Summary Comments and Questions

Phil Myers
CfA

Kavli Institute for Theoretical Physics • UC Santa Barbara • November 9, 2007

Preface

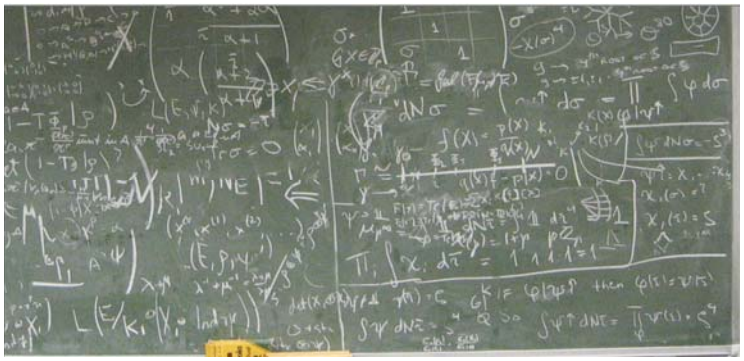
Thanks to our program organizers

Alyssa, Chris, Paolo, and Tom

And to this week's "chef" Alyssa!

We bring many strengths to this meeting, since we have different approaches to the same problem...

Some would describe the palms of Santa Barbara with an image, some with formulas, and some with a table of numbers.



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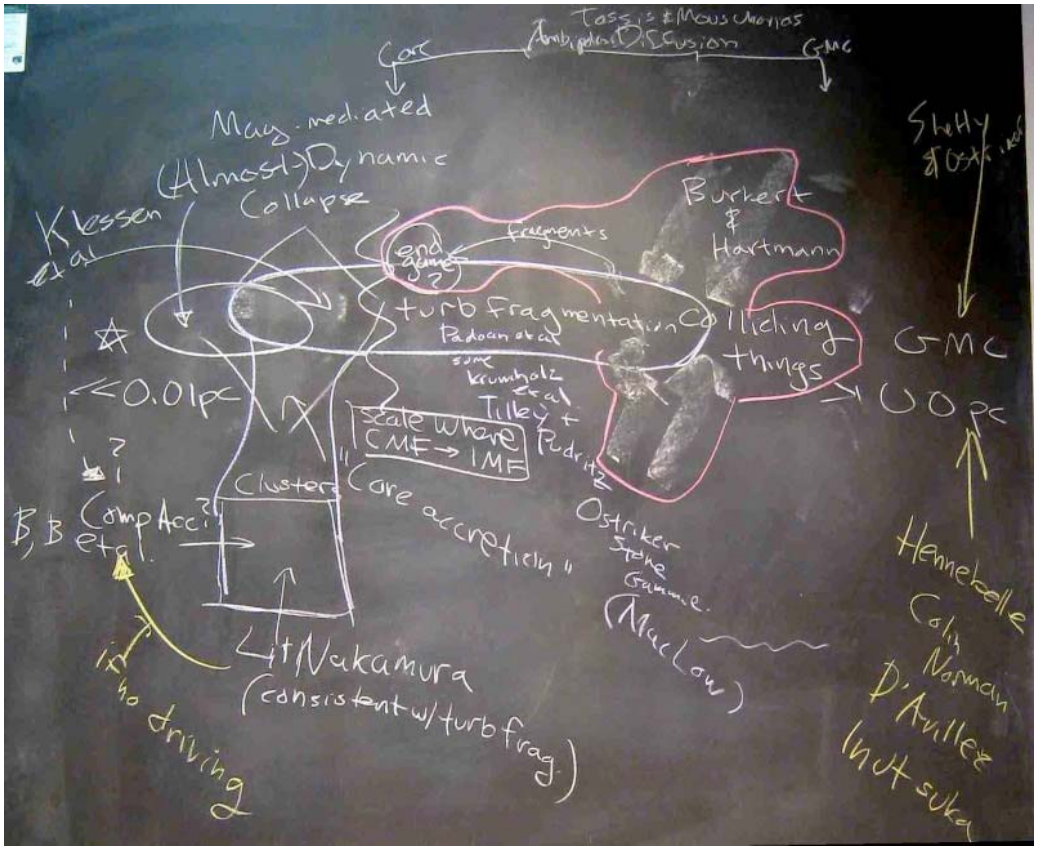
The downside is that sometimes it gets a little confusing



