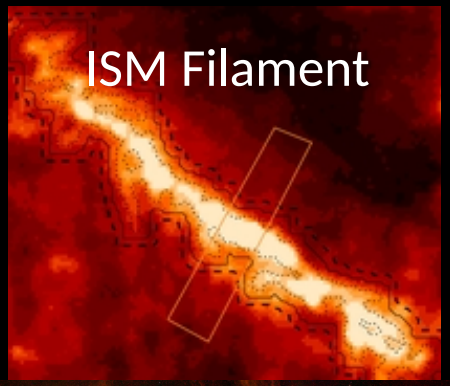
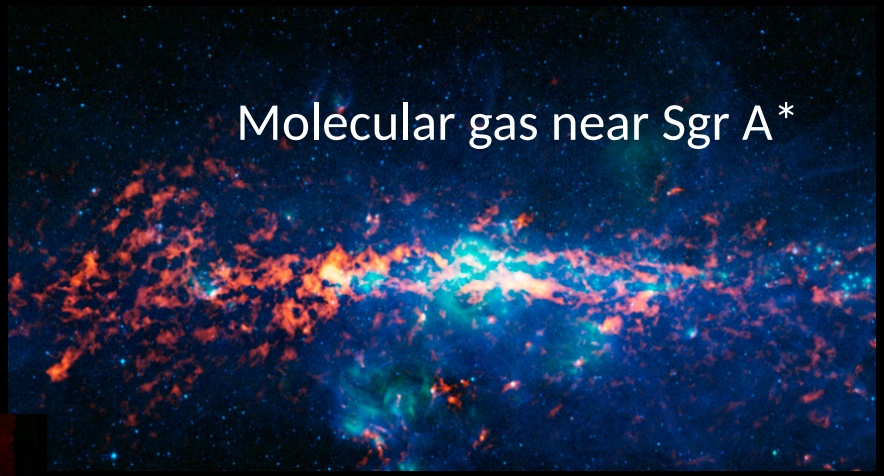
Constraining Structure in the Low Density Universe

