Syllabus for SIO 224 Internal Constitution of the Earth

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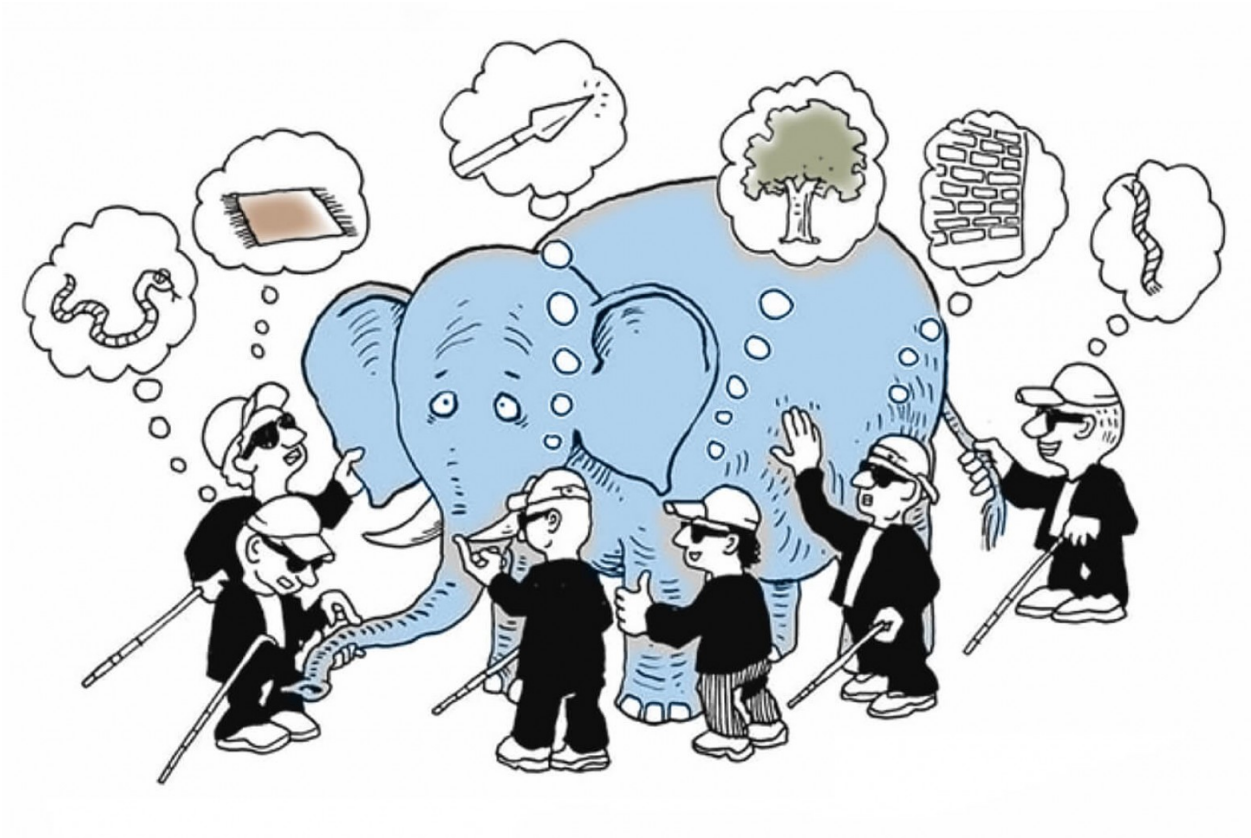
Winter 2020, Tu/Th 10:30-11:50a, Munk 303; Final Exam

Overview:

The study of the structure, composition, and dynamics of Earth's interior is important and fundamental to our understanding of Earth's evolution. It is an active area of research with several major outstanding questions, and it is inherently interdisciplinary and science is not done by a 'lone genius'. Although the deep Earth is the context in this course, in general scientists need training and experience crossing these traditional boundaries to answer fundamental questions make scientific discoveries. This course provides students an opportunity to begin learning how to how to assimilate and apply knowledge from several subdisciplines in geophysics including mantle geochemistry and cosmochemistry, global seismology, thermodynamics, mineral physics, rheology, geodynamics, and geomagnetism.



It is expected that some of the material will have already been introduced in core geophysics classes such as SIO 225, 227A, 229, and 234, and this material will be reinforced.

The course website will be on Slack. This is a collaboration platform that I use for research, and it's a tool that you may also find useful for that, again reinforcing how science is collaborative. I'm going to be using it for teaching materials. You will be sent an invite.

Content convered in this course:
Here is a approximate list of the topics for each class session.

Geochemistry pt 1: What is Earth made of?
Geochemistry pt 2: What is the Urey number?
Rheology pt 1: Deformation and weakening mechanisms, flow rule
Rheology pt 2: Radial viscosity structure of the Earth, dynamic geoid, slab model
Fluid dynamics pt 1: governing eqns, dynamic similarity, Stokes flow around sphere
Fluid dynamics pt 2: Low Re flows (Poiseuille, Couette, channel and corner flows)
Instabilities pt 1: Rayleigh Taylor Instability
Instabilities pt 2: Linear stability analysis
Mantle Convection pt 1: effects of heating mode, geometry, temp- and pressure dependent viscosity, convective and tectonic regimes
Mantle Convection pt 2: Thermochemical convection, dynamics of mantle plumes
Seismology pt 1: 1-D Earth structure
Seimology pt 2: Global seismic tomography
Mineral Physics pt 1: Pressure and temperature in the deep mantle, mineral phase changes
Mineral Physics pt 2: Eqns of state; adiabats, melting curves, experimental results
Mantle Convection pt 3: Compressible mantle convection
Mantle Convection pt 4: Boundary Layer Theory; Thermal history models of the Earth
Geomagnetism: Age of the B-Field; Energetics of the core

Assessments that will be part of this course:

Homeworks will be assigned to develop problem solving and practice solving PDEs

A term paper will be assigned with the topic of your choosing (it must be related to the course). I can help you decide on one. Examples of topics for a term Paper / presentation:
How old is the inner core?
How does the behavior of Earths' B-field (reversals, excursions, high flux patches) relate to the structure and dynamics at the core mantle boundary?
How old are the LLSVPs?
How many supercontinents have there been?
How did the moon form?

For the final Exam we will have a "Great Debate". Additional details will be provided later.

Grading:
10% Class participation (attendance, preparedness, engagement)
60% Homeworks (includes a few mini-projects)
20% Term Paper (5% of which is constructive critique of peer's draft)
10% Debate ("Final")