List of Lists

Interesting things I heard this week

Issues and questions

How surveys can help

Interesting Things

1. Extensive “complete” “unbiased” surveys of gas & dust, YSOs, cores, B...

Once, nearly all our information about nearby star-forming regions was from optical observations—star-count extinction and T Tauri stars.

we can’t still claim that we are still “severely limited” by insufficient completeness, sensitivity, and resolution.

So NOW can we solve the problem of star formation?

2. Similarity of SFE (2-4 % above A_V=2) for Cha II to Ser to Per to Tau to Oph despite big range of SFR…7-91 stars/Myr – more massive clouds make more stars

3. Column density "threshold" 75% of all mm cores have A_V > 8-20 mag, similar for protostars; very few YSOs with A_V <2 despite significant cloud mass.

4. Technical advances--column density comparison favors NIR methods, but limits on resolution and no velocity information; structure tree vs. clumpfind.

5. Cores at 1 mm have big contrast with mean density, n_0/n_u > 30-100, most cores bound (neglecting P_{ext}, B)

6. A well-studied starless core - TMC-1C has central $A_V \sim 80$ mag, $T_d \sim 6$ K, n ~3 10^6 cm^{-3}, detailed decrease of T_{gas} and T_{dust} toward center, $M>3M_{vir}$, infall asymmetry, v_{in}~0.1 km s^{-1}

7. New BDs in Taurus, may change IMF; remarkable 160μm image, detailed correspondence to FCRAO CO map--can yield kinematics and abundance of very faint features.

8. Orion and nearby clusters - Clusters are not isolated, but have nearby groups and "distributed" stars, following elongated and clumpy molecular gas. Nearest neighbor distribution has well-defined peak, similar to Jeans length.

9. Li depletion as a clock for YSO age - reveals some much older members in Ori and σ Ori - possible evidence for accelerating star formation (or maybe multiple “bursts”)

10. Turbulent motions can form elongated regions of very high velocity dispersion and normal density-a possible new diagnostic of molecular cloud turbulence

11. Zeeman observations --increased number of measurements, improved analysis accounts for upper limits: median B(n) flat at low n, $\sim n^{1/2}$ at high n (constant Alfvén speed).

Issues and Questions

Cloud physics - we can now do a much better job in measuring and understanding $\Delta v(r)$ and $N(r)$ from cloud to cloud, core to core, within a cloud and within a core

Cloud structure - “filaments” are an important large-scale component of star-forming clouds - how do we identify and quantify their properties, understand their formation, stability, fragmentation, energy flow?

Where does turbulent energy go when it dissipates? Can one find “shear filaments” systematically in cloud maps?

What accounts for the range of core masses? Do more massive cores have greater Δv? Are some massive cores just poorly resolved groups of cores?

How do core properties depend on definition - and on "background", sensitivity, and resolution?

What is the relative importance of "distributed" and "clustered" star formation? Did distributed YSOs form where we see them, or did they travel significantly from their birthplaces?

Are WTTs the evolutionary product of CTTs, or do they follow a different path?

How long does star formation take in a cluster, does it come in one coeval burst, increase gradually, or in multiple bursts?

How Surveys Can Help

Consistent quantitative definitions are needed to avoid confusion...

Spatial distribution of gas: complex, cloud, clump, core, inter-core gas (“background”)

Spatial distribution of stars: association, cluster, group, “distributed” stars

Definitions “robust” against sensitivity & resolution where possible

YSO classification & stages - try to use all spectral information, eg SED not just 2 bands. Sometimes a continuous variable is less confusing than many discrete "classes."

