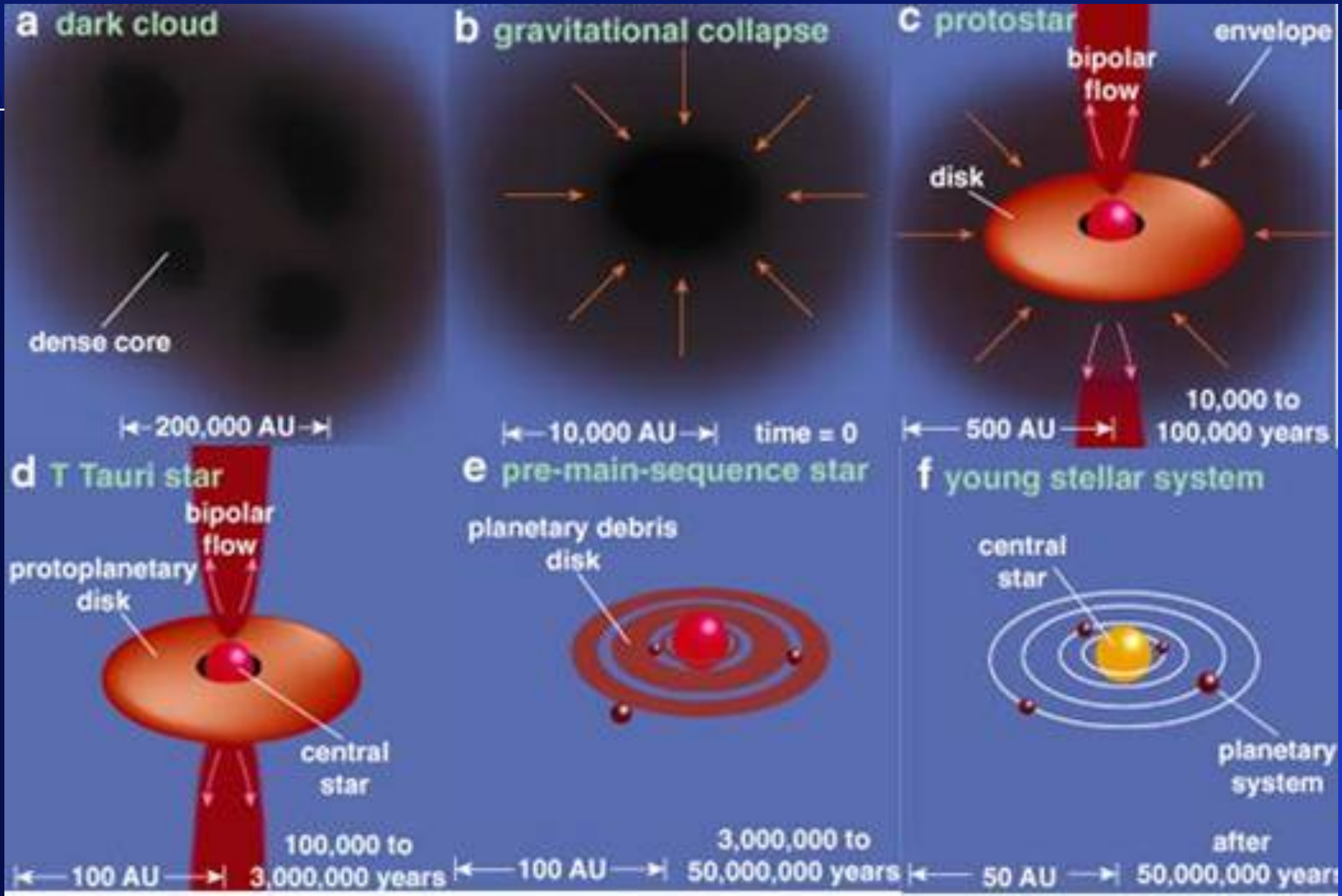
Discussion: Magnetic fields and Polarimetry

Magnetic fields are important for different stages of star formation and polarimetry has been used to study them



