

LIM x LIM

A discussion on strengths and
challenges

CO x CO

CO x [C II]

CO/[C II] x hydrogen

Other molecular lines

FIR lines

Certain questions pertain to all lines.

Degeneracy between average line intensity and line-matter scaling ('bias') in 2pt statistics

- How does this affect (at least early) LIM x LIM cross-correlations?
- Can novel cross-correlation methods break this degeneracy?

Line emission and excitation can have significant variability with ISM environment from galaxy to galaxy

- How will this affect LIM cross-correlations?
- Is this something LIM cross-correlations can target for science?

CO x CO — early target but is it that easy?

- *Can we leverage CO–CO cross-correlations for global excitation/SLED?*
 - Again—how does variability of CO excitation affect cross-correlations?
 - How are concerns similar or different for ...
 - COMAP-type (high z with high gas density in medium)?
 - CO in [C II] experiments (low-redshift environments)?
- **What is the role of cross-correlations in component separation?**
- **How concerned should we be about high-J ‘harmonics’?**
 - e.g., CO(4–3) x CO(6–5) mixing with CO(2–1) x CO(3–2) in cross-correlation

CO x [C II] — carbon synergies

- *What's necessary for ground-based/balloon CO x [C II] cross-correlations?*
- Can cross-correlations between high-J CO lines and [C II] diagnose the high-z ISM?

CO/[C II] x hydrogen — H I, Ly-alpha ...

If we had a late-reionisation cross-correlation detection between cm/mm-wave LIM and hydrogen IM, *how would we interpret that measurement?*

- Are our models for carbon and hydrogen lines good enough to diagnose/interpret model-observation mismatch?
- What is the role of different models (SAMs, LIMFAST, small boxes resolving fine-grain physics)?
- Can we separate neutral hydrogen in ISM vs CGM/IGM?
- Of course—what's needed to get to such a measurement?

Other molecular and FIR lines

What are the most promising targets that have yet to be targeted by surveys/analyses?

- Is there any detectability of other molecular lines in *LIM–LIM* cross-correlation? (HCN, ^{13}CO , ...)
- [O III] x [C II] would be at very high redshift. Can we make sense of it?

We probably haven't asked every question.

Other ideas about LIM x LIM?

- **In theory ... ?**
 - Lines of interest?
 - Model roadmap?
- **In analysis ... ?**
 - Systematics of concern?
 - Novel techniques?
- **In experiment ... ?**
 - Design requirements?