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Effect of Deformation on the Structure of the Proton Bubble in N=28 Isotones

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Introduction

The nuclear density distribution reveals details about the stability and geometry of the nuclear system. According to the nuclear force's saturation property, the nuclear density inside the nucleus remains constant regardless of the number of nucleons. In some instances, a fascinating phenomenon regarding the nuclear density profile known as the "bubble effect" is seen. The decline of the center nucleonic density and the presence of a hump close by are characteristics of the bubble effect in nuclei. The hunt for the central depression in nucleonic density has garnered more attention in recent years. The radial distribution peak of the s-orbit wave function, which contributes to the central density, is located in the nuclear interior of a nucleus. The centrifugal barrier suppresses the peaks of the wave functions of orbitals with non-zero angular momenta, hence these wave functions do not contribute to central density. This indicates that only the s-orbit contributes to the nuclear density in the centre, and that when this state becomes less populated, the central density in the nucleus decreases and a bubble may result.

H.A. Wilson was the first to suggest that stable spherical nuclei might experience core density depletion. Campi and Sprung carried out the initial microscopic calculations for the spherical bubble nuclei in the 1970s. Numerous researches have looked into the possibility of bubble or semi-bubble structures in light, medium, and super heavy nuclei. These investigations made the argument that the central density depletion in light nuclei is caused by the shell effects. The existence of bubble structure in the super heavy area has been attributed to Coulomb repulsion caused by the flow of protons towards the nuclear surface. It's interesting to note that bubble structures can be found everywhere there is mass.

The radial distribution peak of the s-orbit wave function, which contributes to the central density, is located in the nuclear interior of a nucleus. The centrifugal barrier suppresses the peaks of the wave functions of orbitals with non-zero angular momenta; hence these wave functions do not contribute to central density. This indicates that only the s-orbit contributes to the nuclear density in the center, and that when this state becomes less populated, the central density in the nucleus decreases and a bubble may result. Using electron scattering on 206Pb and 205T1, a 3s wave function with such an interior peaked shape was recorded. The spin-orbit potential is also affected by the formation of a bubble structure.

These cutting-edge radioactive ion beam capabilities have made it possible to test out theoretical hypotheses. The majority of bubble nuclei have been studied for spherical examples in the literature. Nuclear deformation makes it more difficult for a bubble to form because it combines s orbitals with higher l orbitals. Shukla et al. conducted the first research of axially deformed bubble nuclei in

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the light mass zone. In our earlier research, we looked into the potential for dual bubble-like structures that are deformed in light nuclei. We discovered some interesting options with a distorted dual bubble structure near N or/and Z=14. In their ground state, the isotones of the N=28 shell closure are not spherical. Our goal in the current effort is to investigate the impact of nuclear deformation on proton bubble structure in N=28 isotones. A novel, exotic nuclear phenomenon known as the "Bubble" structure in atomic nuclei is seen. It is distinguished by distinct core depletions that of the matter distribution.

In the current study, we looked into how nuclear deformation affected the structure of proton bubbles in N=28 isotones. Utilizing the relativistic Hartree-Bogoliubov model based on the density-dependent meson-exchange (DD-ME2) interaction, theoretical computations are performed. It is well known that the ground state of the isotones with N=28 shell closure is distorted. The states get inverted as a result of the weakening of spin-orbit strength. We discovered that nuclear deformation has a significant impact on the core depletion of proton density in these isotones. The development of bubbles is hindered by the high dynamical connections that result from deformation. The rise in the central nucleon density (internal density) brought on by deformation may be related to the decline in the depletion fraction. From an experimental standpoint, it is desirable to investigate the interior density and bubble structure of deformed objects.