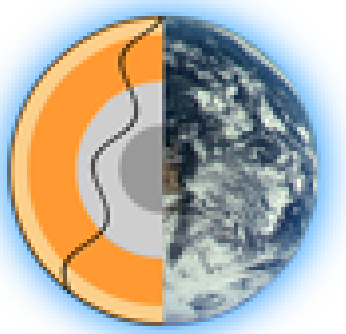
1st Neutrino Oscillation Tomography Workshop



Report of Contributions

https://indico.cern.ch/e/neutrino_oscillation_tomography_2016

Contribution ID: **4** Type: **not specified**

Spectrometry of the Earth

Thursday, 7 January 2016 11:30 (30 minutes)

Summary

Primary author: Dr TAKETA, Akimichi

Presenter: TAKETA, Akimichi

Session Classification: Overview of neutrino spectrometry

Contribution ID: **13** Type: **not specified**

PINGU

Friday, 8 January 2016 09:00 (30 minutes)

Summary

Primary author: ROTT, Carsten (Sungkyunkwan University)

Presenter: ROTT, Carsten (Sungkyunkwan University)

Session Classification: Large Neutrino Telescope experiments, recent progress and application to geoscience I

Contribution ID: **14** Type: **not specified**

ORCA

Friday, 8 January 2016 10:00 (30 minutes)

Summary

Primary author: GALATA, salvatore (CNRS)

Presenter: GALATA, salvatore (CNRS)

Session Classification: Large Neutrino Telescope experiments, recent progress and application to geoscience I

Contribution ID: **15** Type: **not specified**

BAIKAL-GVD and it's extension

Friday, 8 January 2016 10:30 (30 minutes)

Summary

Primary author: SUVOROVA, Olga (Russian Academy of Sciences (RU))

Presenter: SUVOROVA, Olga (Russian Academy of Sciences (RU))

Session Classification: Large Neutrino Telescope experiments, recent progress and application to geoscience I

Contribution ID: **17** Type: **not specified**

HanoHano

Friday, 8 January 2016 12:00 (30 minutes)

Summary

Primary author: MCDONOUGH, William (University of Maryland)

Presenter: MCDONOUGH, William (University of Maryland)

Session Classification: Large Neutrino Telescope experiments, recent progress and application to geoscience II

Contribution ID: **18** Type: **not specified**

Neutrino Tomography: Workshop Goals

Thursday, 7 January 2016 09:35 (10 minutes)

Welcome from the organizers and definition of workshop goals

Summary

Primary author: ROTT, Carsten (Sungkyunkwan University)

Presenter: ROTT, Carsten (Sungkyunkwan University)

Session Classification: welcome

Contribution ID: **19** Type: **not specified**

Recent advances on the composition of the Lower Mantle and Core

Thursday, 7 January 2016 13:30 (30 minutes)

Compositional models of the core and lower mantle will be reviewed and assessed. Assumptions in the models along with constraints and uncertainties of the Earth's interior will be presented. Although a compositional model for the lower mantle that matches that of the upper mantle for major elements is most compatible with observations and constraints, uncertainties are such that competing compositional models are tenable.

Based on chondritic models, more than 90% of the mass for the Earth is composed of Fe, O, Mg and Si and the addition of Ni, Ca, Al and S accounts for more than 98% by mass the composition of the Earth. Geoneutrino studies are placing global scale limits on the amount of Th and U in the Earth, which in turn will constrain models for the composition of the bulk silicate Earth, the mode proportion of the Ca-bearing phase in the deep mantle, and the thermal evolution of the planet.

Compositional models for the core are constrained by limited variation in chondrites for key siderophile element ratios (e.g., Fe/Ni, Ni/Co, and Ni/Ir). However, the amount and relative proportions of light element(s) in the core remain poorly constrained, with tradeoffs and modeling uncertainties in core temperatures and compositional space that allow for a range of model solutions. Constraints on the absolute and relative abundances of moderately volatile and volatile elements in the bulk Earth are consistent with only ~2% by mass of sulfur and a negligible role for H, C or N in the core. There is no evidence that heat producing elements (HPE: K, Th and U) are in the core at any significant level. Important targets for neutrino oscillation studies include establishing Z/A constraints for the outer core and Z/A contrast between inner and outer core.

