If Accretion Controls Filament Evolution...

Fabian Heitsch
UNC Chapel Hill

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(2) ambipolar diffusion loses.

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(4) its signature could still be hidden.

ApJ 769, 115 ApJ 776, 62 MNRAS 443, 230

(1) Accretion and Fragmentation

Fragmentation timescale Nagasawa 87, Tomisaka 95

$$\tau_f = \frac{3}{\sqrt{4\pi G \rho_c}} = 5.24 \times 10^5 \left(\frac{n_c}{10^4 \ \mathrm{cm}^{-3}} \right)^{-1/2} \mathrm{yrs}$$

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Accretion timescale FH+ 09, Palmeirim+ 13

$$\tau_a = 8.31 \times 10^5 \left(\frac{T}{10 \ \mathrm{K}}\right)^{1/2} \left(\frac{n_{ext}}{100 \mathrm{cm}^{-3}}\right)^{-1} \left(\frac{R}{\mathrm{pc}}\right)^{-1} \left(\ln \frac{R_{ref}}{R}\right)^{-1/2} \mathrm{yrs},$$

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Depends on line mass, filament radius.

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Line mass evolution:

$$\frac{dm}{dt} = 2\pi R \rho_{ext} v_R = 4\pi \rho_{ext} R \left(G m(t) \ln\left(\frac{R_{ref}}{R} \right) \right)^{1/2}$$

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Setting the radius:

$$R_f = R_0 \left(\left(\frac{\rho_c}{\rho_{ext}} \right)^{2/p} - 1 \right)^{1/2}$$

arbitrary p $\rho(R) = \rho_c \left(1 + \left(\frac{R}{R_0} \right)^2 \right)^{-p/2}$

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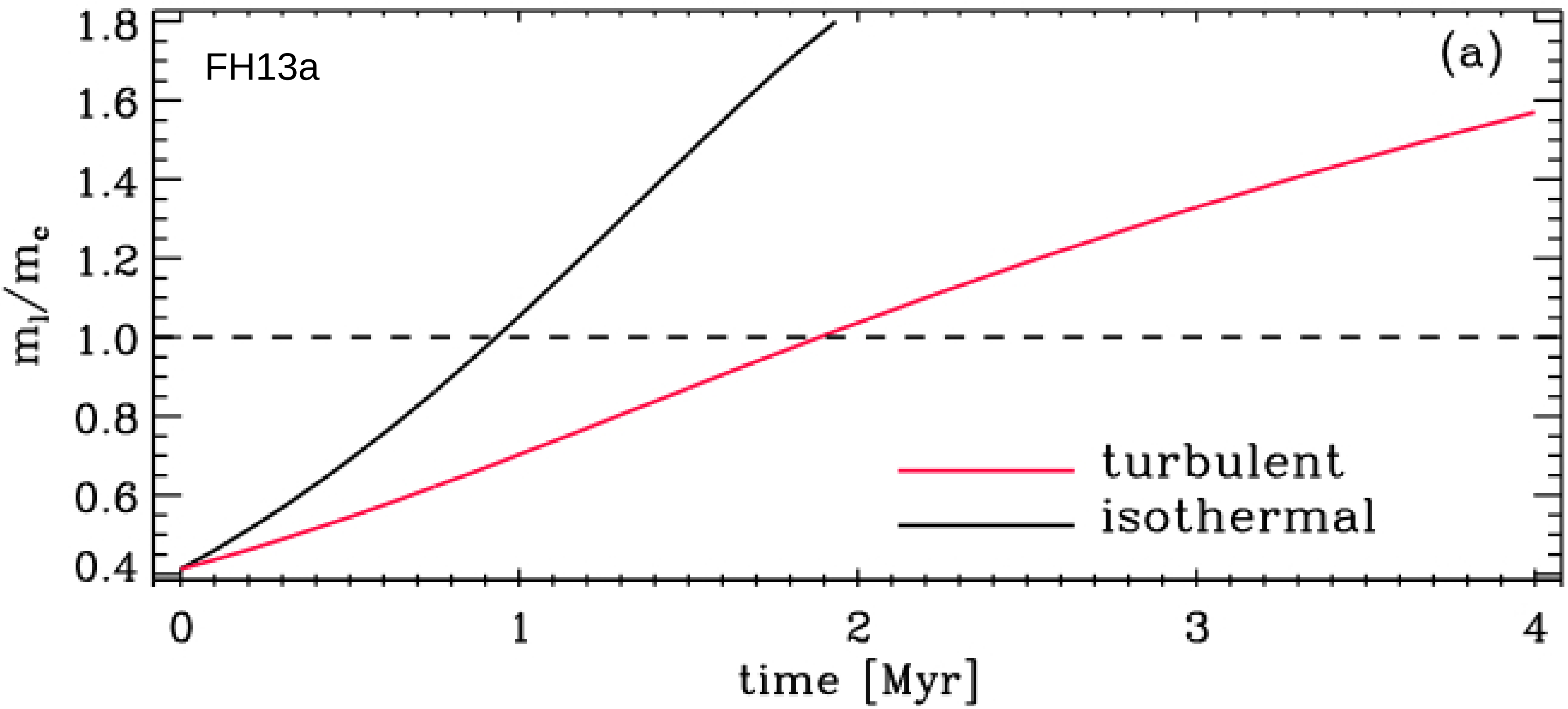
$$R_f = \sigma^2 \left(\frac{2f(1-f)}{\pi G p_{ext}} \right)^{1/2}$$

