Star Formation Newsletter No. 345

13. A wide-field CO survey towards the California Molecular Filament, Weihua Guo et al to appear in ApJ
14. Which Molecular Cloud Structures Are Bound? N.J. Evans II et al. to appear in ApJ
15. Touching the Stars: Using High-Resolution 3D Printing to Visualize Stellar Nurserie, Nia Imara et al. to appear in ApJ
16. Modeling of CO ro-vibrational line emission of HD 141569, S.K. Jensen et al. to appear in PASP
17. Linking Outer Disk Pebble Dynamics and Gaps to Inner Disk Water Enrichment, A Kalyaan et al. to appear in ApJ
18. Massive young stellar objects in the Local Group irregular galaxy NGC6822 identified using machine learning, D. Kinson et al., MNRaS, 507, 5106

花輪 知幸 (千葉大)

13. A wide-field CO survey towards the California Molecular Filament

Weihua Guo et al. to appear in ApJ

紫金山 13.7 m ミリ波鏡

青海(デリンハ)観測所

February 2012 to May 2014

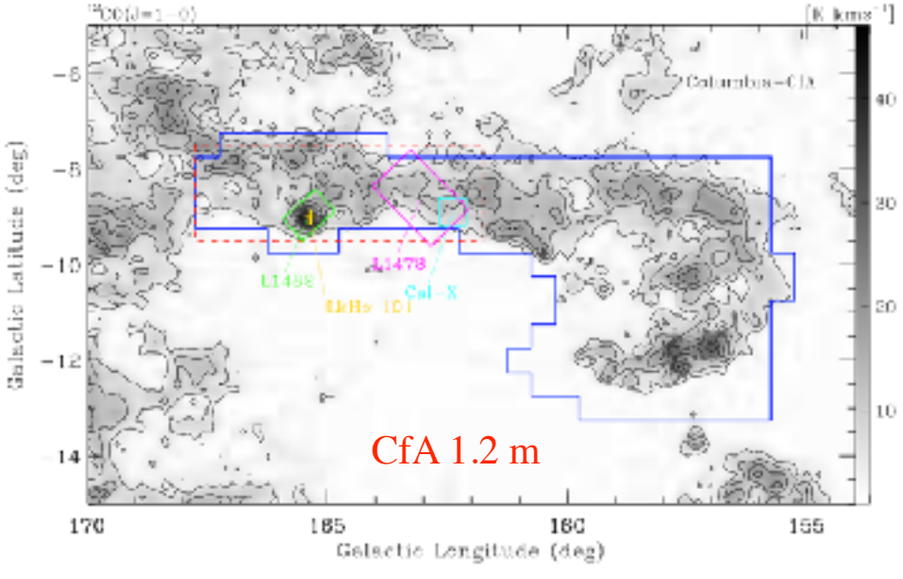
^{12}CO, ^{13}CO, C^{18}O J=1-0

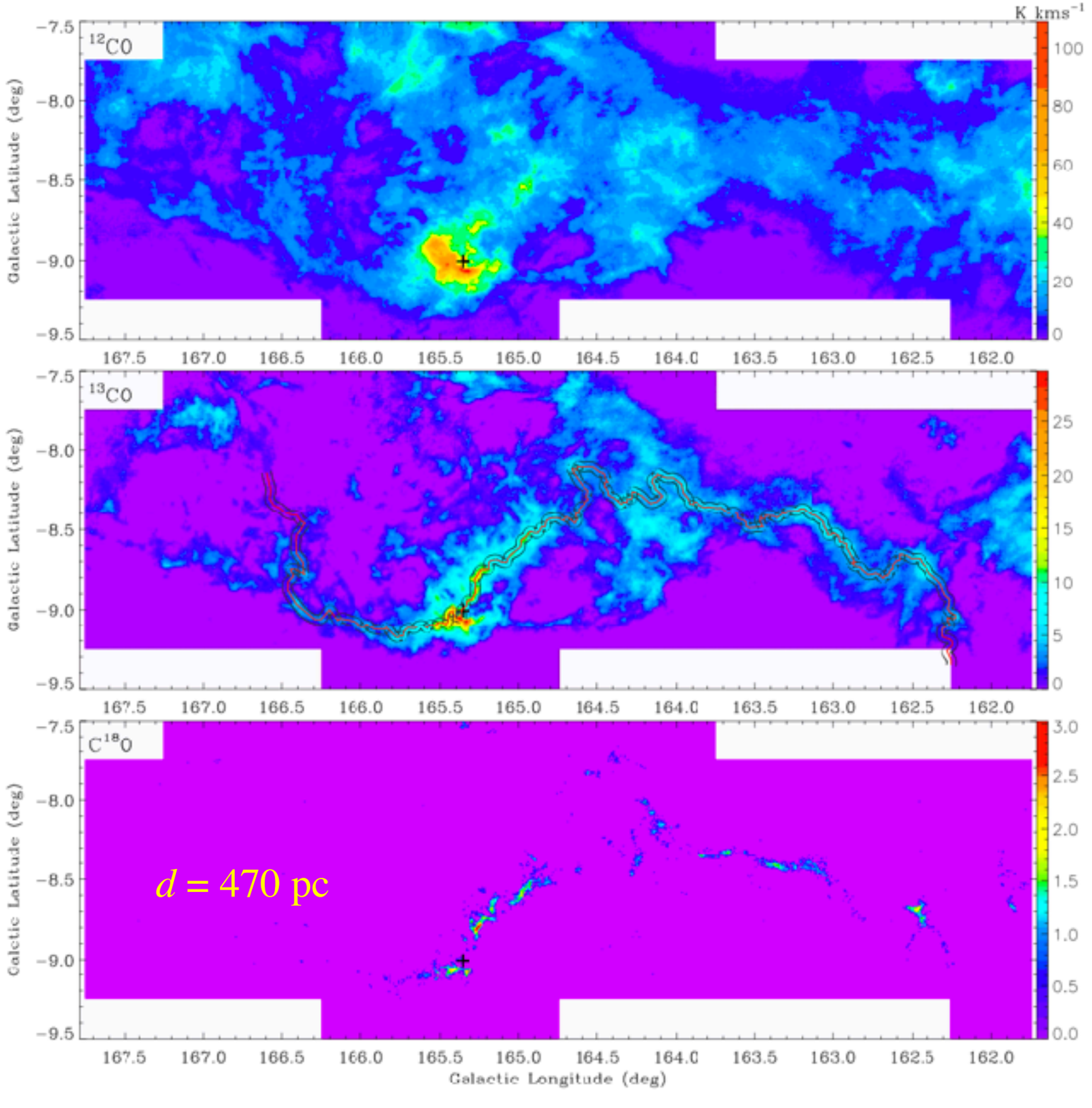
角度分解能 52 - 55”

