



Potential of geo-neutrino measurements at JUNO and the Local 3D model

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On behalf of the JUNO collaboration

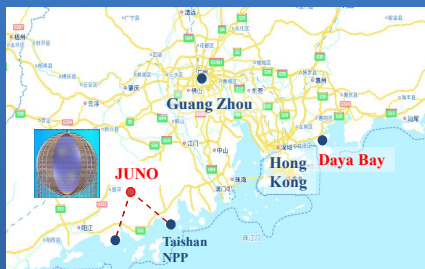


The Jiangmen Underground Neutrino Observatory (JUNO)

20 kton LS detector

3%/sqrt(E) energy resolution

A multiple-purpose neutrino experiment: Reactor neutrinos, Supernova neutrinos, Geo-neutrinos, Solar neutrinos, Sterile neutrinos, Atmospheric neutrinos, Exotic searches



JUNO Location

Local Geo-Neutrino Working Group

Geo-Physics
Zhi Wei LI (IGGWH, CAS)
Ya XU (IGG, CAS)
Geo-Chemistry / Geology
Ruo-Han GAO, Jie XU, Jin-Gao LIU (CUGB)
An-Dong WANG (East China Institute of Technology)
Geo-thermal
Yu Fei XI (IHEG)
Physics
Yu-Feng LI (IHEP)
Ran HAN (BISSE, CAST)
Students
Yan Hong CHEN
Xin MAO

Local Neutrino Geo-Science Working Group

Geo-neutrinos: a new probe of Earth's interior

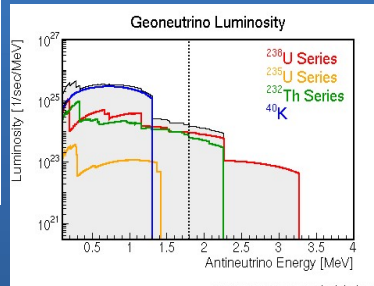
Open questions about natural radioactivity in the Earth

- 1 - What is the radiogenic contribution to terrestrial heat production?
- 2 - How much U and Th are in the crust and particularly in the mantle?
- 3 - A global check of the standard geochemical model (BSE)?
- 4 - What is hidden in the Earth's core? (geo-reactor, ^{40}K , ...)

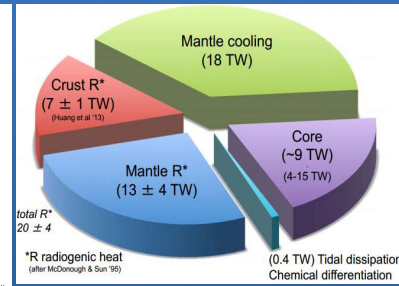
Geo-neutrinos: anti-neutrinos from the Earth.

U and ^{40}K in the Earth release heat together with anti-neutrinos in a well fixed ratio.

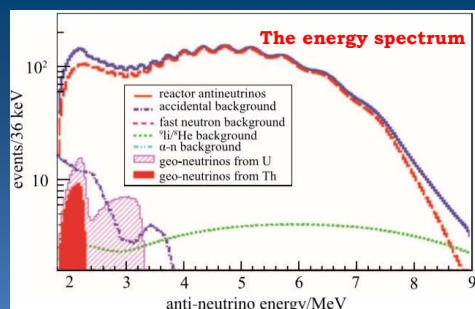
They bring to Earth's surface information about the chemical composition of the whole planet.



Geo-neutrino Spectrum



Earth's surface heat flow

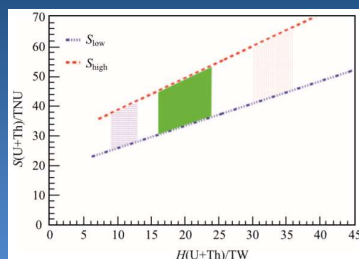


source	events/year	rate uncer tainty (%)	shape uncer tainty (%)
geo-neutrinos	408 (406)	N/A	N/A
reactor	16100 (3653)	2.8	1
$^9\text{Li}-^8\text{He}$	657 (105)	20	10
fast neutrons	36.5 (7.66)	100	20
$^{13}\text{C}(\alpha, n)^{16}\text{O}$	18.2 (12.16)	50	50
accidental	401 (348)	1	negl.

