



# The Spherical MHD Code MagIC, Fundamentals

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# Some MagIC Possibilities

- Explore parameters dependence.
  When is a dynamo Earth-like?
- Anelastic approximation for gas giants.
- Outer stratified layer for Saturn, Mercury, Earth.
- Inhomogeneous CMB heat flux pattern for
  Earth, Mars, Mercury.
- Study statistical properties, time dependence,
  reversals, secular variation.
- Test flow inversions bases on secular variation data.
- Simulate stellar dynamos, star spots ....
- Fundamental problems in spherial shells:
  rotating and non-rotating convection, turbulence, ...
- Simulate laboratory experiments: Sherical Couette

# What MagIC5 can't (yet) do

- Non-spherical geometries.
- Strongly stably stratified layers.
- Two nested layers.
- Double diffusive problems.

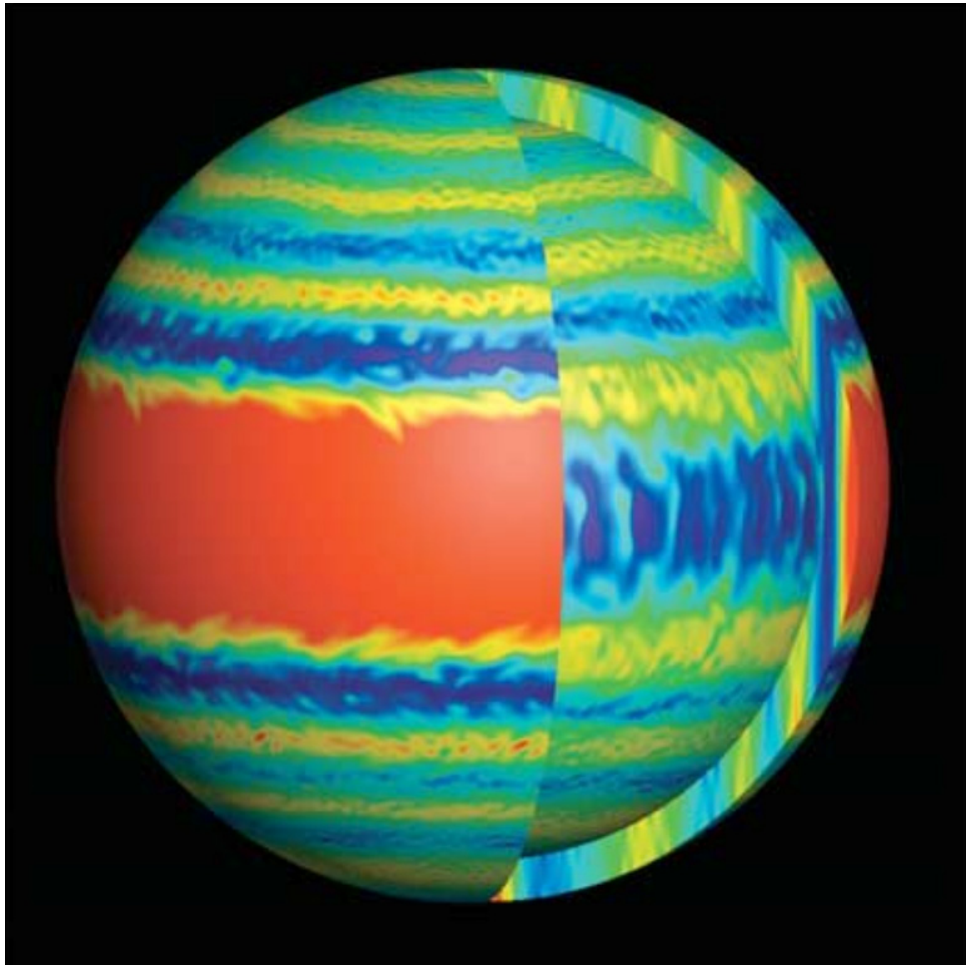
# Zonal Jets

Heimpel et al. 2005

Jupiter like zonal jets
in a thin convective shell

Stress free boundaries

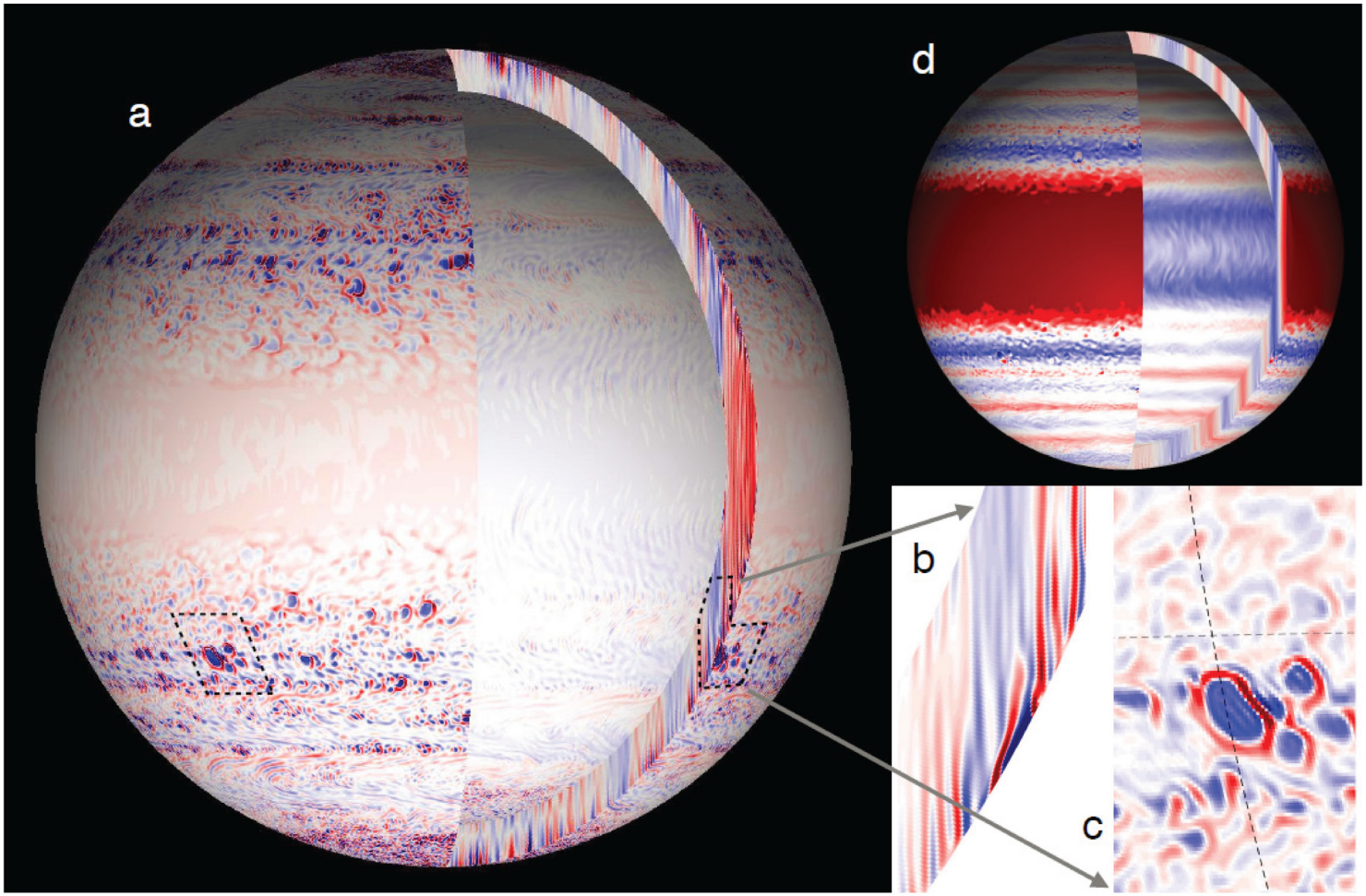
Low $E$, high $Ra$



# Anti-Cyclonic Eddies

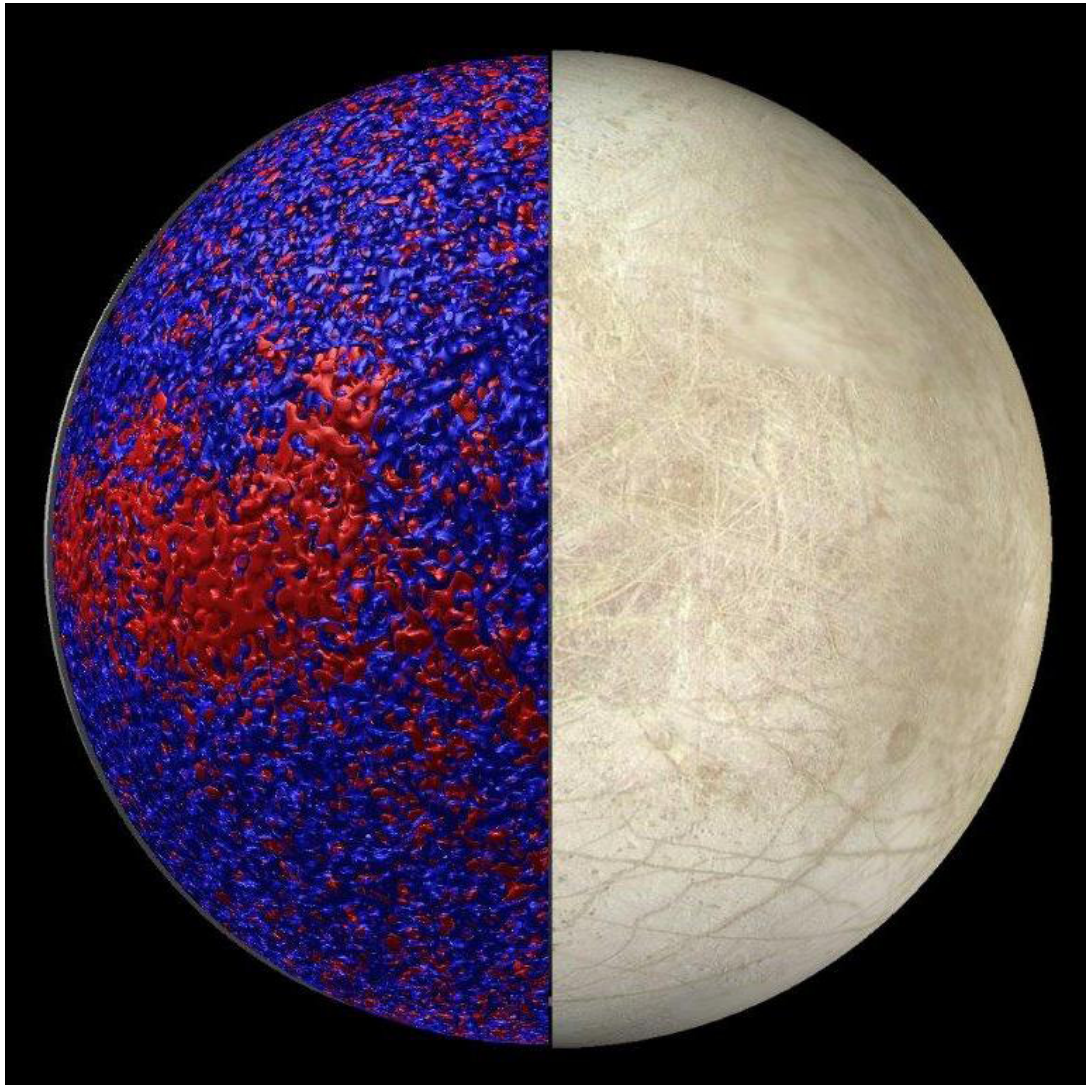
Heimpel et al. 2015

Stably stratified
very outer layer



