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Atomic Recoil Processes following He-6 Beta Decay

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There are currently several experiments in progress to search for new physics beyond the Standard Model by high precision studies of angular correlations in the β decay of the helium isotope $^6\mathrm{He} \rightarrow {}^6\mathrm{Li} + e^- + \bar{\nu}_e$. An essential part of the analysis is to understand the energy distribution and spectra of the recoil ions. After the β decay event, the atomic electrons suddenly find themselves in a $^6\mathrm{Li}^+$ environment with nuclear charge $Z = 3$. The electrons redistribute themselves over all possible states of the $^6\mathrm{Li}^+$ ion, including the continuum leading to $^6\mathrm{Li}^{++}$ and $^6\mathrm{Li}^{3+}$. Evidence for new physics beyond the Standard Model would reveal itself by an additional tensor coupling contribution to the weak interaction, in addition to the simple Gamow-Teller axial-vector mechanism. We will present calculations employing Stieltjes imaging techniques in Hylleraas coordinates to study the probabilities for the shake-up and shake-off mechanisms, and especially the additional recoil accompanying the emission of the shake-off electrons. The results are of key importance in the interpretation of angular correlations following β decay.

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