Project 9: Turbulence statistics in nearby molecular clouds

Using spectral-line data

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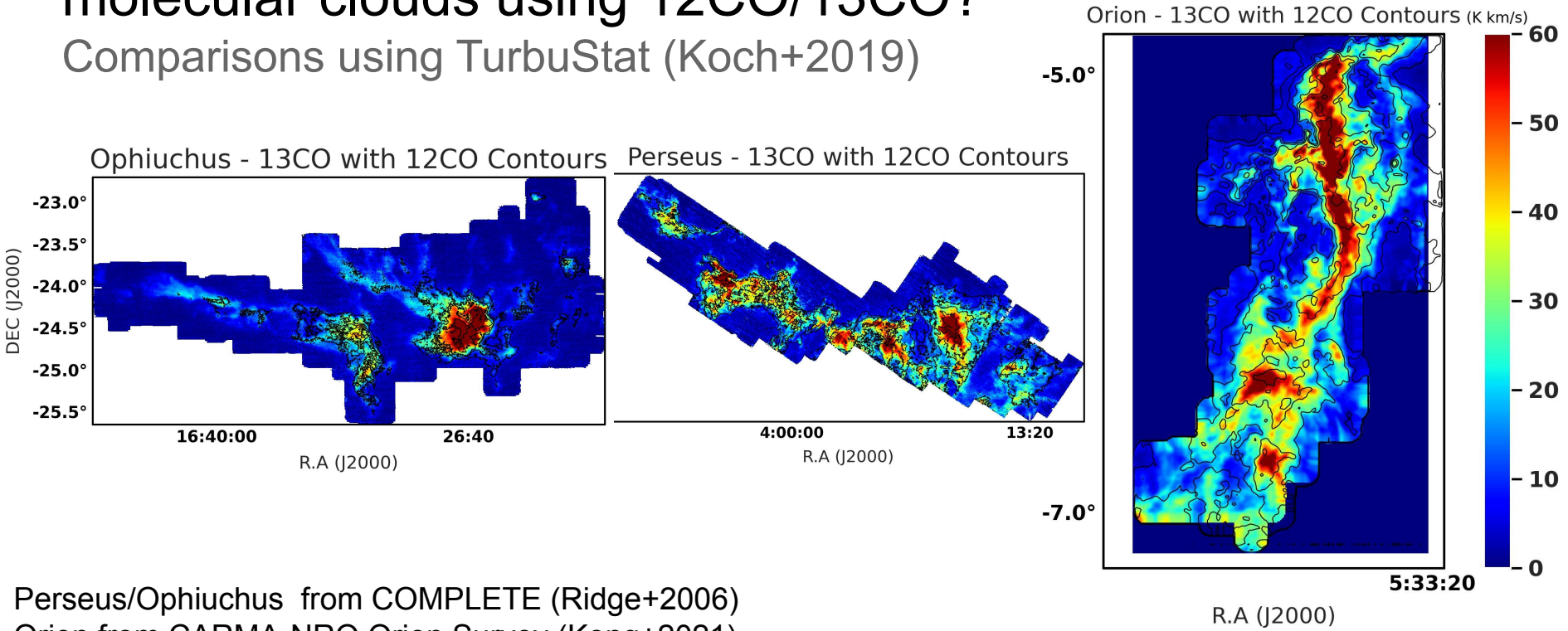
How do turbulence statistics vary between and within molecular clouds using 12CO/13CO?

Comparisons using TurbuStat (Koch+2019)

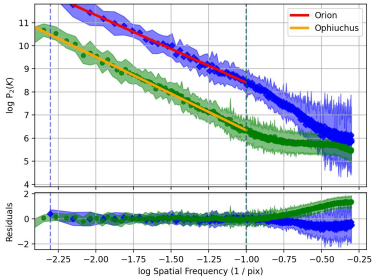


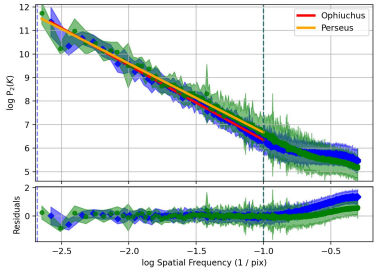
Perseus/Ophiuchus from COMPLETE (Ridge+2006)
Orion from CARMA-NRO Orion Survey (Kong+2021)

