# Dynamo experiments, Planets, Rotation

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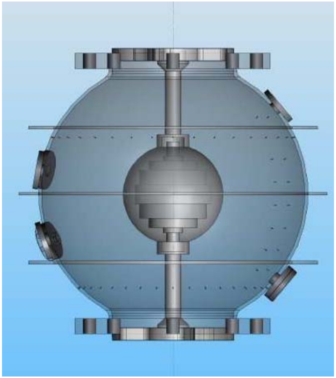
from results obtained by the DTS task force (Philippe Cardin, Henri-Claude Nataf, Thierry Alboussiere, Daniel Brito, Nadège Gagnière, DJ, Denys Schmitt)

# Possible goals for experiments from a geophysical viewpoint

- Interplay of magnetic and rotation forces
- Fast dynamics responsible for the “observed” advection of the magnetic field at the core surface
- Generation of large scale magnetic and velocity fields from forcing at small scale (buoyancy flux at the ICB)
- Saturation mechanisms
- Mechanisms for reversals and excursions

# Measurements in the DTS experiment

Available power: 2x11 kW

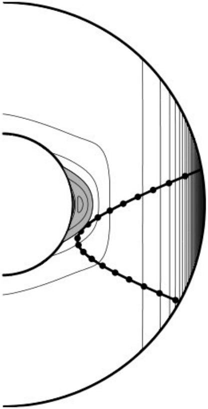


# The magnetized inner core

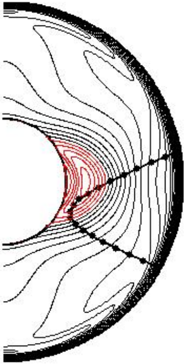
Intensity of the imposed dipolar field varying from 0.345 T.($S \sim 2$) to 8 mT. in the fluid domain.

# The angular velocity distribution

In the presence of rotation,
$M = 210, \; Re = 6.10^4$

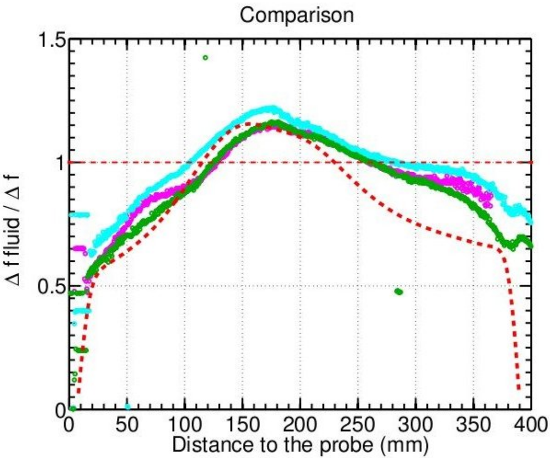


With outer sphere at rest,
$M = 40, \; Re = 1.5\,10^3$



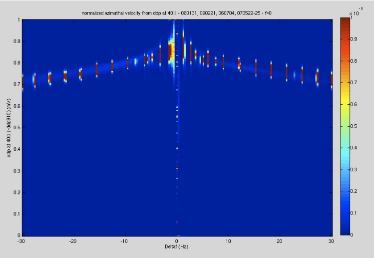
# Angular velocity profiles with outer boundary at rest

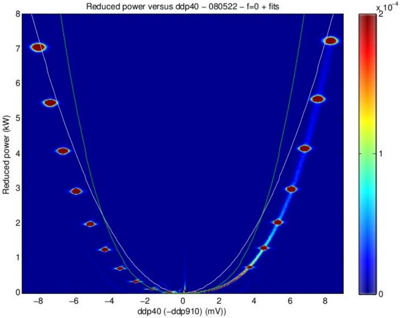
Velocity measured up to $8.m.s^{-1}$, $R_m \sim 20$.



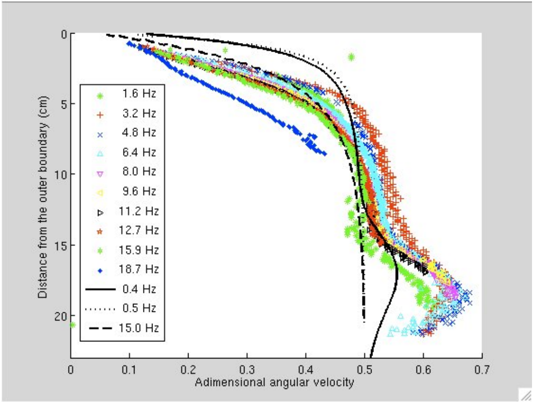
# Efficient entrainment of the fluid by the magnetized inner core

