R. Stroynowski

COMMENT ON ν_τ

- ALL INFORMATION INDIRECT (NOT YET OBSERVED)
- IN STANDARD MODEL $m_{\nu_\tau} = 0$

  HOWEVER - IT MAY BE MASSIVE

- MASS, LIFETIME AND LEPTONIC DECAY RATE OF THE τ ARE RELATED

$$\Gamma(\tau \to \nu_\tau \ell \bar{\nu}_\ell) = \frac{G_F^2 m_\tau^5}{192\pi^3}\left[1 - 8y + 8y^3 - y^4 - 12y^2 \ln y\right] \cdot R_{EW}$$

$$y = m/m_\tau$$

$\rightarrow$ $m_\nu < 40\text{-}50$ MeV DEPENDING ON TREATMENT OF ERRORS

- ASTROPHYSICAL/COSMOLOGICAL ARGUMENTS RESTRICT

$$\Sigma m_\nu < 24\ eV$$

BUT

- LIMIT IS MUCH LESS STRINGENT IF ν CAN DECAY
- LIMIT DEPENDS ON ASSUMPTIONS THAT ARE GENERALLY ACCEPTED BUT NOT PROVEN
- STATISTICAL ERRORS IN EXTRAPOLATION FROM SUPERNOVA NEUTRINO OBSERVATION - HUGE.

IF $m_{\nu_\tau} \neq 0$ – WHAT IS IT ?

- m_{ν_τ} CAN BE COMPLETELY INDEPENDENT FROM m_{ν_e} AND m_{ν_μ}
- FOR "SEE-SAW" MECHANISM

$$m_{\nu_e} : m_{\nu_\mu} : m_{\nu_\tau} = m_e^2 : m_\mu^2 : m_\tau^2$$

IMPLICATION :

$m_{\nu_\tau} < 181$ MeV	FOR	$m_{\nu_e} < 15$ eV	(PDG)
$m_{\nu_\tau} < 36$ MeV	FOR	$m_{\nu_e} < 3$ eV	(NYT)
$m_{\nu_\tau} < 48$ MeV	FOR	$m_{\nu_\mu} < 0.17$ MeV	(PDG)

- SUPERKAMIOKANDE RESULTS CAN BE INTERPRETED AS $\nu_\mu \leftrightarrow \nu_\tau$ OSCILLATIONS WITH

$0.02 < \Delta m < 0.08$ eV

→ VERY LOW m_{ν_τ} FOR STABLE NEUTRINO
⋯→ OTHER INTERPRETATIONS NOT EXCLUDED

ν_τ OBSERVATION AND m_{ν_τ} MEASUREMENT ARE VERY IMPORTANT ISSUES WITH IMPLICATIONS WELL OUTSIDE τ PHYSICS COMMUNITY

- PROBLEMS OF OBTAINING LIMITS ON M_{ν_τ}

  → SEE DISCUSSION BY JEAN DUBOSCQ

- MY PERSONAL OPINION:

  - FOR B-FACTORIES DETECTORS

    $\tau \to K K \pi \nu_\tau$

    $\tau \to K K K \nu_\tau$ $\quad (\eta, \pi^0 \nu_\tau \; ?)$

    ARE MOST LIKELY DECAY CHANNELS FOR IMPROVED MEASUREMENTS

  - COMPETITIVE BUT DIFFICULT CHANNEL

    $\tau \to e \gamma \nu$ (FIT TO DECAY SPECTRUM)

    BUT: RADIATIVE PROCESSES MUST BE WELL CONTROLLED

    → SOFT γ DETECTION WITH GOOD E_γ AND SPATIAL RESOLUTION IS NECESSARY

    NEEDS VERY HIGH STATISTICS + VERY GOOD MOMENTUM RESOLUTION

CAN WE DO BETTER WITH ADDITIONAL INFORMATION ?

2 IDEAS (BOTH DO NOT WORK-OUT)

- MEASURE τ DIRECTION

  e.g., INSERT PIXEL DETECTOR AT CLEO AND SEARCH FOR 3-vs-3 DECAYS WITH BOTH τ's HAVING LONG LIFETIME $> 2\gamma\beta c\tau$, i.e., ≥ 1mm SPATIAL SEPARATION BETWEEN VERTICES SHOULD GIVE A MEASURE OF τ DIRECTION.

  AJ WEINSTEIN – USED CLEO II.5 SVX MONTE CARLO AND SHOWED THAT FOR CLEO II.5 THIS METHOD IS STILL DOMINATED BY TRACKIN RESOLUTION

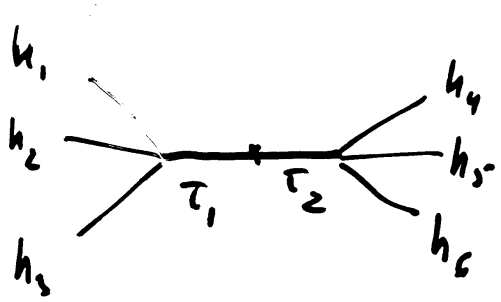
  IS IT BETTER WITH PIXELS AND AT LOWER ENERGY ?

- MEASURE ν_τ DIRECTION

  e.g., USE LARGE EXTERNAL ν DETECTOR TO DETECT $\nu_\tau N \to \tau \cdots$
  NEUTRINO INTERACTION POINT SHOULD PROVIDE GOOD MEASURE OF ν DIRECTION

  PRACTICAL ONLY AT HIGHER ENERGIES SINCE $E_{\text{THRESHOLD}}$ FOR $\nu_\tau N \to \tau X$ IS ~ 3.5 GeV

  ILIA NARSKI – USED CLEO MC AND SHOWED ALSO THAT THE $m_{2\tau}$ MASS RESOLUTION IS DOMINATED BY TRACKING RESOLUTION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h_2
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