Star Formation News Letter #348 Nos. 19-23

No. 19 Constraints on star formation in NGC 2264, R.J. Parker & C. Schoettler, MNRAS, 510, 1136 (2022)
No. 23 Constraining the initial conditions of NGC 2264 using ejected stars found in Gaia DR2, C. Schoettler et al. MNRAS, 510, 3178 (2022)
No. 20 Sh 2-301: a blistered Hii region undergoing star formation, R. Pandey et al., ApJ, 926, 22 (2022)
No. 21 An upper limit on late accretion and water delivery in the Trappist-1 exoplanet system, S.N. Raymond et al. Nature Astronomy, 6, 80 (2022)
No. 22 A new method for measuring the 3D turbulent velocity dispersion of molecular clouds, M. Stewart & C. Federrath, MNRAS, 509, 5237 (2022)

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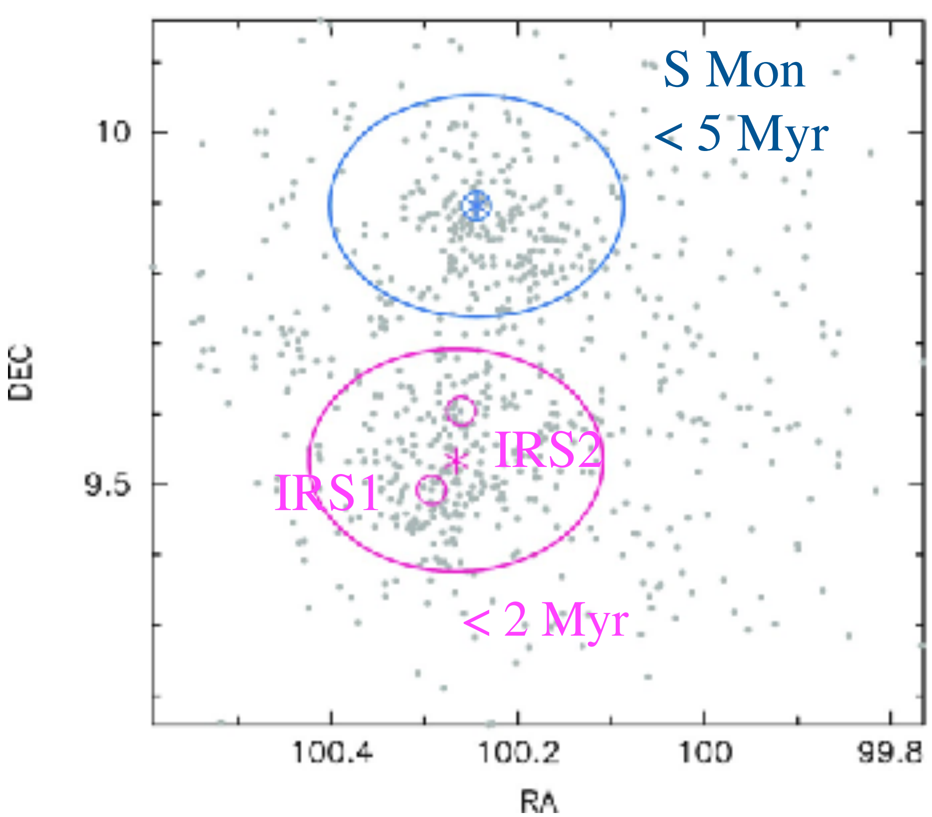
Parker+22 Fig. 1



