Resonant Phases in 1D Potential Scattering

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We compute Time delay, Effective scattering distance, and Trapping probability using Reaction Matrix theory for one dimensional arbitrary semi-infinite localized potentials. Only for sufficiently sharp resonances the local maxima of these three scattering functions occur at the same value of energy. The derivative with respect to the wave vector of the resonant part of the scattering scattering phase ϕ, called the Effective Scattering distance, $l(k)$, has its local maxima at the real part of the complex energy poles of the S matrix, even when the isolated resonances are very wide. We show that the values of ϕ at resonance occur at different values, depending on the boundary conditions of the scattering wave function Ψ at the reaction boundary.Thus, knowledge of $l(k)$ at resonances, immediately provides us withe the real and imaginary resonance poles of the S-Matrix. We show how to determine the boundary condition appropriate for each resonance. Furthermore, we show how knowledge of the corresponding boundary conditions at resonance allows us to apply successfully a one level model for the scattering even for complicated potentials.