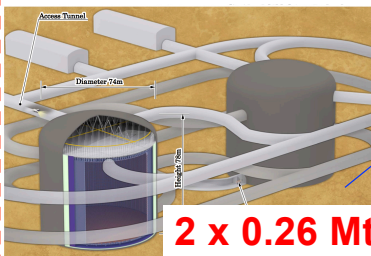


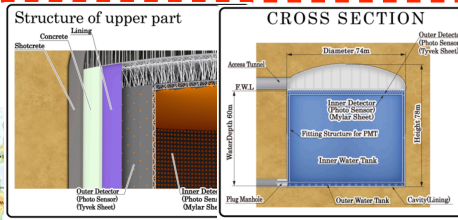
Luis Labarga for the Hyper-Kamiokande proto-Collaboration

The next generation large water-Cherenkov detector



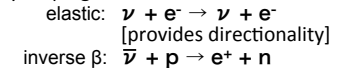
2 x 0.26 Mt

Kamioka-cho, Hida Gifu, JAPAN



Water Cherenkov

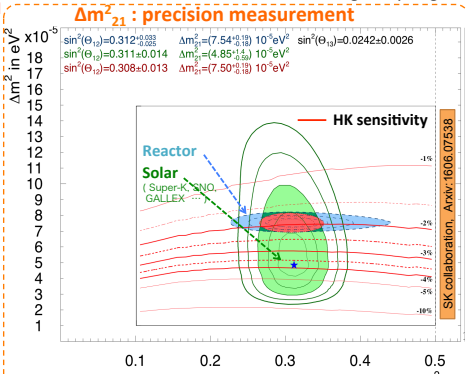
- allows to instrument huge amounts of matter
- reconstruction of energy, position, direction and type of the interacting ν
- most relevant detection reactions for this physics program:



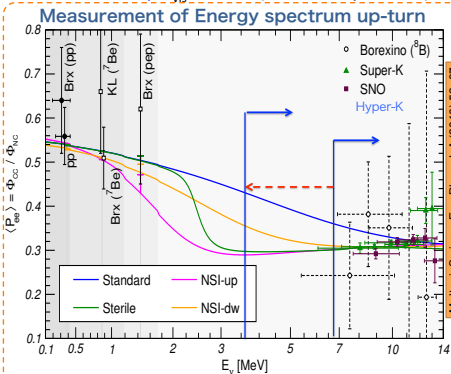
Design	Super-Kamiokande	Hyper-Kamiokande
Shape of tank(s)	1 Cylinder	2 Cylinders. 1 st tank will be ready at 2026 2 nd tank will be 6 yrs later (staging)
N of PMT (ID/OD)	11,129 / 1,885	40,000 / 6,700
Photocoverage	40%	40% (x2 p.e. detectability with new PD)
Total / Fiducial Volume	50 kt / 22.5 kt	0.52 Mt / 0.37Mt (0.187 Mt x2)

Solar Neutrinos

- from nuclear fusion reaction in the Sun: pp-chain, CNO-cycle
- HK brings very large statistics: 130 ν ev./day, $E_{\nu, \text{vis}} > 5$ MeV (15 ν ev./day in SK-IV)

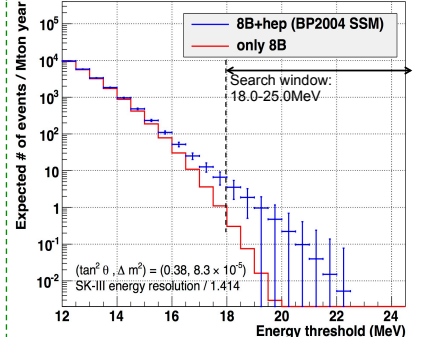


- $\approx 2\sigma$ tension for Δm_{21}^2 between reactor ν and solar ν
- verification by terrestrial matter effect (D/N asym.) separable by $\sim 6\sigma$ (staging 10y)



- Verification of neutrino oscillation and search for BSM physics \rightarrow Non-standard interactions, sterile ν ...
- separable w/ up-turn from w/o up-turn with $\sim 5\sigma$ (3.5MeV threshold, staging 10y)

hep: discovery and measurement



- neutrino from He+p reaction at the sun
- verification of SSM
- very small fraction; yet undiscovered.
- expected (10y): 8.5 ev (+BG 0.7ev.)

