Magicity or deformation at N=28?: The case of ^{42}Si

S. Grévy[1], N. L. Achouri, F. Azaiez, B. Bastin, R. Borcea, C. Bourgeois, A. Burger, J. C. Dalouzy, Z. Dombradi, A. Drouard, S. Franchoo, S. Iacob, B. Laurent, M. Lazar, E. Lienard, J. Mrazek, L. Nalpas, F. Negoita, N. A. Orr, Y. Penionskhevitch, Z. Polonyak, F. Pougheon, P. Roussel-Chomaz, D. Sohler, O. Sorlin, M. Stanoiu, I. G. Stefan, M. G. St-Laurent

[1] GANIL, IN2P3-CEA, Bd Henri Becquerel, 14076 Caen cedex, France.

The shell structure is one of the cornerstone in the description of the nuclei [1] and the magic numbers observed for the stable nuclei are well reproduced in the framework of Shell Model calculations. Nevertheless, the evolution of the single particle energies and then the persistence of the magic numbers (2, 8, 20, 28, 50, 82...) have to be considered. In the light neutron-rich nuclei, it has been shown that N=16 becomes a new shell gap replacing N=20 [2].

The magic number 28 is the first due to the spin-orbit splitting which is believe to be reduced for the most exotic nuclei. Since more than 10 years, it has been demonstrated that the deformation plays an important role in the evolution of the shell structure of the neutron-rich N=28 nuclei below ^{48}Ca and the validity of N=28 for these neutron rich isotopes is therefore discussed [3-5]. In the S isotopes, it has been shown that reduction of the N=28 shell closure itself is moderate and that the proton collectivity is essential to understand the experimental observations [6]. Since the proton configuration of the Si isotopes is expected to be more stable due to the Z=14 sub-shell gap, the magicity of ^{42}Si (14 protons and 28 neutrons) is today highly debated. A recent experiment performed at MSU conclude, based on the measurement of the 2 proton removal cross section that ^{42}Si is a 'new' doubly magic nucleus [7], in contradiction with our measurement of its short half-life interpreted as a consequence of strong deformation [8].

In order to definitively conclude between these two hypothesis, we performed recently at GANIL an in beam-gamma spectroscopy experiment to measure the 2^+ energies of ^{42}Si and neighboring nuclei. In the preliminary analysis, we observe a very low energy gamma ray corresponding to the $2^+ \rightarrow 0^+$ transition which is a clear signature of high collectivity. Then, ^{42}Si cannot be considered as a magic nucleus. We propose to present a more detailed analysis of these data at the FINUSTAR conference.

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