Large-N_c quantum chromodynamics and rational approximants*

Santiago Peris

Grup de Física Teòrica and IFAE, UAB, E-08193 Bellaterra, Barcelona, Spain
email: `peris@ifae.es`

Abstract

Quantum Chromodynamics is the fundamental theory of the interactions of quarks and gluons which underlies, among other things, Nuclear Physics. Mathematically, this is a gauge theory based on the "color" quantum number, N_c, following the structure of the $SU(N_c)$ Lie group. Although in the real world $N_c = 3$, ever since the pioneering work of Ref. [1], it has been widely appreciated that it is very useful to study this theory in a power series in $1/N_c$ around $N_c = \infty$. This expansion is similar to an expansion in the number of components of a field, like e.g. in the CP^N theories. In the limit $N_c \to \infty$, QCD is described in terms of Green's functions which are meromorphic, with infinite isolated poles located on the real axis. The position of these poles corresponds to the value of the mass of the physical particle present in the spectrum of the Hamiltonian. Despite continuous efforts, no solution to QCD at $N_c = \infty$ has been found. On the other hand, in recent years, it has been proposed that saturating these infinite sums with just *one* term could be a reasonable approximation, leading to a significant phenomenological success[2] which encompasses the old and celebrated Vector Meson Dominance approximation from the 60's. I would like to point out with the help of model calculations [3] that this saturation with a finite number of poles can be best understood within the theory of Pade Approximants, explaining different results which have appeared in the recent literature.

References

[1] G. 't Hooft, *A Two-Dimensional Model For Mesons*, Nucl. Phys. B **75** (1974) 461; E. Witten, *Baryons In The 1/N Expansion*, Nucl. Phys. B **160** (1979) 57.

[2] M. Knecht and E. de Rafael, *Patterns of spontaneous chiral symmetry breaking in the large N(c) limit of QCD-like theories*, Phys. Lett. B **424**, 335 (1998) [arXiv:hep-ph/9712457]; S. Peris, M. Perrottet and E. de Rafael, *Matching long and short distances in large-N(c) QCD*, JHEP **9805**, 011 (1998) [arXiv:hep-ph/9805442];

[3] P. Masjuan and S. Peris, *A Rational Approach to Resonance Saturation in large-Nc QCD*, JHEP **0705**, 040 (2007) [arXiv:0704.1247 [hep-ph]].

*Work supported in part by CICYT-FEDER-FPA2008-01430, SGR2005-00916, the Spanish Consolider-Ingenio 2010 Program CPAN (CSD2007-00042) and by the EU Contract No. MRTN-CT-2006-035482, "FLAVIAnet".