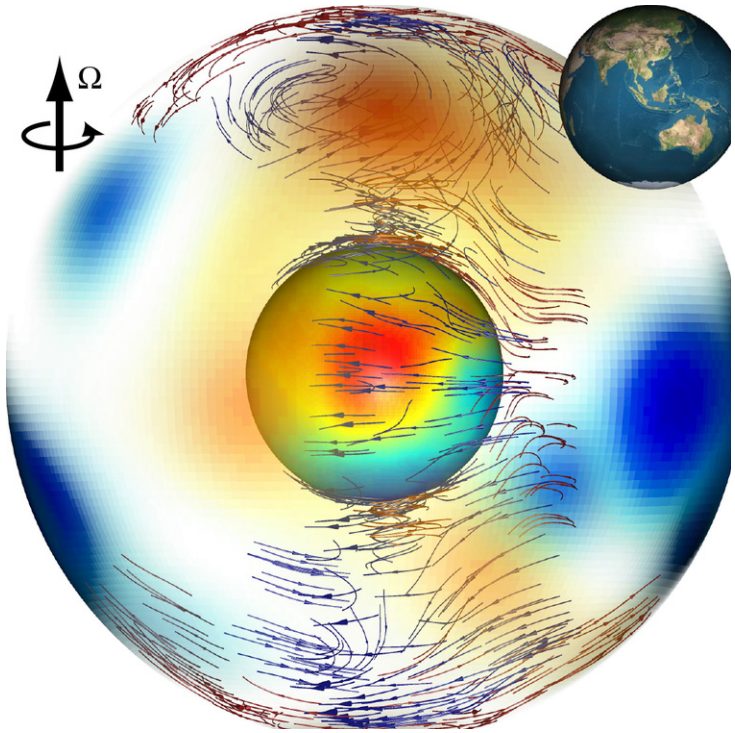
# Explaining Chaos Terrain on Europa

Soederlund et al. 2013  High Ra, low Pr



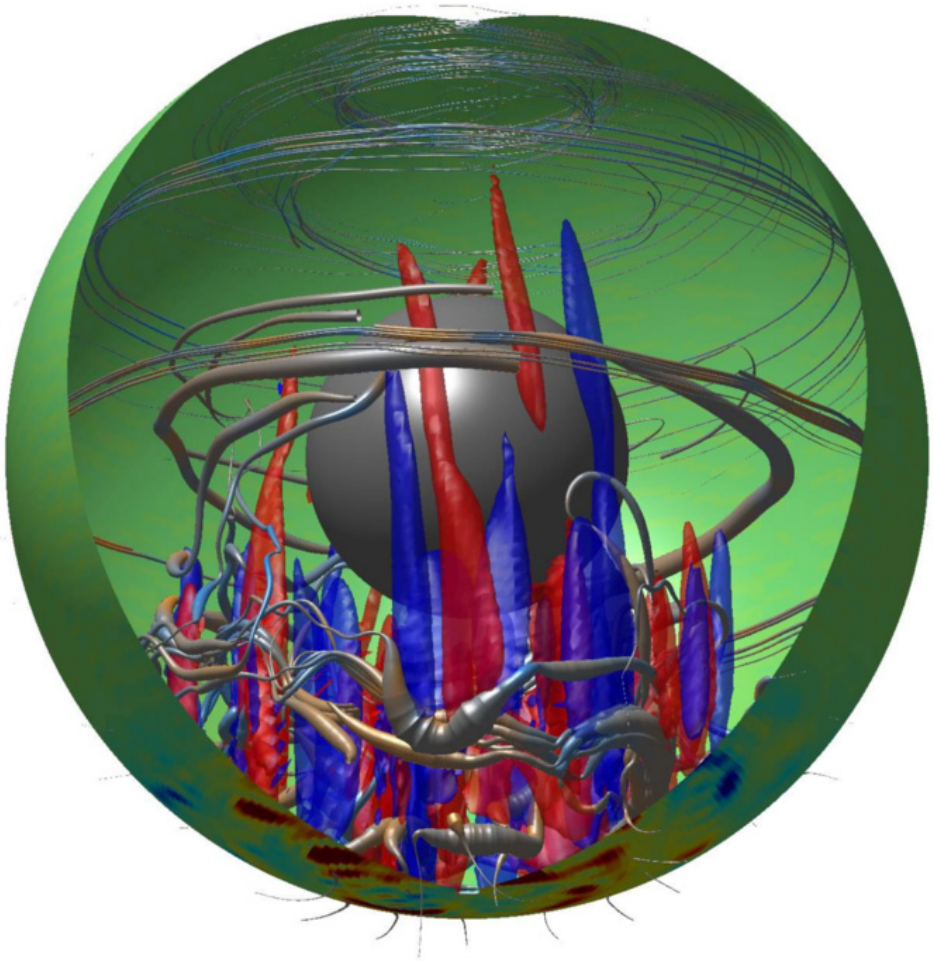
# Explaining Inner Core Anisotropy

Aubert et al. 2008 tomographic CMB heat flux pattern



# Explaining the Martian Crustal Anisotropy

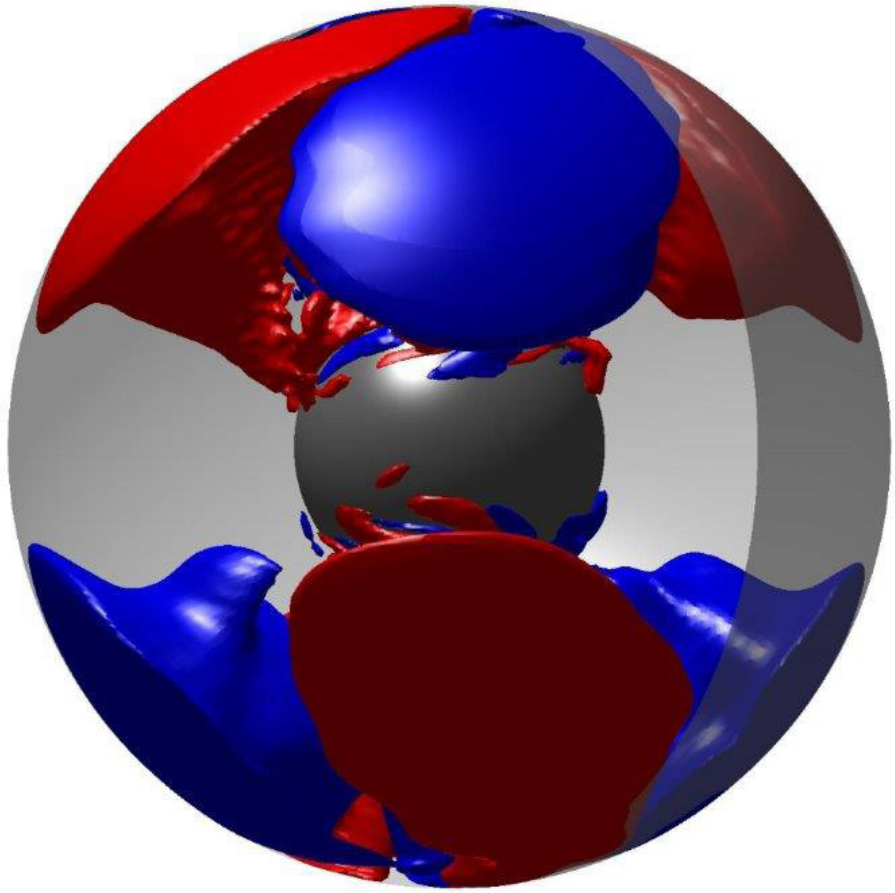
Dietrich & Wicht 2013 increased southern CMB heat flux



