Global hydromagnetic non-adiabatic disc simulations

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- What is the global magnetic field geometry?
- Do they drive outflows?
- What is the saturation field strength?
- How much energy is deposited in the corona?

Main aspects of the model

- Mass source at large outer rim (no disc initially)
  - it is soley built up from mass at outer radius
- Mass sink at the center
  - (Pacynsky-Wiita potential)
- Initially seed field
  - amplified by compression and dynamo action

Non-ideal MHD equation

Energy equation:

$$\rho T \frac{\mathrm{D}s}{\mathrm{D}t} = \eta \mathbf{J}^2 + 2\nu\rho \mathbf{S}^2$$

$$\frac{\mathrm{D}\mathbf{u}}{\mathrm{D}t} = -c_s^2(\nabla \ln \rho + s/c_p) - \nabla\Phi + \frac{1}{\rho}(\mathbf{J}\times\mathbf{B} + \nabla\cdot 2\nu\rho\,\mathbf{S})$$

Momentum and Continuity eqns

$$\frac{\mathrm{D}\ln\rho}{\mathrm{D}t} = -\nabla\cdot\mathbf{u} + \frac{1}{\rho}(q_{\text{source}} - q_{\text{sink}})$$

Induction Equation:

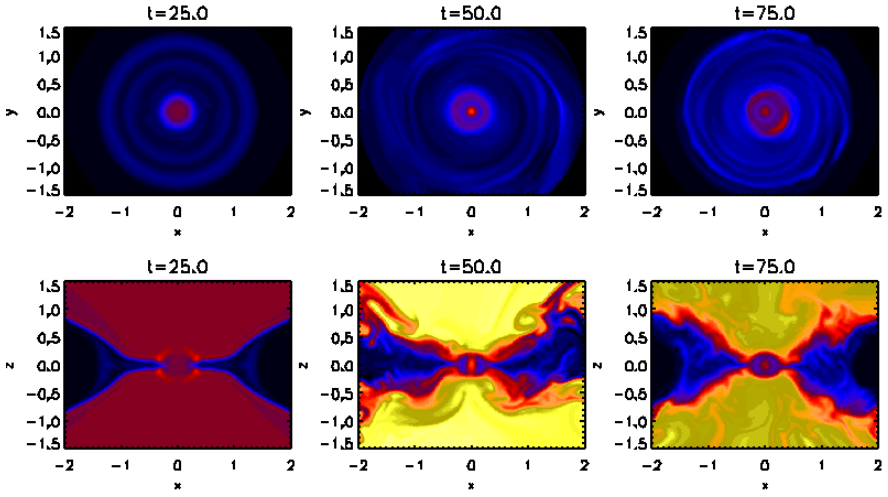
$$\frac{\partial \mathbf{A}}{\partial t} = \mathbf{u}\times\mathbf{B} - \eta\mathbf{J}$$

