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High-momentum nucleons, Tensor blocking, and nuclear Shell Structure

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Recent high-energy (p,pd) reaction study1 has confirmed the existence of high-momentum correlated pair of nucleons with S=1 and T=0 in ground state of 16O nucleus. The effect of such high-momentum correlated pairs affect the structure of ground and low excited nuclei through the tensor blocking.
A new paradigm of the nuclear structure that includes blocking effects of the tensor interactions is proposed. All of the recently discovered magic numbers (N=6, 14, 16, 32, 34) in neutron-rich nuclei are explained by the blocking effects that occur at specific shell configurations. A large amount of binding energy is gained by high-momentum correlated pairs of nucleon produced by the tensor interaction. Such tensor correlations strongly depend on the configuration space available for exciting 2p-2h states. When additional neutron occupy a new orbital, the configuration that was available before may be lost and result in sudden loss of binding energy otherwise gained by the 2p-2h excitation. Such tensor blocking effects enlarge the energy gaps at all observed new magic numbers. The tensor blocking also explains consistently observed peculiar configurations of neutron rich nuclei at the border of shells. The present study will open new horizon in nuclear physics particularly focusing the high momentum properties in excitation spectra.

1. S. Terashima et al., Phys. Rev. Letters 121 242501 (2018).

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