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Nuclear charge radius predictions from DFT-based models

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The nuclear charge radii can provide information about the strong and electromagnetic forces acting inside the atomic nucleus on its constituents. While the global trend of nuclear charge radius is governed by the nuclear-matter bulk properties, its local variation is affected by the quantum mechanical nuclear-structure aspects. In recent years, tremendous progress in the experimental measurement of nuclear charge radii has been made. This has challenged current nuclear-structure models and motivated the development of new ones.

I will discuss predictions of the nuclear charge radii on various isotopic chains with DFT-based models. Recent measurements in K [1], Ag [2], Ni [3], and Pd [4] isotopic chains have shown that while these models can predict overall trends well, there are, nevertheless, some deficiencies. When comparing predictions from Fayans and Skyrme EDF models, we have found that generally Fayans EDF, although often overestimating odd-even staggering of charge radius, tends to follow more closely the experimental trend. This can be attributed to the subtle interplay between pairing correlations, nuclear deformation, and charge radius [4]. The results for potassium charge radii do not support the magic number character of $N = 32$.

With Ag isotopic chain, none of the used EDF models could reproduce the unexpectedly large charge radius of ^{96}Ag, below the $N = 50$ shell gap [2]. It is very unlikely that such kind of increase in the charge radius can be reproduced with any reasonable single-reference EDF model. A possible solution towards a more accurate description would be symmetry-restored, beyond mean-field approaches.

Lastly, I will also discuss the strikingly similar pattern of differential charge radii in even-even isotopic chains from Ca to Zn, predicted with DFT and ab-initio based models [5]. We have found that each theoretical model predicts its own, nearly element-independent sequence of differential charge radii across these isotopic chains. Experimental data, where available, supports this very same picture.

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