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Linear Mass Rules and Hadronic Shells: the Baryons

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Summary

The particle mass spectrum is a mystery. In atomic physics, chemistry, taxonomy and spectral rules were established long before a model and theory became available, and, only months after the formulation of the Schroedinger equation, the spectral lines and chemistry were understood. Paradoxically, mainstream particle physics enjoys accurate chemistry, incomplete taxonomy, no mass rules, a clunky model and a glorious theory that doesn't explain the chemistry nor the masses. Mass rules just must be there, they can be cracked, and once
revealed they may turn out to be more useful than slogans in overcoming the current impasse. No mass rules yet? Not quite. In 1952, Y. Nambu noticed that meson masses are even multiples of a mass unit u of 35 MeV/c^2, baryons odd multiples, so that mass differences are quantized by 70 MeV/c^2 [1]. M. H. Mac Gregor studied
this regularity extensively [2], and several other authors mentioned it as well, proposing various explanations. Recently this rule has been reassessed by the present author for all the mesons listed by the PDG, grouped by quark composition and J^(PC), with evaluation of the statistical significance by Montecarlo [3]. The meson analysis shows also that the slightly different values of u for the various meson groups are 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, from 0 to 12,
is strongly correlated with the quantum numbers. In addition, for some scalar and vector families, but no pseudoscalars, u is spin-dependent. The corresponding baryon analysis is well advanced, and shows that the baryon masses, when grouped by quark composition and J^(PC), are quantized with the same basic quantum u,
and show similar second quantization and selective spin dependence. Charting the values of u for the baryon families on top of the mesonic u-grid reveals a remarkable pattern: the baryons occupy only locations 3,4,5 and
7,8,9, with unflavored and charmed baryons on the lower side, and strange baryons on the upper side. The u value for the questionable Theta(+) baryons also obeys this rule [4]. The multi-linear rules of the meson and baryon mass spectra have been derived empirically a la Balmer by a statistical analysis of the hadron spectrum, without any physics hypothesis. They reinforce a conjecture about shell-structured hadrons [5], and provide ingredients for model building. —— References: – 1. Y. Nambu, Empirical Mass Spectrum of Elementary Particles, Prog. Theor. Phys. 7, 595 (1952). – 2. M. H. Mac Gregor, The Power of Alpha (World Scientific, Singapore, 2007). – 3. P. Palazzi, The Meson Mass System, Int. J. Mod. Phys. A, Vol. 22, Nos. 2-3 (2007) 546-549. – 4. P. Palazzi, Seven at one blow: the mass system of the Theta(+) baryons, http://particlez.org/p3a/abstract/2005-005.html (2005). – 5. P. Palazzi, Are Hadrons Shell-Structured?, FFP8, Madrid (2006), to be published in the conference proceedings, http://particlez.org/p3a/abstract/2006-002.html.

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