Gaia DR2 での解析の再検討

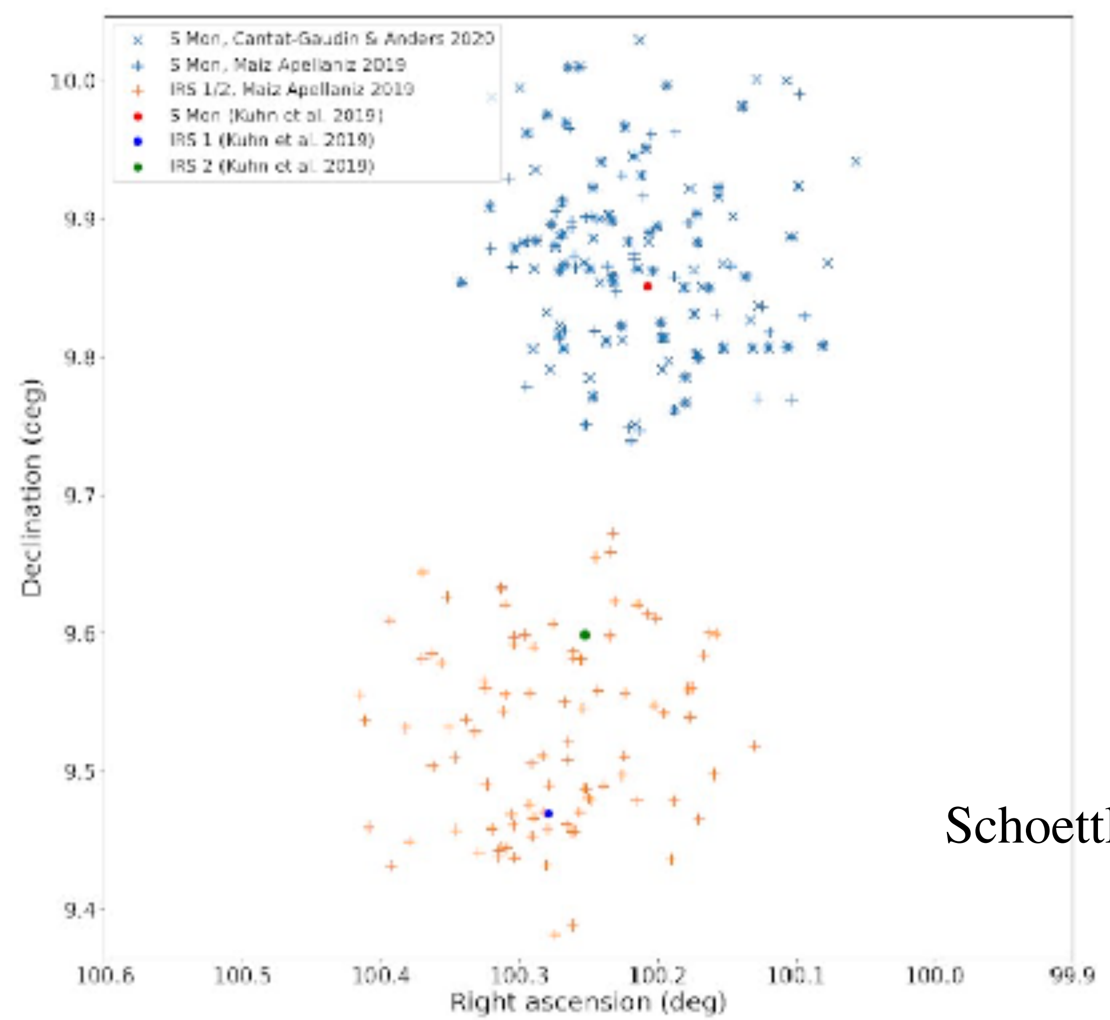
主張は共通: NGC 2264 の**初期密度は$\tilde{\rho} \sim 10^4\ M_\odot\ \mathrm{pc}^{-3}$で高かった**

