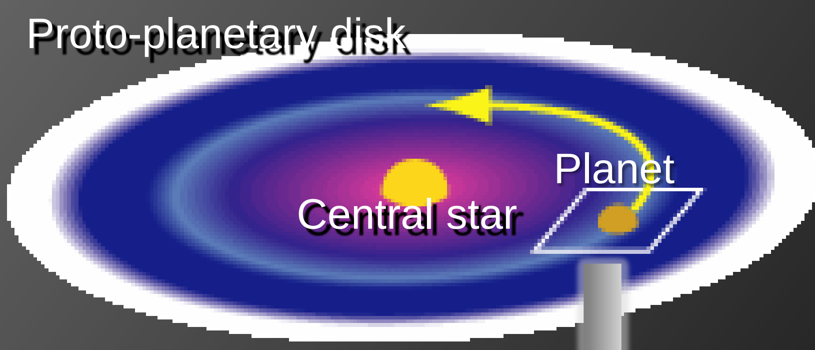
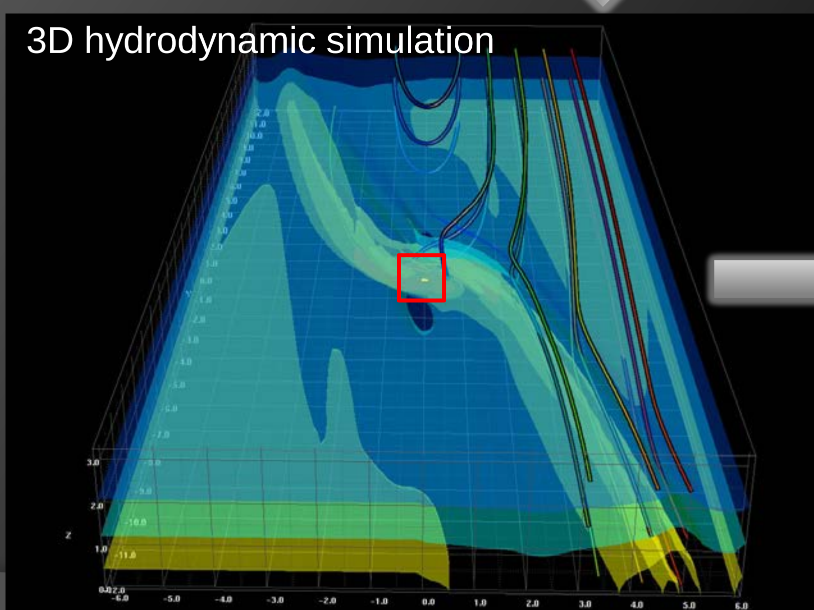
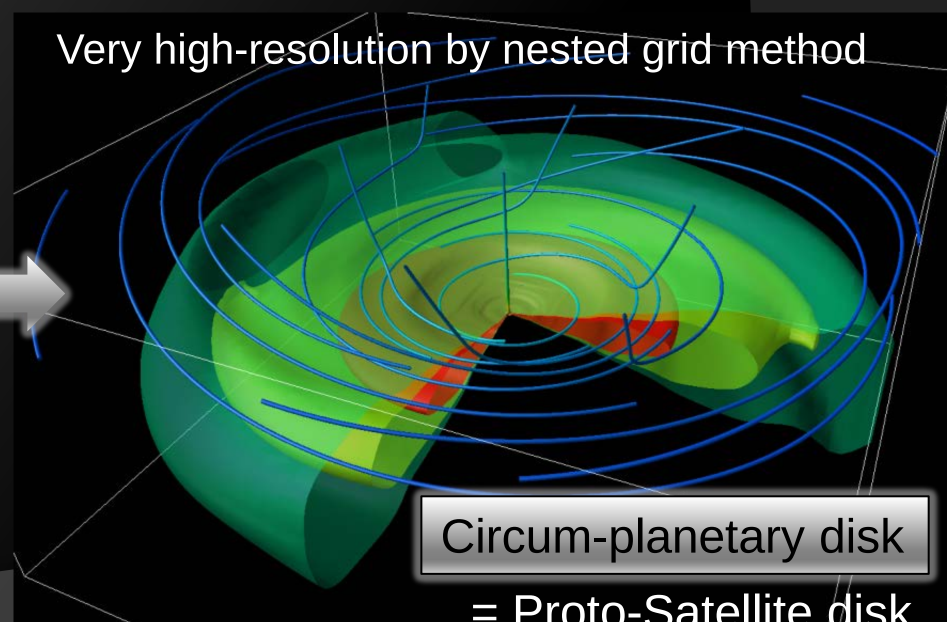
FORMATION OF CIRCUMPLANETARY DISKS

Tanigawa Takayuki (CPS / Hokkaido Univ.),
Ohtsuki Keiji (CPS / Kobe Univ.), Machida Masahiro (NAOJ)

Tanigawa, Ohtsuki, and Machida 2012, ApJ, 747, 47







Development of a Virtual Scattering Laboratory Software Package to Study the Optical Properties of Cosmic Dust Aggregates

Himadri Sekhar Das

Department of Physics, Assam University, Silchar 788011
hsdas@iucaa.ernet.in

Summary

This paper reports the development of a *virtual scattering laboratory software package* to study *the optical properties of cosmic dust aggregates*. The name of the package is **Assam University Virtual Scattering Laboratory Software Package (AUVScatLab).** This package consists of a Graphical User Interface (GUI) in the front hand and a database of related data's on the back hand. Both the interactive GUI and database package directly enables an astronomer to model by self-monitoring respective input parameter (viz. wavelength, complex refractive index, grain size parameter, etc.) to study the related optical properties (viz. Extinction, polarization, etc.), of cosmic dust (interstellar dust, interplanetary dust, circumplanetary dust, intergalactic dust) instantly, i.e. with zero computational time, which directly increases the efficiency of the user. The database of different optical properties of the cosmic dust aggregates is generated in a very wide range using light scattering code: Superposition T-Matrix code with high computational accuracy. This package also has an option where users can compile and run the scattering code directly for aggregates in GUI environment. It is to be noted that **AUVScatLab** is now developed only for WINDOWS environment. It is also planned to develop the package in other environments.

