The Dynamical Legacy of Star Formation

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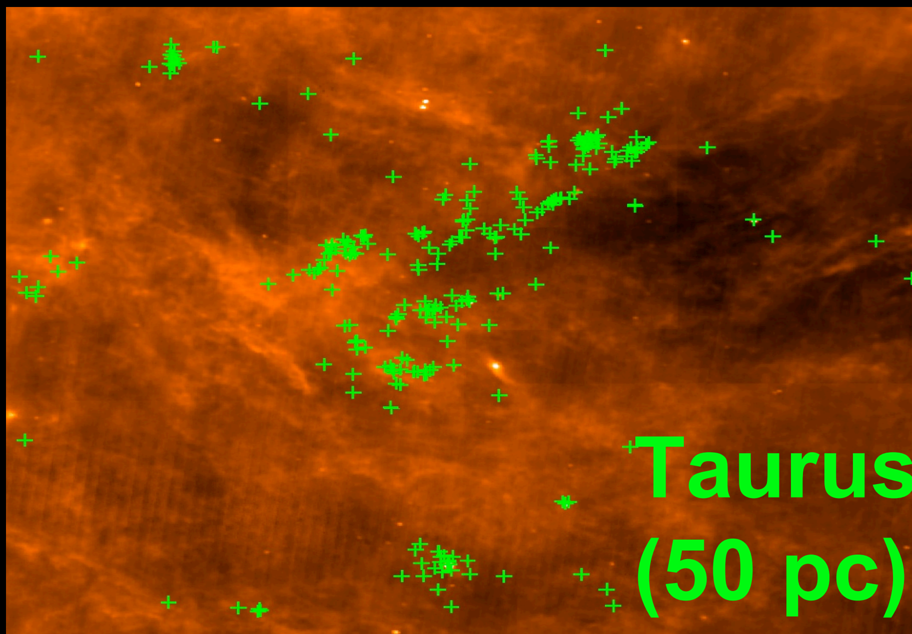
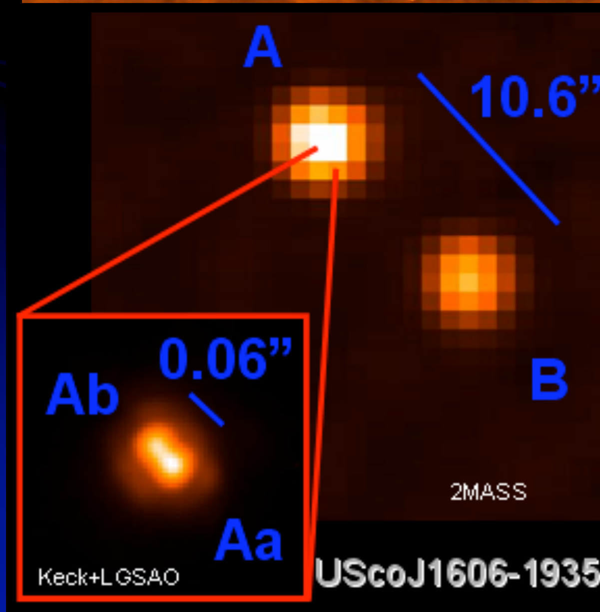
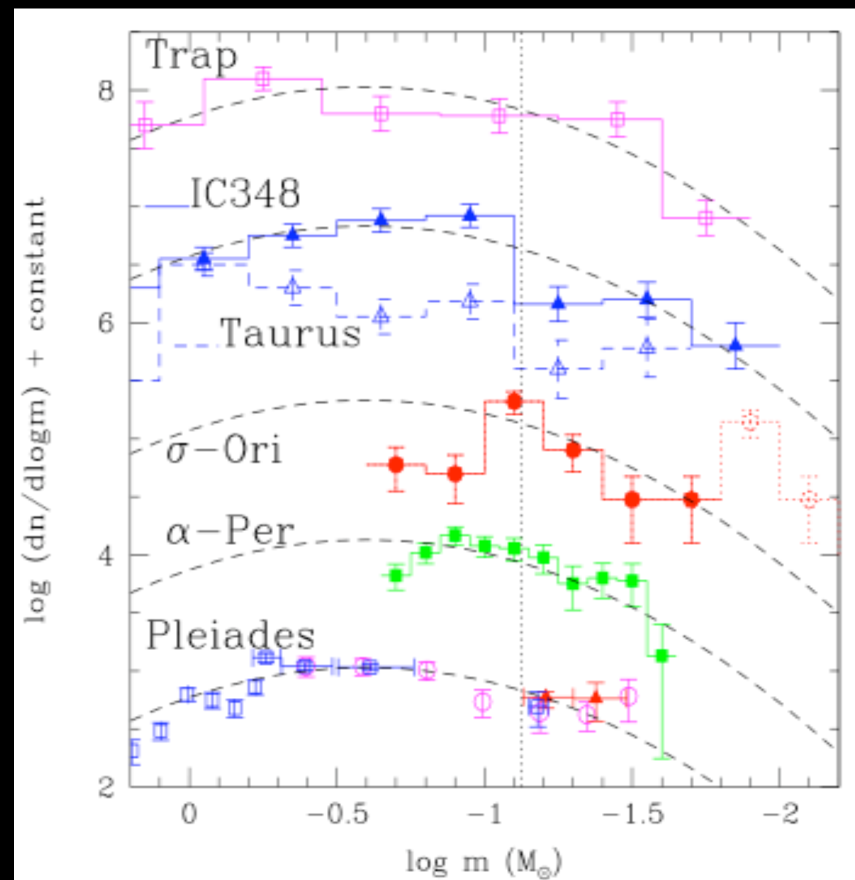
Signatures of Star Formation



Present-day structure in star-forming associations
(Kraus & Hillenbrand 2008)