速度分解能 0.16 -0.17 km s^{-1}

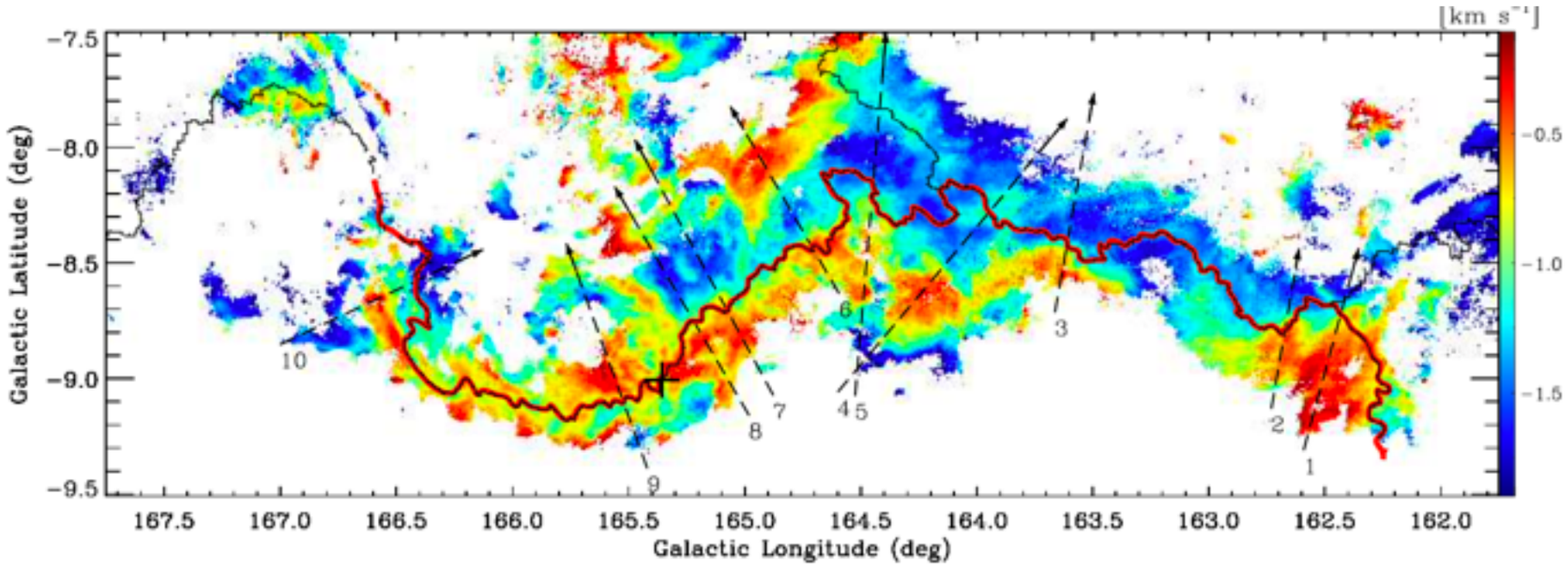
平均雑音 0.28 -0.48 K

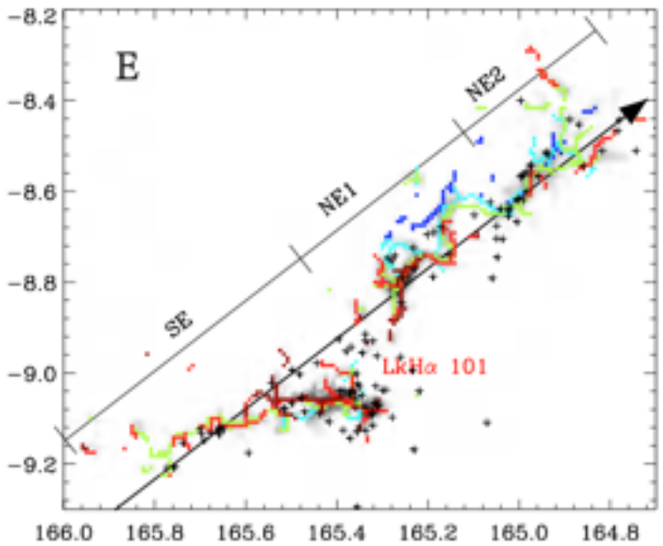
観測領域

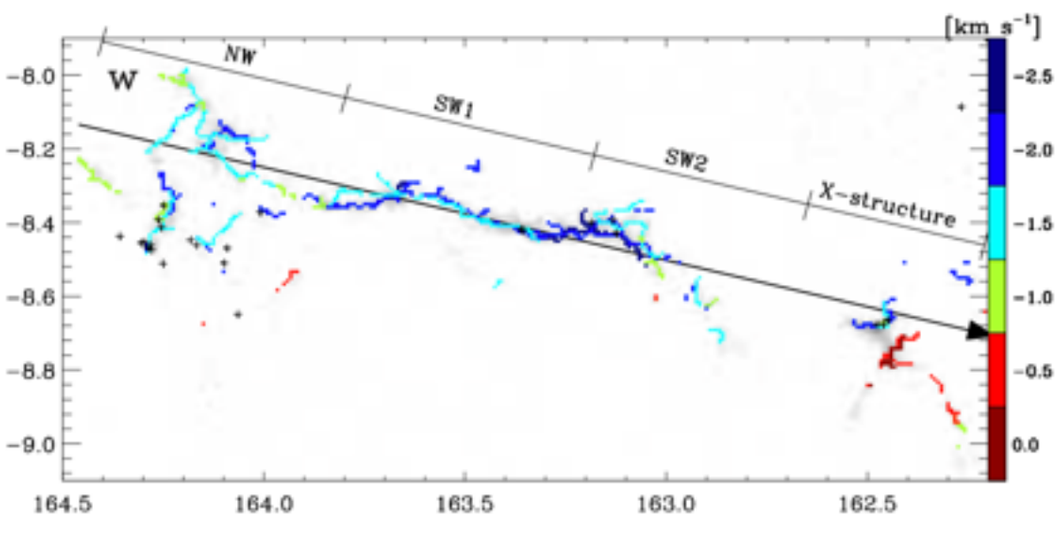




^{13}CO の moment 1







1. ^{13}COで California Molecular Filament (CMF)が見えた。
2. CMFを横切る速度勾配 0.82 km s^{-1} pc^{-1}
3. CMFに沿って 2.3 pc の oscillation
4. C^{18}Oに複数の速度成分
5. C^{18}Oで 225の dense coreを同定

2. Which Molecular Cloud Structures Are Bound?

N. J. Evans et al. to appear in ApJ

ビリアル比 $\alpha_{\rm vir} = \frac{2E_{kin}}{|E_g|}, \qquad E_g = \frac{-3GM^2}{5R}. \qquad E_{kin} = \frac{3{\sigma_v}^2 M}{2}$

$$\alpha_{\rm vir} = \frac{2E_{kin}}{|E_g|} = 1160{\sigma_v}^2 R_{pc}/M_{\rm M_\odot} = 209\Delta v^2 R_{pc}/M_{\rm M_\odot},$$

輝度から質量への変換 $L({\rm CO}) \longrightarrow M({\rm CO})$ $N({\rm H_2}) = N_{13}\left[\frac{\rm H_2}{\rm CO}\right]\left[\frac{\rm CO}{^{13}{\rm CO}}\right].$

H_2/CO = 6000 (最近の値) 銀河内の同位体勾配 $\frac{^{12}{\rm C}}{^{13}{\rm C}} = 5.87R_{\rm gal} + 13.25,$

Name	Tracer	Reference	Notes
CO-Rice	CO $J = 1 \rightarrow 0$	Rice et al. (2016)	1
CO-MD	CO $J = 1 \rightarrow 0$	Miville-Deschênes et al. (2017)	2
CO-CMZ	CO $J = 1 \rightarrow 0$	Oka et al. (2001)	3
CO-OGS	CO $J = 1 \rightarrow 0$	Heyer et al. (2001)	4
CO-Sun	CO $J = 1 \rightarrow 0$	Sun et al. (2020)	5
^{13}CO-GRS	^{13}CO $J = 1 \rightarrow 0$	Roman-Duval et al. (2010)	6
^{13}CO-EXFC55-100	^{13}CO $J = 1 \rightarrow 0$	Roman-Duval et al. (2016)	7
^{13}CO-EXFC135-195	^{13}CO $J = 1 \rightarrow 0$	Roman-Duval et al. (2016)	8
^{13}CO-SEDIGISM	^{13}CO $J = 2 \rightarrow 1$	Duarte-Cabral et al. (2021)	9
Herschel	submillimeter+ NH_3	Merello et al. (2019)	10

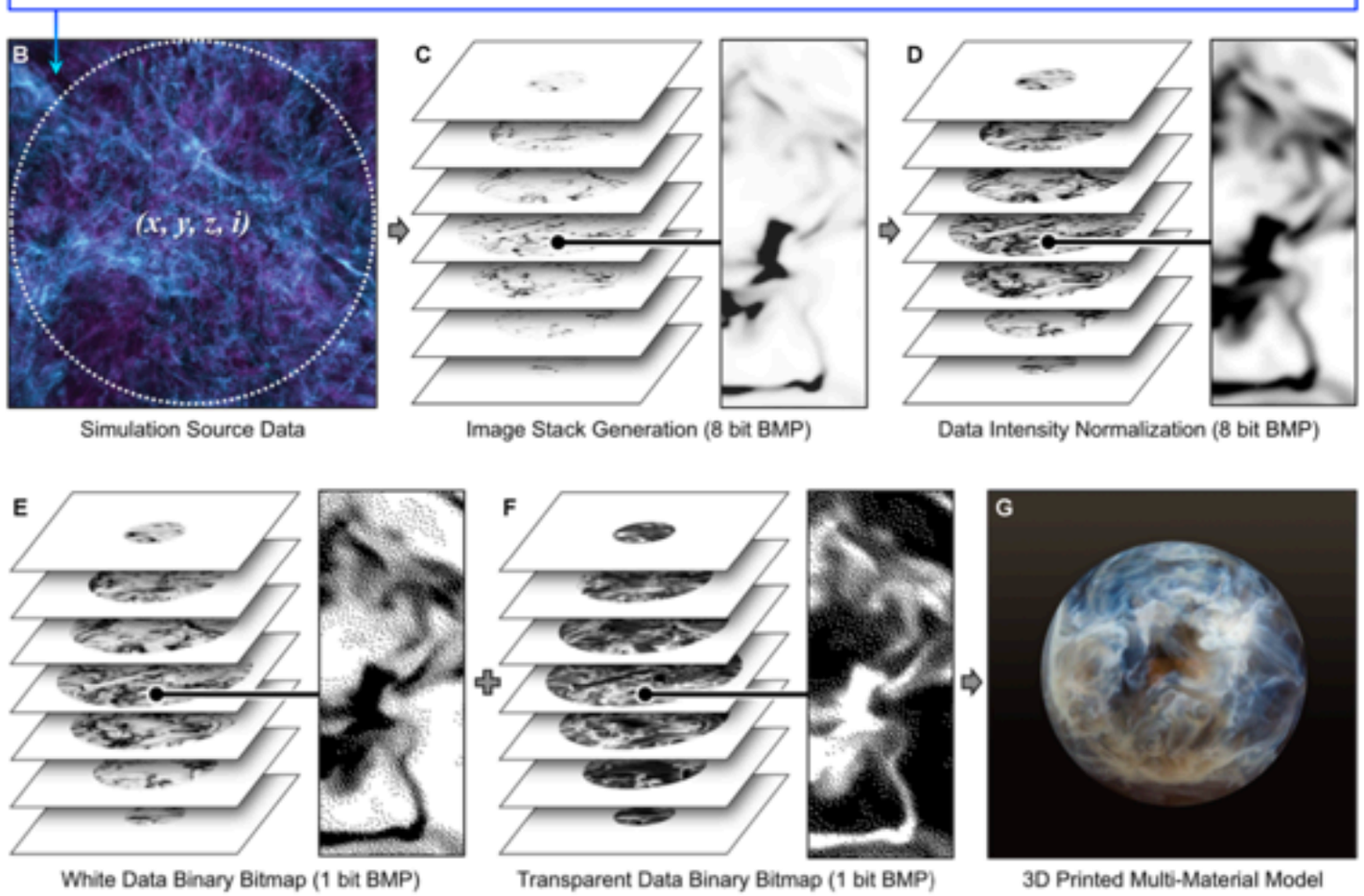
1. 結果が違ってくるのはcloudの同定法の選択による。
2. 採用する分子や遷移は結果に強い影響を与える。
3. 高密度tracerを使うほど 束縛されている割合が急激に増える
4. COで見つかるcloudは束縛されていない。質量の大半は束縛されていない。
5. NH_3で同定された構造はほとんど束縛されている。
6. 13COで同定された構造はCOで同定されたものより束縛されている確率が高い。しかし、結果は同定法に依存する。
7. 面密度が高いほど束縛されている割合が高い。
8. 銀河中心付近 0.5 kpc は面密度が高いが、乱流が強く束縛していない。銀河の外縁部では逆。
9. 銀河中心からの距離が遠いところでは、COや13COで同定された構造も面密度の割には束縛されている確率が高い。
10. 質量が大きいほど束縛されている確率が高いが、これは面密度の影響によるものかも知れない。
11. 現在最も完全性が高いMiville-Deschˆenes+17によれば、束縛されている割合は19%。星形成の効率が低いことを説明する方向ではあるが、量的には不十分。

