Magnetic fields in the ISM and their effect on filaments, stars & discs

James Wurster
with Matthew Bate & Daniel Price

Magnetic Fields and the Structure of the Filamentary Interstellar Medium
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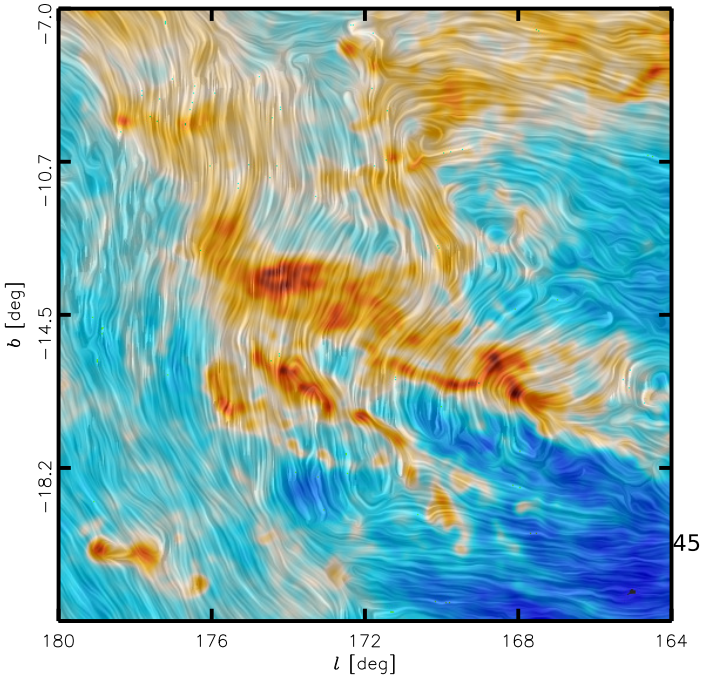
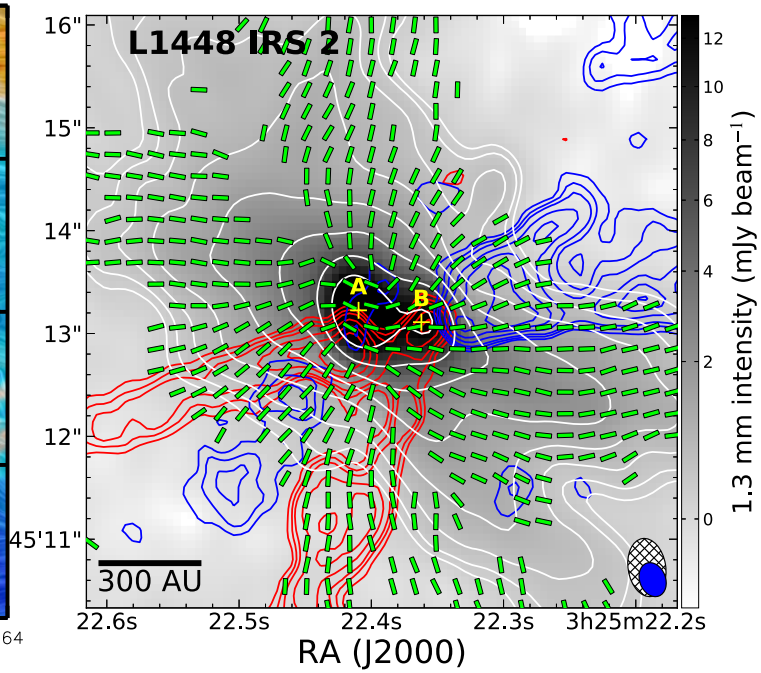
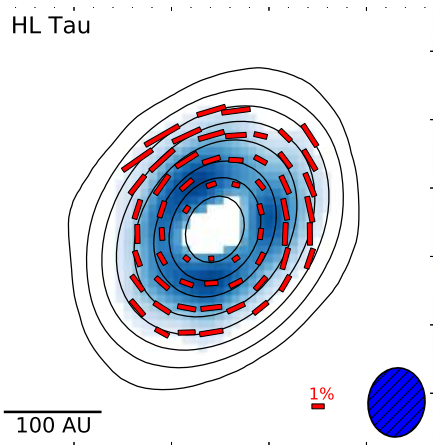
University of St Andrews
University of Exeter
erc
DiRAC
Monash University

Scales of magnetic fields

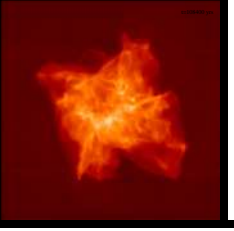
- Magnetic fields in the ISM are perpendicular to dense structures
- Magnetic fields in the ISM are parallel to low-density structures
- Magnetic fields in cores get pinched into dense regions, creating an hour-glass shape
- Magnetic fields in discs are poloidal / toroidal depending on the disc/environment properties