近接遭遇により円盤を力学的に壊わしただろう

Schoettler+21: Gaia によるデータ解析+ Runaway & Walkaway の頻度

Parker & Schoettler 21: Cluster の substructure が残っているから

解析方法は ONC で成功したもの



Schoettler+21 Fig. 1

Runaway: ＞30 km s^{-1} RW

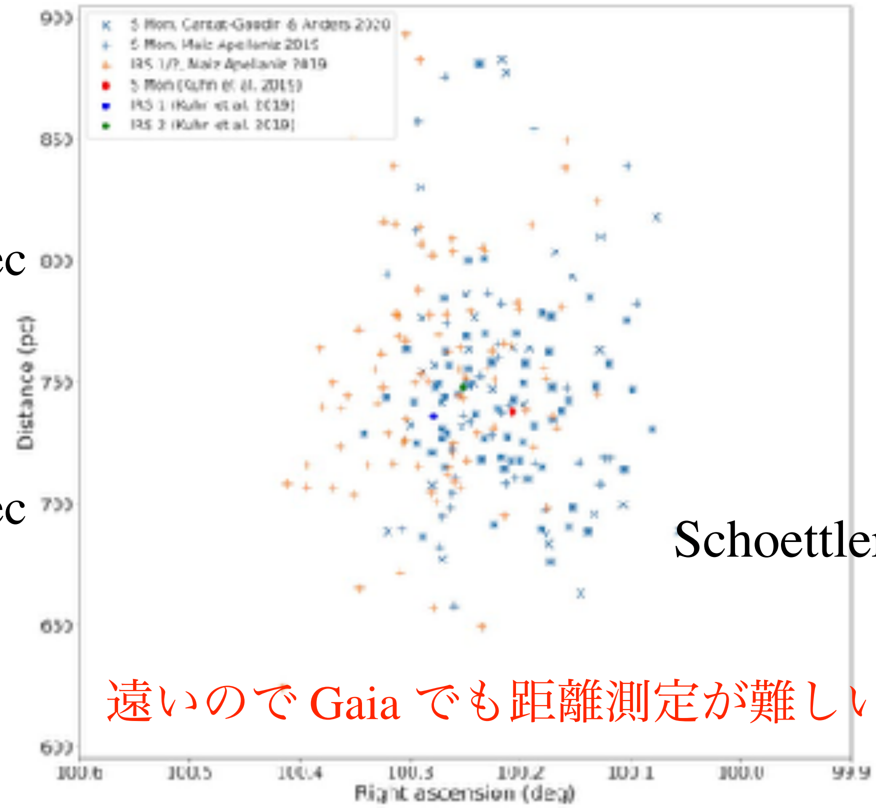
Walkaway: 〜 5 km s^{-1} WW

10 km s^{-1} = 2.6 mas yr^{-1} @800 pc

Gaia EDR3　様々な補正

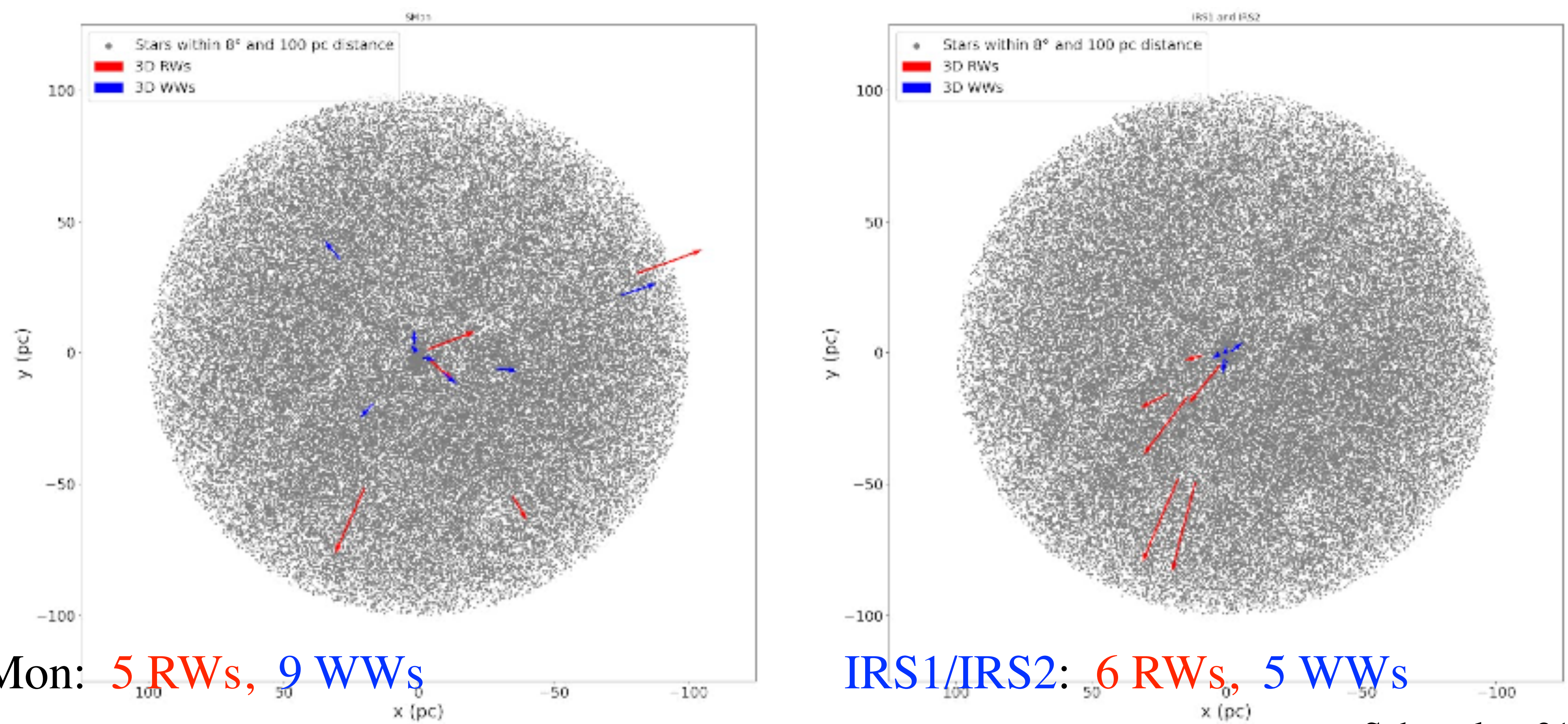
1250 μ arcsec

1429 μ arcsec



Schoettler+21 Fig. 1

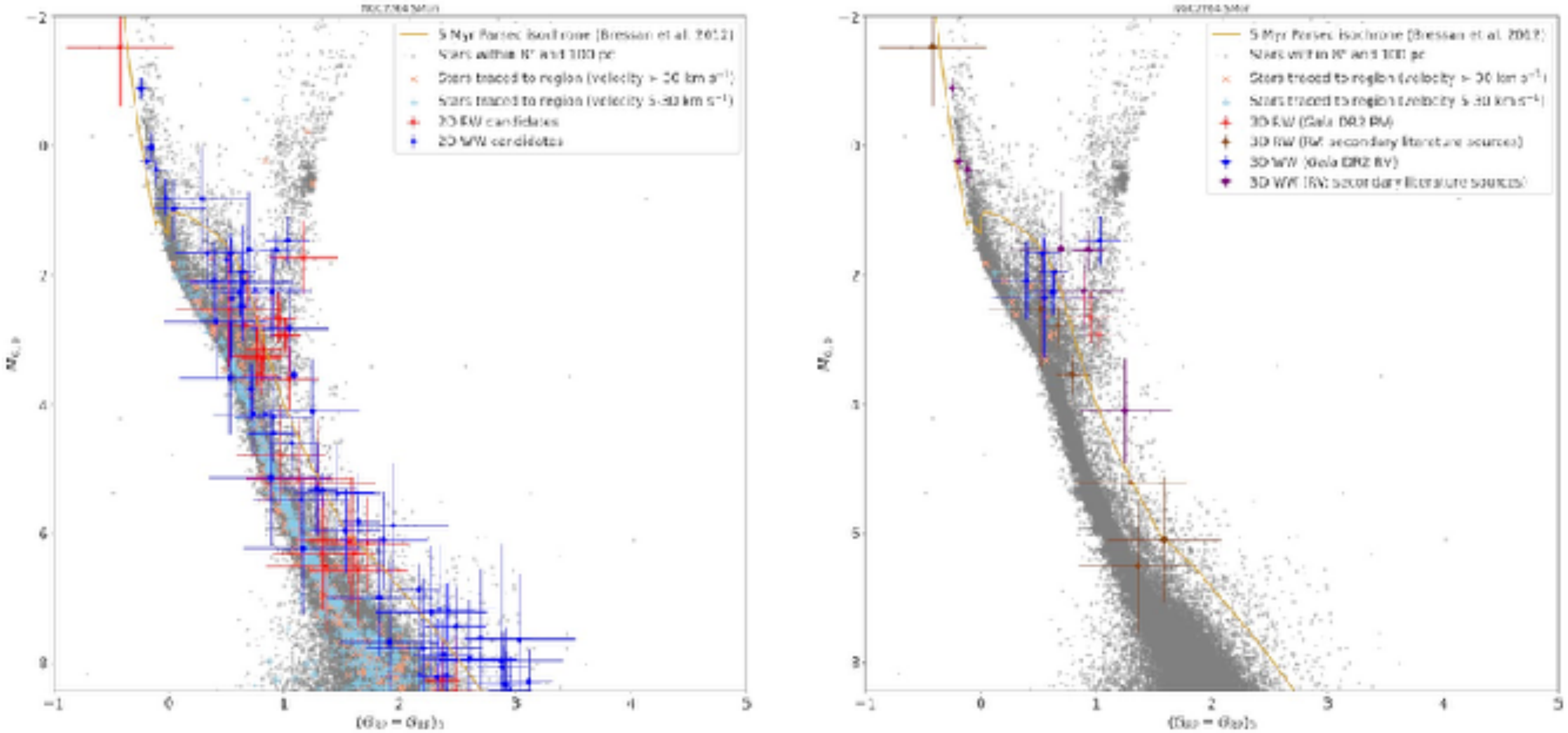