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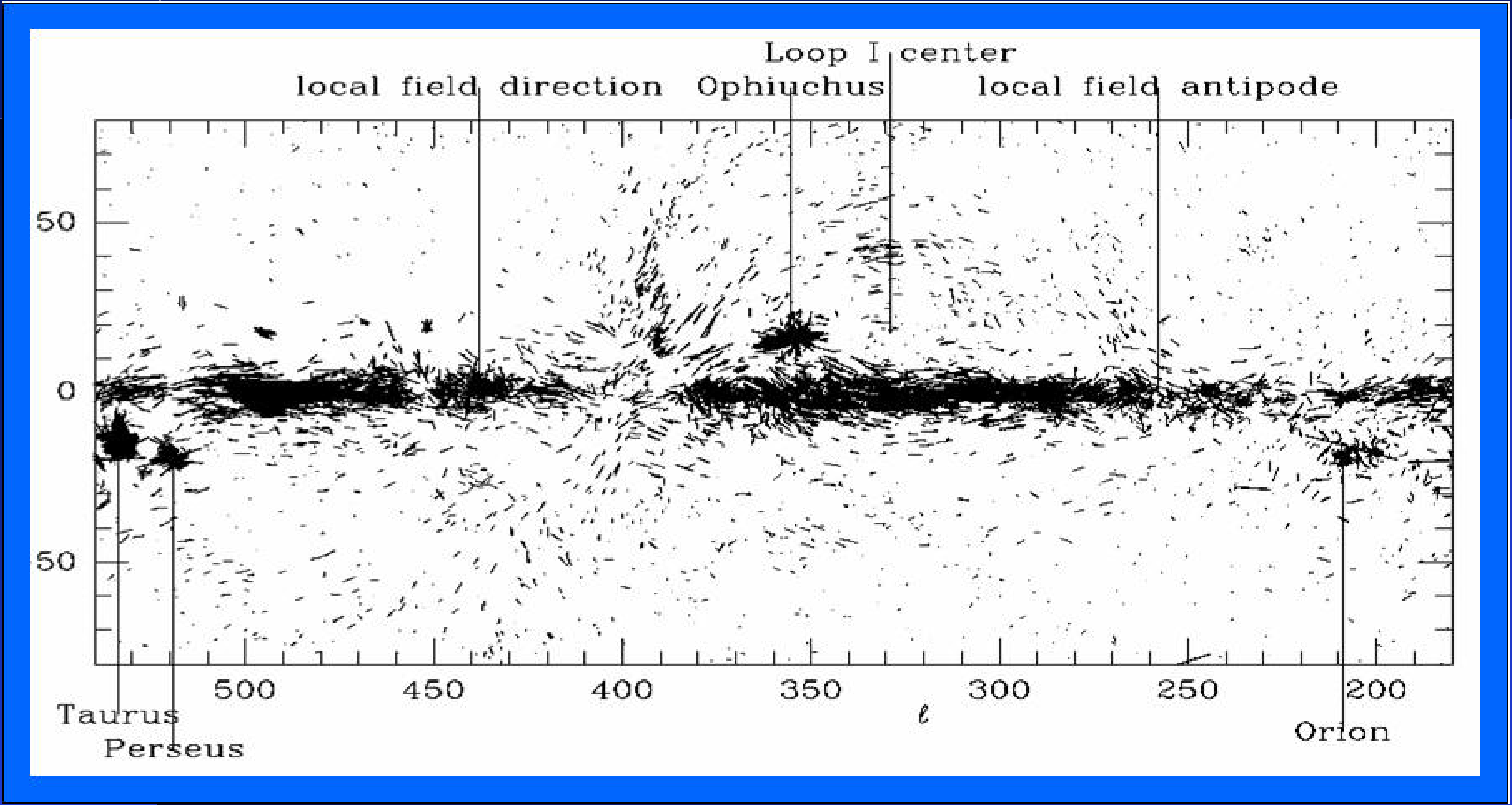
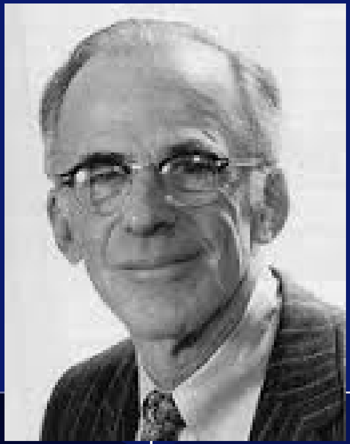
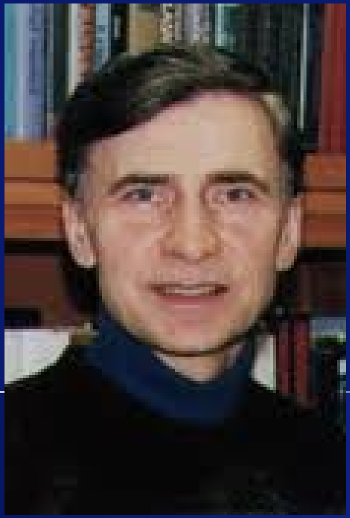


