JUNO: the multipurpose neutrino experiment

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NARIT

Outline

- Introduction
- Neutrinos
- Neutrinos detection
- Neutrino experiments
- Thailand contribution




Introduction

"Multi-messenger astronomy" has become a fashionable word among astronomers. This is because current technologies allow open new windows to the Universe. From the previously illusive particle, neutrino has become one of such promising messenger. However, we still need to understand more about this particle to get a clearer picture of our Universe.

“Everything comes to him who know how to wait”

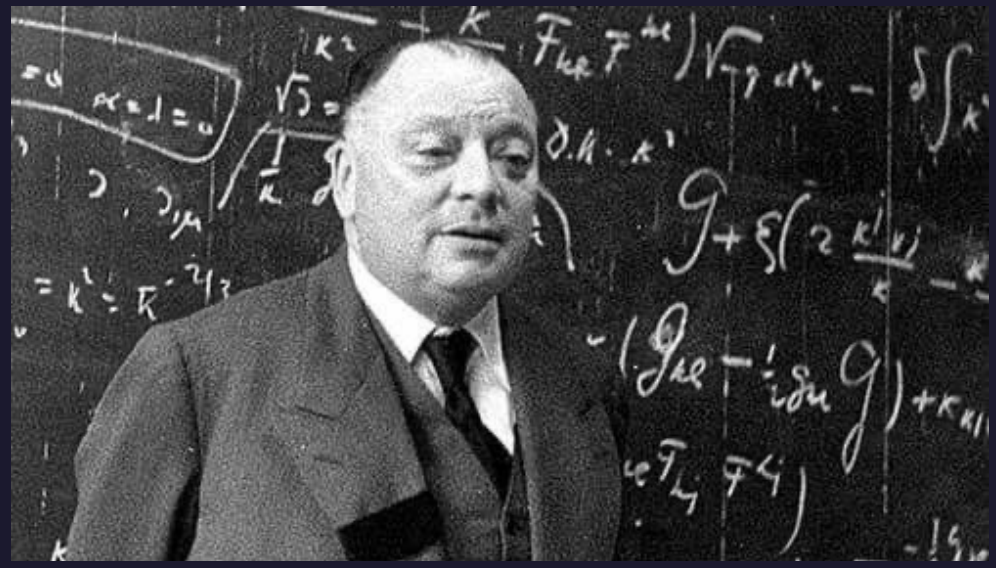
Wolfgang Pauli

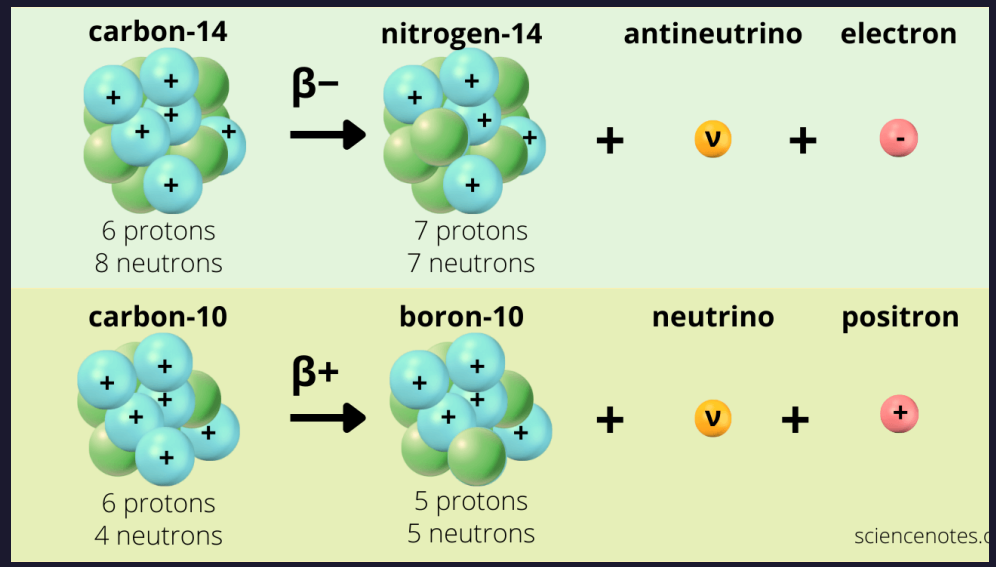
Neutrinos

What is neutrino?

