A very Simple Mass Formula for the Masses of Pseudoscalar Mesons

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The masses of pseudoscalar mesons are approximately proportional to quadratic powers of integers.

Key words: Pseudoscalar mesons; Mass formula.

The masses of pseudoscalar mesons can be approximated by the formula $m_{\text{cal}} = c \times n^2$, where the constant c is 122.6 MeV and n is an integer.

The value of n is 1 for the two π-mesons, 2 for the three K-mesons and the η-meson, 3 for the η' (958)-meson, 4 for the three D-mesons and the D_S-meson, and 5 for the η_c-meson. For $n = 6$ one should obtain the mass of the three B-mesons. However the calculated and experimental values do not agree very well. The constant c was adjusted to minimize

$$\frac{\partial}{\partial c} \sum_i \left(\frac{m_{i\,\text{exp}} - m_{i\,\text{cal}}}{m_{i\,\text{exp}}} \right)^2$$

without taking the B-mesons into account. The experimental masses and the relation $m_{\text{cal}} = c \times n^2$ are shown in Figure 1. The measured masses [1], the calculated masses, and the absolute and percentual differences between the calculated and measured masses are listed in Table 1.

The percentual difference between the calculated masses and measured masses is found to be smaller than or equal to 15.2% for all particles except the B-mesons and smaller than or equal to 5.2% for six (K, D, D_S, and η_c) of the twelve considered particles. When the absolute differences of all particles are considered, the differences for the B-mesons appear to be too large. Additional correction factors are assumed to be necessary for particles which have relatively large percentual and/or absolute differences. At present these factors are not known.

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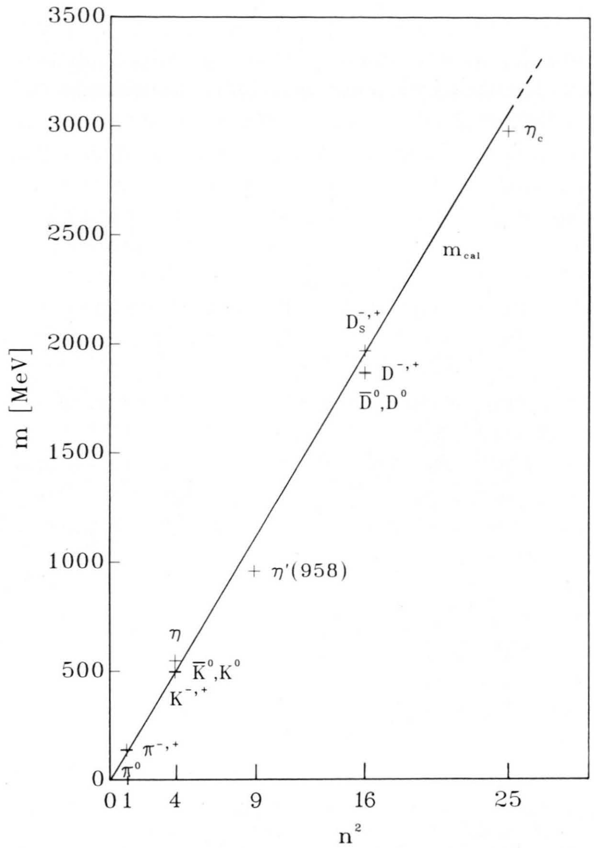

Fig. 1. Mass diagram of the pseudoscalar mesons. The B-mesons were omitted to improve the readability of the graph.

Table 1. Experimental [1] and calculated masses of pseudoscalar mesons.

Meson	m_{exp} [MeV]		n	m_{cal} [a]) [MeV]	Δm [b]) [MeV]	%diff. [c])
$\pi^{-,+}$	139.5679	± 0.0007	1	122.6	-17.0	-12.2
π^0	134.9743	± 0.0008	1	122.6	-12.4	-9.2
$K^{-,+}$	493.646	± 0.009	2	490.4	-3.2	-0.6
$\bar{K}^0, K^0$	497.671	± 0.031	2	490.4	-7.3	-1.5
η	547.45	± 0.19	2	490.4	-57.1	-10.4
η' (958)	957.75	± 0.14	3	1103.4	145.6	15.2
$D^{-,+}$	1869.3	± 0.5	4	1961.6	92.3	4.9
$\bar{D}^0, D^0$	1864.5	± 0.5	4	1961.6	97.1	5.2
$D_s^{-,+}$	1968.8	± 0.7	4	1961.6	-7.2	-0.4
η_c	2978.8	± 1.9	5	3065.0	86.2	2.9
$B^{-,+}$	5278.6	± 2.0	6	4413.6	-865.0	-16.4
$\bar{B}^0, B^0$	5278.7	± 2.1	6	4413.6	-865.1	-16.4

[a]) $m_{\text{cal}} = c \times n^2$, where the constant c is 122.6 MeV.
[b]) Δm represents the mass difference between calculated and measured mass.
[c]) % diff. represents $100 \times \Delta m / m_{\text{exp}}$.

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The large number of well-fitted masses of pseudoscalar mesons should exclude the possibility that this relationship is a chance event. Consequently, the author believes that the relationship is not only a mathematical curiosity but may have an underlying meaning.

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[1] Particle data group, Phys. Rev. D **45,** S1 (1992).

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