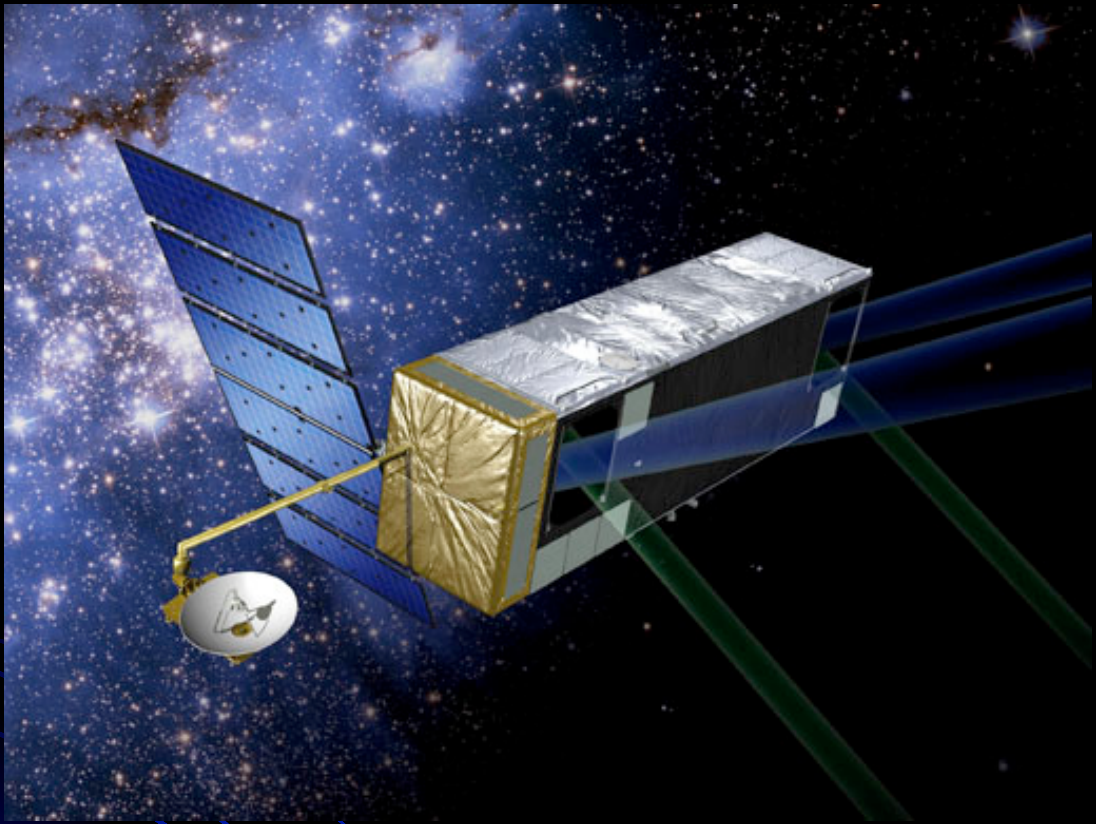


Multiple Star Formation
(Kraus & Hillenbrand 2007)



Initial Mass Function
(Chabrier 2005)

SIM and Star Formation



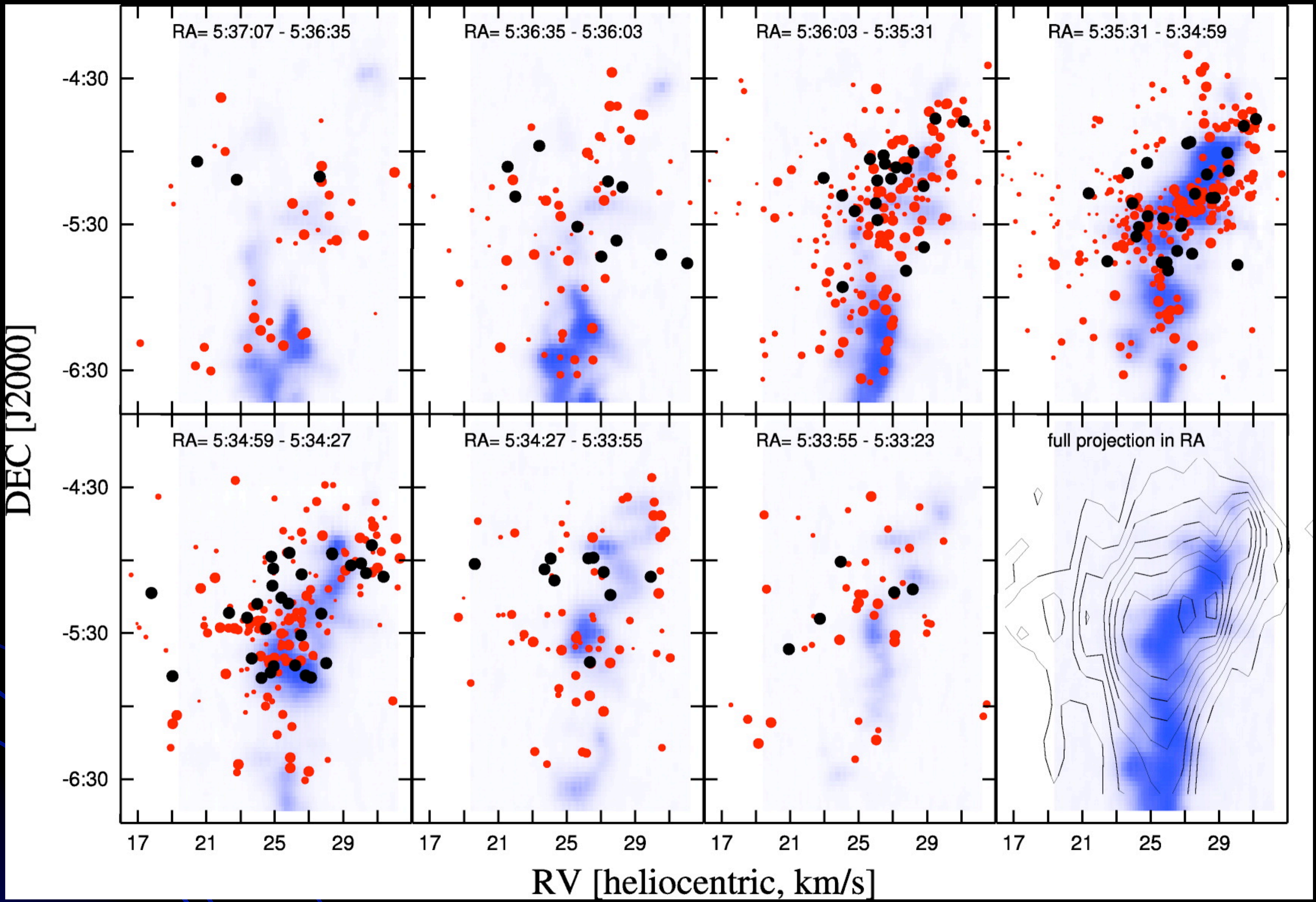
To fully reconstruct the history and primordial state of a star-forming region, we need to analyze the kinematics.

