First Measurement of Form Factors of the Decay $\Xi^0 \to \Sigma^+ e^- \overline{\nu}_e$

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Yuhang

- what's mean about "second class current " in page one ?

$$G = Ce^{i\pi I_2}$$

G parity not conserved
excluded in the SM

Ryuta

- Here is my question on the JC99.
- Q. It would be out of this paper but, is there any investitation/report

on the estimation of this form factor ratio g1/f1 from the lattice calculation side ?(possibly the precision would not be good enough but ...)

The effects of SU(3) symmetry breaking in hyperon semileptonic decays have been extensively studied based on various theoretical frameworks. Donoghue *et al.* used a quark model to analyze the size of the SU(3) breaking effects [13], which triggered subsequent works [14–22]. Chiral perturbation theory (χPT) was also used as a framework to analyze flavor SU(3) breaking effects on the HSD constants [23–27], in which other form factors of HSD have been also studied. The results for V_{us} within HSDs were discussed in Ref. [28] and for the large N_c expansion in Ref. [29]. In lattice QCD [30] all form factors of the $\Sigma^- \to nl\nu$ decay were studied and the results were given as $f_2(0)/f_1(0) = -1.52 \pm 0.81$ and $g_1(0)/f_1(0) = -0.287 \pm 0.052$. In Refs. [31–34] the effects of SU(3) symmetry breaking in HSDs were examined from lattice QCD. Flavor SU(3) symmetry breaking in HSDs was investigated within the $1/N_c$ expansion [35]. The HSD constants were also studied, based on several different approaches in the SU(3) Skyrme model [36–38].

Xin

- In Eq.3, it introduced the “fictitious particle Q”, could you explain more?

Since the average Ξ^0 polarization in our data sample is negligible, only four kinematic variables are needed to describe the signal completely. The process $\Xi^0 \to \Sigma^+ e^- \overline{\nu}_e$ can be described by the energy of the electron in the Σ^+ frame and the angle between the electron and neutrino in the Ξ^0 frame. The polarization of the Σ^+ can be described by the angle between the proton and the electron, and the angle between the proton and the neutrino in the Σ^+ frame. The usefulness of the final state polarization is greatly enhanced by the large asymmetry of the decay $\Sigma^+ \to p\pi^0$ ($\alpha = -0.98$).

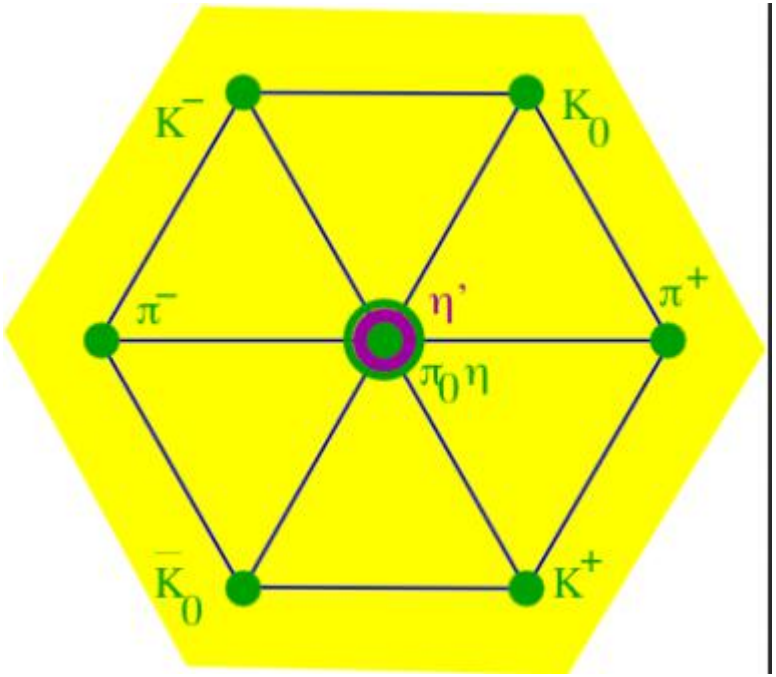
Since the neutrino is unobserved, we cannot unambiguously reconstruct the directions in the center of mass. However, assuming the observed $\vec{p}_\perp$ is equal and opposite to the transverse momentum of the neutrino, we can obtain unambiguous angular variables transverse to the direction of the Ξ^0 momentum. Following Dworkin [6], we consider the decay sequence