externally pressurized, isothermal

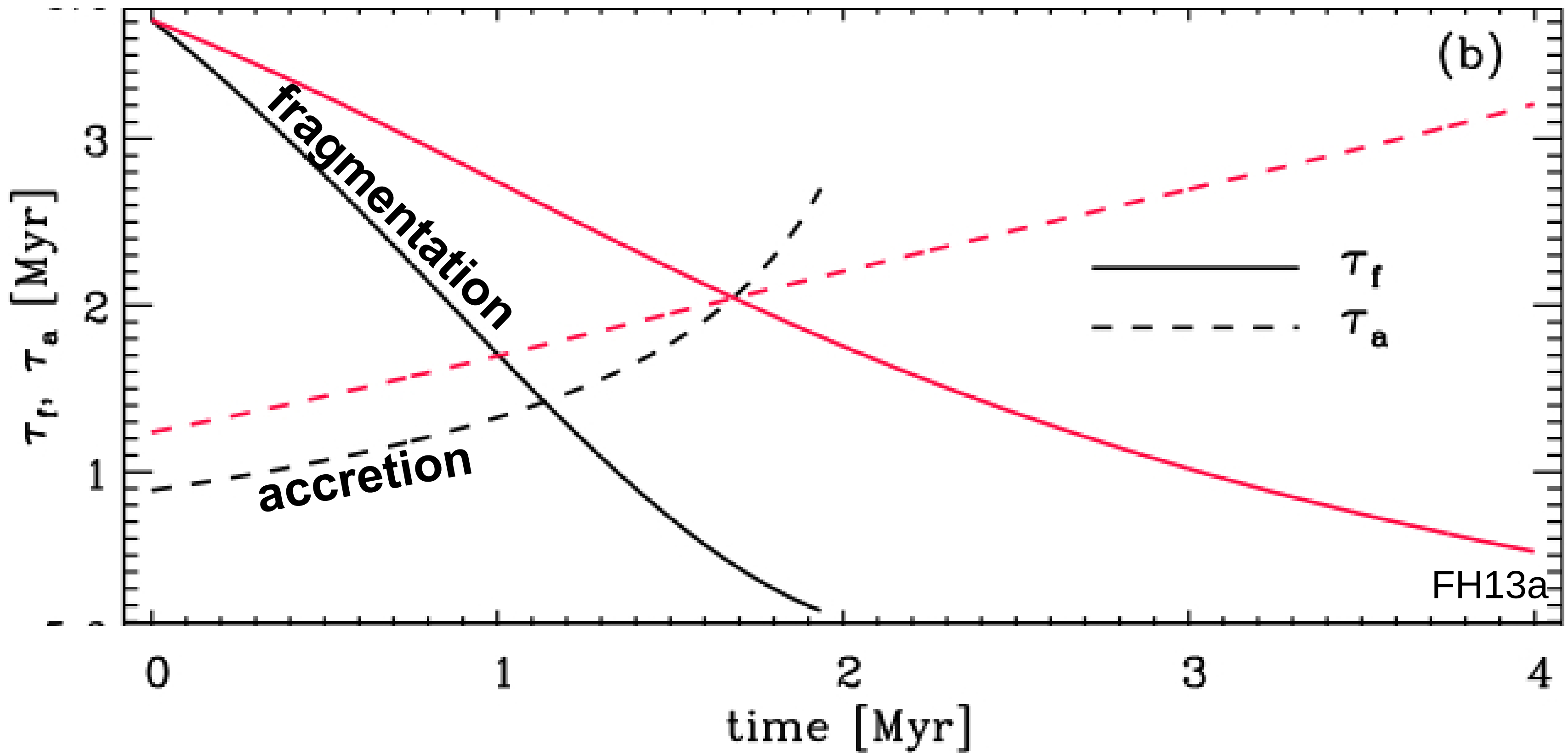
Fischera & Martin 12a,b

(1) Accretion and Fragmentation

line mass m(t) for p=1.5



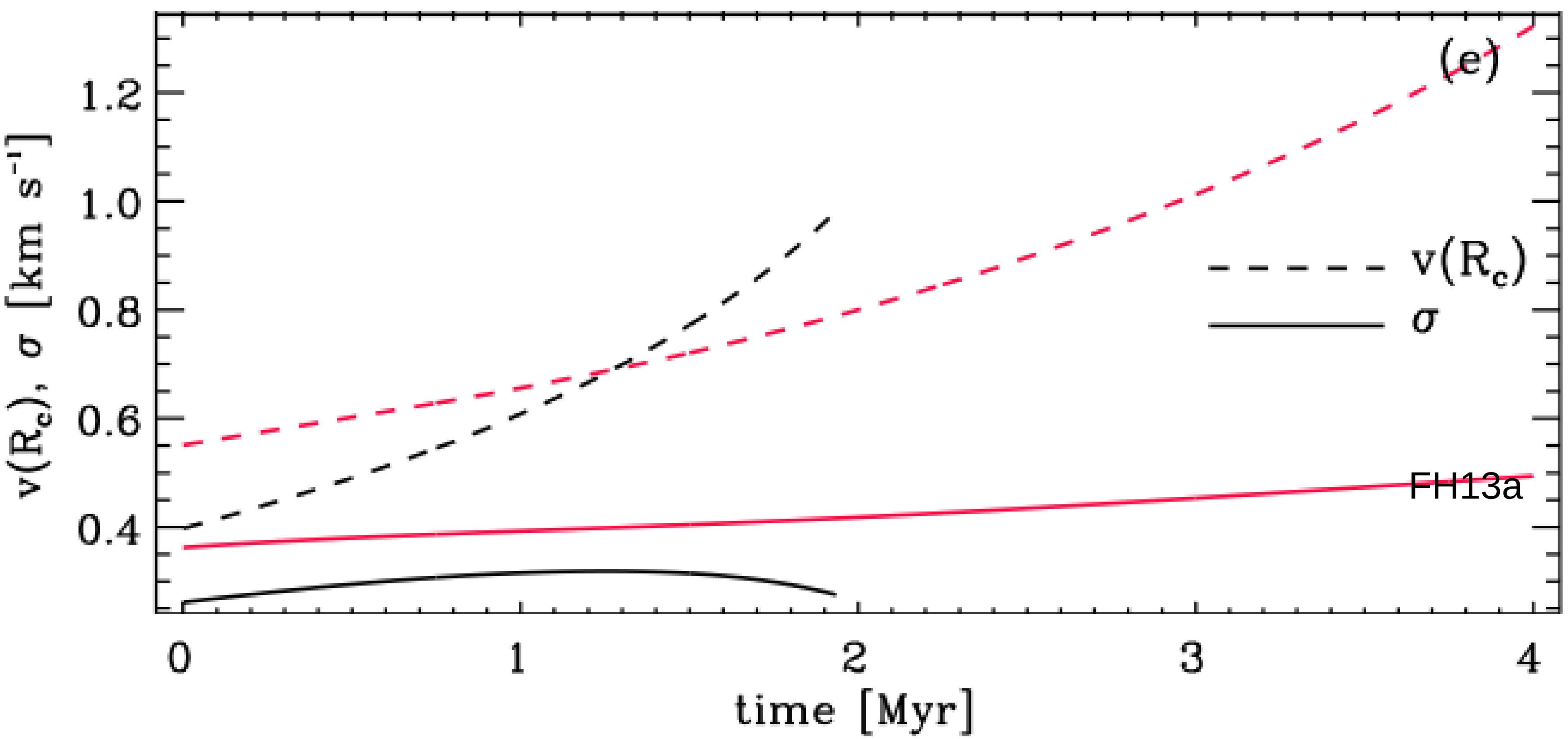
(1) Accretion and Fragmentation



(2) Accretion-driven Turbulence Klessen & Hennebelle 10

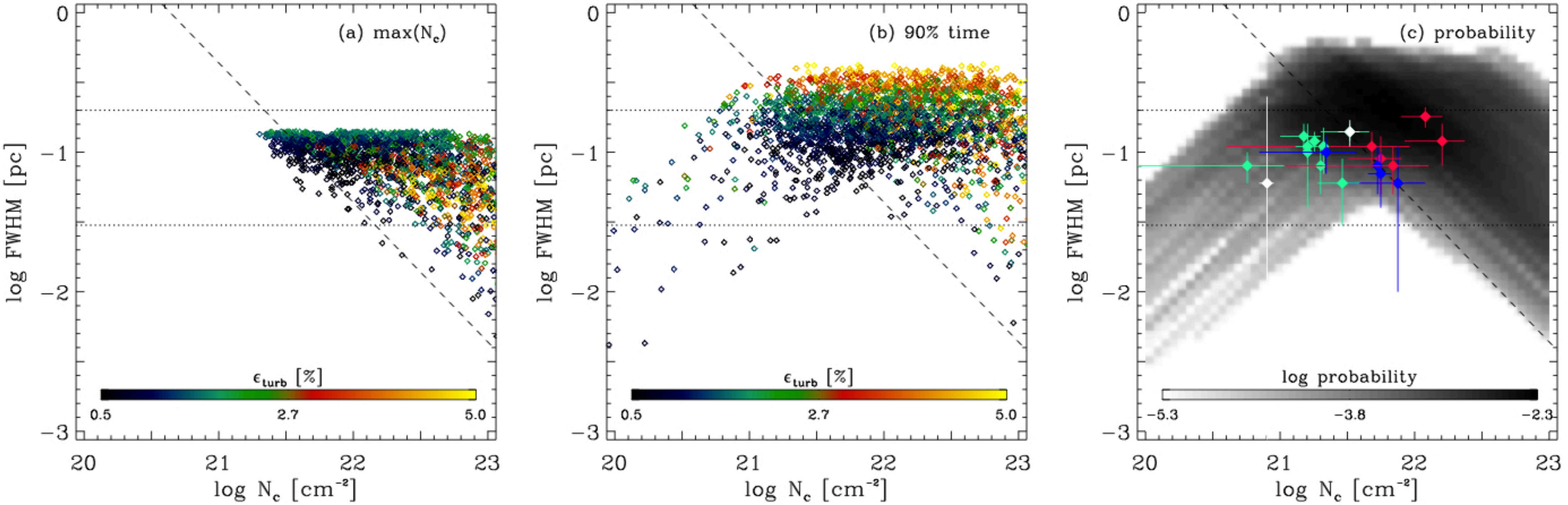
motivated by Vazquez-Semadeni+ 07, FH+ 08, Field+ 08...

