

# The Unexpected Role of D Waves in Low-Energy Neutral Pion Photoproduction

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## Abstract

It has been commonly assumed that the low-energy neutral pion photoproduction from the proton can be described accounting only for S and P waves, and that higher partial waves are irrelevant. In a recent paper [Fernández-Ramírez, Bernstein, Donnelly, arXiv:0902.3412 [nucl-th]] we have found that this assumption is not correct and that the inclusion of D waves is necessary to obtain a reliable extraction of the  $E_{0+}$  multipole from experimental data. This is due in large measure to the spontaneous breaking of chiral symmetry in QCD which leads to very small S-wave contributions. This makes the usual partial wave expansion less accurate and although D waves are small, their contribution is enhanced through the interference with P waves, which compromises the S-wave extraction from data if D waves are not taken into account. In our work we have used Heavy Baryon Chiral Perturbation Theory to one loop, and up to  $\mathcal{O}(q^4)$ , to account for the S and P waves, while D waves are added in an almost model-independent way using standard Born terms and vector mesons. We also show that higher higher partial waves do not play an important role.