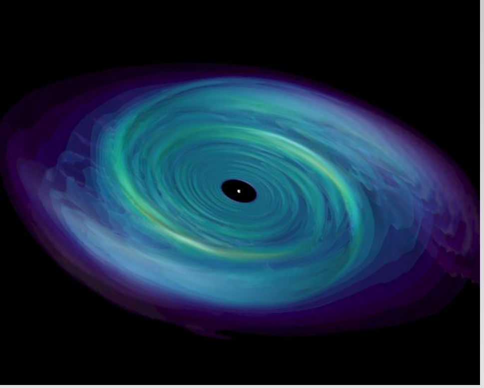

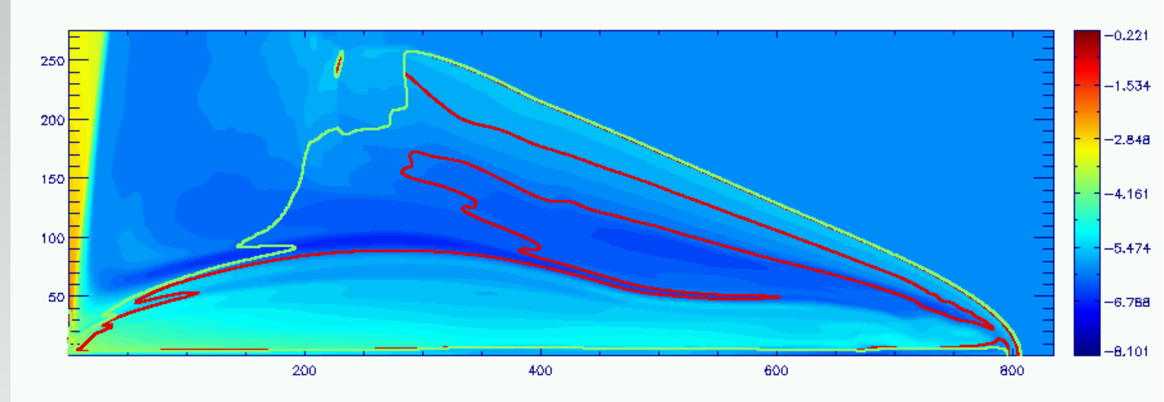

Jets from Viscous Accretion Disks

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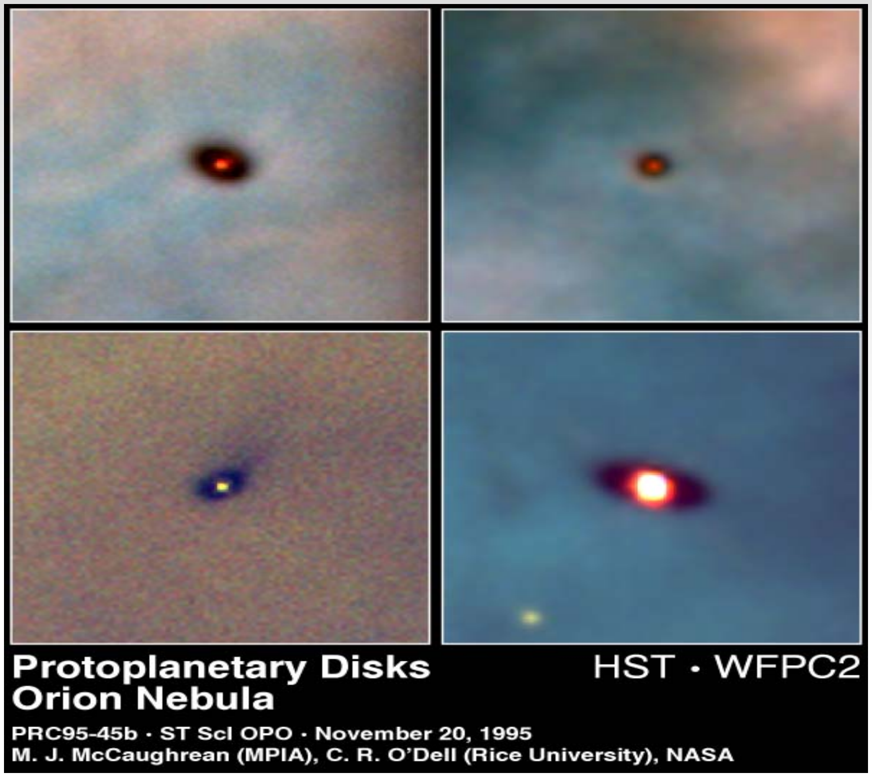
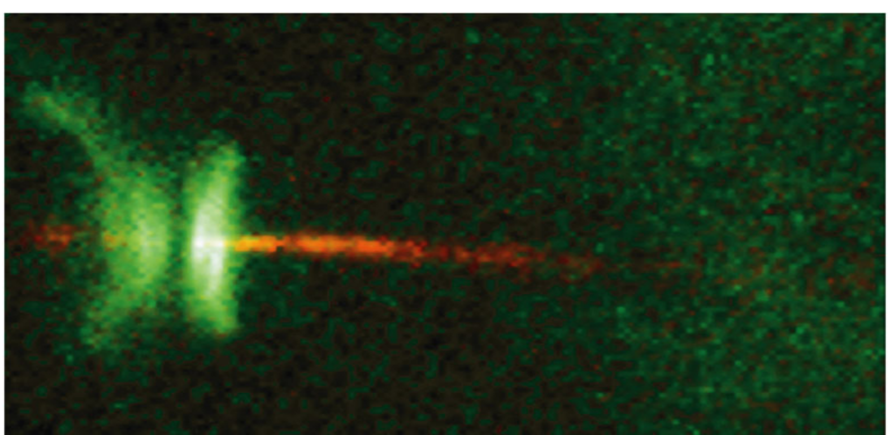
Introduction



- To accrete material, need to lose angular momentum efficiently.
- Either by upward transport (jet), or anomalous viscous transport (disk)