Number distributions of physically useful properties--

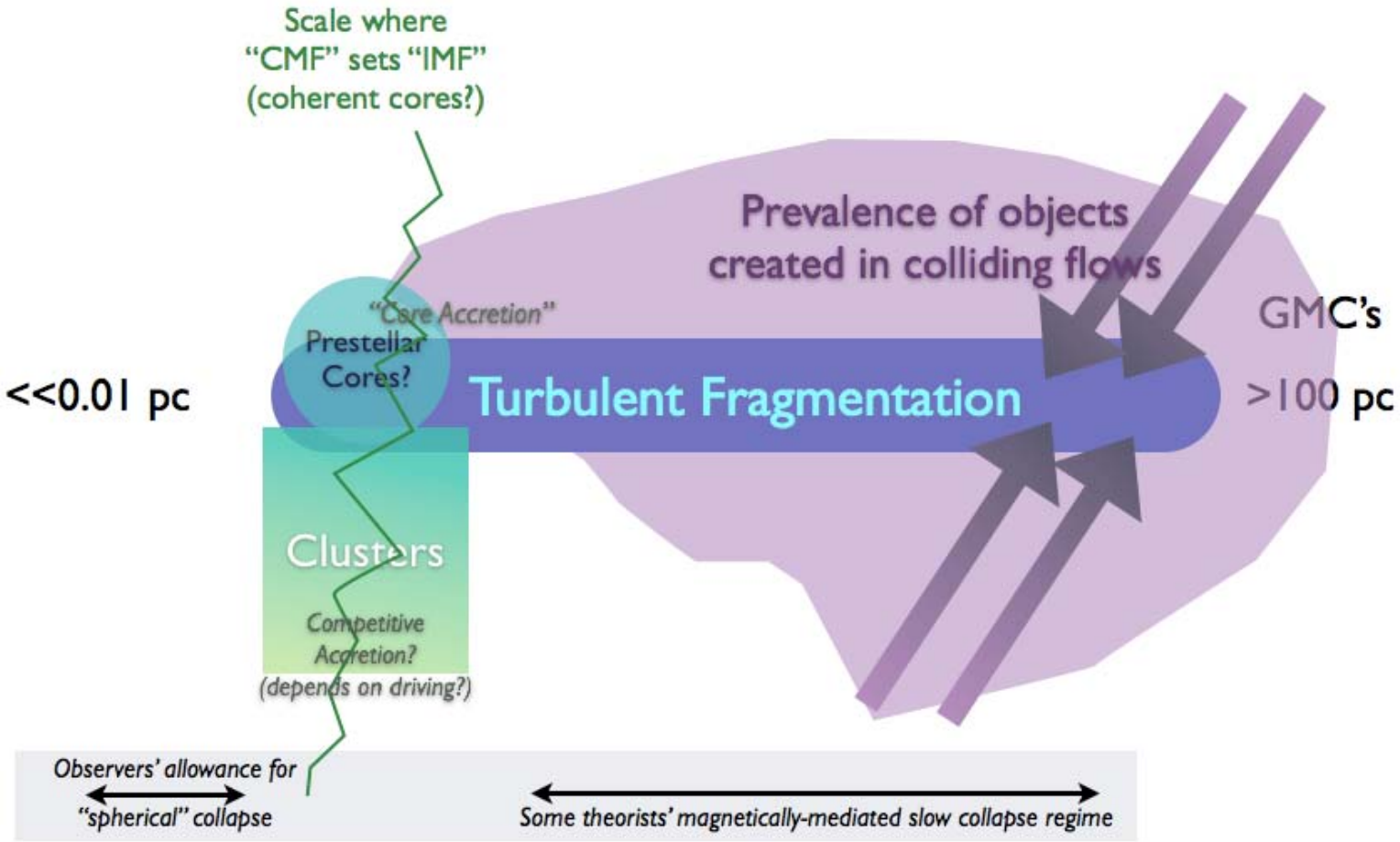
column density, mass, Δv, ∇v, L, T_{bol}, (B_z)

from cloud to cloud, core to core, within and between clusters ("basic data paper" mode). Identify means, medians and extremes, remarkable objects.

Correlations between pairs of properties

publish and put on Wiki, with caveats useful to simulators!