The expected velocity dispersions (<1 km/s) are hard to measure with RVs and almost impossible to measure with ground-based astrometry. However, SIM's accuracy will allow for measurements as precise as 10 m/s!

Study Plan: Three questions

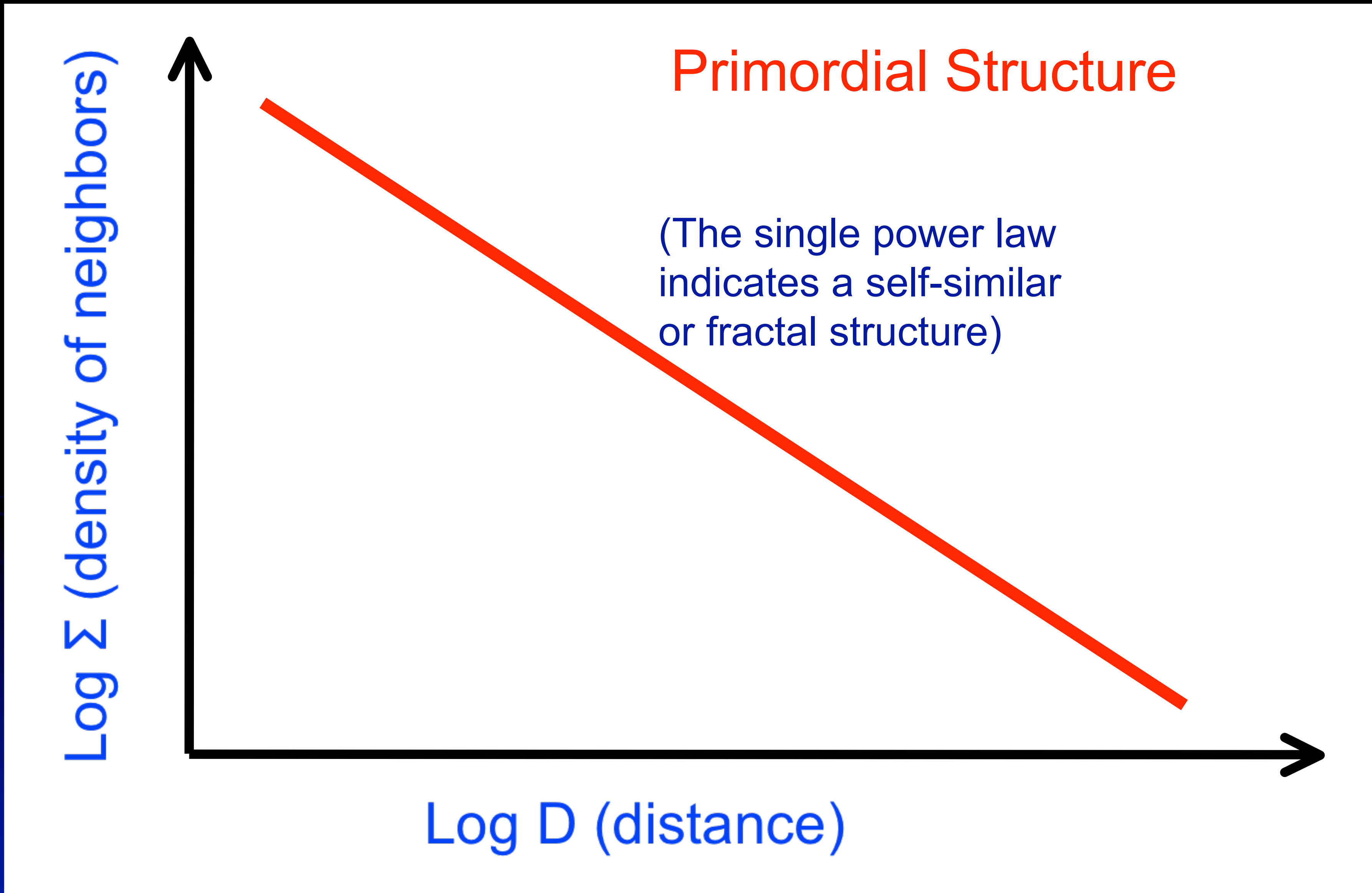
1) What are we really trying to measure?
2) What are the main sources of systematic error, and how can we avoid them?
3) What is SIM's unique contribution to this field?

