^{20}Ne + ^{24}Mg INTERACTIONS BETWEEN 2 AND 5 MEV/A

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A systematic study of ^{20}Ne + ^{24}Mg interactions is underway and we report here part of the data accumulated yet. ^{20}Ne beams were accelerated by the cyclotron of Louvain-la-Neuve to energies ranging from 45 to 105 MeV and directed towards thin ^{24}Mg targets.

In a first step we measured elastic angular distributions at 50, 60, 80, 90 and 100 MeV incident energies. At small angles the scattered ^{20}Ne ions were detected by an array of standard Si(Li) detectors. At larger scattering angles where elastic events were not separated well enough from the inelastic events, we "cleaned" the spectra by requiring the coincident detection of the recoil ^{24}Mg nuclei. We succeeded in this way to perform measurements up to a center-of-mass scattering angle of about 75°. The elastic angular distributions were analyzed in the framework of the optical model [1].

Extensive many-parameter searches were made in order to discriminate between various families of optical potentials ranging from shallow ones to proximity potentials and surface transparent potentials. Within the data available we deduced a set of potentials giving fair agreement with the data. Data points at larger scattering angles would be needed for a further selection among them. These potentials predicted reaction and fusion cross sections which were checked independently with inclusive γ-spectra.

In the second step reported here, we detected inclusive γ-ray spectra induced in a ^{24}Mg target by ^{20}Ne ions. The projectiles had incident energies of 45, 55, 60, 70, 80, 85 and 105 MeV. A Ge(Li) detector of high resolution was positioned at an angle of 90° with respect to the beam direction in order to minimize the Doppler effect. The procedure of analysis has been reported elsewhere [2]. The production cross section of a particular nucleus was deduced from the intensity of gamma transitions leading to its ground states. At each of the incident energies we deduced mass spectra and charge spectra of reaction products. The integration of part or the entire mass spectra give estimates of the fusion or the total reaction cross sections.

Statistical model calculations succeeded to reproduce fairly well the mass spectra in the so-called evaporation region, corresponding to nucleons and/or alpha evaporations from the ^{44}Ti compound nucleus. In general we found that these calculations exhaust some 60 to 70 percent of the total reaction cross sections.[3]

The fusion cross sections versus incident energy were interpreted in two different ways [3] : we checked first whether the angular momentum in the compound system really limits the fusion cross section [4] which seems not to be the case. On the contrary, the hypothesis of dissipative processes [6] nicely fits the experimental results[3] (Fig. 1) although they are unable to distinguish among sticking and rolling.

Another point of interest came from the presence in the mass spectra of nuclei such as ^{43}Sc, ^{42}Sc and ^{42}Ca at all incident energies. Their production would require the emission of very energetic nucleons from the compound system in order to cool down the final nucleus to the region of γ-desexcitation. Such a process is commonly supposed to be unlikely and suggests a very special reaction mechanism. For example[3] Fig. 2 shows the excitation function for the production of $^{43}Sc^{*}$.

References

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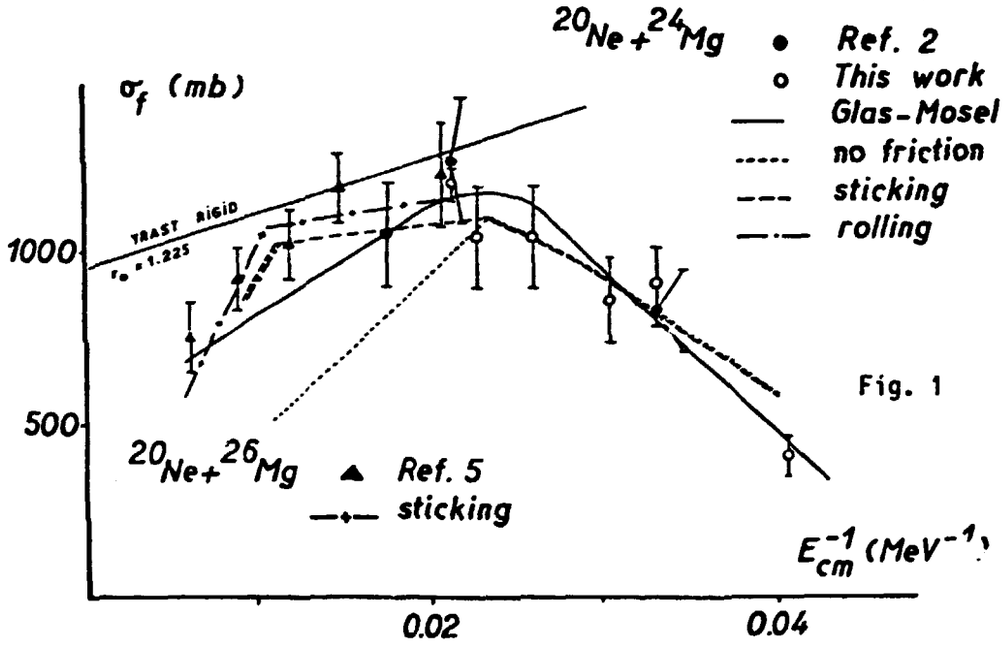

Fig. 1

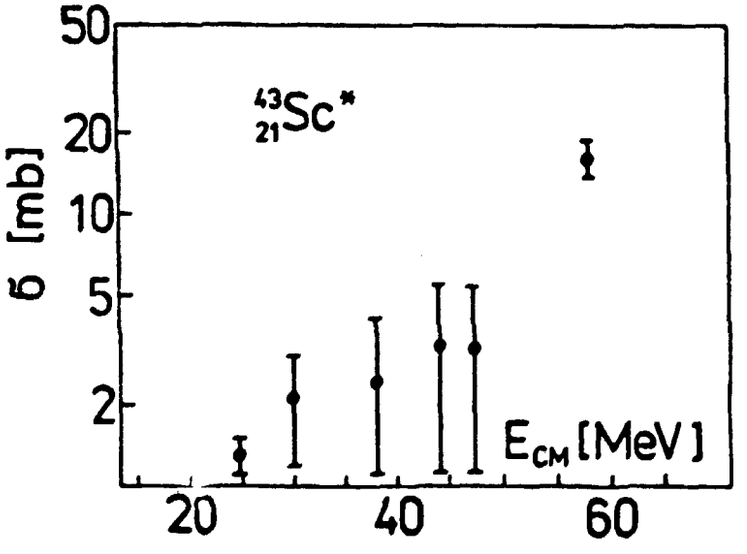

Fig. 2