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Radial and angular-momentum Regge trajectories: a systematic approach

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Abstract. We present the analysis of Ref. [1] of the radial (n) and angular-momentum (J) Regge trajectories for all light-quark meson states listed in the Particle Data Tables. The parameters of the trajectories are obtained with linear regression, with weight of each resonance inversely proportional to its half-width squared, $(\Gamma/2)^2$. The joint analysis in the (n, J, M^2) Regge plane indicates, at the 4.5 standard deviation level, that the slopes in n are larger from the slopes in J. Thus no strict universality of slopes occurs in the light non-strange meson sector. We also extend our analysis to the kaon sector.

In Ref. [2] it was suggested that the light-quark meson states could be grouped into *radial* linear Regge trajectories with the slope $\mu^2 = 1.25(15)$ GeV^2, where the error was estimated as the spread of the values for each meson-family considered (ρ, π, η, a, f). In Ref. [3] a joined formula assuming universality of slopes was proposed, $M^2(n, J) = b + a(n + J)$, with $a = 1.14$ GeV^2. In Ref. [1] we reanalyzed the radial and angular-momentum Regge trajectories with the updated list of the light unflavored mesons from the PDG [4]. For the fits and error estimates we have used the *half-widht rule* [1,5], i.e, the half-widht squared as a weight for each resonance.

The fit to all the light unflavored meson families with linear trajectories using the half-width rule yields $\mu^2 = 1.35(4)$ GeV^2 as the weighted averaged result for the slope of radial trajectories, and $\beta^2 = 1.16(4)$ GeV^2 as the weighted average for the slope of the angular-momentum trajectories (the bands in Fig. 2). Fig. 1 exemplifies the results for the η and ρ families. In Fig. 2, we collect the slopes from both radial and angular-momentum trajectories from all the families considered.

We also considered a joint fit with the formula $M_X^2(n, J) = M_X^2(0, 0) + n\mu^2 + J\beta^2$, with the result $M_X^2(n, J) = (-1.25(4) + 1.38(4)n + 1.12(4)J)$ GeV^2, which means a difference between the radial and the angular-momentum slopes at a statistically significant level of 4.5 standard deviations.

As an extension of Ref. [1], we present in Fig. 3 a study of both radial and angular-momentum trajectories for the kaon sector. The radial fit yields $\mu_K^2 = 1.22(21)$ GeV^2 and $1.12(21)$ GeV^2 for K and K^*, respectively, while the angular-momentum fit returns $\beta_K^2 = 1.36(6)$ GeV^2 and $1.19(7)$ GeV^2 for K and K^*, respectively. Only trajectories containing more than three states are considered.

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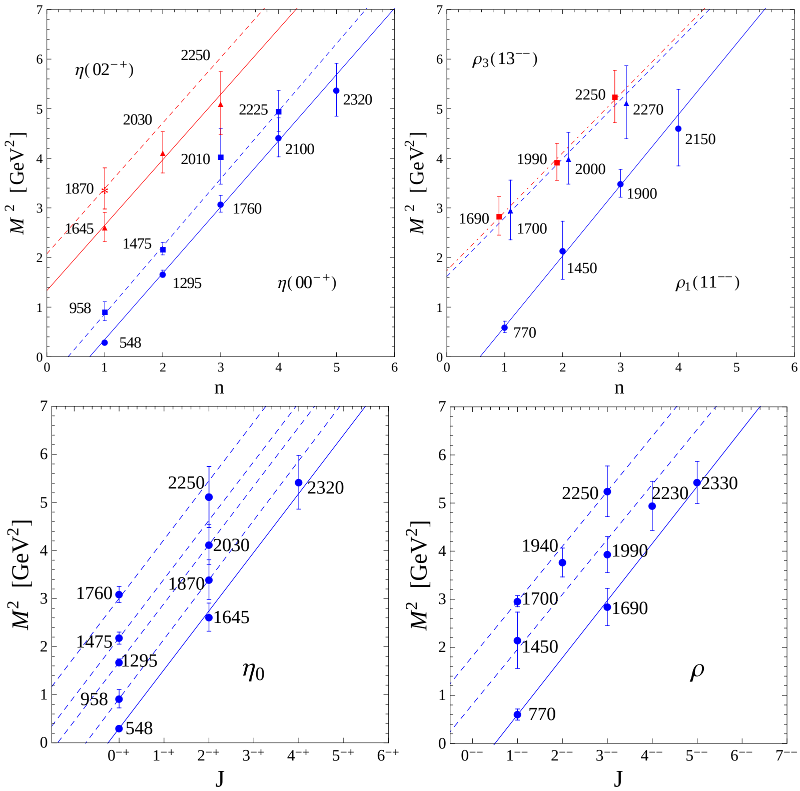

Fig. 1. The (n, M^2) and (J, M^2) plots for the η and ρ meson families.