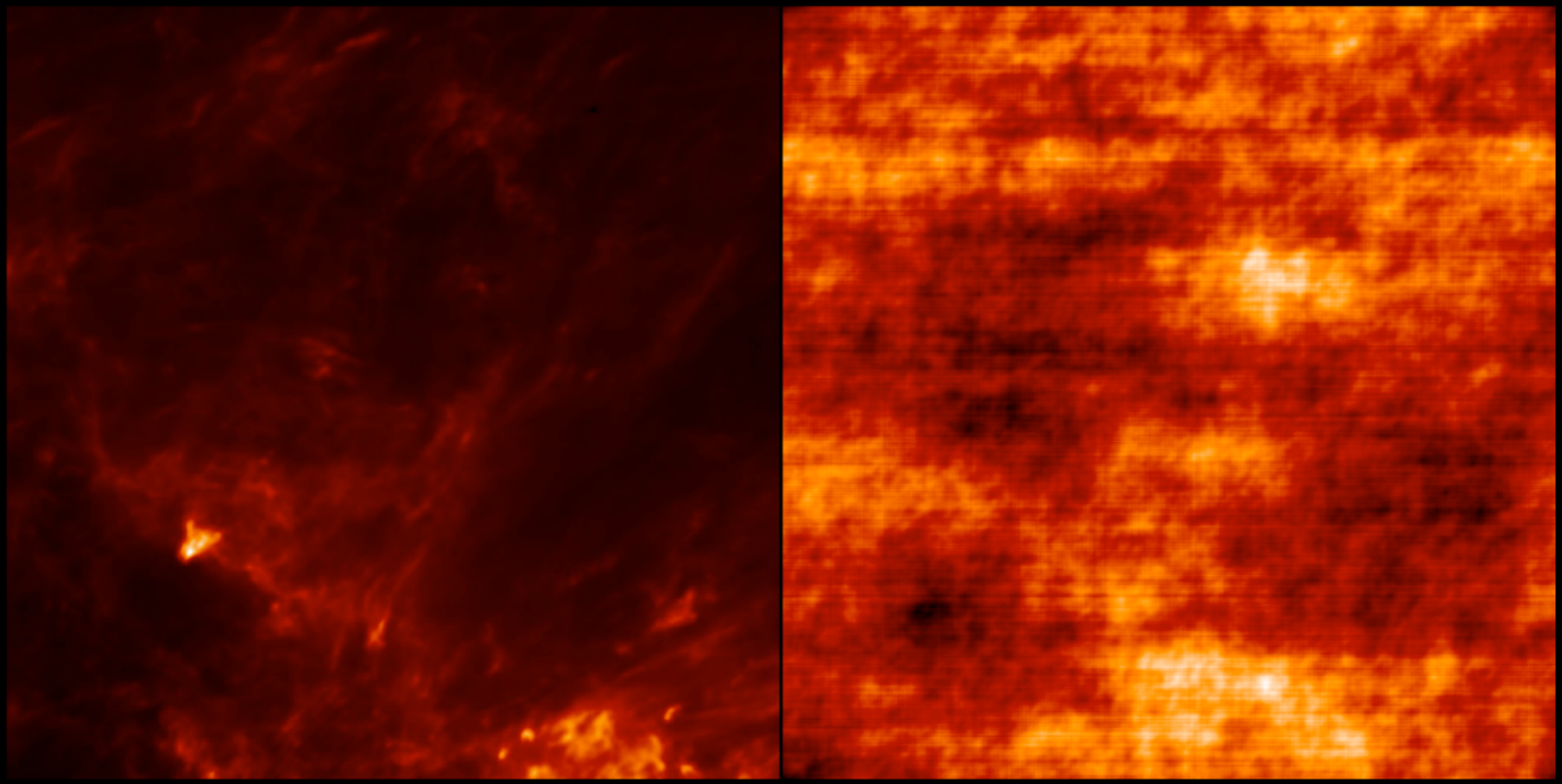




Goal: Build consensus on quantitative measures of structure

The power spectrum isn't everything

Same Power Spectrum



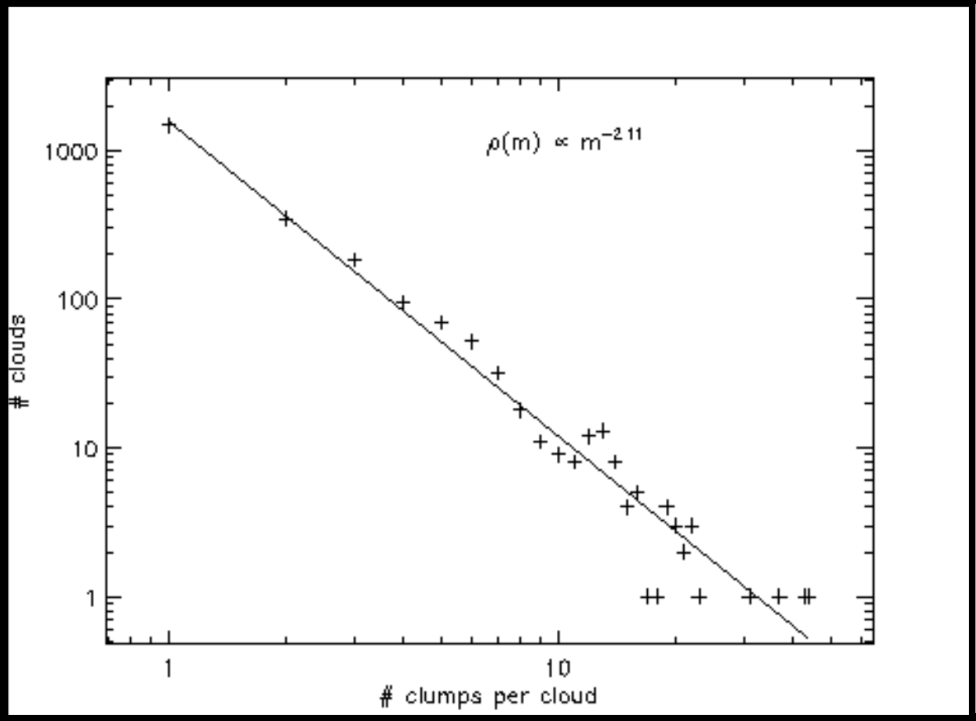
Original **Phase Scrambled**

Peek (priv. comm., 2018)

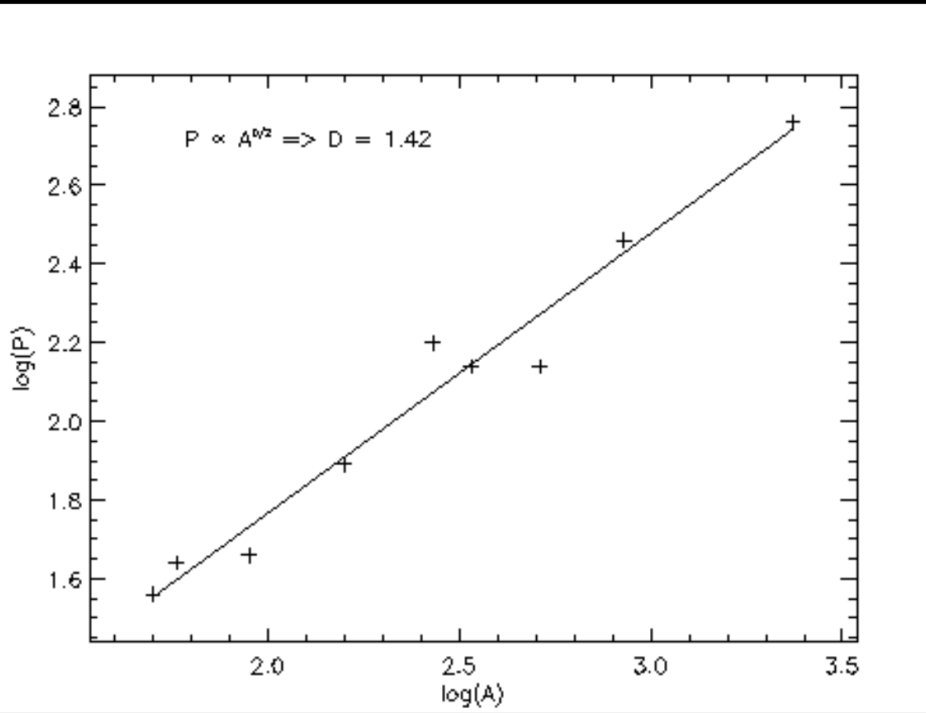
Generation of Realistic ISM Structures Needed for Modeling

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

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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?

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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?

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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

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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

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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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