$$\Xi^0 \to Q + \overline{\nu_e}, \qquad Q \to \Sigma^+ + e^-, \tag{3}$$

where we have introduced the fictitious particle Q. We then construct angular variables out of these transverse quantities. Denoting quantities in the Q rest frame with an asterisk, we have the transverse momenta of the electron, proton, and neutrino in the Q frame: $\vec{p}^{\,*}_{e\perp}$, $\vec{p}^{\,*}_{p\perp}$, and $\vec{p}^{\,*}_{\nu\perp}$ which is approximately equal to $\vec{p}_{\nu\perp}$ since the Ξ^0 and Q momenta are nearly parallel.

Yuzhen

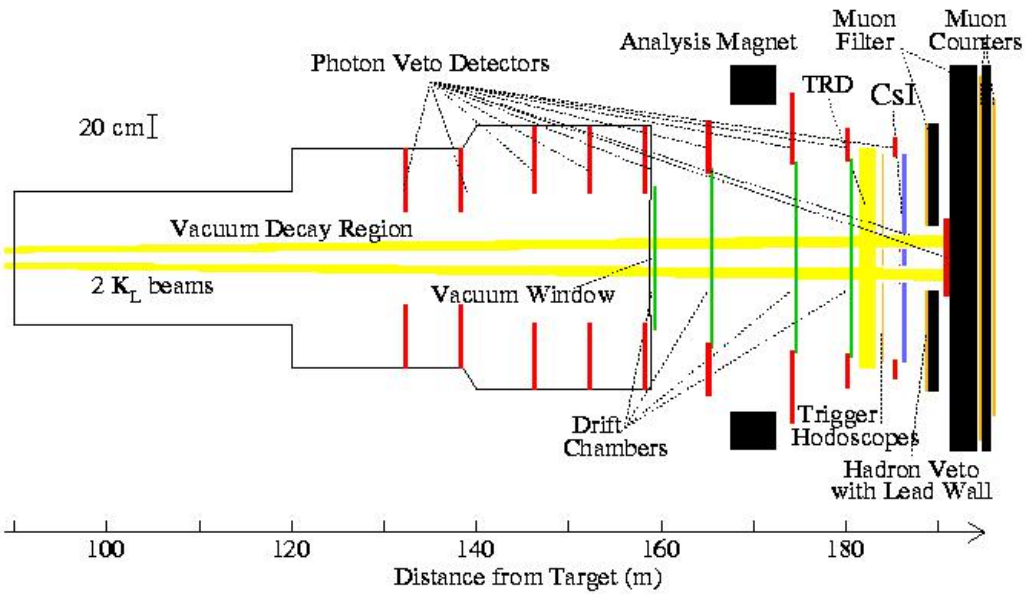
- Could you introduce the details of SU(3)?