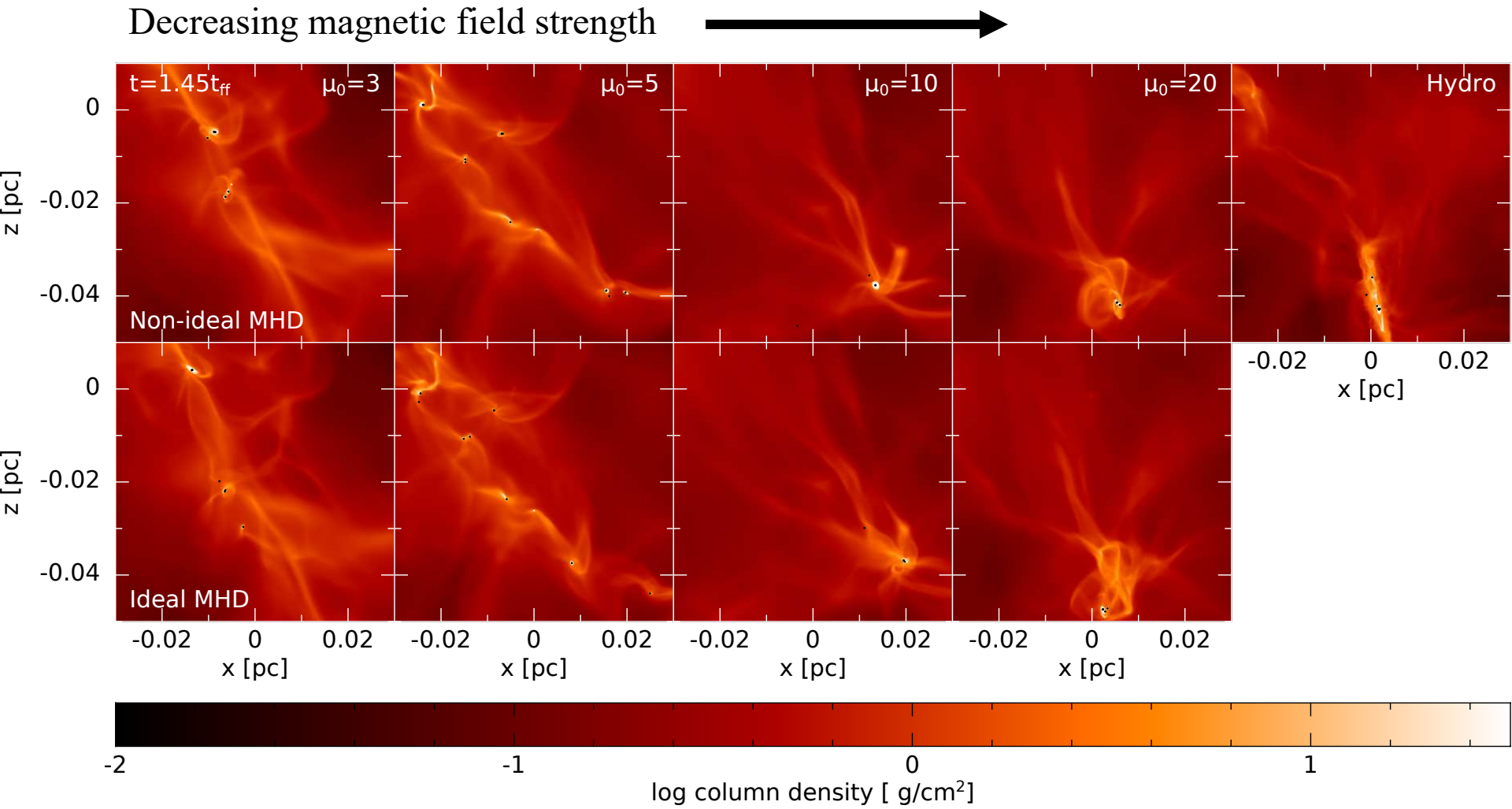




Planck Collaboration (2016) Kwon+ (2019) Stephens+ (2017)



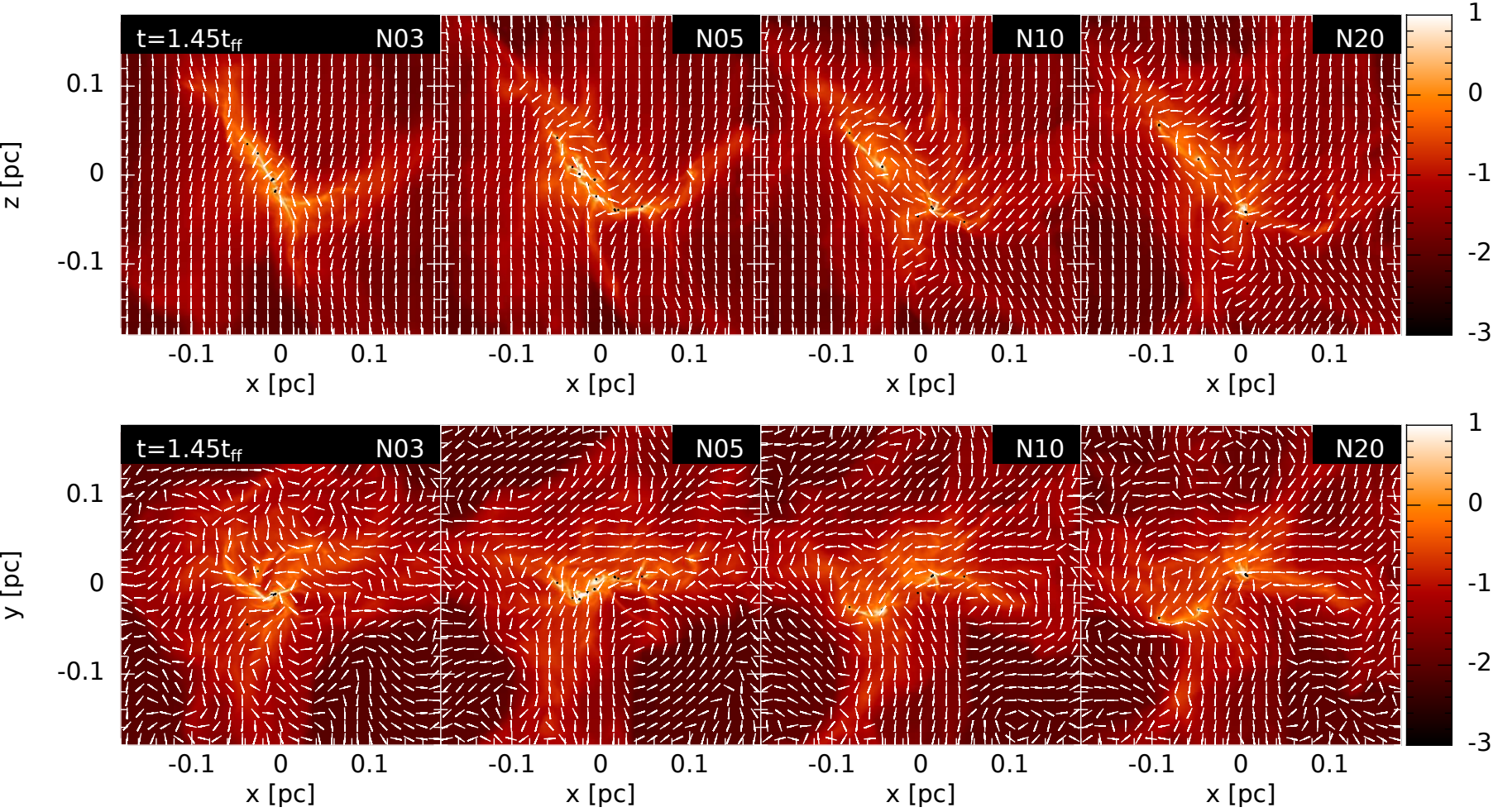
Cluster formation: effect of magnetic fields