JEDs vs SADs

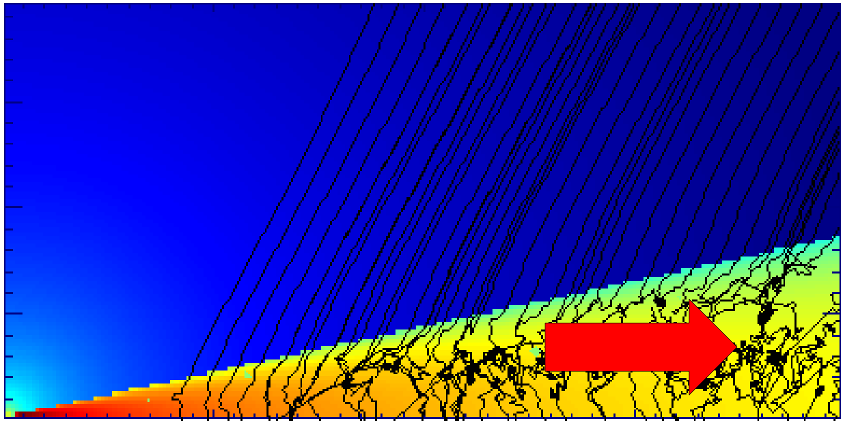
- A Jet Emitting Disk (JED) has equipartition magnetic field in inner regions -> large lever arm (as far as Alfven surface) – the dominant torque is magnetic
- A Standard Accretion Disk (SAD) is weakly magnetised and has small lever arm ($\sim\alpha H$) – the dominant braking torque is viscous

How to get large scale field into disk?

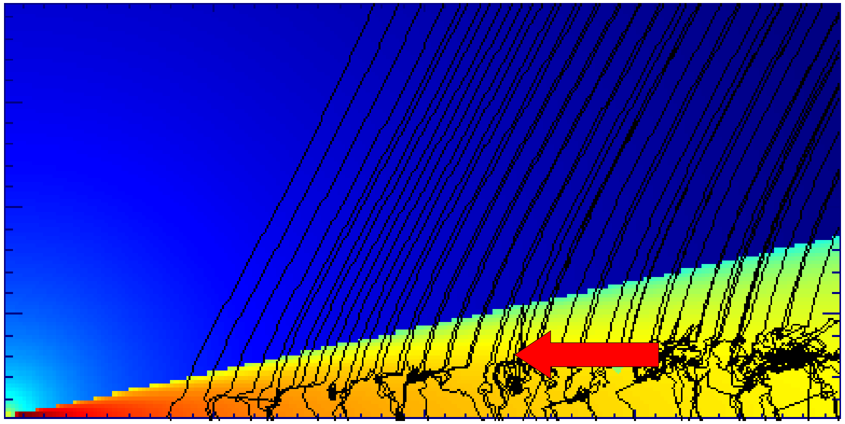
- Dynamo action? (Pudritz 1981, von Rekowski et al 05) May not be able to produce a large steady axisymmetric field
- Magnetic field dragging of fossil field from ISM?
- From star?

Inward drag of ISM field?

- No! Turbulent motions can cause magnetic field to diffuse radially outward (van Ballegooijen 1989, Lubow, Papaloizou & Pringle 1994)

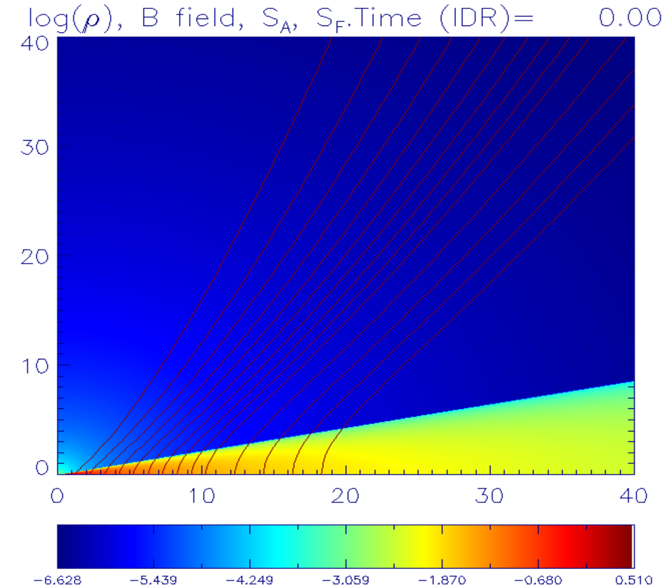


- Yes! Non-turbulent surface layer can advect field inwards (Bisnovyati-Kogan & Lovelace 2007, Rothstein & Lovelace 2008a,b, Lovelace (this meeting))

