

ON THE DIFFERENCE AND SIMILARITY BETWEEN ELASTIC SCATTERINGS OF NE+C AND O+O SYSTEMS

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Comparing the experimental data of elastic scattering excitation functions of the $^{20}\text{Ne} + ^{12}\text{C}$ system ^{1,2)} with the $^{16}\text{O} + ^{16}\text{O}$ system ³⁾, it can be seen that several similar gross resonant peaks are simultaneously exhibited at $\theta_{c.m.} = 90^\circ$, suggesting that a compound system, ^{32}S quasi-molecular states, may be formed in both reactions. However, the 70° excitation functions of these two systems show rather different behaviors. For $^{20}\text{Ne} + ^{12}\text{C}$ scattering the 70° data is lack of structure and the average slope of the excitation function decreases with increasing scattering angle, suggesting that the elastic scattering processes of these two systems have rather different reaction mechanisms. Hence, investigation of the difference and similarity between $^{20}\text{Ne} + ^{12}\text{C}$ and $^{16}\text{O} + ^{16}\text{O}$ systems may reveal valuable information about the potentials and reaction mechanisms.

The gross resonances of the excitation functions for $^{16}\text{O} + ^{16}\text{O}$ systems were assumed to belong to the same quasi-molecular band $N=2n+L=28$ [ref. ⁴⁾]. The gross resonances of the excitation functions for $^{20}\text{Ne} + ^{12}\text{C}$ should belong to the same band as a two-oxygen system, since the same compound systems were composed in these two scattering processes. But the data without structure at $\theta_{c.m.} = 70^\circ$ and with structure at $\theta_{c.m.} = 90^\circ$ and 130° for $^{20}\text{Ne} + ^{12}\text{C}$ system cannot be reproduced by using the same type of optical potential as the two-oxygen system ^{1,2)}.

According to the LCN0 model ⁵⁾ when ^{20}Ne and ^{12}C nuclei approach each other, a quasi-molecular state, $^{20}\text{Ne} + ^{12}\text{C} = ^{12}\text{C} + ^{12}\text{C} + \alpha_1 + \alpha_2$, may be composed at a near Coulomb barrier energy. Thus, during the elastic collision of these two nuclei, the elastic transfer process would interfere with the elastic direct process, so that the structure feature of the excitation functions for the $^{20}\text{Ne} + ^{12}\text{C}$ elastic scattering is different from the $^{16}\text{O} + ^{16}\text{O}$ scattering.

Based on the above analysis, in this note, the LCN0 model with double alpha transfer has been employed to describe the structure feature of the excitation functions for the $^{20}\text{Ne} + ^{12}\text{C}$ system, while the optical model using a deep optical potential has been employed to reproduce the experimental excitation functions and the angular distributions of the $^{16}\text{O} + ^{16}\text{O}$ elastic scattering. The parameters of the optical potential used in the calculations of these two systems are chosen to be approximately equal. Therefore, the difference and the similarity exhibited in the elastic scattering excitation functions of these two systems have been naturally explained. The results show that (i) an optical potential with sufficiently deep real part and J-dependent imaginary part is responsible for the similarity of the gross resonant structures in the excitation functions of the $^{20}\text{Ne} + ^{12}\text{C}$ and the $^{16}\text{O} + ^{16}\text{O}$ systems; (ii) the elastic transfer processes of the double alpha particles in the $^{20}\text{Ne} + ^{12}\text{C}$ scattering plays a rather dominant role in the appearance of the difference between the elastic excitation functions of these two systems.

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