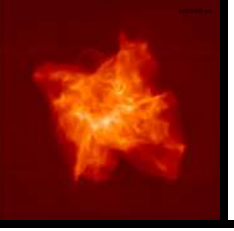
Wurster, Bate & Price (2019)

Cluster Formation: Magnetic field lines

Decreasing magnetic field strength

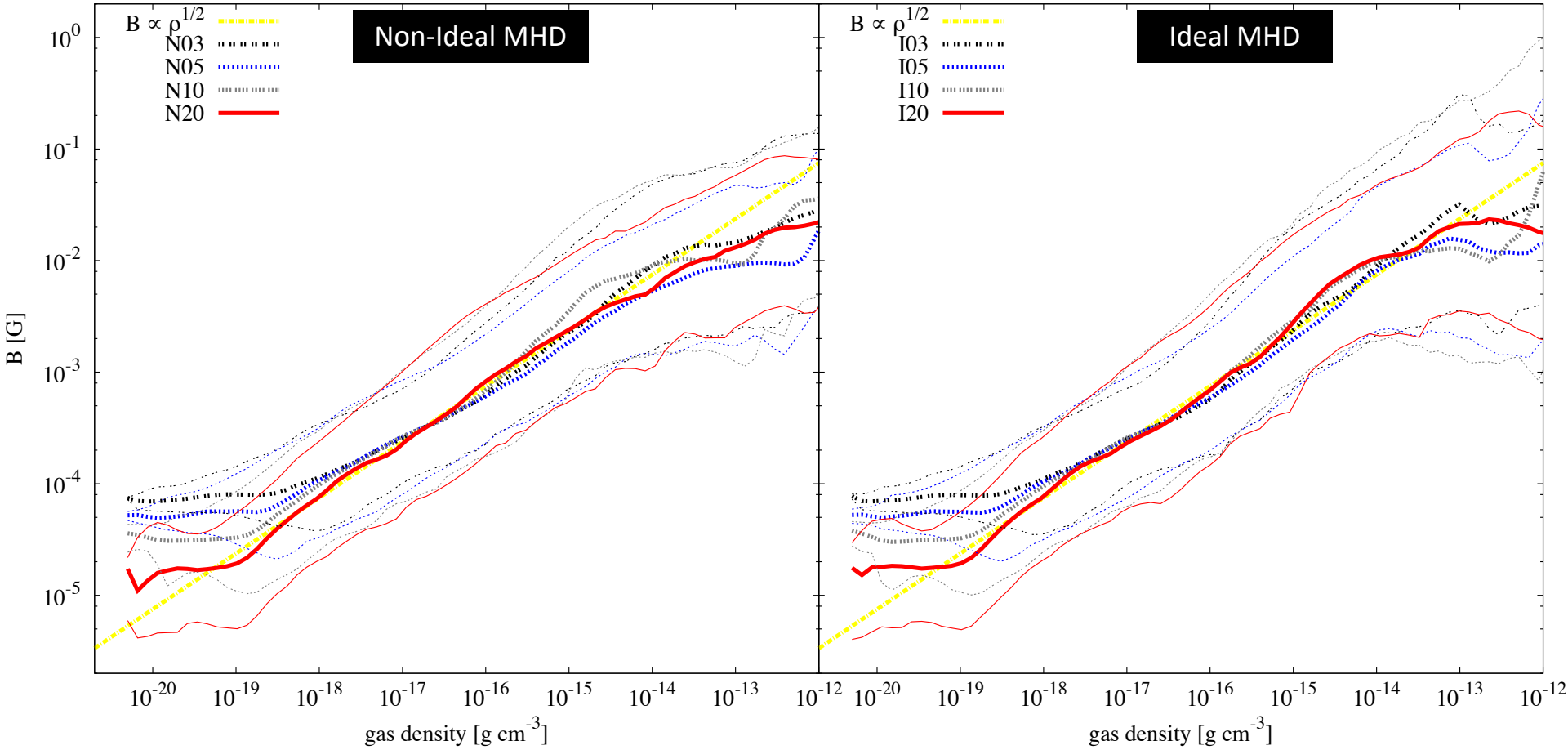


Wurster, Bate & Price (2019)