Radial Velocities

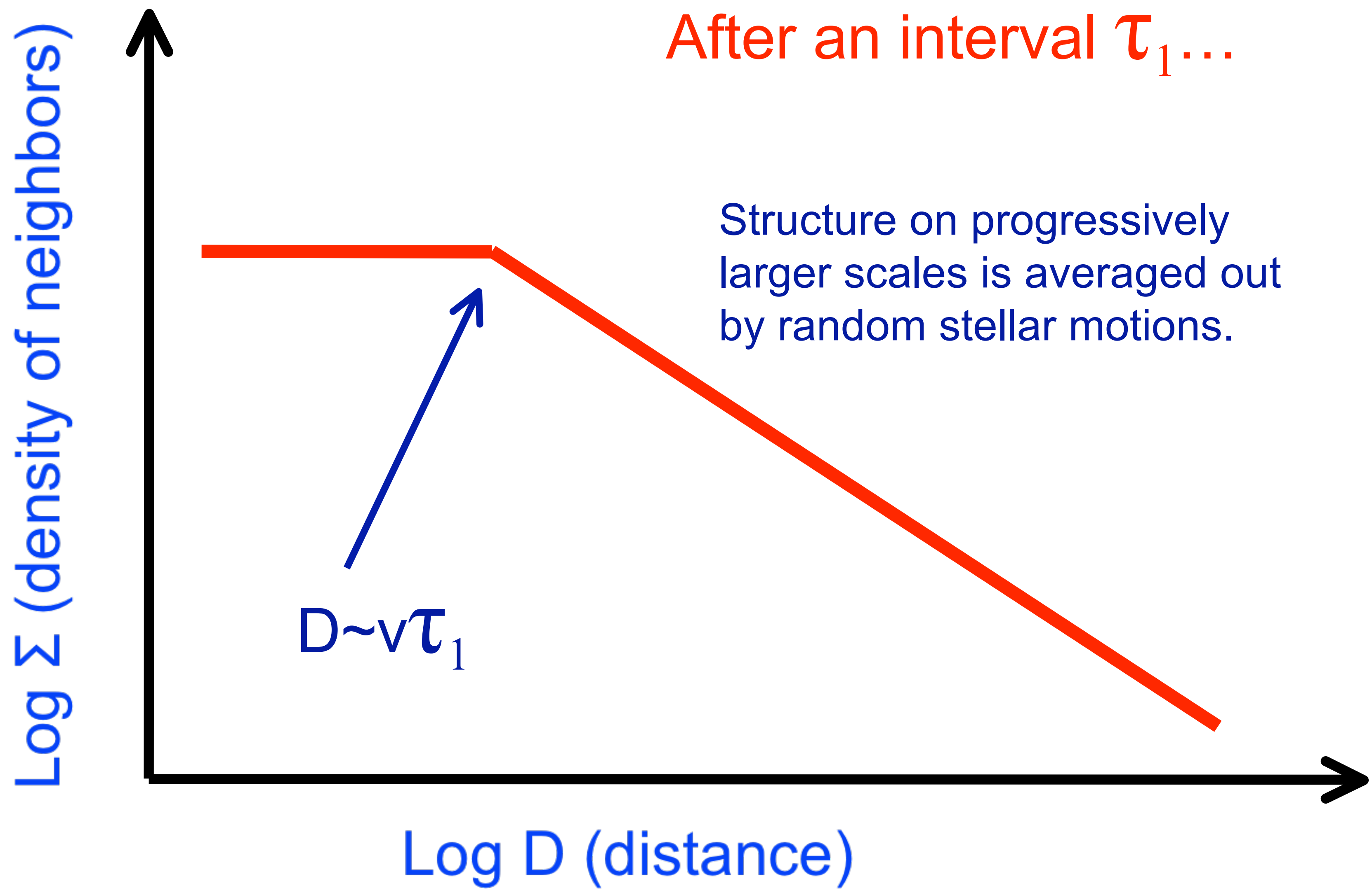


Furesz et al. 2008: RVs for ONC stars (filled circles) plotted over corresponding values for gas. Structure can be seen on scales of ~3 km/s, but any potential small-scale structure is limited by the instrument precision (~1 km/s).