$$\sigma = \left(2\epsilon R_f v^2(R_f)\frac{dm/dt}{m(t)}\right)^{1/3}$$



(2) Accretion-driven Turbulence

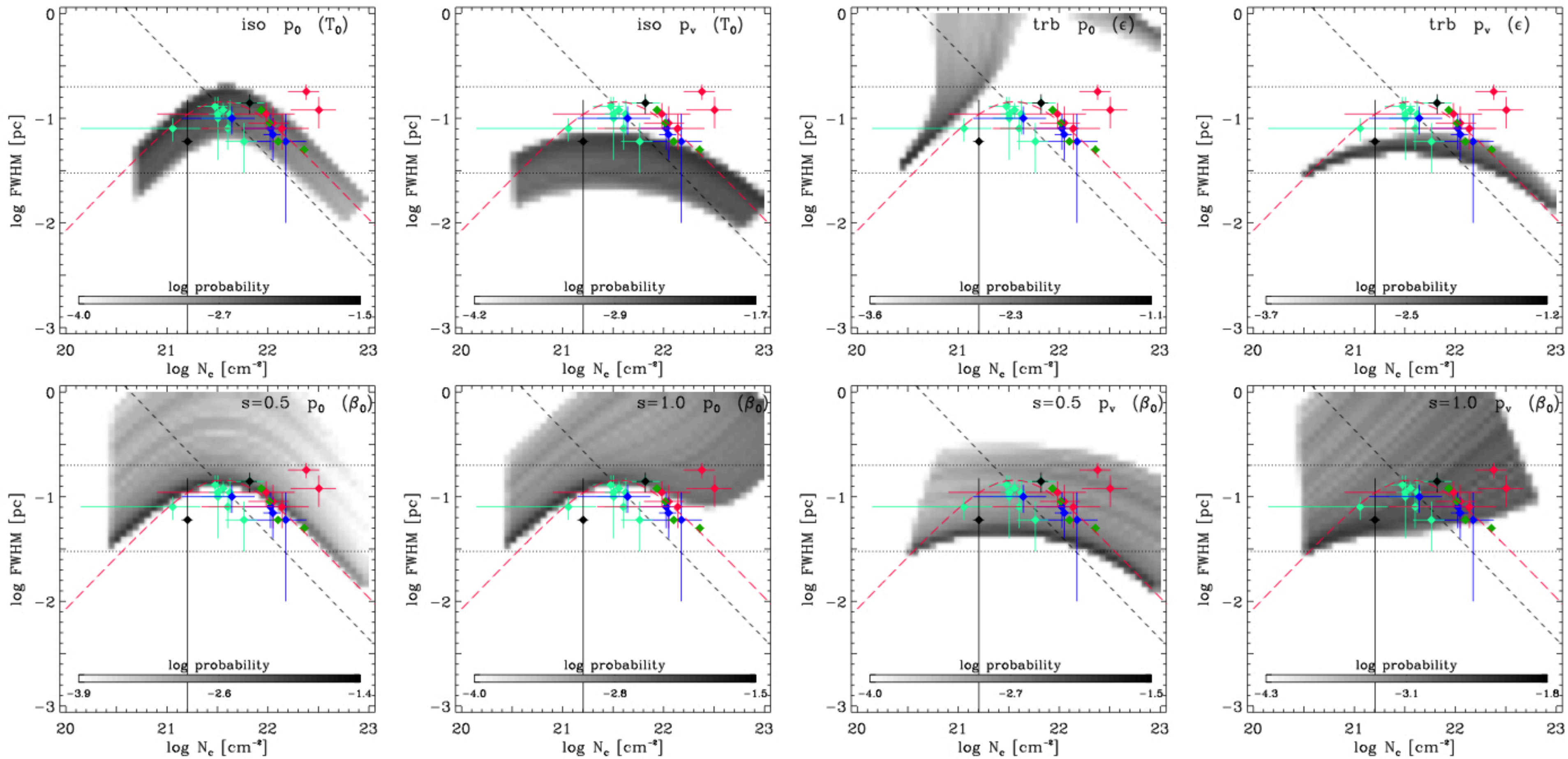
FWHM(N) relations (version 1: p=1.5) [Arzoumanian+ 11]



FH13a

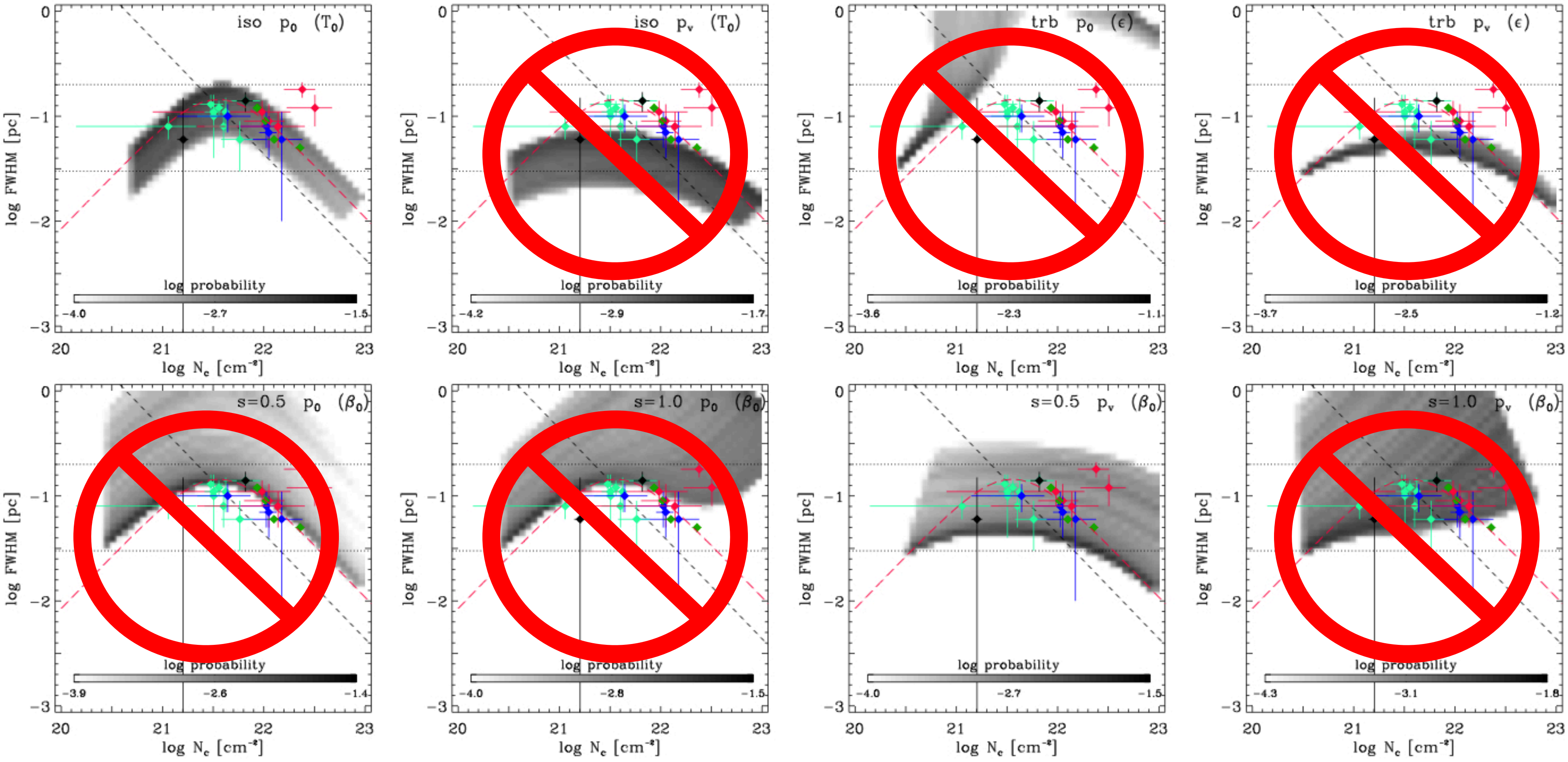
(2) Accretion-driven Turbulence

FWHM(N) relations (version 2: p=2) [Fischera & Martin 12a]



