Magnetic Fields in Collapsing Molecular Clouds

David Collins from Florida State
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University of Florida
with Alexei Kritsuk (UCSD) Paolo Padoan (Barcelona)
Mike Norman (UCSD)
What is the role of Magnetic Fields

• Well, how do they actually behave in an environment that’s

  • turbulent

  • self gravitating
Three Simulations

- Mach 10
- Isothermal Ideal MHD
- Gravity
- AMR+MHD (512+4 levels)
- Enzo:(Collins+2010) enzo-project.org
- Results (Collins+2011, Collins+2012)
- 5 Million CPU hours, Kraken, NICS
Three Simulations

\[ t_{ff} = 1.1n_{H,3}^{-1/2} \text{Myr} \]

\[ L_0 = 4.6c_{s,2}n_{H,3}^{-1/2} \text{pc} \quad (116 \text{ AU zones}) \]

\[ v_{\text{rms}} = 1.8c_{s,2} \text{km s}^{-1} \]

\[ M = 5900c_{s,2}n_{H,3}^{-1/2} M_\odot \]

\[ B_0 = (13, 4.4, 1.3)c_{s,2}n_{H,3}^{1/2} \mu \text{G}, \]

\[ c_{s,2} = 0.2 \text{km s}^{-1} \]

\[ n_{H,3} = n_H/(1000 \text{cm}^{-3}) \]
$t = 0.00e+00 \ t_{ff}$
Turbulent Magnetic PDF

\[ V(b)db = \exp\left[-\left(\frac{b}{b_0}\right)^c\right] db \]

(Kritsuk+ in prep)
Self similar collapse with flux freezing
Field, Density dependent Alignment
Thermal-Magnetic, Gravity

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\[ \beta \propto \rho^A \]
\[ B \propto \rho^{(1-A)/2} \]

\begin{align*}
0.54 \pm 0.23 \\
0.77 \pm 0.15 \\
0.96 \pm 0.02 \\
0.23 \pm 0.39 \\
0.19 \pm 0.41 \\
0.15 \pm 0.43
\end{align*}
Mass To Flux: Weak Field

Simulations of Self Gravitating MHD turbulence

• Show non-monotonic behavior: Weak mean field runs have more small scale strong field.

• Looks like high density tends towards plasma Beta=1

• Even weak fields can reproduce Zeeman measurements.