Cluster Formation: Star forming regions

- Star forming regions have a wide range of initial magnetic field strengths, that are approximately independent of the global environment



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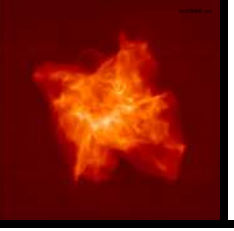
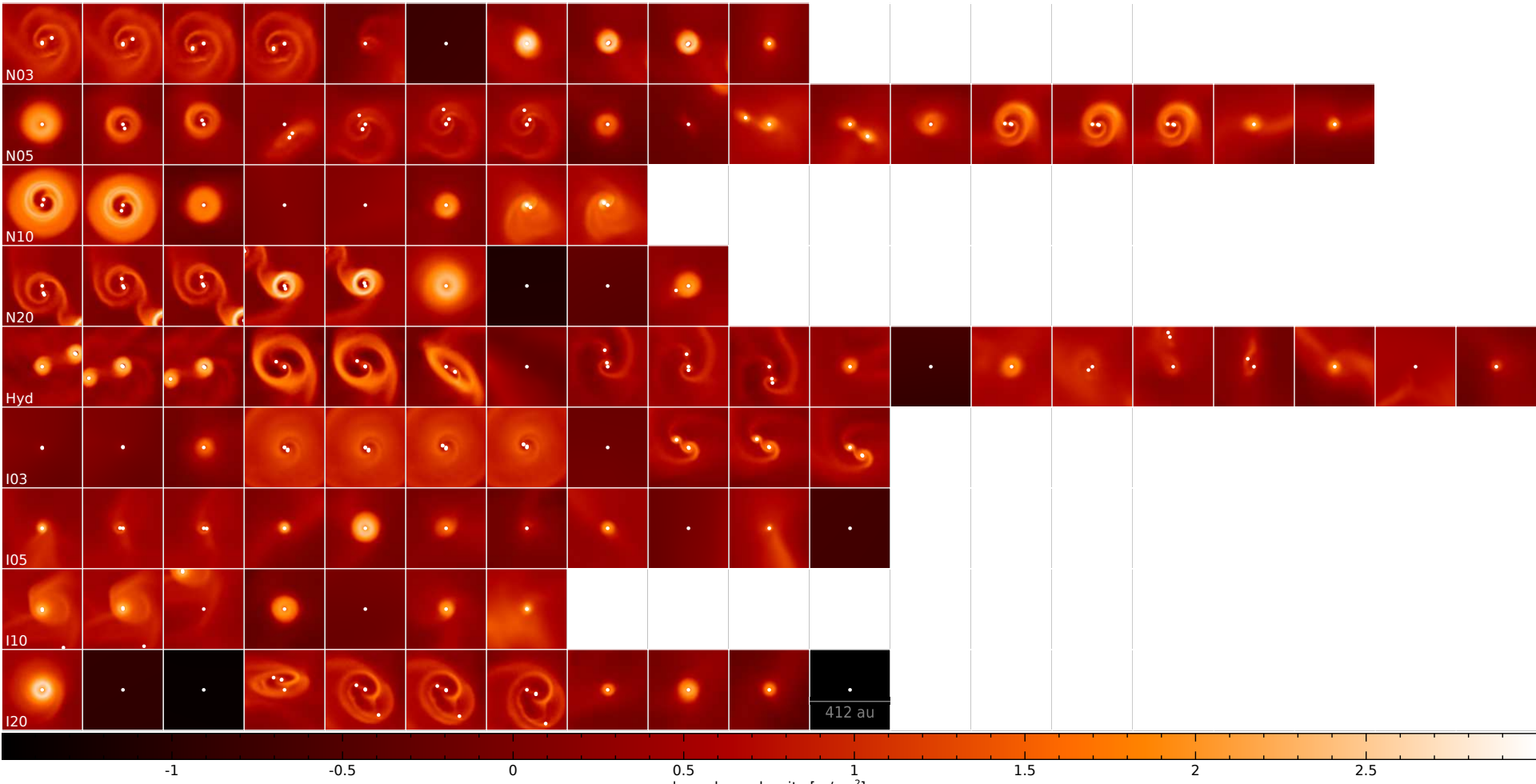


