Large Scale Shell Model Calculations For $_{20}$Ca Isotopic Chain From N=22 To N=38

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Exotic nuclei exhibit different phenomena which is not found in stable nuclei in nature. One of them is the evolution of shell closure along the isotonic and isotopic chains around the traditional magic numbers 8, 20, 28, 50, 82, and 126 when going to neutron rich or proton rich side. The exotic regions of the chart of nuclides have been expanded during the last few years with discovery of a large no. of exotic nuclei of which one is $_{20}$Ca isotopic chain [1].

In the present work we have studied the shell evolution of $_{20}$Ca isotopic chain in going from N=22 to N=38 in the frame work of Shell Model.

In this work we have performed large-scale shell model calculation using Nushell code [2] for neutron rich even even $_{20}$Ca isotopes covering N = 22 to N=38. In our calculation $^{40}_{20}Ca_{20}$ is chosen as core and valence space comprises of full fp shell ($f_{7/2}$ $P_{3/2}$ $P_{1/2}$ $f_{5/2}$) for neutrons. Calculations have been carried out with KB3G interaction specially developed for fp shell and suitably modified for monopole correction [3,4].

The energy levels of excited state up to 5 MeV are shown in fig 1 and compared with experimental data wherever available in fig 2. Fig 3 shows the variation of energy of first 2^+ excited state with neutron number. B(E2) transition rates as a function of neutron number are shown in fig 6. Experimental values of $E(2^+)$ and B(E2) values are given in fig 4 and 5.

The large values of $E(2^+)$ are indicative of shell closure at N=28 and N=32. This is further supported by small B(E2) values at the above neutron numbers. $_{20}Ca^{48}$ is known to be a magic nucleus. The theoretical results predict the next magic nucleus as $_{20}Ca^{52}$ in the Ca isotonic chain.

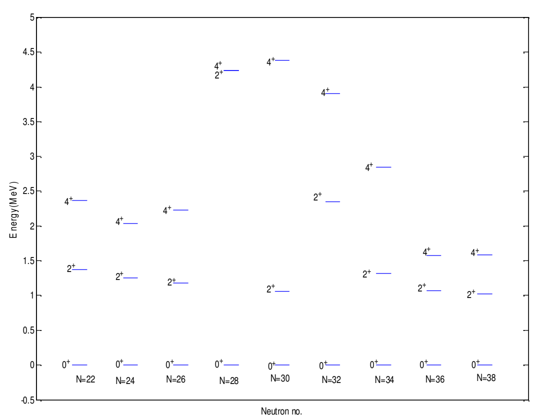

Fig:1 Theoretical energy levels of even even $_{20}$Ca isotopic chain

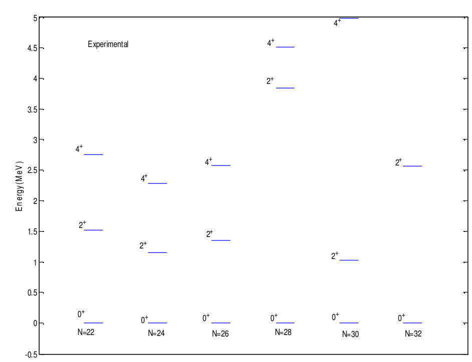

Fig 2: Experimental energy levels of even even $_{20}$Ca isotopic chain

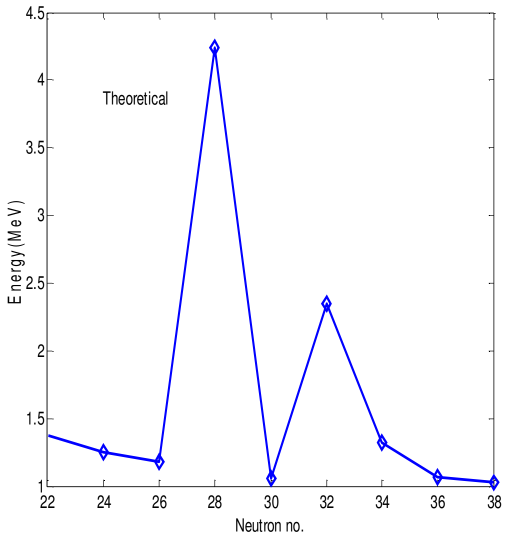

Fig 3:Theoretical energy of first 2^+ excited state of $_{20}$Ca isotopic chain

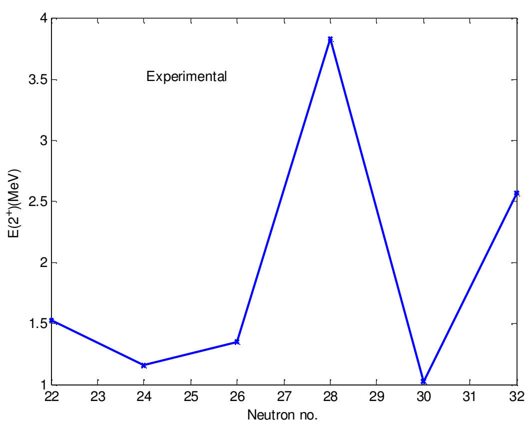

Fig4:Experimental energy of first 2^+excited state of $_{20}$Ca isotopic chain

References:

[1] O. Sorlin *et. al.* ,Progress in Nuclear and Particle Physics **61** (2008) 602-673.

[2]Nushell @ MSU, B. A. Brown and W. D. M. Rae(unpublished)

[3] Kuo and Brown, NPA **114** (1968) 241

[4] A. Poves. *et. al*., NPA **694** (2001) 157-198

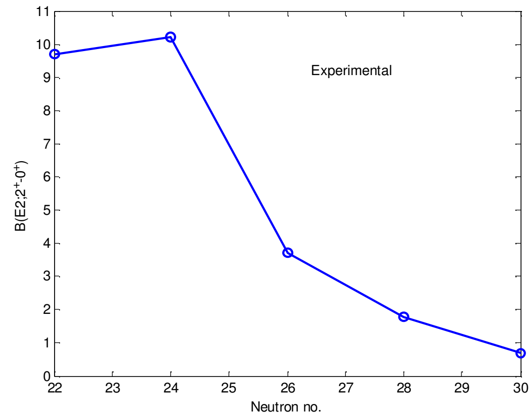

Fig 5: Experimental B(E2) values of first 2^+ state of Ca isotopic chain

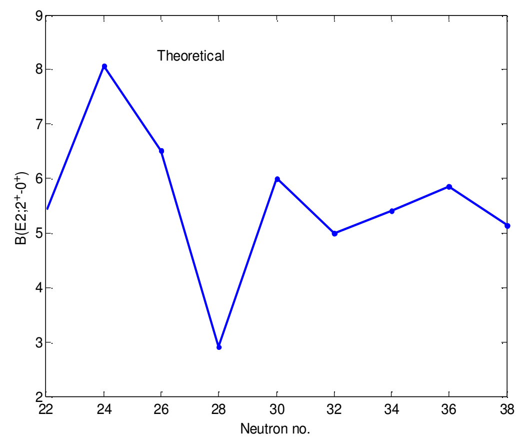

Fig 6:Theoretical B(E2) values of 2^+ state of $_{20}$C Isotopes