15. Touching the Stars: Using High-Resolution 3D Printing to Visualize Stellar Nurseries, N. Imara et al. to appear in ApJ

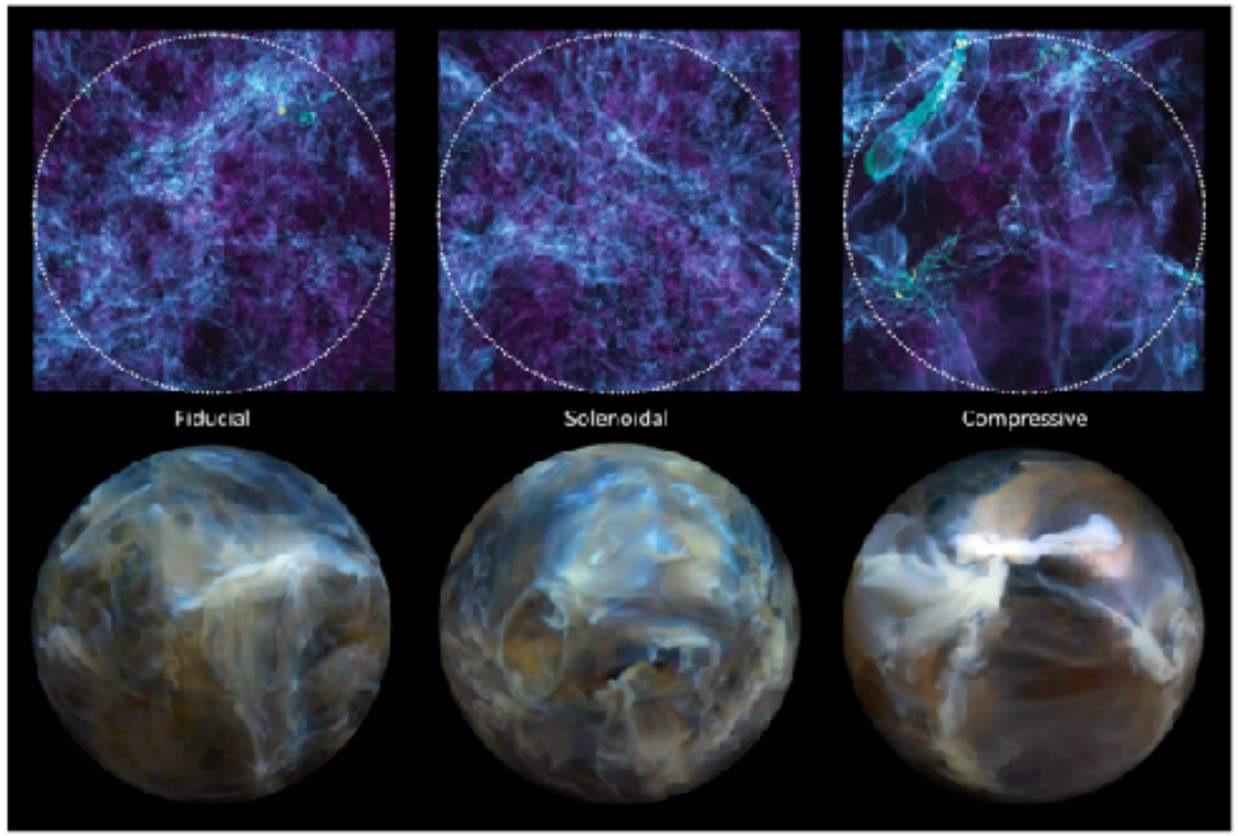
A

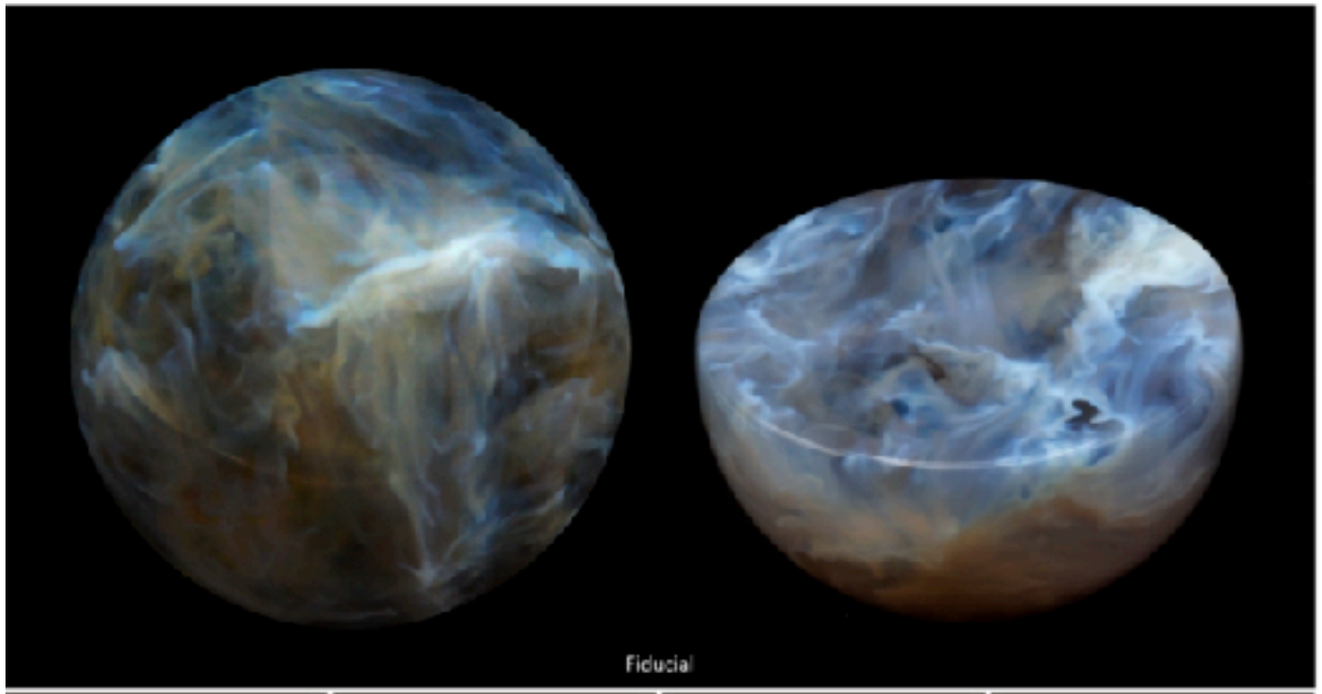
Molecular Cloud Simulation Parameters

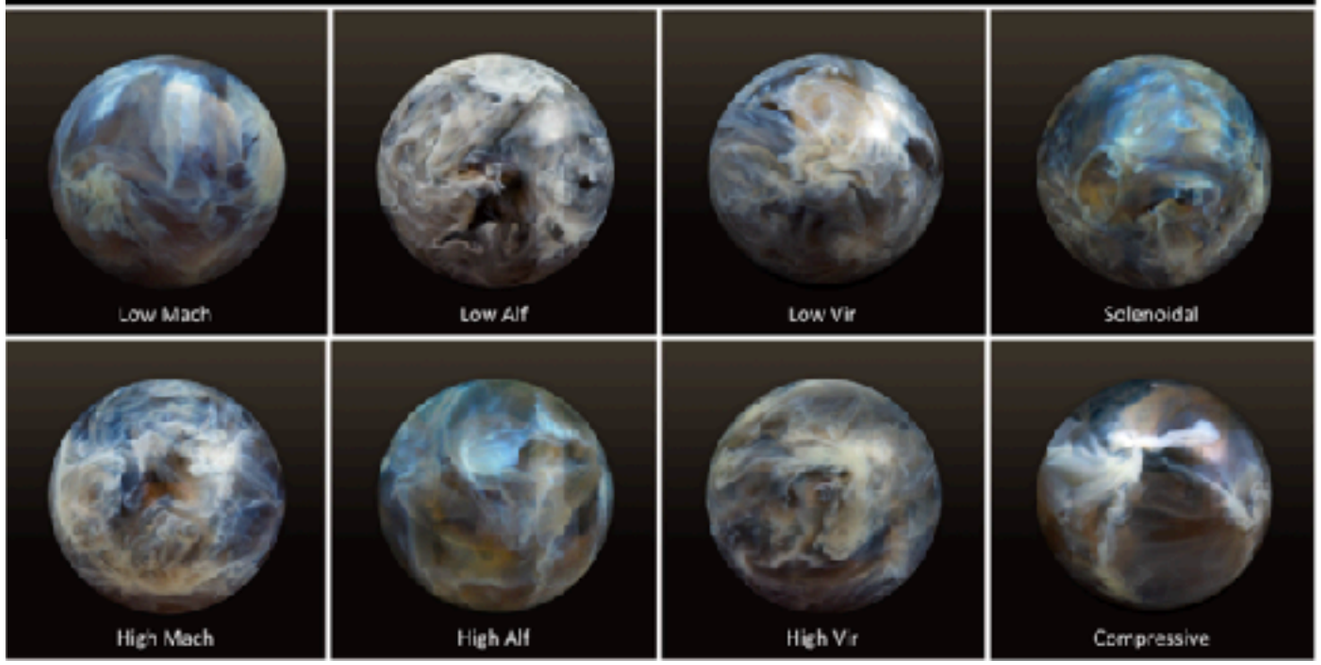
Model	$\mathcal{M}$	$\mathcal{M}_A$	α_{vir}	Forcing	ρ_0 [g cm^{-3}]	L [pc]	σ_v [km s^{-1}]	β_0	B_0 [μG]
Fiducial	10	3	1.0	mixed	1.66×10^{-22}	25.1	2	0.6	1.7
Low Mach	5	3	1.0	mixed	1.66×10^{-22}	12.6	1	1.2	1.2
High Mach	20	3	1.0	mixed	1.66×10^{-22}	50.3	4	0.3	2.4
Low$\mathcal{M}_A$	10	1	1.0	mixed	1.66×10^{-22}	25.1	2	0.2	2.9
High$\mathcal{M}_A$	10	30	1.0	mixed	1.66×10^{-22}	25.1	2	6.0	0.5
Low Vir	10	3	0.5	mixed	1.66×10^{-22}	35.5	2	0.6	1.7
High Vir	10	3	2.0	mixed	1.66×10^{-22}	17.8	2	0.6	1.7
Sol	10	3	1.0	solenoidal	1.66×10^{-22}	25.1	2	0.6	1.7
Comp	10	3	1.0	compressive	1.66×10^{-22}	25.1	2	0.6	1.7

