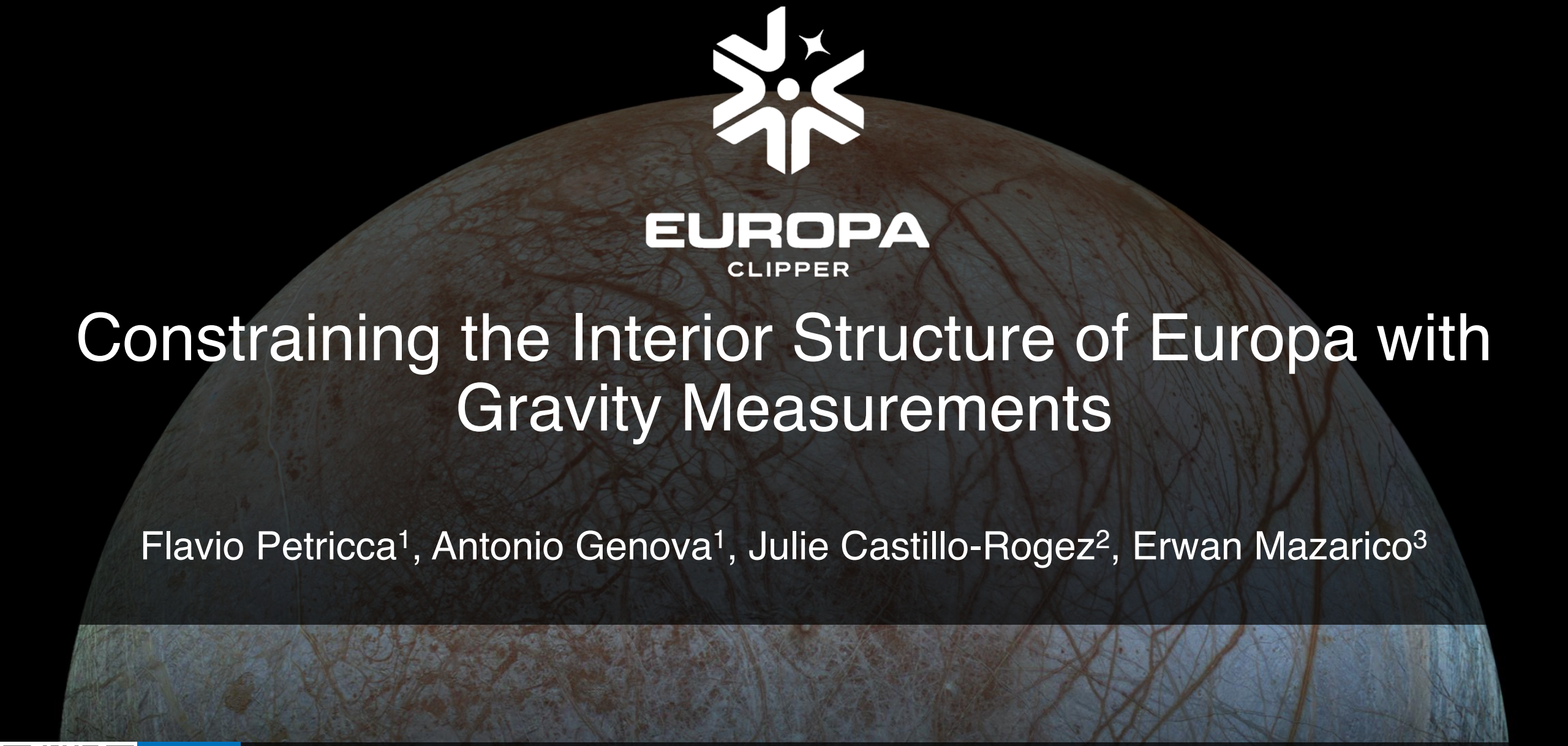

Constraining the Interior Structure of Europa with Gravity Measurements

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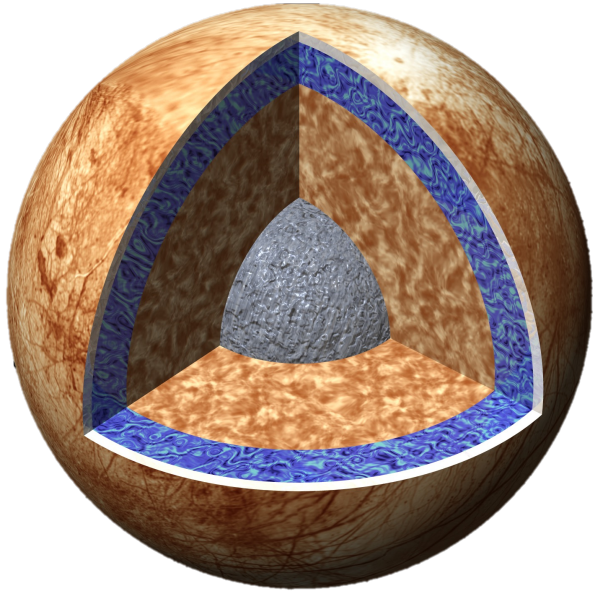
Outline

EUROPA CLIPPER



- Develop a Markov-chain Monte Carlo (MCMC) simulation framework to determine the likely interior structure of Europa.
- Assess how geophysical parameters (*e.g.*, mass, MoI, tidal Love number k_2) constrain the inversion of Europa's interior structure models.
