PROCEEDINGS OF SCIENCE

Renormalization of the baryon axial vector current in large-N_c

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The baryon axial vector current is computed at one-loop order in heavy baryon chiral perturbation theory in the large$-N_c$ limit, where N_c is the number of colors. Loop graphs with octet and decuplet intermediate states cancel to various orders in N_c as a consequence of the large-N_c spin-flavor symmetry of QCD baryons. We present a preliminary study of the convergence of the chiral expansion with $1/N_c$ corrections. The physical values $N_f = 3$ (where N_f is the number of light quark flavors) and $N_c = 3$ are used in the case of g_A in QCD.

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1. Renormalization of the baryon axial vector current

The QCD operators have well-defined $1/N_c$ expansions. For the baryon axial vector current A^{kc} its $1/N_c$ expansion can be written as

$$A^{kc} = a_1 G^{kc} + \sum_{n=2,3}^{N_c} b_n \frac{1}{N_c^{n-1}} \mathscr{D}_n^{kc} + \sum_{3,5}^{N_c} c_n \frac{1}{N_c^{n-1}} \mathscr{O}_n^{kc}, \tag{1.1}$$

The correction containing the full dependence on the ratio Δ/m_Π, where $\Delta \equiv M_\Delta - M_N$ is the decuplet-octet mass difference and m_Π is the meson mass. Was derived in Ref. [1] and reads

$$\begin{aligned}\delta A^{kc} =& \frac{1}{2}\left[A^{ja},\left[A^{jb},A^{kc}\right]\right]\Pi^{ab}_{(1)} - \frac{1}{2}\left\{A^{ja},\left[A^{kc},\left[\mathscr{M},A^{jb}\right]\right]\right\}\Pi^{ab}_{(2)} \\ &+ \frac{1}{6}\left(\left[A^{ja},\left[\left[\mathscr{M},\left[\mathscr{M},A^{jb}\right]\right],A^{kc}\right]\right] - \frac{1}{2}\left[\left[\mathscr{M},A^{ja}\right],\left[\left[\mathscr{M},A^{jb}\right],A^{kc}\right]\right]\right)\Pi^{ab}_{(3)} + \ldots\end{aligned}$$

Here $\Pi^{ab}_{(n)}$ is a symmetric tensor which contains meson-loop integrals with the exchange of a single meson: A meson of flavor a is emitted and a meson of flavor b is reabsorbed. $\Pi^{ab}_{(n)}$ descomposes into flavor singlet, flavor **8** and flavor **27** representations [2].

2. Results and Conclusions

We have computed the renormalization of the baryon axial vector current in the framework of heavy baryon chiral perturbation theory in the large$-N_c$ limit. The matrix elements of the space components of A^{kc} between $SU(6)$ symetric states give the actual values of the axial vector couplings. For $N_c = 3$ and $N_f = 3$ the couplings g_A of barions with corrections at relative orders N_c, $1/N_c$, $1/N_c^2$ and $1/N_c^3$ for flavor singlet contribution are shown in Table 1.

		Singlet			
Process	$\mathscr{O}N_c$	$\mathscr{O}(1/N_c)$	$\mathscr{O}(1/N_c^2)$	$\mathscr{O}(1/N_c^3)$	Total
$n \to pe^-\bar{\nu}_e$	1.271	−0.1138	0.1402	−0.0256	1.272
$\Sigma^+ \to \Lambda e^+\nu_e$	0.615	−0.0396	0.0663	0.0111	0.653
$\Sigma^- \to \Lambda e^-\bar{\nu}_e$	0.598	−0.0266	0.0446	0.0074	0.624
$\Lambda \to pe^-\bar{\nu}_e$	−0.941	0.0837	−0.0855	0.0389	−0.904
$\Sigma^- \to ne^-\bar{\nu}_e$	0.330	0.0014	0.0188	0.0239	0.375
$\Xi^- \to \Lambda e^-\bar{\nu}_e$	0.212	−0.0423	0.0179	−0.0483	0.139
$\Xi^- \to \Sigma^0 e^-\bar{\nu}_e$	0.868	−0.0522	0.0643	−0.0117	0.869
$\Xi^0 \to \Sigma^+ e^-\bar{\nu}_e$	1.310	−0.0998	0.1231	−0.0225	1.312

Table 1: Corrections at relative order for the axial vector couplings of the baryons

References

[1] R. Flores-Mendieta, C. P. Hofmann, E. Jenkins, and A. V. Manohar, Phys. Rev. D **62**, 034001 (2000).

[2] R. Flores-Mendieta, C. P. Hofmann, Phys. Rev. D **74**, 094001 (2006).