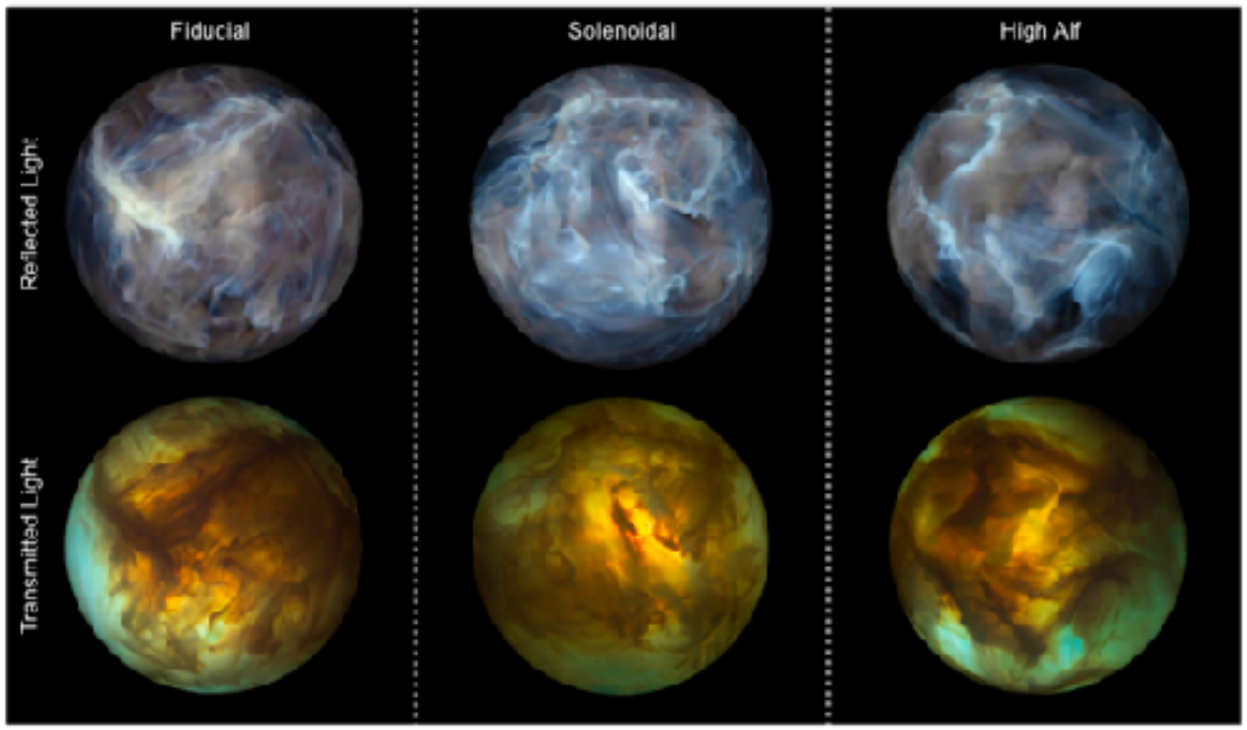


Driven turbulence
ENZO









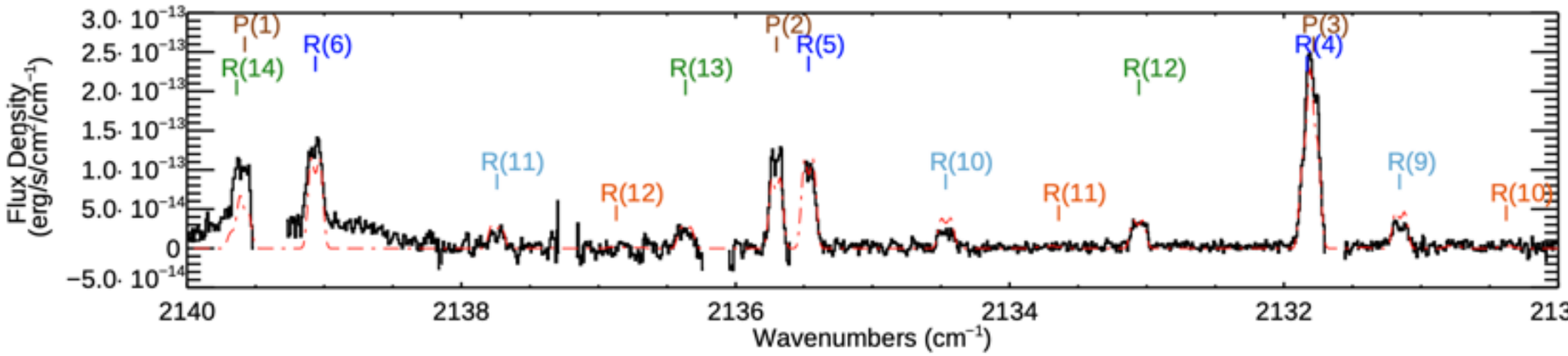
Our bitmap-based 3D printing approach thus faithfully reproduces the subtle density gradient distribution within molecular clouds in a tangible, intuitive, and visually stunning manner.

16. Modeling of CO ro-vibrational line emission of HD 141569

S.K. Jensen Jr. et al. to appear in PASP

HD141569: Herbig Ae/Be (2-2.4 M_o) transition disk と debris disk の中間

inner disk が非対称かどうか調べたい



CO の振動回転遷移 IRTF M-band (4.52-5.25 μm)