HISTORICAL FACT

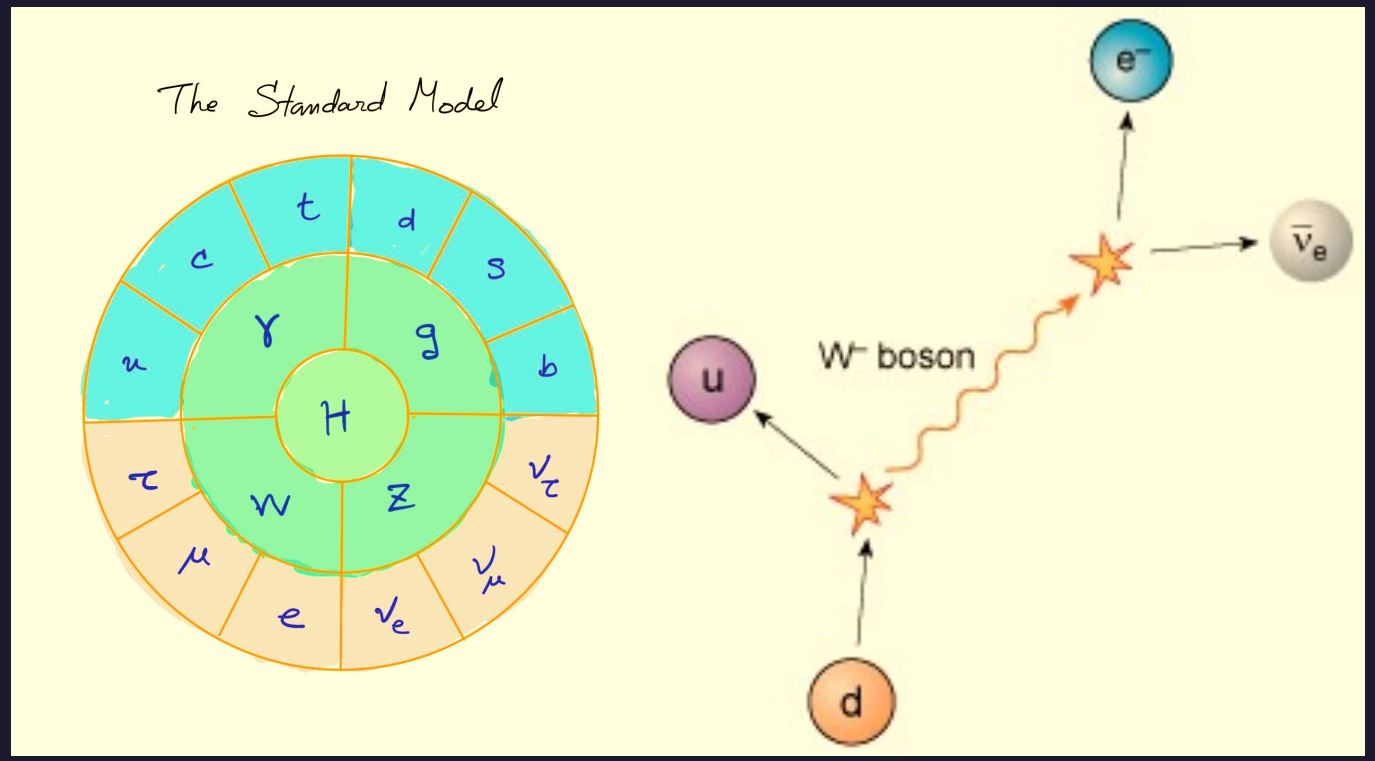
- Postulate by Wolfgang Pauli
- Beta decay
- Need a neutral particle: momentum conservation
- Possibly has tiny mass or massless





What is neutrino?

WHAT WE KNEW NOW



- SM particle
- There are 3 species: ν_e , ν_μ , ν_τ
- Weak interaction
- Massive but very small
- There is oscillation between species

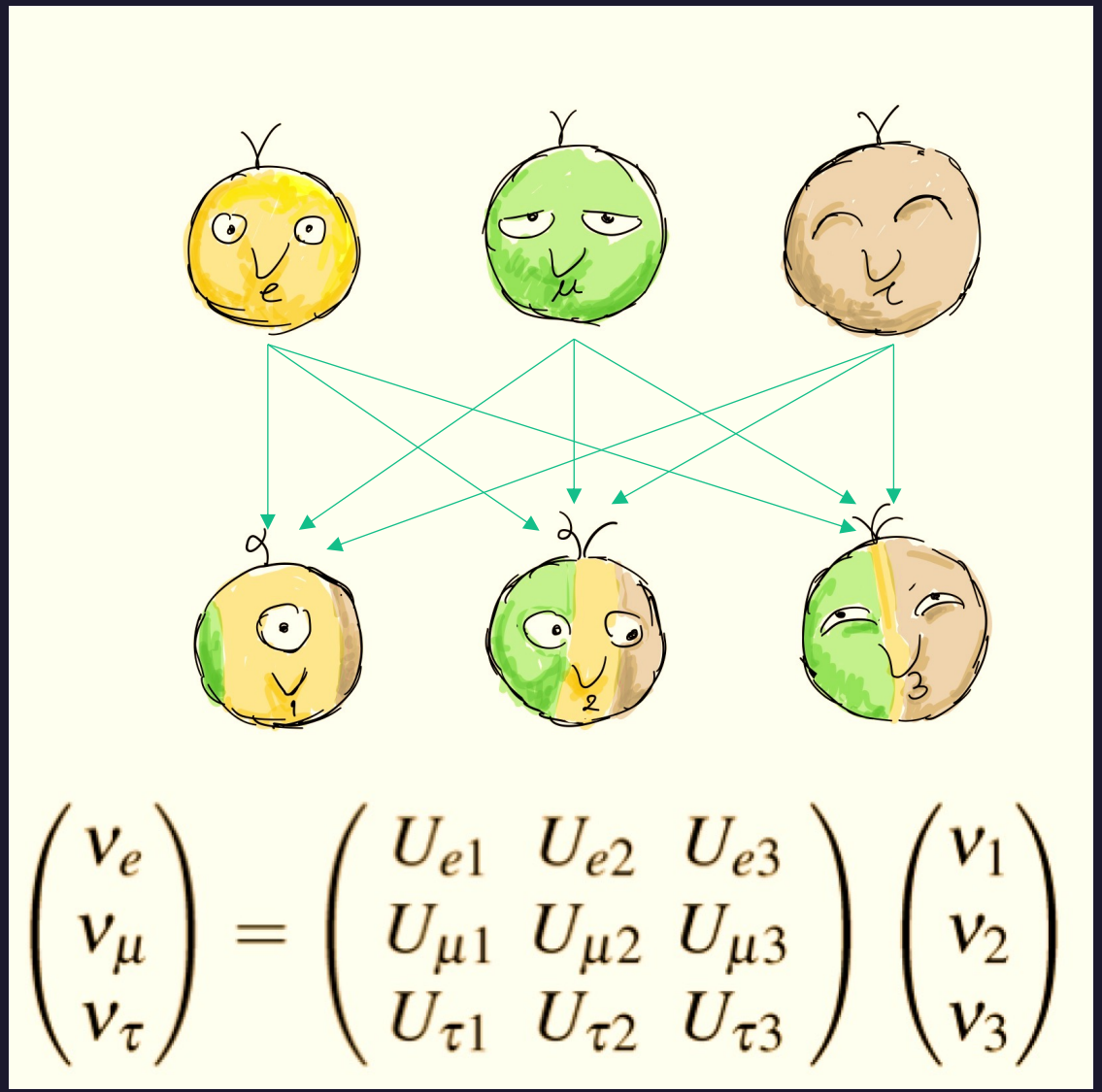
What is neutrino?