FH13b

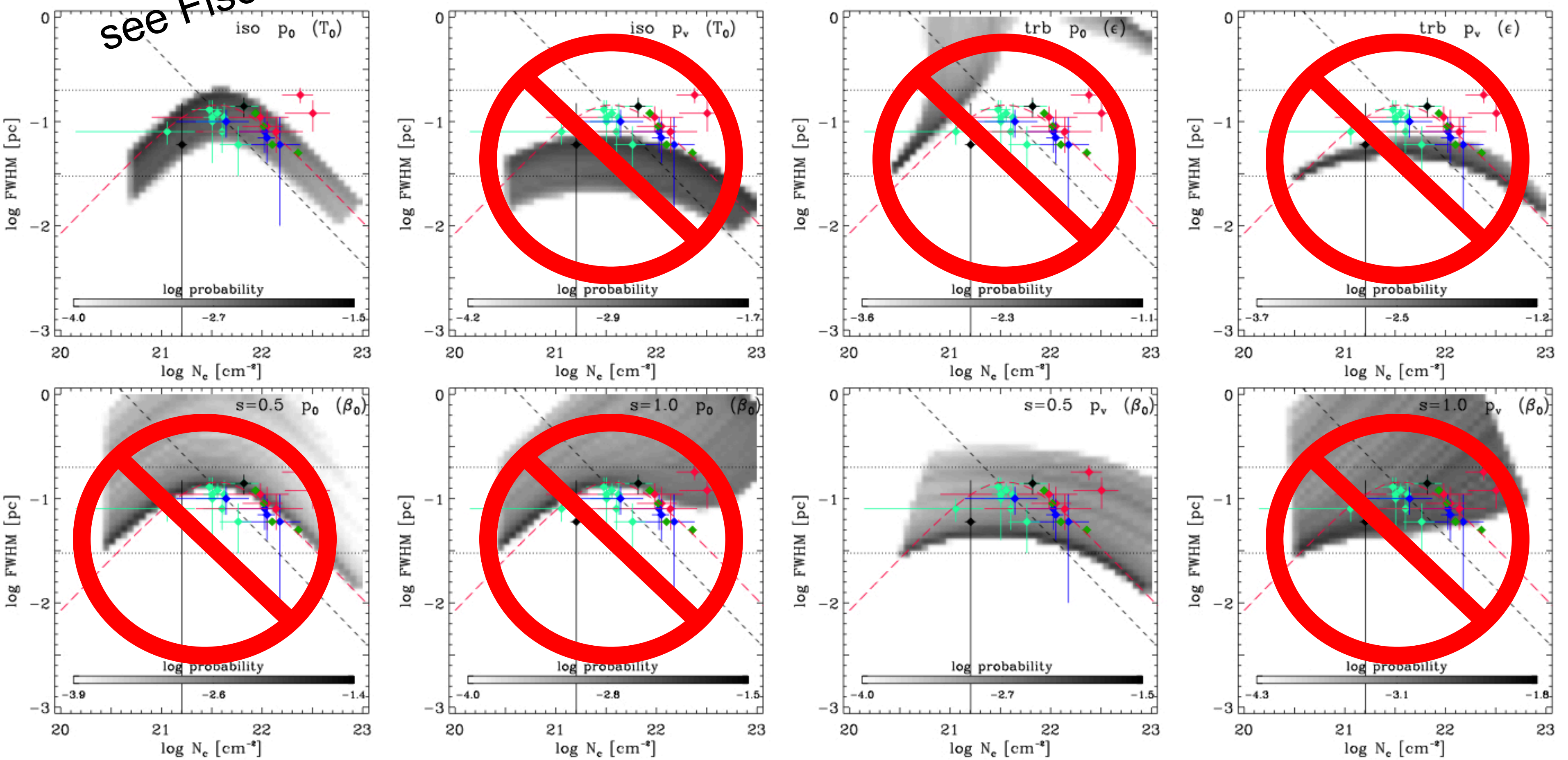
(2) Accretion-driven Turbulence



FH13b

(2) Accretion-driven Turbulence

see Fischera & Martin 12



FH13b

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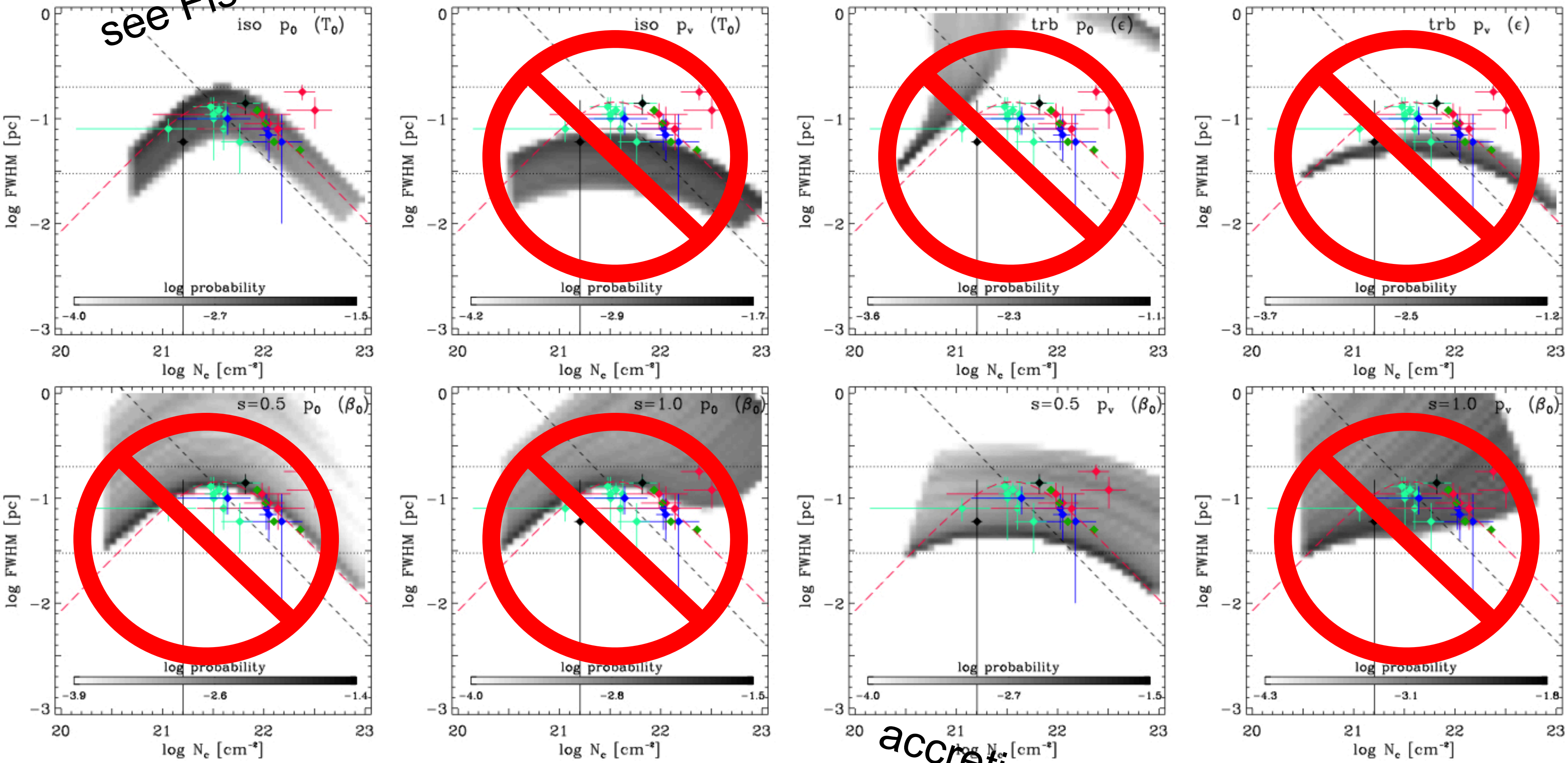
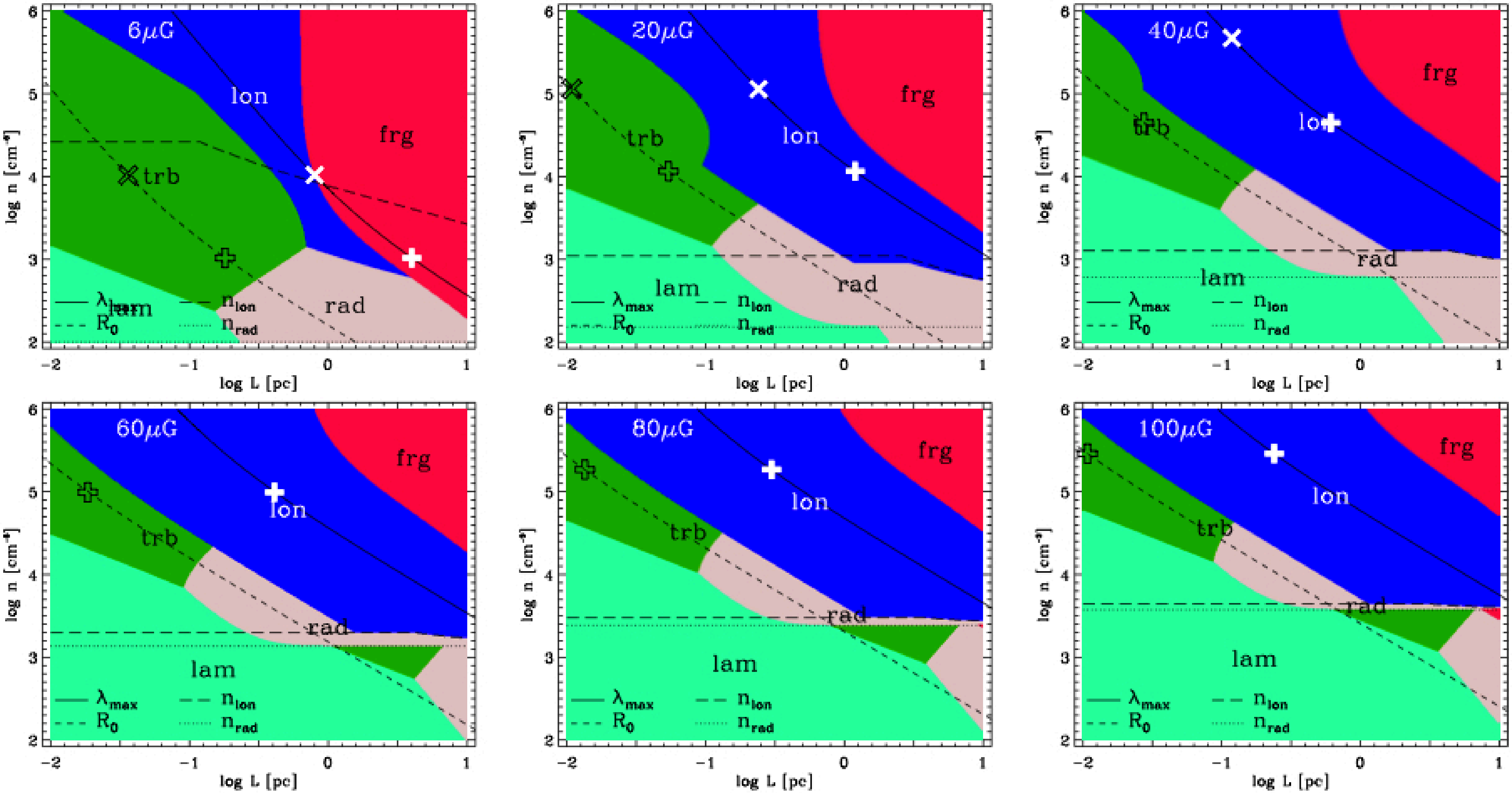