The petrological expression of the thermal evolution of Mars

D. Baratoux[1], M. Toplis[1], M. Monneau[1]

[1]University Paul Sabatier, Toulouse – Observatory Midi-Pyrénées, Institut de Recherche en Astrophysique et Planétologie (IRAP), UMR CNRS 5277

Reconstruction of the geological history of Mars has been the focus of considerable attention, with important discoveries being made concerning variations in surface conditions. On the other hand, despite a significant increase in the amount of data related to the morphology, mineralogy and chemistry of the Martian surface, there was no clear global picture of how magmatism has evolved over time and how these changes relate to the thermal evolution of the planet. With this in mind we have used Silica, Iron, and Thorium global maps from the data Gamma Ray Spectrometer (GRS) onboard the Mars Odyssey spacecraft, focusing on 12 major volcanic provinces of variable age. This analysis reveals trends in chemical composition which are consistent with varying degrees of melting of the Martian mantle. In detail, there is evidence for thickening of the lithosphere (17–25 km/Gy) associated with a decrease of mantle potential temperature over time (30–40 K/Gy) [1]. This thermal scenario for the mantle of Mars may be now used to predict the composition of primary melts as a function of time. Then, the characteristics of mineralogical assemblages after crystallization of these primary melts may be calculated and directly compared to the variable proportions and compositions of pyroxene, olivine and plagioclase in igneous rocks as revealed by spectroscopic observations. In particular, a trend in the composition of pyroxene was revealed by OMEGA (Mars Express) and CRISM (Mars Reconnaissance Orbiter) data. This trend is characterized by a decrease of the ratio between low-calcium-pyroxene and rich-calcium pyroxene end-members at the Noachian/Hesperian boundary (3.7 Gy ago). Our thermodynamic calculations indicate that this change results from a higher degree of partial melting in the Noachian associated with a hotter mantle and/or a higher geothermal gradient. The thermal scenario inferred from GRS data [1] may be thus extended back to early Mars. This study of the igneous mineralogy and alterations phases of rocks and soils formed during this period of time is a major objective of the Mars Science Laboratory mission launched in November 2011. We thus hope to provide useful constrains (such as a range of possible geothermal gradients) to discuss the surface and sub-surface conditions at the landing site (Gale crater).

Taken together, these petrologic analyses are consistent with simple models of mantle convection and with the reconstruction of the thermal evolution of the mantle from paleo-heat flows inferred from the evolving elastic thickness of the lithosphere. They also argue for the existence of a period of active volcanism in the Noachian, which had participated to a large extent to the construction of the crust after the crystallization of a magma ocean. This scenario provides also non-geochronological arguments to the debate surrounding the age of a group of martian meteorite, and supports an old age for the basaltic shergottites.

[1] Baratoux, D., Toplis, M., Monnereau, M., Gasnault, O. Thermal history of Mars inferred from orbital geochemistry of volcanic provinces, Nature, doi:10.1038/nature09903 (2011).

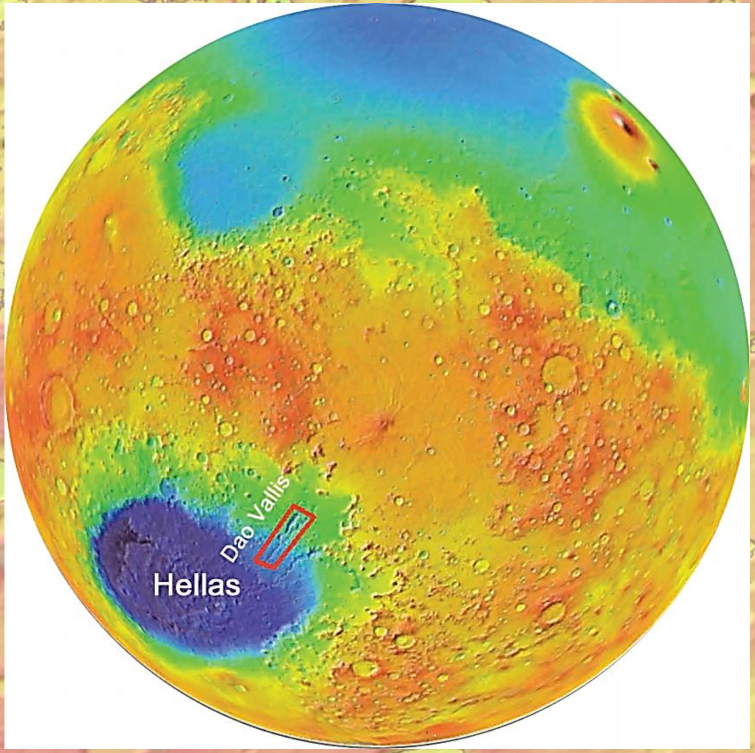
EVOLUTION OF THE FLUVIAL SYSTEMS IN THE EASTERN HELLAS REGION, MARS: A CASE STUDY OF DAO VALLIS.