# Inertial Modes in the Lathrop Experiment

Wicht 2014

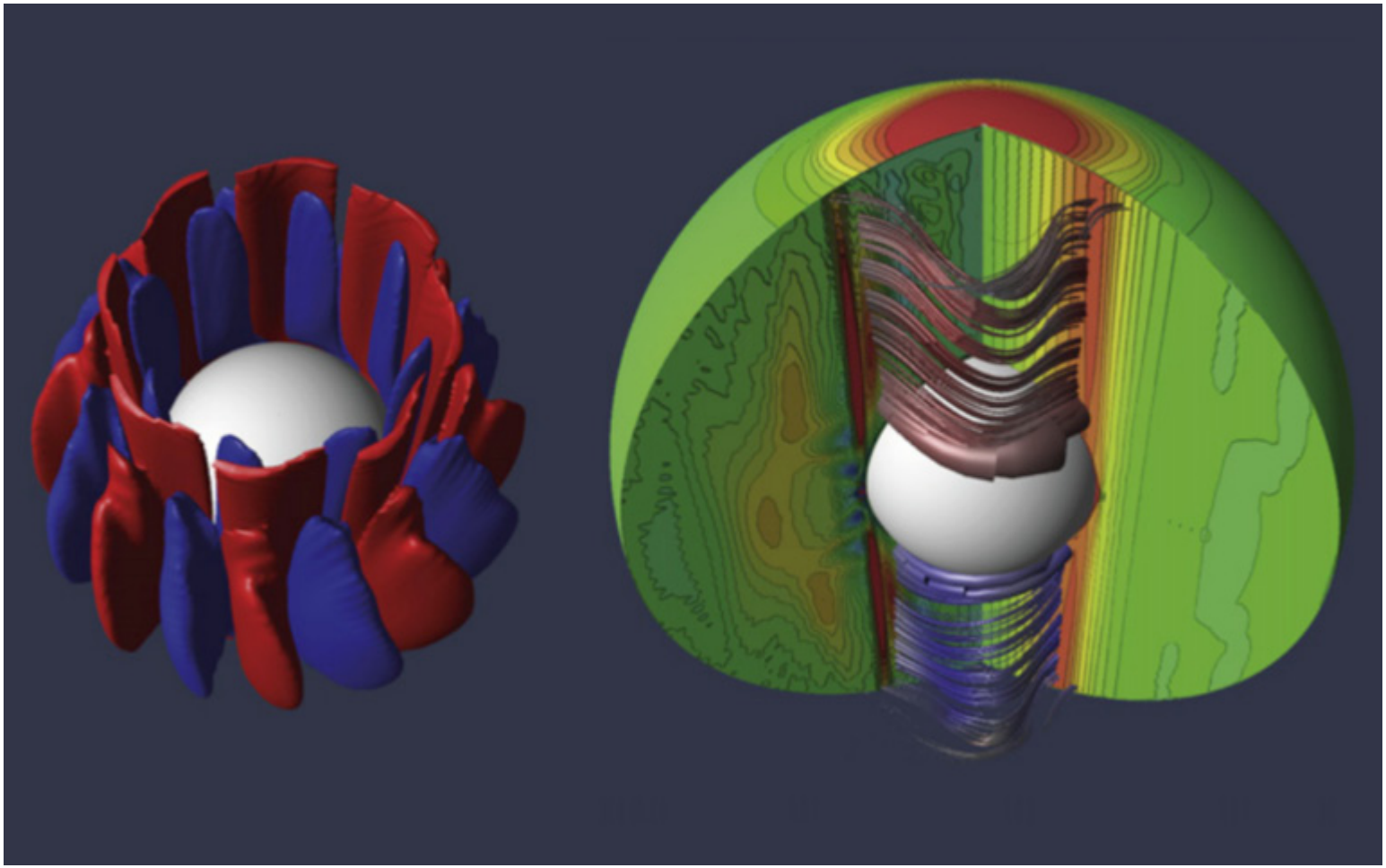
Spherical Couette flow
at small enough $E$



