Spin–dependent forward scattering amplitude of Ω^-–hyperon on an unpolarized proton in Glauber eikonal approximation and possibility of the constituent quark rescattering observation.

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Abstract

Forward scattering amplitude of the particles with spin can be measured by the spin dichroism, rotation and oscillation observation. This effects can be described by particle spin-dependent refractive index in a medium which is proportional to the forward scattering amplitude on target particle. For particles with spin $S \geq 1$ (Ω^--hyperon, deuteron) the effects above exist even in unpolarized target. Forward scattering amplitude of particle with $S \geq 1$ on, for instance, an unpolarized proton has the form:

$$\hat{F}(0) = f_1 + f_2 (Sn)^2 \quad ,$$

where S is particle spin operator and n is direction of the momentum. It is significant that in the frame of Glauber multiscattering theory f_2 is determined only by the rescattering of the colliding particle constituents i.e. first term of Glauber series does not contribute to the f_2. So one have unique possibility to checks hypotheses of the constituent quarks by observation of their rescattering. Picture of hadrons as being made of spatially separated constituent quarks is not new. It was considered on phenomenological grounds many times since the pioneer works of Gell-Mann. After some period of misunderstanding it was clearly stated by Gell-Mann that "constituent" and "current" quarks are completely different objects. The constituent quarks or appear as quasiparticles, that is as current quarks and surrounding them clouds of gluons and quark-antiquark pairs. The elastic hadron scattering can be understood in terms of constituent quark collisions. The main idea of our work is the possibility of the testing constituent quark model. We calculated Ω^- dichroism $A \approx 2.0 \times 10^{-4} - 2.6 \times 10^{-4}$ and rotation angle $\phi \approx 7.1 \times 10^{-5} - 1.1 \times 10^{-4}$ for 300 Gev hyperon in 1 metre hydrogen target of $\rho = 0.0675 g/cm^3$ density. Here

$$\phi(z) = 2\pi\rho Re(F_{3/2}(0) - F_{1/2}(0))z,$$

and

$$A(z) = \frac{I_{1/2}(z) - I_{3/2}(z)}{I_{3/2}(z) + I_{1/2}(z)} = 2\pi\rho Im(F_{3/2}(0) - F_{1/2}(0))z$$

describes dichroism. $I_m(z)$ is the intensity of hyperons on the depth z with the spin projection m on the direction of the Ω^- momentum, if the incident beam is unpolarized. We can also present quantity

$$\frac{\sigma_{3/2} - \sigma_{1/2}}{\sigma_{3/2} + \sigma_{1/2}} \approx 1.5 \times 10^{-3}.$$