高分散分光 $\lambda/\Delta\lambda = 75{,}000$ $\Delta v = 4$ km s^{-1}

スリット幅 0”. 375 Position angle 356° と 176°

Moffat function

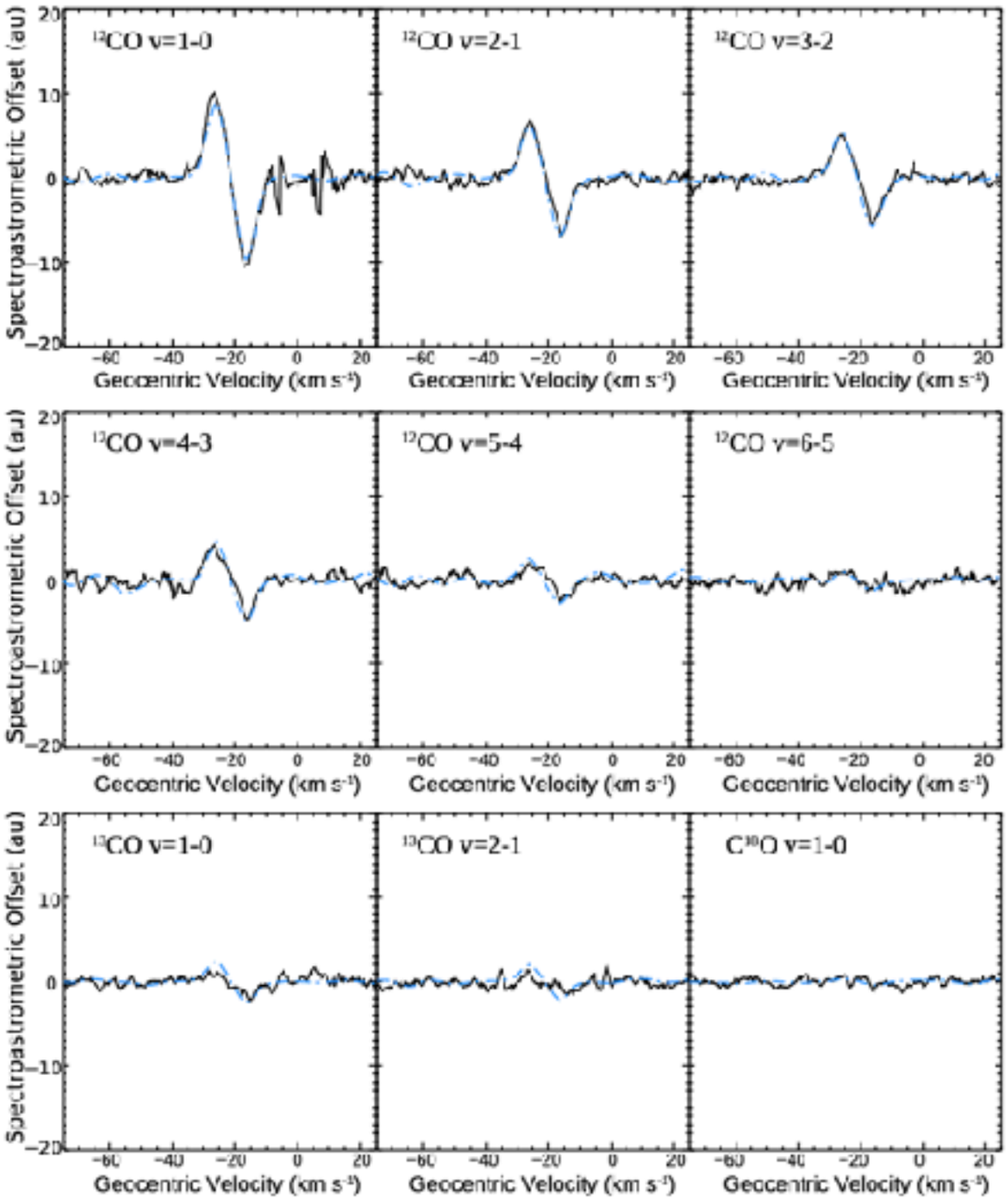
Gaussian + diffraction

$$f = p_0 \left(\frac{(x - p_1)^2}{u^2} + 1 \right)^{-p_4} + p_5$$

p_1: 中心, p_2: 幅

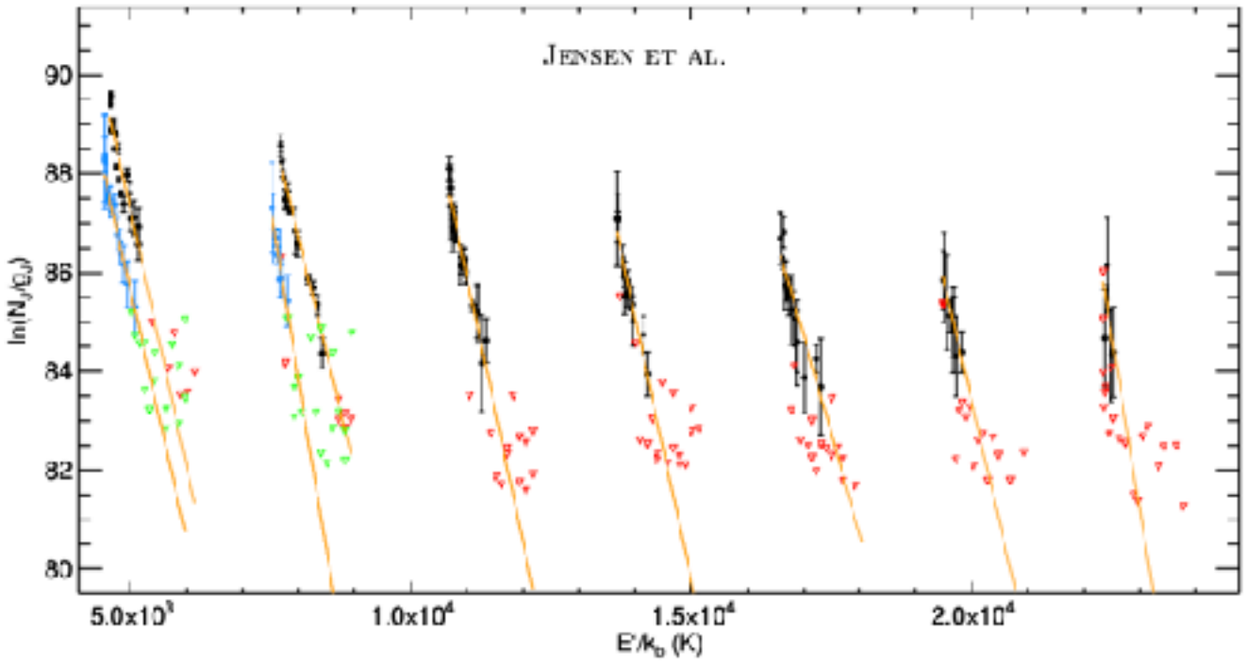
$$u = \frac{2 \cdot p_2}{1 + e^{p_3 (x - p_1)}}$$

PV diagram みたいなもの



Kepler 回転

Excitation diagram

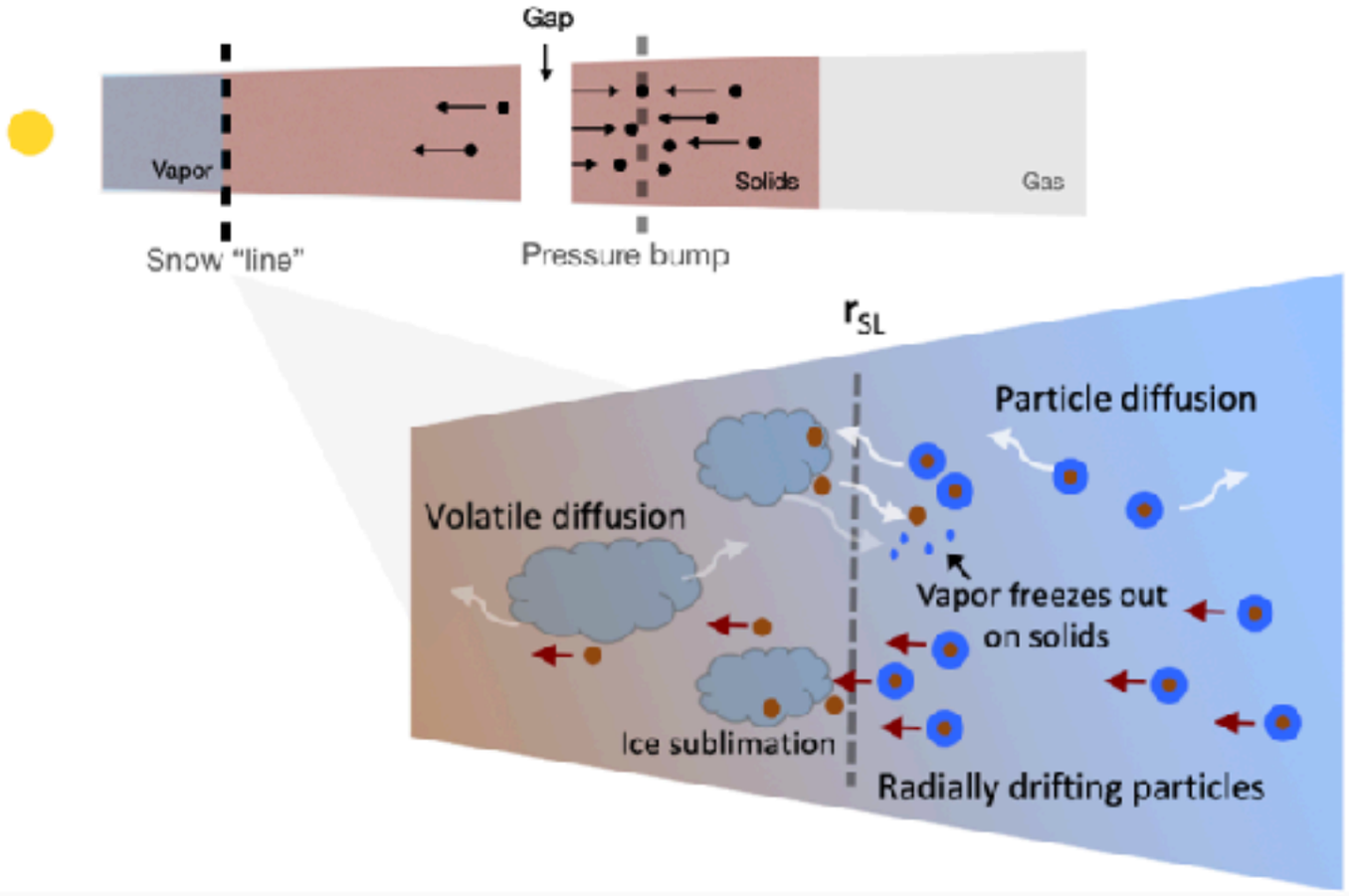


$T_{回転}$ ＝ 200 K

$T_{振動}$ = 4540±440 K

UVによる蛍光

17. Linking Outer Disk Pebble Dynamics and Gaps to Inner Disk Water Enrichment, A. Kalyaan et al. to appear in ApJ



動機:

ダスト円盤が大きいほど内側の円盤に水が豊富にあることを説明したい。

方法:

Gapを考慮した1次元モデル(0.1 -500 au)を考える。(300 zones)

ガスとダストの輸送

$$\frac{\partial \Sigma}{\partial t} = \frac{1}{2\pi r}\frac{\partial \dot{\mathrm{M}}}{\partial r}, \qquad \dot{\mathrm{M}} = 6\pi r^{1/2}\frac{\partial}{\partial r}\left(r^{1/2}\Sigma\,\nu\right). \qquad \nu = \alpha\frac{c_s^2}{\Omega_k}; \qquad \alpha = 10^{-3} \qquad \mathrm{T_{pass}}(r) = 118\left(\frac{r}{1\,\mathrm{au}}\right)^{-0.5}\mathrm{K}.$$

$$\dot{\mathrm{M}}_\mathrm{p} = c_\mathrm{p}\dot{\mathrm{M}} - 2\pi r\, c_\mathrm{p}\,\Sigma\,\mathrm{V_{drift}} + 2\pi r\,\Sigma\,\mathcal{D}_\mathrm{p}\frac{\partial\, c_\mathrm{p}}{\partial r}, \qquad \mathrm{V_{drift}} = \frac{-\mathrm{St}^2\,\mathrm{V_{g,r}} - \mathrm{St}\,\eta\, r\,\Omega_k}{1+\mathrm{St}^2}, \qquad \mathrm{St} = \frac{\pi}{2}\frac{\rho_\mathrm{p} a_\mathrm{p}}{\Sigma}\left[1+\frac{4}{9}\frac{a_\mathrm{p}}{\lambda_\mathrm{mfp}}\right],$$

$$c_\mathrm{p} = \Sigma_\mathrm{p}/\Sigma \qquad \mathcal{D}_\mathrm{p} = \frac{\mathcal{D}_\mathrm{gas}}{1+\mathrm{St}^2}. \qquad \mathcal{D}_\mathrm{gas} = \nu$$