Cluster Formation: Protostellar discs

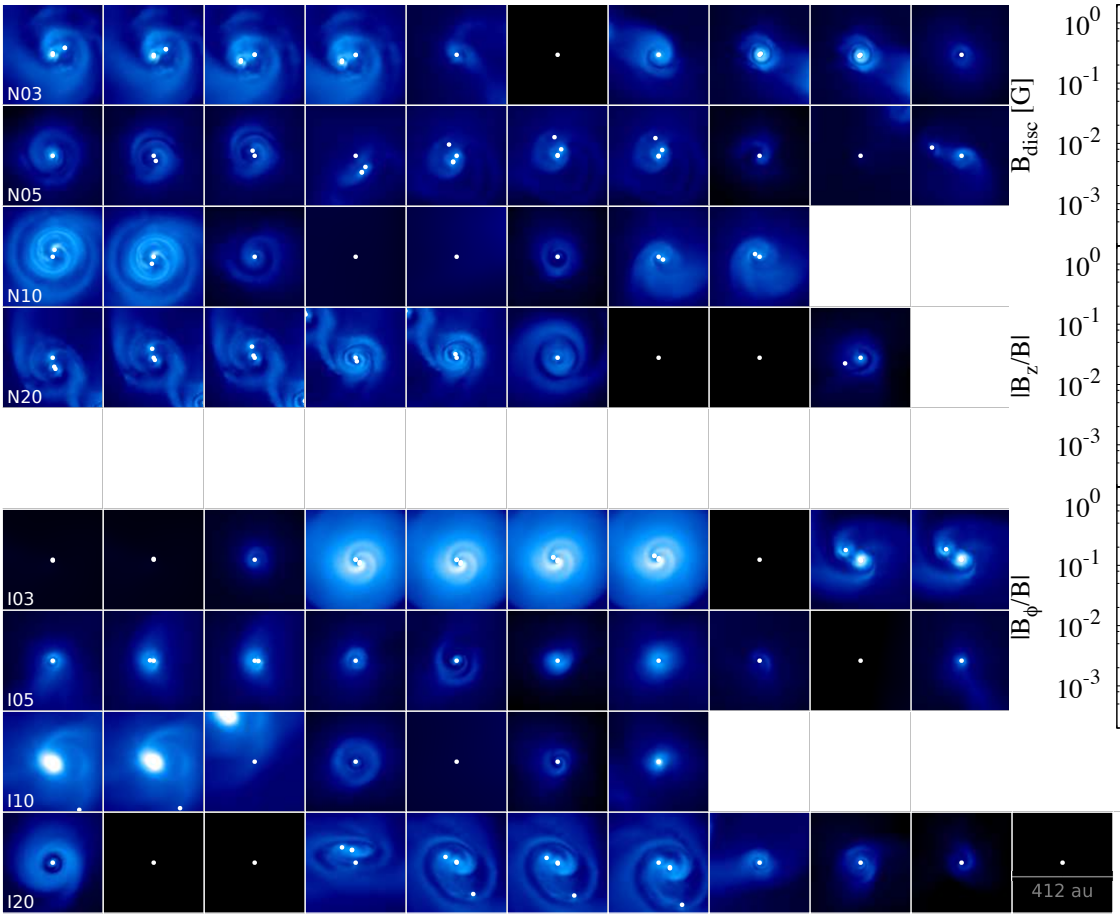
- Discs form in *every* model
- Discs surround 1-4 stars
- Evolution is very dynamic given multiple interactions

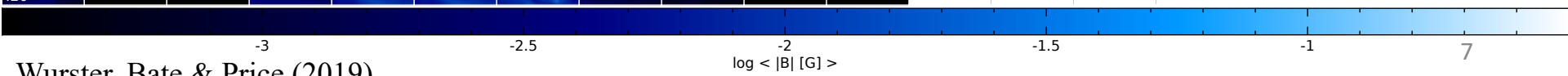


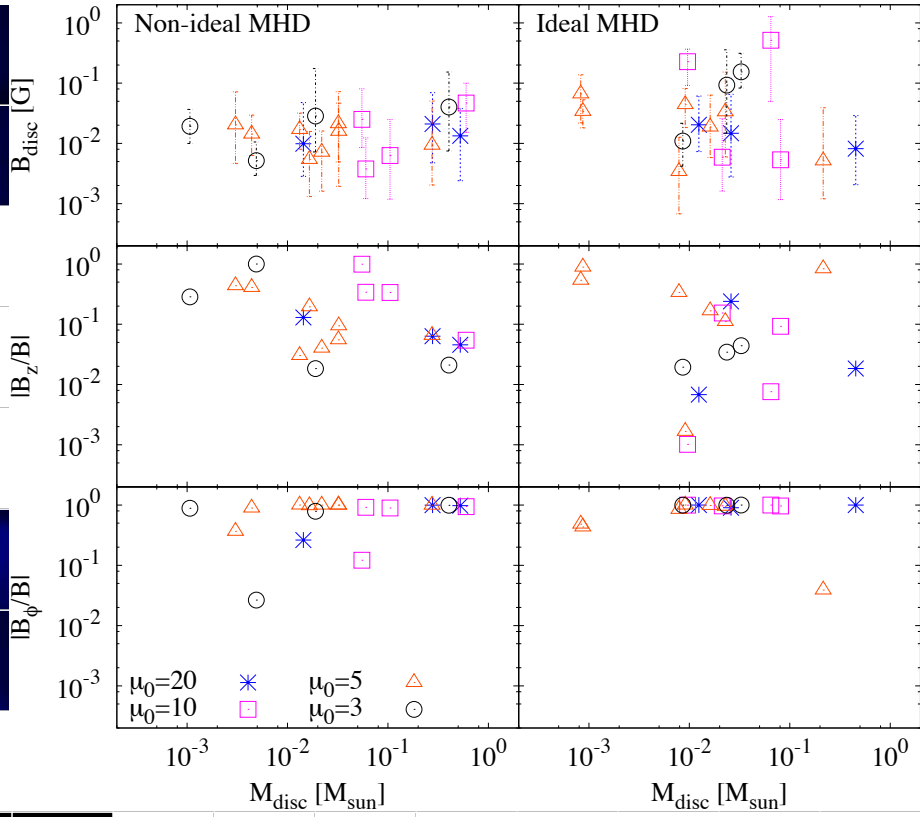
Wurster, Bate & Price (2019); see also Bate (2018)

