PHASE SHIFTS OF COULOMB pp SCATTERING

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The importance of accounting for relativistic and form-factor corrections to the phase shifts of Coulomb proton-proton scattering is pointed out.

FOR a sufficiently accurate analysis of proton-proton interaction it is necessary to know the amplitude and phase shifts of the Coulomb scattering. In the energy region in which $e^2 \ll \hbar V\sqrt{1 - V^2/c^2}$, where V is the proton laboratory velocity, it is necessary to include in the Coulomb scattering phase shifts only the terms proportional to $\eta = e^2/\hbar V$. It is necessary, however, to take into account with the same accuracy the relativistic corrections to the matrix elements obtained by Garren, [1] and the form factors of the charge and magnetic moment of the proton, determined experimentally by Hofstadter [2].

By using the general formulas (see [3]) for the connection between the elements of the F and S matrices, we obtain for the phase shifts, rather cumbersome expressions, which we shall not cite here. We present merely a table of the phase shifts $\bar{\delta}$ and mixing parameters $\bar{\epsilon}$ (in Stapp's parametrization [4]) for a proton kinetic energy of 660 MeV. In this table δ_{NR} denotes the nonrelativistic phase shift, $\Delta_R\bar{\delta}$ the relativistic correction to it, $\Delta_F\bar{\delta}$ the form-factor correction to the preceding quantities, and $\bar{\delta}$ the total phase shift (mixing parameter $\bar{\epsilon}$). We see that at this energy for the lower momenta neither correction is small compared with the nonrelativistic phase shifts, although each is small compared with a radian. For larger momenta, the nonrelativistic phase shifts increase logarithmically, and all the corrections decrease to insignificant values. At higher energies both corrections increase and the δ_{NR} decrease, so that an account of the corrections becomes even more important.

State	δ_{NR}	$\Delta_R\bar{\delta}$	$\Delta_F\bar{\delta}$	$\bar{\delta}$	State	δ_{NR}	$\Delta_R\bar{\delta}$	$\Delta_F\bar{\delta}$	$\bar{\delta}$
$^1S_0$	—17′.2	—35′3	1°23′.5	31′.0	$^3F_4$	38′.8	8′.3	3′.5	50′.6
$^3P_0$	13′.1	—52′.1	1°8′.9	29′.9	$\bar{\varepsilon}_4$	0	1′9″	—23″	46″
$^3P_1$	13′.1	—3′.3	17′.9	27′.7	$^1G_4$	46′.6	0	1′.5	48′.1
$^3P_2$	13′.1	14′.3	13′.8	41′.2	$^3H_4$	52′.9	—8′.2	2′.5	47′.2
$\bar{\varepsilon}_2$	0	3′.0	—6′.5	3′.5	$^3H_5$	52′.9	0	1′.0	53′.9
$^1D_2$	28′.6	0	6′.9	35′.5	$^3H_6$	52′.9	5′.7	0′.9	59′.5
$^3F_2$	38′.8	—14′.5	10′.5	34′.8	$\bar{\varepsilon}_6$	0	26″	—6″	20″
$^3F_3$	38′.8	0′.1	4′.4	43′.3	$^1I_6$	58′.0	0	0′.3	58′.3

[1] A. Garren, Phys. Rev. **101**, 419 (1956).

[2] R. Hofstadter, Phys. Rev. Lett. 8, 381 (1962).

[3] A. S. Davydov, Teoriya atomnogo yadra (Theory of the Atomic Nucleus), Gostekhizdat, 1-58, p. 308.

[4] Stapp, Ypsilantis, and Metropolis, Phys. Rev. **105**, 302 (1957).

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