NEUTRONOS' OSCILLATION

- Need to be massive to have oscillation
- Change flavor with time
- Well-defined mass → mixed flavor
- Well-defined flaver → combination of mass states

What is neutrino?

- We don't know the absolute mass of neutrinos
- The mixing proportion is not fully characterised
- There are some constraint between these parameters
- Mixing matrix



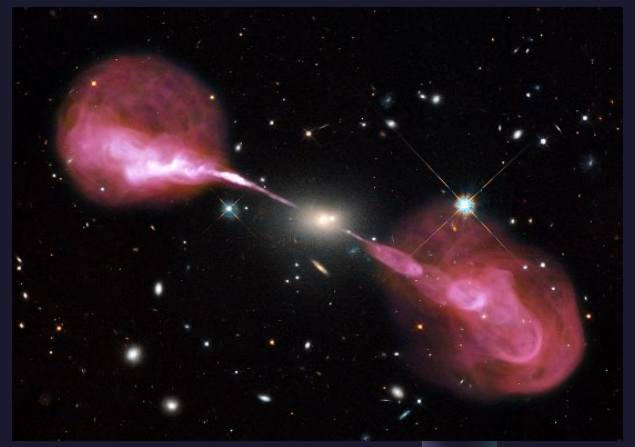
Why do we care?

- Neutrino sources all over our universe
- Understanding weak interaction
- Information from distance object e.g. AGN
- Possibly related to dark matter?
- Cosmological evolution
- New physics?

The sun [Freepik.com]

Nuclear Power plant
[Photo:Getty]

Super Nova
[James webb Telescope]

