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Beyond Woods-Saxon and Perey-Buck paradigms from microscopic grounds

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Based on a momentum-space in-medium folding model, we disclose the universal separability of the optical potential, revealing its radial and non-locality features at beam energies in the range 40-400 MeV and target mass numbers in the range $40 \leq A \leq 208$. From this microscopic study we find that the nonlocality form factor is inherently complex and of hydrogenic nature, affecting both central and spin-orbit components of the potential. A striking outcome from this study is the consistent appearance of a nodal point in the imaginary radial form factor, notably suppressing surface absorption peaks, in evident contrast with Woods-Saxon's assumption of an absorptive peak at the nuclear surface. Our analysis reveals that the complex radial form factor can effectively be represented as convolutions of uniform spherical distribution with a Gaussian form factor and a Yukawa term. These robust microscopically driven findings offer new ways for investigating nuclear reactions beyond the restricting Woods-Saxon and Perey-Buck assumptions.

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