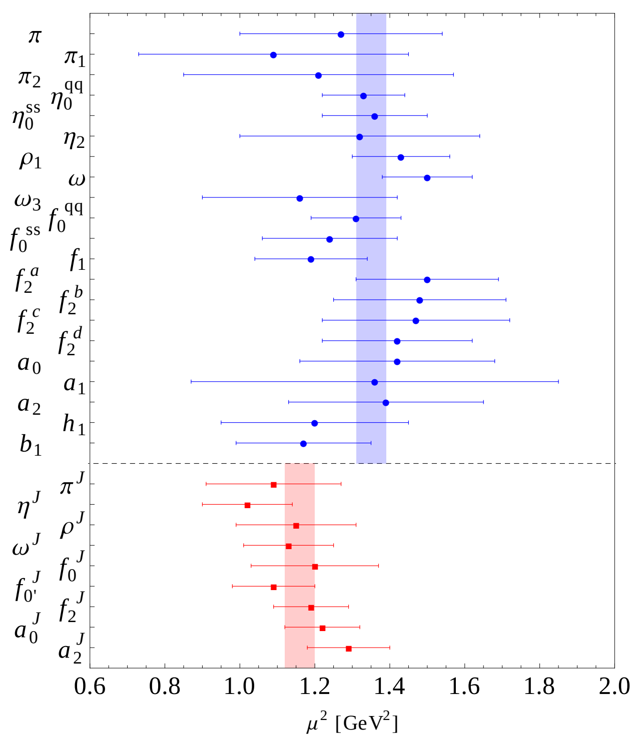

Fig. 2. (n, M^2) and (J, M^2) slopes for the meson families considered in Ref. [1].

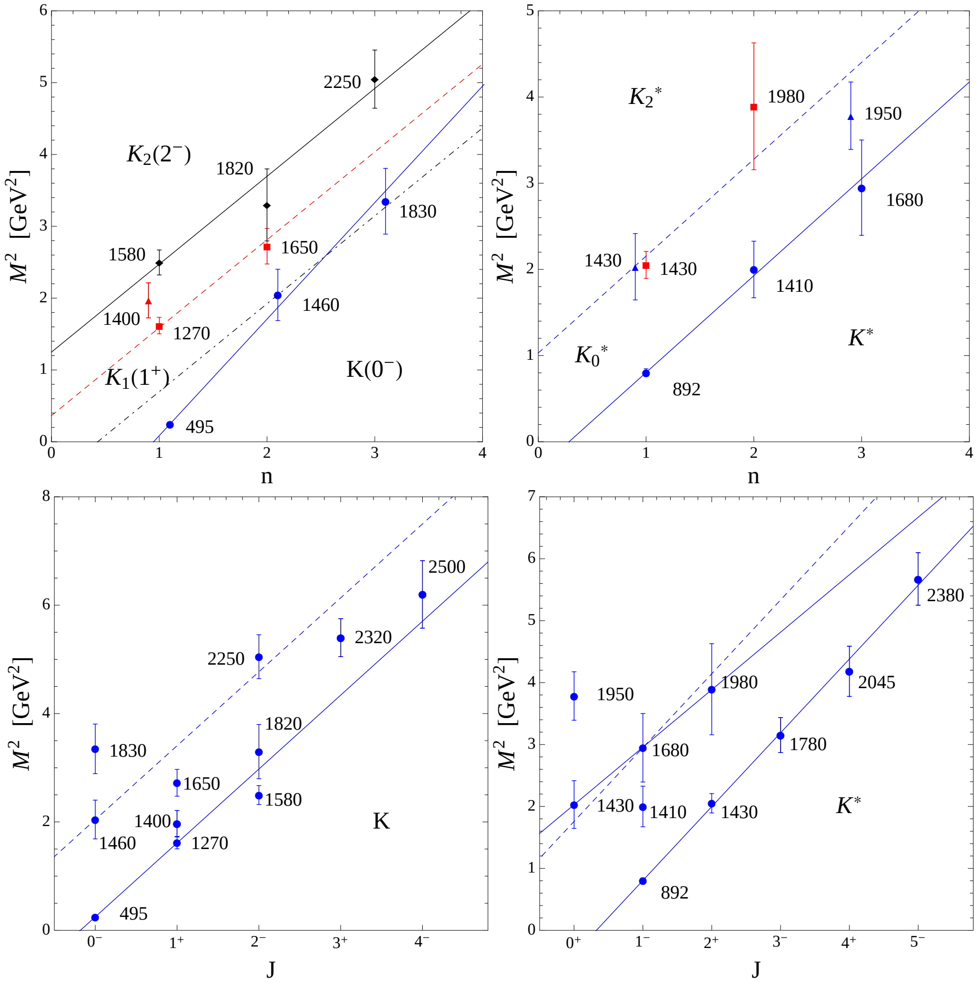

Fig. 3. (n, M^2) and (J, M^2) slopes for the kaon sector. The error bars follow from the half-width rule.

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