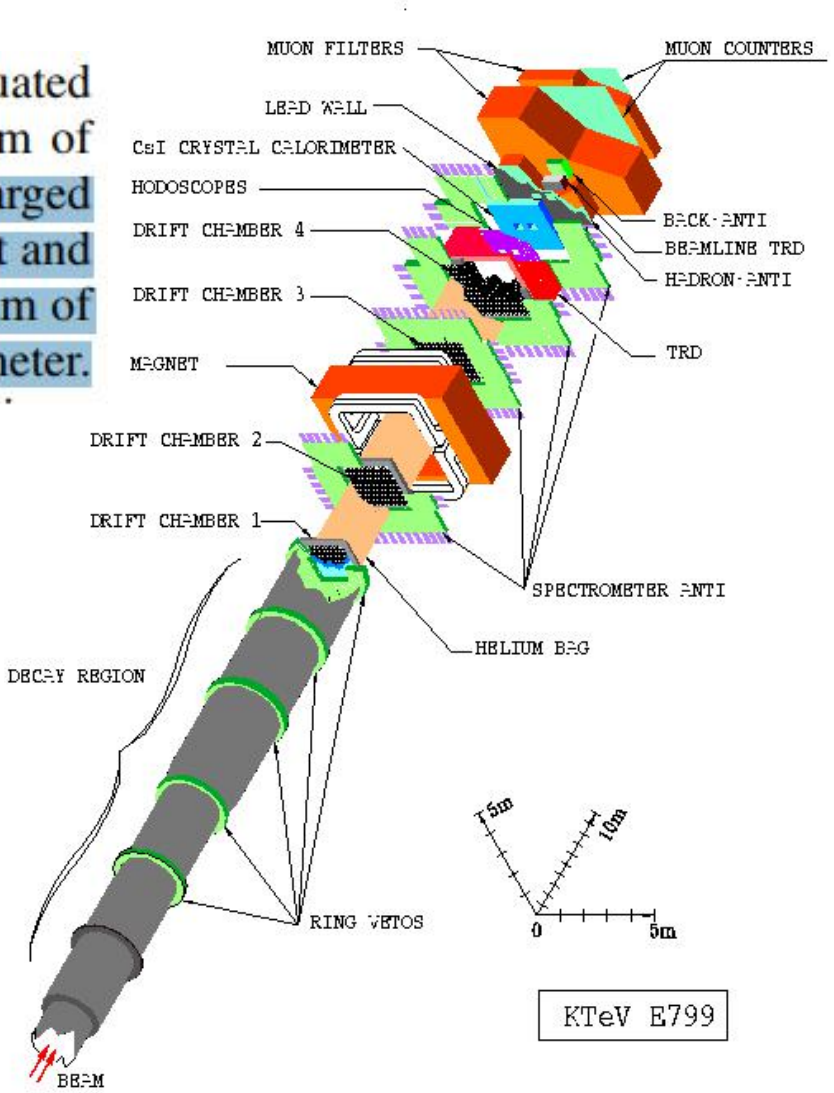


Suyu

- What are upstream and downstream?

average of the Ξ^0 polarization negligible. An evacuated decay volume extends from 94 to 159 m downstream of the target. Downstream of the decay volume is a charged particle spectrometer consisting of an analysis magnet and four drift chambers, two upstream and two downstream of the magnet, followed by a CsI electromagnetic calorimeter.





Amit

- Why the SU(3) value has been shifted towards left from central value also the theoretical values? (Fig 3)

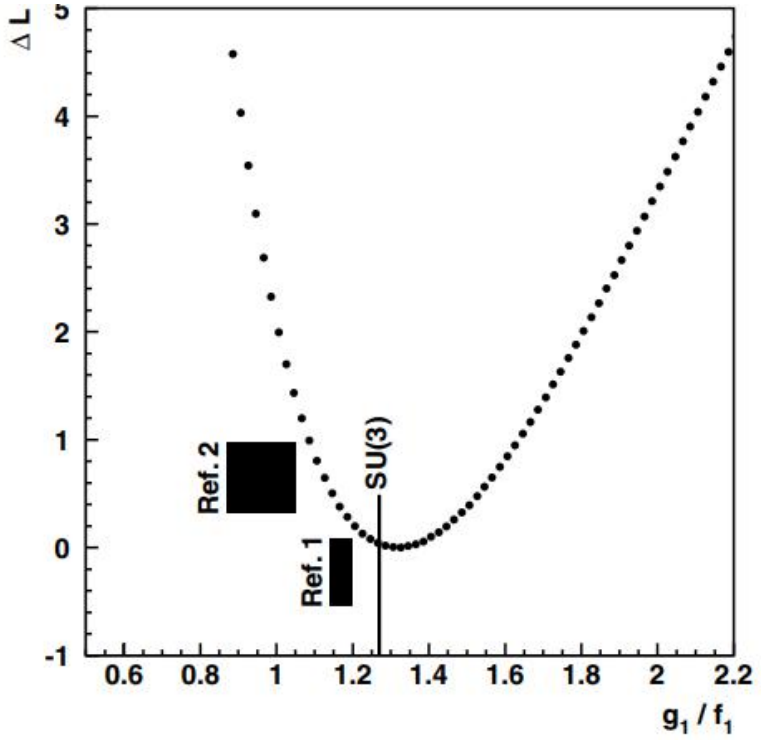


FIG. 3. Maximum likelihood fit to g_1/f_1. The black bands indicate the range of the g_1/f_1 theoretical predictions found in [1,2]. The vertical line is the exact $SU(3)_f$ value.