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CALCULATIONS OF THE ^{16}O + ^{28}Si ELASTIC SCATTERING IN THE FRAMEWORK OF THE SEMI-CLASSICAL APPROXIMATION WITH COMPLEX TRAJECTORIES.

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Systematic semi-classical calculations using complex trajectories [1]) have been done for elastic scattering of ^{16}O on ^{28}Si as a function of energy with the optical potential E18 of Ref. 2. This allows to include in the same formalism both absorptive, diffractive and refractive effects. These semi-classical calculations agree fairly well with the corresponding quantum mechanical calculations. In the forward region, for angles smaller than the rainbow angle the trajectories are almost real (the CT^+ and NT^+ trajectories of Ref. 1) and correspond to classical contribution, the fall-off at the larger angles corresponds to a complex trajectory (the DT^+ trajectory of Ref. 1) which is of quantum mechanical nature and describes diffractive effects. As shown in Ref. 1, this diffraction can be caused either by the edge of the real potential, or by the edge of the absorptive part. In the latter case, it would correspond to the usual picture of Fresnel diffraction by a black screen. In order to discriminate between these two models, we have done a comparison with the calculation using the *same* CT^+, NT^+ and DT^+ trajectories but 1) for the real part of the optical potential alone and 2) for the imaginary part alone. The trajectory at the large angles corresponds thus to the diffraction by the edges of these two potentials. Whereas at 33 MeV the calculation with the full potential lies in between the calculations 1 and 2 (Fig. 1) and so it is hard to decide which model is the more correct one, at 50 and 215 MeV the diffraction by the edge of the real potential alone is quite close to the full calculation. One should note in this case that the contribution of the inner trajectories which for a purely real potential are far from being negligible has been omitted. In the realistic case these are absorbed, and make the diffractional pattern due to the real potential fully apparent. These calculations show that, although absorption plays an important role, heavy ion scattering cannot be simply interpreted by the Fresnel diffraction picture. At least for energies of about twice the Coulomb barrier one is much closer to the rainbow picture followed by diffraction by the edge of the real potential. We have also been able to understand the connection between the complex semi-classical deflexion function and the so-called quantum mechanical deflexion function obtained by taking the derivative of the real part of the quantal phase shifts. Both approaches to elastic scattering of heavy-ion are consistent with our picture for this reaction mechanism.

1) J. Knoll and R. Schaeffer, Ann. Phys. (N.Y.) 97 (1976) 307 ; Phys. Reports, to be published.
2) J.C. Cramer et al., Phys. Rev. C14 (1976) 2158.