S. Kukkonen, J. Korteniemi and V.-P. Kostama
Astronomy, Department of Physics, University of Oulu, Finland
(soile.kukkonen@oulu.fi)

- *Dao Vallis - one of Martian large canyons on the eastern Hellas rim region.*
- *How the units on the Dao Vallis relate to each other and the canyon formation?*

-> Mapping and Crater Counting

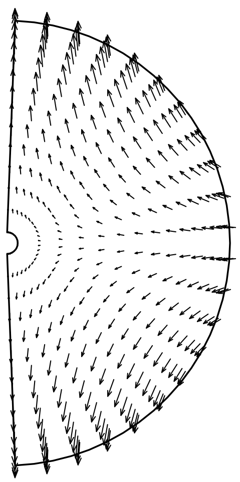
The work is part of an ongoing project looking into the eastern Hellas fluvial systems, where the goal is to form a detailed picture of the drainage system evolution and to relate them to changes in the Martian climate.



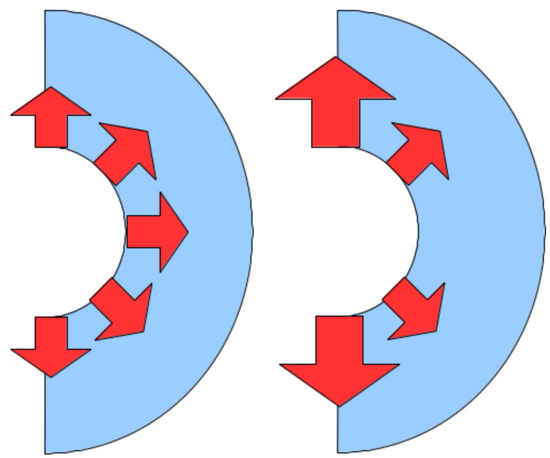
Effects of latitudinally heterogeneous buoyancy flux conditions at the inner boundary on MHD dynamos in a rotating spherical shell

Sasaki, Y., Takehiro, S., Nishizawa, S., Nakajima, K., Hayashi, Y.-Y.

Inner core flows

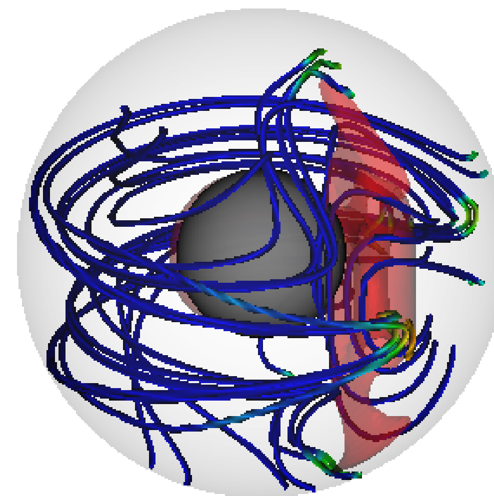


Buoyancy fluxes



develop develop decay

Field lines/votex tube



- Inner core flows $\longrightarrow$ latitudially varying buoyancy flux at ICB $\longrightarrow$ MHD dynamo calculations

- Magnetic field does not develop when strong buoyancy flux is given around the polar regions

The Initial State of the Moon Forming Disk and the Mantle of the Earth

P-14

Miki Nakajima & David J. Stevenson (Caltech)

Observation

The mantles of the Earth and the Moon:
Similar isotope ratios

Motivation

We need to identify the initial state of

(1) The Earth's mantle

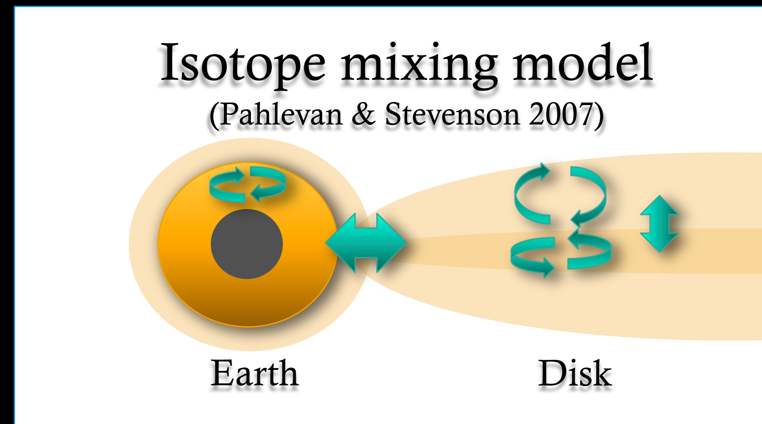
(2) The Moon forming disk

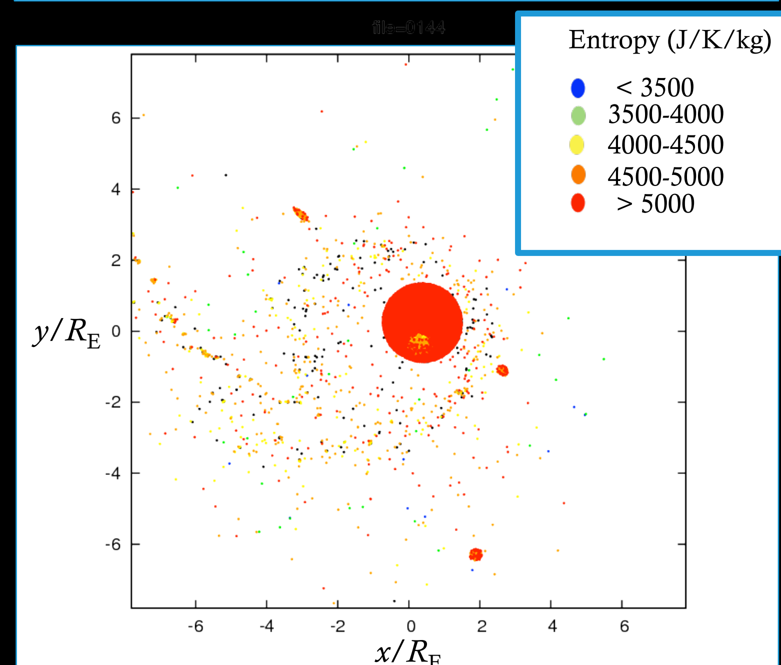
In order to test the isotope mixing model

Results

- The disk's 2D thermal structures are derived.
- The disk's vapor mass fraction is 0.1-0.2.
- The whole mantle is likely to be molten.
- The mantle is stable to convection.

