

SOLARE NEUTRINOS

HERKUNFT UND NACHWEIS

DAVID PLOTZKI

MATERIAL: PHSK.NET/NEUTRINO

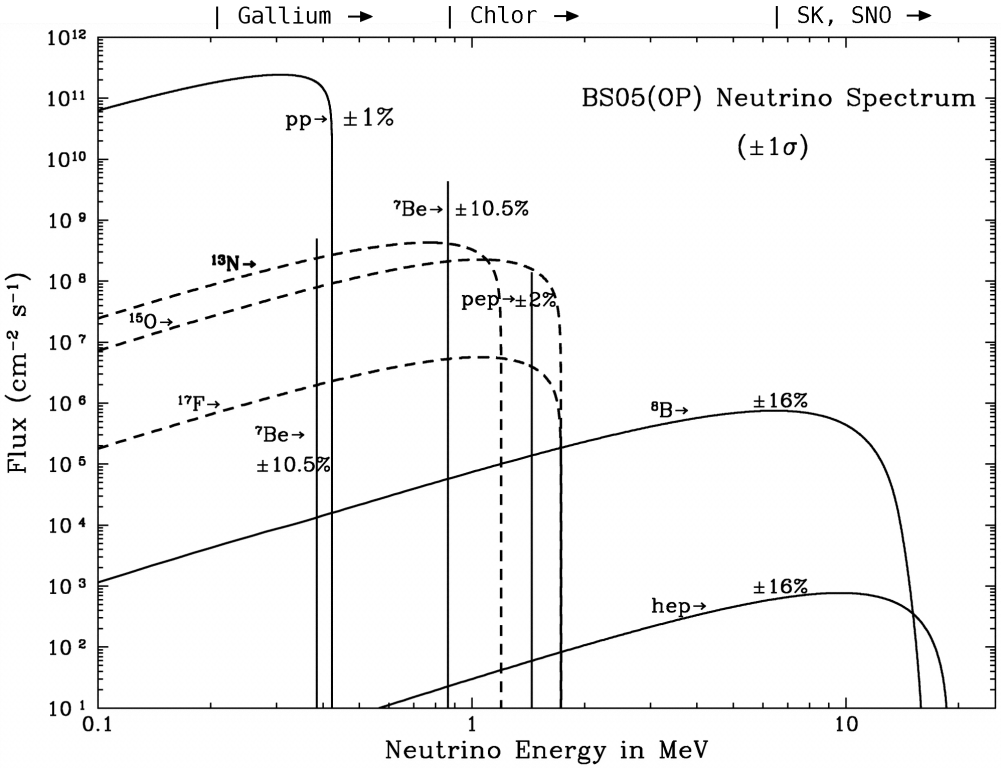
LEPTONEN

e	μ	τ	$q = -1$
ν_e	ν_μ	ν_τ	$q = \pm 0$

KERNFUSION IN DER SONNE

		$\langle E_\nu \rangle$ (MeV)	$E_{\nu, \max}$ (MeV)
pp	$p + p \rightarrow d + e^+ + \nu_e$	0.2668	0.423 ± 0.03
pep	$p + e^- + p \rightarrow d + \nu_e$	1.445	1.445
hep	${}^3\text{He} + p \rightarrow {}^4\text{He} + e^+ + \nu_e$	9.628	18.778
${}^7\text{Be}$	$e^- + {}^7\text{Be} \rightarrow {}^7\text{Li} + \nu_e$	0.8631	0.8631
${}^8\text{B}$	${}^8\text{B} \rightarrow 2 {}^4\text{He} + e^+ + \nu_e$	6.735 ± 0.036	≈ 15
${}^{13}\text{N}$	${}^{13}\text{N} \rightarrow {}^{13}\text{C} + e^+ + \nu_e$	0.7063	1.1982 ± 0.0003
${}^{15}\text{O}$	${}^{15}\text{O} \rightarrow {}^{15}\text{N} + e^+ + \nu_e$	0.9964	1.7317 ± 0.0005
${}^{17}\text{F}$	${}^{17}\text{F} \rightarrow {}^{17}\text{O} + e^+ + \nu_e$	0.9977	1.7364 ± 0.0003