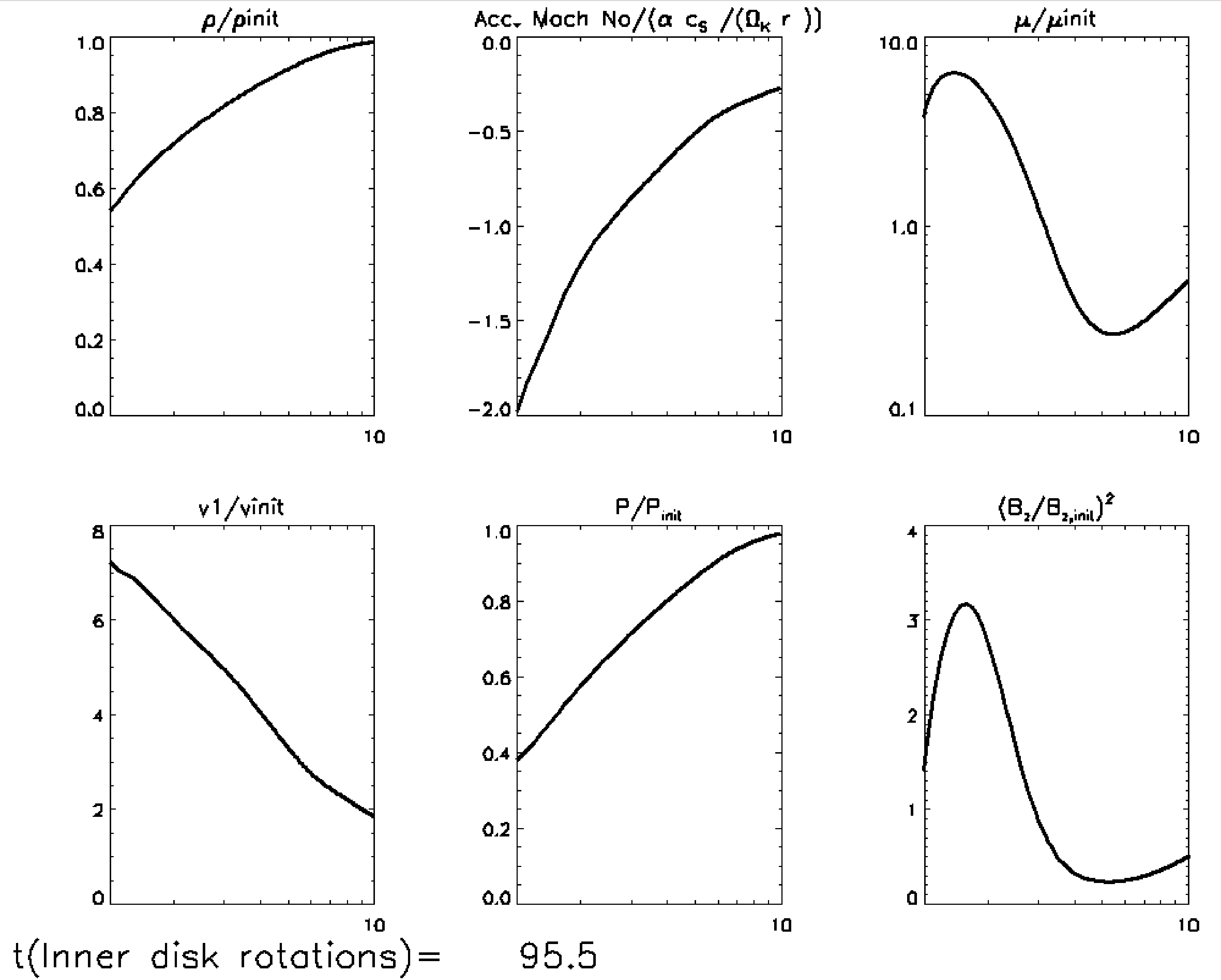


Standard Accretion Disk Model

- Kluzniak-Kita (2000) - perturbative solution for steady accretion flow in thin disk
- α > α_crit for accretion at all heights during the simulation
- Superimpose an ordered, weak magnetic field on the disk.
- Include viscosity, resistivity
- Prandtl number=1
- Damps MRI

