# Keynotes

## Turbulence regimes in planetary cores

H-C. Nataf

ISTerre, CNRS/University Grenoble Alpes

The organization of fluid motions and magnetic field in planetary cores remains a puzzle. We know that the rotation of the planet plays a key role. So do the spherical boundaries of the liquid core, and the magnetic field itself, once produced by dynamo action. In these peculiar conditions, what kind of turbulence sets in? During my talk, I will address several questions that are directly linked to this problem. Such as: why is the magnetic energy $E_M$ in the Earth's core much larger than the kinetic energy $E_K$? What controls the saturation of the magnetic field? What are the consequences of having $E_M >> E_K$? Which are the relevant asymptotic regimes? Is viscous dissipation negligible? Down to which length scale are motions quasigeostrophic? What happens at smaller scales? Is there a typical organization of the magnetic field? Are strong zonal flows incompatible with a strong magnetic field? Numerical simulations have shed a new light on convective dynamos. Yet they rarely display $E_M >> E_K$ and negligible viscous dissipation. Universal scaling laws have been derived from these numerical simulations. How relevant are they for planetary cores? $E_M$ is limited by the available power in these laws. Is this incompatible with a magnetostrophic balance? Numerical simulations show a change in dynamo character when inertia balances Coriolis forces at the dominant length-scale. Should not it be when the Lorentz force balances Coriolis in planetary conditions? I will discuss all these important issues with the help of the tau-ell regime diagrams I introduced together with Nathanaël Schaeffer in the Treatise on Geophysics, second Edition (2015).

---