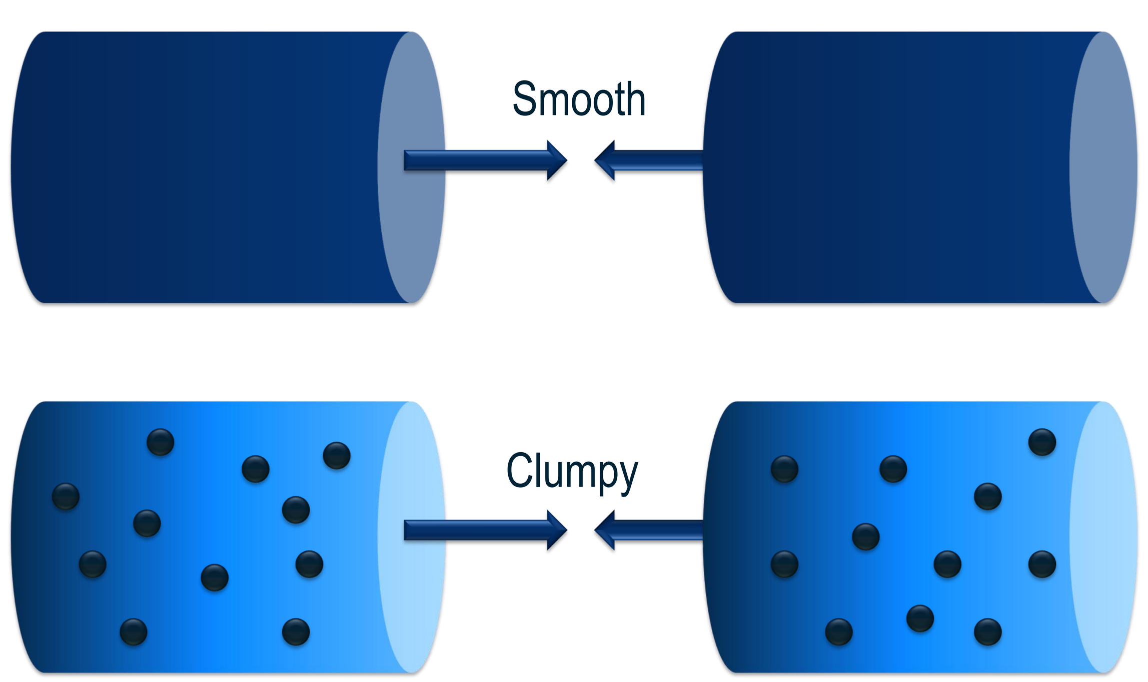
The Effects of Inhomogeneities within Colliding Flows on the Formation and Evolution of Molecular Clouds

Jonathan Carroll-Nellenback[1], Adam Frank[1], Fabian Heitsch[2]

[1] University of Rochester, Rochester, NY

[2] Univesity of North Carolina Chapel Hill, Chapel Hill, NC

Physical Model

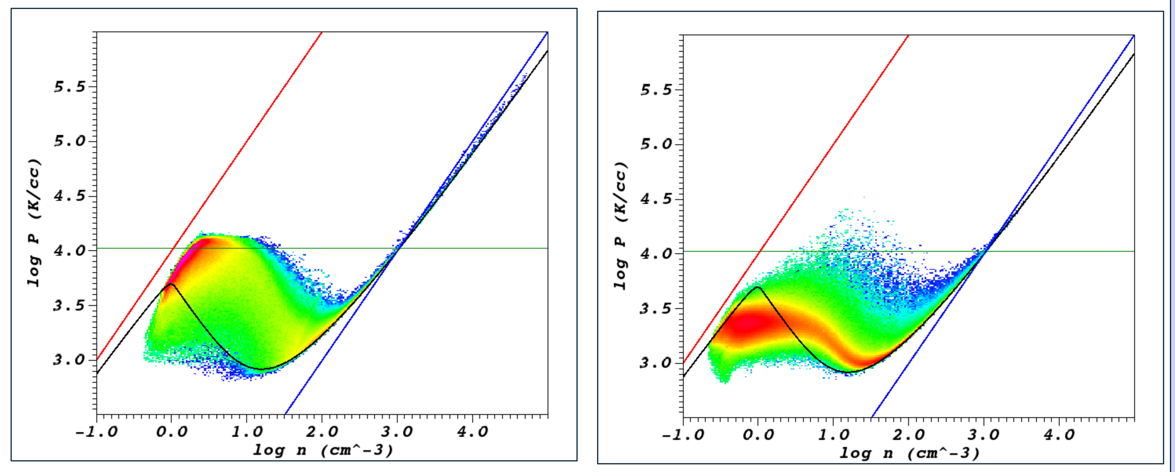


Parameters

Density	1/cc	.25/cc
Clump Density	----	15/cc
Pressure	4951 K/cc	1714 K/cc
Flow Diameter	40 pc	
Velocity	8.25 km/s	
Mass Flux	665 $M_{\odot}$/Myr	
Ram Pressure	10,472 K/cc	