→ Potentially a big challenge for the isotope mixing model.



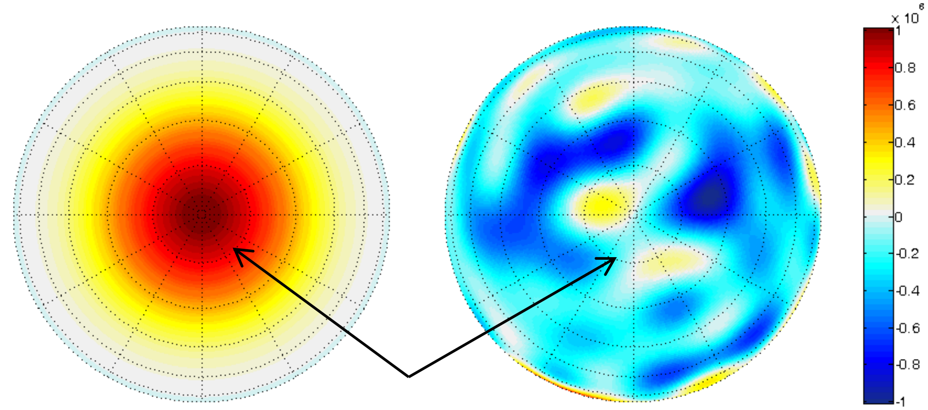


UCLA

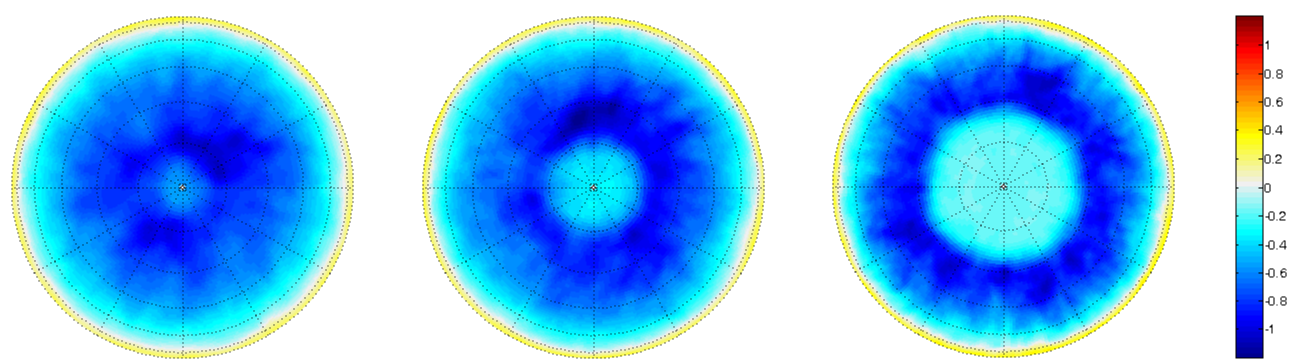
Does Saturn have a solid core? Evidence from its intrinsic magnetic field

Hao Cao

- Planetary magnetic field → planet interior structure
- Magnetic field morphology (at the dynamo surface)
- Polar field maxima (Saturn) V.S. Polar field minima (Earth)
- Solid core to fluid core size ratio sets the dynamo region geometry
- Solid core controls polar field minima



