1. Measurement of pp/Be solar neutrino

- Purpose: precise oscillation parameter $\theta_{13}$
  - $90\%$ C.L. allowed region obtained by global fit
  - LMA solution (blue) vs CHG + SIK (DIN spectrum)
  - KamLAND (green) = confirm $\theta_{13} < 27^\circ$

- 2$\pi$ going solar $\beta$ experiment
  - KamLAND (liquid scintillator, electron elastic scattering [EES])
  - Borexino (liquid scintillator, ESI)

- Future solar pp/Be experiment
  - XMASS (LXe, ES, DARK MATTER)
  - LENS (liquid scintillator loaded In/Ye, charged current [CC])

- Solvent: Benzonitrile (PCN: C$_4$H$_6$CN)
- Density: 1.0g/mL, flash point: 77°C
- Photon emission: 291nm at maximum
- Solubility of InQ$_3$: complex 2mole
- Attenuation length: 66cm ($\sim$0.5%)

2. IPNOS phase-I experiment

- Indium Project on Neutrino Observation for Solar interior (IPNOS) experiment
  - Hybrid structure of In and external scintillator
    - In: multi-pixel detector (10cmX10cmX2.2mm cell)
    - External scintillator (LXe or LXe)
  - 4tons of $^{109}$In detector for solar $\nu$ experiment
  - InP: 5.1tons (2.0X10$^2$ modules with $\Delta E$-E-10%)
  - High Z material for external scintillator
  - Total size ~5m X 5m X 5m (depends on structure)

- IPNOS phase-I detector
  - 30cm cubic chamber (like XMASS 100kg prototype detector)
  - InP multi-pixel detector inside of Liquid Xenon
  - Chamber includes ~10kg InP detector
  - Spectral could be detected by InP itself

- Purpose
  - Demonstrate LowBG environment
  - Long stable operation (1ppv event will be expected for half year)
  - Detect scintillation form $\beta$ by InP detector

3. Neutrinoless Double Beta Decay

- Neutrinoless double beta decay
  - Lifetime and neutrino mass
    - $T_{1/2}^{\beta\beta}(\text{in}^{208}Tl)$
  - Energy spectrum and lifetime measurement
    - Monochromatic energy $\sim$ Q-value
    - $T_{1/2}^{\beta\beta}$-a(Me/EBE): a: abundance M: mass
      t: mean, time $\Delta E$: energy res. B: BG cnt. rate

- Double beta decay candidates
  - $^{209}$Pb, $^{210}$Pb, $^{76}$Ge, $^{116}$Cd,

- Experimental limits for neutrino mass

- Zirconium ($^{115}$Zr) is possible candidate

4. Metal complex in liquid scintillator

- Development of liquid scintillator using metal complexes
  - Goal: solubility: 10wt%, light yield: 60% of BGO
- 8-quinolinolate metal complex (organic Electro Luminescence)
  - $^{115}$In-8-quinolinolate indium (InQ$_3$)
  - $^{115}$InQ$_3$ (for solar $\nu$) and ZrQ$_4$ (10$\beta$ decay) have photo luminescence

- Synthesis efficiency
- Solution of organic solvent

- Luminescence of 8-quinolinolate metal complex

- Modification of 8-quinolinolate ligand

- Quantum Yield: 9.6% (PL: 5.0%)
- QE: 0.09
- 8-quinolinolate: Quantum Yield: 7.6% (PL: 1.1%)
- QE: 0.10
- Low light yield due to small QY (order ~5%)

- Double beta decay candidates

- Experimental limits for neutrino mass

- Zirconium ($^{115}$Zr) is possible candidate

5. Next step

- Develop liquid scintillator using metal complexes
- Solution of organic solvent

- Modify 8-quinolinolate ligand

- Dimethoxy-Triazine as substitute

- Quantum Yield: 26.0% (PL: 20%)
- 2 X InQ$_3$
- QE: 0.19
- 2 X InQ$_3$
- L.Y.: 2.7 X InQ$_3$

- Synthesize ZrQ$_4$(T$_2$)$_3$ complex

- Synthesize Zr-ODZ complex

- Emission and Absorption problem
  - Absorption band was overlapped with emission light from anisole

- Synthesize diketon (acetyl aceton) complex with substitute
- Beta diketon complex

- Good solubility (over 10wt.%) for anisole has been reported

- Introduce electron-poor substitute

- Move absorption band to shorter wavelength