Constraining Structure in the Low Density Universe
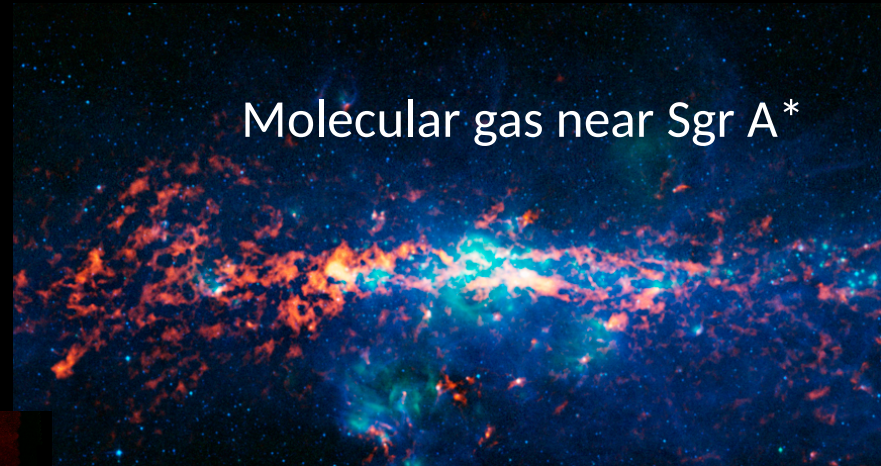
ISM Filament

Molecular gas near Sgr A*

Dust in LMC

Accreting Streams

Goal: Build consensus on quantitative measures of structure

The power spectrum isn't everything

Same Power Spectrum
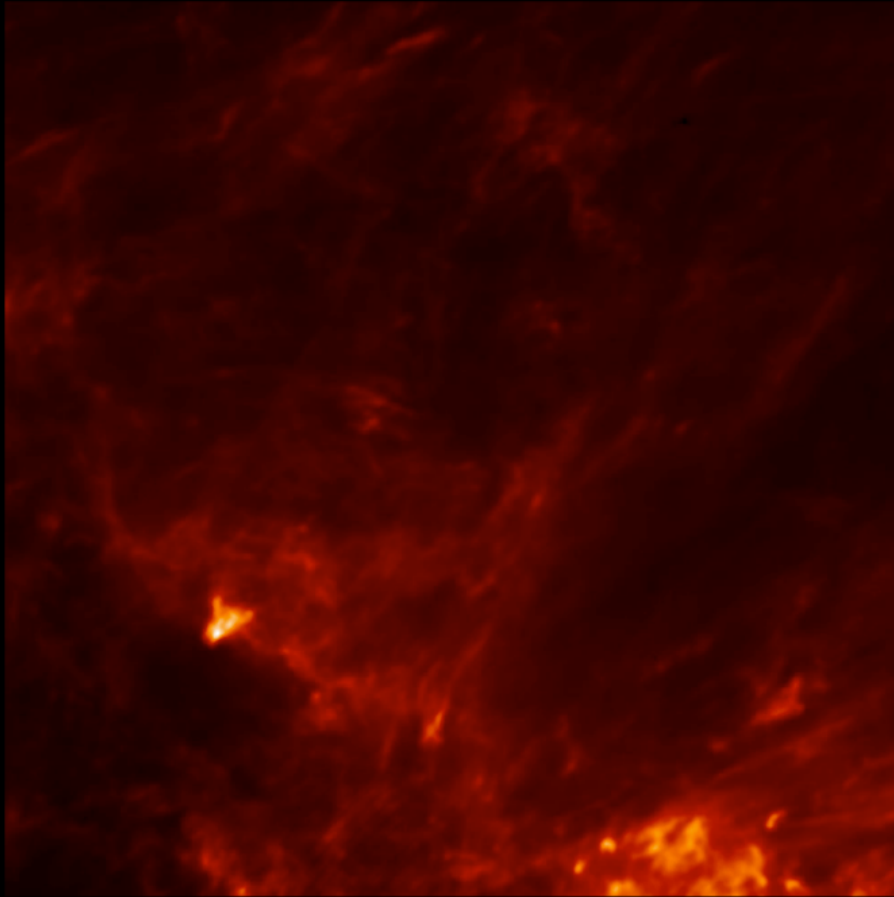
Original   **Phase Scrambled**

Peek (priv. comm., 2018)

Generation of Realistic ISM Structures Needed for Modeling

Simple structure recipe: Use a filling factor and a density ratio
→ reproduces some measures of ISM structure
→ filling factor = 15%; dense/diffuse density ratio = 100

