, based on the Gamow Shell Model approach.

The second part of the presentation will be devoted to discussion of future possible developments of the CCB facility in Kraków, which would allow the extension of the proposed investigations to other nuclear systems. In particular, the option assuming construction of a new experimental hall and installation of a magnetic spectrometer will be considered. As the precise determination of the excitation energy of the resonance induced by inelastic proton scattering could be obtained with such spectrometer, investigations of states in the continuum would be accessible in a very broad range of nuclei and their excitation energies.