GZKNeutrinos
@
ARENAworkshop

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Overview

- WhatareGZKneutrinos&whywecare
- Techniques
- Cosmicevolution&modelparameters
- Reasonable,Guaranteed?

UHEProduction:Acceleration
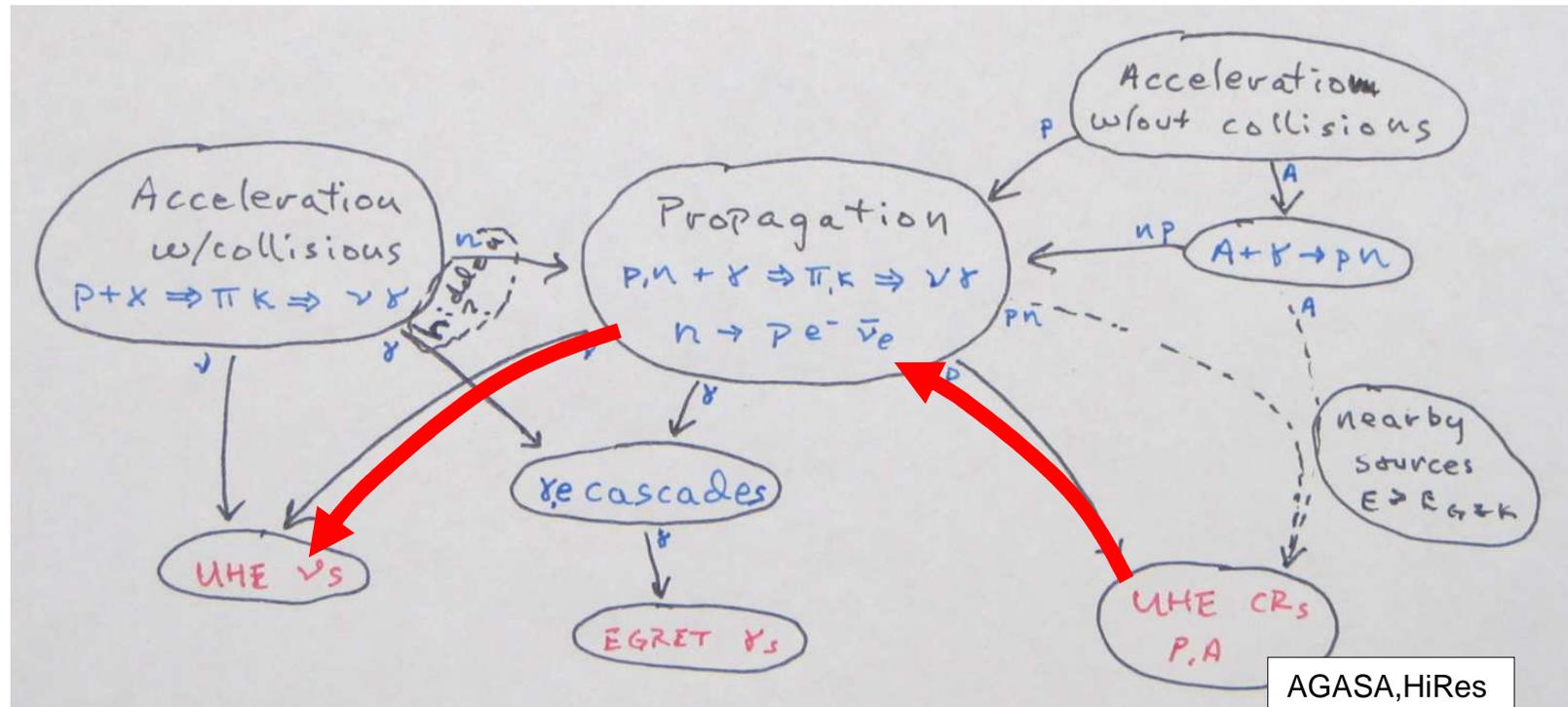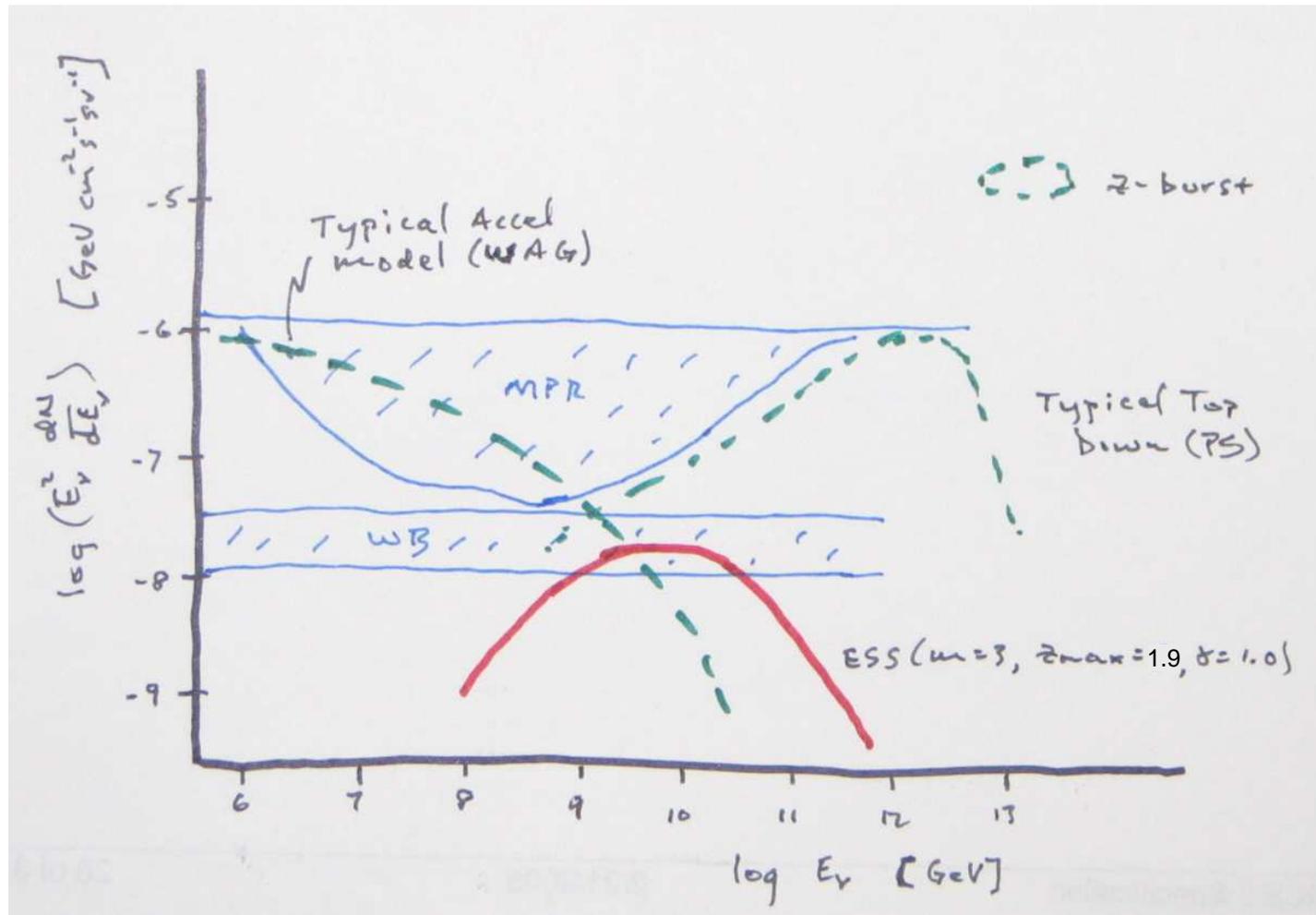