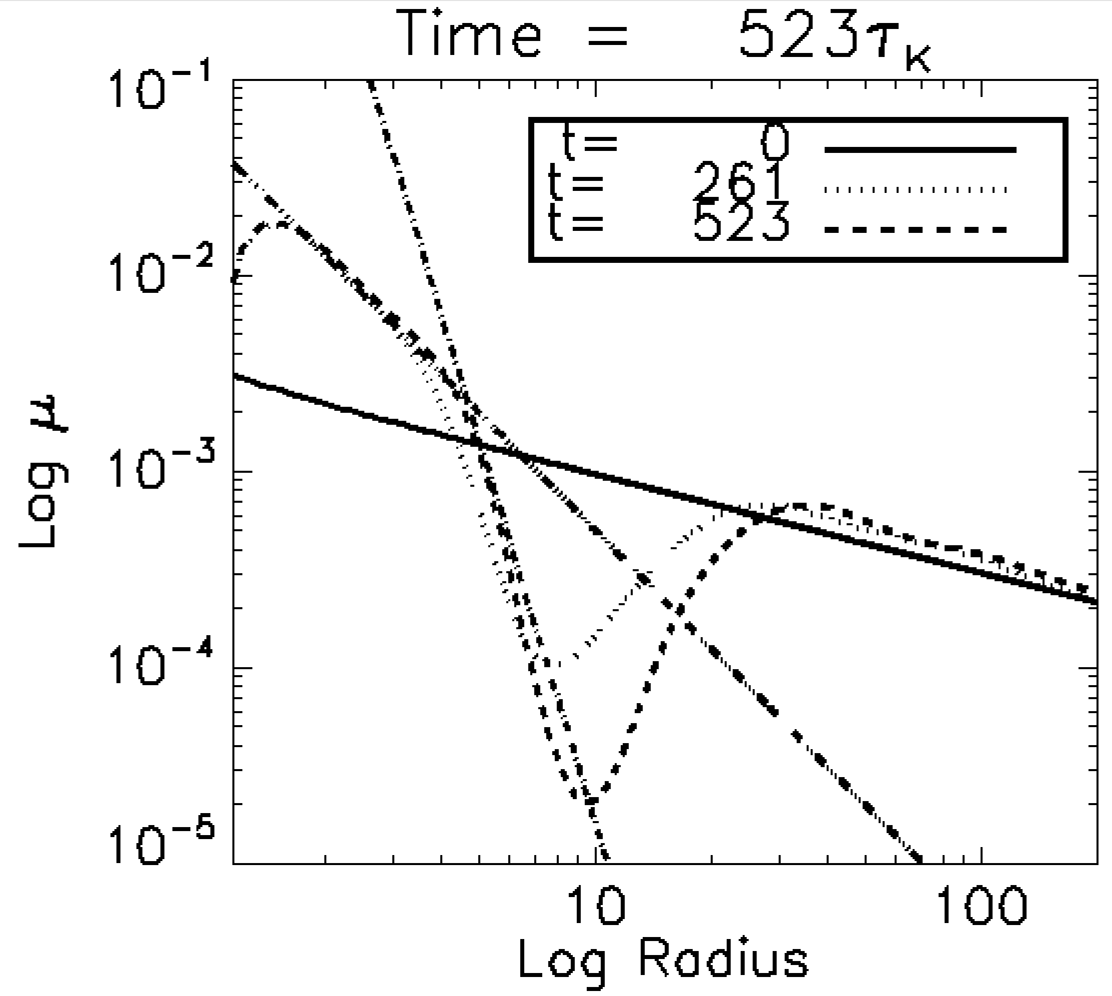


SAD-like disk

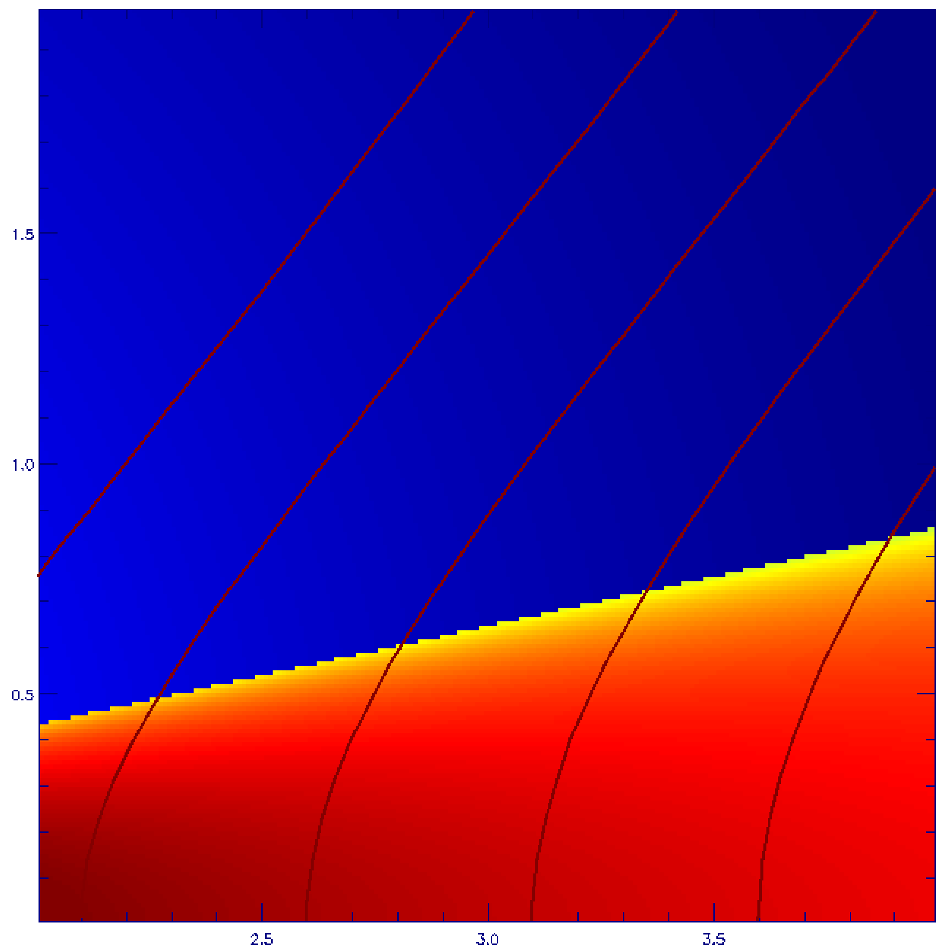


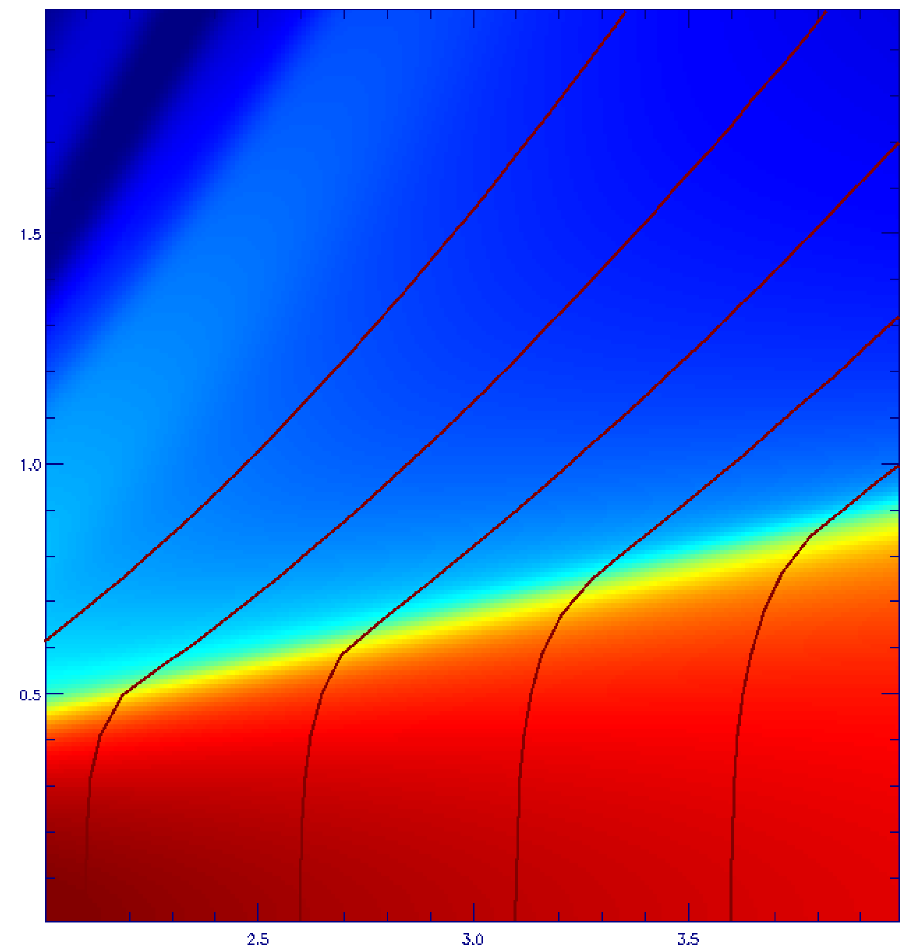
Field Redistribution

- After 2 accretion timescales, mu has a broken power law distribution
- -0.5 init
- -2 inner region
- Magnetic Reynolds number of about 1