ENERGIESPEKTRUM



STANDARD SOLAR MODEL

JOHN NORRIS BAHCALL

SOLARES NEUTRINODEFIZIT

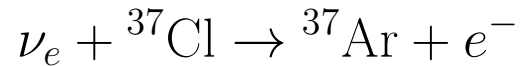
NEUTRINOOSZILLATIONEN

BRUNO PONTECORVO, 1957

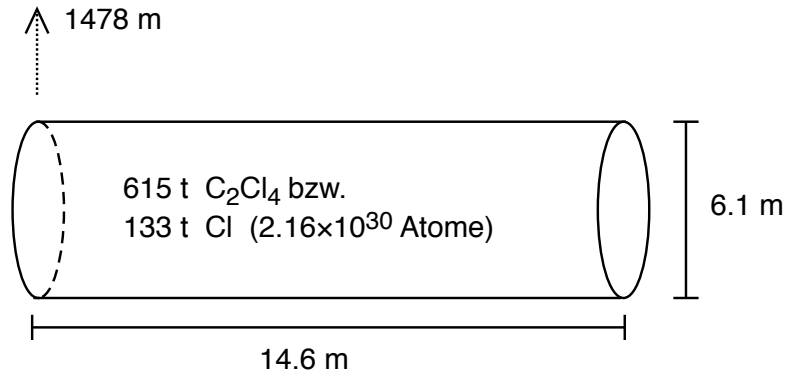
$$\nu_e \longleftrightarrow \nu_\mu \longleftrightarrow \nu_\tau$$

HOMESTAKE-EXPERIMENT

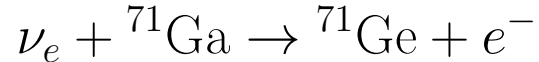
1970 - 1994, RAYMOND DAVIS JR., NOBELPREIS 2002



