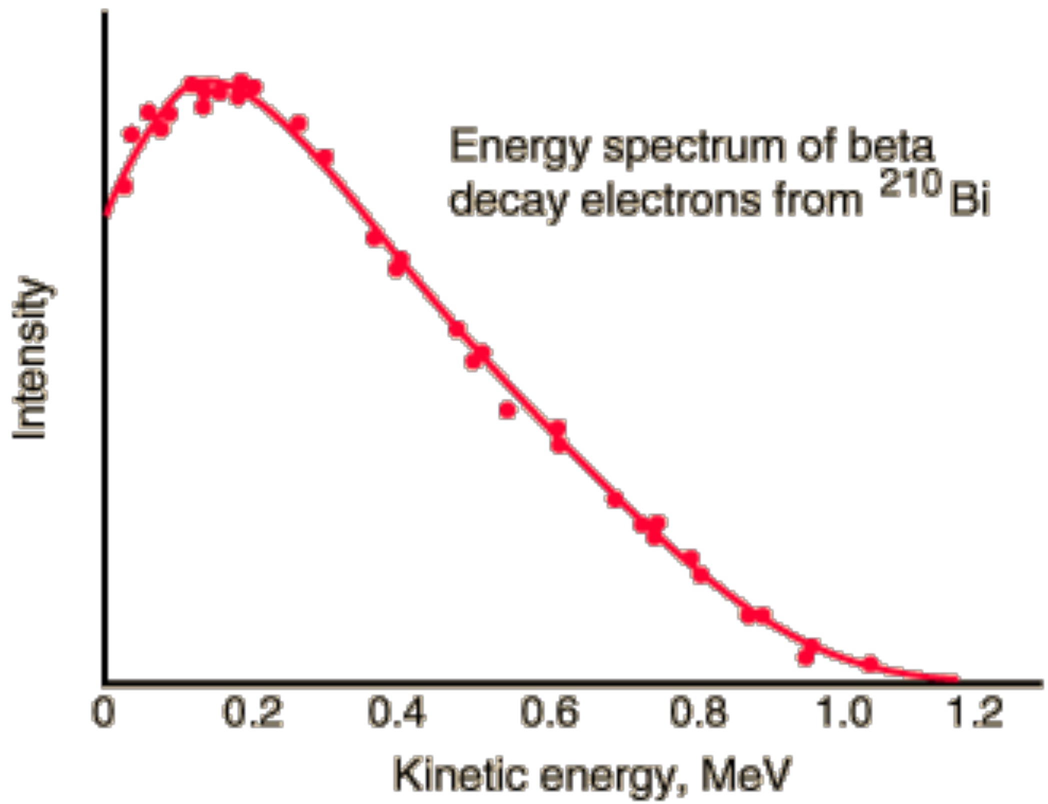
Depends on nuclear wave functions

$$\mathcal{W}_{i\to f}\left(p_{e^-}\right)dp_{e^-} = \frac{\left|M'_{fi}\right|^2}{2\pi^3\hbar^7c^3}F\left(Z_D,p_{e^-}\right)p_{e^-}^2\left(E-E_{e^-}\right)^2\sqrt{1-\frac{m_{\bar{\nu}}^2c^4}{\left(E-E_{e^-}\right)^2}}dp_{e^-}$$

Fermi function: $F\left(Z,p_{e^-}\right)=\frac{2\pi\eta}{1-e^{-2\pi\eta}}$, $\eta \equiv \pm\frac{Ze^2}{\hbar v_{e^-}}$ positive (negative) sign used for β^- (β^+) decay



Dear radioactive ladies and gentlemen,

As the bearer of these lines [...] will explain more exactly, considering the 'false' statistics of N-14 and Li-6 nuclei, as well as the continuous β-spectrum, I have hit upon a desperate remedy to save the "exchange theorem" of statistics and the energy theorem. Namely [there is] the possibility that there could exist in the nuclei electrically neutral particles that I wish to call neutrons, which have spin 1/2 and obey the exclusion principle, and additionally differ from light quanta in that they do not travel with the velocity of light: The mass of the neutron must be of the same order of magnitude as the electron mass and, in any case, not larger than 0.01 proton mass. The continuous β-spectrum would then become understandable by the assumption that in β decay a neutron is emitted together with the electron, in such a way that the sum of the energies of neutron and electron is constant. […]
But I don't feel secure enough to publish anything about this idea, so I first turn confidently to you, dear radioactives, with a question as to the situation concerning experimental proof of such a neutron, if it has something like about 10 times the penetrating capacity of a γ ray.

I admit that my remedy may appear to have a small a priori probability because neutrons, if they exist, would probably have long ago been seen. However, only those who wager can win, and the seriousness of the situation of the continuous β-spectrum can be made clear by the saying of my honored predecessor in office, Mr. Debye, [...] "One does best not to think about that at all, like the new taxes." [...] Therefore one should seriously discuss every way of rescue. Thus, dear radioactive people, scrutinize and judge. -
Unfortunately, I cannot personally appear in Tübingen since I am indispensable here in Zürich because of a ball on the night from December 6 to 7.

With many greetings to you, also to Mr. Back, your devoted servant,

W. Pauli

Beta decay: nuclear matrix elements

$$V_{\mathrm{int}} \approx g\delta\left(\vec{r}_n - \vec{r}_p\right)\delta\left(\vec{r}_n - \vec{r}_{e^-}\right)\delta\left(\vec{r}_n - \vec{r}_{\bar{\upsilon}}\right)\hat{O}(n \rightarrow p)$$ zero-range

The nuclear operator transforming a neutron into a proton must be one body in nature. Hence it must involve the isospin raising or lowering operators.

In the non-relativistic limit, the vector part may be represented by the unity operator times $\tau_\pm$ and the axial-vector part by a product of $\tau_\pm$ and σ. (A proper derivation requires manipulation with Dirac 4-component functions and γ matrices!)

$$V_{\mathrm{int}} \rightarrow G_V \sum_{j=1}^{A}\left[\tau_\pm(j) + g_A \vec{\sigma}(j)\cdot\vec{\tau}(j)\right]$$

Fermi decay, carries zero angular momentum

Gamow-Teller decay, carries one unit of angular momentum

G_V determined from superallowed Fermi beta decays!