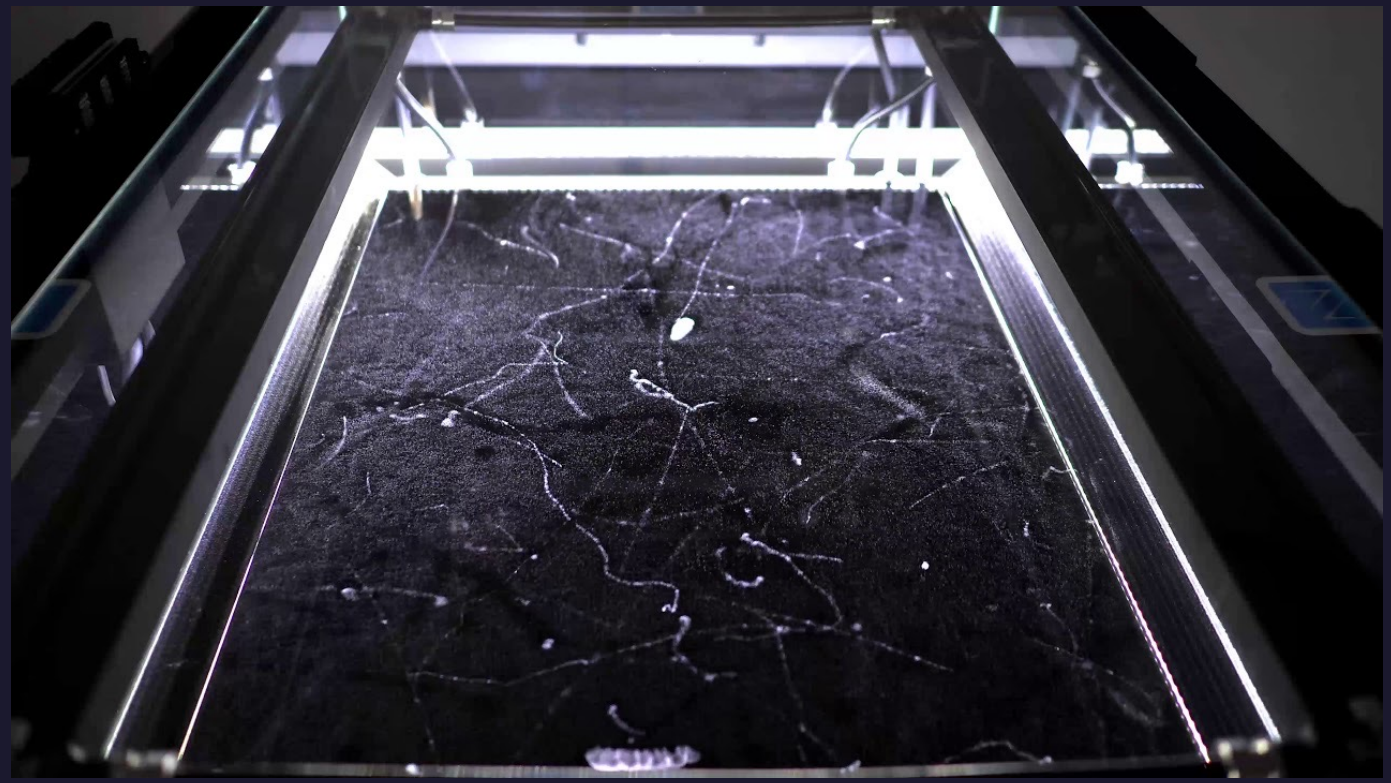


AGN jets

Neutrino detection

Detectingn neutrinos

CLOUD CHAMBER?



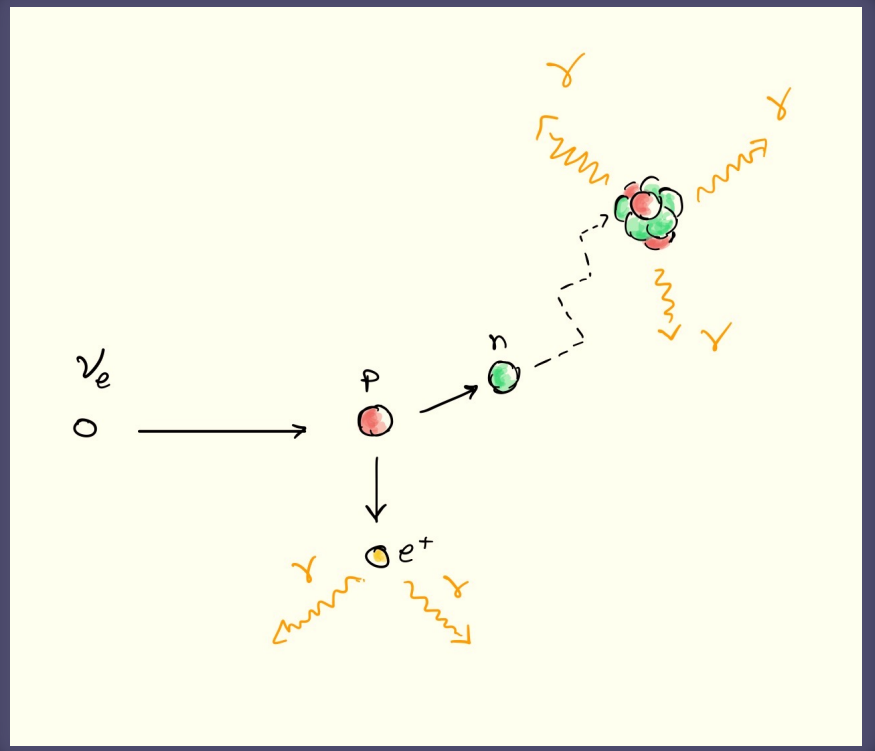
Detectingn neutrinos

CLOUD CHAMBER?

