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Exploring the production of N*s with pion and electron beams

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The study of electromagnetic transitions opens a window into the very nature of the strong interaction. And, indeed, such a study of how a ground-state nucleon transitions to an excited state, over a broad range of q^2, will provide keen insight into the evolution of how dynamically-generated masses emerge from the asymptotically-free, nearly massless quarks of perturbative QCD as well as provide information on the ancillary effects from the meson-baryon cloud. The space-like ($q^2 < 0$) region has been explored more intensively, particularly at JLab, but efforts are well under way in studying the time-like ($q^2 > 0$) region with HADES at GSI. We further expect to collect data with J-PARC Experiment E45 in 2025 using the Hyperon Spectrometer in the K1.8 beamline.

We initiated these discussions at the May 2017 ECT*workshop, which was titled space-like and time-like electromagnetic baryonic transitions. The ECT* workshop established the need and made the first steps towards a consistent description spanning the two kinematical regimes in q^2. This talk will continue the discussions of space-like and time-like baryonic transition form factors. The world's data in the second and third resonance regimes are dominated by the electroproduction of N*s. We will ultimately require a coupled-channel approach for properly ascertaining the complementary features and overlapping information in forming excited baryons through employing both pion beams and electron/photon beams. Such partial-wave amplitude analyses are especially relevant in the two-pion decay mode (including the $K\Lambda$ and $N\omega$ channels), where the pion-induced N* data at these higher energies are, at best, sparse to altogether nonexistent. These studies will require the apt coordination of experimental and theoretical groups in Asia, Europe, and North America.

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