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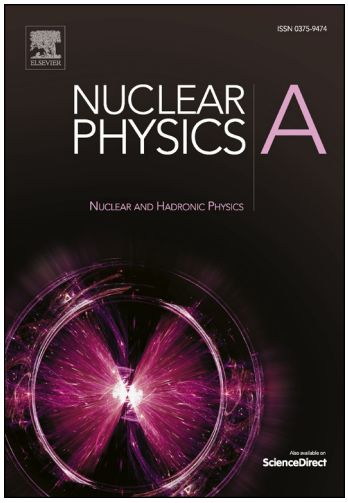


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# Numerical calculation of the decay widths, the decay constants, and the decay energy spectra of the resonances of the delta-shell potential

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**Abstract**

We express the resonant energies of the delta-shell potential in terms of the Lambert $W$ function, and we calculate their decay widths and decay constants. The ensuing numerical results strengthen the interpretation of such decay widths and constants as a way to quantify the coupling between a resonance and the continuum. We calculate explicitly the decay energy spectrum of the resonances of the delta-shell potential, and we show numerically that the lineshape of such spectrum is not the same as, and can be very different from, the Breit-Wigner (Lorentzian) distribution. We argue that the standard Golden Rule cannot describe the interference of two resonances, and we show how to describe such interference by way of the decay energy spectrum of two resonant states.

*Keywords*: Decay constant; decay width; resonant states; Gamow states; resonances; Golden Rule; Lambert $W$ function.

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