Summary

Primary author: MCDONOUGH, William (University of Maryland)

Presenter: MCDONOUGH, William (University of Maryland)

Session Classification: Recent progress of history, structure, chemical composition of deep Earth I

Contribution ID: **21** Type: **not specified**

Overview of neutrino oscillation measurements

Thursday, 7 January 2016 10:15 (30 minutes)

This talk will discuss an overview of neutrino oscillation measurements

Summary

Primary author: TANAKA, Hidekazu (University of Tokyo)

Presenter: TANAKA, Hidekazu (University of Tokyo)

Session Classification: Overview of neutrino science

Contribution ID: **22** Type: **not specified**

KamLAND

Friday, 8 January 2016 11:30 (30 minutes)

The **Kam**ioka **L**iquid-scintillator **A**nti-**N**eutrino **D**etector (KamLAND) is located in a rock cavern in the Kamioka mine, 1,000 m below the summit of Mt. Ikenoyama in Japan. KamLAND is marked by the ability to detect low-energy anti-neutrino signals at 1,000 tons of ultra pure liquid scintillator through the inverse \beta reaction, \bar{\nu}*{e} + p \rightarraw e + n. We demonstrated the oscillation nature of neutrino flavor transformation by observing electron anti-neutrino (\bar{\nu}*{e}) from nuclear reactors and neutrino properties have been explored precisely. Since neutrinos interact with other particles only via weal interaction, they have extremely low reaction probabilities. Such elusive property of neutrinos provides us with the ability to investigate optically invisible deep interior of the astronomical objects, such as the Earth. Neutrino measurement evolved understanding of neutrino properties to utilization of neutrino as a "probe".

The detection of geo-neutrinos, \bar{\nu}*{e}'s produced in \beta-decays from primordial radioactive elements (uranium, thorium and potassium) within the Earth's interior, brings unique and direct information about the Earth's interior and thermal dynamics. KamLAND detects geo \bar{\nu}*{e} signals above 1.8 MeV due to the reaction threshold energy of the inverse \beta-decay, resulting to have sensitivity to \bar{\nu}*{e}'s from the decay chains of ^{238}U and ^{232}Th. The KamLAND collaboration reported the result of the first study of geo \bar{\nu}*{e} in 2005. Later the geo \bar{\nu}*{e} signals at KamLAND were used to estimate our planet's radiogenic heat production and constrain composition models of the bulk silicate Earth (BSE). Following the Fukushima nuclear accident in March 2011, the entire Japanese nuclear reactor industry, which generates >97% of the reactor \bar{\nu}*{e} flux at KamLAND, has been subjected to a protracted shutdown. This unexpected situation allows us to improve the sensitivity for geo \bar{\nu}*{e}'s.

Currently, geo \bar{\nu}*{e} observed rate is in agreement with the prediction from existing BSE composition models within 2\sigma C.L., but some extreme models start to be disfavored. This ability to discriminate is limited by the experimental uncertainty and crust modeling. Continuing the data taking under the present low-reactor situation yields better signal-noise ratio and provides promising power of uncertainty (21% \rightarraw 15% with 5-year measurement). Enhanced geo \bar{\nu}_{e} flux calculation model using latest crustal structure model and geochemical understanding around Japan Island Arc will be a key issue for the further constraint on the Earth models and observation of mantle contribution.

Summary

Primary author: Dr WATANABE, Hiroko (Tohoku University)

Presenter: Dr WATANABE, Hiroko (Tohoku University)

Session Classification: Large Neutrino Telescope experiments, recent progress and application to geoscience II

Contribution ID: **23** Type: **not specified**

Last and next decade in geoneutrino measurements.

Thursday, 7 January 2016 17:00 (30 minutes)

In July 2005 KamLAND collaboration claimed the first evidence of geoneutrinos on Nature journal. After a decade of measurements, KamLAND (Japan) and Borexino (Italy) experiments confirmed that the technology is ready to measure the geoneutrino signal with enough statistics for answering some fundamental questions of Earth Science. Taking into account that SNO+ (Canada) and JUNO (China) experiments will collect new data in the next decade, the talk will focus on the new challenges for combining the multi-site measurements and for integrating data in coherent picture of the Earth.