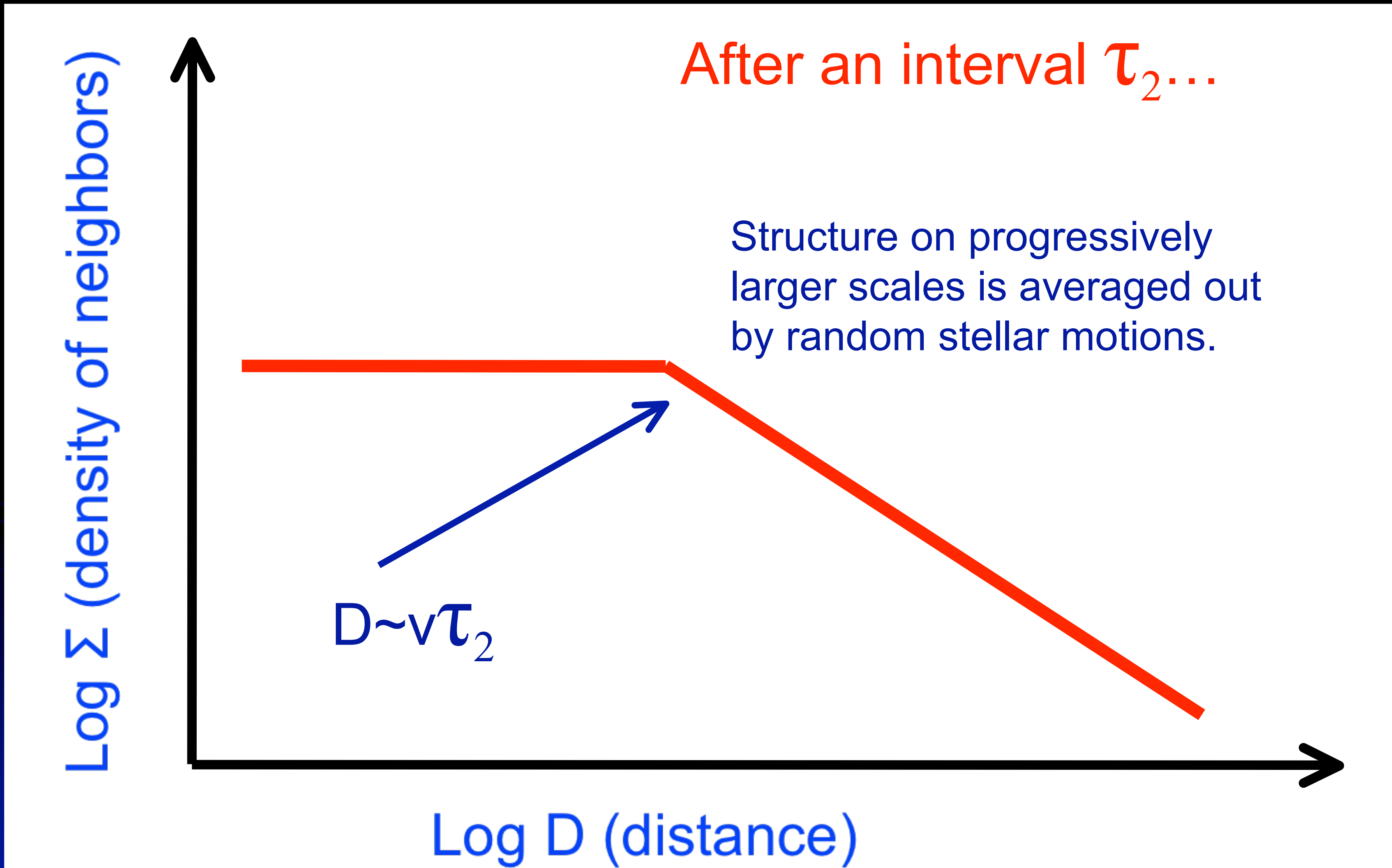
Signatures of Dynamical Evolution



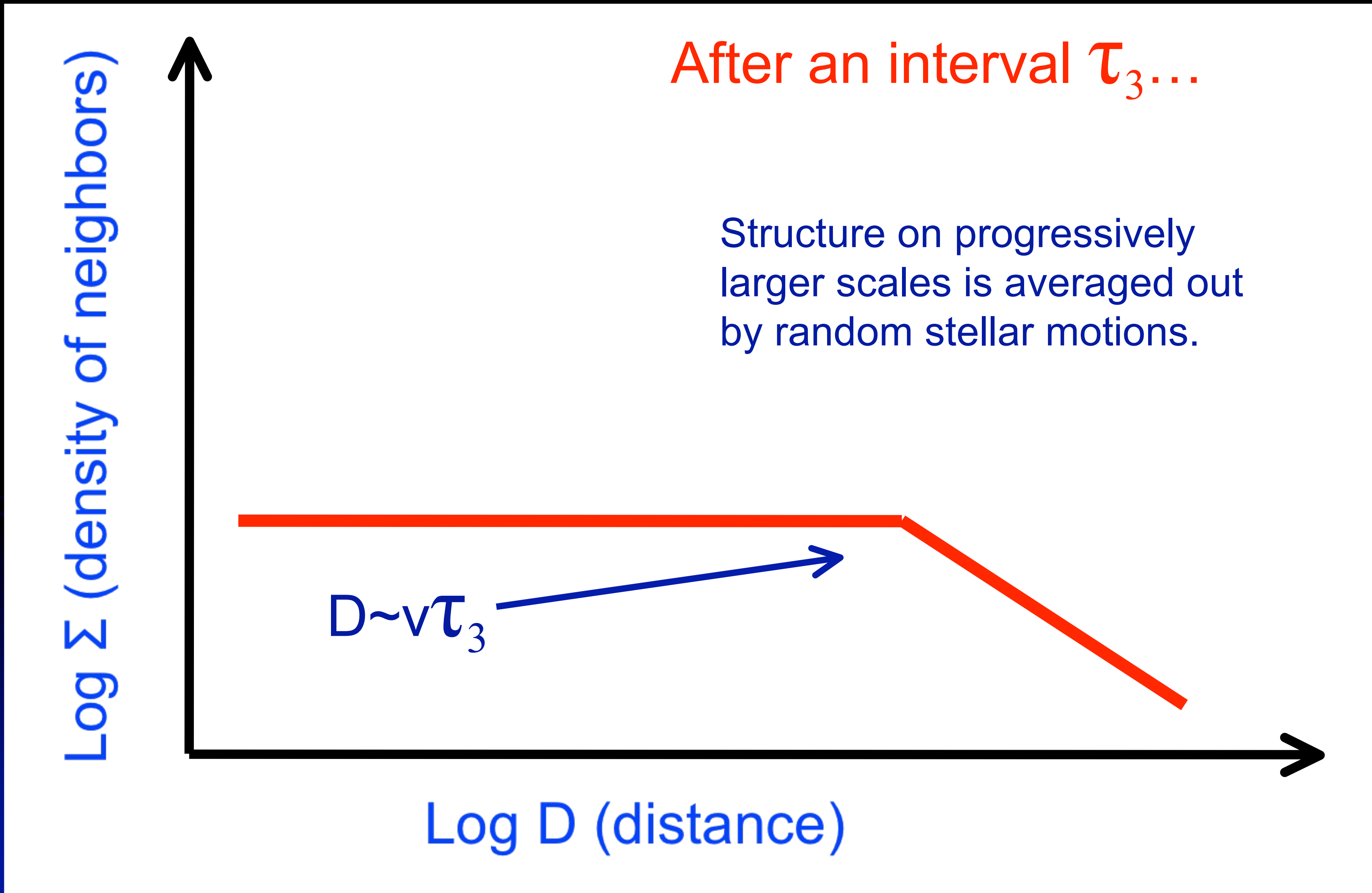
Signatures of Dynamical Evolution

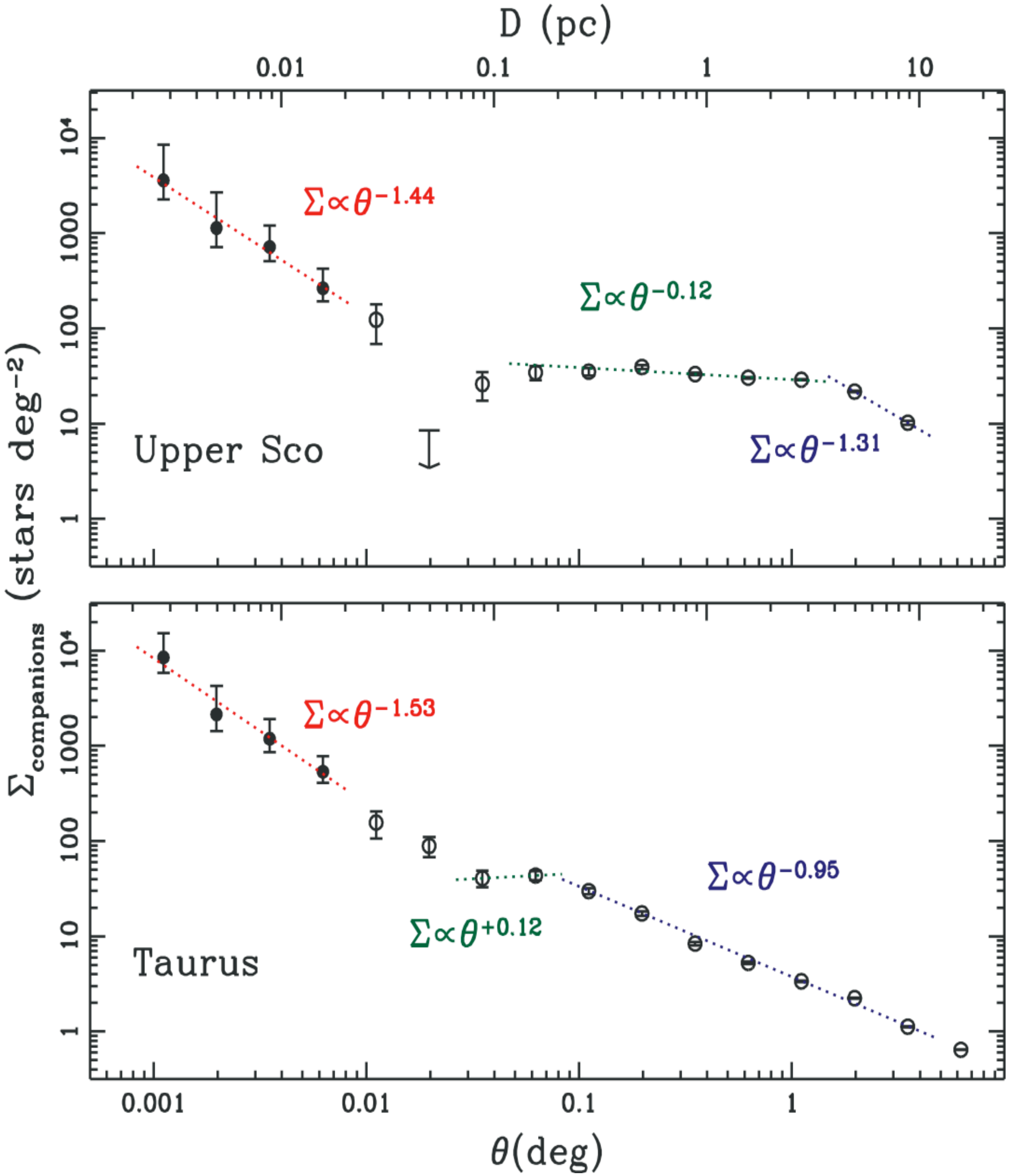


Signatures of Dynamical Evolution