Point 1. Weak versus Strong Magnetic Field





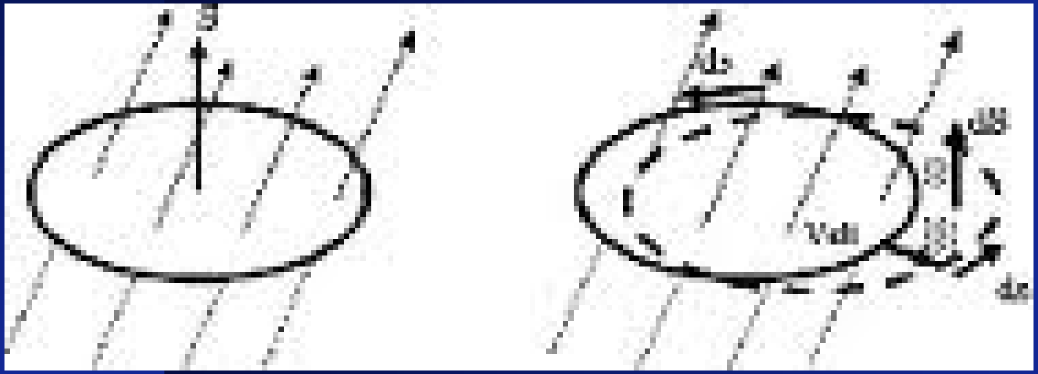
Strong magnetic field

Weak magnetic field

Point 2. Problem of Flux Freezing

Idea of magnetic flux being frozen in a highly conducted fluid was at the heart of star formation paradigm.

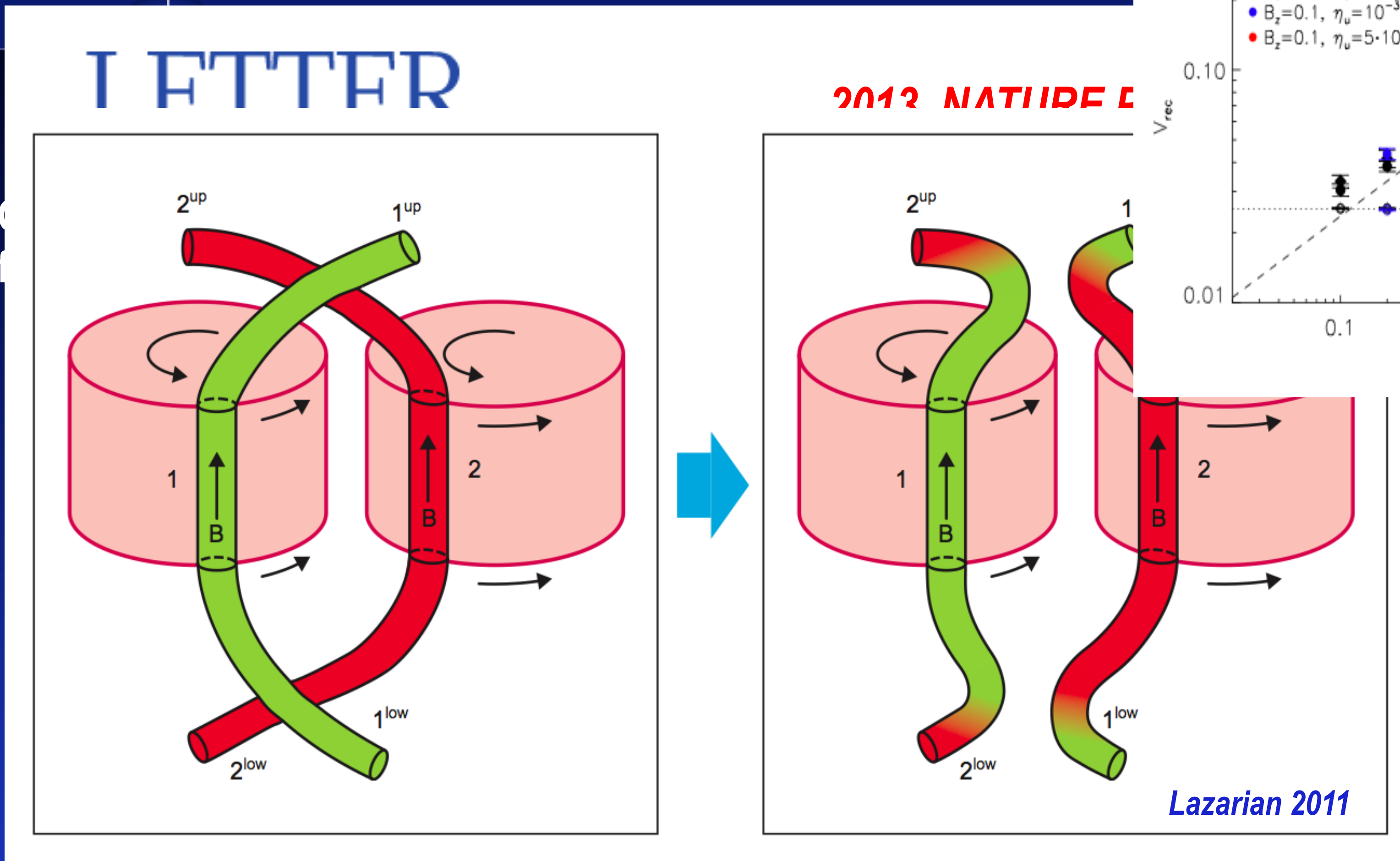
Alfven theorem 1942:

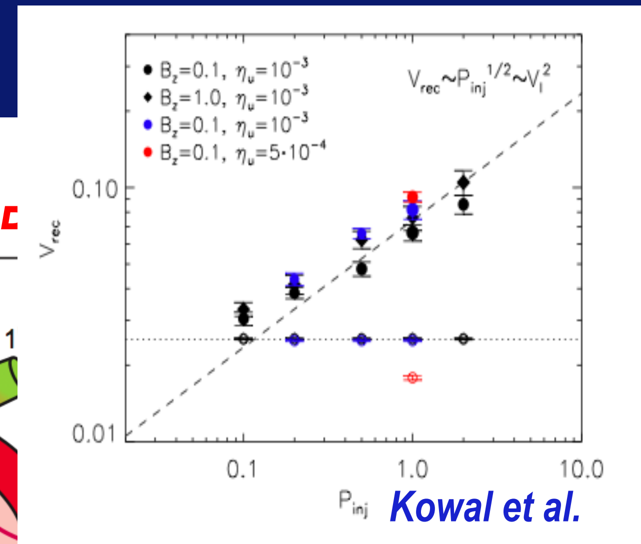


Hannes Alfven

Paradigm: to change magnetic field to flux ratio one must have ambipolar diffusion

Flux Freezing is not applicable in the presence of fast reconnection!





Kowal et al.

Eyink, Lazarian & Vishniac 2011 demonstrated that LV99 means violation of flux freezing