遠いので Gaia でも距離測定が難しい



S Mon: 5 RWs, 9 WWs

IRS1/IRS2: 6 RWs, 5 WWs

Schoettler+21 Fig. 6



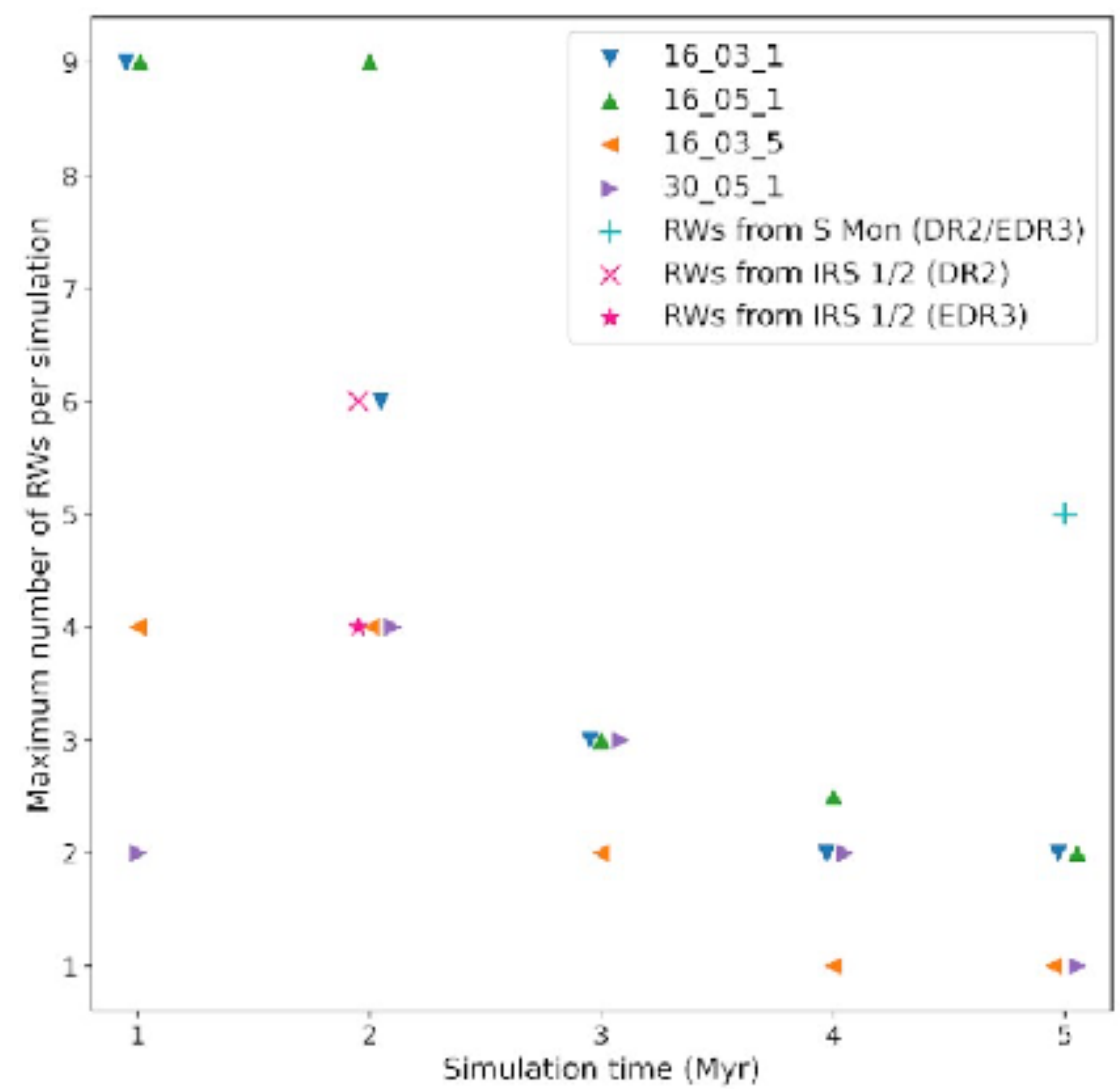
S Mon

RW, WW 候補星，Schoettler+22 Fig. 5

IRS1/IRS2 についても同様の解析．２ Myr.

