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NICS

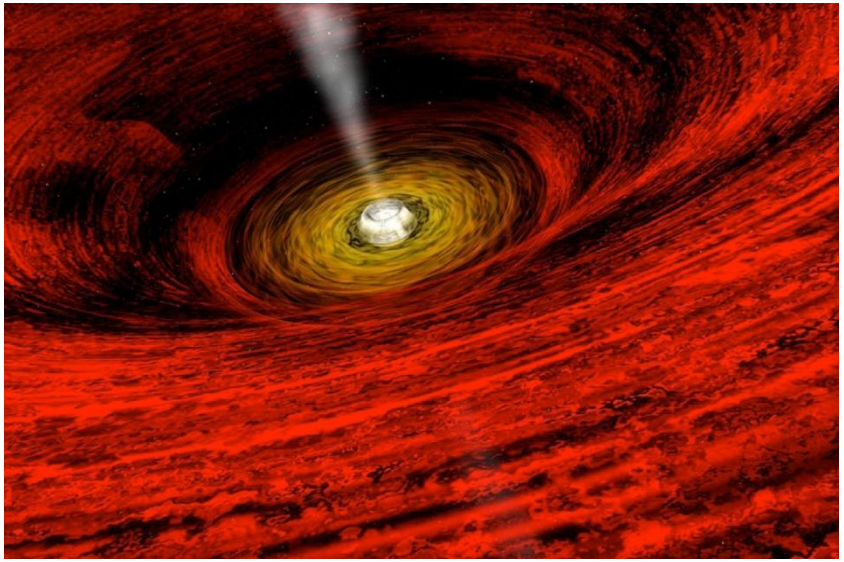
Magnetic Helicity and Astrophysical Disk Dynamos

Jeffrey S. Oishi
Stanford Linear Accelerator Center

Mordecai-Mark Mac Low
American Museum of Natural History

Astrophysical disks transport material toward their centers via magnetohydrodynamic turbulence

How do physical parameters such as magnetic Prandtl number affect this turbulence?



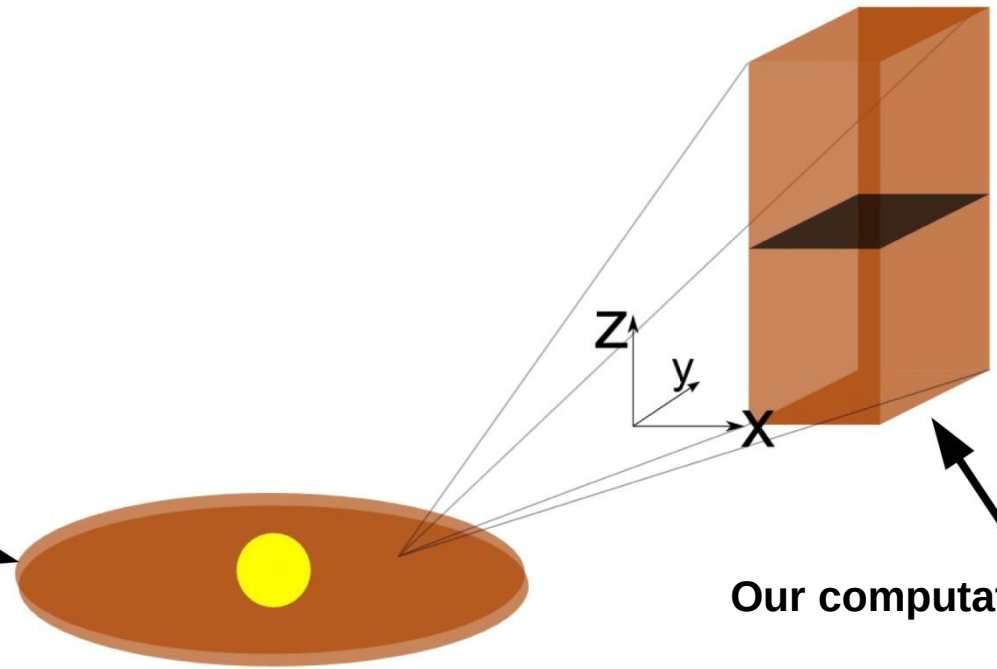
Credit: April Hobart, CXC

Can the disk act as a dynamo, generating its own magnetic field?

We performed simulations on Kraken using The Pencil Code

(http://code.google.com/p/pencil-code/)