Magn. Vector potential

$$\mathbf{J} = \nabla\times\mathbf{B}$$

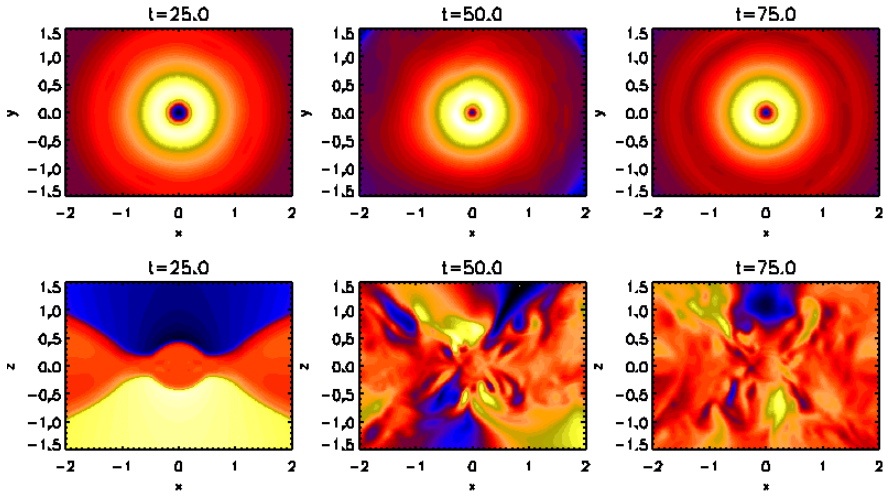
$$\mathbf{B} = \nabla\times\mathbf{A}$$

Entropy structure



Wedge-shaped accretion flow

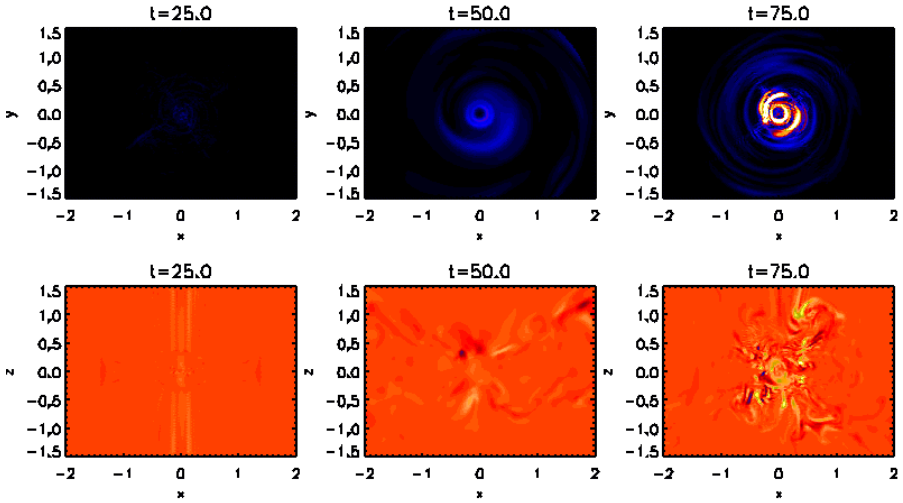
Vertical velocity



blue: down yellow: up

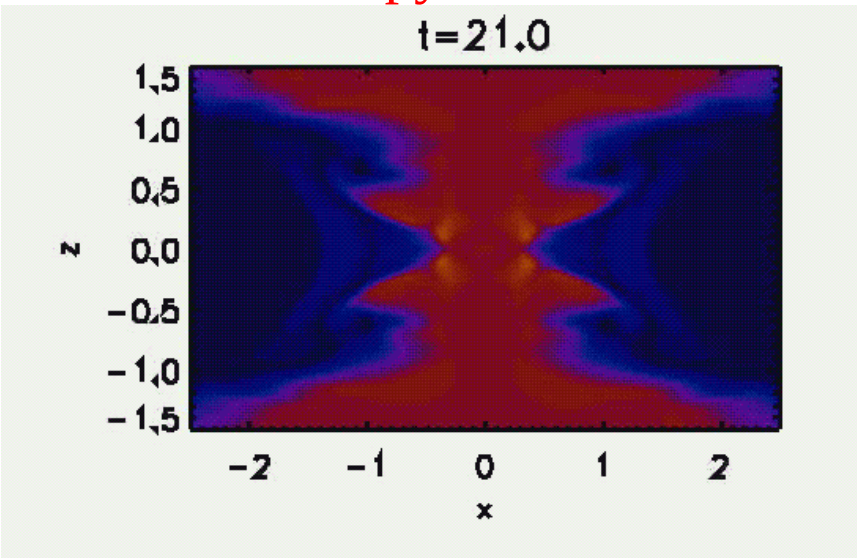
Coexisting in/outflows

Magnetic field structure



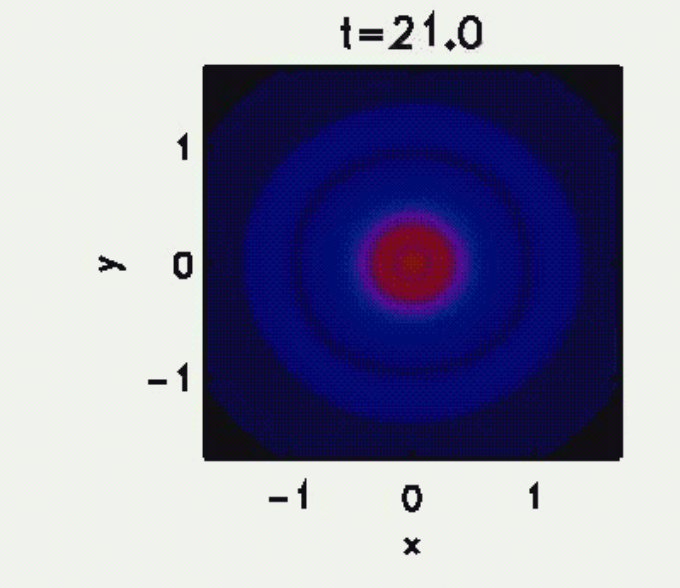
Irregular magnetic field; slowly amplifying