accretion through layer

FH13b

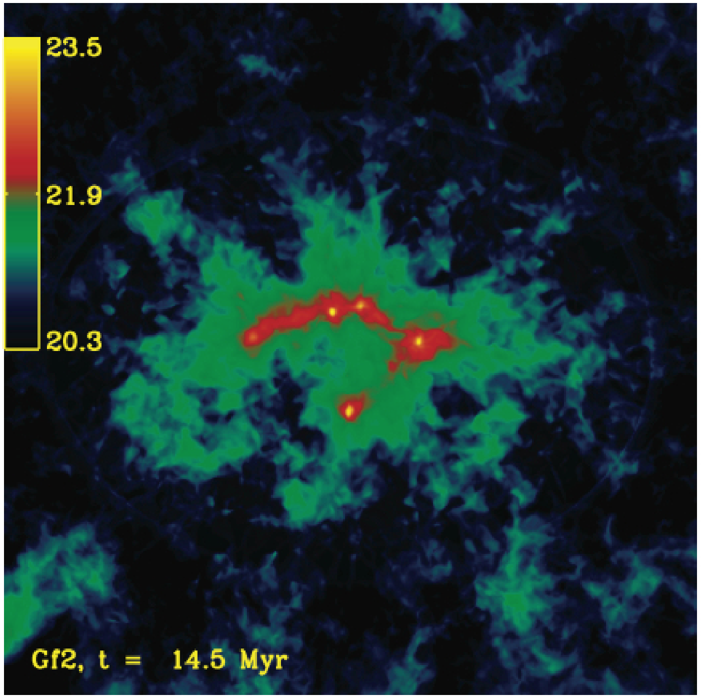
(3) Accretion and Ambipolar Diffusion



FH & Hartmann 14

Filament turns supercritical via accretion, not AD.

(4) Accretion signatures



FH+ 08, see Vazquez-Semadeni+ 07, Banerjee+ 09 etc.

Burkert & Hartmann 04 effect

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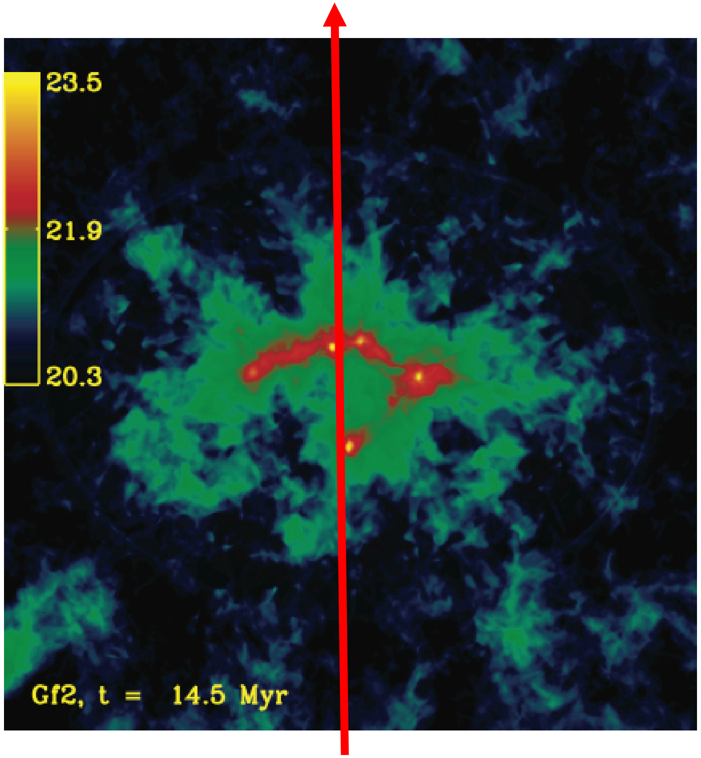

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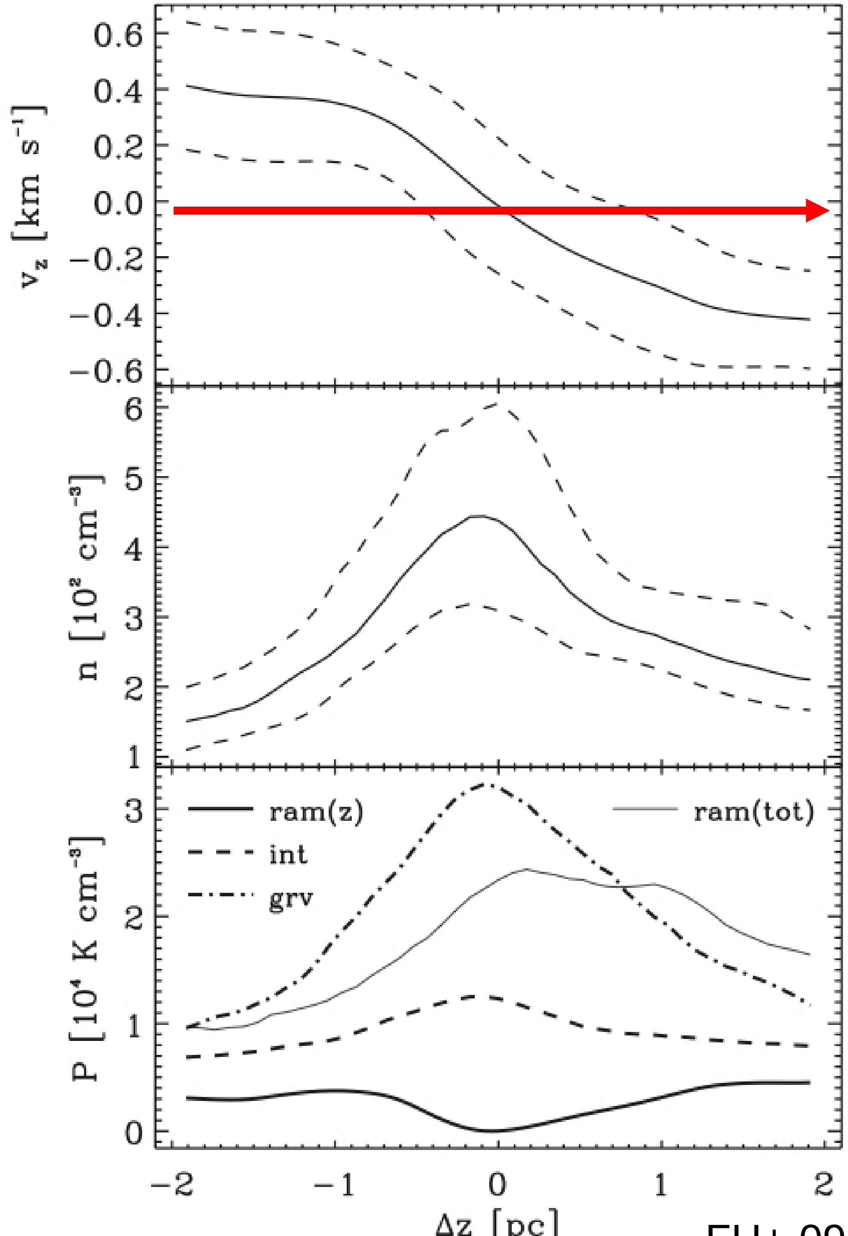

