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Bias-Free Method for the Detection of Bound, Antibound, and Resonant States from Error-Affected Experimental Data

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It has already been recognized that if the scattering amplitude is known only along a limited part of the cuts and with a limited accuracy, its analytic continuation to other points of its domain of holomorphy is not only nonunique but also unstable. The latter is a crucial fact both for the phenomenological analyses and for the theory unless we are in the fortunate position to have a theory which predicts the amplitude at all energies at once. Indeed, as a consequence of the finiteness of the energy range, it is always possible to set up an infinite set of holomorphic functions inside the error corridor, no matter how narrow it is, which are such that they differ by an arbitrary amount at any other point of the holomorphy domain. However, it is a remarkable mathematical fact that the maxima of the moduli of all these functions have to be greater than a certain lower bound which is uniquely determined and which can be computed numerically from the data function and its errors. This number can be used as a sensitive device for the location of the singularities as well as the zeros of the scattering amplitudes in a way which avoids the false particles that might be produced by specific parametrizations (e.g., Breit-Wigner form). The paper exemplifies the extreme sensitivity of this bias-free method to two model amplitudes, one of which exhibits a pole and the other a zero in the complex energy plane.