Questions for first 2 points

- y are weak
  um?
- f weak versus

  a. bservations
- on process in

a. fo ccretion disks
- olar diffusion

Point 3. Magnetic Turbulence in ISM

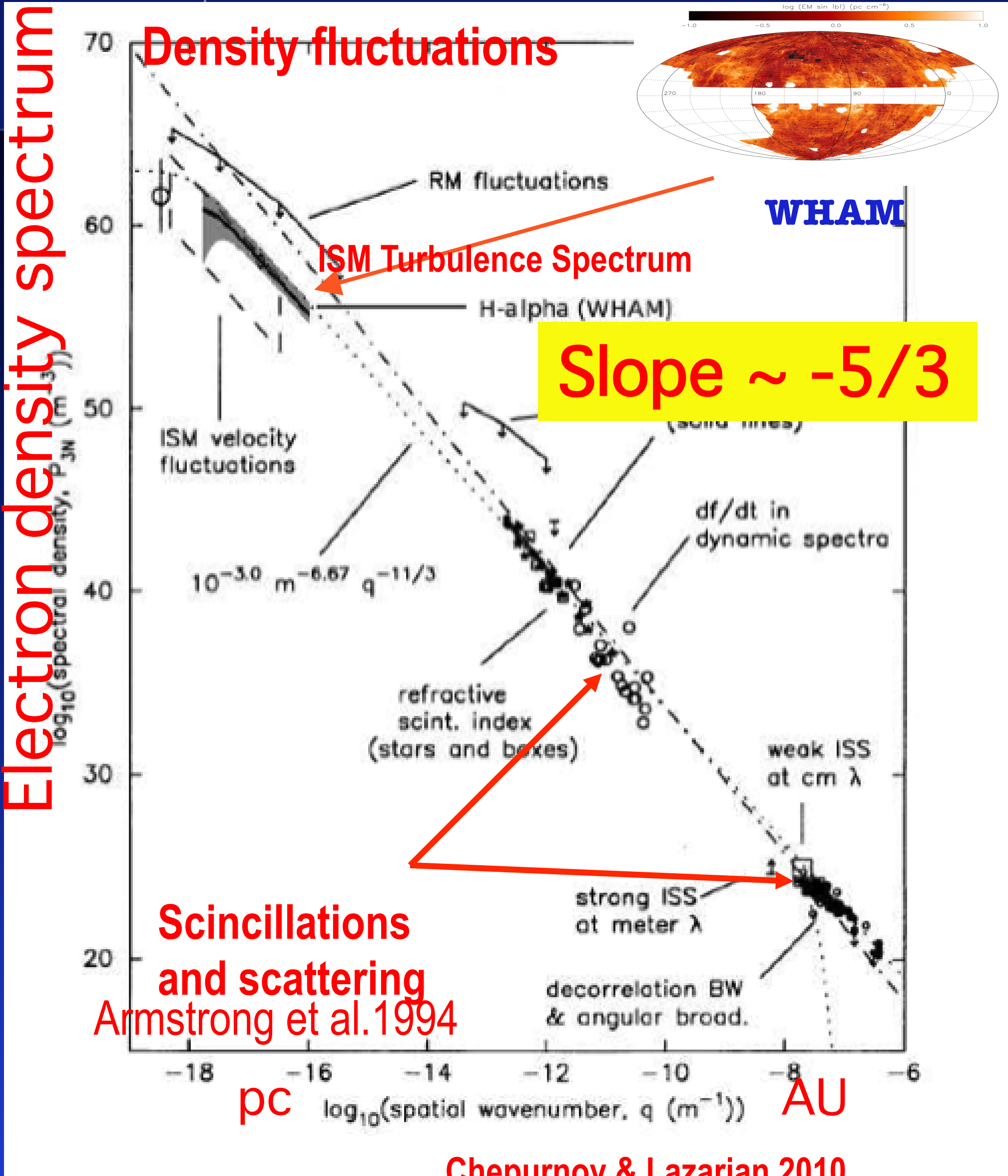


Fig. 5.— WHAM estimation for electron density overplotted on the figure of the Big Power Law in the sky figure from Armstrong et al. (1995). The range of statistical errors is marked with the gray color.

Guido Munch

Evidence:

1. *High Re numbers-- turbulence*
2. *Linewidths*
3. *Spectral slopes*

Questions for point 3

- 1. Do we have interstellar turbulence?
- 2. Is it superAlfvenic or subAlfvenic?
- 3. Is the GS95 theory applicable? Is theory of compressible MHD turbulence applicable?
- 4. What does cause fast dissipation? Is coupling of compressible and incompressible motions important?
- 5. What is the purpose of studying ISM turbulence?
- 6. What is the inertial range and how to define it?