$$E_\nu^{\text{th}} = 0.814 \text{ MeV}$$



GALLIUM-EXPERIMENTE

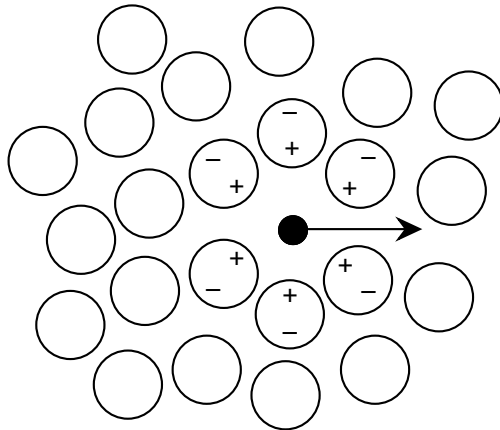


$$E_\nu^{\text{th}} = 0.233 \text{ MeV}$$

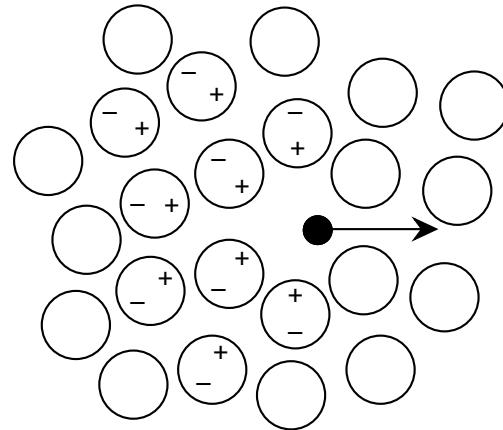
GALLEX/GNO ITALIEN 1991 - 2003

SAGE SU/USA seit 1990

ČERENKOV-EFFEKT



$V < C_{\text{med}}$



$V > C_{\text{med}}$

KAMIOKANDE

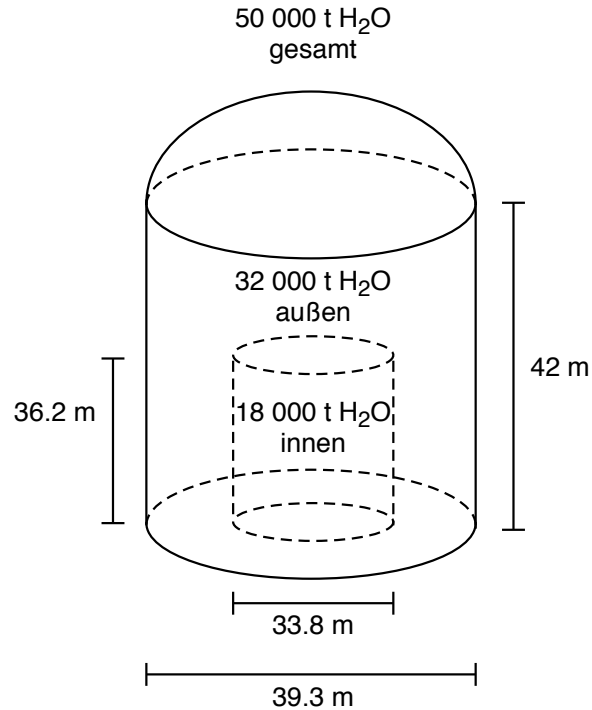
STUFE I	1983 - 1987	$E_\nu^{\text{th}} = 9.0 \text{ MeV}$
STUFE II	1987 - 1990	$E_\nu^{\text{th}} = 7.2 \text{ MeV}$
STUFE III	1990 - 1996	$E_\nu^{\text{th}} = 6.7 \text{ MeV}$

ELASTISCHE ELEKTRONENSTREUUNG

$$\nu_\alpha + e^- \rightarrow \nu_\alpha + e^-$$

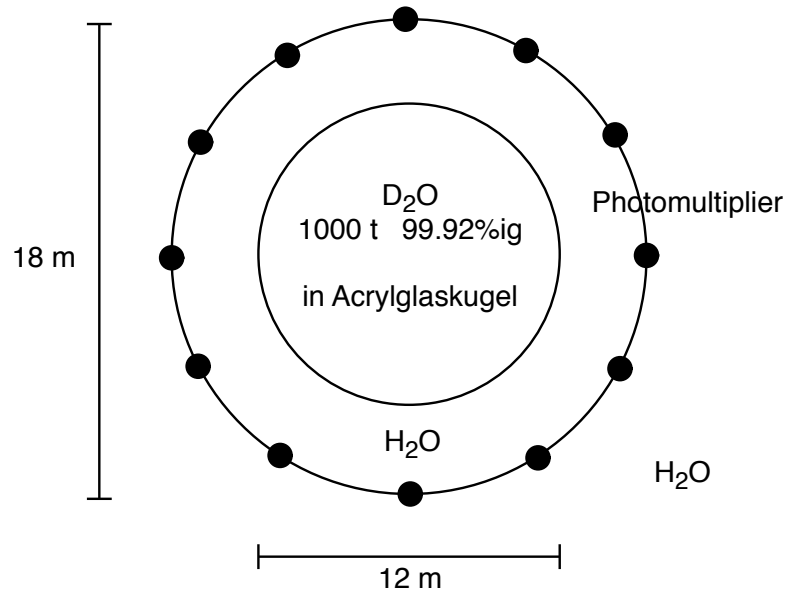
SUPER-KAMIOKANDE

MASATOSHI KOSHIBA, NOBELPREIS 2002



SNO

SUDBURY NEUTRINO OBSERVATORY, CANADA



SNO: REAKTIONEN

$$\mathbf{CC} \quad \nu_e + d \xrightarrow{W^-} p + p + e^- \quad E_\nu^{\text{th,CC}} = 1.442 \text{ MeV}$$

$$\mathbf{NC} \quad \nu_\alpha + d \xrightarrow{Z} p + \mathbf{n} + \nu_\alpha \quad E_\nu^{\text{th,NC}} = 2.224 \text{ MeV}$$

$$\mathbf{ES} \quad \nu_\alpha + e^- \rightarrow \nu_\alpha + e^- \quad E_\nu^{\text{th,ES}} = 5.7 \text{ MeV}$$

NEUTRONENNACHWEIS

$$\text{D}_2\text{O}: \quad n + d \rightarrow {}^3\text{H} + \gamma \quad (6.25 \text{ MeV})$$

$$\text{NaCl}: \quad n + {}^{35}\text{Cl} \rightarrow {}^{36}\text{Cl} + x\gamma \quad (8.57 \text{ MeV})$$

$${}^3\text{He}: \quad {}^3\text{He} + n \rightarrow p + {}^3\text{H}$$

DANKE FÜR DIE AUFMERKSAMKEIT!

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ASTROPHYSICS, CARLO GIUNTI and CHUNG W. KIM**

RAYMOND DAVIS JR.'s WEBSITE

bnl.gov/bnlweb/raydavis/research.htm

THE SNO WEBSITE

sno.phy.queensu.ca