1. Accelerationpredictionsdependonscenario– cou   ldbe"no ν's".

2. "GZK"neutrinosareguaranteed– aguide forexper   imentdesign.

3. Stillsomemodeldependence.
4. ConstraintsfromEGRET&UHECR
5. $E_\nu \sim .05E_p$

UHEproduction:topdown
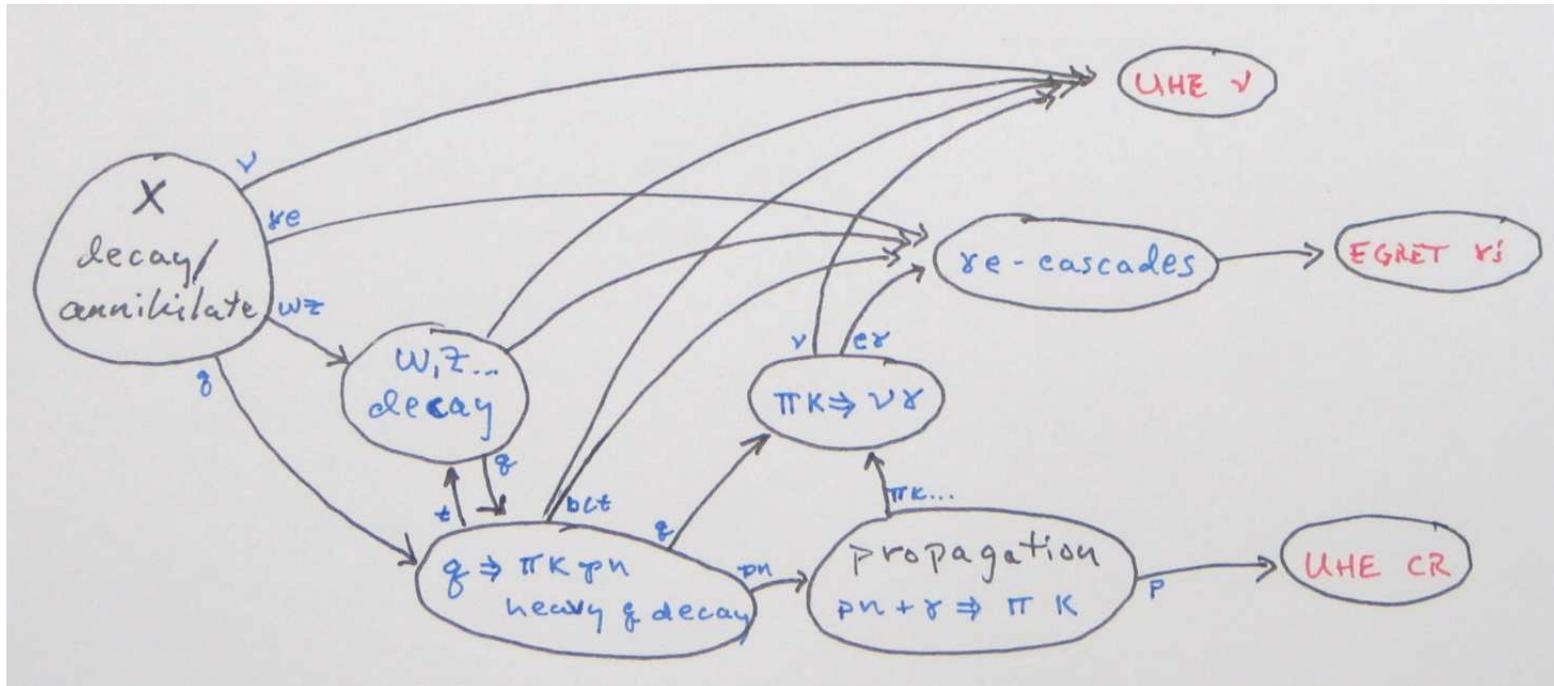
1. For "direct" production, $E_\nu > E_p$
2. #direct > #p
3. ConstraintsfromEGRET
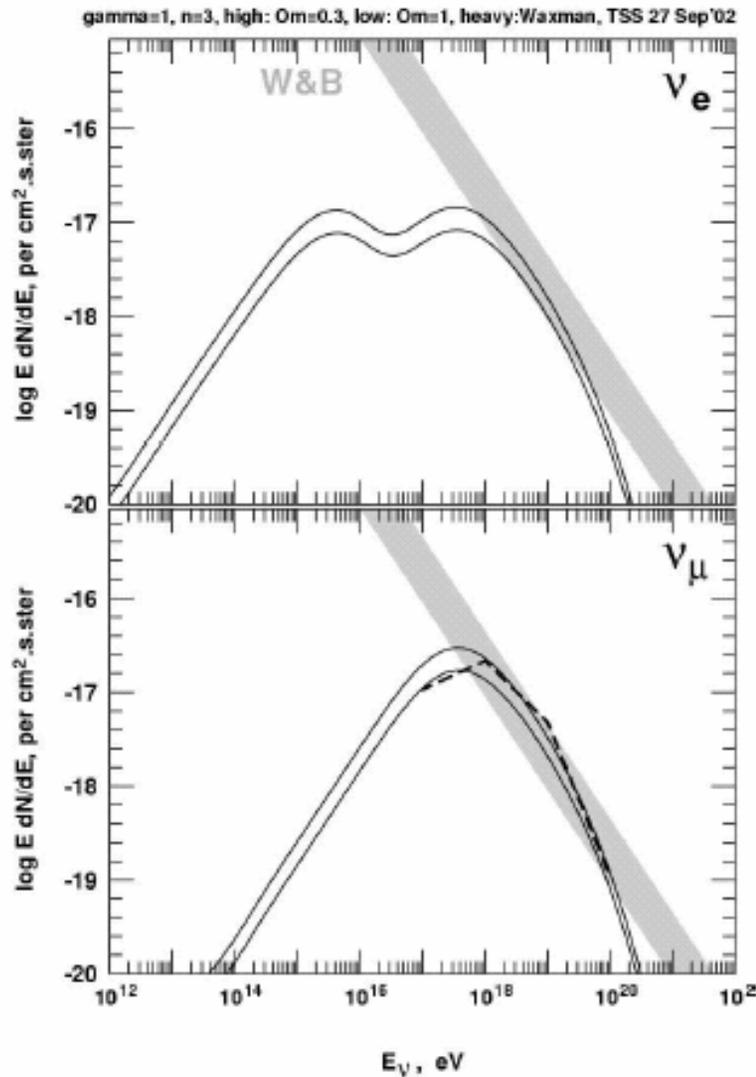4. "GZK" there, but unimportant

