The spin polarizabilities of the baryons in relativistic baryon chiral perturbation theory.

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Introduction

The electromagnetic polarizabilities are the quantities of fundamental interest in the understanding of the hadron structure [1]. They characterize the dynamical response of the hadron to external electromagnetic fields. While a rather large amount of work has been devoted, both theoretically and experimentally, to the study of the nucleon polarizabilities [2] very little is known about hyperon polarizabilities. The calculations performed to investigate the nucleon polarizabilities are in the frame work of the non relativistic quark model (NRQM) and in the frame work of heavy baryon chiral perturbation theory (HBCHPT) [2-4]. But, the HBCHPT suffers from a deficiency: The corresponding perturbation series fails to converge in part of the low energy region. The problem is generated by a set of higher order graphs involving insertions in nucleon lines. It has been shown that infrared singularities of the various one loop graphs occurring in the chiral perturbation series can be extracted in a relativistically invariant fashion. This procedure is known as infrared dimensional regularization (IDR). The IDR respects the constraints of chiral symmetry as expressed through the chiral Ward identities [5]. Hence, in our present investigation, we have computed the forward spin dependent polarizability of the nucleons and hyperons in the frame work of baryon chiral perturbation theory (BCHPT). We have investigated the real Compton scattering of the photons from the nucleons and hyperons. We have calculated the spin observables to order $O(P^3)$ (where P stands for small momenta/quark mass/meson mass) in the chiral expansion. At present no calculations have been performed in the frame work of BCHPT to calculate spin observables of the hyperon.

Investigation

Hence, in our present study we have investigated the spin polarizabilities of the nucleons and hyperons in the frame work of BCHPT to order $O(P^3)$ [6]. The diagrams which contribute to forward spin polarizability of the nucleons and hyperons are listed in **Fig.1**. At order P^3, the contributions are from the one loop diagrams with vertices from the lagrangian $L^1\varphi B$ (where φ stands for octet pseudo scalar meson and B stands for baryon and superscript specifies the chiral dimension of the Lagrangian). Furthermore, there are contact term graphs stemming from the lagrangian $L^3\varphi B$ which give rise to the most general polynomial contribution at order $O(P^3)$ to scattering amplitude. The calculations and results of the forward spin polarizability will be discussed

At order O(P3) the forward spin polarizability of the nucleons is

$$\gamma_0 = \frac{e^2 g_A^2}{96\pi^3 M_\pi^2 F_\pi^2} = 4.45x10^{-4}\, fm^4$$ for

protons which is in agreement with O(P3) calculations of HBCHPT [7] and the corresponding result for Σ+ is

$$\gamma_0 = \frac{31 e^2 F^2}{1440\pi^3 M_\pi^2 F_0^2} = 1.02x10^{-4}\, fm^4$$

Which is the prediction of BCHPT. The calculations of other polarizabilties are in progress**.**

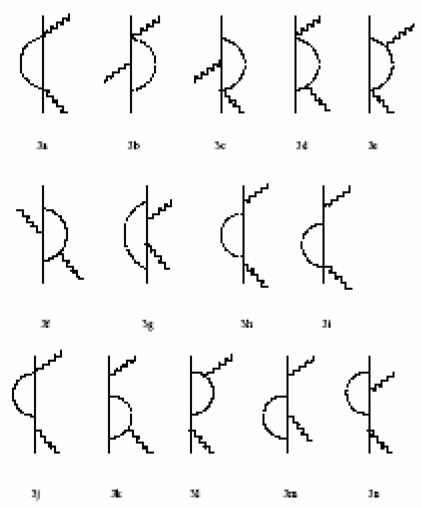

Fig.1 The loop diagrams which contribute at $O(P^3)$ to forward spin polarisablities of the nucleon and Σ+ hyperon.

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