On the Reduction of Nuclear Collision Problems

By Hideki Yukawa

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Abstract

§ 1. Introduction

In the previous paper[1] the author (colaboration with Miyagawa,) recently, calculated the cross section~~s~~ of the disintegration of the nucleus ~~with~~ by neutron impact with proton emission, ~~and~~ the elastic scattering (~~and~~ in addition to those of) and the capture of the neutron. ~~The method used was~~ The theoretical basis of the method used ~~was~~ is, however, rather obscure, so that ~~and~~ its ~~the~~ thorough discussion ~~of it~~ is urgently needed. In this paper a comprehensive procedure of reduction of ~~the~~ general problems ~~of collision~~ of the collision ~~nucleus~~ nucleus ~~wi~~ and the heavy particle.

First, if only the possibility of the elastic scattering is considered, the stationary state of the whole system will be expressed in the form

$$u_0(q_0)\,\chi_0(q_1 q_2 \cdots q_N),$$

where u_0 is the superposition of plane and scattered waves for the impinging particle, in the neutron state for instance, and χ_0 represents the normal state with energy W_0 of the nucleus with atomic number Z and mass number N. ~~for instance.~~ ~~It~~ q's should be understood ~~that~~ to involve ~~The recoil of~~ coordinates, spins and variables discriminating neutron and proton states of ~~the~~ $N+1$ ~~also~~ particles ~~respectively~~ are all involved in q's.

The recoil of the nucleus will be neglected throughout, which will be permitted for majority of cases.

~~Now, if the possi~~ Now, if the possibilities of the excitation of the nucleus to ~~another~~ one of the states, $\chi_1, \cdots$ ~~say~~, with energies $W_1 \cdots$ ~~represent~~ respectively, and of the disintegration with the emission of a heavy particle, in the proton state for instance, are taken into account, the stationary solution should have the general form

$$\psi(q_0\, q_1 q_2 \cdots q_N) = u_0(q_0)\chi_0(q_1 q_2 \cdots q_N) + u_1(q_0)\chi_1(q_1 q_2 \cdots q_N) + \cdots + v_1(q_0)\varphi_1(q_1 q_2 \cdots q_N) + \cdots, \quad (1)$$

where $u_1, \cdots$ and $v_1, \cdots$ represent inelastically scattered neutron waves and outgoing proton waves respectively and $\varphi_1, \cdots$ represent stationary states, with energies $W_1', \cdots$ respectively, of the ~~next~~ nucleus ~~of~~ with atomic number $Z-1$ formed by disintegration. Inserting (1) into the Schrödinger equation

$$(H_1 + H_2 + V)\psi = E\psi, \quad (2)$$

where $H_1, H_2,$