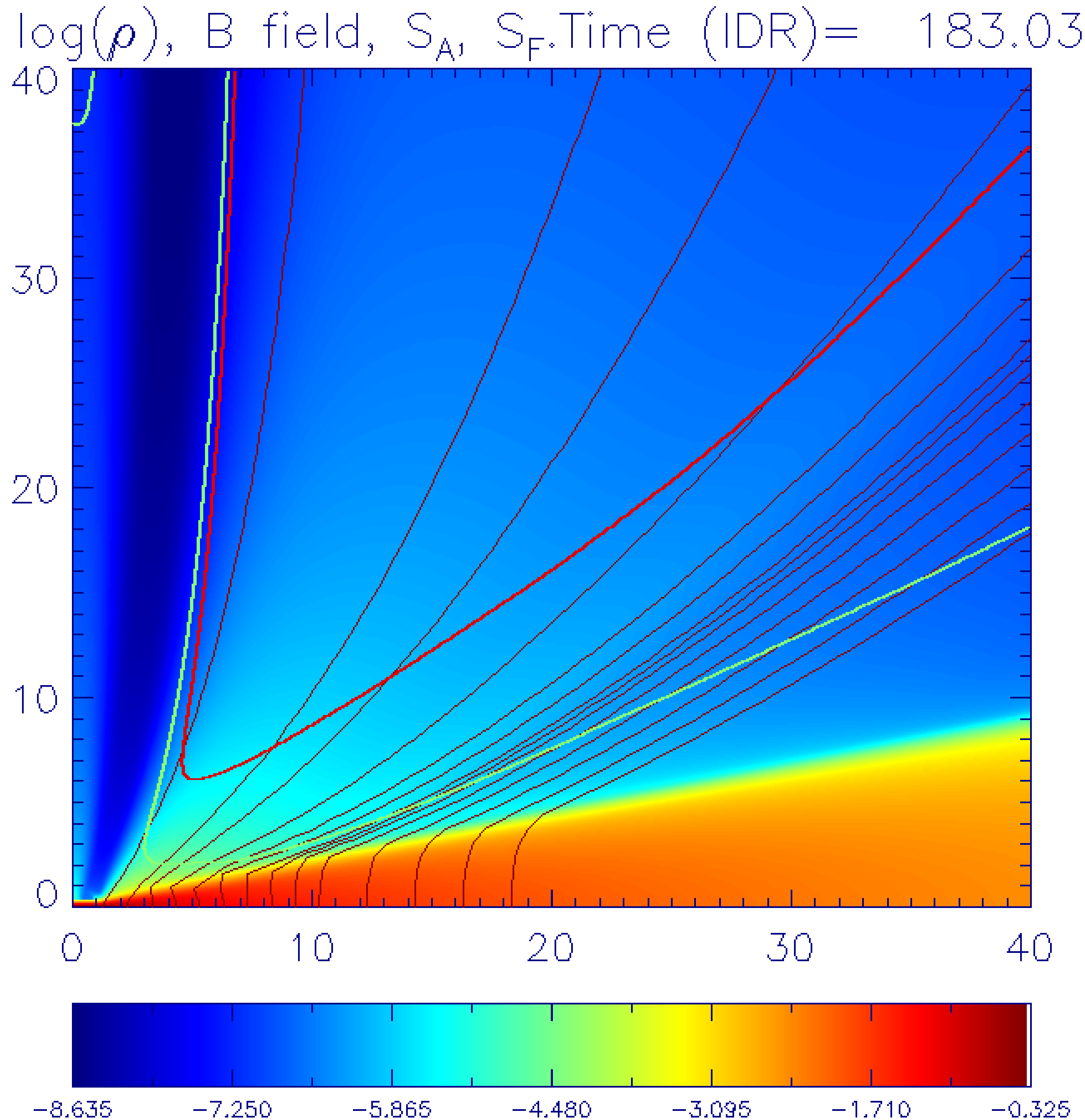


Magnetic field geometry





- Super-fast magnetosonic jet
- Fast SM & Alfven critical surfaces



Questions

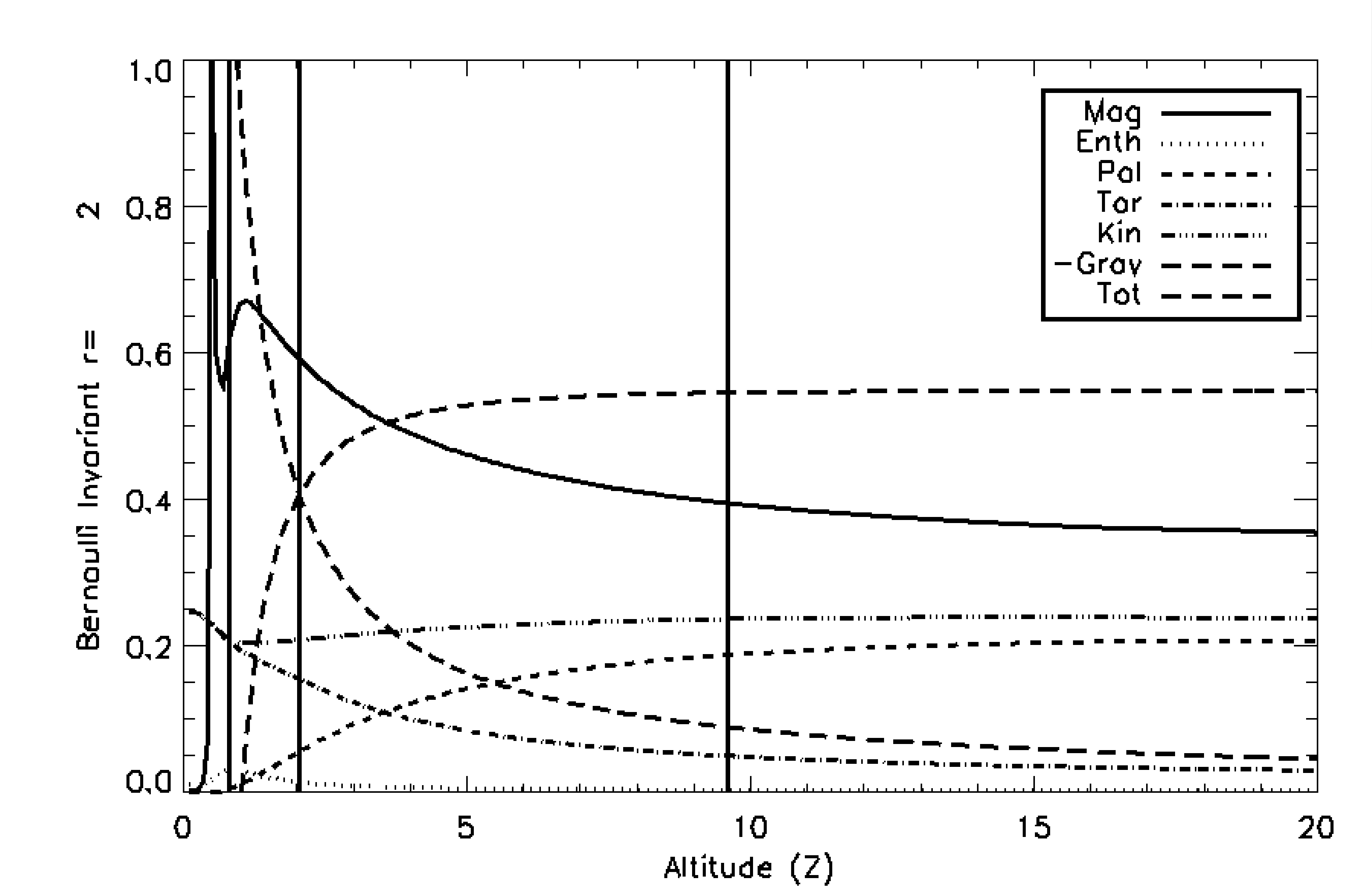
- Stable outflow?
- Powerful?
- Is it driven by magnetocentrifugal forces or thermal pressure gradients?