Detectingn neutrinos

LIQUID SCINTILLATOR

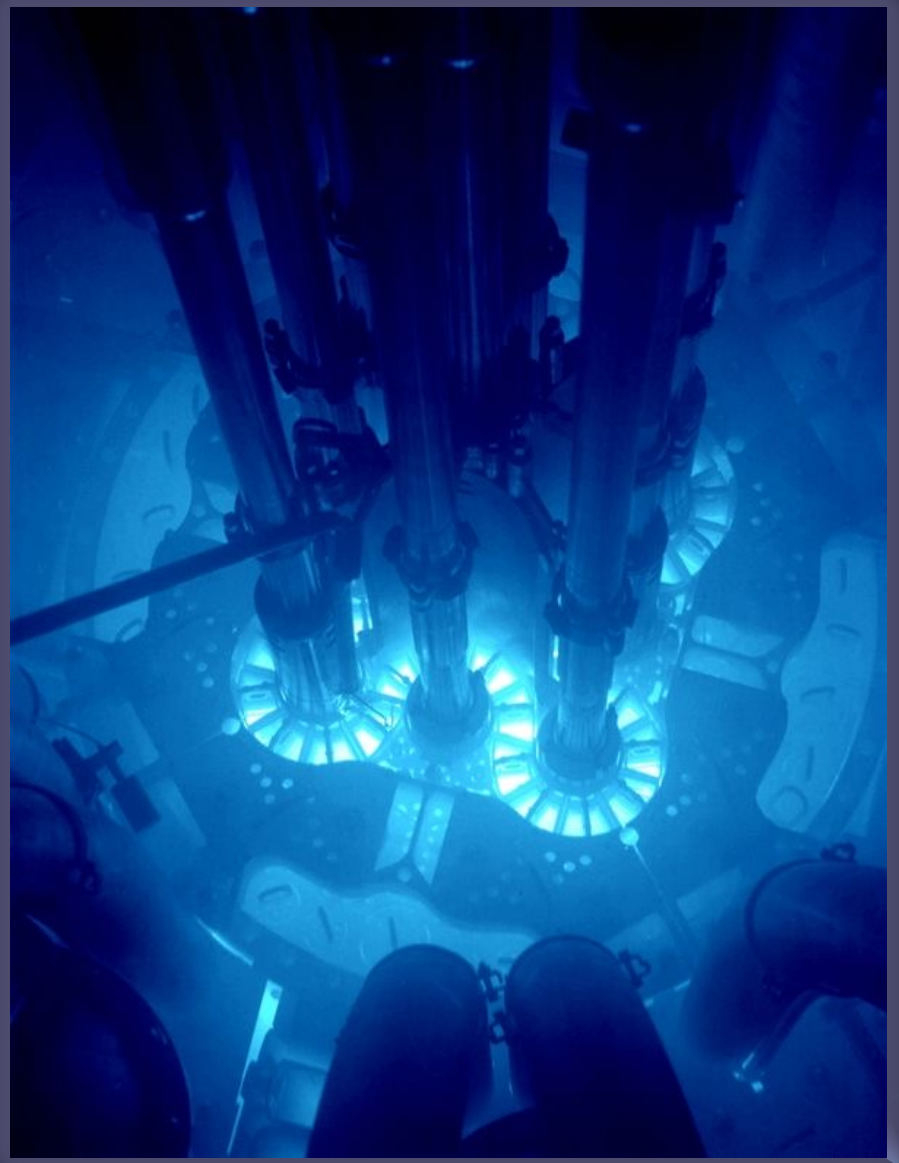
Need lots of these toIncrease the interaction rate