# Explaining Saturn's Peculiar Magnetic Field

Cao et al. 2012

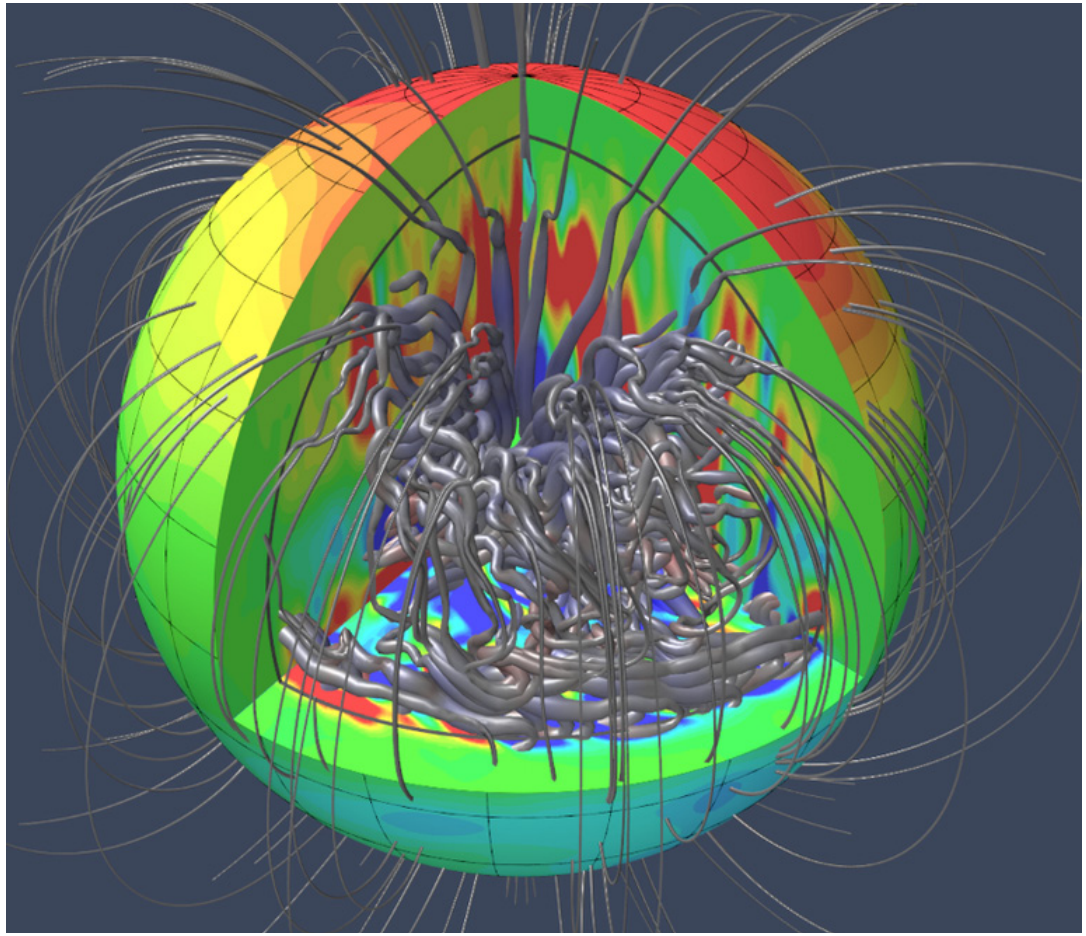
slightly supercritical
spherical Couette dynamo