Signatures of Dynamical Evolution





Preliminary Results

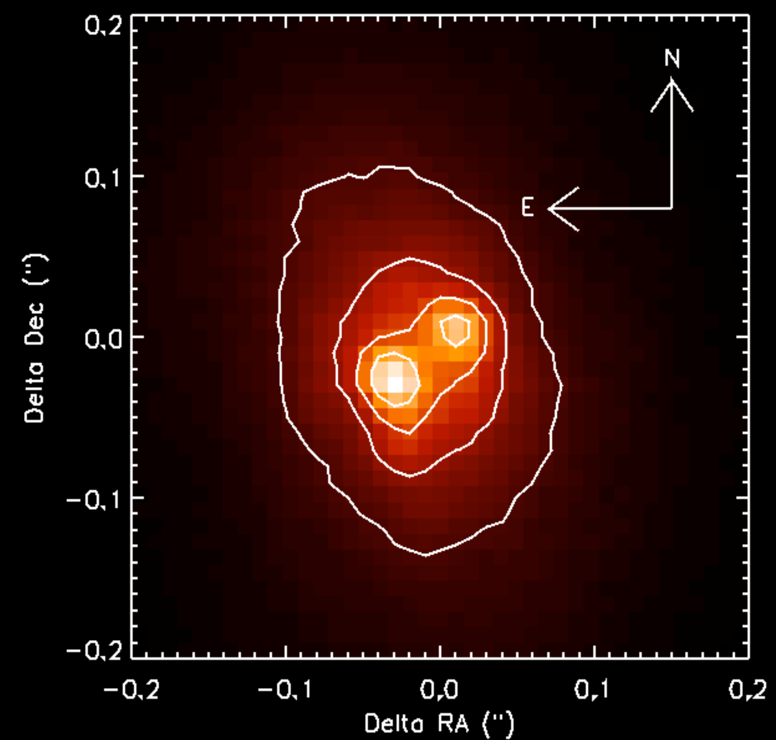
We've already applied this technique for two young associations with well-studied populations, Taurus (1-2 Myr) and Upper Scorpius (5 Myr).

