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Magicity of neutron rich isotopes: Lorentz tensor effect

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The formation of new shell gaps in neutron-rich nuclei are investigated within relativistic Hartree-Fock-Bogoliubov theory and the role of Lorentz tensor is studied in detail.
We show that the global variation of the single-particle energy is due to the isoscalar component of the effective Lagrangian, while the characteristic behavior of the spin-orbit partner or pseudo-spin partner is due to its Lorentz tensor part.
Based on the Foldy-Wouthuysen transformation, we analyzed the role played by the different terms of the Lorentz tensor in the formation and/or quenching of the N = 16, 32 and 34 shell gaps.
It is shown that the Lorentz tensor leads to the increasing of N = 32 gap, when going along isotonic chains, from ^{60}Ni to ^{52}Ca. Whereas the increasing of N = 34 gap from ^{62}Ni to ^{54}Ca is due, primarily, to the central term.
The relativistic model automatically produces the decreasing of N = 16 gap from ^{30}Si to ^{24}O because it naturally includes the spin-orbit interaction and its isospin dependence, also the inclusion of the Lorentz tensor enlarge the energy difference.

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