Thermodynamics

Smooth **Clumpy**



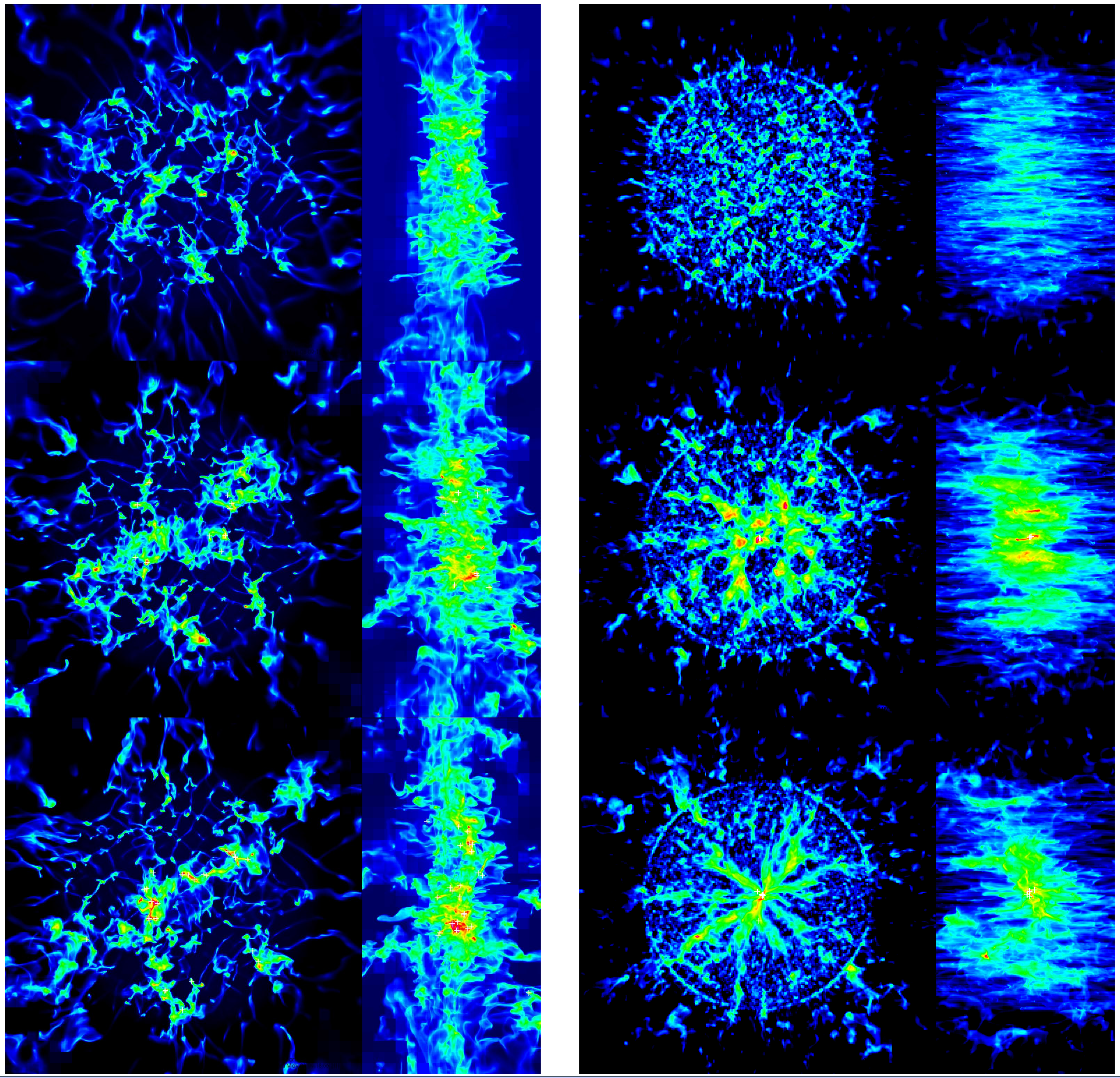
Numerical Model

Simulations were performed using the Adaptive Mesh Refinement (AMR) code AstroBEAR. The base resolution was 64^3 with 5 levels of AMR for a total resolution of 2048^3. The simulation included the effects of self-gravity as well as various heating and cooling processes appropriate for the interstellar medium. The simulations took 500,000 CPU hours to complete.