Movie of entropy: meridional slice

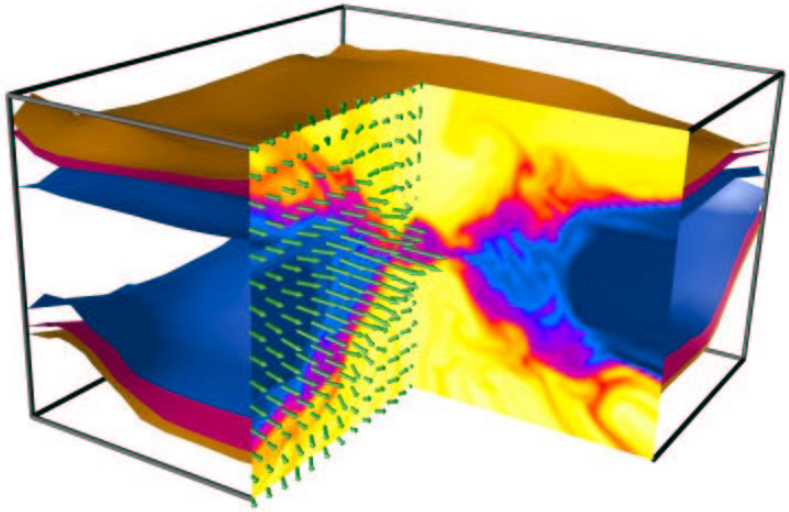


Development of wedge-shaped structure

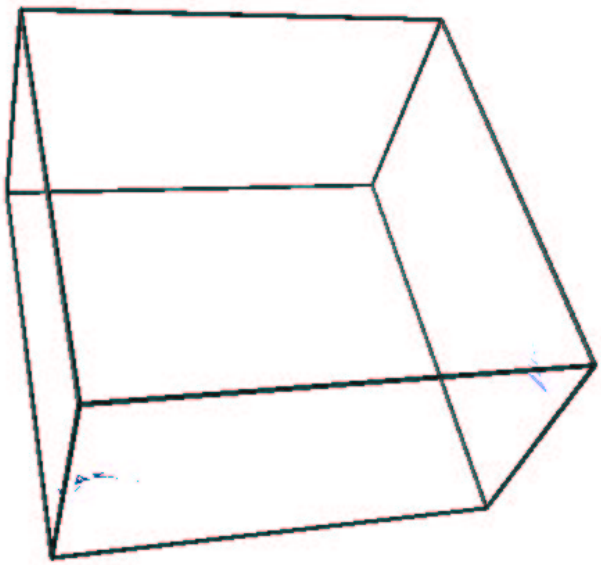
Movie of entropy: azimuthal slice



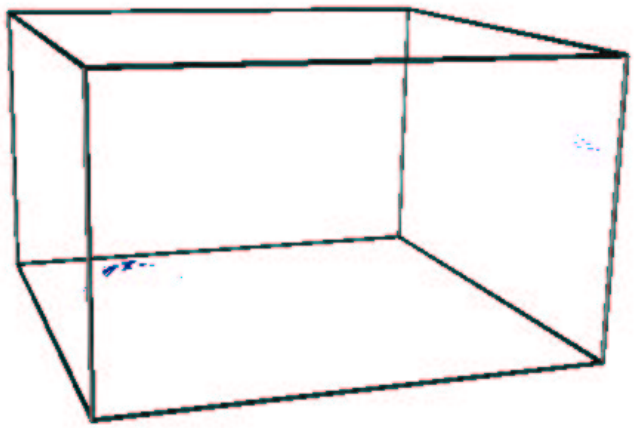
3-D visualization of entropy



3-D movie of entropy



Same, but from a different angle



Conclusions

- Only about 30% off mass is accreted
  - The rest goes into outflow
- Disc develops a wedge-shaped structure
- Magnetic field growth too slow

Acknowledgement:
The calculations have been carried out on the astrophysical fluids facility UKAFF