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Calculation of radial moments of charge distribution compared to precision spectroscopy data

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The charge radius is one of the most fundamental quantities concerning nuclear structure. Recent advancements in high-precision spectroscopic measurements utilizing isotope shifts have provided accurate experimental data on the second-order moments of charge distribution, including isotopes in regions of proton and neutron excess. However, there is no precise theoretical calculation that can match these experimental values. In this study, we conduct an analysis to develop theoretical calculations capable of reproducing the experimental data. Our calculations take into account not only the contribution from proton distribution but also the contribution from neutron distribution in determining the charge distribution of nucleus. By comparing the calculated results with experimental values, we investigate the systematic change among various isotopes. Calculations employing the Fayans type density functionals in the mean field model successfully reproduce the changes in the second-order moments of charge distributions observed in Ca isotopes and other isotopes. However, we know that there are unstable regions where experimental values cannot be reproduced. We will discuss current state of charge radius calculations and the necessity to construct theoretical models beyond the mean field approximation.

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