Summary

Primary author: MANTOVANI, Fabio (INFN - National Institute for Nuclear Physics)

Presenter: MANTOVANI, Fabio (INFN - National Institute for Nuclear Physics)

Session Classification: Recent progress of history, structure, chemical composition of deep Earth II

Contribution ID: **24** Type: **not specified**

Importance of tighter constraints on U and Th abundances of the whole Earth by Geo-neutrino determinations

Thursday, 7 January 2016 16:30 (30 minutes)

The Earth is differentiated and chemically heterogeneous planet. Chondrites, undifferentiated meteorites, have been used to estimate the composition of the Earth. Chondrites are similar in composition to the Sun except volatile elements. They have been considered to keep the composition of the building blocks of the Earth regarding refractory (not volatile) elements.
Because both parent and daughter elements of 147Sm-143Nd decay system are refractory and lithophile (distributed in silicate phase), it has been considered that 143Nd/144Nd isotope evolution of the silicate part of the Earth can be estimated by that of chondrites.
Short life radioactive isotope 146Sm decays to 142Nd, which constitutes another Sm-Nd decay system. The high precision of state of the art thermal ionization mass spectrometers has revealed that 142Nd/144Nd of terrestrial samples are slightly higher than those of chondrites, which suggests that the Earth has different Sm/Nd ratio (about 6% higher) from chondrites.
The different 142Nd/144Nd of terrestrial samples from chondrites has been explained by 1) that the building blocks of the Earth had different Sm/Nd ratio from chondrites, 2) that we have obtained no samples from the part with lower Sm/Nd than chondrites, 3) that the Earth lost a part with lower Sm/Nd than chondrites. The third candidate assumes that the surface layer, which was enriched in incompatible elements with low Sm/Nd ratio, in the early time of the Earth was abraded off by heavy bombardments of impactors. If the dissipation of the enriched layer to the space happened, it can be anticipated that the Earth lost about half of U and Th. In that case, the present composition of the Earth is no more chondritic. The second candidate, on the other hand, would predict that the abundances of U and Th are similar to that of chondrites.
It is hoped that tighter constraints on U and Th abundances of the whole Earth by Geo-neutrino determinations may solve the problem.

Summary

Primary author: NAKAI, Shun'ichi

Presenter: NAKAI, Shun'ichi

Session Classification: Recent progress of history, structure, chemical composition of deep Earth II

Contribution ID: **25** Type: **not specified**

Status of Hyper-Kamiokande

Friday, 8 January 2016 09:30 (30 minutes)

Hyper-Kamiokande is a next-generation water Cherenkov detector whose expected size and detection efficiency will enable it to make contributions to the field of geophysics, in particular studies of the earth's chemical composition, through observations of atmospheric neutrinos. This talk will focus on the status of the Hyper-Kamiokande project and will discuss sensitivity estimates relevant to the measurement of the chemical composition of the outer core.

Summary

Primary author: WENDELL, Roger (The University of Tokyo)

Presenter: WENDELL, Roger (The University of Tokyo)

Session Classification: Large Neutrino Telescope experiments, recent progress and application to geoscience I

Contribution ID: **26** Type: **not specified**

Seismological Constraints on Velocity and Density in the Earth's Core

Thursday, 7 January 2016 14:00 (30 minutes)

I review the seismological studies on the velocity and density in the Earth's core. I will introduce (1) how their models have been obtained, (2) how much uncertainties such models have, and (3) what is important future research topics.

Summary

Primary author: TAKEUCHI, Nozomu (University of Tokyo)

Presenter: TAKEUCHI, Nozomu (University of Tokyo)

Session Classification: Recent progress of history, structure, chemical composition of deep Earth I

Contribution ID: **27** Type: **not specified**

Recent progress in studies of the geomagnetic field and dynamics of the Earth's core

Thursday, 7 January 2016 15:00 (30 minutes)

Main part of the geomagnetic field is generated by dynamo process in the Earth's core.
This implies that the geomagnetic field and its secular variation have potential to reveal
the dynamics of the Earth's core. In this talk, I am going to introduce recent progress
of the studies of Earth's core using the geomagnetic field. It has been suggested that
decadal variation of the geomagnetic field is compatible with stable stratification at the
top of the core although the cause of the stratification is not very certain yet.

Summary

Primary author: Prof. SHIMIZU, Hisayoshi (Earthquake Research Institute, The University of Tokyo)

Presenter: Prof. SHIMIZU, Hisayoshi (Earthquake Research Institute, The University of Tokyo)

Session Classification: Recent progress of history, structure, chemical composition of deep Earth I

Contribution ID: **28** Type: **not specified**

Composition, physical properties, and thermal state of the core

Thursday, 7 January 2016 16:00 (30 minutes)