飽和水蒸気圧

$$P_{eq}(T) = 0.1 \exp(28.868 - 6132.9/T)\ \mathrm{dyn\,cm^{-2}}, T > 169\,\mathrm{K} \quad (10)$$

from Marti & Mauersberger (1993), and

$$P_{eq}(T) = 0.1 \exp(34.262 - 7044.0/T)\ \mathrm{dyn\,cm^{-2}}, T \leq 169\,\mathrm{K} \quad (11)$$

from Mauersberger & Krankowsky (2003)

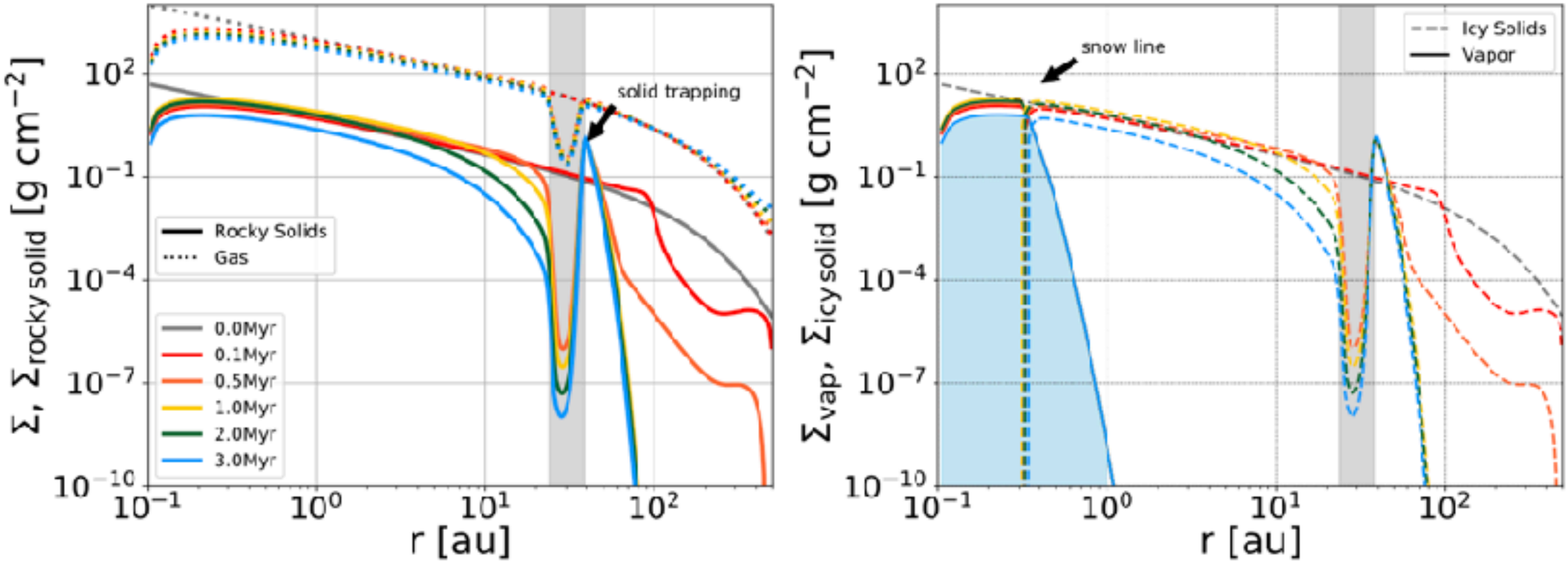
$$\Sigma_{vap,eq} = (2\pi)^{1/2} \left(\frac{P_{eq}}{c^2_{H_2O}}\right) H,$$

水蒸気も 濃度(c) の勾配に比例して拡散

$$\frac{\partial \Sigma_{vap}}{\partial t} = \frac{1}{2\pi r}\frac{\partial \dot{M}_{vap}}{\partial r}, \qquad \dot{M}_{vap} = 2\pi r\, \Sigma\, \mathcal{D}_{vap} \frac{\partial c}{\partial r}.$$

Gapでは拡散係数が 75倍大きい

$$\alpha(r) = \alpha_{const} + (\alpha_{gap} - \alpha_{const}) \exp(-x^2),$$
$$x = (r - r_{gap}) \,/\, \text{gap width},$$



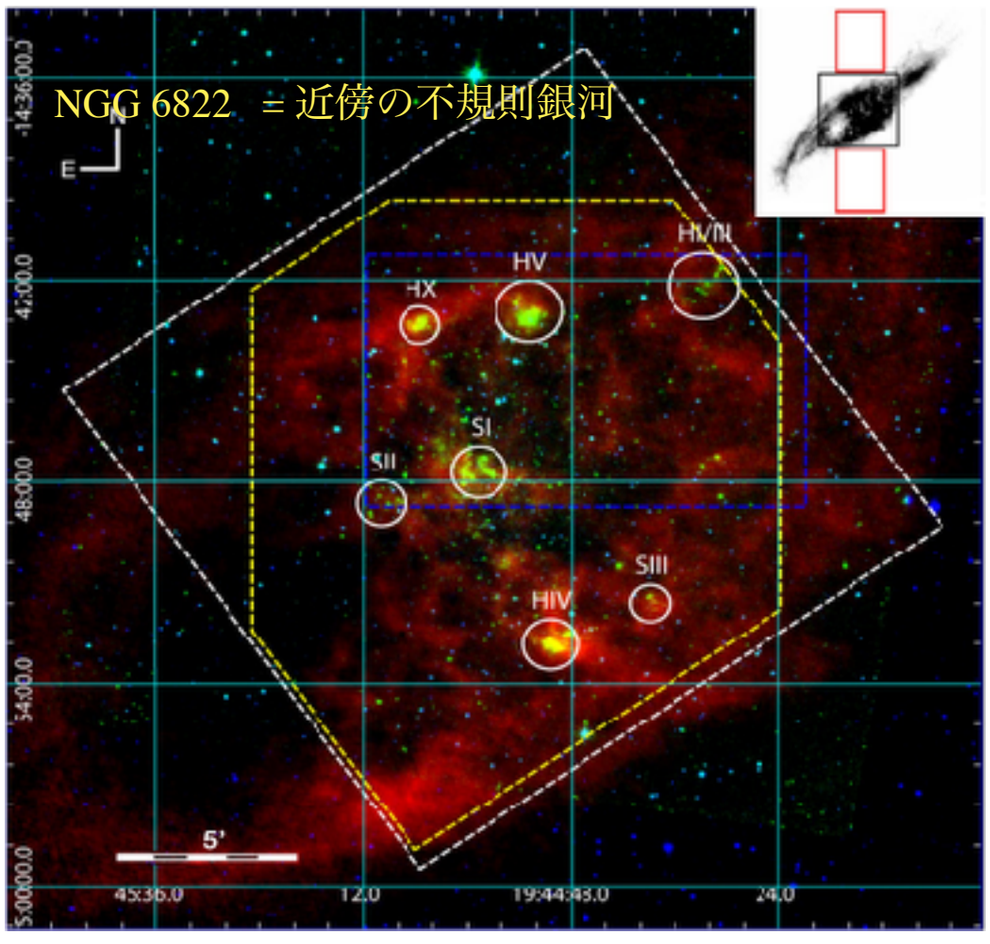
パラメータ依存性を議論している。

MNRAS 507, 5106–5131 (2021)
Advance Access publication 2021 August 19

https://doi.org/10.109

Massive young stellar objects in the Local Group irregular galaxy NGC 6822 identified using machine learning

David A. Kinson ,★ Joana M. Oliveira and Jacco Th. van Loon
Lennard-Jones Laboratories, School of Chemical and Physical Sciences, Keele University, Keele ST5 5BG, UK



J, *H*, *K*, 70 μm, 160 μm

教師付き機械学習

Supervised Machine Learning (PRF)

YSOs, oxygen-rich asymptotic giant branch stars (OAGBs), carbon asymptotic giant branch stars (CAGBs), red giant branch stars (RGBs), red super-giant stars (RSGs), active-galactic nuclei (AGNs), massive main-sequence stars (MMSs), and galactic foreground stars (FGs) に分類

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https://doi.org/10.3847/1538-3881/aaf101