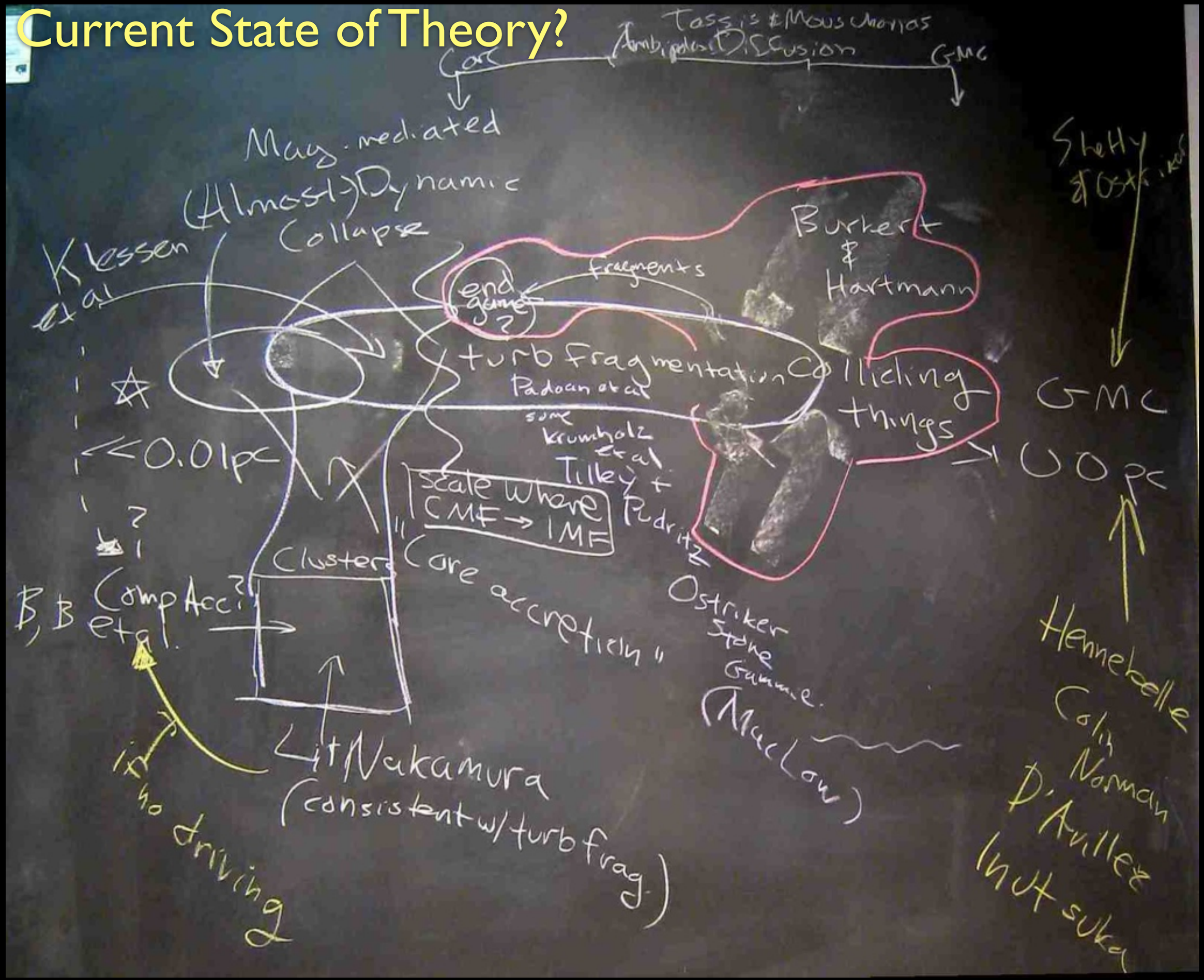
"(Getting to) Star Formation"