- How important is the back reaction of the jet torque on the disk?

Accretion & Ejection Power

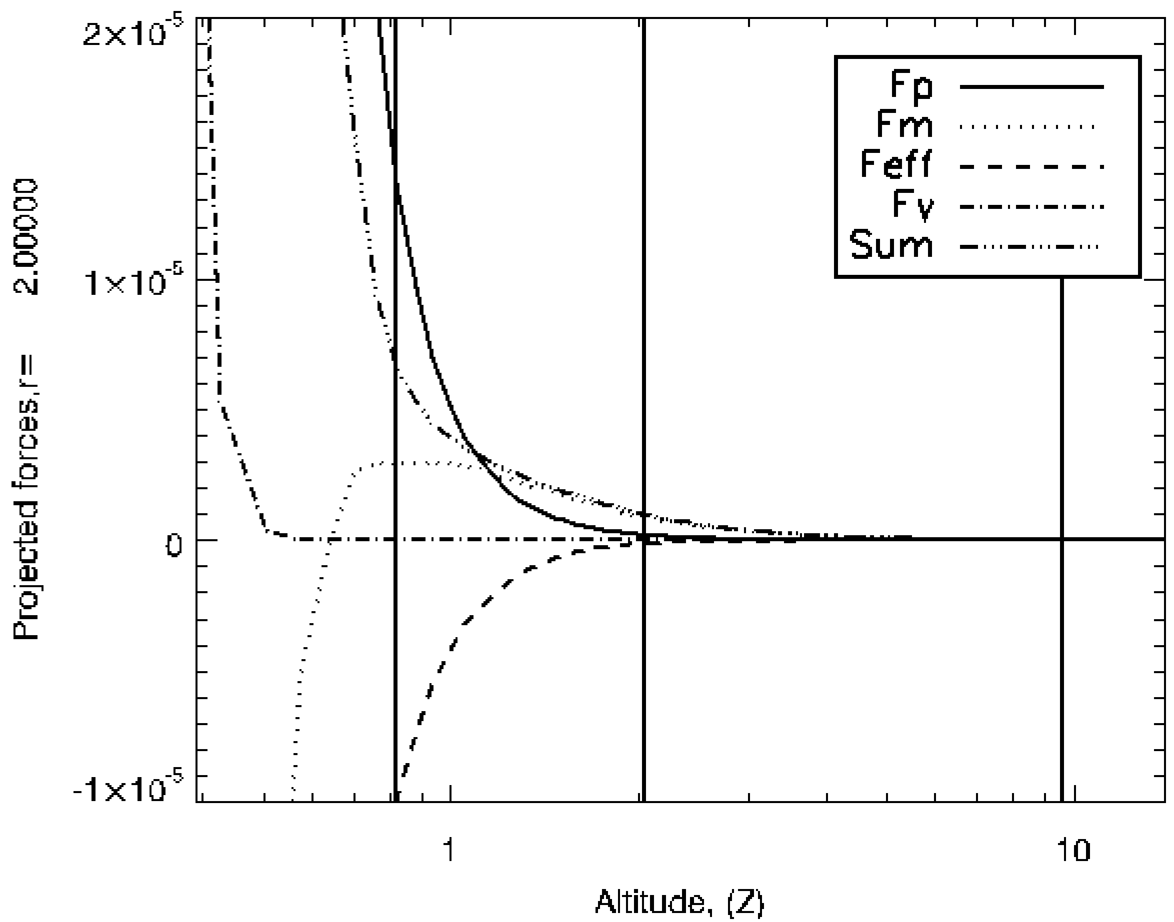
- Total jet power is a small fraction of accretion power
- Mechanical = (Thermal + Gravitational + Kinetic)