PRF

Probabilistic Random Forest: A Machine Learning Algorithm for Noisy Data Sets

Itamar Reis, Dalya Baron , and Sahar Shahaf
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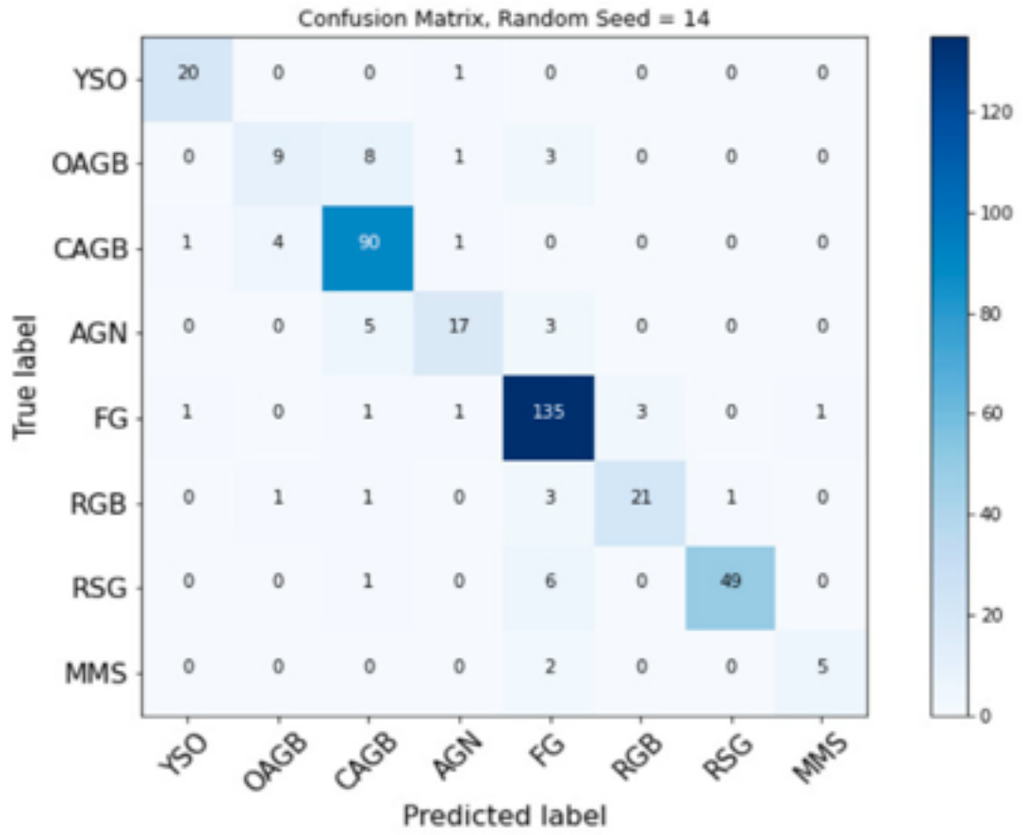
Received 2018 October 11; revised 2018 November 7; accepted 2018 November 12; published 2018 December 20

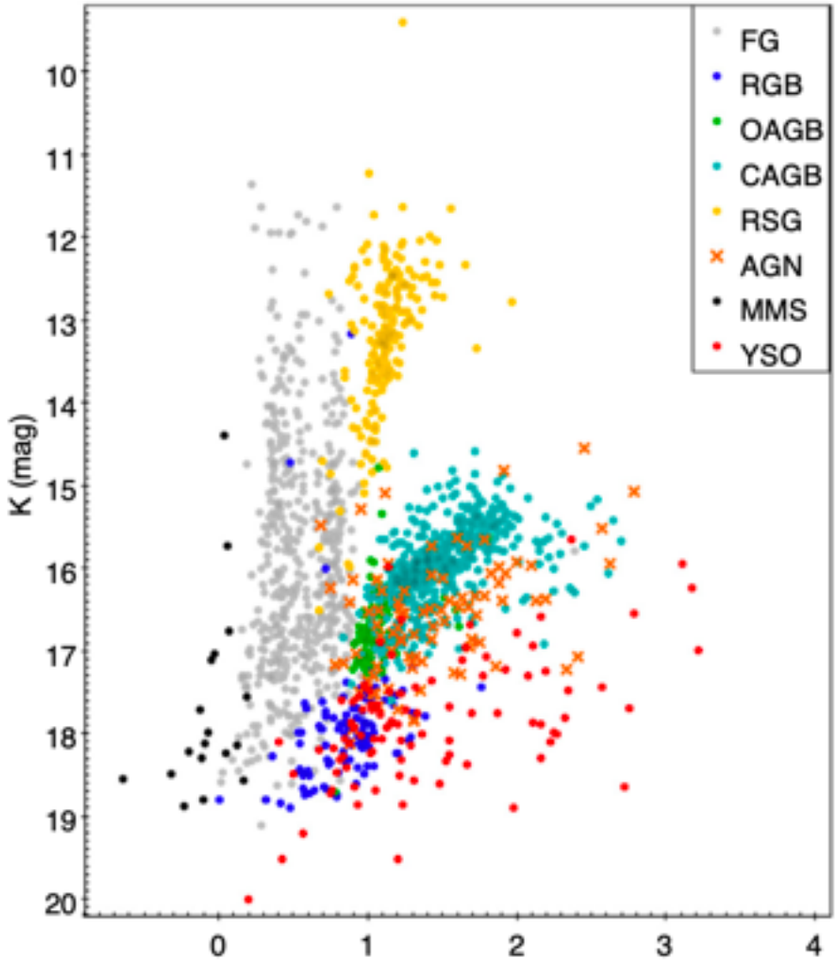
Supervisor (教師)

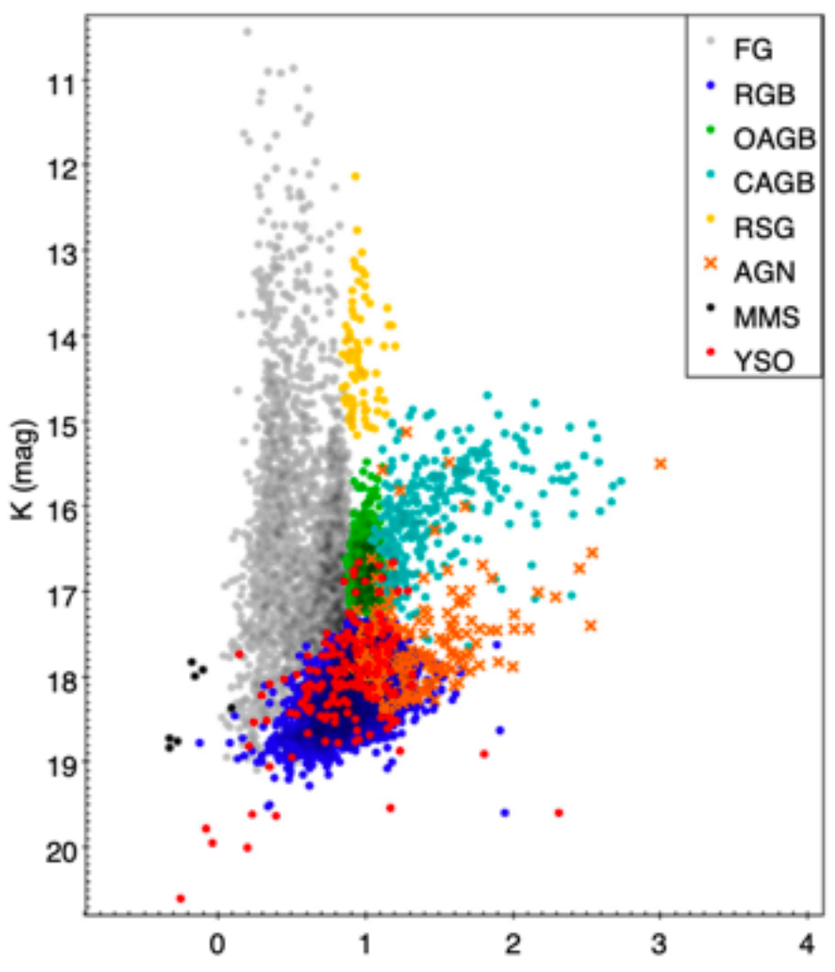
Class	Number of sources	Identification method
YSO	43	*Spitzer*-IRS spectra
OAGB	99	VIS/NIR spectra, narrowband indices
CAGB	461	VIS/NIR spectra, narrowband indices
AGN	89	Various
FG	500	*Gaia* proper motions
RGB	124	*Spitzer*-IRS spectra
RSG	192	Optical and *Spitzer*-IRS spectra
MMS	18	*Gaia* proper motions

改良された学習データでの成績

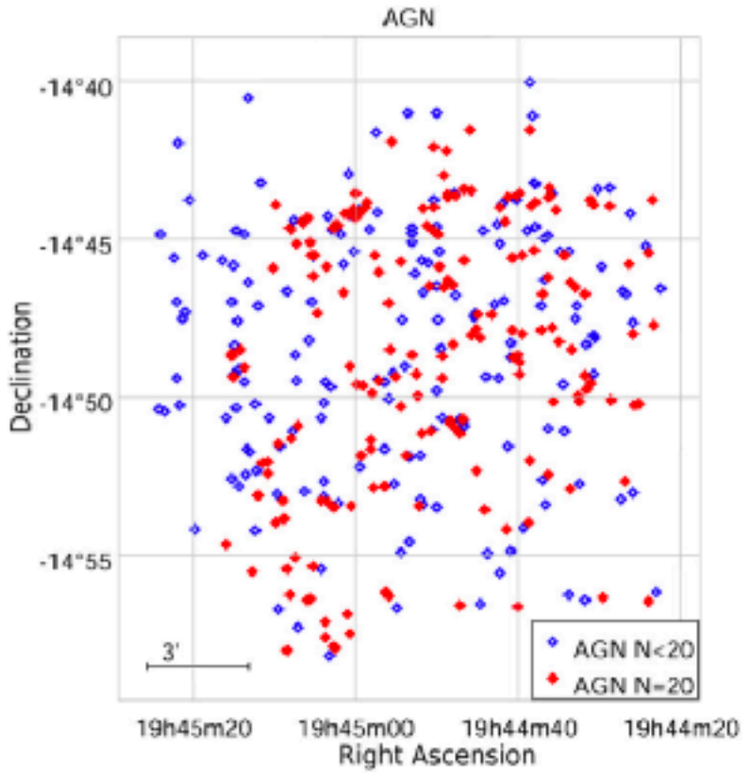


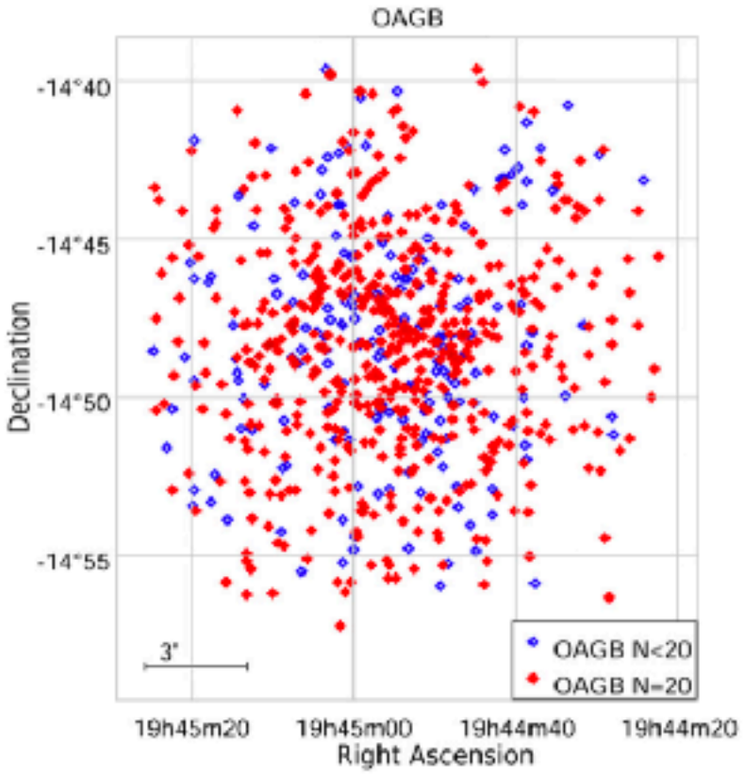
Training data (学習用)