Typicalsummaryofmodels

GZKcosmiccascadecodes

- propagation&dE/dx
  - adiabatic(cosmicexpansion)
  - photonuclear: $\gamma + p \to B + X$(ESSuseSOPHIA)
  - pairproduction: $\gamma + p \to pe^+ e^-$

- sourcecharacteristics
  - injectionspectrumdN/dE $\sim E^{-(1+\gamma)}$
  - sourcecutoffE_c
  - luminosity(ESS– normalizetoUHECR,KKSSlimitfro   mEGRET)
  - homogenous

- cosmology
  - integrateoverred-shift
  - sourceevolution:$(1+z)^m, z_{max}$
  - $H_0, \Lambda \dots$

dE/dx (γ+p $\rightarrow$ B+X(SOPHIA))

Moretolifethanthe Δ-resonance
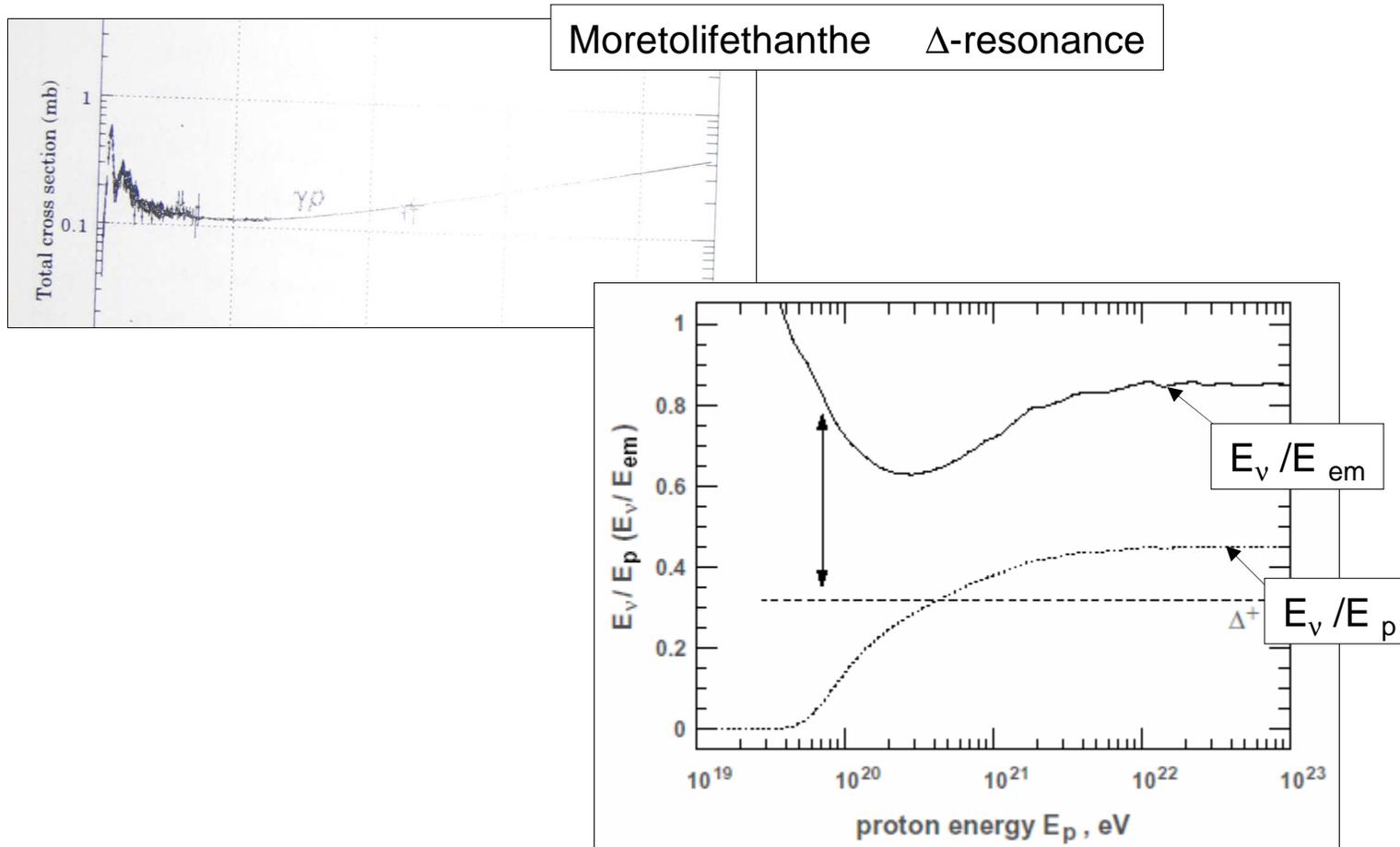
ESSresultfora"reasonable"model

gamma=1, n=3, high: Om=0.3, low: Om=1, heavy:Waxman, TSS 27 Sep '02

- **Model**
  - z_{max}=1.9,flatto2.7,rolloff forz>2.7.
  - LogE $_c$=21.5
  - Norm.(19<LogE $_{cr}$ <21)
  - $\Lambda = 0.0, 0.7$

- **Flux"grazes"WB**
- $\nu_\mu \sim 2\nu_e$
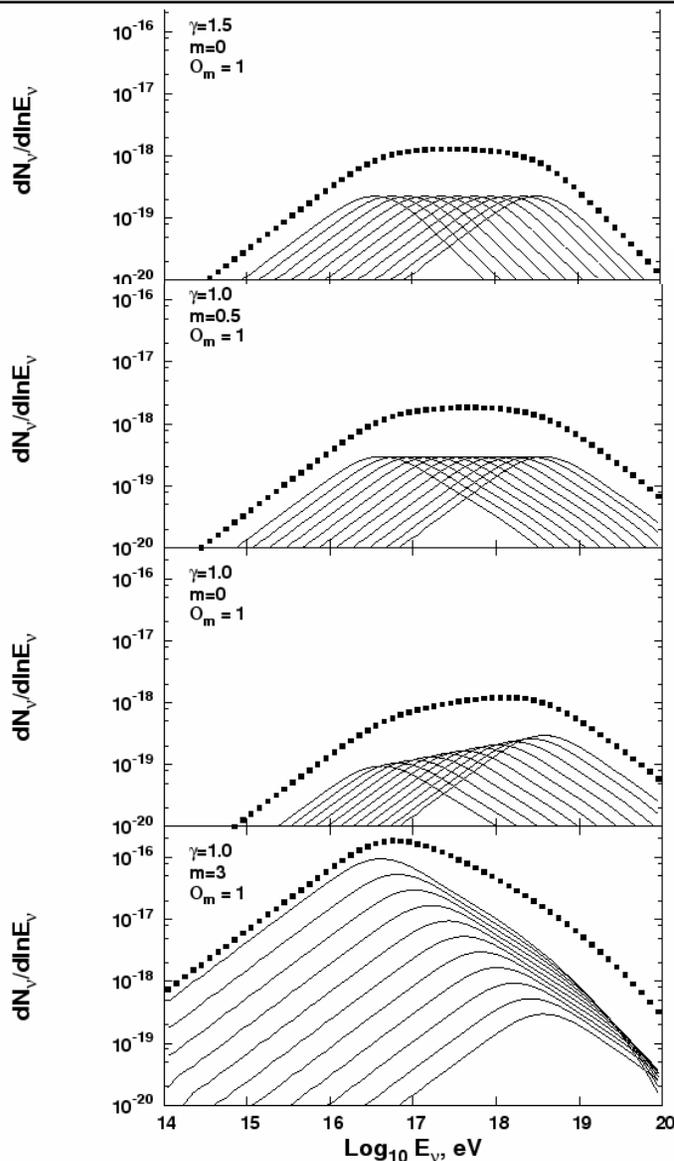- n-decayforanti- ν_e

