Big Bang Neutrinos

$$\overline{\nu}_e + p \rightarrow n + e^+$$

Number density of BB nus: $n_\nu \sim 10^2$ cm^{-3}

Weak interaction cross section: $\sigma \sim 10^{-44}$ cm^2

Interaction length on CR p^+ : $\lambda_\nu \sim (\sigma n_p)^{-1} \sim (n_p)^{-1}\ 10^{44}$ cm

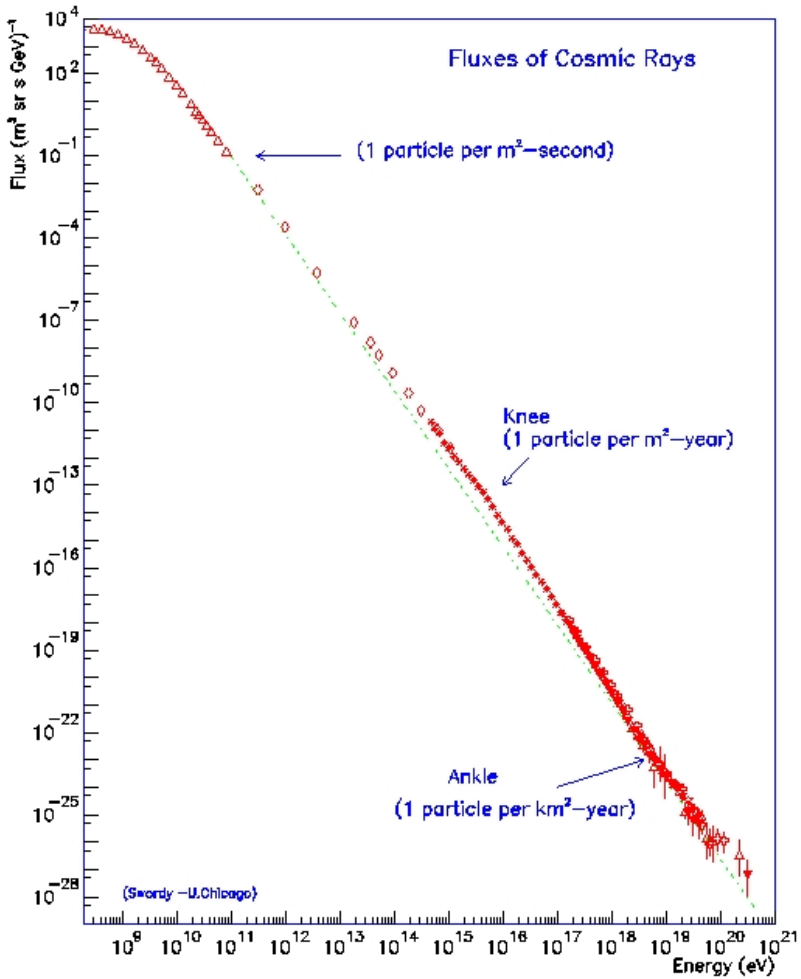
Radius of visible universe: $R \sim cT \sim 10^{28}$ cm

Probability of interaction: $P \sim R/\lambda_\nu \sim 10^{-16}\ n_p$

Number density of interaction positrons: $n_e \sim n_\nu P \sim 10^{-14}\ n_p$

Flux of positrons: $\Phi_e \sim n_e c \sim 10^{-4}\ n_p$ cm^{-2} s^{-1}

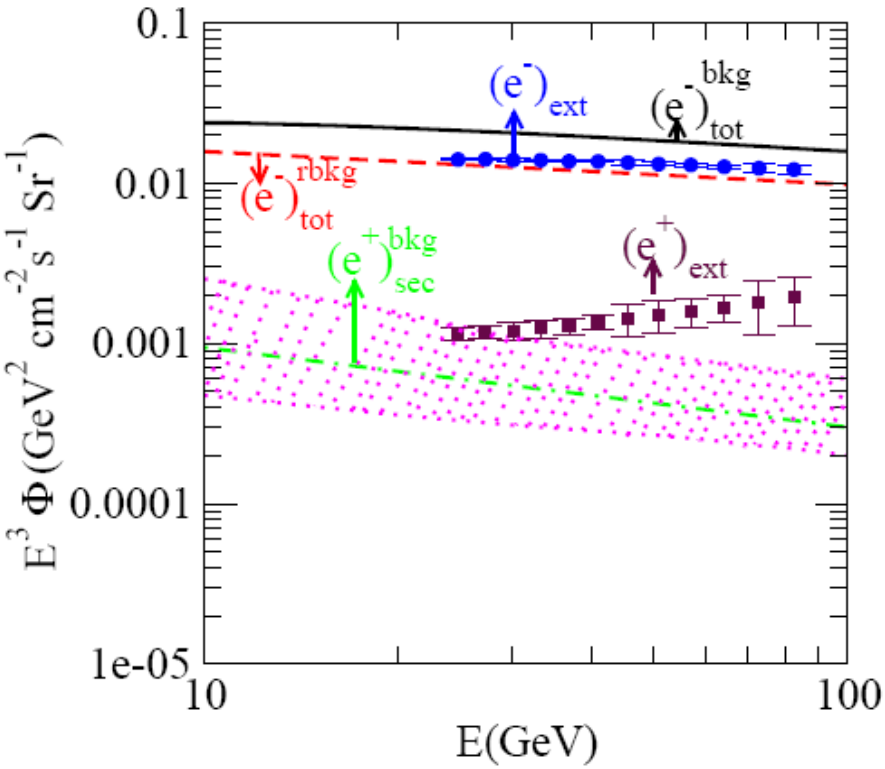
CR Flux



$\Phi_p \sim 10^{-3}$ m^{-2} s^{-1} GeV^{-1} (10^3 GeV)(10^{-6} m^2/cm^2)(4π) ~ 10^{-5} cm^{-2} s^{-1} (E_p > 1 TeV)

$n_p \sim \Phi_p/c \sim 10^{-16}$ cm^{-3} (E_p > 1 TeV)

Pamela Positron Excess



$\Phi_e \sim 10^{-3}$ GeV^2 cm^{-2} s^{-1} Sr^{-1} (50 GeV)(4π)(60 GeV)$^{-3}$ ~ π x 10^{-6} cm^{-2} s^{-1}

COMPARABLE to BB Flux!!!