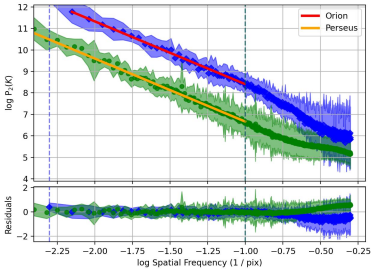
Comparing turbulence statistics of different clouds: ^{12}CO

Ngan Le

Spatial Power Spectrum (SPS):
Orion - Ophiuchus: 3.9
Orion - Perseus: 0.1
Ophiuchus - Perseus: 2.5

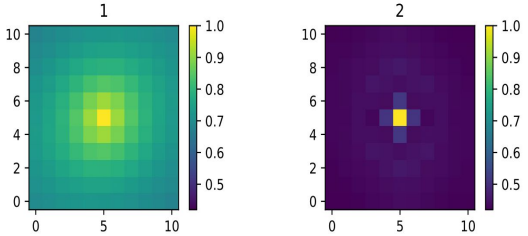




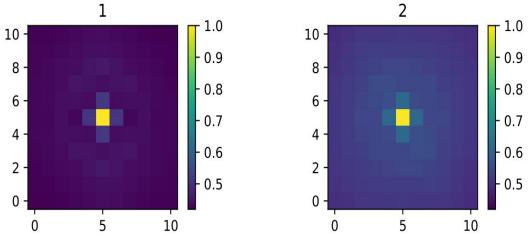


Spectral Correlation Function (SCF):
Orion - Ophiuchus: 0.3464
Orion - Perseus: 0.2524
Ophiuchus - Perseus: 0.09423

Orion - Ophiuchus



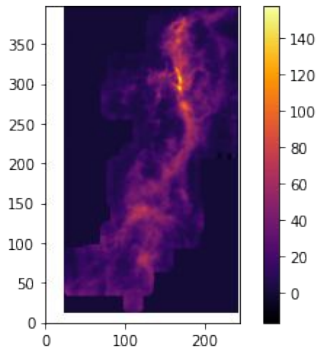
Ophiuchus - Perseus



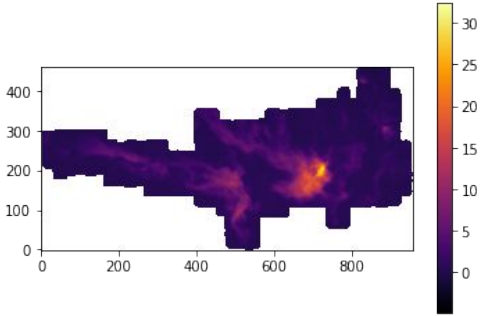
Comparing turbulence statistics of different clouds: ^{13}CO

Fazlu Rahman

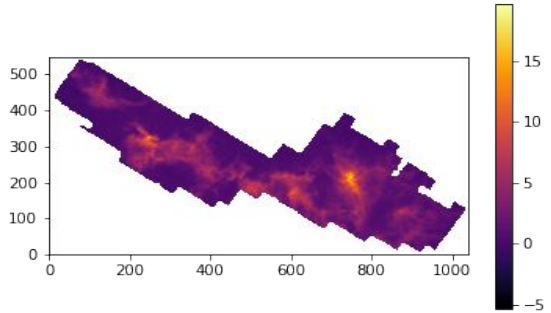
Orion



Ophiuchus



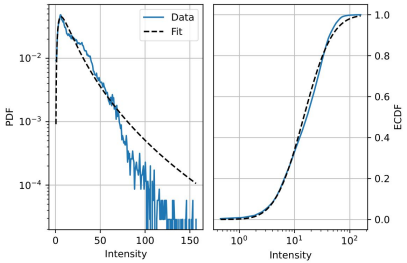
Perseus

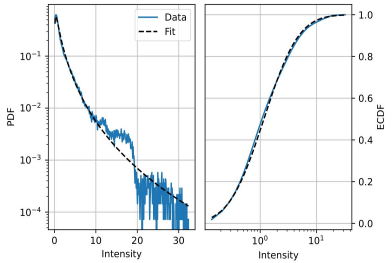


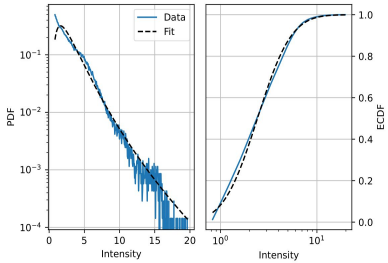
Probability Distribution Function (PDF)