Recent advance in high-pressure mineral physics of the Earth's central regions are reviewed. The density of the core is lower than that of pure iron under the core conditions. Recent analyses of the equation of state and the sound velocity of solid and liquid iron and iron–nickel alloys strongly suggest that the core contains light elements. Possible candidates for the light elements in the core are considered to be Si, S, O, C, and H. Although both inner and outer core should be composed of combinations of these light elements, the light element abundance may be different between the outer and inner cores if the inner core is crystallized from the liquid core due to the element partitioning between solid and liquid metals. The nature and amounts of light elements in the core are the key to clarify the early processes of formation of the Earth. The phase relations, compression, and sound velocity of iron-light-element alloys have been studied intensively based on the static experiments, shock compression, and theoretical works such as ab-initio calculations. I will review the present status of these works and discuss their implications for the compositions of the outer and inner cores. To achieve a definite conclusion on the light element contents of the core, we need to establish pressure scales at the high pressure and temperature of the Earth's core, and to measure the density and sound velocity of the iron–light–element alloys covering the pressure and temperature conditions of the inner core.

Summary

Primary author: Prof. OHTANI, Eiji (Tohoku University)

Presenter: Prof. OHTANI, Eiji (Tohoku University)

Session Classification: Recent progress of history, structure, chemical composition of deep Earth II

Contribution ID: **32** Type: **not specified**

Introduction to the physhics of neutrinos and their oscillations

Thursday, 7 January 2016 09:45 (30 minutes)

Explanation of basic particle properties of neutrinos are given with the relevant experiments. Several historically important experiments are also briefly introduced including oscillation observation .

Summary

Primary author: Prof. ARAFUNE, Jiro (Univ. of Tokyo)

Presenter: Prof. ARAFUNE, Jiro (Univ. of Tokyo)

Session Classification: Overview of neutrino science

Contribution ID: **33** Type: **not specified**

Greeting

Thursday, 7 January 2016 09:30 (5 minutes)

Summary

Presenter: Prof. OBARA, Kazushige

Session Classification: welcome

Contribution ID: **34** Type: **not specified**

Theoretical Mineral Physics for Study on Earth's Deep Interior

Thursday, 7 January 2016 14:30 (30 minutes)

Recent progress in theoretical and computational mineral physics based on the density functional techniques has been dramatic in conjunction with the advancement of computer technologies. It is now possible to predict phase stability and several physical properties of complex minerals quantitatively in the pressure and temperature conditions corresponding directly to the deep planetary interiors with uncertainties that are comparable to or even smaller than those attached in experimental data. Our challenges include calculations of phase equilibria of planetary materials up to terapascal pressures (1-3), high-pressure and high-temperature elasticity to constrain the thermochemical property of the Earth (4,5), and thermal, electrical, and mass transport properties to investigate the planetary dynamics (6-8).

References
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(2) Tsuchiya, Wentzcovitch, da Silva, and de Gironcoli, Phys. Rev. Lett. 96, 198501 (2006).
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(4) Wang, Tsuchiya, and Hase, Nature Geo. 8, 556-559 (2015).
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(8) Ichikawa and Tsuchiya, Phys. Earth Planet. Int. 247, 27-35 (2015).

Summary

Primary author: Prof. TSUCHIYA, Taku (Geodynamics Research Center, Ehime University, Japan Dearth-Life Science Institute, Tokyo Institute of Technology, Japan)

Presenter: Prof. TSUCHIYA, Taku (Geodynamics Research Center, Ehime University, Japan Dearth-Life Science Institute, Tokyo Institute of Technology, Japan)

Session Classification: Recent progress of history, structure, chemical composition of deep Earth I

Contribution ID: **35** Type: **not specified**

Neutrino Absorption Tomography

Thursday, 7 January 2016 11:00 (30 minutes)

For more than 30 years, the idea of probing the interior of the Earth with neutrinos has been discussed. Of all the matter that exists on Earth, only neutrinos can penetrate the maximum thickness of the Earth. Some neutrinos interact with atoms deep inside the Earth where we cannot sample the material. They provide information about the matter density or the electron density of materials along the neutrino's trajectory.

In the first half of my talk I introduce the principle of neutrino absorption tomography and will discuss about the requirements to perform each proposed techniques. The second topic will be the report about ongoing analysis: measuring the density profile of the Earth with IceCube neutrino observatory using high-energy atmospheric neutrino. Updated analysis method and the median sensitivity to separate an Earth model and the PREM Earth model will be presented. We also discuss about the sensitivity for future upgrade of IceCube, Gen-2 detector.

Summary

Primary author: HOSHINA, Kotoyo (Earthquake Research Institute, the University of Tokyo)

Presenter: HOSHINA, Kotoyo (Earthquake Research Institute, the University of Tokyo)

Session Classification: Overview of neutrino spectrometry