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Electroexcitation of the D-wave resonances*

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Abstract. The meson scattering and electroproduction amplitudes in the D13, D33 and D15 partial waves are calculated in a coupled-channel approach incorporating quasi-bound quark-model states. In contrast to our previous results involving the P11, P33 and S11 partial waves the meson and photon couplings obtained in the quark model turned out to be underestimated, but otherwise our results exhibit a consistent behaviour in all channels.

We have developed a coupled-channel formalism which provides a unified treatment of meson scattering and electroproduction. The formalism incorporates in a consistent way quark-model resonance states as excitations of the quark core supplemented by a meson cloud. The approach has been used to systematically study the interplay of quark and meson degrees of freedom in the region of the low lying nucleon resonances as well as in the intermediate region.

In our earlier work we have pointed out the important role of the pion cloud in the electro-excitation of the $\Delta(1232)$ resonance in which case the cloud contributes almost a half to the strength of the M_{1+} amplitude and dominates the E_{1+} amplitude [1–3]. Next we have investigated the meson degrees of freedom in the case of the $N(1440)$ resonance [4] and confirmed the important contribution of the σN and $\pi\Delta$ inelastic channels to scattering in the P11 partial wave [5]. We have further demonstrated that the zero crossing of the helicity amplitude for electroexcitation of the Roper resonance at $Q^2 \approx 0.5\,\mathrm{GeV}^2/c^2$ can be explained as an effect of the pion cloud which dominates the amplitude at small Q^2 and has the opposite sign with respect to the contribution of the quark core [6].

In the case of the negative parity resonances in the S11 partial wave we have shown that the quark model extended to pseudoscalar meson octet correctly predicts the behaviour of the πN and ηN amplitudes in the region of the lower resonance as well as the admixture of the $K\Lambda$ channel at somewhat higher energies [7–9].

In the recent work [10, 11] we have applied the same formalism to the description of scattering and electroproduction of mesons in the resonance region in the D13, D33 and D15 partial waves. In contrast to our results for the P11, P33 and S11 resonances, the results for the D-wave resonances show a more pronounced

* Talk delivered by Bojan Golli

disagreement with experiment, in particular for the prediction of the d-wave meson coupling to the quark core. The model predicts too small helicity amplitudes – though in accordance with other quark model calculations – and consequently also the electro-production amplitudes for the considered resonances. Nonetheless, our calculation exhibits a consistent overall qualitative agreement with the multipole analysis in the D13, D33 and D15 partial waves. Our results, in particular for the D33 wave, show that the meson cloud effects are important in describing the long-range part of the wave-function. We expect that a more elaborate description of the quark core, supplemented by the meson cloud, may eventually bring the results in the ballpark of acceptable values.

References

1. M. Fiolhais, B. Golli, S. Širca, Phys. Lett. B **373**, 229 (1996)
2. B. Golli, S. Sirca, L. Amoreira, M. Fiolhais Phys.Lett. B553 (2003) 51-60
3. P. Alberto, L. Amoreira, M. Fiolhais, B. Golli, and S. Širca, Eur. Phys. J. A **26**, 99 (2005).
4. P. Alberto, M. Fiolhais, B. Golli, and J. Marques, Phys. Lett. B **523**, 273 (2001).
5. B. Golli and S. Širca, Eur. Phys. J. A **38**, (2008) 271.
6. B. Golli, S. Širca, and M. Fiolhais, Eur. Phys. J. A **42**, 185 (2009)
7. B. Golli, S. Širca, Eur. Phys. J. A **47** (2011) 61.
8. B. Golli, talk given at the 6th International Workshop on Pion-Nucleon Partial-Wave Analysis and the Interpretation of Baryon Resonances, 23–27 May, 2011, Washington, DC, U.S.A., `http://gwdac.phys.gwu.edu/pwa2011/Thursday/b_golli.pdf`
9. Simon Širca, Bojan Golli, Manuel Fiolhais and Pedro Alberto, in Proceedings of the XIV International Conference on Hadron Spectroscopy (hadron2011), Munich, 2011, edited by B. Grube, S. Paul, and N. Brambilla, eConf C110613 (2011) [`http://arxiv.org/abs/1109.0163`].
10. B. Golli, S. Širca, Eur. Phys. J. A **49** (2013) 111.
11. B. Golli, talk given at the 7th International Workshop on Pion-Nucleon Partial-Wave Analysis and the Interpretation of Baryon Resonances, 23–27 September 2013, Camogli, Italy, `http://www.ge.infn.it/pwa7/talks/20_golli.pdf`