Reasonablelandmark– but…

- Whatarelimits?
- Simplescalingwithm, γ formatterdominated

$$E_\nu \frac{dy}{dE_\nu}(E_\nu, \epsilon_p, z) = E_\nu \frac{dy_0}{dE_\nu}(q^2 E_\nu, q\epsilon_p)$$

$q = 1+z$

$$E_\nu \frac{d\Phi}{dE_\nu}(E_\nu) = \frac{A}{H_0} \int_0^{q_{max}} d(\ln q) q^{(m+\gamma-\frac{3}{2})} E_\nu \frac{dY_{0\gamma}}{dE_\nu}(q^2 E_\nu)$$

Changemagnitudeofyield
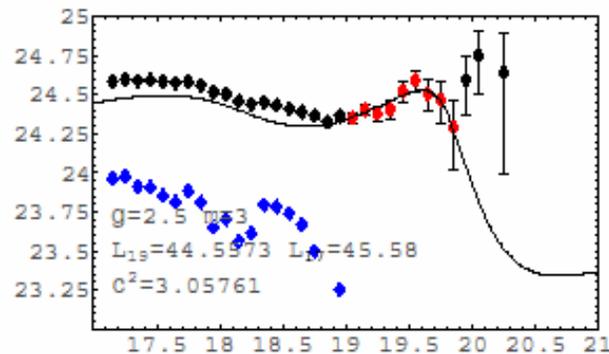withepoch

Shiftenergyofyield