Cluster Formation: Protostellar discs

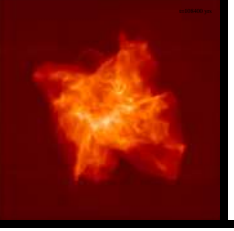
- There is a wide range of magnetic field strengths in the discs
- Magnetic fields in discs are strongly poloidal





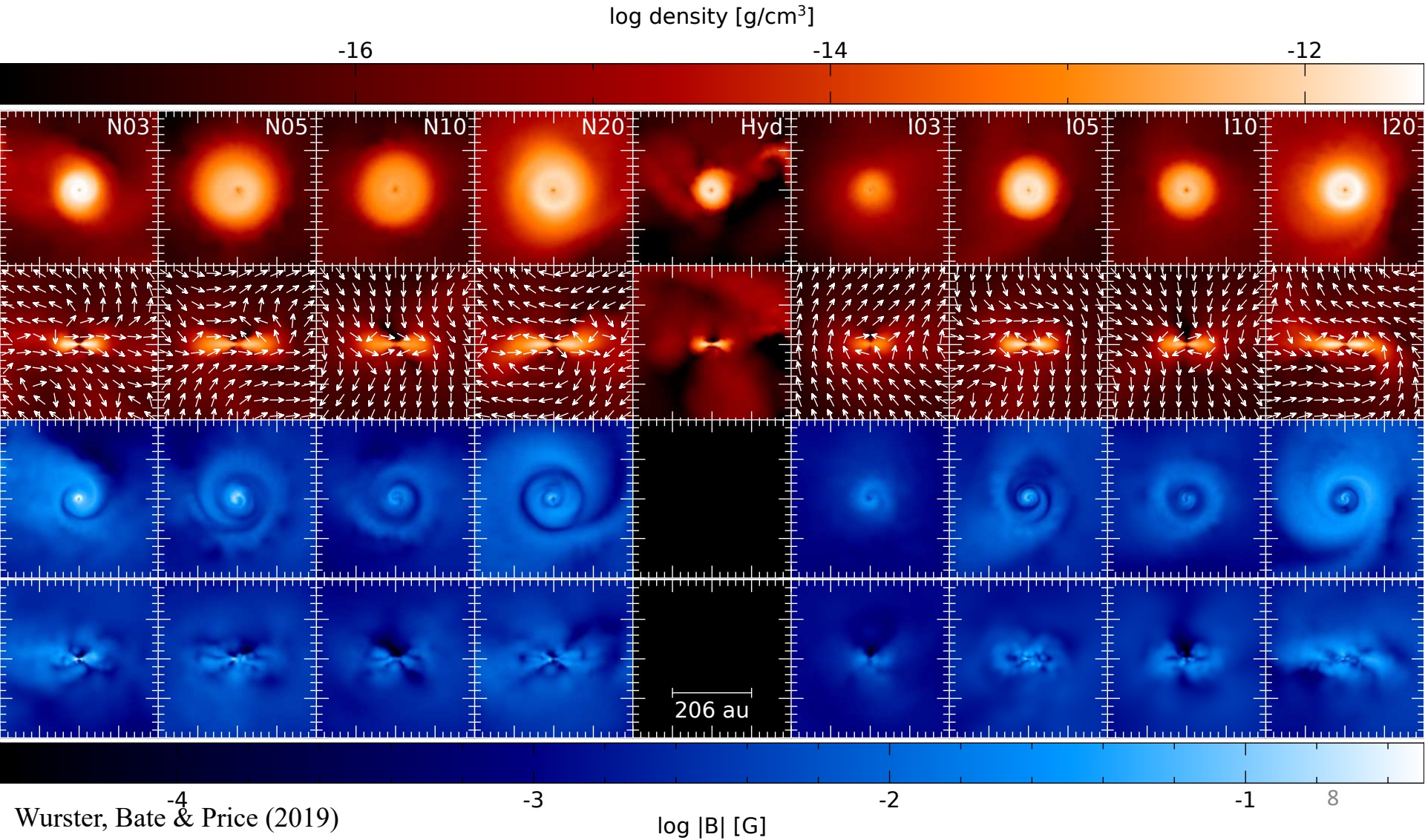


Wurster, Bate & Price (2019)