FH+ 09

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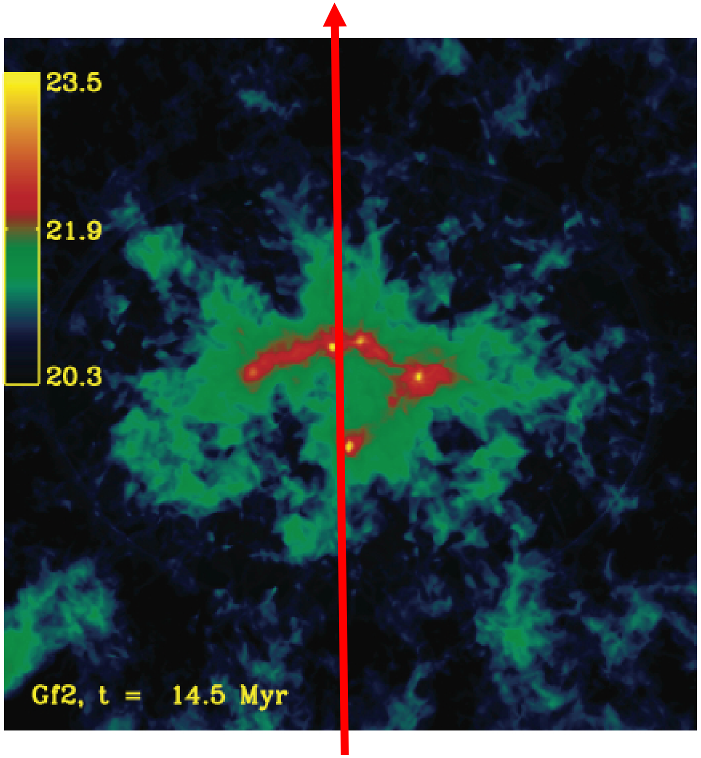

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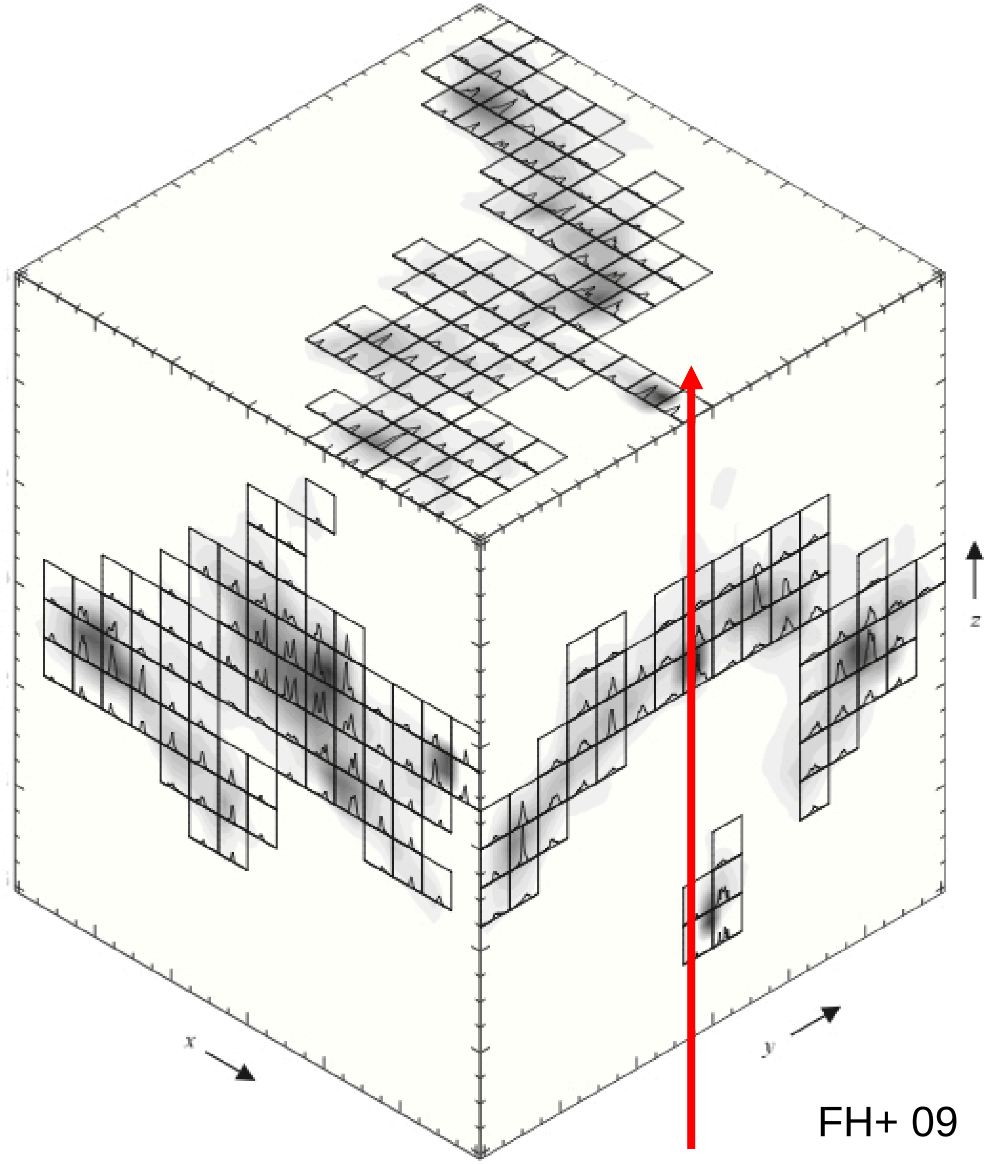
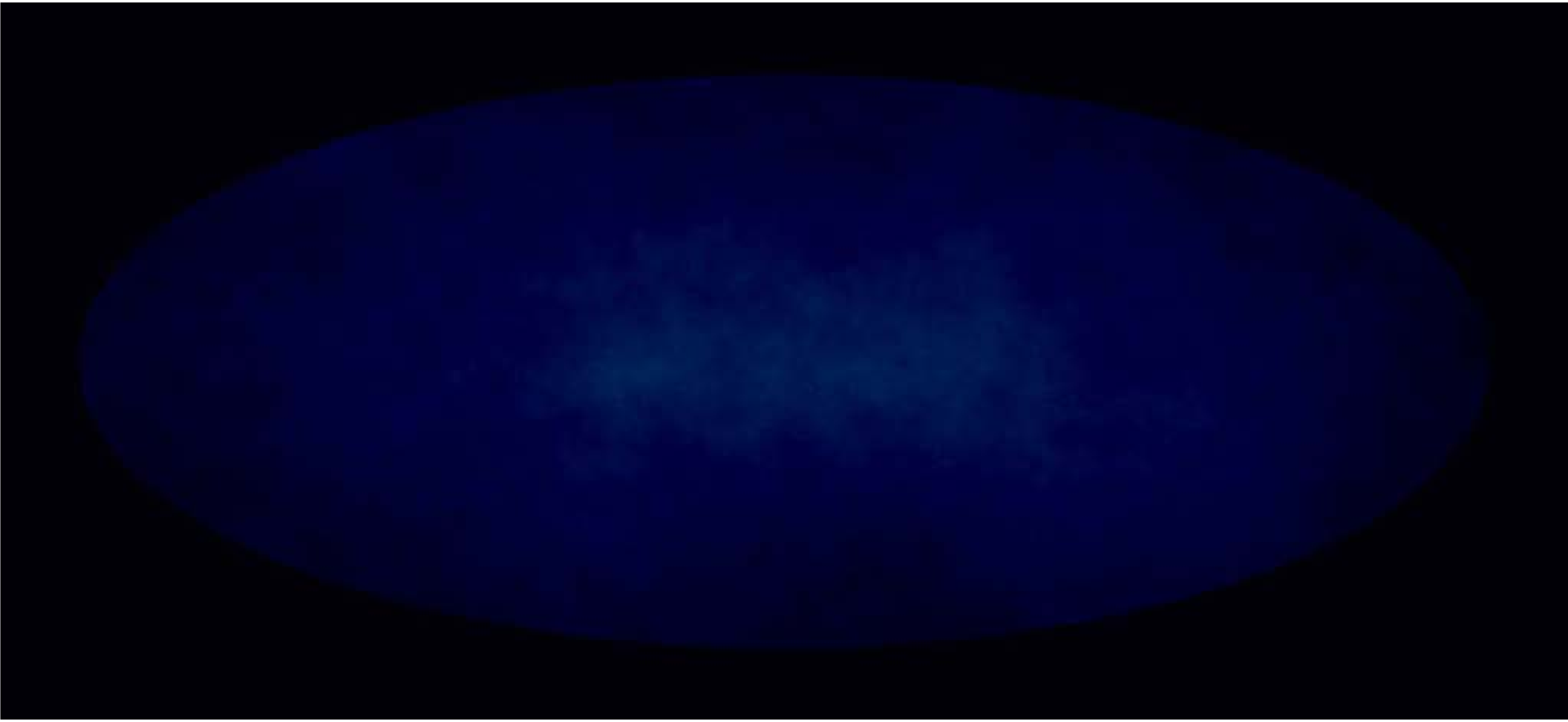