- MCMC enables parametric exploration of the interior, providing probability distributions for its properties (layers' size, density; Genova et al. 2019[1]).

[1]Genova, A. et al. (2019). Geodetic evidence that Mercury has a large solid inner core, Geophysical Research Letters

Interior Structure Modeling

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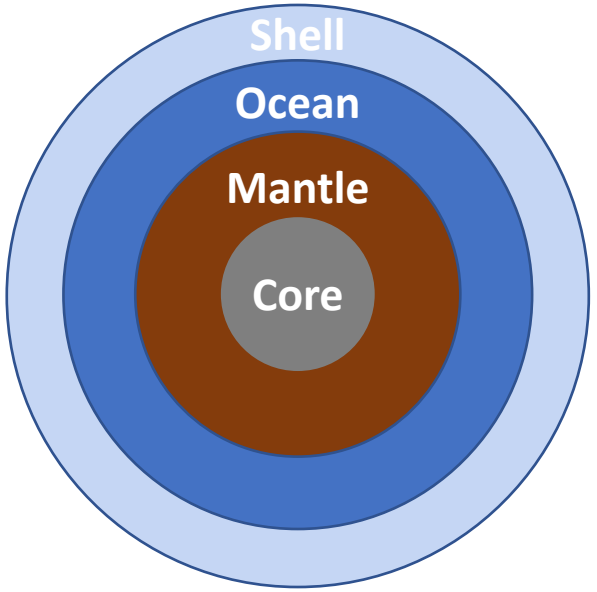
- Models are generated in chains by using the Metropolis-Hastings algorithm.
- For each model, the mass and MoI are computed and compared to the observed values (constraints).

