cm^{-2} sec^{-1}. Furthermore, the short-wavelength cutoff[12] for coronal x rays is about 6 to 7 A so energy discrimination could be used in the detectors. During flares, x rays down to 2 A have been observed, but bremsstrahlung from the solar stream instability region would not reach the earth until many hours after such a flare. X rays associated with intense storm-associated aurorae should also appear before the barrier bremsstrahlung.

We note that the gross upper limit to the barrier x-ray intensity established here is comparable to that thought to be required for ionospheric phenomena such as the production of sudden phase anomalies. Inspection of ionospheric records might therefore disclose evidence for the arrival of such x rays after a storm or allow a better determination of the upper limit to the proton-electron energy interchange efficiency. Finally, solar streams which miss the earth completely, such as those at high angles to the ecliptic, could nevertheless produce measurable effects which are uncorrelated with other terrestrial phenomena. Especially useful information might be obtained if these could be detected with directional x-ray detectors and correlated with solar and radio astronomical observations.

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$\Delta T = 1/2$ SELECTION RULE AND $K_{2\pi}{}^{+}$ DECAY

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A rather impressive amount of evidence has accumulated on the validity of the $\Delta T = 1/2$ selection rule in the weak decays of mesons and hyperons into strongly interacting particles.[1] The observed inhibition of the $K^+ \to \pi^+ + \pi^0$ decay mode relative to $K_1{}^0 \to 2\pi$ points to a high degree of effectiveness of the rule. The former requires a ΔT of at least 3/2, and is thus a forbidden transition under the rule, while the latter can go to the $T = 0$ state and is thus allowed. The observed transition rates for the $K^+ \to \pi^+ + \pi^0$ and $K_1{}^0 \to 2\pi$ are in the ratio of 1/400, which corresponds to 1/200 for the ratio of K^+ rate to the K^0 rate, since $K_1{}^0$ is a particle mixture. The $K_1{}^0$ rate agrees in order of magnitude with what one expects from phase space considerations and other strange particle decays.[2] It is the $K_{2\pi}{}^{+}$ rate which is anomalous.

Since the rule works well, one is tempted to postulate that it is exact, but then the question arises by what mechanism the $K^+ \to \pi^+ + \pi^0$ decay occurs. One a priori possibility is that electromagnetic effects which permit $\Delta T = 1$ are responsible; these together with a strict $\Delta T = 1/2$ weak interaction will allow processes with $\Delta T = 3/2$. It has generally been supposed, however,[3] that these are of insufficient strength to provide the required amount of $\Delta T = 3/2$, since the $\Delta T = 3/2$ rate is presumably of order $e^4 = 1/(137)^2 = 1/19\,000$ of the $\Delta T = 1/2$ rate, much smaller than the 1/200 mentioned above. A discrepancy of $\approx 19\,000/200 \cong 100$ in the rates exists, if the $\Delta T = 1/2$ rule is taken to be exact.

The point we wish to make here is that there is a natural resolution of this discrepancy in the recently proposed strong attraction between two pions in the $T = 2$, $J = 0$ state at low energy.[4] In reference 4, the asymmetry which is observed in the energy spectrum of the π^- in the τ^+ decay mode has been interpreted in terms of such an interaction, and it is difficult to see how such an asymmetry could arise in any other way. Furthermore the angular correlation of the pions of like charge as compared to that of unlike charge observed in the annihilation of antinucleons may be evidence for the same effect.[5] The proposed interaction is very strong, giving a scattering length $a_{20} \approx \hbar/M_\pi c$. The existence of such an interaction would enhance the decay rate of $K^+ \to \pi^+ + \pi^0$.[6] Fermi's[7] method may be used to estimate the enhancement factor E.F., for which he obtains

$$\text{E.F.} = \left| \frac{(\cos\delta) j_0(k\alpha) - (\sin\delta) n_0(k\alpha)}{j_0(k\alpha)} \right|^2,$$

where k refers to the relative momentum of the two pions in the s state, α is an ill-defined radius of interaction of the outgoing particles, and δ is the phase shift resulting from the final-state interaction. For $K_{2\pi}$ decay, we have $1/k = 0.7\ \hbar/M_\pi c$. We shall see that α must be chosen sufficiently small that $k\alpha \ll 1$, so that the small-argument approximation to the spherical Bessel functions may be made, giving

$$\text{E.F.} = \frac{\cot^2\delta}{1+\cot^2\delta} \left| 1 + \frac{1}{\alpha k \cot\delta} \right|^2.$$

For $k \cot\delta = 1/a_{20}$, and $a_{20} = \hbar/M_\pi c$, $\cot\delta = 0.7$. Then

$$\text{E.F.} = \tfrac{1}{3} | 1 + (a_{20}/\alpha) |^2.$$

Perhaps the smallest value of α which is reasonably acceptable is 1/2 nucleon Compton wavelength. On the other hand, lengths appreciably greater than this might not enter the problem, for (1) intermediate $N - \bar{Y}$ states are essential in reasonable Feynman diagrams for the decay, because the direct vertex $K^+ \to \pi^+ + \pi^0$ is forbidden on the $\Delta T = 1/2$ hypothesis; (2) the pion-pion scattering might go only through virtual N-$\bar{N}$ pairs. This choice of $\alpha = \hbar/2M_p c = (1/14)(\hbar/M_\pi c)$ gives $a_{20}/\alpha = 14$ and E.F. $\simeq 75$.

This result indicates that it may not be necessary to introduce explicitly a $\Delta T = 3/2$ weak interaction to account for the $K_{2\pi}{}^+$ decay but that it decays through a strict $\Delta T = 1/2$ weak interaction, modified by electromagnetic effects, with an attendant enhancement by a strong $T = 2$ final-state interaction.

It should be emphasized that additional more accurate data on the energy and angular distributions of the pions in the τ^+ mode and a more thorough and complete calculation of the $K_{2\pi}{}^+$ transition rate incorporating the physical ideas suggested above would be very worthwhile. It should also be made explicit that the proposal presented here can be maintained only if (1) the pion-pion interaction in the $T = 2$, $J = 0$ state has a very short range and (2) there is no correspondingly strong interaction in the $T = 0$ state.

Since a fourth order electromagnetic process seems to give a rather large effect, we must consider whether this large effect is consistent with the experimental fact that other processes of order e^2 or e^4 (for example, $K^+ \to \pi^+ + \gamma$, $K^+ \to \pi^+ + \pi^0 + \gamma$, $K^+ \to \pi^+ + e^+ + e^-$) do not compete successfully with $K^+ \to \pi^+ + \pi^0$ decay. A number of these alternative processes have been investigated by Dalitz,[3,8] with the conclusion that for a spin zero K^+, they are quite negligible in comparison with the normal $K_{2\pi}$ decay.

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