$$d_{\mathrm{LN}} = \frac{|w_1 - w_2|}{\sqrt{\sigma_{w_1}^2 + \sigma_{w_1}^2}}$$

Lognormal Distance -
Orion - Ophiuchus: 53.24
Orion - Perseus: 91.98
Ophiuchus - Perseus: 217.87





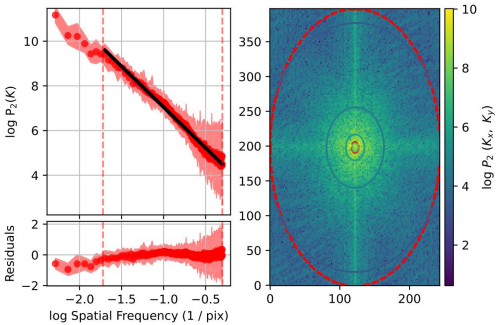


Spatial Power Spectrum (SPS)

$$d_{\text{slope}} = \frac{|\beta_1 - \beta_2|}{\sqrt{\sigma_{\beta_1}^2 + \sigma_{\beta_1}^2}}$$

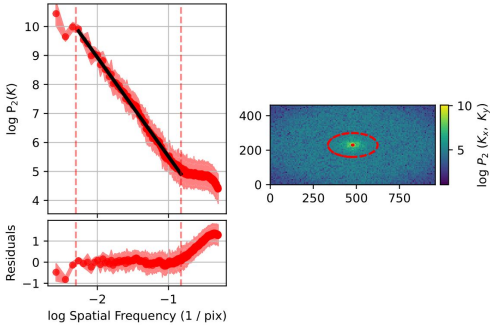
SPS Distance -
Orion - Ophiuchus: 5.61
Orion - Perseus: 0.36
Ophiuchus - Perseus: 12.34