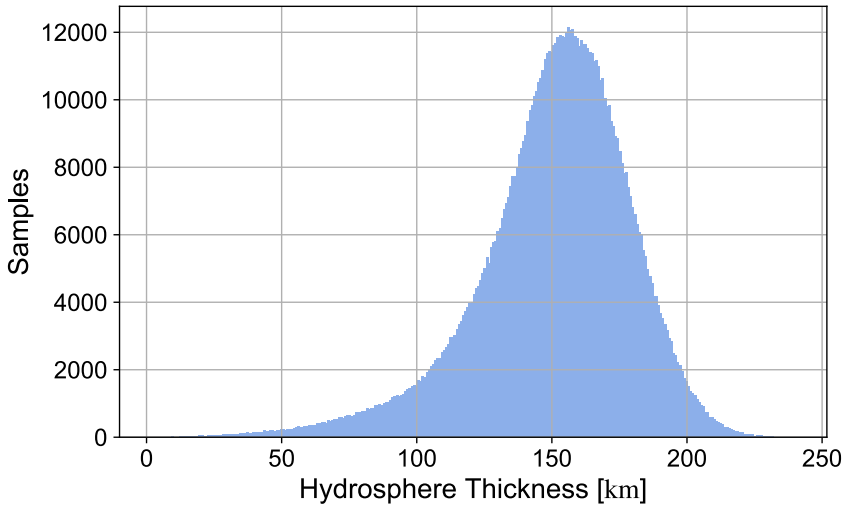


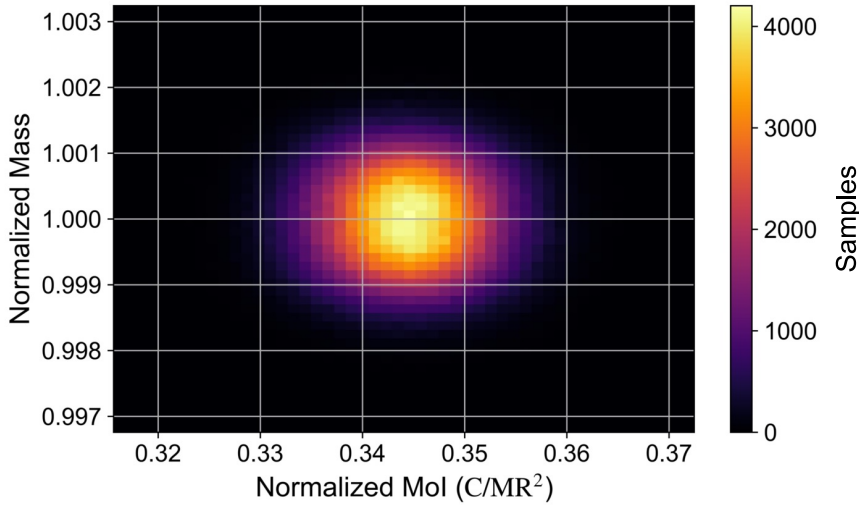
Constraints	Anderson et al. (1998)
Mass ($\times 10^{22}$ kg)	4.7792 ± 0.00062
MoI (hydrostatic)	0.346 ± 0.005

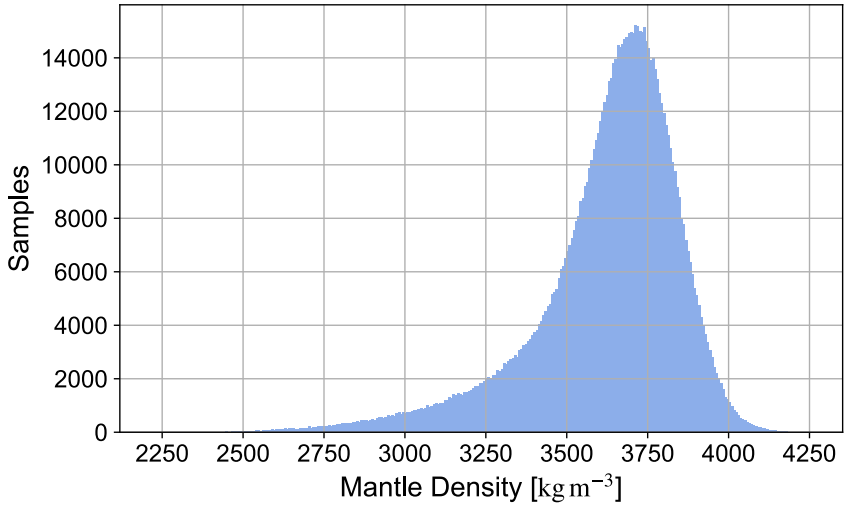
Parameters	Core Size [km]	Core Density [kg / m³]	Mantle Density [kg / m³]	Ocean Thickness [km]	Ocean Density [kg / m³]	Icy Shell Thickness [km]
Bounds	0 – 1200	5000 - 8000	2000 - 5000	0 – 200	1000 - 1300	0 - 200

Interior Parameters Determination

- Only models compliant with the constraints are accepted.
- Ocean and icy shell thickness not well individually determined. The hydrosphere thickness is better constrained (~155 km).

