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Breakdown of Isobaric Multiplet Mass Equation: Charge-Violating Nuclear Interactions in Nuclear Medium

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The Isobaric Multiplet Mass Equation (IMME) is the most fundamental prediction in nuclear physics based on the concept of isospin. However, the IMME does not in itself provide any information on the nature of the charge-violating nuclear interactions. One related long-standing question is the microscopic origin of the Nolen-Schiffer anomaly found in the Coulomb displacement energy of mirror nuclei. We introduce new corrections to the IMME in which the charge-asymmetric and charge-independent components of the nucleonnucleon interaction in nuclear medium are established in the framework of Brueckner theory with the AV18 bare interaction. We derive the correction terms for finite nuclei that naturally enter into the coefficients of the IMME,
and systematically analyze their effects in different isobaric multiplets. We confirm that the charge-symmetry breaking component in nuclear medium is responsible for explaining the Nolen-Schiffer anomaly. On the other hand, the IMME was challenged by recent high-precision nuclear mass measurements. The breakdown of the IMME presents a great interest as it is of fundamental importance in nuclear and particle physics. However,its explicit mechanism remains a diffculty for extant theoretical models. Based on the corrected IMME (CIMME), we derive explicitly the terms which break the IMME for the first time. The strong breakdown is found to arise primarily from the CSB component, and the degree of breakdown apparently exhibits a nuclear-structuredependent behavior.

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