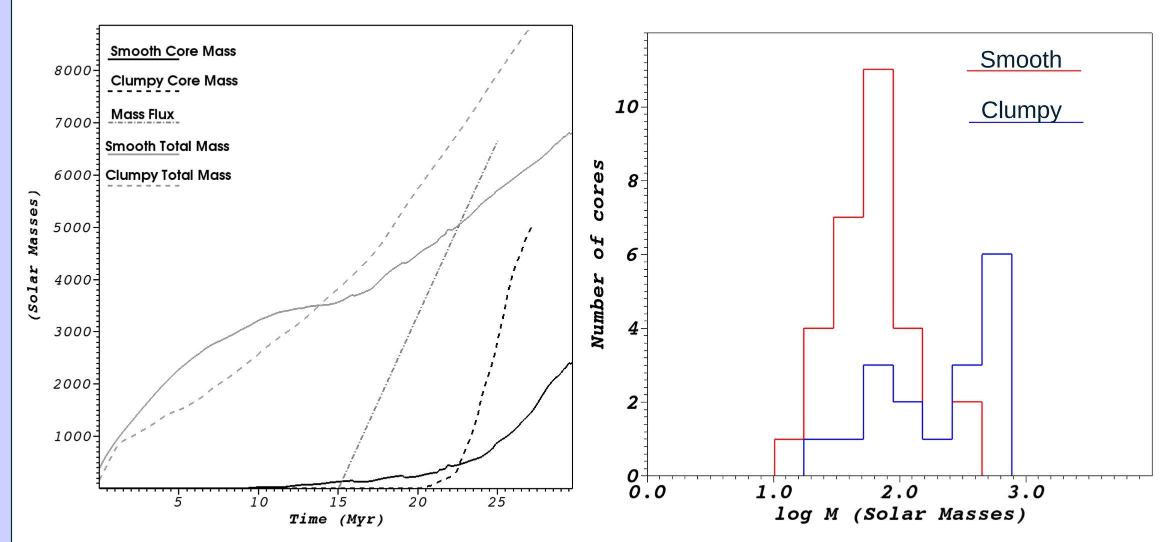
Abstract

Observational evidence from local star-forming regions mandates that star formation occurs shortly after, or even during, molecular cloud formation. Models of the formation of molecular clouds in large-scale converging flows have identified the physical mechanisms driving the necessary rapid fragmentation. They also point to global gravitational collapse driving supersonic turbulence in molecular clouds. Previous cloud formation models have focused on turbulence generation, gravitational collapse, magnetic fields, and feedback. Here, we explore the effect of structure in the flow on the resulting clouds and the ensuing gravitational collapse. We compare two extreme cases, one with a collision between two smooth streams, and one with streams containing small clumps. We find that structured converging flows lead to a delay of local gravitational collapse (“star formation”). Thus, more gas has time to accumulate, eventually leading to a strong global collapse, and thus to a high star formation rate. Uniform converging flows fragment hydrodynamically early on, leading to the rapid onset of local gravitational collapse and an overall low sink formation rate.

