Excited-state structure. Adding energy to the nucleon provides a complementary look at its structure. The quarks and gluons change configurations to form excited states, just as the nucleons and mesons do to form excited states of nuclei. Many modern QCD-inspired models attempt to describe the spectrum of these excited states, as well as their detailed structure. For example, many of these models predict that the lowest-lying excited state of the nucleon, the delta resonance, is photoexcited predominantly by magnetic dipole radiation, with electric quadrupole excitation becoming significant in high-resolution electroexcitation. An accurate measurement of the quadrupole excitation of the nucleon can thus be of great importance in testing the forces between the quarks and, more generally, models of the nucleon.

With the current generation of electron accelerators, the ability to carry out such experiments has advanced greatly. Recent data on two different measures of the nonmagnetic contributions to excitation of the delta, represented by the quantities R_{EM} and R_{SM}, are compared with theoretical calculations in Figure 2.3. The R_{SM} data tend to support the underlying QCD prediction that they be independent of Q^2 as $Q^2 \rightarrow \infty$. The R_{EM} data appear to discriminate among detailed models of the nucleon.

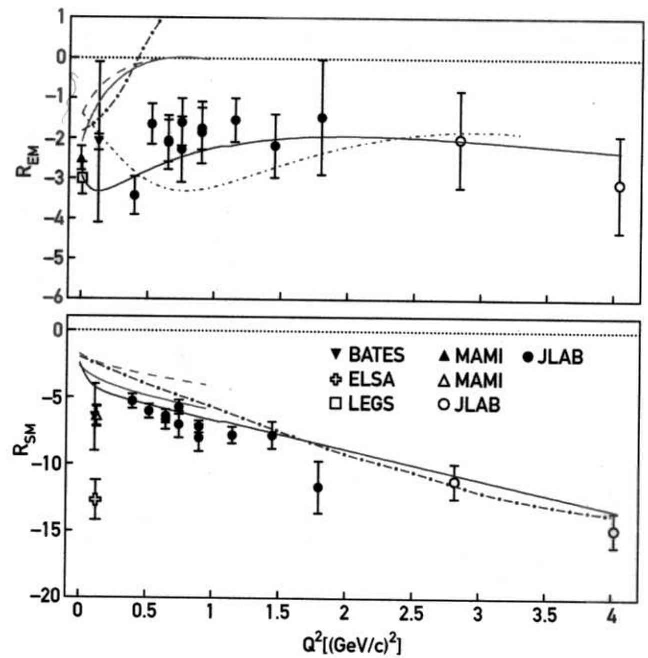

Figure 2.3. Data from LEGS (Brookhaven), MAMI (University of Mainz), ELSA (University of Bonn), MIT-Bates, and Jefferson Lab on the Q^2 dependence of the multipole ratios R_{EM} and R_{SM} for excitation of the delta resonance, the lowest-lying excited state of the proton. Curves show model calculations.