The Meson Mass System

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The mass spectrum is one of the big mysteries of particle physics. Quarks and their mixing describe accurately the chemistry of particle interactions, but mass rules based on unitary symmetries were not successful. The values of the quark masses are also quite mysterious, and the computation of hadron masses within the mainstream theory is making very slow progress. In atomic physics spectral rules had been discovered before a satisfactory model and theory became available, while with particles the understanding seems to proceed backwards. Of all the empirical hadron mass rules proposed up to now, only the 70 MeV/c^2 mass quantum hypothesis is still mentioned today: meson masses are even multiples of a mass unit of 35 MeV/c^2, baryons odd multiples. Postulated initially in 1952, this idea has been rediscovered a number of times, updated when new particles were detected, and explained in various ways. Unfortunately, in most of the cases the estimates of its statistical relevance are either missing or incorrect. In addition, this rule seems to contradict the established body of knowledge, so that publishing about it in journals and electronic preprint repositories is strongly discouraged. This numerical mass quantization hypothesis has been recently reassessed and refined for the mesons, considering all the states listed in the PDG RPP, with evaluation of the statistical significance by Montecarlo simulation, showing that:

- for all particles with mass below 1 GeV/c^2, mesons and baryons, the rule is statistically significant, but in its simple form it breaks down at higher masses;
- grouping all mesons in families defined by quark composition and J^{PC}, the hypothesis is statistically significant separately for each group, only with different mass units all in the vicinity of 35 MeV/c^2;
- some scalar and vector families show a linear dependence of the mass unit from the spin, while for pseudoscalars the effect is not present;
- the mass units of the various families are themselves quantized on a grid of 12 intervals of about 0.25 MeV/c^2, centered around 35.4 MeV/c^2, and their location on the grid shows intriguing correlations with the quantum numbers that just cannot be by chance.

These results were obtained with automatic procedures and without any physics hypothesis, and show that the meson mass system is multi-linear and highly structured with amazing patterns. The baryon masses show very similar regularities.

[1] P. Palazzi, Patterns in the Meson Mass Spectrum, p3a-2004-001 (2004), http://particlez.org/p3a/abstract/2004-001.html

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