Université Scientifique et Médicale de Grenoble

INSTITUT DES SCIENCES NUCLÉAIRES
DE GRENOBLE

53, avenue des Martyrs – GRENOBLE

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LOW ENERGY NUCLEUS-NUCLEUS ELASTIC SCATTERING AND THE OPTICAL LIMIT OF GLAUBER THEORY.

J. Chauvin, D. Lebrun, A. Lounis, M. Buenerd, P. de Saintignon, P. Martin

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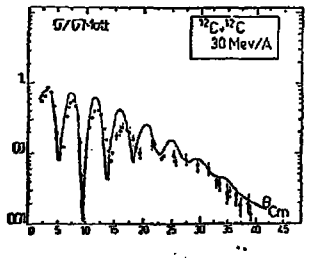
Institut des Sciences Nucléaires, 53 avenue des Martyrs
38026 - GRENOBLE Cedex, FRANCE

A description equivalent to the optical limit of Glauber theory[1] is used to reproduce low energy nucleus-nucleus collisions (E_{lab}/A = 30 MeV). Both reaction cross-section and elastic scattering differential cross-section are fairly well reproduced for the $^{12}C + {}^{12}C$ system. In this crude model, the nuclear phase shift is related to a complex refractive index given by the nucleon-nucleon scattering amplitude $f_{NN}(0°)$ at $E_{NN} = E_{lab}/A$ and the overlap of the nuclear densities ρ_1 and ρ_2.

$$\delta(b) = \pi\lambda_{NN} \; f_{NN}(0°) \int_{-\infty}^{+\infty} \rho_1(b,z)\, \rho_2(b,z)\, dz$$



Assuming gaussian densities, the overlap function is also a gaussian[2]. To calculate the average N - N scattering amplitude used in Glauber theory, we remark that at low energy only S waves contribute to the nucleon-nucleon scattering and then :

$$f_{NN}(0°) = \frac{\lambda_{NN}}{2} \; \sin 2\bar{\delta}_o + i(1 - \cos 2\,\bar{\delta}_o)$$

With the constraint on the "average" phase shift

$$\sigma_{NN} = \frac{1}{2}(\sigma_{pp} + \sigma_{np}) = 2\pi\,\lambda_{NN}(1 - \cos 2\,\bar{\delta}_o)$$

due to the optical theorem.

The calculated $^{12}C + {}^{12}C$ reaction cross section is 1262 mbarn, to be compared to the 1315 ± 40 mbarn experimental value. The elastic scattering differential cross section is quite well reproduced with no need for renormalization. The only input is the experimental value σ_{NN} = 196 mbarn at E_{NN} = 30 MeV, besides the standard rms ^{12}C radius : 2.37 fm. Similar results have been obtained at E_{NN} = 25 MeV and 85 MeV. Interpretation of this surprising success in under progress.

1) R.J. Glauber, Lectures on Theoretical Physics (Interscience, New-York 1959) Vol I.

2) P.J. Karol, Phys. Rev. C11, 4 (1975) 1203.