Solves MHD equations in shearing box geometry*



Accretion disk around young star or black hole

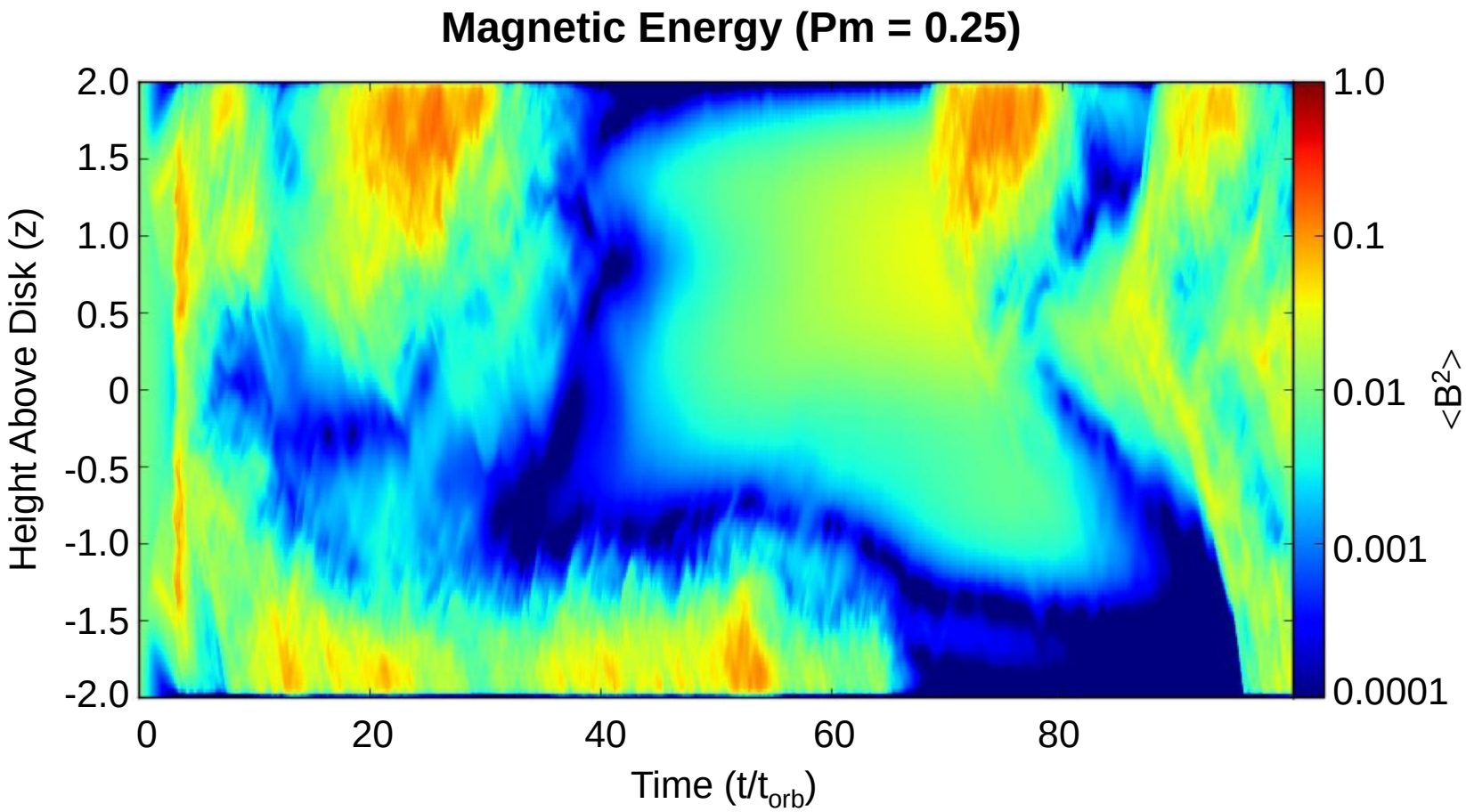
Our computational domain

At resolutions up to 128 x 512 x 512
(with 256 x 1024 x 1024 runs pending)

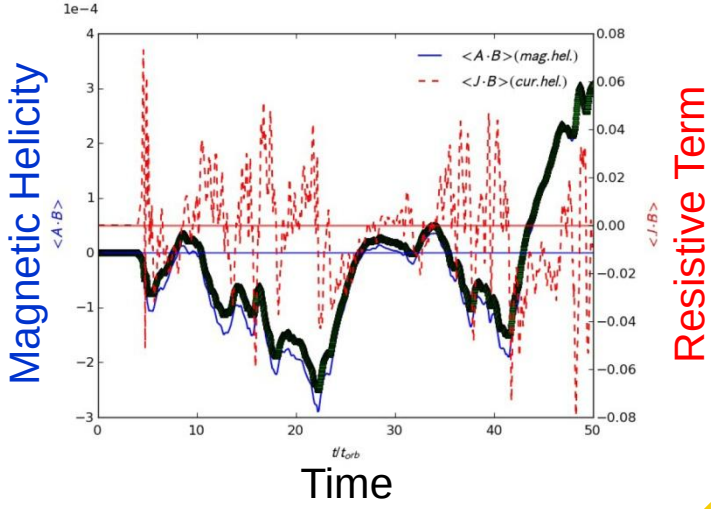
6th order spatial derivatives
3rd order Runge-Kutta temporal derivatives

*among many other geometries and equations

Disks *can* create their own fields even when the magnetic Prandtl Number Pm < 1



But, boundary conditions are *essential*

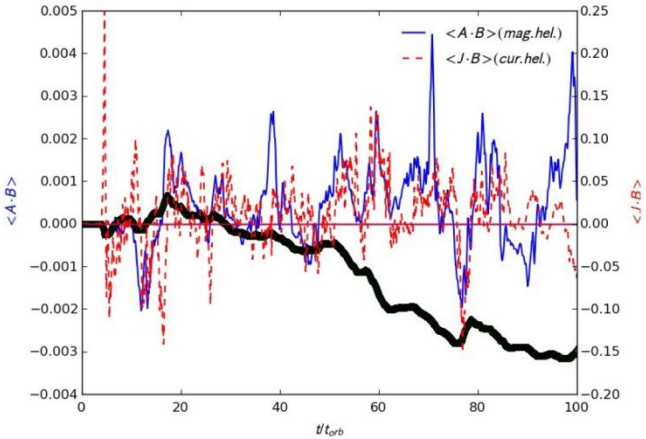


Periodic Boundary Conditions

Magnetic helicity measures the linkage of magnetic field lines. If resistively limited, then dynamo action is not possible in astrophysical disks because resistivity is too small

Helicity is controlled (and limited) by resistivity
Green triangles: integration of resistive term

Open Boundary Conditions



Helicity also escapes through boundary
Integrated resistive term (green triangles) does not track helicity

Jeffrey S. Oishi

Stanford Linear Accelerator Center

jsoishi@astro.berkeley.edu