Detectingn neutrino

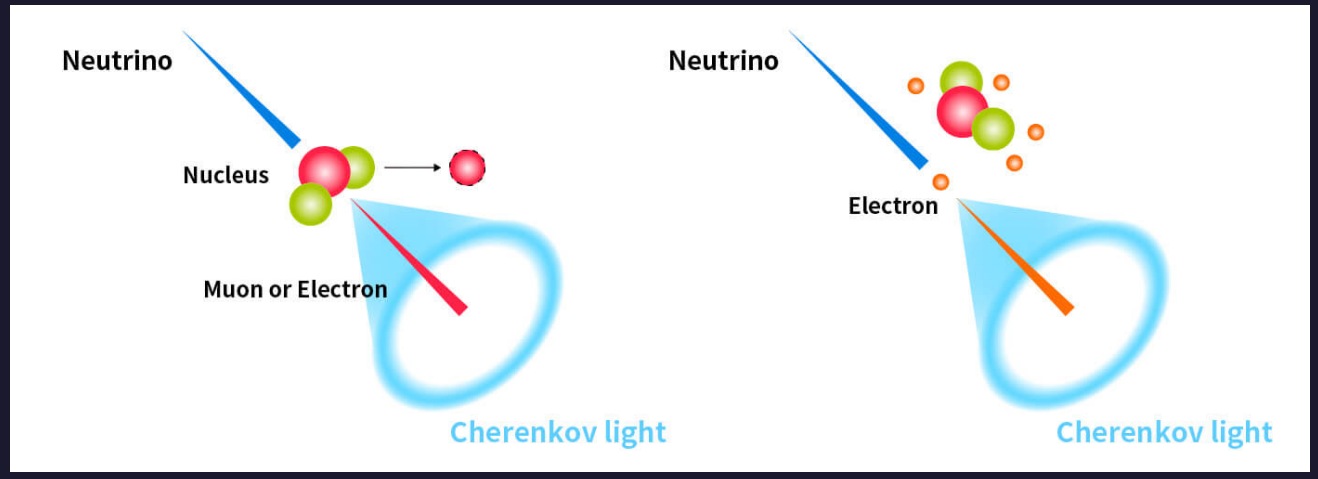
WATER: CHERENKOV RADIATION

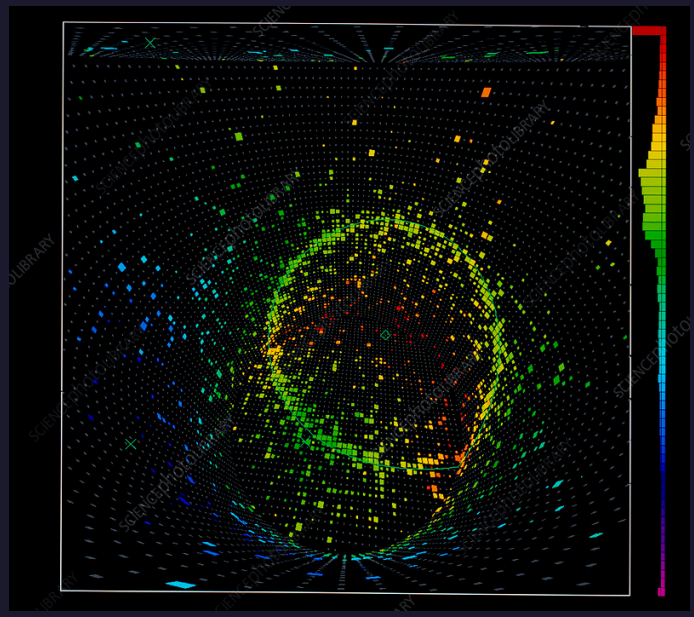
- Great for detecting high energy neutrinos
- Giving off blue glow
- Charge particle is faster than light (in the medium)



Detectingn neutrino

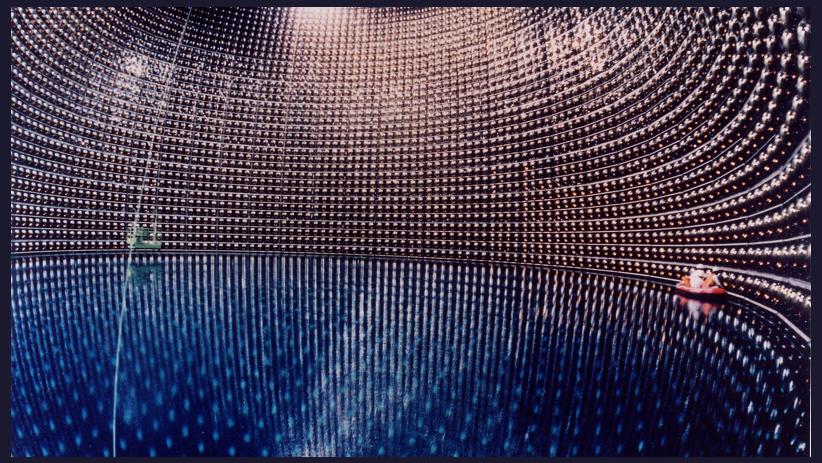
- Two possible processes
- Photo multiplier tube (PMT): JUNO
- Signal in super-K experiment