# Jupiter's two Dynamos

Gastine et al. 2014

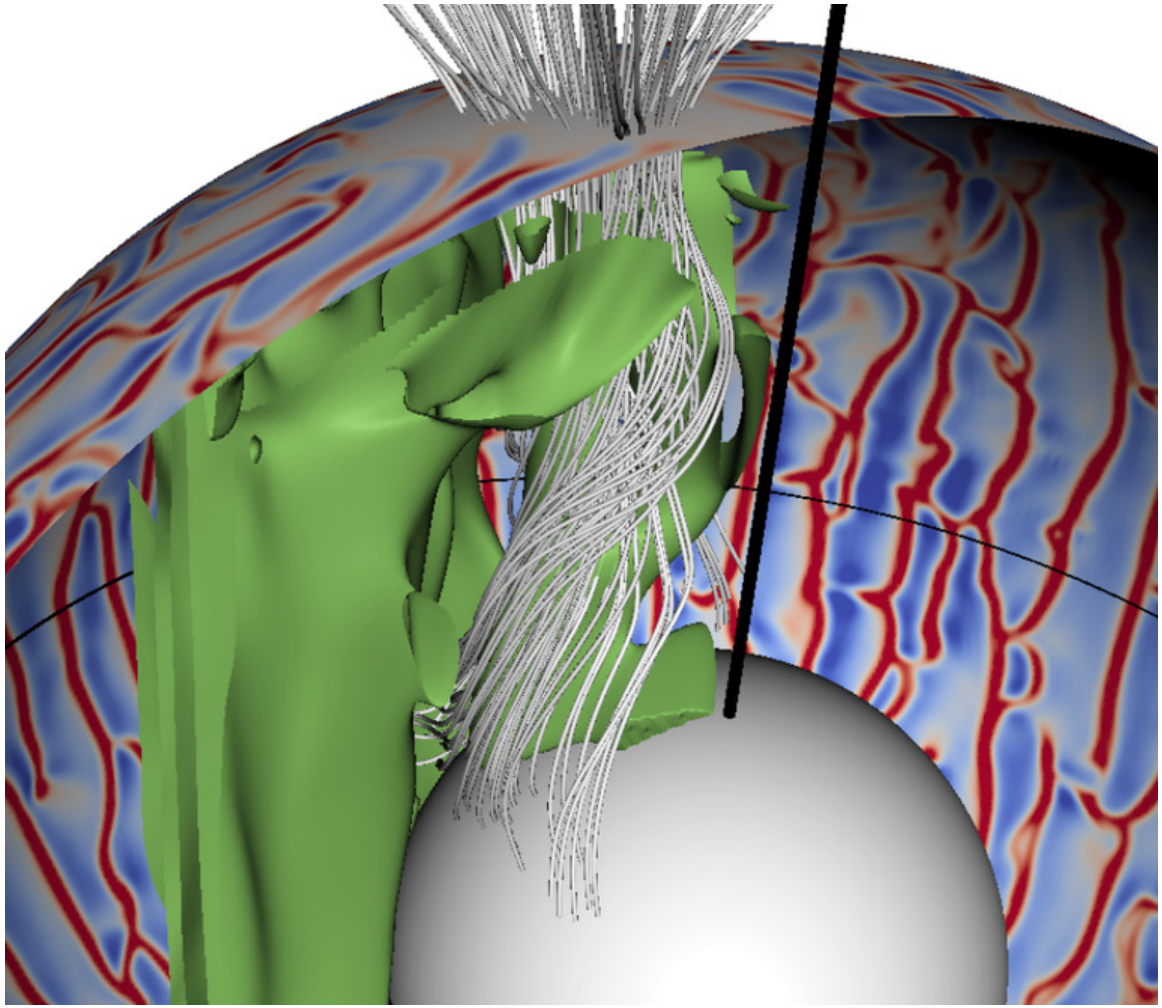
strong density stratification
strong electrical conductivity variation
large enough $Ra$



# Star Spots

Yadav et al. 2015

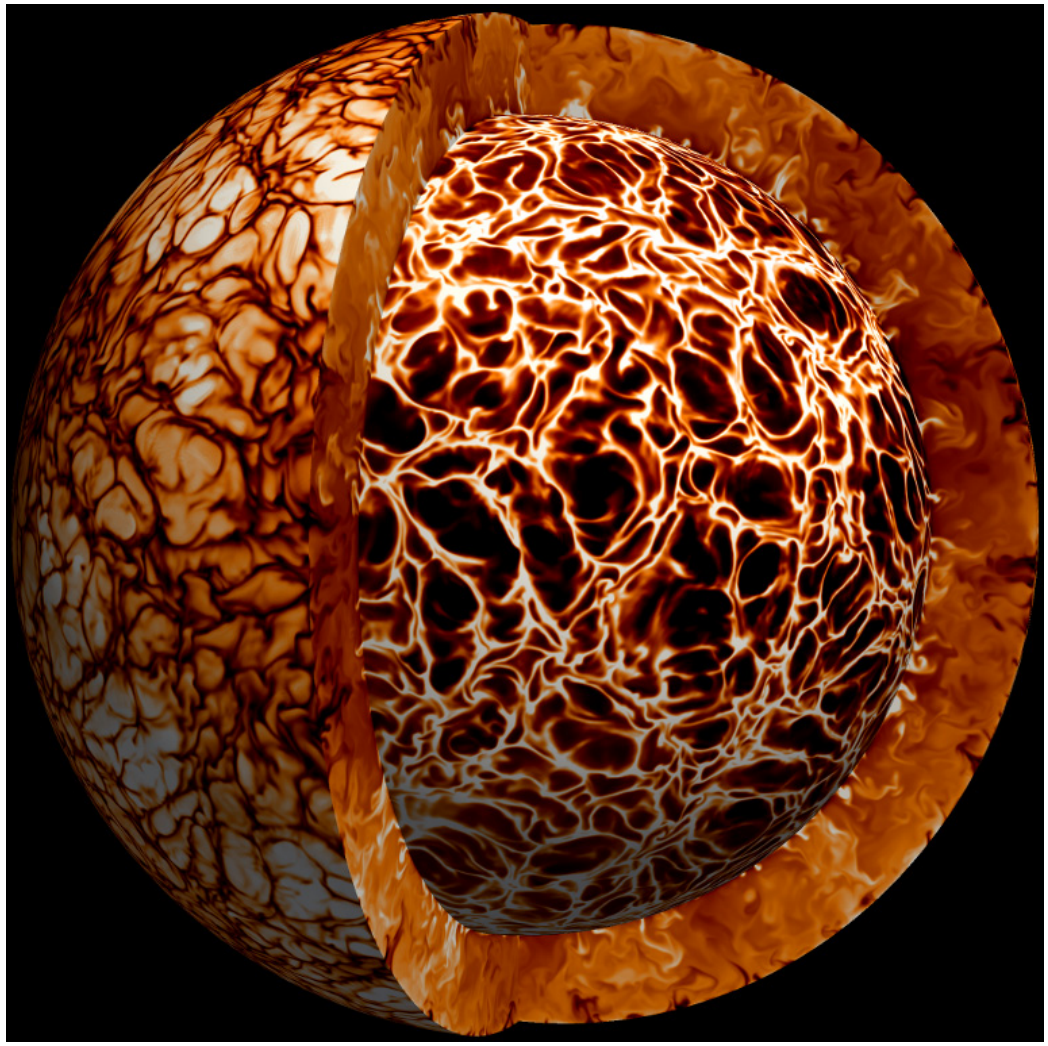
strong density stratification
large enough $Ra$



