Low Mass Star Formation

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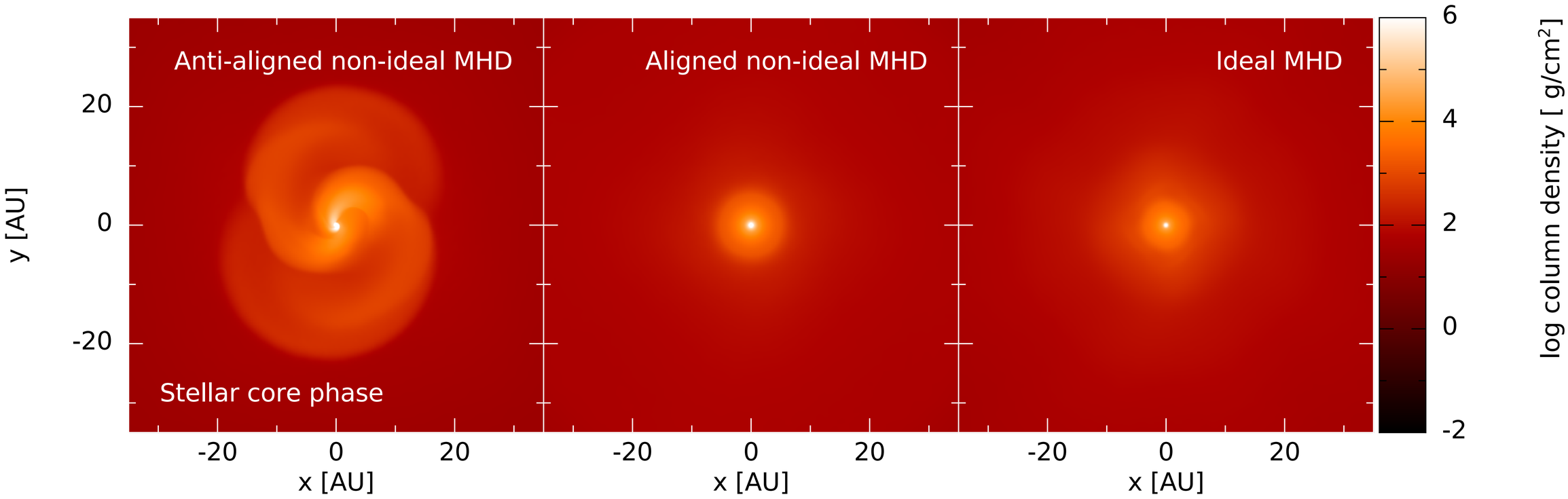
Overview and Method:

We perform radiative smoothed particle non-ideal magnetohydrodynamics simulations of low-mass star formation in a magnetised medium. We initialise our simulations as a $1M_{sun}$ rotating gas cloud of uniform density, threaded with a magnetic field that is initially parallel to the rotation axis. We simulate one ideal MHD model and two non-ideal MHD models that include Ohmic resistivity, ambipolar diffusion and the Hall effect. The Hall effect is directionally-dependent, thus we perform simulations with the initial magnetic field aligned and anti-aligned with the rotation axis.

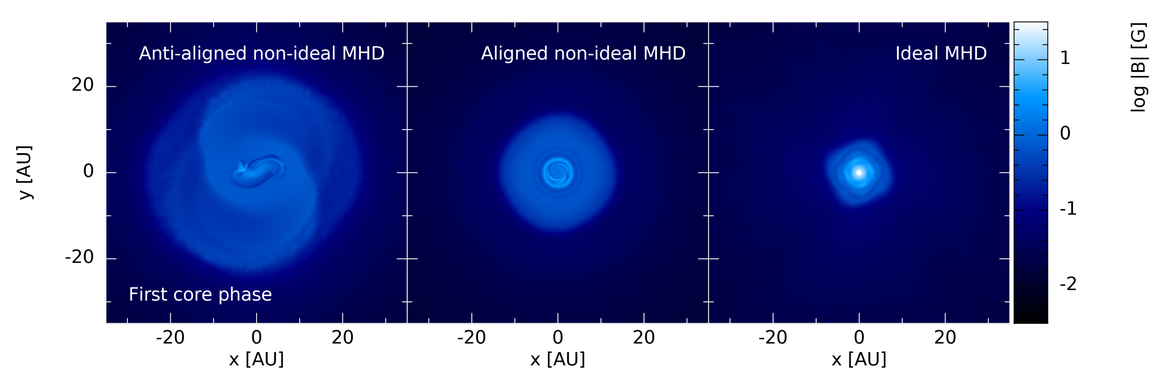
Density:

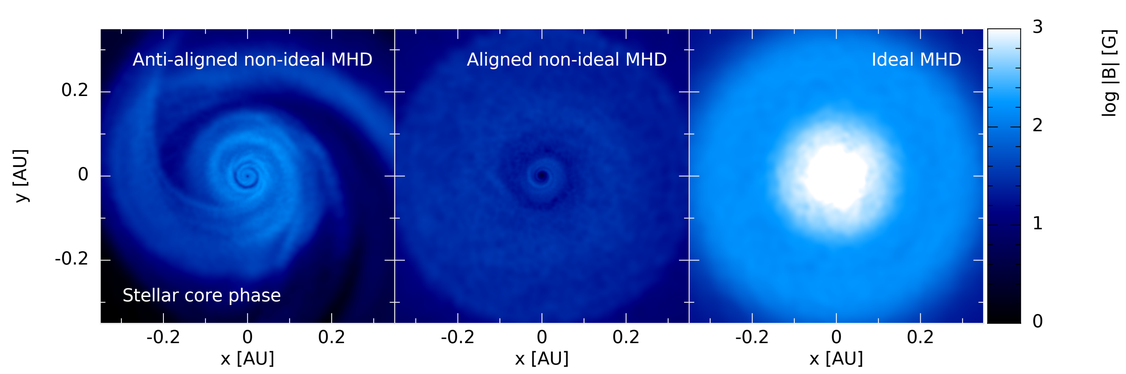
Protostellar discs of similar size to those observed (~25au) form during the first hydrostatic core phase in the anti-aligned non-ideal MHD model. A ~1au disc forms during the stellar core phase in the aligned non-ideal MHD model. No disc forms in the ideal MHD model.



Magnetic field structure:

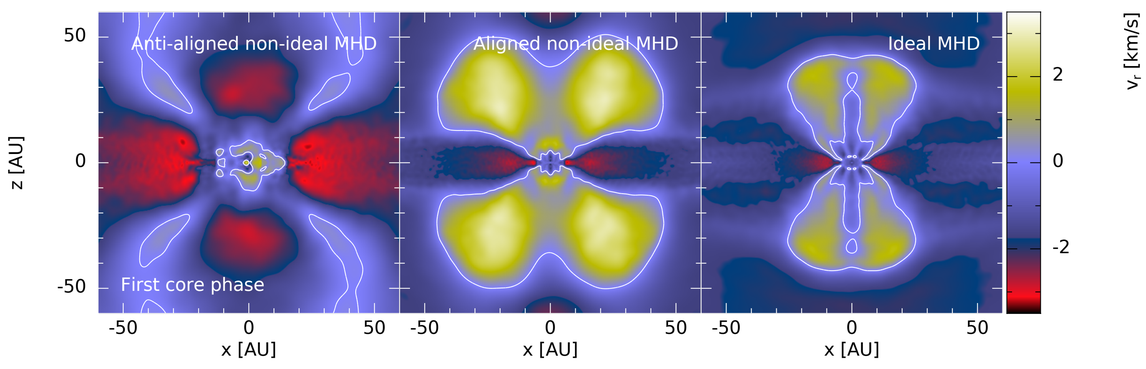
In the non-ideal MHD models, the magnetic field piles up in a wall around the core during the first hydrostatic core phase. Thus, the maximum magnetic field strength is not coincident with the maximum density; this is true for the duration of the evolution. The maximum magnetic field strength is coincident with the maximum density in the ideal MHD model.

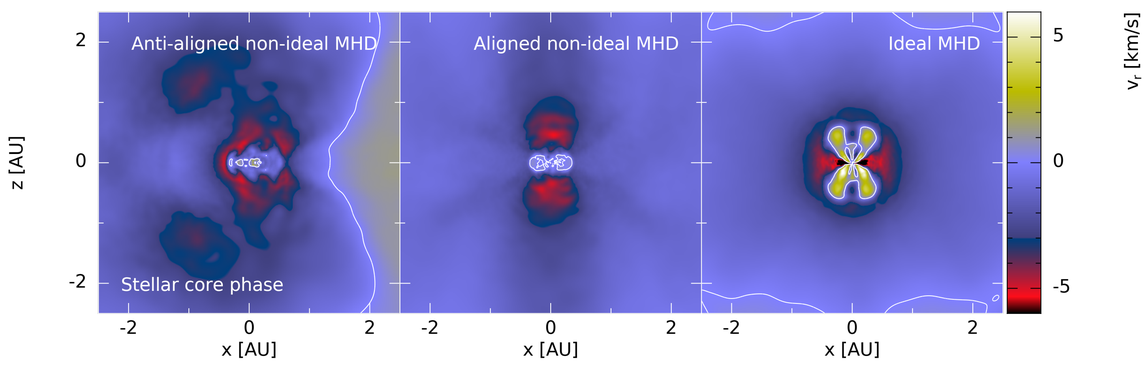




Outflows:

First core outflows are suppressed in the anti-aligned non-ideal MHD model, but enhanced in the aligned non-ideal MHD model. Stellar core outflows are suppressed in both non-ideal MHD models.





References:

Wurster, Bate & Price (2018a):
The collapse of a molecular cloud core to stellar densities using radiation non-ideal magnetohydrodynamics
Wurster, Bate & Price (2018c): Hall effect-driven formation of gravitationally unstable discs in magnetized molecular cloud cores
Wurster, Bate & Price (2018d): On the origin of magnetic fields in stars