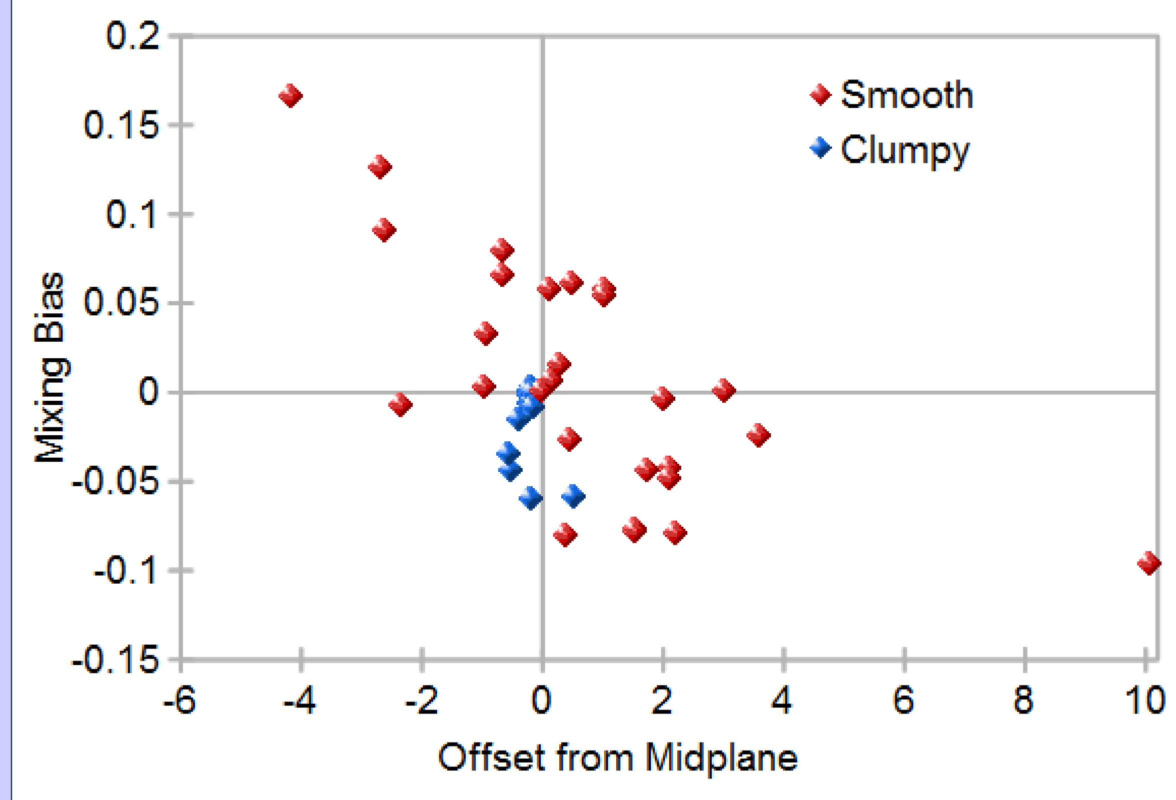
Numerical Simulations



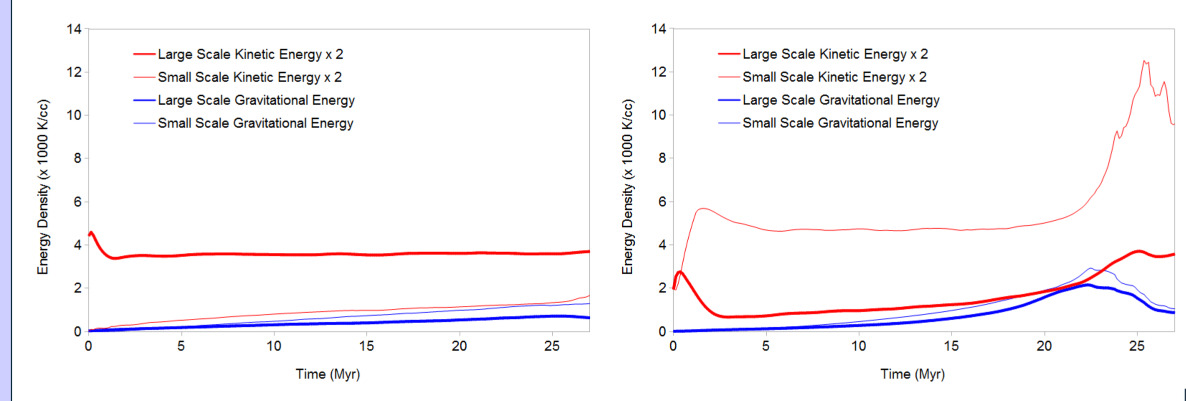
Core Mass Growth and Distribution



Mixing



Energy Evolution



Conclusions

- ➢Large scale (though small) perturbations in the initial interface can, via the NTSI, direct significant material into valleys and nodes that undergo local collapse.
- ➢Inhomogeneities in the streams can produce small scale turbulence capable of suppressing local star formation though not global collapse.
- ➢The evolution of molecular clouds formed via colliding flows can vary dramatically depending on initial conditions.