# Non-Rotating Convection

Gastine et al. 2015

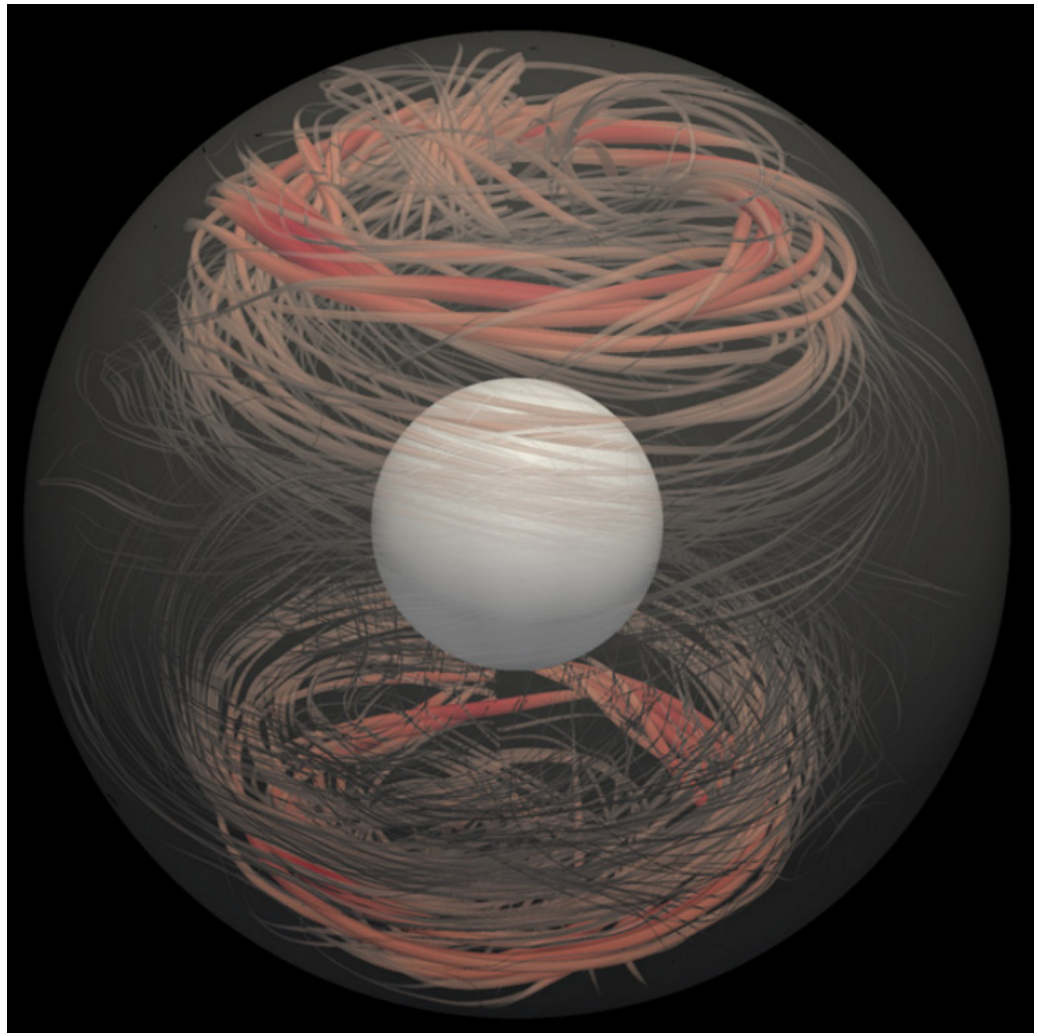
no rotation, no magnetic field
large enough $Ra$



# MRI Instability

Jouve et al. 2015

(imposed) strong differential rotation
strong magnetic field



# What are Your Plans?

Its up to you now!
(Don’t worry! We can help.)