New insight on structure of neutron-rich nuclei using neutron separation energies

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In the past twenty years our understanding of the structure of light neutron-rich nuclei has developed very dramatically. The nuclear shell model has been successful in the description of various aspects of nuclear structure for nuclei near the valley of stability, and has enabled to involve the magic numbers that has become very important quantities reflecting the nuclear structure. Near the neutron dripline, however, a breaking of magicity has been observed at the N=20 shell closure where an "island of inversion"in shell ordering has been shown to exist. Though some theoretical calculations predict the existence of new neutron magic numbers N=6, 16 and 34 untill lately, no experimental evidence about new magic numbers been available.

Recently, two experimental surveys resulting in an appearance of neutron magic number N=16 have been published. We have surveyed experiments performed at GANIL from the point of view of two-neutron separation energies for determination of neutron shells in this region. On the other hand, Ozawa et al. have inspected the information on one neutron separation energies and interaction cross section σ_I measured at RIKEN. Kanungo et al. have published systematics of the beta decay Q-values indicating new regions of shell closures at N=6, 16 and also near 32. In order to establish new evidence for new neutron magic numbers we have tried to analyze the form of the two neutron separation energy dependence on neutron number near the shell closures. Since the slope of the S_{2n} dependence on neutron number for isotopes at the valley of stability changes very drastically, mainly at the drop points N_{sh} +2 corresponding to the shell closures at N=8 and 20, we decided to use an angle between the slope for isotopes with N ¡ (N_{sh}+2) and the slope corresponding to N > (N_{sh} +2), i.e. before the shell closure and during the start of the filling the new shell to identify magic neutron numbers.

For nuclei near the valley of stability, the dependence of this angle on the proton number shows clearly two peaks corresponding to the regions of validity the magic neutron numbers N=8 and 20 and confirms the ability to identify the magic numbers using changes of the S_{2n} slope. However, for the neutron-rich nuclei the assumption that N=8 or 20 could be magic numbers is found to be in a disagreement with rather low changes of the slopes at these shell closures.

On the other hand, for nuclei near the neutron dripline, the angles we obtain for the shell closure at N=16 are relatively large in the region from carbon to neon, and thus this fact supports the neutron N=16 magicity in this region.