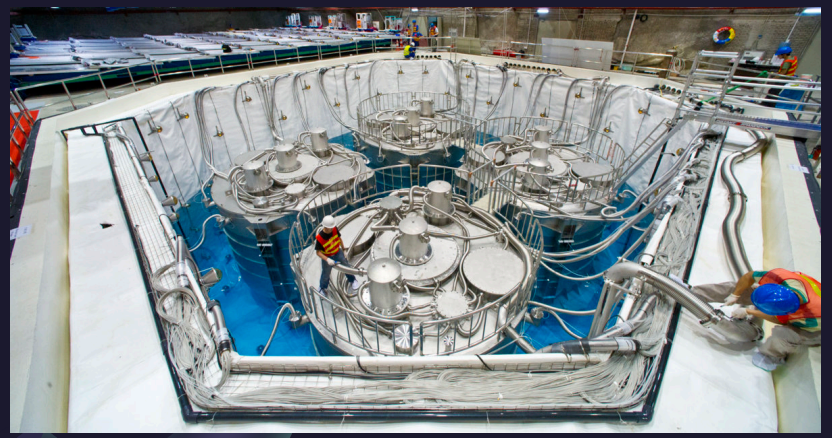


Neutrino experiment

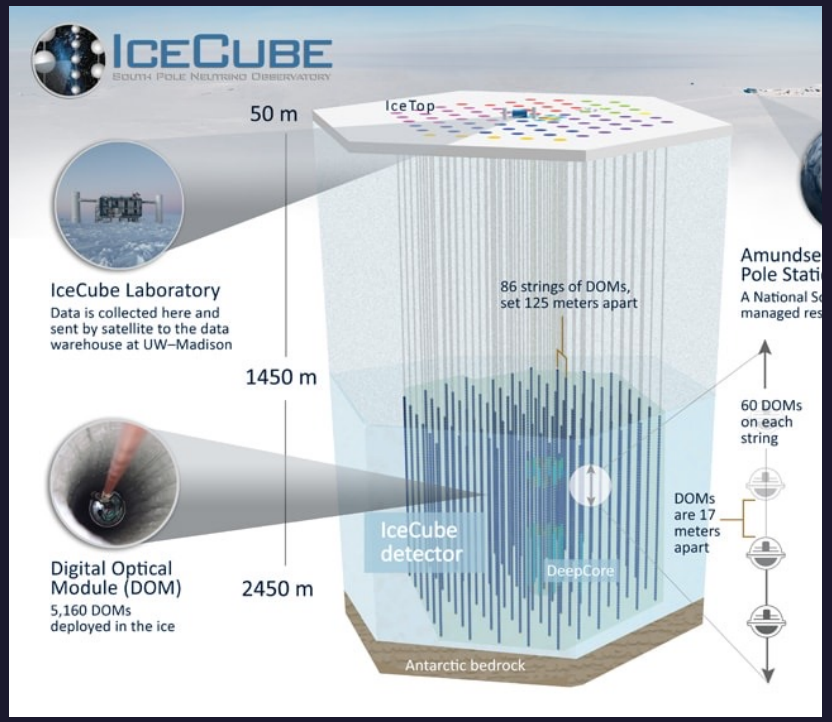
Neutrino experiments



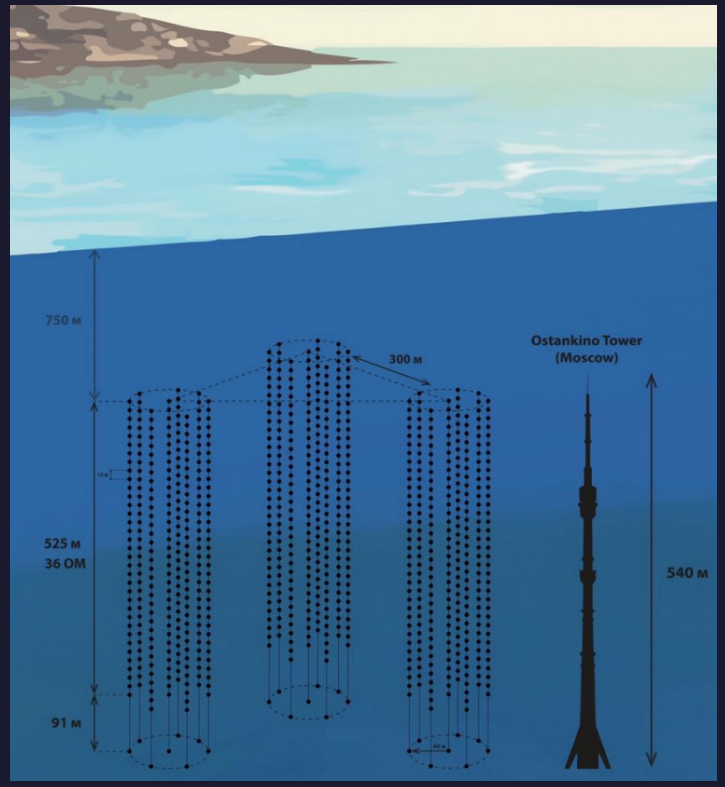
Super Kamiokande



Daya bay



IceCube



BULNT

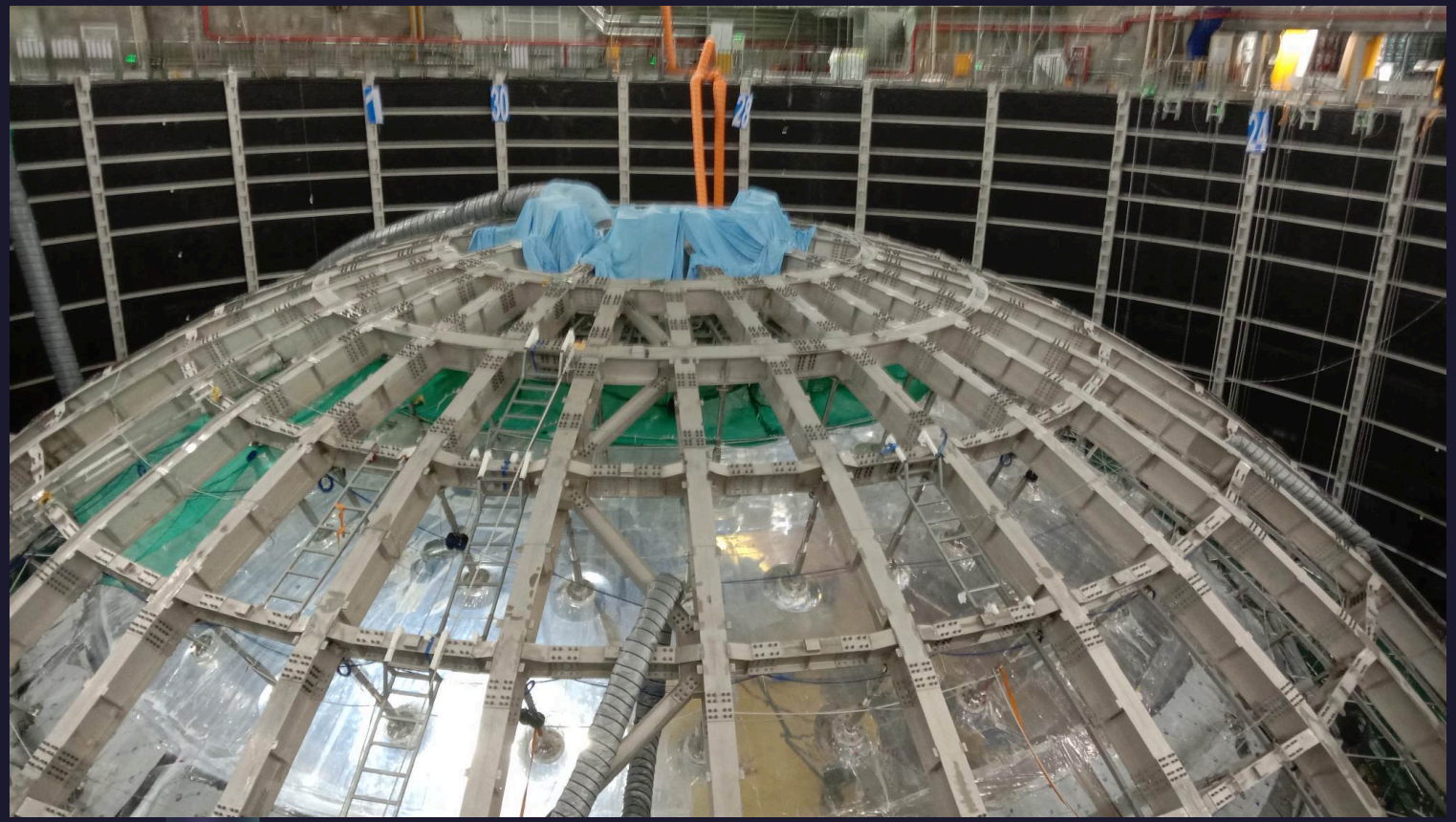
Jiangmen Underground Neutrino Observatory (JUNO)

