

Neutrino Physics: Lecture 6

Solar neutrino problem

Amol Dighe

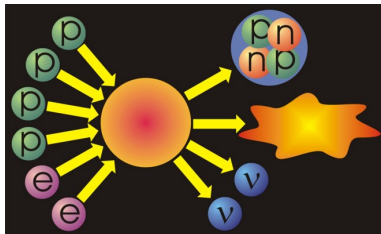
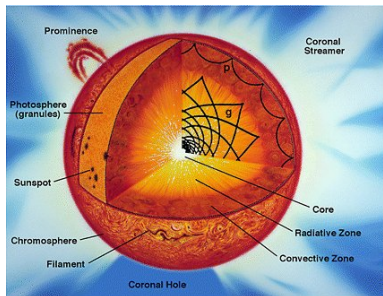
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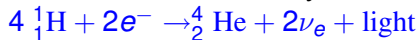
- 1 Neutrinos from the sun
- 2 Solar neutrino measurements

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The interior of the sun



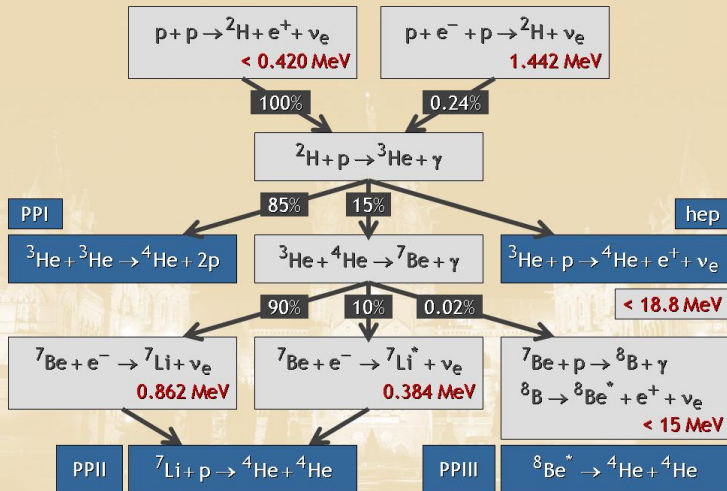
- Nuclear fusion reactions: effectively



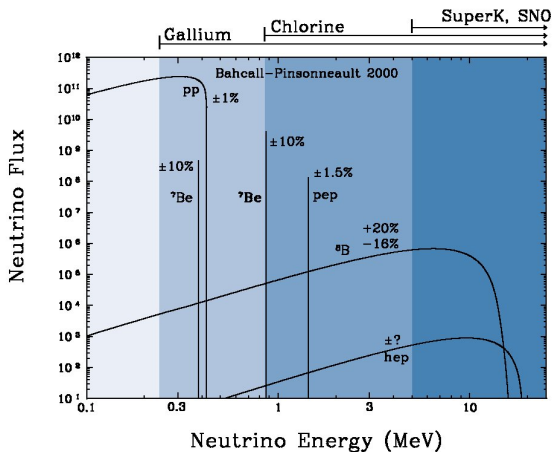
- Neutrinos an essential part of all the sub-reactions:

Nuclear reactions inside the Sun

Hydrogen burning: Proton-Proton Chains



The solar neutrino spectra



- Magnitudes of fluxes depend on details of solar interior
- Spectral shapes robustly known

- 1 Neutrinos from the sun
- 2 Solar neutrino measurements

Radiochemical experiments

Chlorine experiment: $\nu_e + {}^{37}\text{Cl} \rightarrow {}^{37}\text{Ar} + e^-$ (0.814 MeV)

- Homestake Data/SSM: $0.33 \pm 0.03 \pm 0.05$

Gallium experiments: $\nu_e + {}^{71}\text{Ga} \rightarrow {}^{71}\text{Ge} + e^-$ (0.233 MeV)

- SAGE Data/SSM: $0.58 \pm 0.06 \pm 0.03$
- Gallex Data/SSM: $0.60 \pm 0.06 \pm 0.04$
- GNO Data/SSM: $0.51 \pm 0.08 \pm 0.03$

Radiochemical experiments

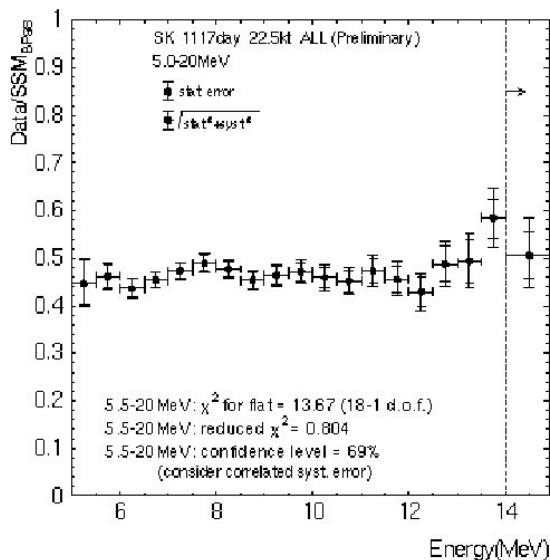
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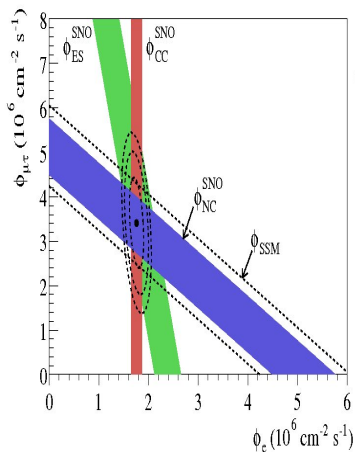
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Water Cherenkov experiment: Super-Kamiokande

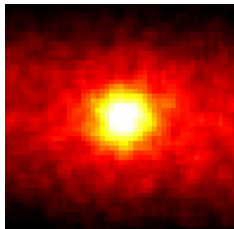
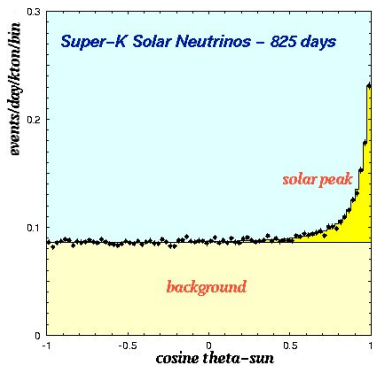


Heavy water experiment: SNO



- $\nu_e D \rightarrow p p e^-$
sensitive to Φ_e
- $\nu_{e,\mu,\tau} e^- \rightarrow \nu_{e,\mu,\tau} e^-$
Sensitive to $\Phi_e + \Phi_{\mu\tau}/6$
- $\nu_{e,\mu,\tau} D \rightarrow n p \nu_{e,\mu,\tau}$
sensitive to $\Phi_e + \Phi_{\mu\tau}$

Looking at the sun in neutrinos



Consolidated solar neutrino results

Total Rates: Standard Model vs. Experiment
Bahcall-Serenelli 2005 [BS05(OP)]