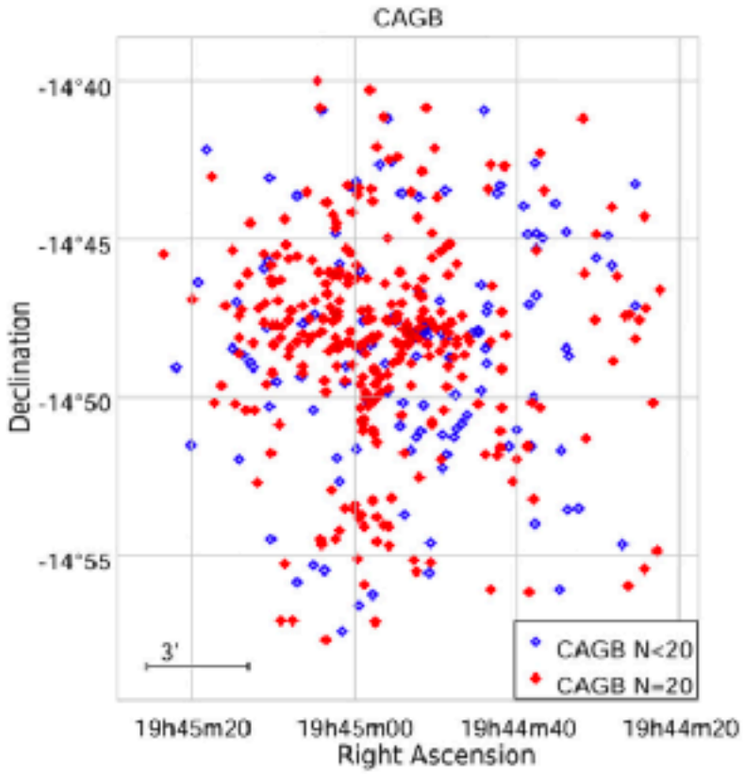


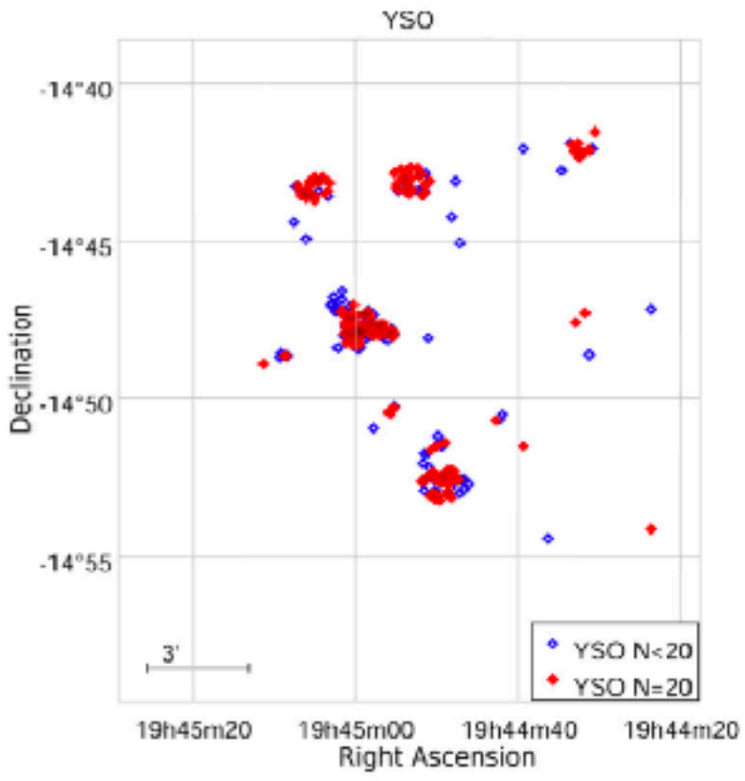


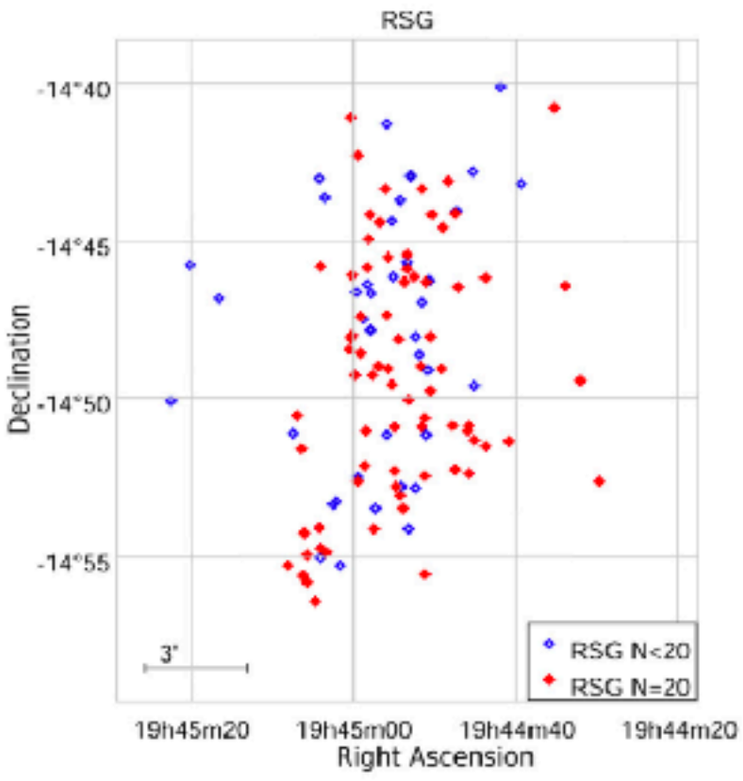
分類ごとの空間分布

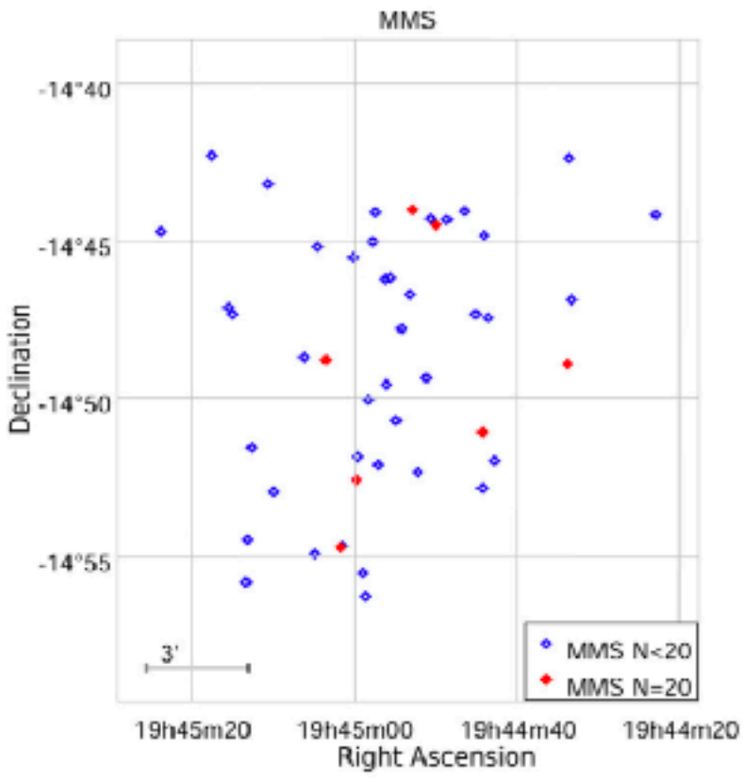

AGN
-14°40
-14°45
-14°50
-14°55
Declination
3'
AGN N<20
AGN N=20
19h45m20
19h45m00
19h44m40
19h44m20
Right Ascension


OAGB
-14°40
-14°45
-14°50
-14°55
Declination
3'
OAGB N<20
OAGB N=20
19h45m20
19h45m00
19h44m40
19h44m20
Right Ascension


CAGB
-14°40
-14°45
-14°50
-14°55
Declination
3'
CAGB N<20
CAGB N=20
19h45m20
19h45m00
19h44m40
19h44m20
Right Ascension


YSO
-14°40
-14°45
-14°50
-14°55
Declination
3'
YSO N<20
YSO N=20
19h45m20
19h45m00
19h44m40
19h44m20
Right Ascension


RSG
-14°40
-14°45
-14°50
-14°55
Declination
3'
RSG N<20
RSG N=20
19h45m20
19h45m00
19h44m40
19h44m20
Right Ascension


MMS
-14°40
-14°45
-14°50
-14°55
Declination
3'
MMS N<20
MMS N=20
19h45m20
19h45m00
19h44m40
19h44m20
Right Ascension