FH+ 09

Signature can be hidden in “turbulent” medium.
A filament for us may not be a filament for E.T.

(4) Accretion signatures



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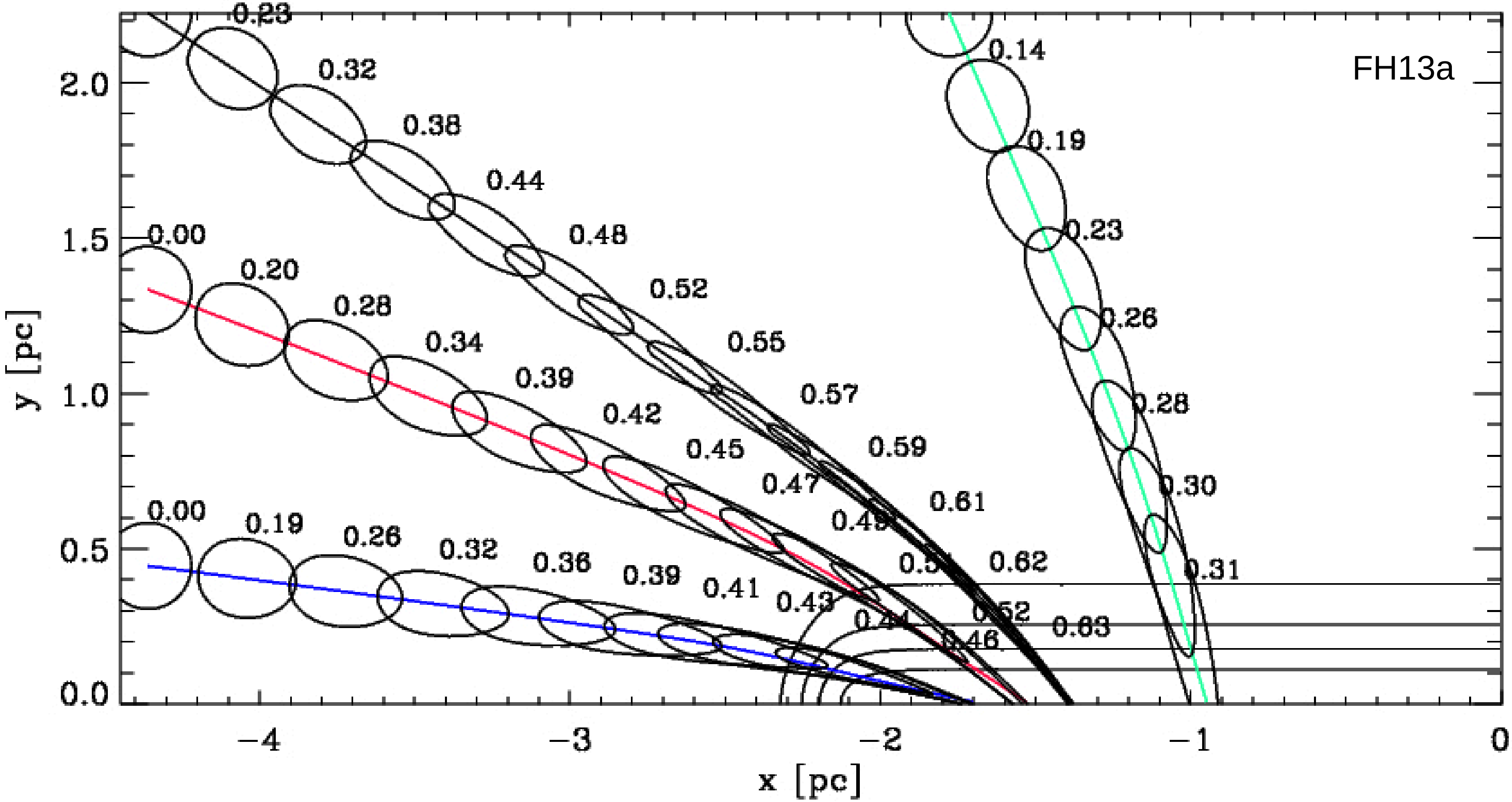

