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Spectrum and structure of octet and decuplet baryons and their positive-parity excitations

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A continuum approach to the three valence-quark bound-state problem in quantum field theory is used to compute the spectrum and Poincar\'e-covariant wave functions for all flavour-$SU(3)$ octet and decuplet baryons and their first positive-parity excitations. Such analyses predict the existence of nonpointlike, dynamical quark-quark (diquark) correlations within all baryons; and a uniformly sound description of the systems studied is obtained by retaining flavour-antitriplet–scalar and flavour-sextet–pseudovector diquarks. Thus constituted, the rest-frame wave function of every system studied is primarily S-wave in character; and the first positive-parity excitation of each octet or decuplet baryon exhibits the characteristics of a radial excitation. Importantly, every ground-state octet and decuplet baryon possesses a radial excitation. Hence, the analysis predicts the existence of positive-parity excitations of the Ξ, Ξ^*, Ω baryons, with masses, respectively (in GeV): 1.75(12), 1.89(03), 2.05(02). These states have not yet been empirically identified. This body of analysis suggests that the expression of emergent mass generation is the same in all u, d, s baryons and, notably, that dynamical quark-quark correlations play an essential role in the structure of each one. It also provides the basis for developing an array of predictions that can be tested in new generation experiments.

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