LETTERS TO THE EDITOR

MEASUREMENT OF POLARIZATION QUANTITIES

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To determine in practice the polarization $\langle\sigma_i\rangle$ and the polarization correlation $\langle\sigma_{ik}\rangle$ in nucleon-nucleon scattering, one measures the integral intensities of the nucleons subjected to secondary scattering by analyzer nuclei. Let us consider how the polarization formulas vary for "point" intensities (see Refs. 1 and 2) when integrating over a solid angle.

The total scattering cross section of nucleons by analyzers with spin zero is

$$\sigma(\theta_1, \theta_2, \theta) = J_1(\theta_1) J_2(\theta_2) \{1 + \langle\sigma_{1i}\rangle n_{1i} P_1(\theta_1) + \langle\sigma_{2i}\rangle n_{2i} P_2(\theta_2) + \langle\sigma_{ik}\rangle n_{1i} n_{2k} P_1(\theta_1) P_2(\theta_2)\}, \quad (1)$$

where $\boldsymbol{\theta}_1(\theta_1, \varphi_1)$ and $\boldsymbol{\theta}_2(\theta_2, \varphi_2)$ are the angles of scattering by analyzers 1 and 2, $J_{1,2}$ and $P_{1,2}$ are the cross sections and the polarizations, respectively, while n_1 and n_2 are the vectors normal to the planes of these scatterings, along whose directions the integration is carried out.

Integration with respect to φ_1 and φ_2 in a cone 2φ gives, for example, for the normal correlation (relative to the nucleon-nucleon scattering plane)

$$\langle\sigma_{nn}\rangle = \frac{J_{++} + J_{--} - (J_{+-} + J_{-+})}{J_{++} + J_{--} + J_{+-} + J_{-+}} \frac{1}{P_1 P_2} \frac{\varphi^2}{\sin^2\varphi}, \quad (2)$$

where, for example, $J_{++} \equiv \sigma(\varphi_1 = 0, \varphi_2 = 0)$ and $J_{+-} \equiv \sigma(\varphi_1 = 0, \varphi_2 = \pi)$ etc. Integration over the polar angles does not change the structure of formula (2), but the quantities J and P become integral (with respect to θ_1 and θ_2).

Compared with $\langle\sigma_{nn}\rangle$ for point intensities, formula (2) contains a factor $\alpha(\varphi) = \varphi^2/\sin^2\varphi$, which varies from 1 (at $\varphi = 0$, corresponding to "point" intensities) to ∞ (for $\varphi = \pi$, corresponding to integration over the total sphere). It is seen from formula (2) that increasing the count intensity (increasing the aperture of the 2φ counters) leads to a reduction in the asymmetry of the scattering

$$\varepsilon = \frac{J_{++} + J_{--} - (J_{+-} + J_{-+})}{J_{++} + J_{--} + J_{+-} + J_{-+}},$$

and consequently, to an increased error in $\langle\sigma_{nn}\rangle$. The optimum 2φ aperture can be determined from the minimum error. An estimate yields $\pi/2 \lesssim 2\varphi \leq 2$. The quantity $\alpha(\varphi)$ can be called the coefficient of "smearing" of the asymmetry of scattering. When measuring the polarization, this coefficient turns out to be $[\alpha(\varphi)]^{1/2}$. Corresponding formulas, analogous with (2), are obtained if only one analyzer is considered in (1), as proposed Ia. A. Smorodinskii.

[1] Ia. A. Smorodinskii and V. V. Vladimirskii, Dokl. Akad. Nauk SSSR **103**, 713 (1955).
[2] Ia. G. Zimin, J. Exptl. Theoret. Phys. (U.S.S.R.) **32**, 1239 (1957).

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