Introductory Astronomy

Week 4: Stars
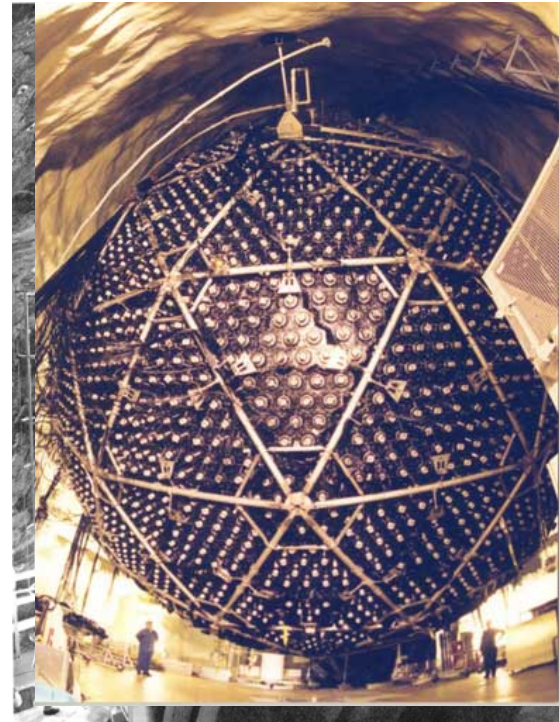
Clip 4: Neutrinos and a Surprise

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How Do We Know?

- Theory (Eddington, Bethe 1932) first
- Davis, Bahcall (1968): Detect the ν_e
- Pro: Penetrate Sun
- Con: Penetrate detector
- Flux at Earth: $10^{11}\,\dfrac{\nu_e}{\mathrm{m}^2\,\mathrm{s}}$

- Put a tank with $380\,\mathrm{m}^3$ of Chlorine in Homestake Gold Mine

$$^{37}\mathrm{Cl} + \nu_e \rightarrow {}^{37}\mathrm{Ar} + e$$

- Requires high-energy ν_e produced in other processes
- Expect one atom per six days

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Where Are the Neutrinos?

- Flux Found is less than predictions

- Is Solar Model wrong?

- Is detector model wrong?

- Decided in 2001 by SNO: particle physics

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More Particles, More Charges

Particle	Q	N_e	N_μ	N_τ	Mass
p	1	0	0	0	935
n	0	0	0	0	938
e	-1	1	0	0	0.511
ν_e	0	1	0	0	?
μ	-1	0	1	0	106
ν_μ	0	0	1	0	?
τ	-1	0	0	1	1777
ν_τ	0	0	0	1	?

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So What?

- Neutrinos change spontaneously en route

- pp process produces ν_e

- When they arrive, 1/3 are ν_e

- This implies, in particular, that neutrinos are not massless although light.

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Credits

- SNO: View of the SNO detector after installation of the bottom PMT panels, but before cabling. Photo courtesy of Ernest Orlando Lawrence Berkeley National Laboratory
http://www.sno.phy.queensu.ca/sno/images/publicity_photos/index.html

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