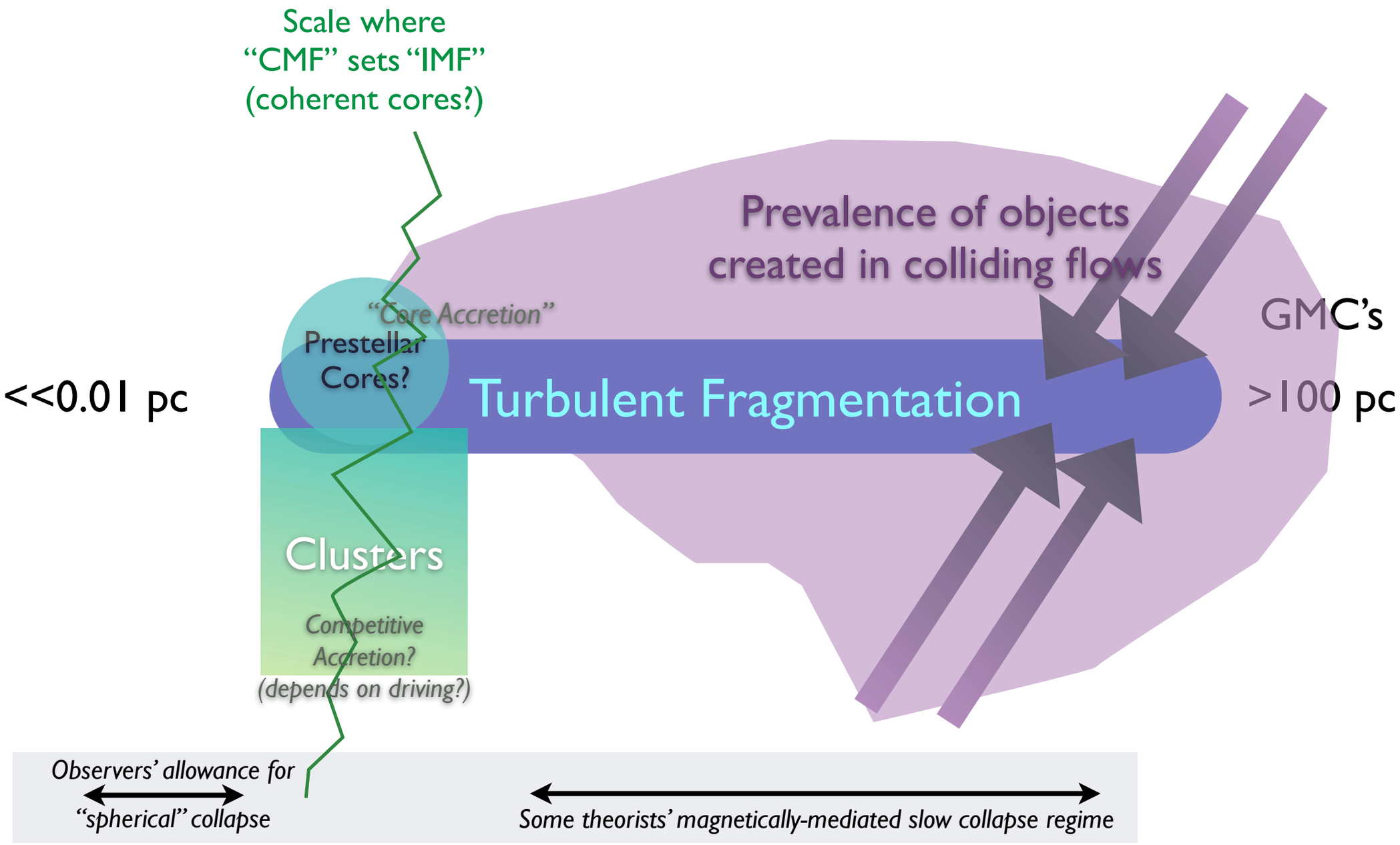
Slides (including blackboard photos) from Concluding Discussion of KITP Star Formation Surveys Week (November 5-9, 2007)

Uploaded by Alyssa Goodman
November 9, 2007

Current State of Theory?



Summarizing Theory? Can it be done?!



GOALS & Issues Raised in Phil Myers' Discussion

GOALS

④ More/better stellar "age" surveys (& vel. surveys for ★'s)

① N(r) connecting core to "Background" (same for, v, ΔV, T, B)

② Filaments
Identification, Quantif.
Origin/Fate

③ DEFINITIONS e.g.
Identification of Resolved cores
what is $\Delta V(M_{core})$?

