

Correlation between zeroes and poles of S matrix for complex potentials

I JAMIR, E F P LYNGDOH and C S SHASTRY

Department of Physics, North Eastern Hill University, Shillong 793 022, India

MS received 6 October 1997; revised 13 March 1998

Abstract. Using several illustrative examples, the nature of resonance poles and the corresponding zeroes of the s -wave S matrix is examined for several potentials having an absorptive pocket followed by a barrier. It is shown that even though the presence of absorption practically suppresses the manifestation of resonance in the elastic scattering cross section, the effect of the resonances generated by the absorptive pocket is more clearly manifested in the absorption cross section provided the barrier width is not too large. We further find that the signature of barrier top resonances are also more clearly manifested in the absorption cross section rather than in the elastic scattering cross section. These results have been interpreted in terms of complex resonance poles and corresponding zeroes of the S matrix. This implies that in complex potential scattering like heavy ion collisions, the reaction channel cross section peak is a more reliable signature of resonance phenomenon than the variation of the elastic channel cross section with energy.

Keywords. S -matrix; resonance.

PACS Nos 24.90; 03.65

1. Introduction

The analytic properties of the S matrix for real well-behaved potentials, their applications in scattering theory and the interpretation of physical states of quantal systems, are well-established subjects [1–3]. However, in nuclear scattering, the effective potential between the interacting systems is complex and detailed investigations and applications of the analytic properties of the S matrix for complex nuclear potentials have been studied only to a limited extent [4–7]. Recently, there has been some renewed interest in the nature of the singularities of the S matrix for complex potentials and its applications to nuclear physics [8–11]. It may be noted that in complex potential scattering, the primary observables of interest are the scattering cross section σ_s and the absorption cross section σ_{ab} . It is desirable to study to what extent both of these quantities can be correlated with the analytic features and poles of the S matrix.

In this connection, we note that the poles of the S matrix in the complex energy plane with positive real part and small negative imaginary part can be correlated with resonance states of energy E_R and width Γ [1]. These poles are obtained from the study of the s -wave S matrix as a ratio of the Jost functions $f(k)$ and $f(-k)$,