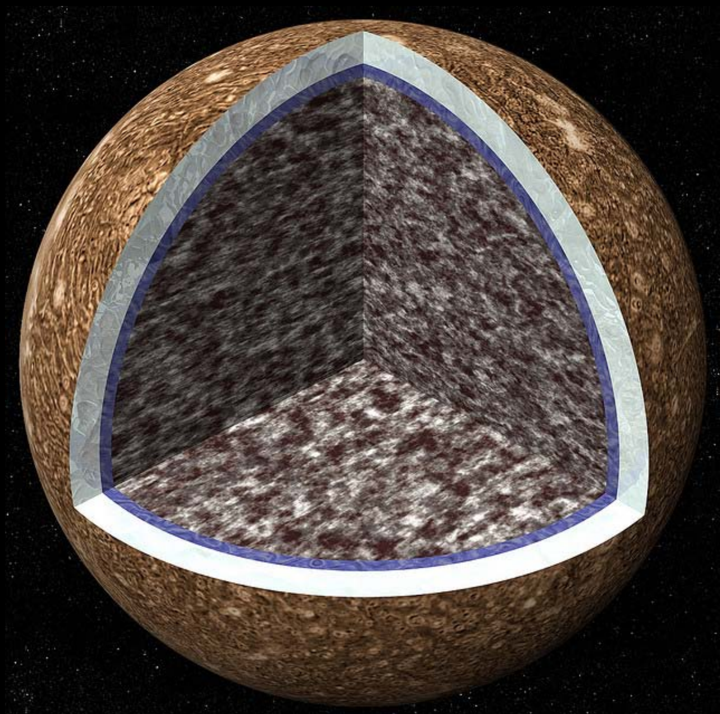
Saturn Earth

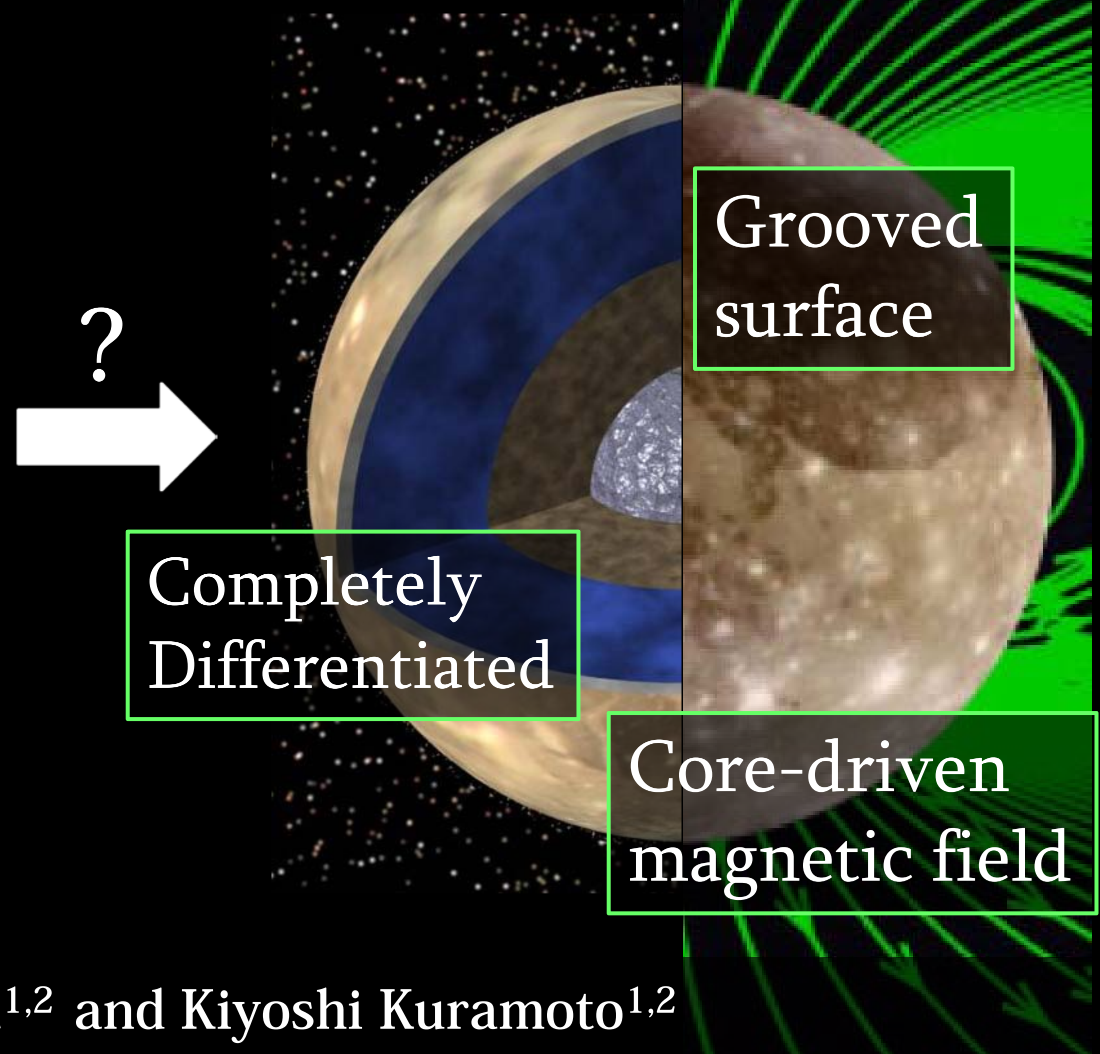


$\chi = 0.20$ $\chi = 0.35$ $\chi = 0.50$

In spite of its small radius (252 km), Enceladus is active satellite radiating high heat and emanating water plume. As a conventional heat source, tidal heating is thought to be the main mechanism to invoke such a large activity. However, Maxwell response with completely differentiated is insufficient to generate large heat as observed (around 10 GW). Other rheological model than Maxwell is proposed for the research of Iapetus, which results in appropriate response of Iapetus. Although we cannot say, of course, that Enceladus has the same rheology to Iapetus, analogy between Enceladus and Iapetus is a good approach because they both are Saturnian icy satellite. In addition to that, recent gravity measurement implies that Enceladus' core is not completely but partially differentiated, which means thickness of the ice mantle is relatively thin compared to former research. In this work, as ice alternative rheology, Burgers and Andrade body is applied to calculate heating rate in Enceladus by constructing new structure model consistent with latest observational results. While, in the case of Maxwell body, only small amount of heat was generated even though the new structure model, a few giga watt of heat was produced at Burgers and Andrade body when ocean exists. With a lack of ocean magnitude of tidal heat reduced by two of order.

Dehydration of primordial hydrous rock in Ganymede: Formation of the conductive core and the grooved terrain





Jun Kimura[1,2] and Kiyoshi Kuramoto[1,2]

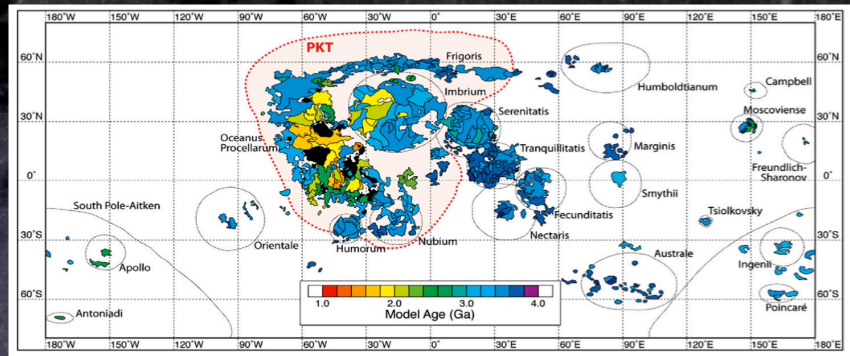
[1]Center for Planetary Science, [2]Hokkaido Univ.

