CHAOS IN BARYONS

C. Fernández-Ramírez*[,1] and A. Relaño[2]
[1]European Centre for Theoretical Studies in Nuclear Physics and Related Areas (ECT*), Villa Tambosi, Strada delle Tabarelle 286, I-38050 Villazzano (TN), Italy
[2]Grupo de Física Nuclear, Departamento de Física Atómica, Molecular y Nuclear, Universidad Complutense de Madrid, Avda. Complutense s/n, E-28040 Madrid, Spain

Hadronic Physics

In the last decade quantum chaos has become a well established discipline with outreach to different fields, from condensed-matter to nuclear physics. The most important signature of quantum chaos is the statistical analysis of the energy spectrum, which distinguishes between systems with integrable and chaotic classical analogues [1]. In recent years, spectral statistical techniques inherited from quantum chaos have been applied successfully to the baryon spectrum [2,3] revealing its likely chaotic behaviour even at the lowest energies, despite of the low statistics involved. This result implies that the baryonic low-energy spectrum is highly correlated at low energy. In this communication we compare the spectral properties of the experimental spectrum to the theoretical ones provided by different relativistic quark models [4,5]. Experimental data [6] happen to follow the Wigner surmise -typical of a highly correlated system- while the models are closer to a Poisson distribution -typical of uncorrelated systems where the mean field component accounts for most of the energy. The statistical significance of our analysis is not able to establish without doubts that the experimental spectrum is a Wigner surmise due to the low statistics involved, instead we obtain that the theory does not match the statistical properties of the experimental data, making theory and experiment statistically incompatible. We also find that the usual statement of missing resonances in the experimental spectrum when compared to the theoretical one cannot account for the discrepancies. Hence, the statistical properties of models differ significantly from the experiment, and these differences cannot be reconciled unless a major revision and improvement of the models is performed.

References

[1] F. Haake, *Quantum signatures of chaos*, Springer-Verlag, Heidelberg (2001); T. Guhr, A. Müller-Groeling, and H. A. Weidenmüller, Phys. Rep. 299 (1998) 189; J. M. G. Gómez, K. Kar, V. K. B. Kota, R. A. Molina, A. Relaño, and J. Retamosa, Phys. Rep. (2010) to be published.

[2] V. Pascalutsa, Eur. Phys. J. A 16 (2003) 149.

[3] C. Fernández-Ramírez, A. Relaño, Phys. Rev. Lett. 98 (2007) 062001.

[4] S. Capstick and N. Isgur, Phys. Rev. D 34 (1986) 2809.

[5] U. Löring, K. Kretzschmar, B.Ch. Metsch, and H.R. Petry, Eur. Phys. J. A 10 (2001) 309; U. Löring, B.Ch. Metsch, and H.R. Petry, Eur. Phys. J. A 10 (2001) 395; Eur. Phys. J. A 10 (2001) 447.

[6] C. Amsler et al. (Particle Data Group), Review of Particle Physics, Physics Letters B 667 (2008) 1.