Study of the γ-decay from the near-neutron-threshold 2^+ state in ^{14}C

G. Corbari[1,2], S. Bottoni[1,2], M. Ciemała[3], F.C.L. Crespi[1,2], S. Leoni[1,2], B. Fornal[3], R.V.F. Janssens[4,9], S.D. Pain[5], M. Siciliano[6], E. Albanese[1,2], A.D. Ayangeakaa[4,9], G. Benzoni[2], S. Carmichael[7], M. Carpenter[6], K. Chipps[5], N. Cieplicka[3], P. Copp[6], J. Forson[8], E. Gamba[1,2], Ł.W. Iskra[3], H. Jayatissa[6], F. Kondev[6], T. Lauritsen[6], B. Million[2], C. Müller-Gatermann[6], A. Palmisano[8], M. Polettini[1,2], C. Porzio[1,2], W. Reviol[6], N. Sensharma[4,9], D. Seweryniak[6], C. Ummel[10], O. Wieland[2], G. Wilson[6,11], S. Zhu[12], and S. Ziliani[1,2]

[1] *Dipartimento di Fisica, Universitá di Milano, Milano, Italy*
[2] *INFN, Sezione di Milano, Milano, Italy*
[3] *Institute of Nuclear Physics, IFJ-PAN, Krakow, Poland*
[4] *University of North Carolina at Chapel Hill, North Carolina, USA*
[5] *Oak Ridge National Laboratory, Tennessee, USA*
[6] *Argonne National Laboratory, Illinois, USA*
[7] *Notre Dame University, Indiana, USA*
[8] *University of Tennessee-Knoxville, Tennessee, USA*
[9] *Triangle Universities Nuclear Laboratory, Duke University, North Carolina, USA*
[10] *Rutgers University, New Jersey, USA*
[11] *Louisiana State University, Louisiana, USA and*
[12] *Brookhaven National Laboratory, New York, USA*

Near-threshold states, i.e. narrow resonance appearing in proximity of particle emission threshold, are of fundamental importance for nuclear structure and astrophysical reaction modelling. According to advanced theory approaches, such as Shell Model Embedded in the Continuum (SMEC) [1], the existence of near-threshold state in light nuclei emerges as a universal phenomenon when the coupling with the continuum is included in the calculations. The structure of these near-threshold states, described as a core coupled to a particle-decay channel, is expected to provide relevant information on the onset of collectivization and clusterization phenomena in molecular-like nuclei, such as C, O and Ne. Due to their importance in nucleosynthesis processes, affecting capture rates of fusion reactions (as the Hoyle state of ^{12}C in the 3α reaction), an accurate modelling of near-threshold states is needed.
Thus far, a limited knowledge on the decay properties of near-threshold states in neutron-rich systems is available: the expected γ-decay branch from these states is at the level 10^{-3}-10^{-5} of the dominant particle-decay mode, which calls for significantly enhanced detection capabilities with respect to conventional γ-ray spectrometers.
In this contribution, we present the results of an experiment performed at Argonne National Laboratory (ANL) with the state-of-the-art GRETINA γ-ray spectrometer and the highly-segmented ORRUBA charged-particle Si detector. Our goal was to search for the γ-decay from the near-neutron-threshold 2_2^+ state in ^{14}C, located 142 keV above the neutron separation energy ($S_n = 8176$ keV). According to the SMEC model, the γ-decay branch from the 2_2^+ state significantly depends on the continuum coupling constant, with an expected branching value at the level of the present experiment sensitivity (i.e., 5×10^{-5}) [2]. The results of the GRETINA experiment will be complemented by information on the lifetime of the 2_1^+ state in ^{14}C, from an AGATA experiment performed at GANIL [3], with the aim of achieving a comprehensive description of the fragmented 2^+ strength in ^{14}C, in comparison with theory predictions.

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