P-22

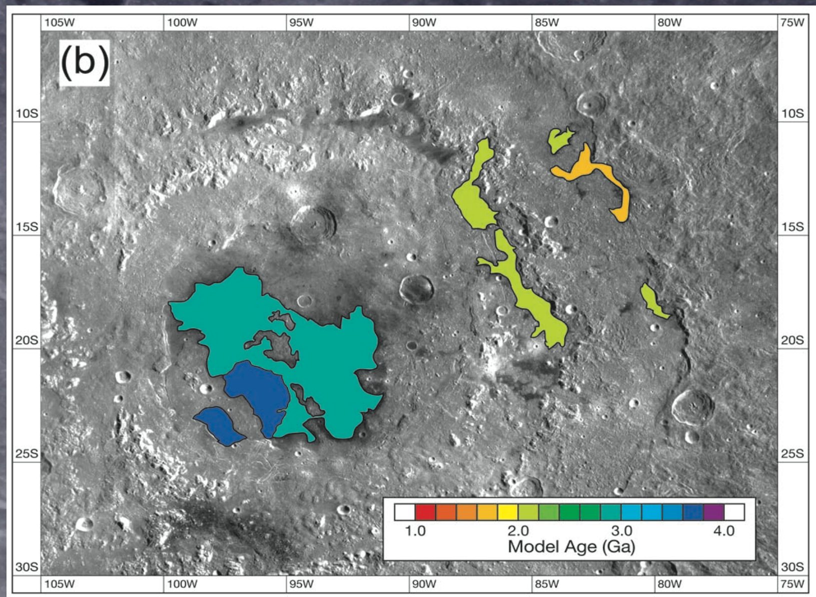
Young mare volcanism in the Orientale region contemporary with ~2Ga PKT volcanism peak period

Yuichiro Cho
University of Tokyo

- The ages of mare basalt in the Orientale basin were estimated using High-resolution observation by SELENE Terrain Camera.
- The uniform age (~2 Ga) of the mare deposits around the Orientale basin rims, which are rather far away from the PKT, suggests that the suspected peak of volcanic activity at around 2 Ga was not limited to the regions with enhanced radioactive elements at the surface (PKT) but extended to other regions.



Model age distribution on the nearside of the Moon (Morota+ 2011, Hiesinger+ 2008).