Inferred velocities are ~1.2 km/s in Upper Sco and a mere 200 m/s in Taurus!

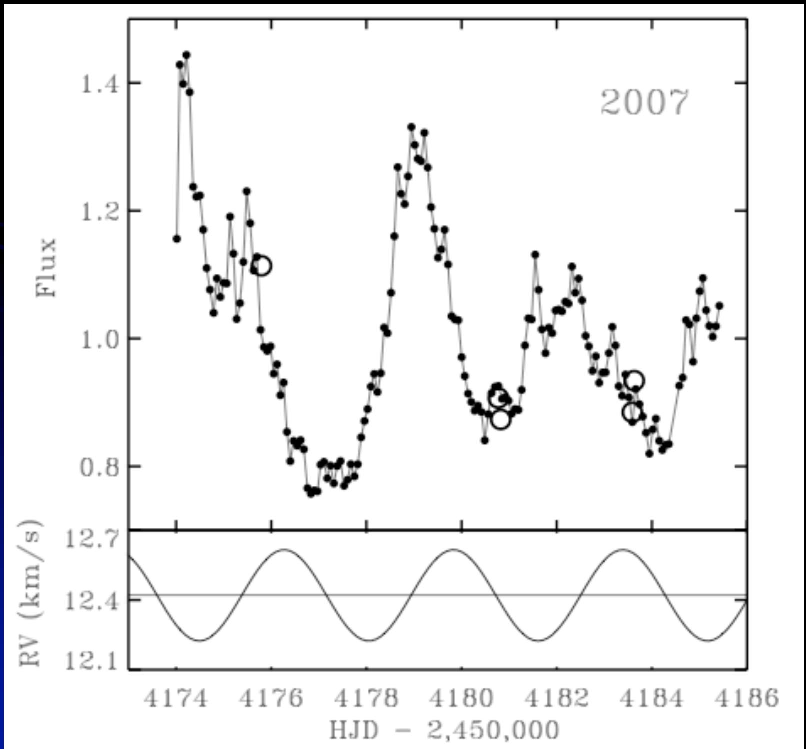
(Kraus & Hillenbrand 2008, arXiv:0809.0893)

Potential Sources of Systematic Error

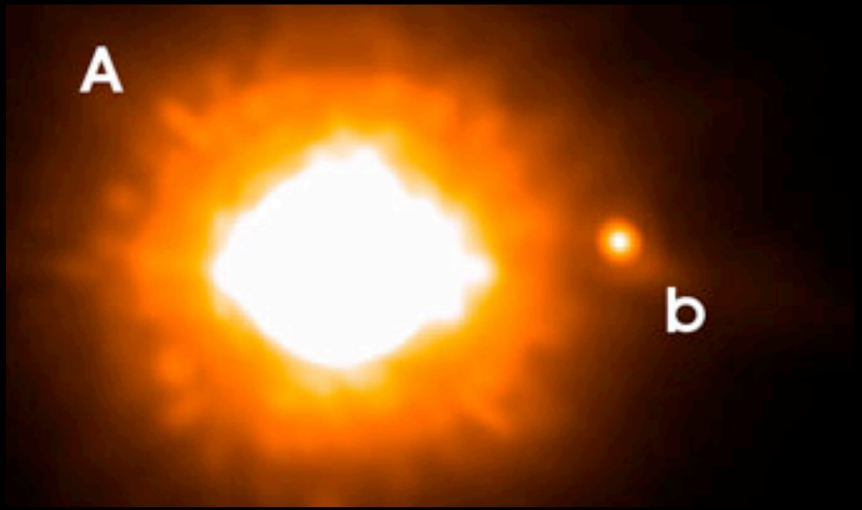
Astrometric jitter could be introduced by several astrophysical sources: variability of luminous binary companions, orbital motion due to unseen low-mass companions, and star spots. (See Tanner et al. 2007)



(Ireland & Kraus 2008)



(Rucinski et al. 2008)

