SURFING

SURveying Filaments in Nearby Gas clouds

Mike Chen (Queen's U) & the SURFING team



Image Credit: Gendler & Colombari (NOAO/AURA/NSF)

Star-forming cores form in dense filaments



Credit: ESO/APEX (MPIfR/ESO/OSO)/A. Hacar et al. Acknowledgment: Davide De Martin.



Log₁₀ column density [cm⁻²] 5 .5

21.0

(e) Grav vs. Turb+Magnetic

28

Sim. (Turb + Mag)

 $N_{\rm filoments} = 33$

-Sim. (Gravity + Turb + Mag) 🖉

C. Federrath 2015

The need for kinematics studies



Recent works on kinematics



Systematic Kinematic Survey

- Current kinematics studies tends to focus on small number of filaments
- · Systematic surveys tend to be lacking
 - Particularly with < 30" resolution
- Green Bank Ammonia Survey (GAS; Friesen+ 2017)
 - Samples nearby clouds at 32"
 - Uses dense gas tracer (NH₃)



Spatial Anatomy – Dense Gas Tracer



Kinematics Anatomy



Hacar+ 2013



CO (J=1-0) isotopologue survey



- Mapping feasible now with the new 'Ū'ū instrument
 - 4x more sensitive than Receiver A
- At 220 GHz, takes advantage of the the highly transmittable atmosphere in poorer weather (band 4)
- 21.3" resolution
 - 0.014 0.06 pc res. (140 600 pc)
- Up to 0.04 km s⁻¹ spectral resolution for a single line

SURFING – CO (J=1-0) Survey of nearby filaments



RA (J2000)

Taurus Filaments



ESA/Herschel/NASA/JPL-Caltech.

- Taurus Cloud at 140 pc away
 - 0.014 pc resolution
 - 3 times improvement over pervious kinematic studies (e.g., Hacar+ 2013)
- L1495
 - Total mass: 220 M_{\odot}
 - Average M_{lin} : 50 $M_{\odot}\ pc^{\text{-1}}$
- L1506
 - Total mass 35 M_{\odot}
 - Average M_{lin} : 14 M_{\odot} pc⁻¹



Taurus Filaments



Li, P. K.+ (2021)

Planck Collaboration (XXXV; 2016)

Filament Networks



- NGC 1333
 - Total mass: 370 M_{\odot}
 - Average M_{lin} : 200 $M_{\odot}\ pc^{\text{-1}}$
- Serpens South
 - Total mass: 610 M_{\odot}
 - Average M_{lin} : 100 $M_{\odot}\ pc^{\text{-1}}$
- IC 5146
 - Total mass 940 M_{\odot}
 - Average M_{lin} : 60 $M_{\odot}\ pc^{\text{-1}}$

Filament Network



Sugitani+ 2011

Pillai+ 2020

Anatomy of a filament complex



Anatomy of a filament complex



Comparing with Synthetic Observations



Anatomy Diagnostics: Filament ID in PPV Space



Anatomy Diagnostics: Cluster ID in N-D Space





Comparing with Synthetic Observations



Hacar+ 2013

Clarke, Williams, & Walch 2020

In some synthetic observations:

Cores form at subfilaments junction are typically more massive and form little clusters

Comparing with Synthetic Observations



SURFING – CO (J=1-0) Survey of nearby filaments





SURFING - We are still recruiting!





- 30 team members from regions of
 - Canada (coordinator: Mike Chen)
 - China (coordinator: Tie Liu)
 - Japan (coordinator: Yoshito Shimajiri)
 - Korea (coordinator: Chang Won Lee)
 - Taiwan (coordinator: Sheng-Yuan Liu)
 - Thailand (coordinator: Ram Kesh Yadav)
- Still recruiting!
 - Enrollment open until March 1st, 2022

QR for sign up!