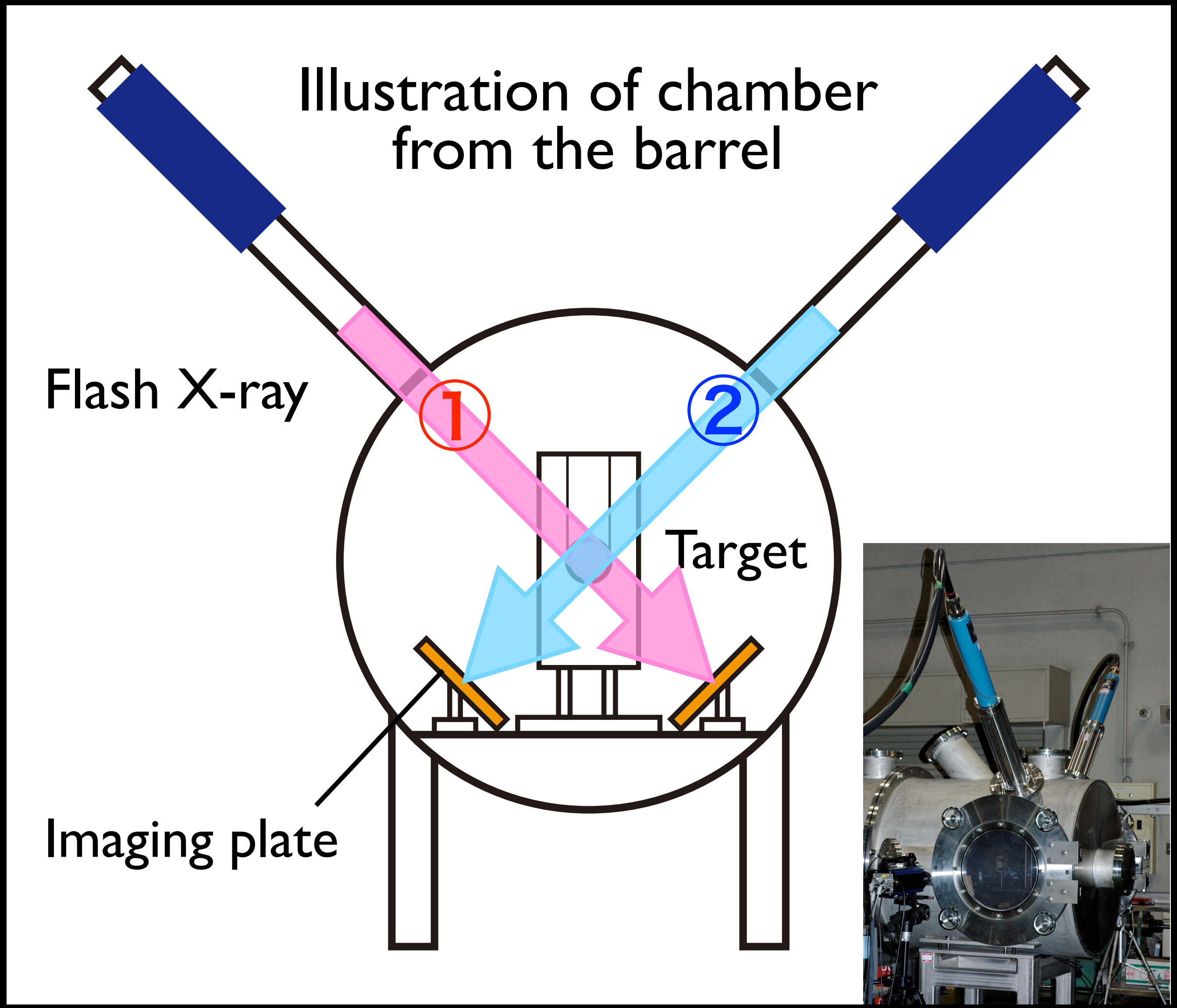


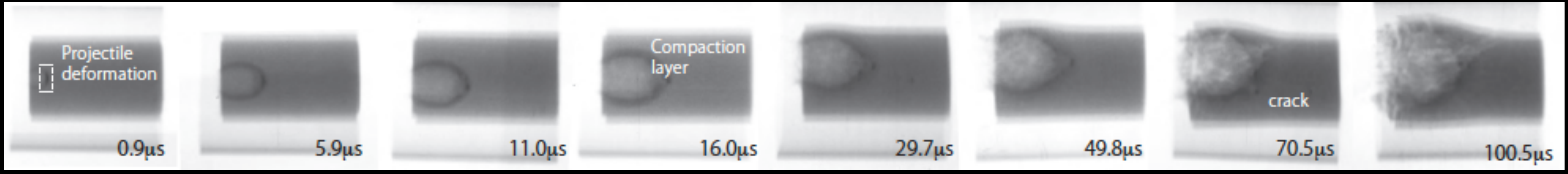
Model age distribution obtained in this study.

In-situ observation of impact crater formation in porous gypsum using a flash X-ray

M. Yasui, M. Arakawa, S. Hasegawa, K. Kurosawa, Y. Fujita, T. Kadono

- What happened in the interior of porous asteroids during the crater formation
- High-impact experiments by using a flash X-ray
- Crater cavity shape & Time change of crater size (depth, diameter, etc.)
- Scaled the crater volume by using parameters proposed by Schmidt and Housen (1987)





Development of an anelastic convection model in rotating spherical shells for stars, gas and icy giant planets.

Youhei SASAKI, Department of Mathematics, Kyoto University, Kyoto, Japan.
Shin-Ichi Takehiro, Research Inst. for Math. Sci., Kyoto University, Kyoto, Japan.
Ken-suke Nakajima, Faculty of Science, Kyushu University, Fukuoka, Japan
Kiyoshi Kuramoto, Department of Cosmoscience, Hokkaido University, Sapporo, Japan.
Yoshi-Yuki Hayashi, Faculty of Science, Kobe University, Kobe, Japan

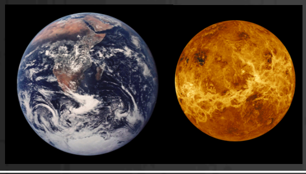
The problem of convection in rotating spherical shells has been studied vigorously as a fundamental model of global convection presumably emerging in celestial bodies, such as stars, gas and icy giant planets, and terrestrial planetary interiors. Recently, according to development of numerical computational abilities, fundamental aspects and characteristics of convection has been revealed and knowledge about this issue is increased under the assumption of Boussinesq approximation, which ignores compressibility of the fluid. However, compressible convection in rotating spherical shells has not yet understood compared with Boussinesq convection, although some studies performed so far use the anelastic approximation in order to deal with compressibility. Compressibility is an important element for discussing deep convection of stars and gas and icy planets, since thickness of their convection layers is several times larger than the scale height. Not only for these celestial bodies but also for extra-solar gas giant planets, which have been so many discovered with recent sophisticated technologies of astronomical observation, compressibility could not be ignored for considering fluid motion in their interiors. Investigation into effects of compressibility on convection in rotating spherical shells is expected to contribute to the basic knowledge for considering fluid motions in the interiors of these many celestial bodies.

Based on the consideration described above, we are now developing a numerical model of an anelastic fluid in rotating spherical shells in order to assess effects of compressibility on convective motions. On the development of the model, we extended our numerical model of Boussinesq convection in rotating spherical shells accomplished so far to the anelastic system. Instead of velocity field in the case of Boussinesq fluid, we described mass flux with poloidal and toroidal potentials, which was able to extend our Boussinesq model constructed so far to the anelastic case in a natural way.

In the presentation, results of some numerical experiments using our newly developed model will be shown, and future planning is also discussed.

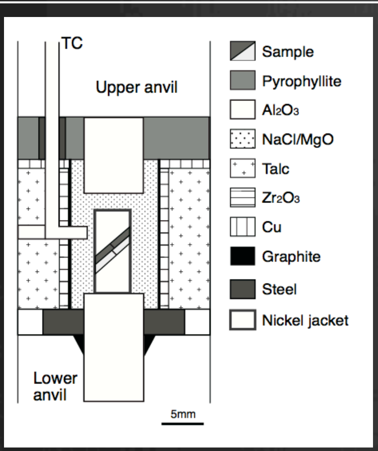
Rheological structure of earth and venus inferred from strength contrast between plagioclase and olivine

S. Azuma[1], I. Katayama[1], T. Nakakuki[1] [1]Hiroshima University



Why does plate tectonics not work on Venus?? or stopped??

