MRI-Driven Turbulence & Thermal Hydraulics

Aleksandr Obabko $^{1,2,3,4}$

in collaboration with

Fausto Cattaneo $^{1,2,3,4}$

Paul Fischer $^{3,4}$

Andrew Siegal $^{3,4}$

Workshop on Scientific Data Analysis and Visualization for Petascale Computing

Granlibakken, Tahoe City, CA

August 3-6, 2009

1 NSF sponsored Physics Frontier Center for Magnetic Self-Organization in Laboratory and Astrophysical Plasmas (CMSO)
2 Department of Astronomy and Astrophysics, University of Chicago
3 Division of Mathematics and Computer Science, Argonne National Laboratory
4 Computation Institute, University of Chicago

KITP 2008
Axisymmetric vs 3D (z-periodic, $Bz_0=0.05$)

⇒ Axisymmetric solution is strongly unstable to 3D perturbations
⇒ Saturation both through dissipation and modification of background velocity for axisym / 3D toward constant azimuthal / constant angular velocity (cf. Julien & Knobloch 2005)

*† Acknowledge the use of resources of NERSC at Lawrence Berkeley National Laboratory (as INCITE 2005)
§ Acknowledge the help of NERSC Visualization Group, LBNL
ϒ Run time on 32,768 processors of Blue Gene Watson (BGW) was provided courtesy of the IBM Corporation & acknowledgement of the use of resources of Argonne Leadership Computing Facility operated by ANL

KITP 2008
Streaks of high and low speed / angular momentum
Angular Momentum Transport

Angular momentum fluxes \((x \cdot r)\)

\begin{align*}
\text{Reynolds and Maxwell stress fluxes of AM} \\
r u'_\theta u_r - r B_\theta B_r
\end{align*}

\(\Rightarrow\) Reynolds stress flux confinements to cylinder “boundary layers”

\(\Rightarrow\) Maxwell stress flux domination

KITP 2008
LES
Re=50,000

Visualization: Hank Childs
(LLNL/LBNL)

ANL 2008