Orion



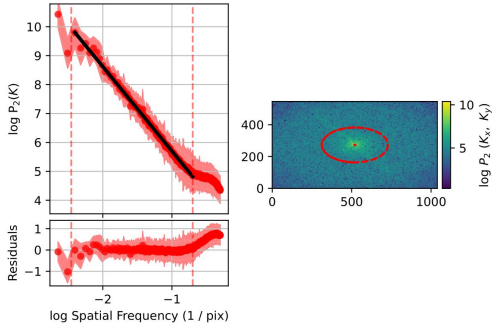
Slope= -3.65

Ophiuchus



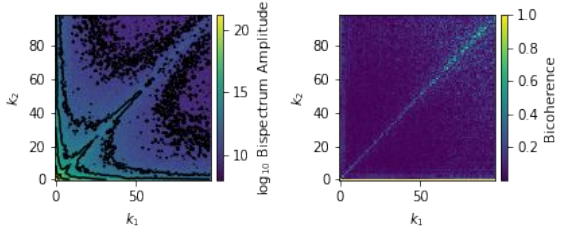
Slope= -3.42

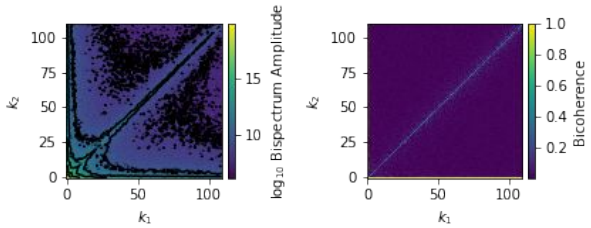
Perseus

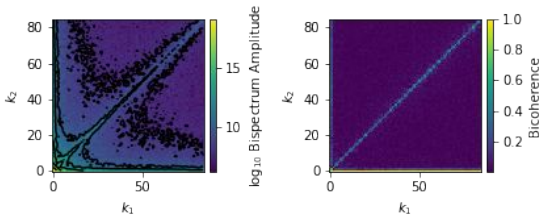


Slope= -2.922

Bispectrum







Comparing turbulence statistics in different tracers

12CO vs 13CO PDFs in different clouds

MJ Shahhoseini

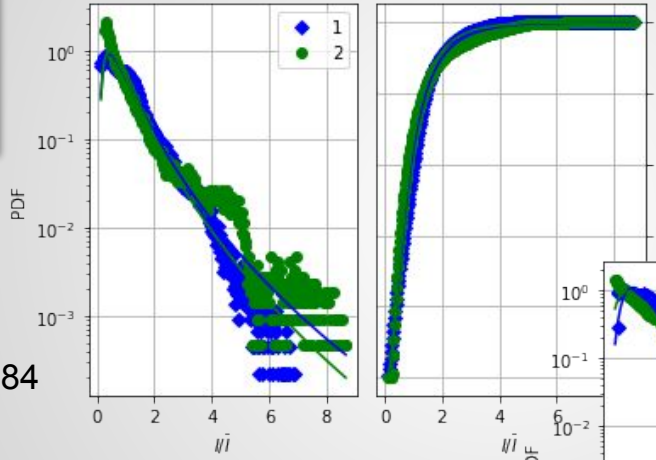
$$d_{\mathrm{LN}} = \frac{|w_1 - w_2|}{\sqrt{\sigma_{w_1}^2 + \sigma_{w_1}^2}}$$