JUNO EXPERIMENT

Underground experiment:

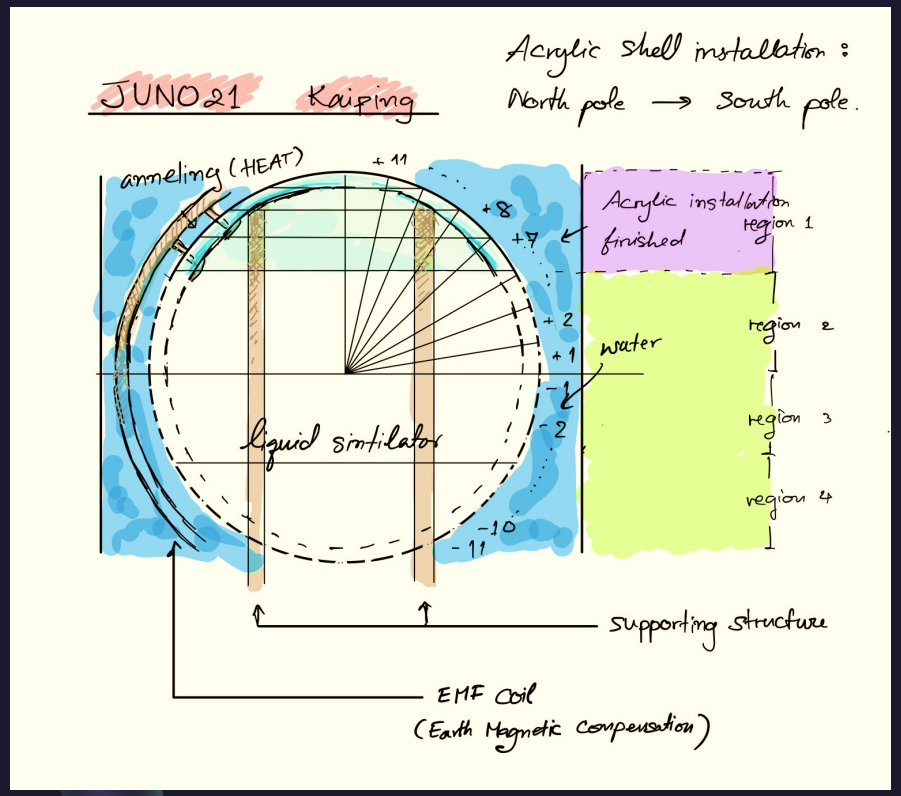
- placed 700 m underground to avoid cosmic ray
- Can be reach by a minecart
- Vertical shaft

JUNO experiment



- Arcrylic sphere of 35.4 m diameter filled with liquid scintillator: low energy neutrinos
- Water filled cylindrical cavern: VITO
- Surround by PMT: facing in&out
- Water and Scitillator: need to be purified
- Submarine: Cleaning

JUNO experiment



PHYSICS

- Study neutrino mass hierarchy and oscillation
- Geoneutrinos
- Super nova neutrinos.
- Solar neutrinos
- Dark matter

Thailand contribution

Thailand contribution

NARIT

- Design EMF compensation coil for JUNO
- Dark matter constraint
- PMT development
- ……?

HRH Princess Sirindhorn

HRH Princess Sirindhorn will visit JUNO experimental site on the 3th June this year before they close the tunnel

Summary

The main aim of JUNO is to understanding neutrino mass hierarchy and oscillation. Such understanding would greatly benefit physicists as well as astronomers. Thailand got a chance to participate in this frontier experiment, there are room for more contribution.

Thank You