① SFE/SFR

② ~~Bonnor-Ebert?~~
T(r)? contrast too high? Collapsing?

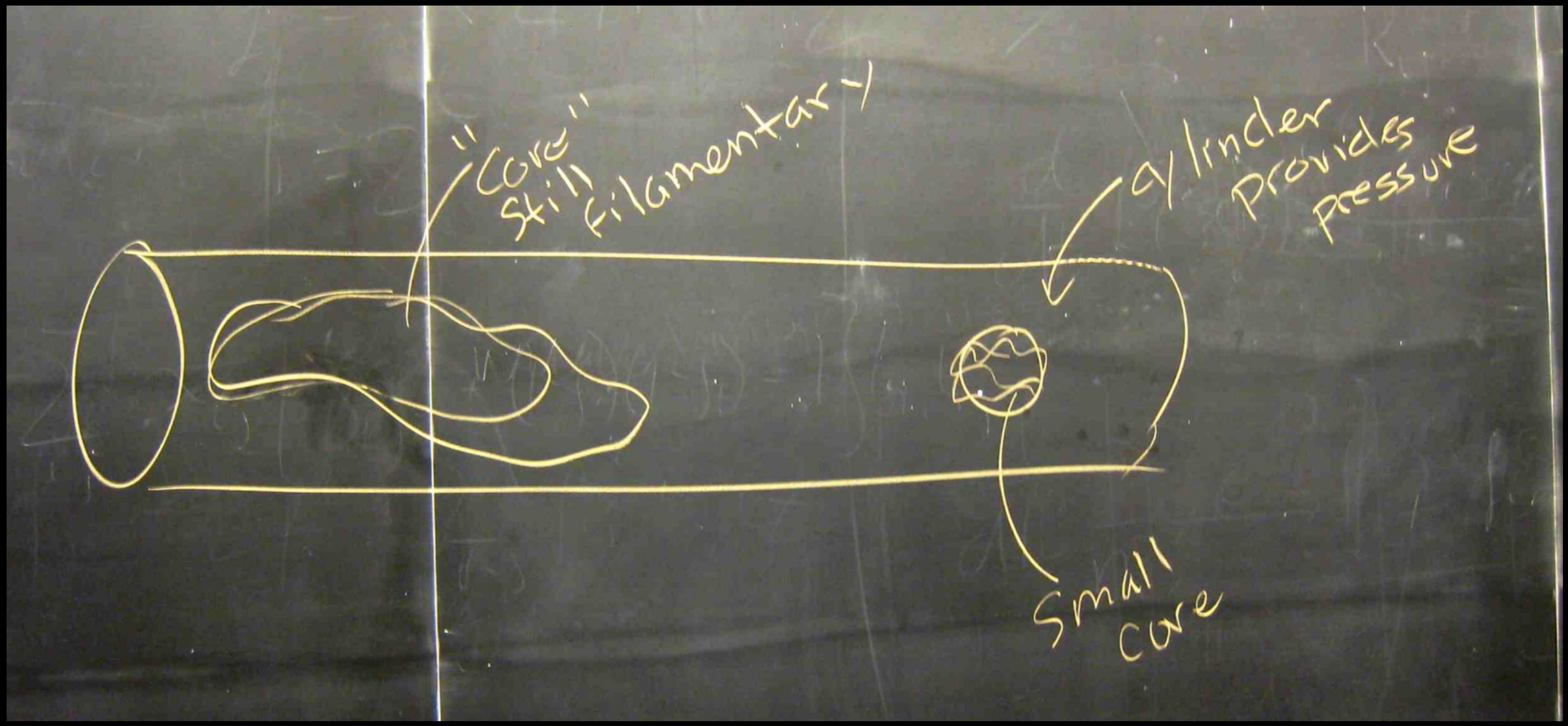
③ Distbt'd. Cluster Popn.
Did gas disperse?
Stars move?
Both?

④ B-n relation

→ Massive ★ Reg's
Feedback/Interaxns

→ Disk Evolution, $\vec{\omega}$

What is core structure inside filaments?



Paolo's Filaments & a List that Needs Definition(s)