Cloud Mass Spectrum   Cloud Fractal Dimension

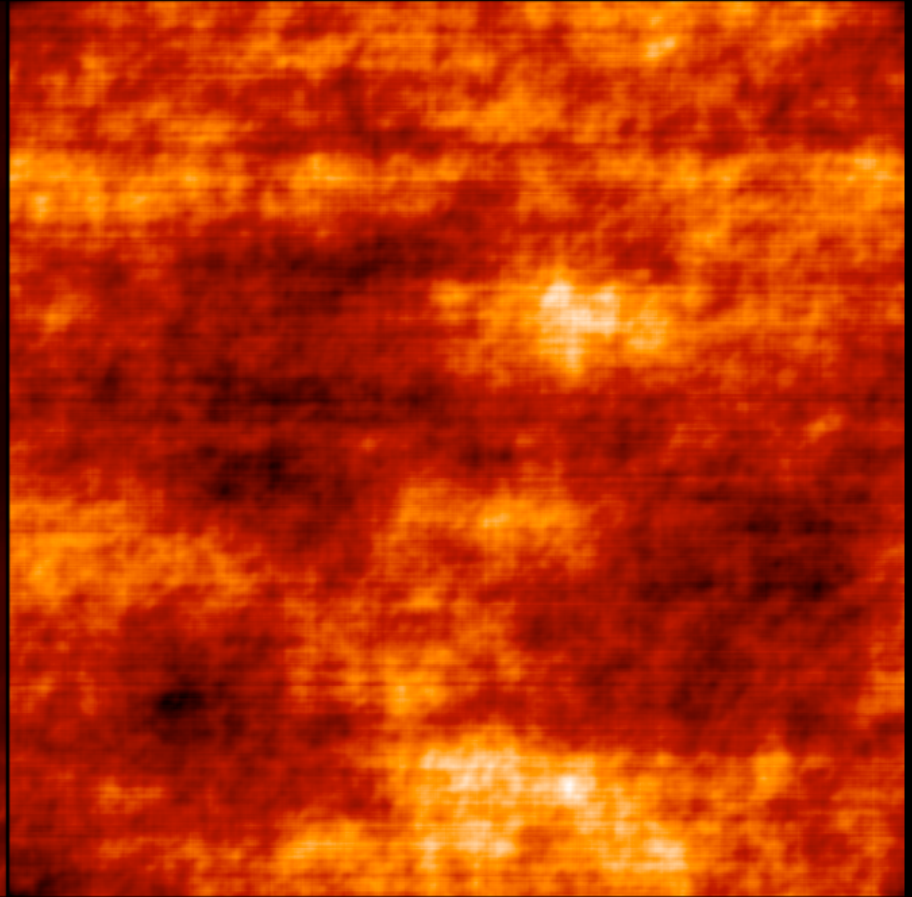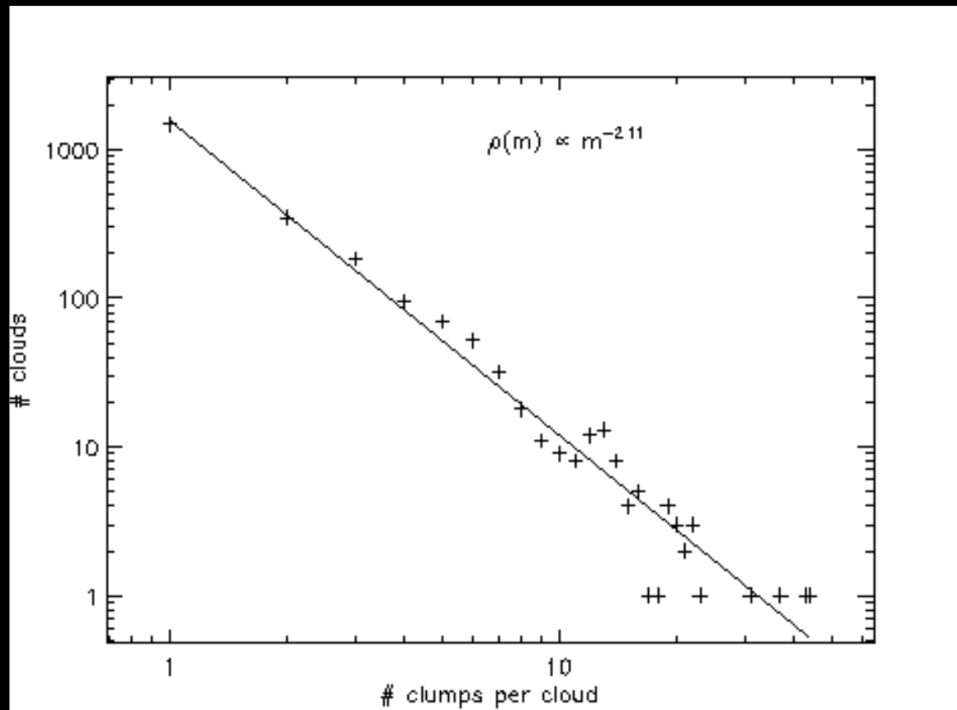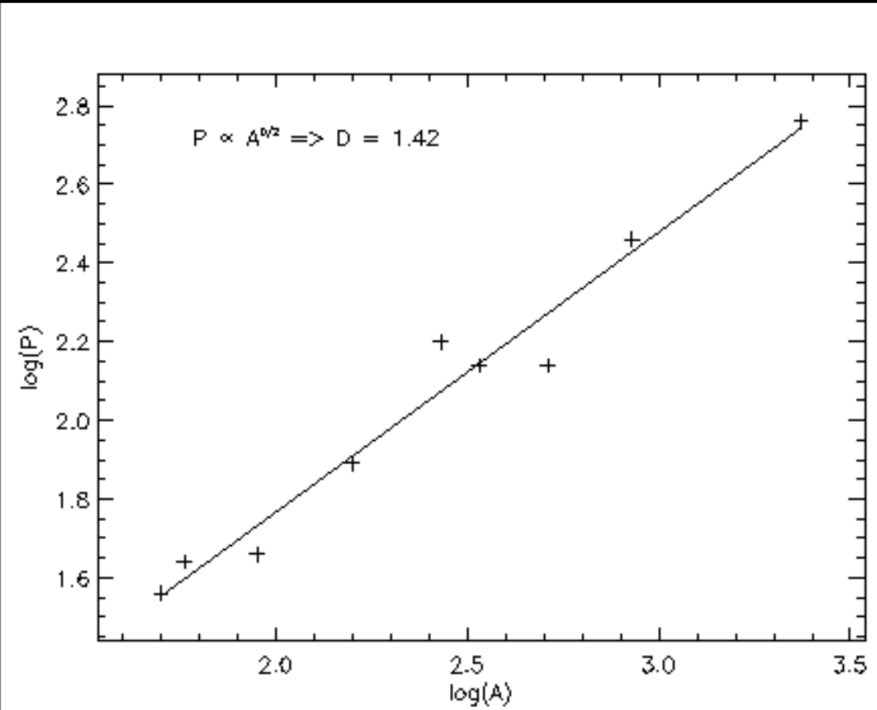Witt & Gordon (1996)

