Novel Approach to Neutral Pion and Eta Production in Proton-Proton Collisions ◇

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We evaluate the threshold matrix-element for the reaction $pp \to pp\pi^0$ in a fully relativistic Feynman diagrammatic approach. We employ a simple effective range approximation to take care of the S-wave pp final-state interaction. The experimental value for the threshold amplitude $A = (2.7 - i0.3) fm^4$ can be reproduced by contributions from tree level chiral (long-range) pion exchange and short-range effects related to heavy-meson exchanges, with these two different contributions of roughly the same size. Pion loop effects appear to be small. We stress that the commonly used heavy-baryon formalism is not applicable in the NN-system above the pion production threshold due to the large external momentum, $|\vec{p}| \cong \sqrt{mM_\pi}$. We furthermore investigate the reaction $pp \to pn\pi^+$ near threshold within the same approach. We extract from the data the triplet threshold amplitude, $B = (2.8 - i1.5) fm^4$. Its real part can be well understood from tree level meson exchange diagrams. In addition, we investigate the process $pp \to pp\eta$ near threshold. We use a simple factorization ansatz for the $pp\eta$ final-state interaction and extract from the data the modulus of the threshold amplitude, $|C| = 1.32 fm^4$. With $g_{\eta N} = 5.3$, this value can be reproduced by tree level meson exchange diagrams and η-rescattering, whose strength is fixed by the ηN scattering length. We also comment on the recent near-threshold data for η'-production.

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Nucleon Polarizabilities for Virtual Photons ◇

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We generalize the sum rules for the nucleon electric plus magnetic polarizability $\Sigma = \alpha + \beta$ and for the nucleon spin-polarizability γ, to virtual photons with $Q^2 > 0$. The dominant low energy cross sections are represented in our calculation by one-pion-loop graphs of relativistic baryon chiral perturbation theory and the $\Delta(1232)$-resonance excitation. For the proton we find good agreement of the calculated $\Sigma_p(Q^2)$ with empirical values obtained from integrating up electroproduction data for $Q^2 < 0.4 GeV^2$. The proton spin polarizability $\gamma_p(Q^2)$ switches sign around $Q^2 = 0.4 GeV^2$ and it joins smoothly the "partonic" curve, extracted from polarized deep-inelastic scattering, around $Q^2 = 0.7 GeV^2$. For the neutron our predictions of $\Sigma_n(Q^2)$ and $\gamma_n(Q^2)$ agree reasonably well $Q^2 = 0$ with existing determinations. Upcoming (polarized) electroproduction experiments will be able to test the generalized polarizability sum rules investigated here.

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Chiral Dynamics in Dense Matter: In-Medium Meson Spectra ◇

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We summarize recent developments related to meson spectra in a dense nuclear medium. Our primary emphasis is on vector meson mass spectra in matter and their role as possible indicators of a tendency toward restoration of spontaneaously broken chiral symmetry.

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