Core excited Fano-resonances in exotic nuclei

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Over the last few years various unexpected phenomena have been observed in the study of light exotic nuclei, indicating a shift away from mean-field dynamics towards a new type of correlation dynamics [1]. Here, we consider a particular class of states above the neutron emission threshold, the so-called Fano-resonances, which are investigated as a new continuum excitation mode in exotic nuclei [2]. By theoretical model calculations we show that the coupling of a single particle elastic channel to closed core-excited channels leads to sharp resonances in the low-energy continuum of the [n + (A – 1)] system [2]. These states are known as Bound States Embedded in the Continuum (BSEC) [3, 4, 5], which, for example, we have observed in ^{11}Be [6, 7] and ^{15}C [8, 9].

A signature for such BSEC are characteristic interference effects leading to asymmetric line shapes. We have observed a such interference in the ^{15}C spectra [8, 9]. Fano interference [10] consists of the quantum-mechanical interaction between discrete and continuous configurations, leading to characteristically asymmetric peaks in the spectra. The first model for auto-ionizing atomic states was developed by Fano in the 1960's [10]. Following the Quasiparticle-Core Coupling model [11] we consider the coupling of 1-QP (one-quasiparticle) and 3-QP components and find a number of long-living resonance structures close to the particle threshold [2]. The approach described here also extends the QPC model into the continuum. Results of the theoretical calculations for the ^{15}C nucleus are compared with the experimental data. The experimentally observed spectral distribution (both the narrow resonances and the interference pattern) are reproduced in a qualitative way, showing an agreement with a BSEC interpretation [2].

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