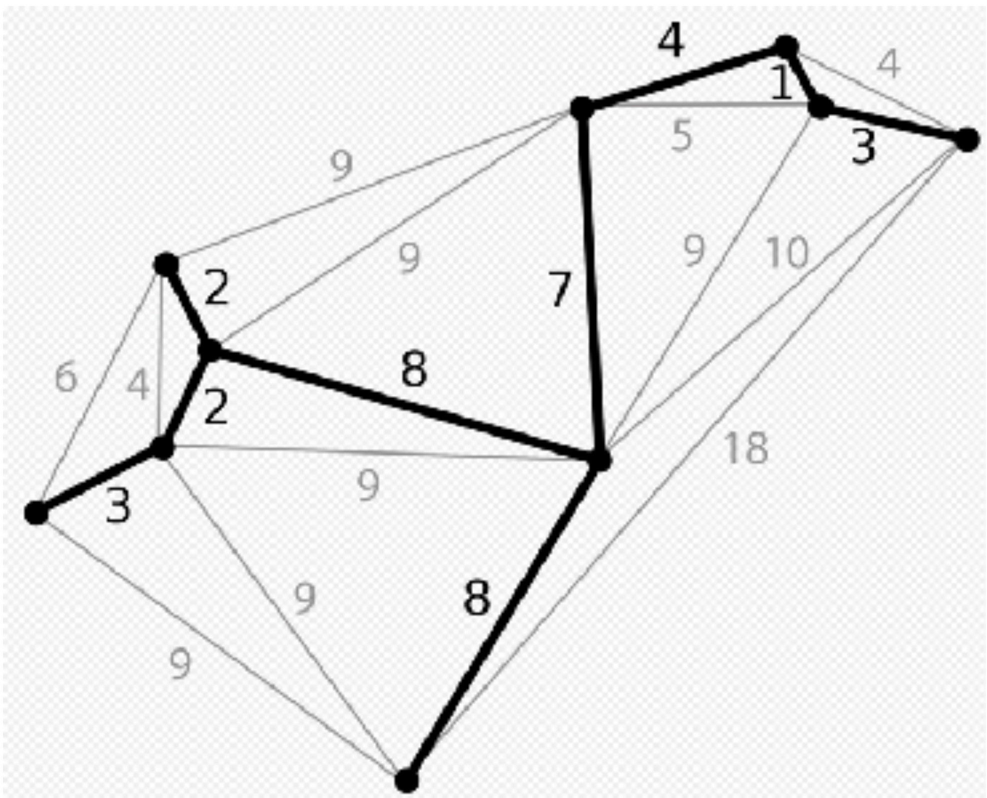
N体シミュレーションとの比較

Schoettler+22 Fig. 5



Cluster の性質を数値化

Minimum Spanning Tree (MST)   Wikipedia



Q-parameter is the mean length of the MST, $\bar{m}$, divided by the mean edge length of the complete graph, $\bar{s}$:

$Q < 0.7$ clumpy
$Q > 0.9$ smooth

$$Q = \frac{\bar{m}}{\bar{s}}.$$

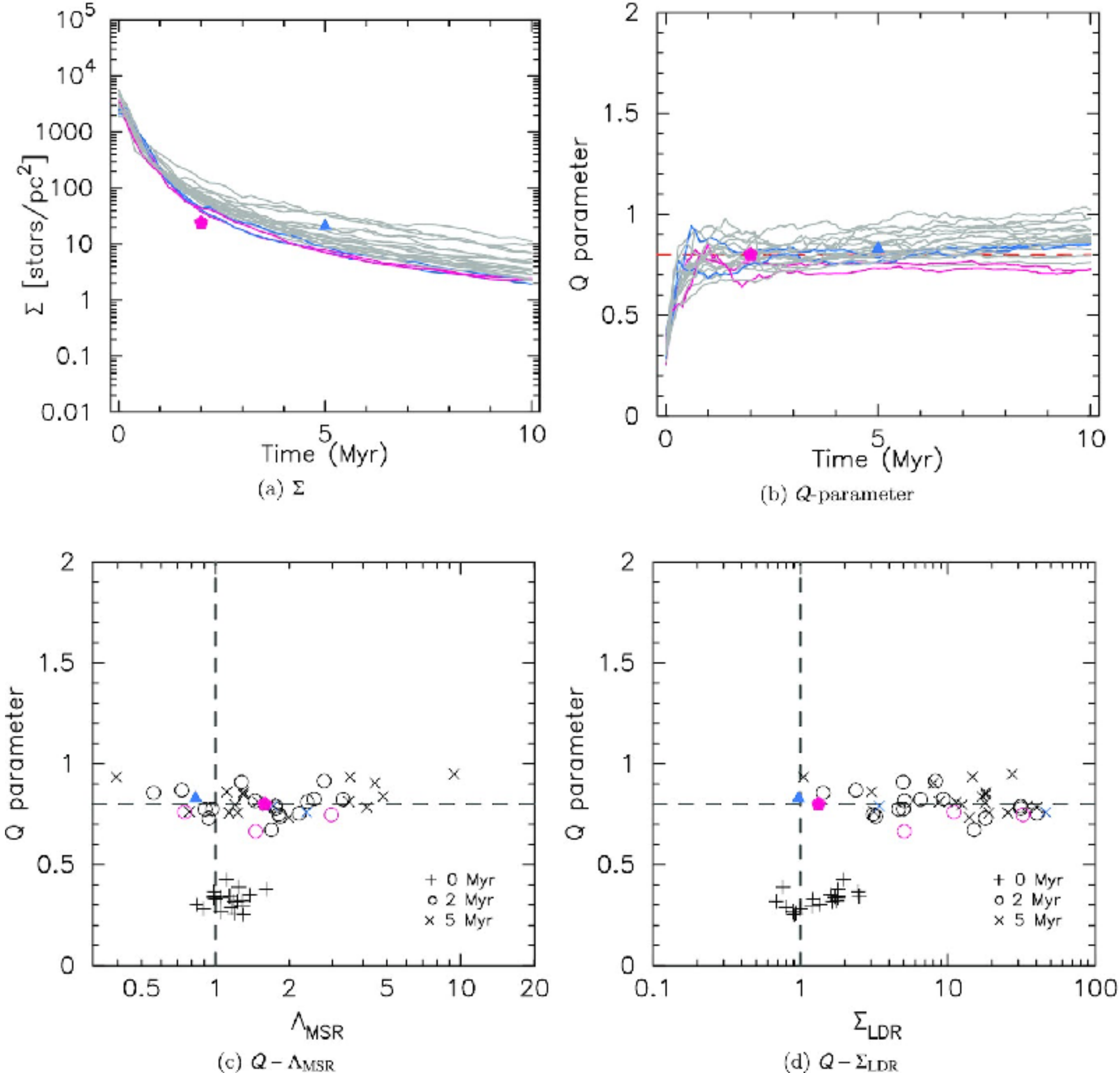
Mass segregation ratio

$$\Lambda_{\mathrm{MSR}} = \frac{\langle l_{\mathrm{average}} \rangle}{l_{\mathrm{subset}}} {}^{+\sigma_{5/6}/l_{\mathrm{subset}}}_{-\sigma_{1/6}/l_{\mathrm{subset}}},$$

Sufrace density

$$\Sigma = \frac{N-1}{\pi r_N^2},$$

$N = 10$



(a) Σ

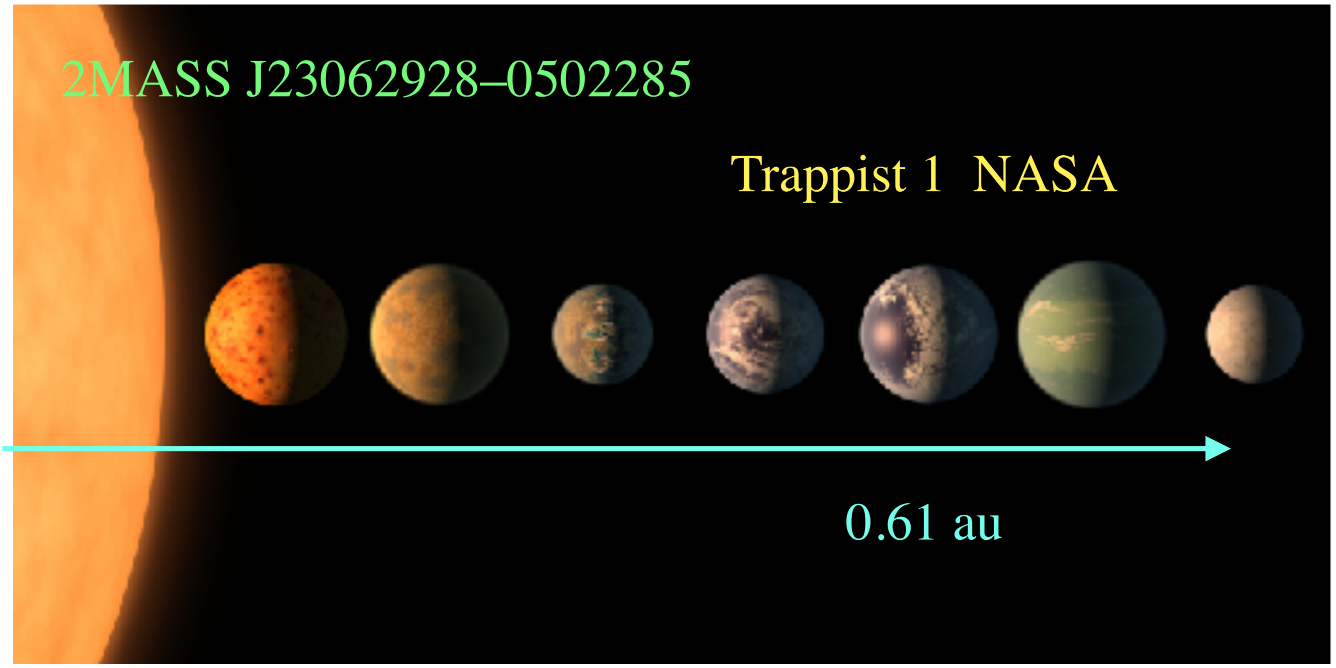
(b) Q-parameter

(c) $Q-\Lambda_{\rm MSR}$

(d) $Q-\Sigma_{\rm LDR}$

初期状態は substructure の度合いが高く、(sub) virial であったはず

No. 21 An upper limit on late accretion and water delivery in the Trappist-1 exoplanet system, S.N. Raymond et al. Nature Astronomy, 6, 80 (2022)