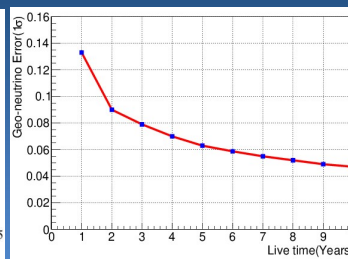
JUNO Potential in Measuring Geo-neutrinos

- 400 events/year, much larger than existing experiments
- With 10 years: total uncertainty reach 5% (2TNU)
- Comparison of the global reference model (18% crust) and a benchmark accuracy of the local model (8% crust)

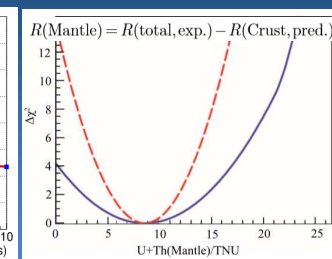
R. Han, Y.F. Li et al. Chin. Phys. C (2016)



geoneutrino signal vs radiogenic heat



the precision of the geo-neutrino measurement



The chi2 distribution of Mantle geo

What's the special of JUNO Geology

- Near continental margin, affected by the geology evolution of South China Block and the South China Sea
- Paleogeographic evolution of South China fold belt during Permian-Jurassic time and proposed flat-slab subduction model for propagating
- Local geology, including the geometry of strata, distribution rocks play important role in geo-v flux estimation

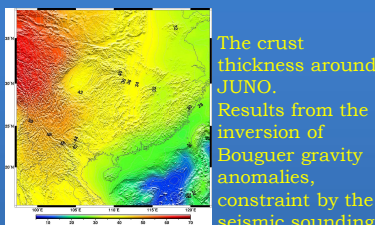
The Local Crust Geophysical Model Zhi-Wei LI (IGGWH, CAS)

Why Local 3D model

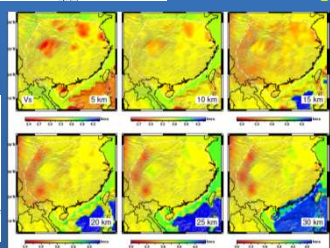
- > Significant uncertainties exist in current global models. High-resolution local crust model are needed
- > Global CRUST1.0 model has low resolution ($1^\circ \times 1^\circ$)
- > Global abundance model has no spatial resolution and large uncertainties

Geophysical data source

Continuous Seismic Waveforms, from 450 Stations in South China



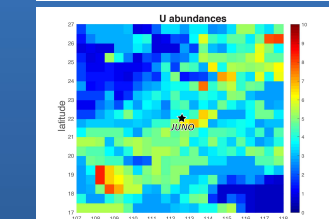
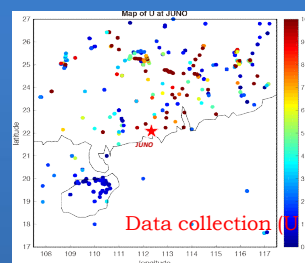
The crust thickness around JUNO. Results from the inversion of Bouguer gravity anomalies, constraint by the seismic sounding



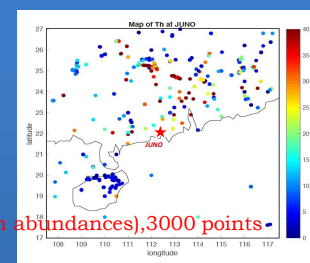
The 3D density distribution (one line)

The 3D Vs structure

The Local Crust Geochemical Model Ruo-Han GAO (CUGB)



Preliminary surface model (0.5° x 0.5°)



	U (ng/g)	Th (ng/g)
U Upper Crust	3.3	12.0
L Upper Crust	3.1	19.0
Middle Crust	0.5	1.8
Lower Crust	0.07	0.2

Preliminary vertical model (4 layers)