withepoch

SimplescalingofGZK
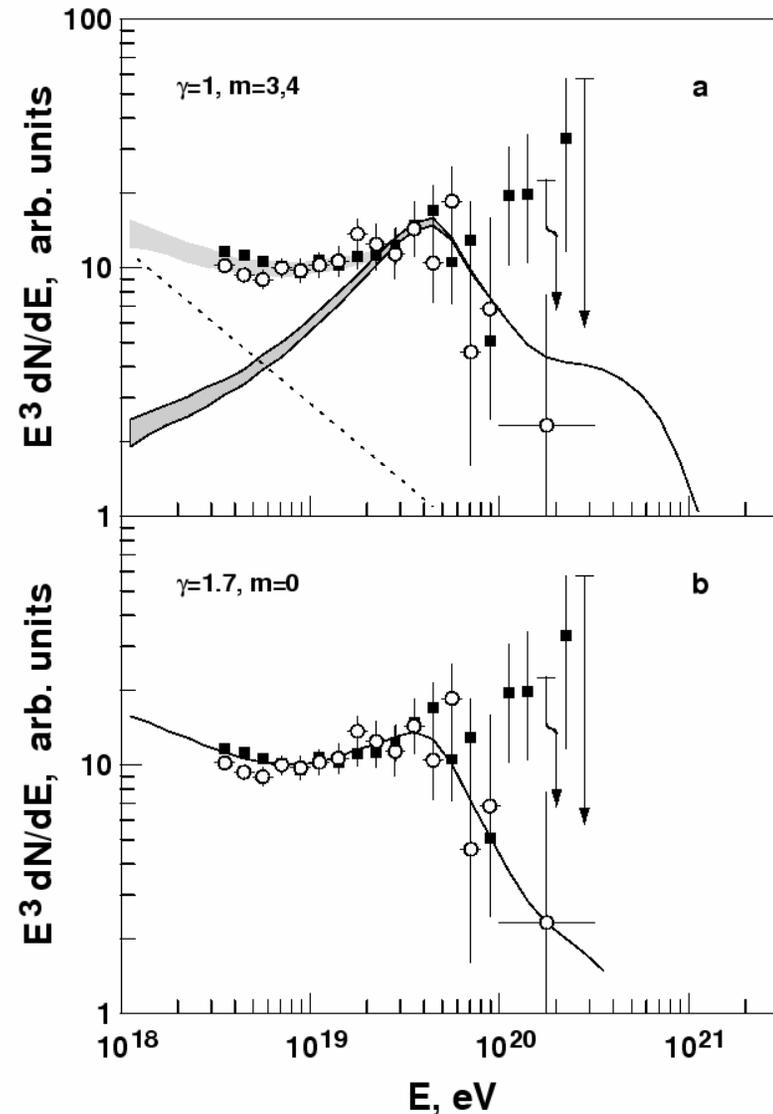

- Spectrum: $(E_p)^{-(1+\gamma)}$

- Evolution $(1+z)^m$

- Matterdominatedcosmology $(1+z)^{-5/2}$

- Spacing $\Delta(\ln q) = 1 dB$

- Considereffectsof z_{max}, Λ

- ShapeofYchangeswith γ

Discussion: Degeneracy of UHECR models

a) Flat spectrum, evolution, galactic contribution

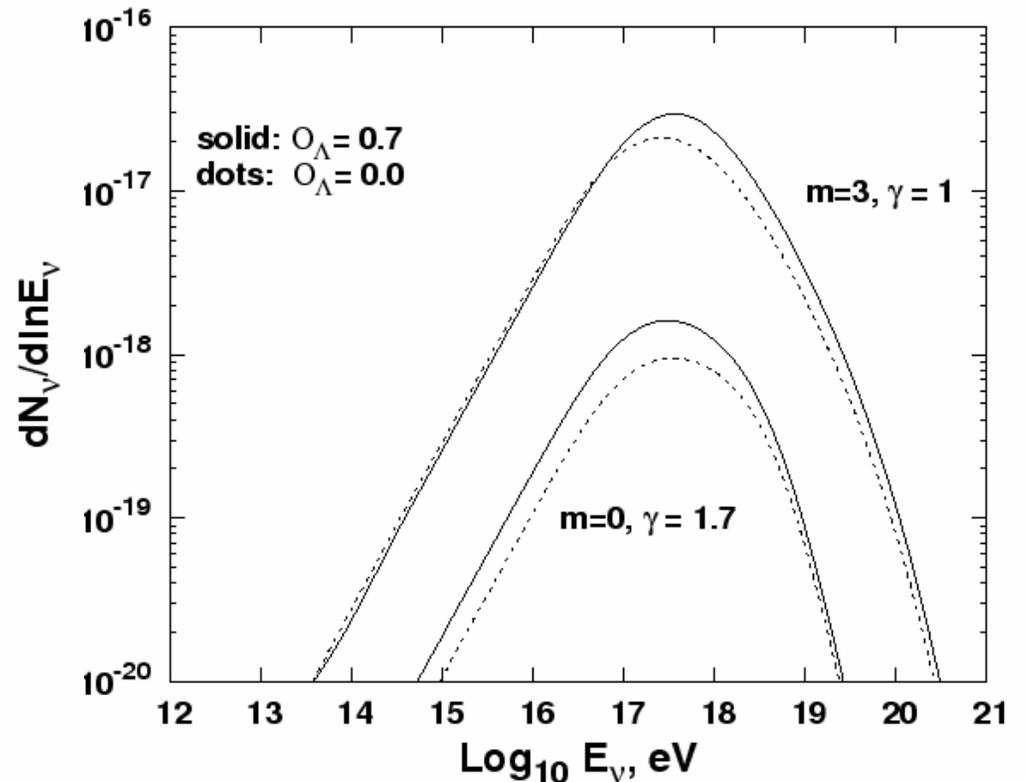b) Steep spectrum, no evolution, no galaxy