Deformation experiment (Modified Griggs)



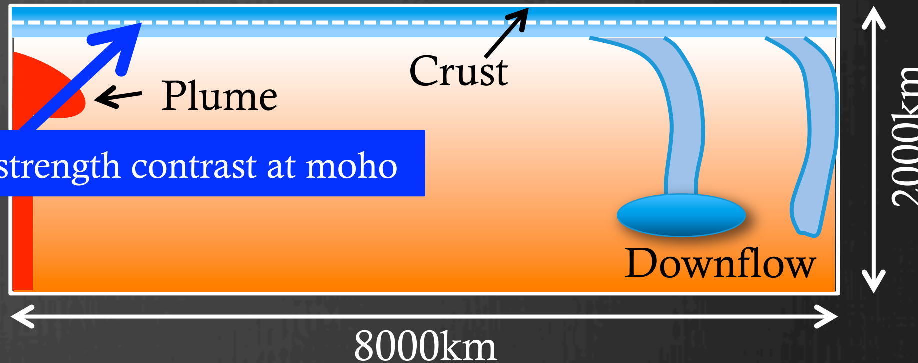
(Experimental assembly)

・Experimental condition
(Temperature) 600-1000°C
(Pressure) 1GPa
(Piston velocity) 500μm/hr

Strength contrast between plagioclase and olivine is observed from two-phase deformation experiments.

Extrapolating to strength contrast at moho

Numerical simulation (mantle convection)

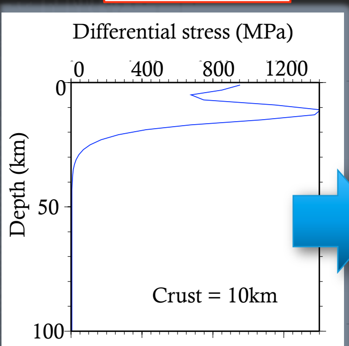


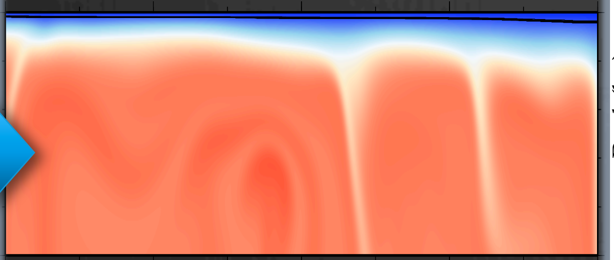
To conduct numerical simulation based on the rheological model including crust which is inferred from deformation experiments.

Results

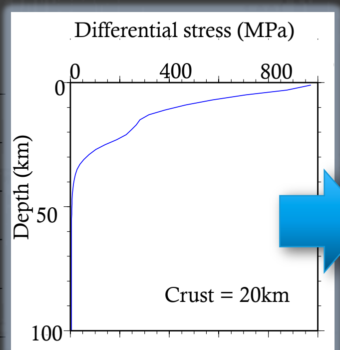
Difference on rheological structure produces different planetary tectonics.

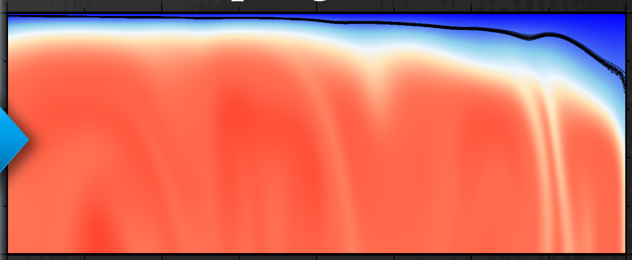
Decoupling model





Coupling model

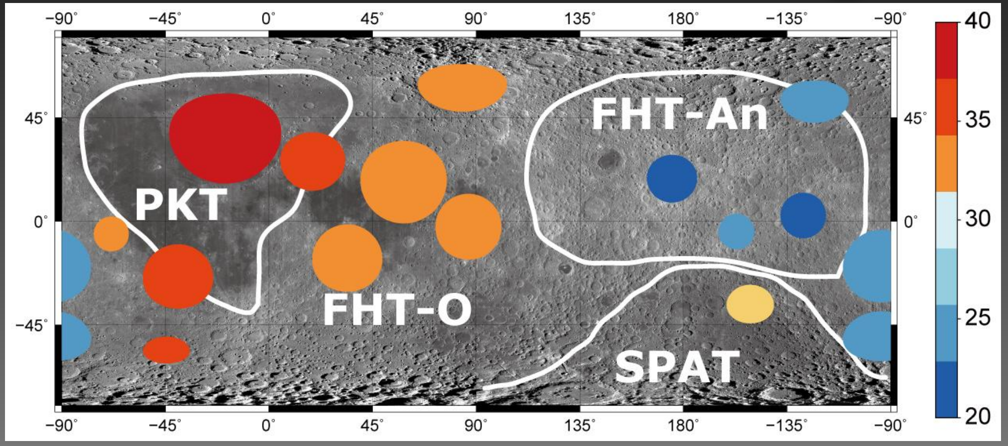




Viscoelastic deformation of major lunar impact basins: Implications for concentrations of heat-producing elements in the lunar crust

Shunichi Kamata (Univ. Tokyo)

- We calculate both the thermal evolution and long-term viscoelastic deformation of major lunar impact basins under a wide variety of parameter conditions
- We estimate crustal structure around impact basins at the basin formation age
- Based on non-negative crustal thickness condition, we constrain the thermal structure at the basin formation age
- Thermal constraints varies widely region by region, suggesting strong heterogeneity in radioactive element concentration



Upper limit of surface temperature gradient (K/km)