Transfer of energy from Alfven modes to slow and fast modes is rather marginal for many total, i.e. $M_{total}= v/(v_A^2+v_s^2)^{1/2}$, Mach number

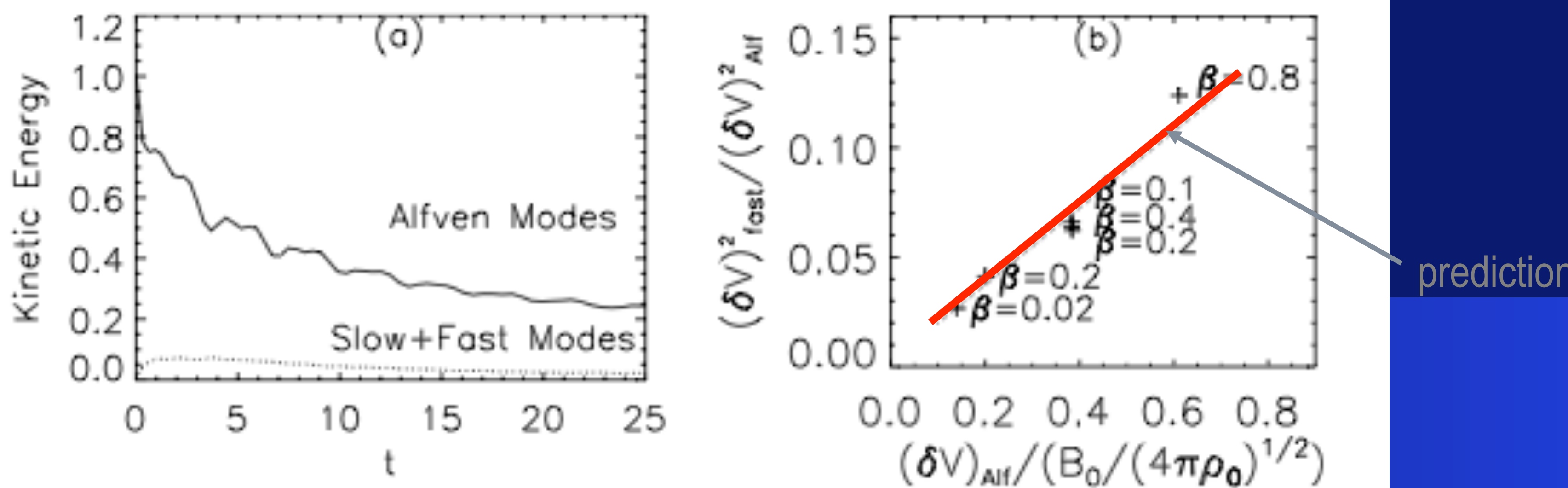
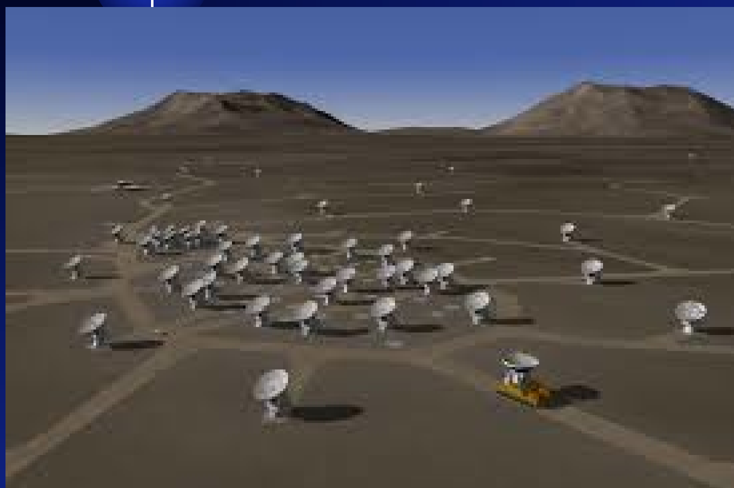


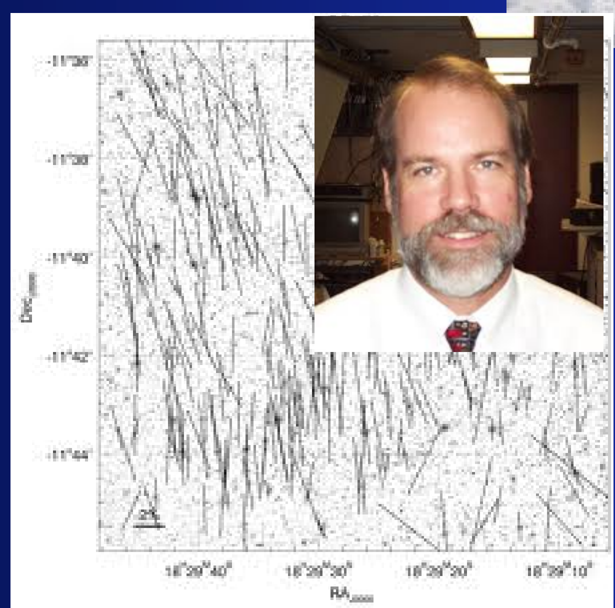
FIG. 1. (a) Decay of Alfvénic turbulence. The generation of fast and slow waves is not efficient. Initially, $\beta \sim 0.2$ and $B_0/\sqrt{4\pi\rho_0} = 1$. (b) The ratio of $(\delta V)^2_f$ to $(\delta V)^2_A$. The ratio is measured at $t \sim 3$ for all simulations. The ratio strongly depends on B_0, but only weakly on (initial) β. The initial Mach numbers span 1–4.5.