DeMarco: Steep w/ evolution is OK
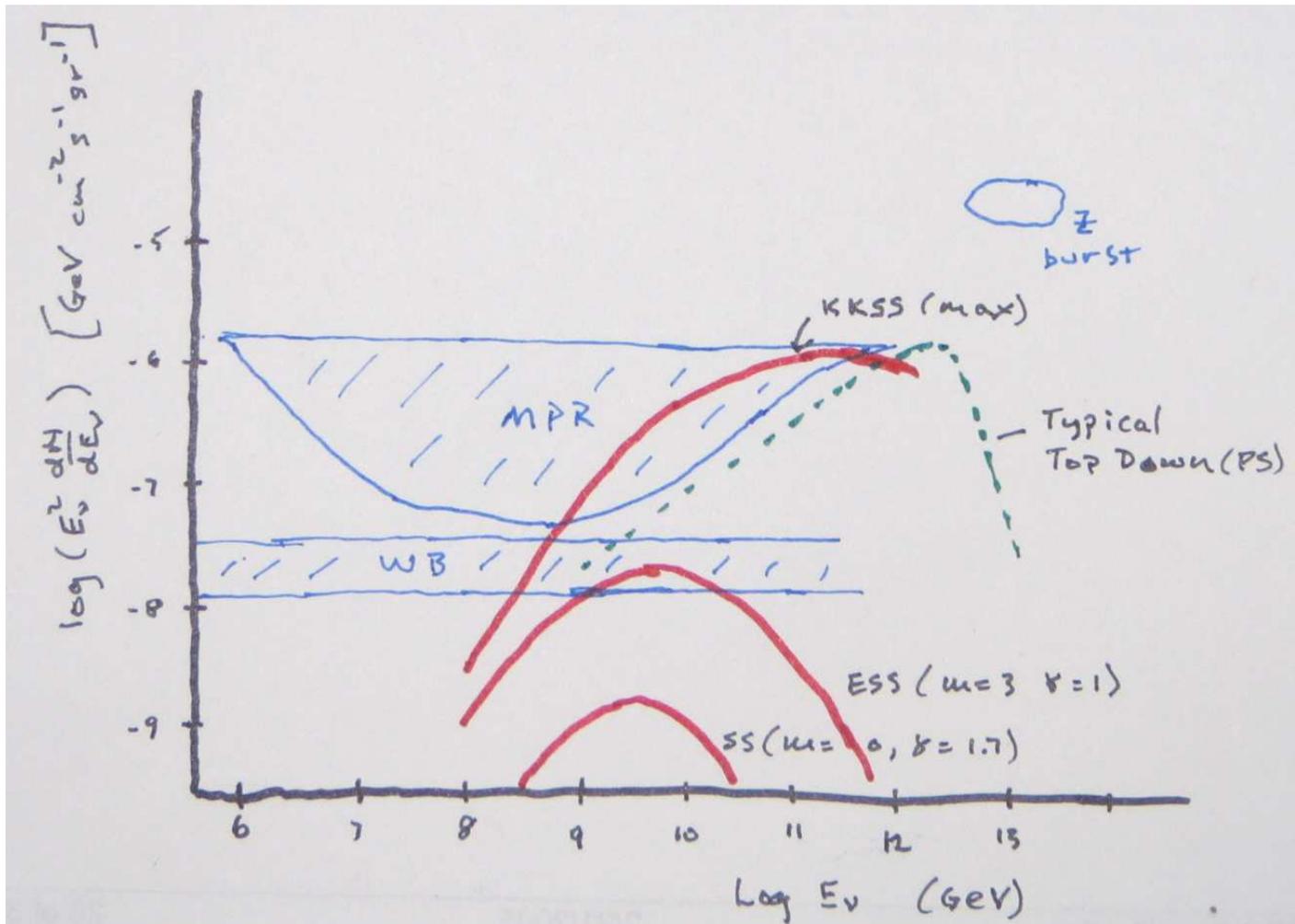
Neutrinosbreakdegeneracy

a)Flatspectrum,
    evolution,galactic
    contribution

b)Steepspectrum,no
    evolution,no
    galaxy

c)Cutoffs,Lambda…

RangeofGZKpossibilities

Summary

- WiderangeofmodelsforUHEneutrinoproduction

- GZKmechanismisconsequenceofUHECR observations

- GZKneutrinosarerobustprediction,butstillperhap s one orderofmagnitudeuncertainty

- ESSfluxmaybeconsideredasa"landmark"

- ObservationofGZKneutrinoswouldbeanimportant constraintonsourcemodelsforUHECR