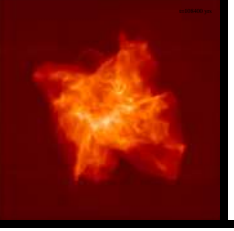


Cluster Formation: core magnetic fields

- Hour-glass magnetic field structure is not prominent in these models

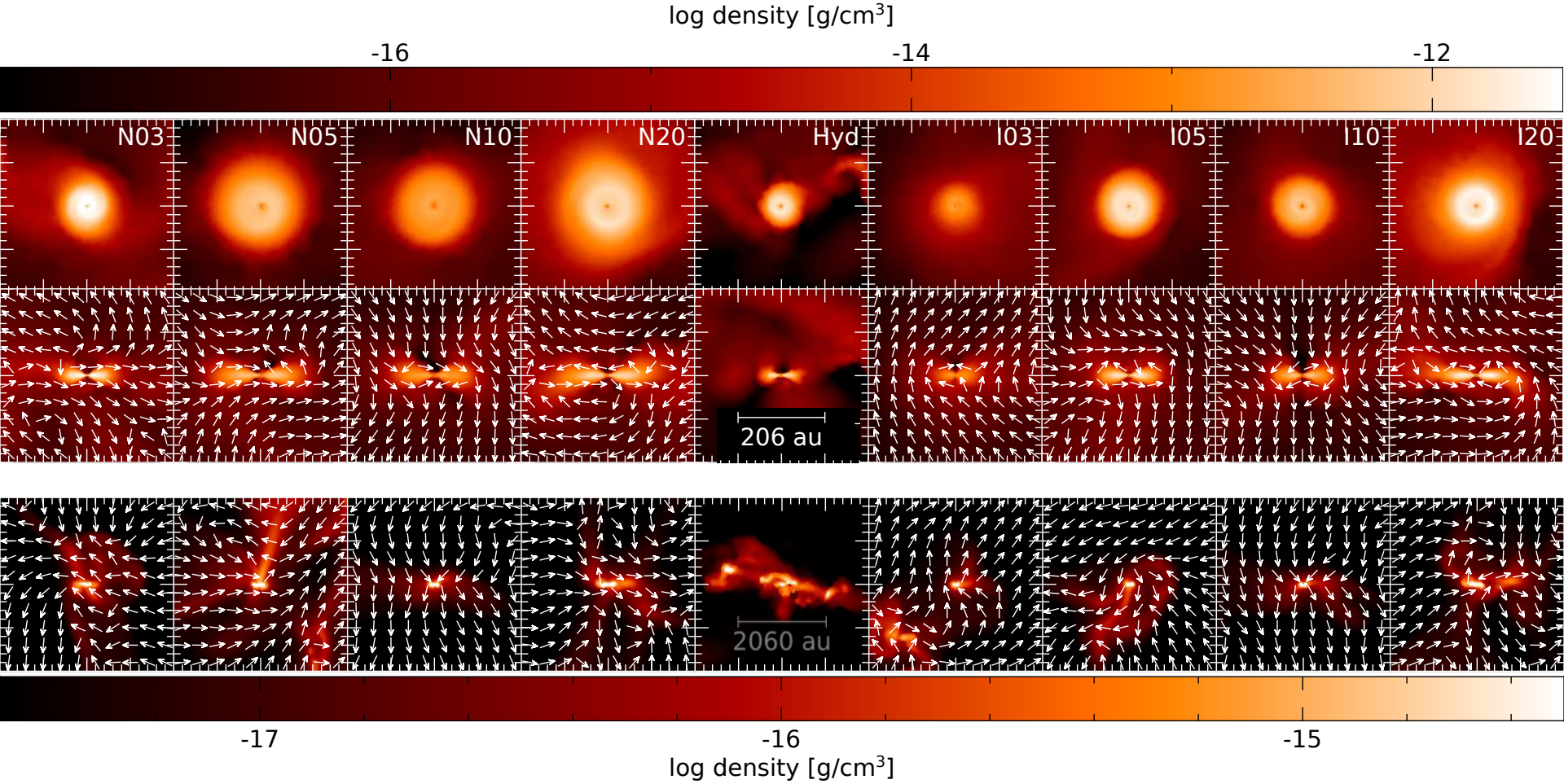


Wurster, Bate & Price (2019)



Cluster Formation: core magnetic fields

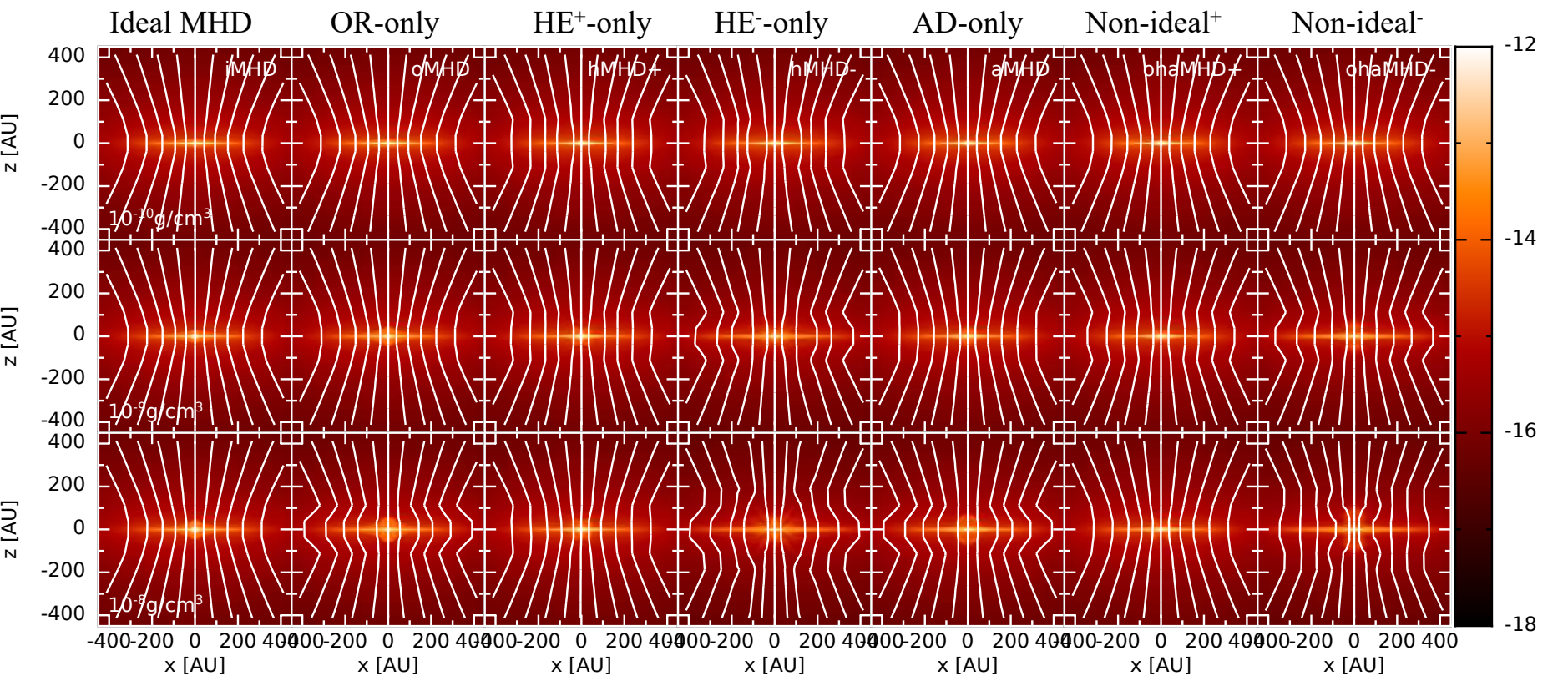
- Hour-glass magnetic field structure is not prominent in many models



