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Asymmetric Wavefunctions from Tiny Perturbations

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We present an undergraduate-accessible analysis of a single quantum particle within a simple double well potential through matrix mechanics techniques. First exploring the behavior in a symmetric double well (and its peculiar wavefunctions), we then examine the effect that varying well asymmetry has on the probability density. We do this by embedding the potential within a larger infinite square well, expanding in this simple basis, and solving for the matrix elements. The resulting wavefunctions are drastically different than those of the unperturbed system. A relatively tiny drop in one of the well depths results in a nearly complete collapse (localization) of the wavefunction into one of the wells. This system can be accurately mapped to a much simpler two-state "toy model"; this makes it clear that this localization is also a property of a generic double well system.

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