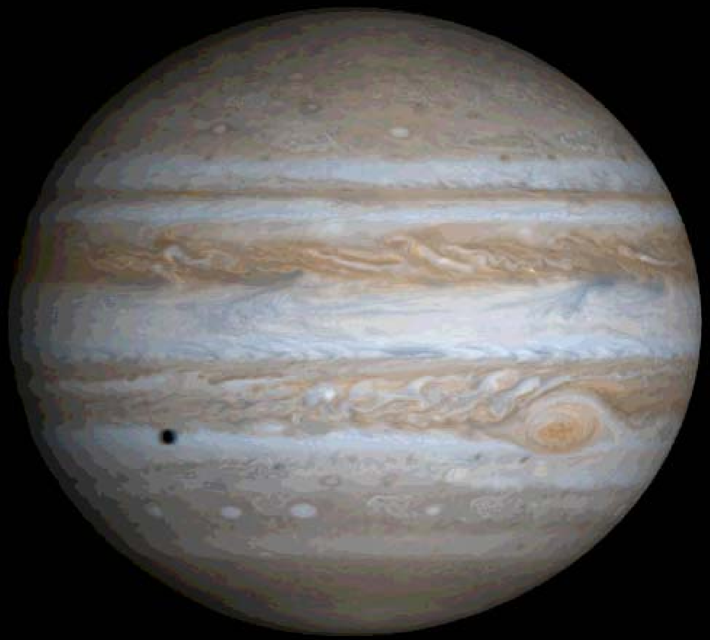
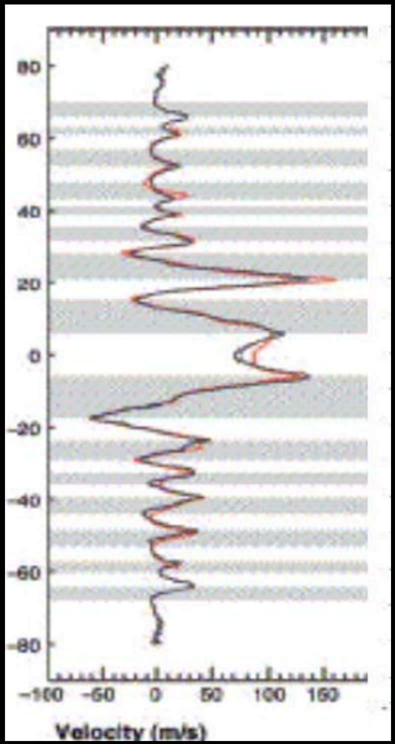
Surface observations of Jupiter





Internal heat flux minimum at equator.
Luminosity = 3×10^{24} ergs/s

Dipolar magnetic field
10^{o} tilt, ~10g

Constraint: Ohmic heating < observed luminosity

Test a prescribed profile of differential rotation (constant-on-cylinders).

B is axisymmetric and time independent.

Poloidal part is prescribed as an extrapolation into the interior from the observed external potential field.

Toroidal part is obtained via the *Omega Effect* balanced by magnetic diffusion.

J is obtained by taking the curl of the toroidal field.

Volume integral of $J^2/\sigma(r)$ gives the total Ohmic heating.

That is, local Ohmic heating is proportional to $(\mathbf{B}_{poloidal} \bullet \nabla\Omega)^2$, which is the *Ferraro Iso-rotation law* (1937).

So (assuming axisymmetry and steady-state) if surfaces of constant angular velocity are everywhere parallel to the internal poloidal field, total Ohmic heating vanishes.

However, convective dynamos are 3D and time dependent.

3D MHD simulations of Jupiter’s dynamo attempt to produce a banded zonal wind pattern, convective velocities and a magnetic field at the surface that are similar in structure and amplitude to those observed.

To test the dynamics below the surface, such models should employ realistic profiles of $\rho(r)$ and $\sigma(r)$ and also be constrained to produce a total Ohmic heating less than Jupiter’s observed luminosity - even if the model’s luminosity needs to be greater due to large thermal and viscous diffusivities.