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# COUPLING CONSTANT SUM RULES FOR THE DECAY OF THE $J^P = 2^+$ NONET IN BROKEN SU(3)

V. P. GAUTAM AND P. GHOSE

INDIAN ASSOCIATION FOR THE CULTIVATION OF SCIENCE, JADAVPUR, CALCUTTA-32.

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Currently the assignment of the $J^P = 2^+$ mesons $K^{**}$ (1430), $A_2$ (1320), $f'$ (1500) and $f$(1250) to the reducible $1 \oplus 8$ representation of SU(3) with considerable $f'-f$ mixing is being discussed by many authors (Hwa *et al*, Glashow *et al*, Barnes *et al*, Chung *et al*, 1965). Since unitary symmetry is found, in fact, to be broken in nature, it is more realistic to compare observed decay widths with broken SU(3) predictions. We give in this note coupling constant sum rules for the decay of these mesons into (a) a pair of pseudoscalar mesons and (b) a vector and a pseudoscalar meson. The violation of unitary symmetry is assumed to transform like the eighth component of a unitary octet and the mixing angles are kept arbitrary.

In case (a) there are five sum rules for the ten coupling constants :

$$\sqrt{\frac{2}{3}}\, G(f,\pi\pi) - 2\sqrt{2}G(f\ K\bar{K}) + 3\sqrt{2}G(f,\eta\eta)$$
$$= \{2\sqrt{6}\, G(A_2, K K) - 6G(A_2, \pi\eta)\} \sin\theta \qquad (1)$$

$$\sqrt{\frac{2}{3}}\, G(A_2, K K) - G(A_2, \pi\eta) - G(K^{**}, K\eta) + \tfrac{1}{3}G(K^{**}, K\pi) \qquad (2)$$

$$\sqrt{3}\, G(f', \eta\eta) - \sqrt{\frac{4}{3}}\, G(f', K K) + \tfrac{1}{3}G(f', \pi\pi)$$
$$= \{2G(A_2, K K) - \sqrt{6}G(A_2, \pi\eta)\} \cos\theta \qquad (3)$$

$$3G(f, \eta\eta) + \frac{1}{\sqrt{3}}\, G(f, \pi\pi) - 2\, G(f, K K)$$
$$= \{3G(f'\eta\eta) - 2\, G(f'\ K K) + \frac{1}{\sqrt{3}}\, G(f', \pi\pi)\} \tan\theta \qquad (4)$$

$$\sqrt{\frac{1}{2}}\, G(f, K K) - \sqrt{\frac{3}{2}}\, G(f, \pi\pi)\left(\frac{2}{3} - \cos^2\theta\right) - \sqrt{\frac{3}{2}}\, \sin\theta\cos\theta G(f', \pi\pi)$$
$$= \sqrt{\frac{1}{2}}\, G(A_2, K K)\left(x\frac{\cos\theta}{4}\sqrt{\frac{10}{3}} - \frac{\sin\theta}{\sqrt{3}}\right)$$
$$-\sqrt{\frac{1}{2}}\, G(K^{**}, K\pi)\left(\frac{4\sqrt{2}}{3}\sin\theta + \frac{\sqrt{5}}{3}\, x \cos\right. \qquad (5)$$

In case (b) also there are five sum rules for the nine coupling constants :

$$G(K^{**}, K^*\pi) \qquad G(K^{**}, \rho K) \qquad \dots \quad (6)$$

$$G(K^{**}, \phi K) \qquad G(K^{**}, K^*\eta) \cos\varphi \qquad \dots \quad (7)$$

$$G(K^{**}, \omega K) - \qquad G(K^{**}, K^*\eta) \sin\varphi \qquad \dots \quad (8)$$

$$\frac{5}{3\sqrt{2}} G(K^{**}, K^*\pi) + G(f', K^*\bar{K}) \cos\theta + G(f, K^*K) \sin\theta$$

$$\frac{1}{\sqrt{2}\sin\varphi} G(K^{**}, \omega K) + \frac{1}{2\sqrt{3}} G(A_2, \rho\pi) \qquad (9)$$

$$G(f', K^*K) \cos\theta + G(f, K^*K) \sin\theta$$

$$\frac{1}{\sqrt{3}} G(A_2, K^*K) + \frac{1}{\sqrt{3}} G(A_2, \rho\pi) \quad \frac{4\sqrt{2}}{3} G(K^{**}, K^*\pi) \qquad (10)$$

$\theta \gtrsim 20^\circ 30'$ (Glashow, *et al*, Barnes *et al.*) and $\varphi \gtrsim 40^\circ$ (Sakurai 1962) are the $f' - f$ and $\omega - \phi$ mixing angles respectively, $x$ is related to the parameters $F$ and $G$ of Glashow and Socolow by $x \quad \sqrt{\frac{2}{5}} \cdot \frac{G}{F} \quad \frac{1}{\sqrt{5}}$.

The sum rules listed above can be properly tested only when more extensive and accurate experimental data become available. Detailed considerations will be published elsewhere

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REFERENCES

Barnes, V. E., *et al.*, 1965, *Phys Rev Letters*, **15**, 322

Chung, S U., *et al*, 1965, *Phys Rev Letters*, **15**, 325. The references to other experimental data are given here.

Glashow, S L. and Socolow, R H, 1965, *Phys Rev. Letters*, **15**, 329 The references to other theoretical works regarding this Nonet are given here.

Hwa, R. C and Patil, S. H., 1965, *Phys Rev.*, **139**, B969.

Sakurai, J. J., 1962, *Phys Rev Letters*, **9**, 472.