- "Average" angular rotation normalized by the inner core angular rotation
- Power dissipated in the fluid region



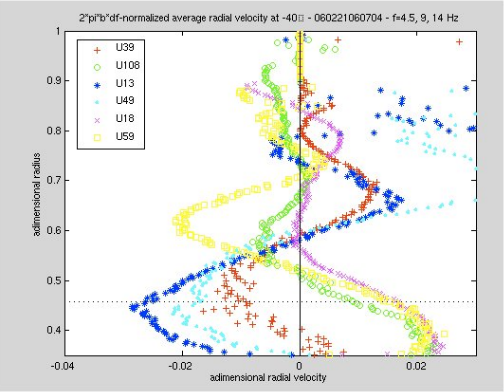
# Angular velocity profiles in the presence of rotation



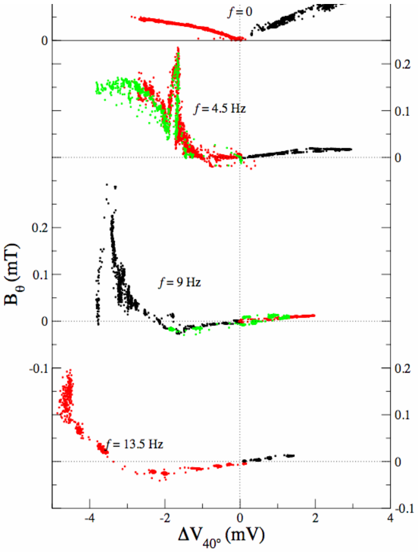

Analytical calculation of the profile in the geostrophic region using a turbulent friction law at the outer boundary (Gagnière and Nataf, in preparation) after Kleeorin et al. (1997).

# Average radial motions in the presence of rotation

$v \sim 0.2 m.s^{-1}$, $R_m \sim 0.5$



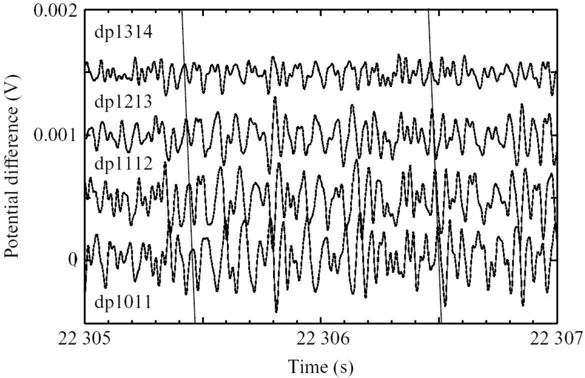
# Time average induced field at the surface



# Detection of wave motions

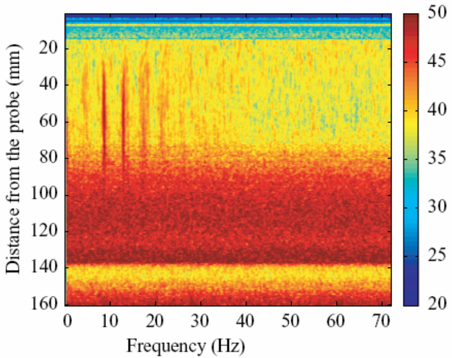
from electrical potential measurements at the surface (Schmitt et al., 2008)

Meridional component of the wave motions measured below the outer surface: $v \sim 0.4 m.s^{-1}$, $R_m \sim 1$

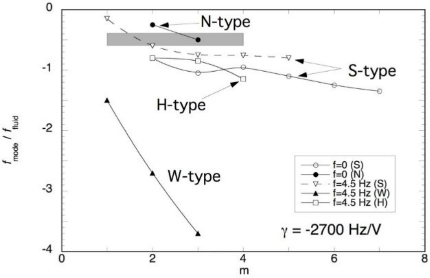


# Detection of wave motions
from ultrasound measurements (radial velocity)

Penetration of the waves deep inside the core.



# Different types of waves




N waves: no magnetic signature; explanation?: negligible magnetic field induced, at the surface, by the interaction between Rossby-type inertial waves and the imposed axial dipole field

# Informations/questions gained from the experiment

- Turbulent Ekman boundary layer inferred at the outer boundary
- Observation of a variety of waves not predicted from the numerics
- Dynamo efficiency of these waves?
- Nonlinear interaction between the waves?

# An important limitation of experiments

- Importance of magnetic diffusion
- Geophysical case: observation of magnetic field changes on fast (non-diffusive) timescales, for which rotation forces dominate magnetic forces
- Nearly 2D quasi-geostrophic dynamics
- Dynamics in presence of a z-independent toroidal field?