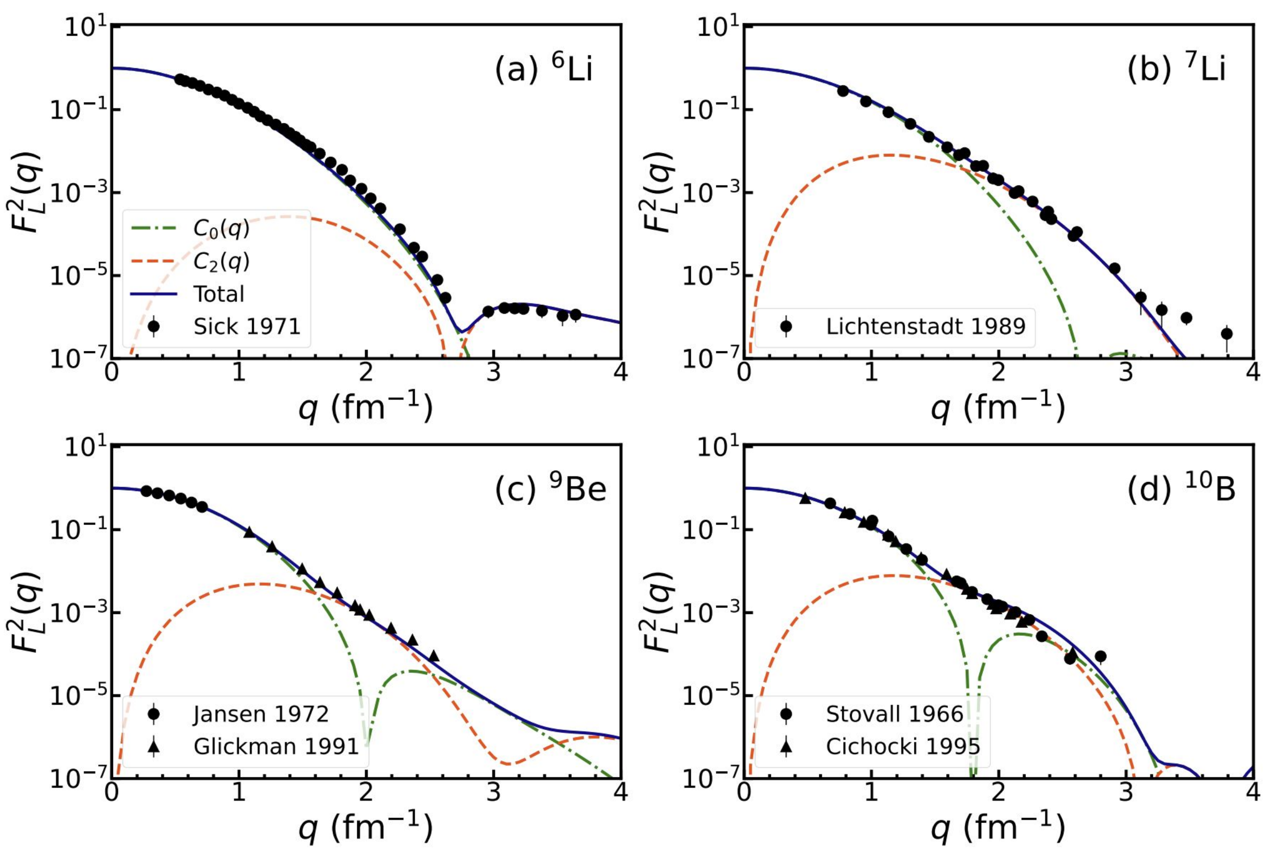
Charge form factors of light nuclei

Objectives

In this work, we present quantum Monte Carlo (QMC) calculations of charge or “longitudinal” form factors in the 3 ≤ A ≤ 10 mass region. These calculations are compared to elastic electron scattering data where available to validate the chiral effective field theory (χEFT) approach to modeling the nucleus over a range of momentum transferred to the nucleus.



Charge form factors of 6Li, 7Li, 9Be, and 10B as a function of momentum transfer q. The total form factor (blue line) is broken down into contributions with different multipolarities that are sensitive to either the spherically averaged charge distribution (green dot dashed line) or the quadrupole deformation (orange dotted line). The latter is crucial to describe intermediate momentum transfers.

Impact

The QMC results provide very good agreement at low-momentum transferred, and the region where the electron transfers a large amount of momentum to the nucleus allow us to better understand the breakdown scale of this low-energy formalism. This work represents the first *ab initio* evaluation of charge form factors in the 7 ≤ A ≤ 10 mass range. We established the validation of the χEFT formalism, and identified where it breaks down. These theoretical efforts are laying the groundwork to study elastic electron scattering in radionuclei, a topic of great experimental interest. These efforts go hand-in-hand with experiments at DOE facilities like FRIB. For example, BECOLA aims to measure nuclear sizes with laser spectroscopy. Charge radii extracted from these form factors describing new electron scattering measurements will provide complementary data to better pin down the size of these exotic systems, while the form factor itself can help to interpret the nuclear shape.

Accomplishments

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