Supernova Neutrinos

- one of the most energetic phenomena in the Universe

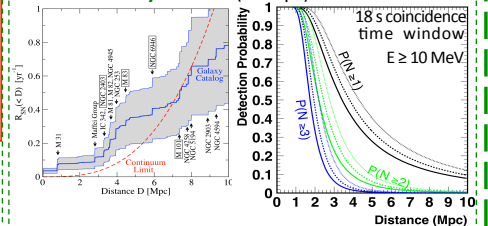
- E released $\approx 3 \times 10^{53}$ ergs, mostly carried out by ν s

Galactic Supernova

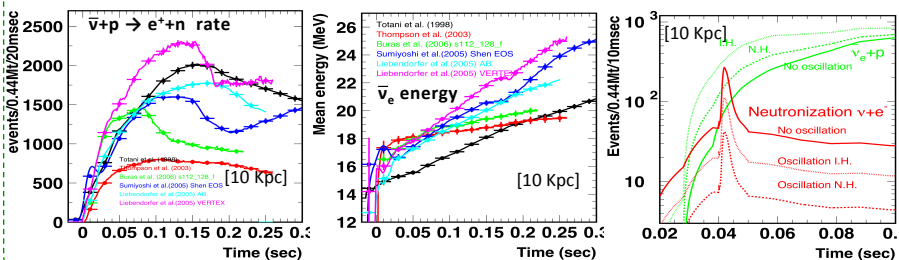
- SN at ~ 10 Kpc: $\sim 100 - 160k$ ν events at HK \rightarrow (10kpc, Livermore model)
- HK's unique: very low E threshold ≈ 3 MeV, $\Delta E/E \approx 10\%$ at 10-20MeV, sensiti. to $\bar{\nu} + p \rightarrow e^+ + n$
- properties of SN: time evolution of ν flux, energy, type
- properties of ν s: neutrino-neutrino self-interaction, mass hierarchy, absolute mass, ν 's lifetime

Neutrino source	2 tanks
$\bar{\nu}_e + p$	98,000~136,000
$\nu_e + e^-$	4,200~5,000
$\nu_e + ^{16}\text{O}$ CC	160~8,200
$\bar{\nu}_e + ^{16}\text{O}$ CC	1,300~7,800
$\nu_e + e^-$ (Neutronization)	12~80
Total events.	104,000~158,000

SN in nearby Galaxies (> 1Mpc)



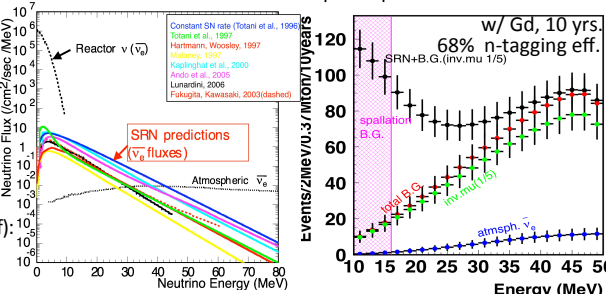
- large volume of HK: $\approx 2-20$ SN events in 20y
- reference energy spectrum, without varying red-shift effects. for DSNB E spectrum
- prove strange supernovae, eg. dim supernovae



Diffuse Supernova Neutrino Background

also Supernova Relic Neutrino (SRN): diffused, integrated ν from all past supernovae of Universe

- history of star formation, rate
- Energy spectrum: red-shifted average along the history of the Universe
- prospects for HK
- 10 yrs: $\sim 98 \pm 20$ events (4.8 σ)
- 20 yrs: 240 ± 30 events
- if neutron tagging (Gd, 68% eff): ~ 560 events in 10 yrs (see fig.)



Summary

- The next generation water Cherenkov experiment, **Hyper-Kamiokande**, is becoming a reality
- Astrophysics is an important part of its scientific mission
- Very relevant results on solar neutrino physics
- Fantastic info. on SN formation (if a galactic SN occurs)
- Measurement of ν interactions at high temperatures and densities (if a galactic SN occurs)
- Discovery and measurement of Diffuse SN ν Background

Hyper-Kamiokande: the unique experiment for low and medium energy ν astrophysics

- #638-talk Y. Nishimura "New 50 cm Photo-Detectors for HK"
- #1036-talk M. Gonin "HK's neutrino oscillation physics sensitivity"
- #516-talk L. Labarga "Non-accelerator physics with HK" <xz>