Orion:
lognormal_distance = 56.684

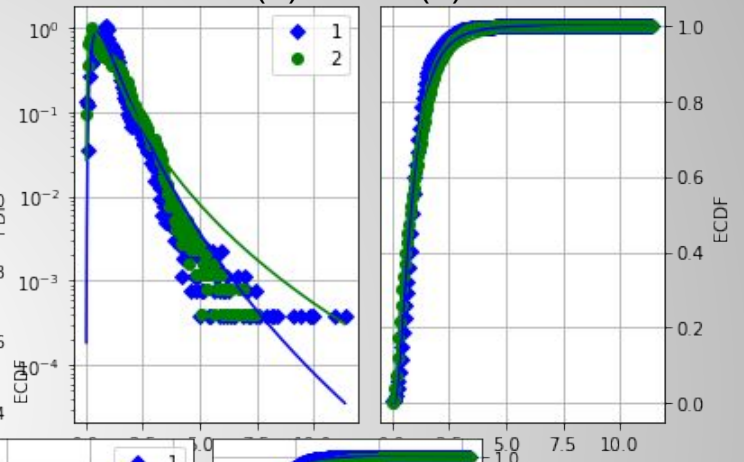
Perseus
lognormal_distance = 103.158

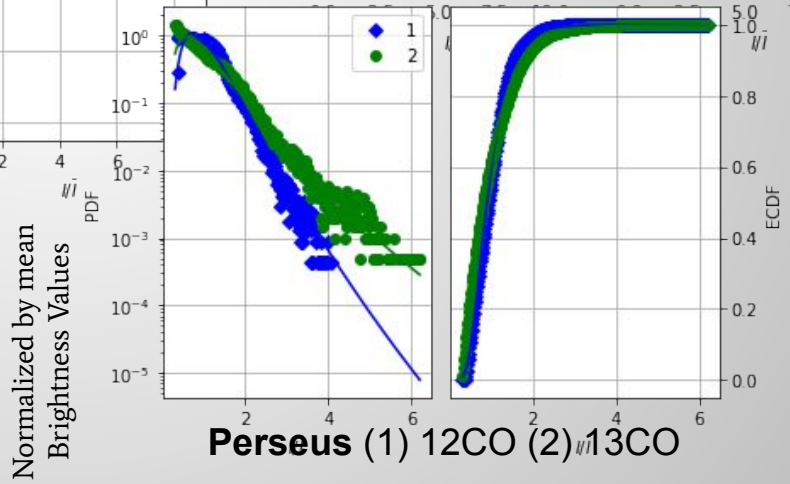
Ophiuchus
lognormal_distance = 16.555

Ophiuchus. (1) 12CO (2) 13CO



Orion. (1) 12CO (2) 13CO





Perseus (1) 12CO (2) 13CO

Comparing turbulence statistics of regions in Orion

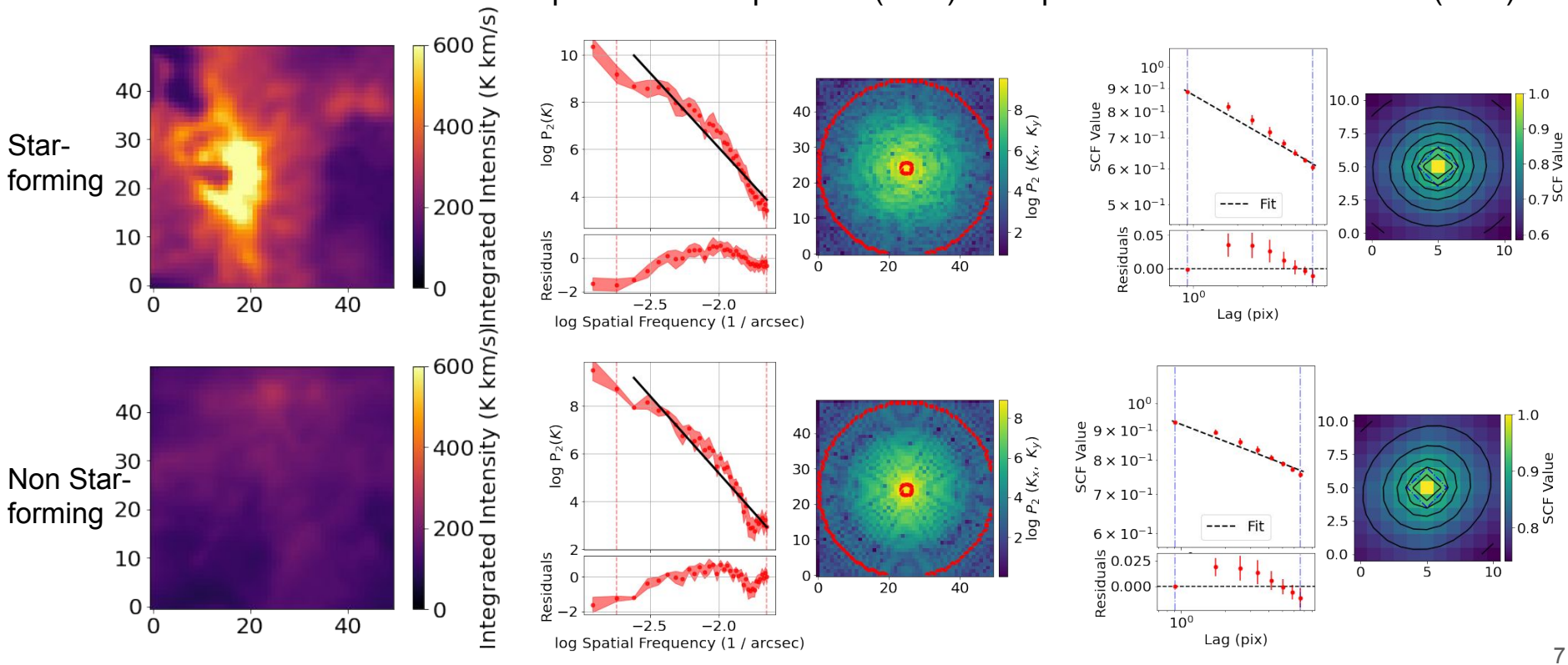
Yuankang Liu

Spatial Power Spectrum (SPS)

Spectral Correlation Function (SCF)

Star-forming

Non Star-forming



Summary: Turbulence statistics in nearby molecular clouds

- **Ngan Le**: Do ^{12}CO turbulence statistics vary between clouds?
  - The SCF (with velocity information) traces different variations between clouds than the SPS.
- **Fazlu Rahman**: Do ^{13}CO turbulence statistics vary between clouds?
  - Bispectrum retains more information than PDF or SPS, and shows larger variations between clouds.
- **MJ Shahhoseini**: How do ^{12}CO vs. ^{13}CO PDF properties compare?
  - Relative PDF widths of ^{12}CO vs. ^{13}CO vary significantly between clouds.
- **Yuankang Liu**: Do turbulence statistics vary between a star-forming vs. non-star forming region in Orion?
  - Using spectral information (SCF) shows larger differences than only spatial information (2D power spectrum).