	Total Power	Mechanical	Poynting
Jet	1.7	1.03	0.69
Disk (r =1.2)	35.4	35.1	0.3

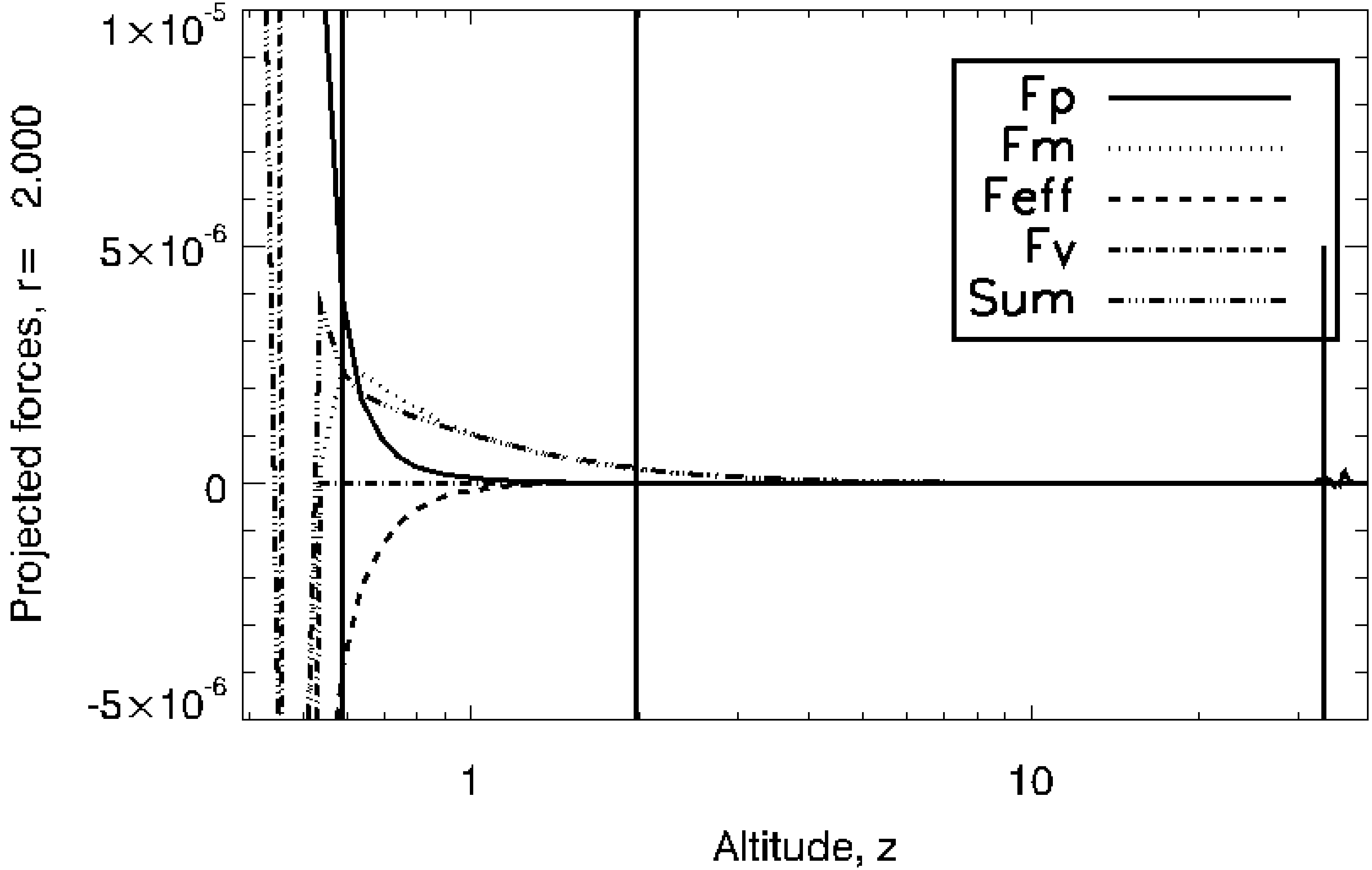
Specific Energy (Bernoulli) Invariant



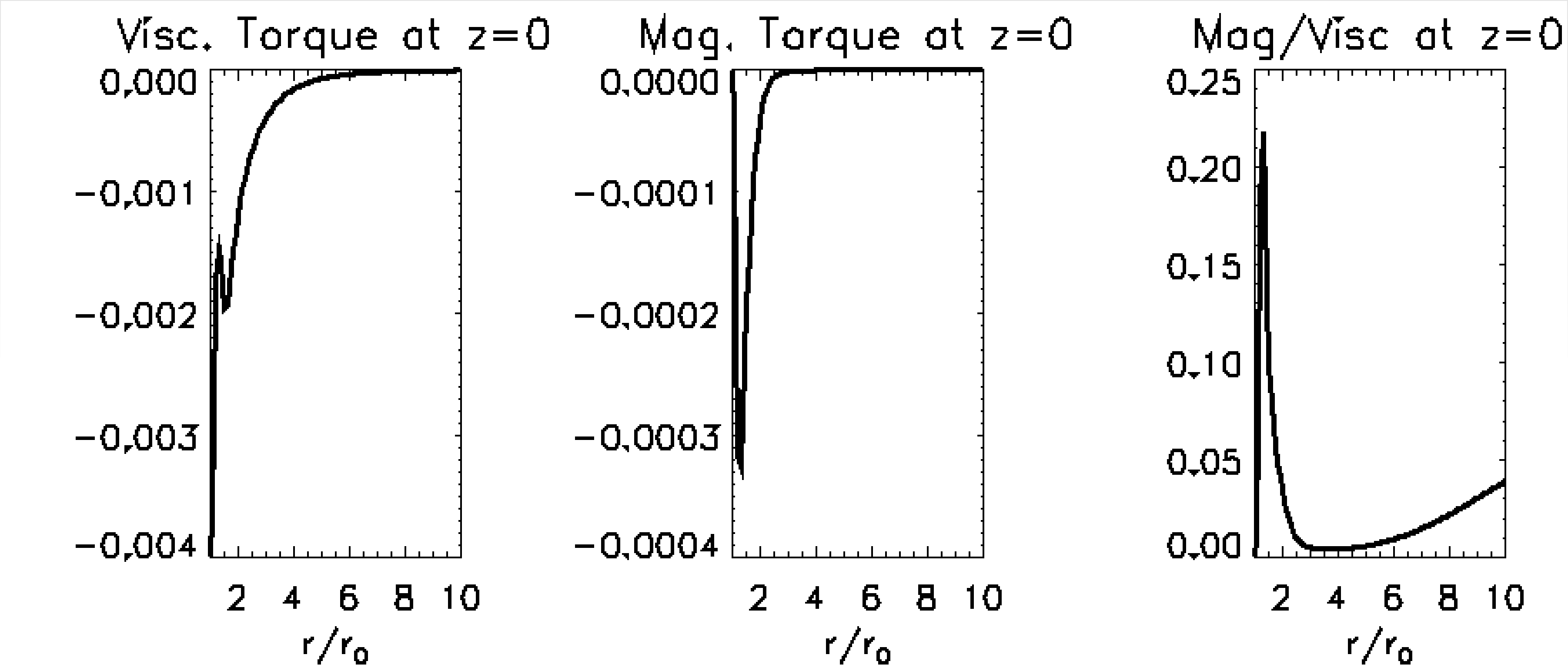
Poloidal forces projected along a magnetic surface



Poloidal forces projected along field lines



Effect of Mag Torque vs Visc Torque

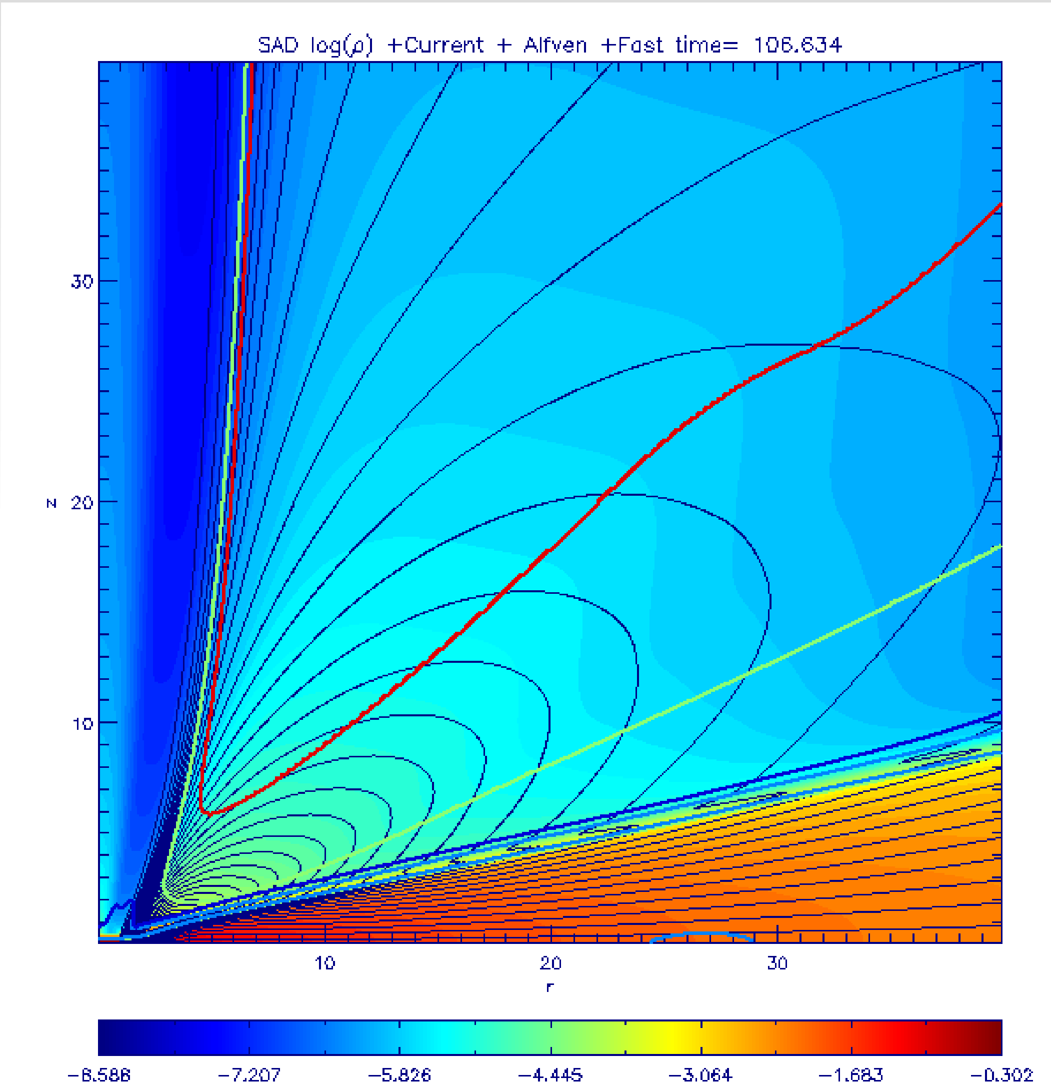


- Magnetic torque is small compared with viscous – accretion mainly due to viscosity

Perspectives

- Weak, large scale field threading a thin disk can be advected inward.
- Super fast magnetosonic jet launched from weakly magnetised accretion disk.
- Jet appears to be numerically launched
- Magnetic torque negligibly affects disk

Poloidal current contours



- I=rB