Test particle trajectory at filament end

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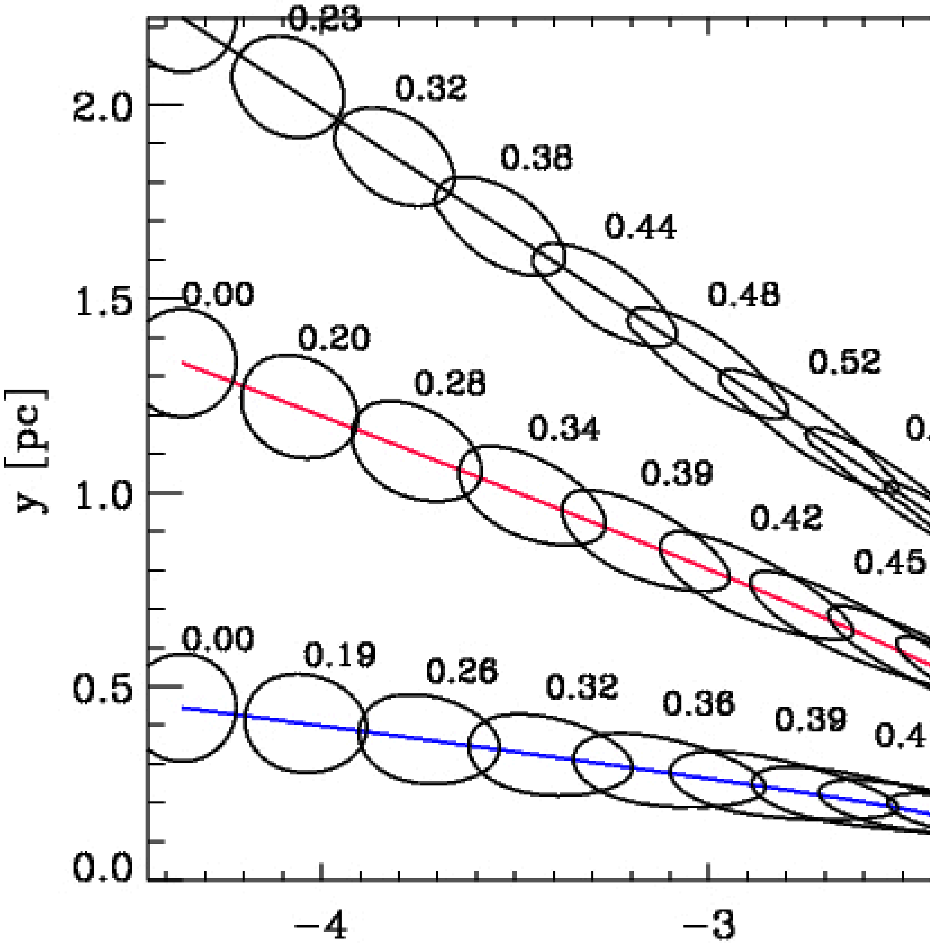
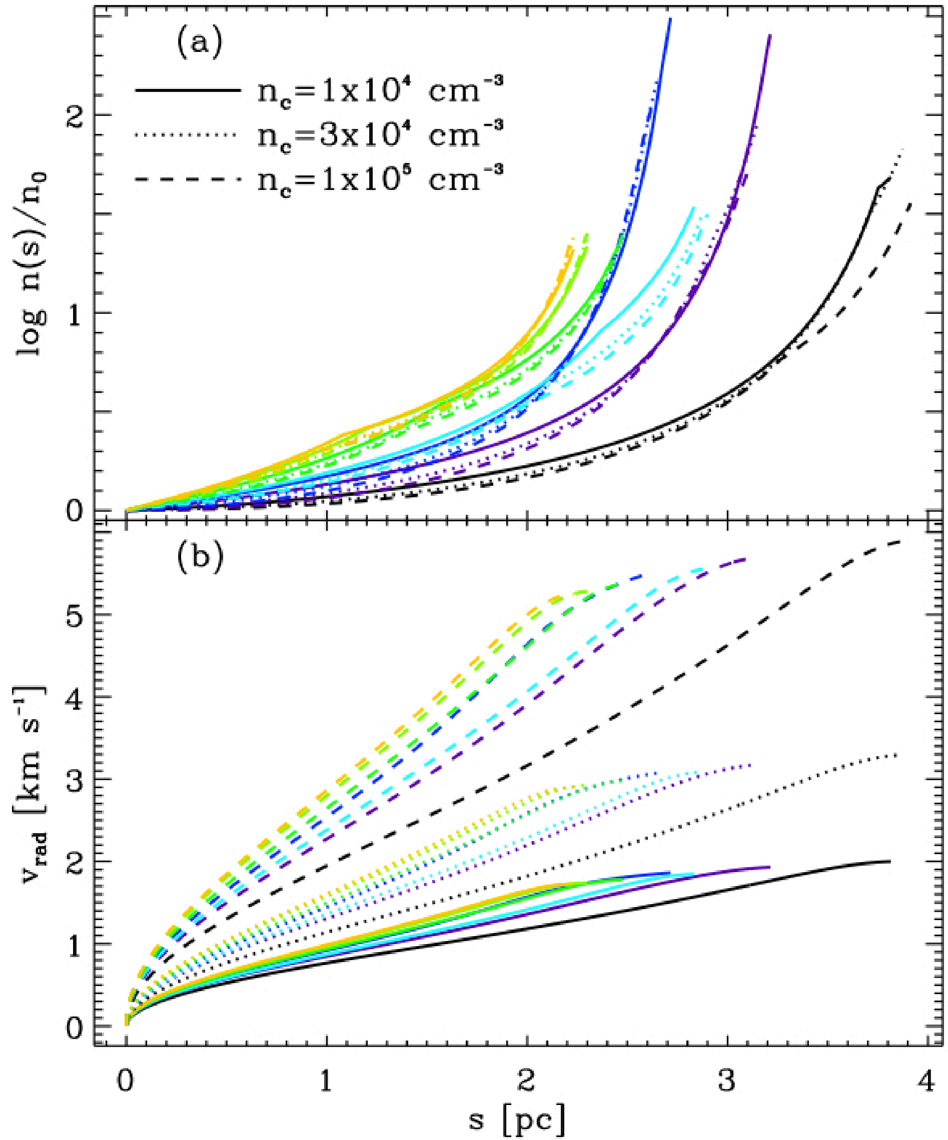
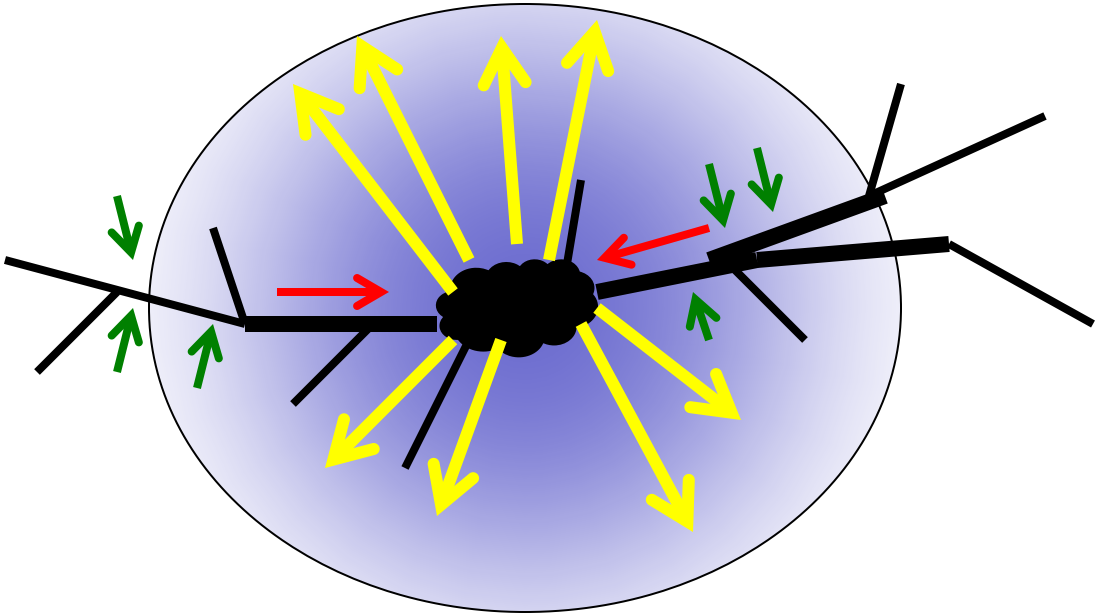




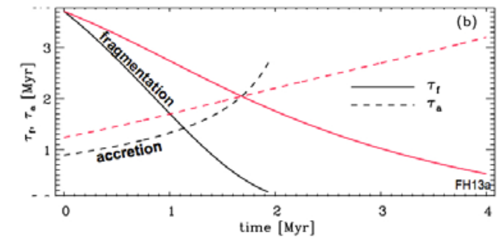
Test particle trajectory at filament end

[Spekulatius]

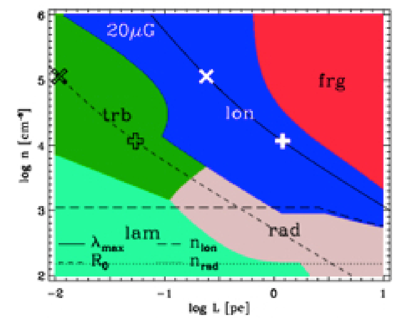


If accretion controls filament evolution, then

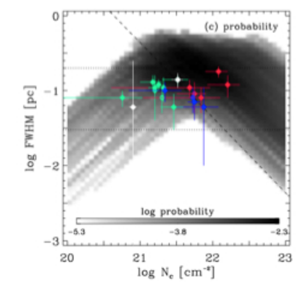
(1) longitudinal fragmentation loses.



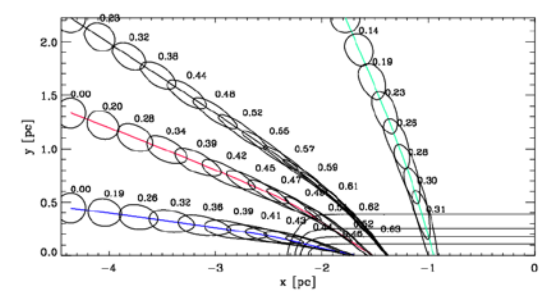
(2) ambipolar diffusion loses.



(3) “turbulence” is a natural consequence.



(4) its signature could still be hidden
in v-space, but revealed in structures.



Thank you!