Constraining Structure in the Low Density Universe
Motivation

- Structure is found in the diffuse Universe over all scales, from clouds and sheets in the ISM, to accreting streams in CGM, and filaments in the IGM.
- The nature of this structure has implications for star formation, stellar feedback, the baryon cycle, escaping ionizing photons, and the reionization of the Universe.
- New ways to observe, quantify, and simulate this structure are emerging.

- Tools to measure physically relevant structure are incomplete

Constraining Structure in the Low Density Universe

Meeting Outline

- Day 1 am: **Overview** (intro to structure in the LDU),
- Day 1 pm: **Observational tracers of structure**: H I, metals, dust, molecules, magnetic fields
- Day 2 am: **Spatial/Kinematic/Phase Structure** in the LDU (theory & observations)
- Day 2 pm: half-day unconferencing/collaboration time
- Day 3 am**: Quantifying structure** (metrics & statistics)
- Day 3 pm: half day unconferencing/collaboration time
- Day 4 am: **Origin of structure**

Topics: Filaments, sheets, turbulence, kinematic & spatial structure, small-scale structure, impact of star formation, metal mixing, spiral structure, absorption vs emission, fractals
Not: star formation itself

Overall questions for speakers and unconference sessions to address:
Q) what is the importance of structure?
Q) how do we measure structure?

Constraining Structure in the Low Density Universe
Unconference/collaboration Goals

Generate ideas for quantifying structure in observations and models

Directly test those ideas during the meeting
- have example observation and model datasets available
- Observations
  - 2D measures (Spitzer/Herschel; dust mass maps)
  - 3D measures (HI cubes; Milky Way dust maps)
  - 4D, 5D, & 6D measures (combining velocity and position)
- Models
  - Hydro & MHD simulations
  - From individual cloud to the universe scales

Potential outcomes from the meeting
- Consensus on quantitative structure measures
- White paper?

Constraining Structure in the Low Density Universe

Candidates for Invited Speakers

Overview: Mary Putman, Naomi McClure-Griffiths, Jay Lockman,
   Snezana Stanimirovic, Andrew Wetzel, Filippo Fraternali
Metal mixing: Robin Shelton, Joop Schaye, Romeel Dave
Turbulence: Blakesley Burkhart, Stella Offner, Mark Heyer
Molecules: Clare Dobbs
Magnetic fields: Alex Hill, Gina Panopoulou
Filaments: Susan Clark
Dust structure: Eddie Schlafly, Gail Zasowski
Turbulence/instabilities: Marc-Antoine Miville-Deschenes
Global ISM structure: Alyssa Goodman

Constraining Structure in the Low Density Universe

Potential SOC Membership

Alessandra Aloisi, Andy Fox, Steve Goldman, Karl Gordon, Lea Hagen, Bethan James, Claire Murray, Josh Peek, Marc Rafelski, Julia Roman-Duval, Ravi Sankrit, Jason Tumlinson, Alberto Noriega-Crespo, & others that are interested

Co-Chairs: Karl Gordon, Ravi Sankrit

Constraining Structure in the Low Density Universe

Other Relevant Meetings

- "Olympian Symposium 2018: Gas and stars from milli to mega-parsecs", Greece, May 2018

- "Cosmic Dust: Origin, Application & Implications", Copenhagen, June 2018

- "Circumgalactic Medium Workshop", Evanston IL, July 2018 (CGM only)

- "Linking the Milky Way and Nearby Galaxies" Helsinki, June 2019 (more star formation)

None focusing on structure (at most, structure as a minor component)

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