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A. Fujii: A DOUBLET SYMMETRY SHARED BY STRONG AND WEAK IBTERACTIONS.

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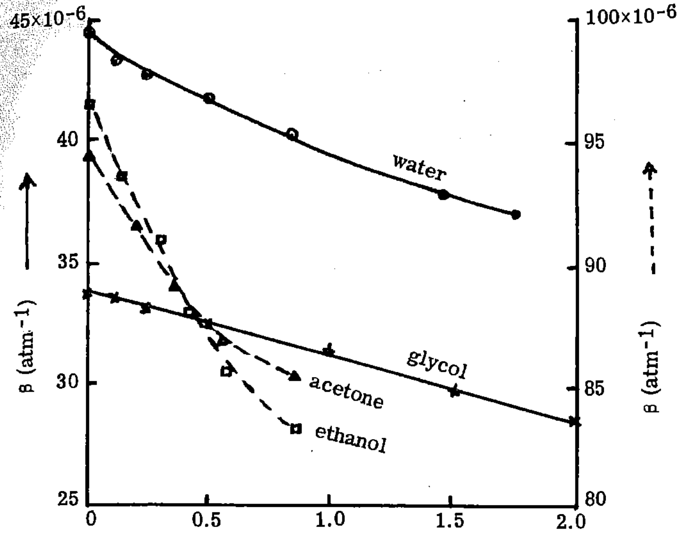

Fig. 1.

tions and an examination of the values of this constant for different solvents indicates that ionisations increases in the order glycol, acetone, ethanol and water. Normally, the ionisation of an electrolyte is expected to increase with increasing dielectric constant of the solvent. With the exception of glycol, the results conform to the expected order. Cadmium iodide lowers the compressibility of glycol to a very small extent, indicating that it is least ionised in this solvent. Direct compression measurements on glycol solutions of cadmium iodide by Gibson [2] also indicate the same result.

Table 1
Density and compressibility variations of cadmium iodide solutions at 27°C.

Solvent	Dielectric constant	$\frac{1}{\rho_0}\left(\frac{\partial\rho}{\partial C}\right)_\infty$	$\frac{1}{\beta_0}\left(\frac{\partial\beta}{\partial C}\right)_\infty$
Water	80	0.322	0.269
Ethanol	24	0.415	0.239
Acetone	20	0.387	0.204
Glycol	37	0.235	0.059

The apparent molar compressibility does not show any regular variation with the square root of the concentration.

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References

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2) R.E.Gibson, J. Am. Chem. Soc. 59 (1937) 1521.

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A DOUBLET SYMMETRY SHARED BY STRONG AND WEAK INTERACTIONS

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Treiman [1] and Pais [2] have derived the important relation between the amplitudes of the hyperon decay $Y \to N + \pi$,

$$\sqrt{2}\,\langle\Lambda^0|p\pi^-\rangle = \langle\Sigma^+|n\pi^+\rangle + \langle\Sigma^-|n\pi^-\rangle \,,$$

from the hypothesis of weak global symmetry. This relation has also been obtained in the pole approximation for a simple phenomenological model which includes both pion and kaon effects [3]. The purpose of this note is to show that this relation follows from the invariance under certain symmetry operations shared by strong and weak interaction hamiltonians, hence its validity does not depend on the pole approximation.

Let us assume that the origin of non-leptonic weak processes lies in the strangeness violating interaction

$$N \to N + K \,,$$

where N can be any of four conventional baryon doublets,

$$N = \binom{p}{n} \,, \quad Y = \binom{\Sigma^+}{Y^0} \,, \quad Z = \binom{Z^0}{\Sigma^-} \,, \quad \Xi = \binom{\Xi^0}{\Xi^-} \,,$$

$$Y^0 = \frac{1}{\sqrt{2}}(\Lambda^0 - \Sigma^0) \,, \qquad Z^0 = \frac{1}{\sqrt{2}}(\Lambda^0 + \Sigma^0) \,,$$

but for a while suppose that N represents the nucleon doublet. This interaction clearly satisfies the condition $|\Delta S| = 1$. The most general interaction hamiltonian in charge space is

$$H = f_1\,\bar{p}\,p\,K^0 + f_2\,\bar{n}\,n\,K^0 + f_3\,\bar{p}\,n\,K^+ + \text{h.c.} \,,$$

or equivalently

$$H = f_1\,\bar{N}\,N\,K^o + f_2\,\bar{N}\,\tau_3\,N\,K^o + f_3\,\bar{N}\,\tau^{(+)}\,N\,K^+ + \text{h.c.}\ ,$$

where f's are coupling constants,

$$\tau^{(\pm)} = \frac{1}{\sqrt{2}}(\tau_1 \pm i\tau_2)\ ,$$

and all operators in coordinate space are left out.