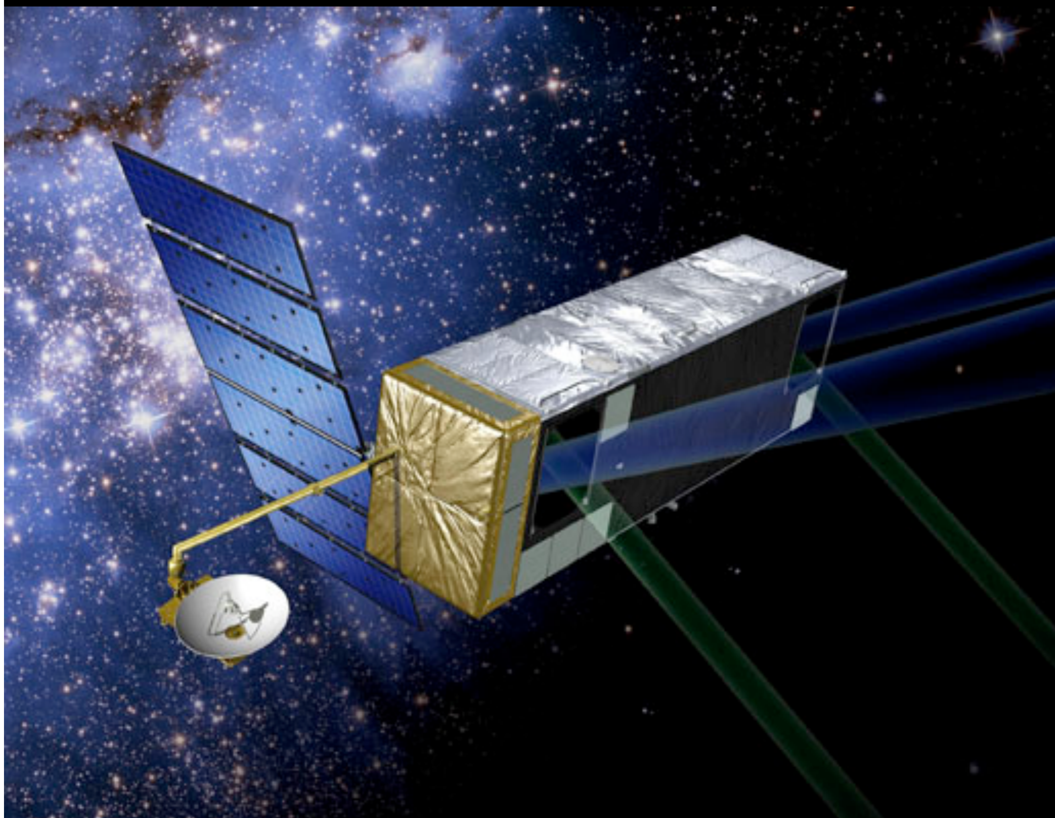


(Neuhauser et al. 2005)

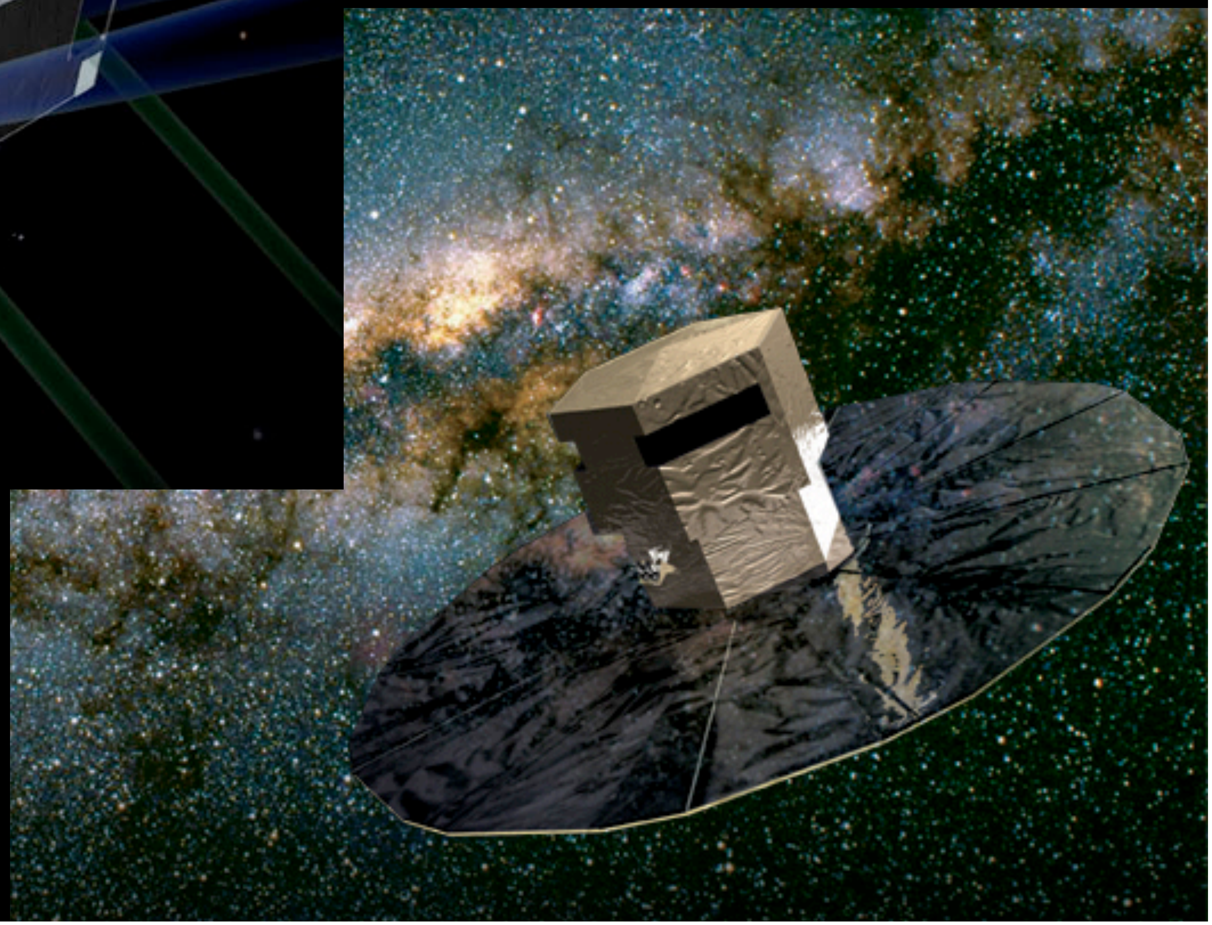
Other Systematic Effects

- Environment: Our study should span a range of environments: sparse aggregates (Taurus), OB associations (Sco-Cen), and clusters (ONC, IC348)
- Evolutionary stage – As a proxy for age, our study should include WTTSs, CTTS, and hopefully earlier-stage protostars
- Mass – Is early mass segregation primordial or dynamical? Is there direct evidence of brown dwarfs being ejected?

What is the role of SIM?



SIM's niche includes objects which are optically faint (brown dwarfs and embedded protostars) or too distant for GAIA's more modest precision (high-mass clusters).



For bright, nearby stars, GAIA should deliver the necessary precision in the course of its survey.

Summary

- Goal #1: Define the problem by inferring the velocity dispersions that we need to measure (in progress; see Kraus & Hillenbrand 2008)
- Goal #2: Identify a sample of young stars that spans a range of mass, environment, and evolutionary stage, then use existing data to screen unsuitable targets
- Goal #3: Determine the complementary roles of SIM and GAIA