Cho & Lazarian 02

Coupling of Alfvenic, fast and slow modes is weak for M_{total}<<1 . Thus Alfvenic motions persist.

Point 4. New telescopes are available and we at last have testable grain alignment theory





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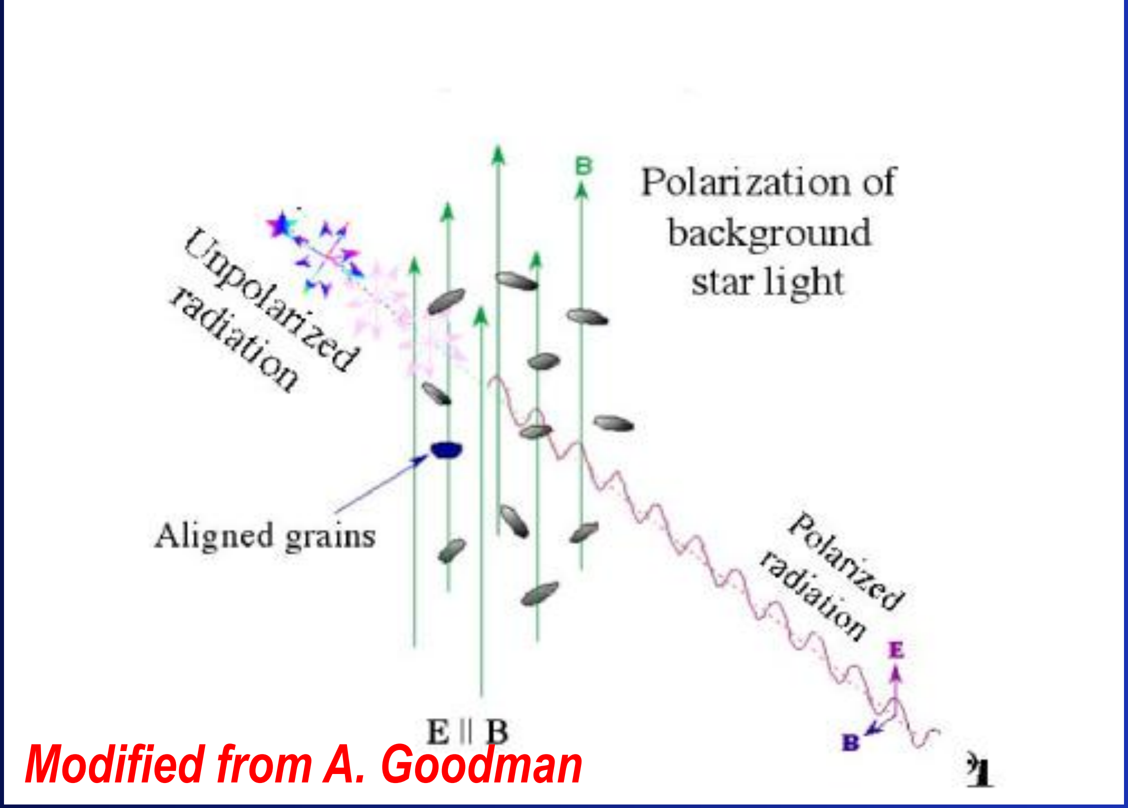
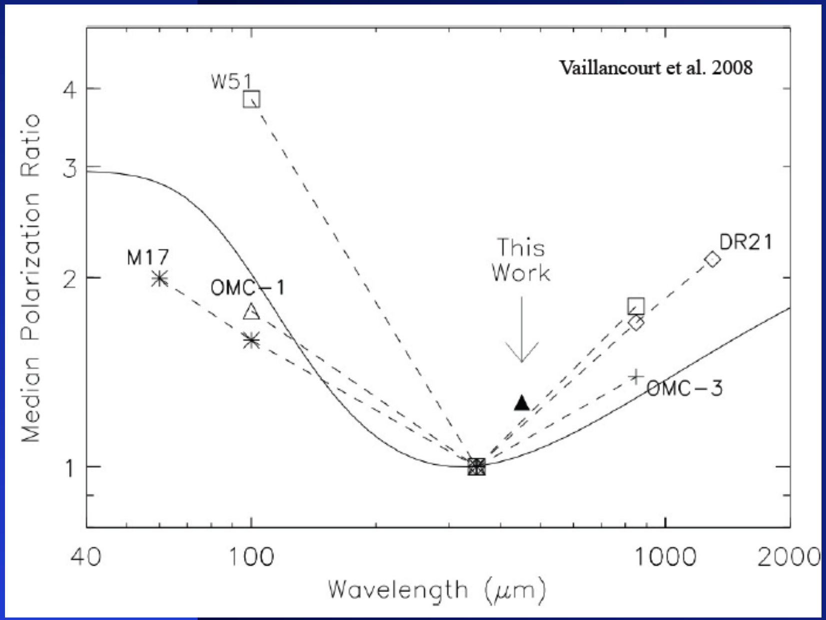
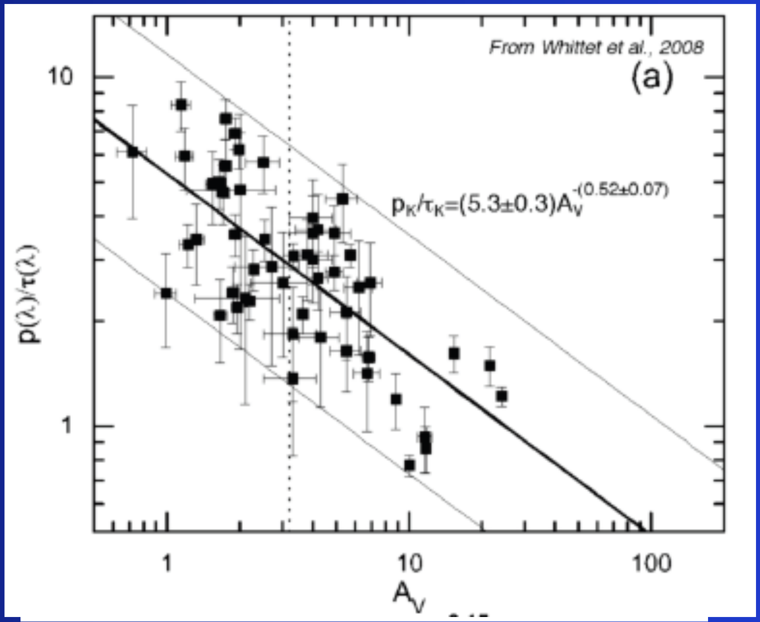


Point 3. New telescopes are available and we at last have testable grain alignment theory

Theory: Radiative torques (RATs) replaced the Davis-Greenstein process (orig. proposed by Dolginov & Mytrophanov 78, studied numerically Draine & Weingartner 96)

Analytical model in Lazarian & Hoang 2007 explains main properties of RATs:





Tracing of magnetic fields and measuring magnetic fields with CF technique

Basic idea

$$\delta\phi = \frac{\delta V}{V_A}$$

Numerical studis:
Ostriker et al. 2001
Padoan et al. 2001
Heisch et al. 2001
Falceta-Goncalves et al. 2008

Questions for point 4

- 1. RATs align all grains > 10^{-5}cm in diffuse media, in molecular clouds, the efficiency decreases. Near stars we can align, but not further. Patchy alignment. What do we trace with aligned grains in molecular clouds (MC)? Is it useful?
- 2. Chandrasekhar-Fermi technique to get magnetic field intensity assumes homogeneous alignment. In MC this is not the case. What is the value of C-F for MC? How to improve?
- 3. What is the synergy between absorption and emission polarimetry?
- 4. What is the domain where grain alignment polarimetry is most useful and unique

a. Diffuse media? b. MCs? c. Accretion disks?