MOLECULAR ORBITAL THEORY FOR HEAVY ION
ELASTIC AND INELASTIC SCATTERING

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In the scattering between two heavy ion nuclei some anomalous phenomena often appear. An uprising oscillatory structure is sometimes observed in the large angle region of differential cross section and the intermediate structure frequently arise in the excitation function which cannot be interpreted easily by the simple conventional optical model and statistical theory. Molecular orbital theory has been formulated to interpret these phenomena naturally for many cases.

When two nuclei collide with sufficient energy, all the nucleons will interact with each other. The nuclei may break up and the nucleons undergo regrouping. To keep the total energy of the system low the cores formed should be as stable as possible. They prefer to be in closed shell. The residual nucleons will form one or more clusters which can move around and be transferred between the cores in molecular orbits.

This theory is now extended to the inelastic scattering cases where the nuclear cores may stay in the ground state or be excited to an activated state after the collision process. In this formulation the wavefunction of the cluster is expressed in terms of the possible "molecular" orbits instead of the "atomic" orbits commonly used. This way, the elastic and inelastic scattering channels become decoupled from each other for cases with two identical nuclear cores.

This theory has been applied to the elastic and inelastic scattering Ne+O system. It is possible to choose one set of parameters to reproduce simultaneously all the sixteen experimental curves of angular distribution for both elastic scattering $^{20}$Ne($^{16}$O, $^{16}$O)$^{20}$Ne and inelastic scattering $^{20}$Ne($^{16}$O, $^{16}$O)$^{20}$Ne (2, 1.63 Mev) in a certain energy range. The two anomalous phenomena appeared in the differential cross section and excitation function of this system can be interpreted naturally.