Wurster, Bate & Price (2019)

Isolated Star Formation: core magnetic fields

➢Hour-glass magnetic field structure is prominent, and depends on the included magnetic processes



From top to bottom: time evolution with $\rho_{max} = 10^{-10}$, 10^{-9},10^{-8} g/cm^3
Wurster, Bate & Bonnell (submitted)

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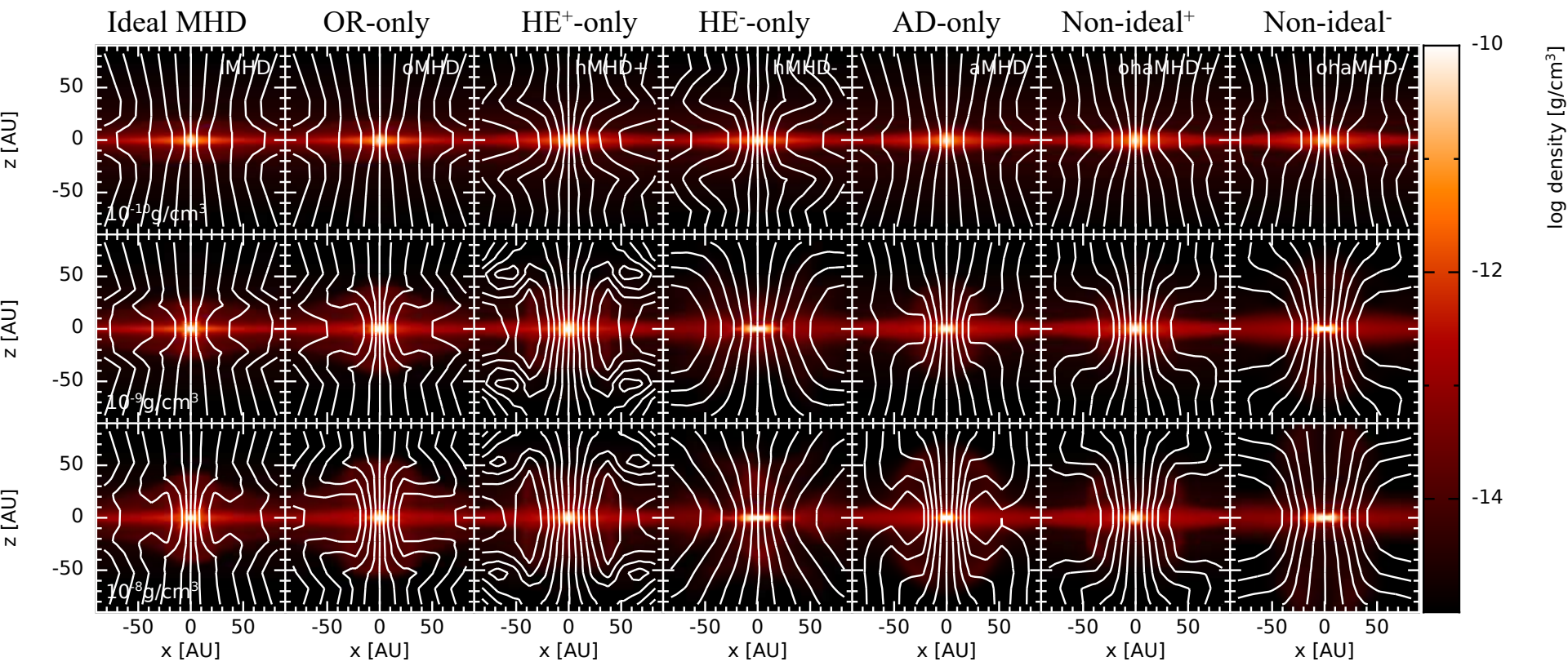

From top to bottom: time evolution with $\rho_{max} = 10^{-10}, 10^{-9}, 10^{-8}$ g/cm^3
Wurster, Bate & Bonnell (submitted)

Conclusions

- Ideal MHD affects large-scale structures, while non-ideal MHD affects small-scale structures
- A ~2dex range of magnetic fields strengths exists at all ‘evolved’ gas densities,
- Magnetic field strength in the disc is primarily poloidal
- ‘Hour-glass’ magnetic field is prominent in high-resolution simulations of isolated stars, but not at the lower resolution in the cluster setting

University of St Andrews | University of Exeter | erc | DiRAC | Monash University

James Wurster jhw5@st-andrews.ac.uk https://jameswurster.bitbucket.io/