Theoretical calculations of MIFs caused by the nuclear volume effect

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Evidences showed that heavy isotope systems could be significantly fractionated as the consequence of the nuclear volume effect (NVE) or so-called the nuclear field shift effect, which is a driving force of mass-independent fractionation induced by differences in nuclear size and nuclear shape of isotopes. Here, the MIFs of Hg, Pb and U isotope systems caused by the NVE are investigated with careful evaluation on quantum relativistic effects via the Dirac's formalism of full-electron wave function.

We show that the NVE can cause moderate MIFs for not only odd-mass isotopes but also even-mass isotopes. Interestingly, the NVE produce quite strange kinetic isotope fractionations for chemical reactions predominated by one direction. The heavy isotopes often can react faster than the lighter ones due to the NVE. We also show the effect of MIFs of U and Pb isotope systems on the accuracy of U-Pb dating methods.