We propose that the non-leptonic weak interactions are described by the following highly symmetric hamiltonian H:

$$H = H_1 + H_2 + H_3\ ,$$

$$H_1 = f_1(\bar{N}\,N\,K^o + \bar{Y}\,Y\,K^o - \bar{Z}\,Z\,K^o - \bar{\Xi}\,\Xi\,K^o + \text{h.c.})\ ,$$

$$H_2 = f_2(\bar{N}\,\tau_3\,N\,K^o + \bar{Y}\,\tau_3\,Y\,K^o + \bar{Z}\,\tau_3\,Z\,K^o + \bar{\Xi}\,\tau_3\,\Xi\,K^o + \text{h.c.})\ ,$$

$$H_3 = f_3(\bar{N}\,\tau^{(+)}\,N\,K^+ + \bar{Y}\,\tau^{(+)}\,Y\,K^+ + \bar{Z}\,\tau^{(+)}\,Z\,K^+ + \bar{\Xi}\,\tau^{(+)}\,\Xi\,K^+ + \text{h.c.})\ ,$$

The hamiltonians for the strong interaction of baryons with the pion and kaon are written in the doublet approximation as [4]

$$H_\pi = g_\pi(\bar{N}\,\vec{\tau}\,N + \bar{Y}\,\vec{\tau}\,Y + \bar{Z}\,\vec{\tau}\,Z + \bar{\Xi}\,\vec{\tau}\,\Xi)\cdot\vec{\pi}\ ,$$

$$H_K = g_K(\bar{N}\,Y\,K^o + \bar{N}\,Z\,K^+ + \bar{\Xi}\,Y\,K^- - \bar{\Xi}\,Z\,\bar{K}^o + \text{h.c.})\ .$$

Each of the hamiltonians H_π, H_K, H_1, H_2 and H_3 is shown to be invariant under the following operations:

$$\text{(I)}\quad \begin{cases} N \rightleftarrows Y\ , \quad Z \rightleftarrows \Xi \\ \pi^\pm \to \pi^\pm,\ \pi^o \to \pi^o,\ K^\pm \to K^\pm,\ K^o \rightleftarrows \bar{K}^o \end{cases}$$

$$\text{(II)}\quad \begin{cases} N \to i\tau_2 Z,\ Y \to i\tau_2\Xi,\ Z \to -i\tau_2 N,\ \Xi \to -i\tau_2 Y \\ \pi^\pm \to -\pi^\mp,\ \pi^o \to -\pi^o,\ K^\pm \to -K^\mp,\ K^o \to -K^o, \\ \bar{K}^o \to -\bar{K}^o\ , \end{cases}$$

provided that the baryon masses are degenerate. The symmetry operation (I) implies that

$$\langle Y^o|p\pi^-\rangle = \langle n|\Sigma^+\pi^-\rangle\ ,$$

and (II)

$$\langle Z^o|p\pi^-\rangle = \langle n|\Sigma^-\pi^+\rangle\ .$$

If the final state interactions are neglected

$$\langle n|\Sigma^+\pi^-\rangle = \langle\Sigma^+|n\pi^+\rangle\ , \qquad \langle n|\Sigma^-\pi^+\rangle = \langle\Sigma^-|n\pi^-\rangle\ ,$$

therefore

$$\langle Y^o|p\pi^-\rangle = \langle\Sigma^+|n\pi^+\rangle\ , \qquad \langle Z^o|p\pi^-\rangle = \langle\Sigma^-|n\pi^-\rangle\ .$$

It follows then in the Λ-Σ notation

$$\sqrt{2}\,\langle\Lambda^o|p\pi^-\rangle = \langle\Sigma^+|n\pi^+\rangle + \langle\Sigma^-|n\pi^-\rangle\ ,$$

which is the Treiman-Pais relation quoted in the beginning.

It may be of some interest to rewrite H_1 and H_2 in the form

$$H_1 + H_2 = f_+\,[(\bar{N}(1+\tau_3)N + \bar{Y}(1+\tau_3)Y - \bar{Z}(1-\tau_3)Z - \bar{\Xi}(1-\tau_3)\Xi)\,K^o + \text{h.c.}] + f_-[(\bar{N}(1-\tau_3)N + \bar{Y}(1-\tau_3)Y - \bar{Z}(1+\tau_3)Z - \bar{\Xi}(1+\tau_3)\Xi)\,K^o + \text{h.c.}]\ ,$$

where

$$f_\pm = \tfrac{1}{2}\,(f_1 \pm f_2)\ .$$

References

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2) A.Pais, Nuovo Cimento 18 (1960) 1003.
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4) Y.Yamaguchi, Relations de dispersion et particules élémentaires (Hermann, Paris, 1960), p. 616.

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