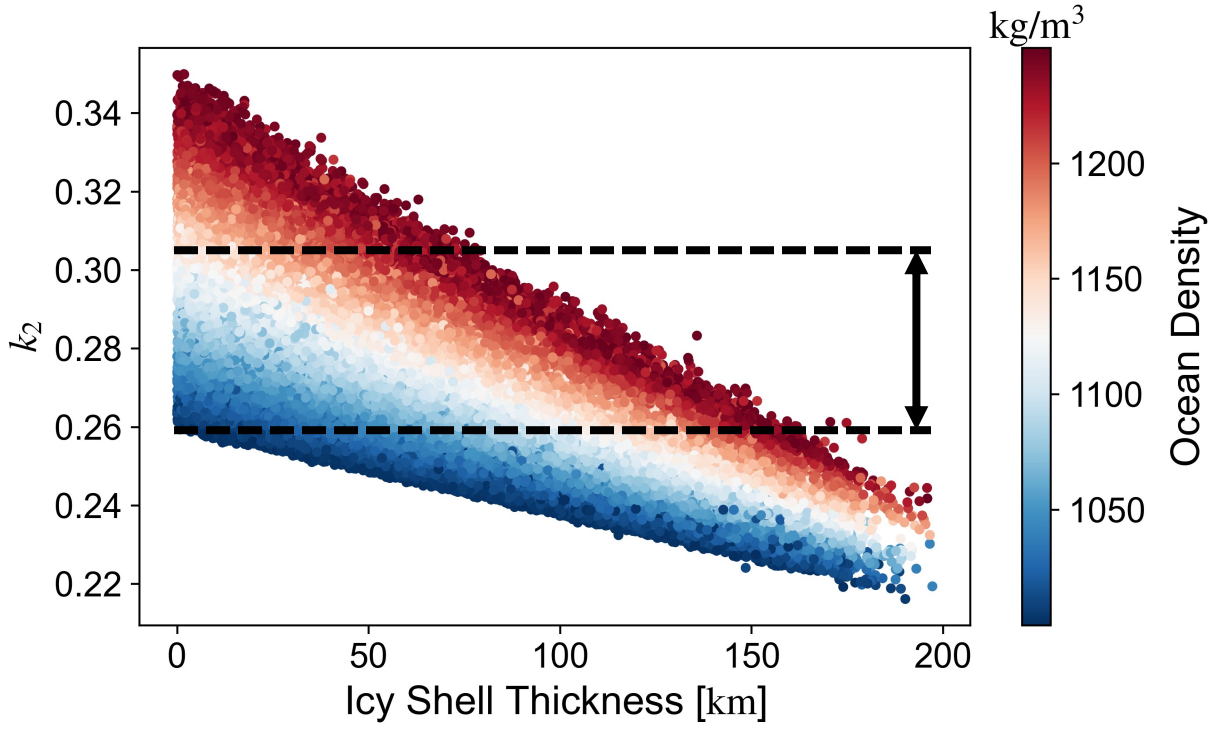






Predicted Tidal Love Numbers

- Love number k_2 is computed with ALMA (Spada, 2008[2]) for all the accepted models.
- Modeling assumes layers with constant viscosity and rigidity.
- Ocean density greatly influences k_2 and introduces large uncertainties.



Black dashed line: Europa Clipper expected 3σ uncertainty (~0.045)

[2]Spada, G. et al. (2008). A Fortran program for computing the viscoelastic Love numbers, Comput. Geosci.

Summary

- MCMC methodology employed to constrain Europa's interior structure given current knowledge of the moon's geophysical parameters.
- Europa Clipper is expected to greatly improve this knowledge and to yield unprecedented measurements of Europa's tidal Love numbers.
- These measurements alone may not provide accurate constraints on the properties of the ocean and icy shell.
- Combination with data of other Europa Clipper instruments (*e.g.*, ECM magnetometer) may provide further constraints on the outer layers.