Transiting Planets and Planetesimals Small Telescope

d = 12 pc,

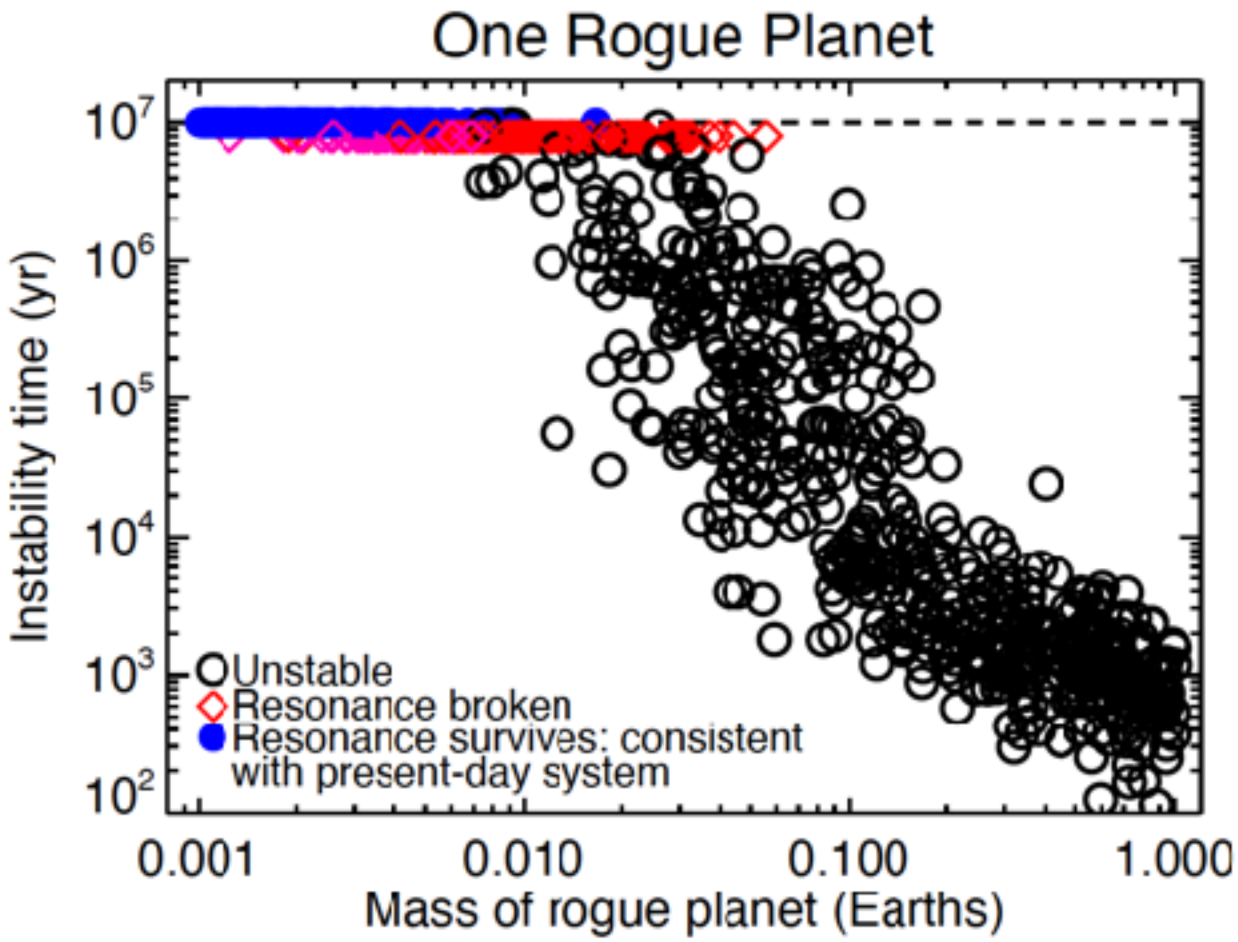
コンパクトな惑星系

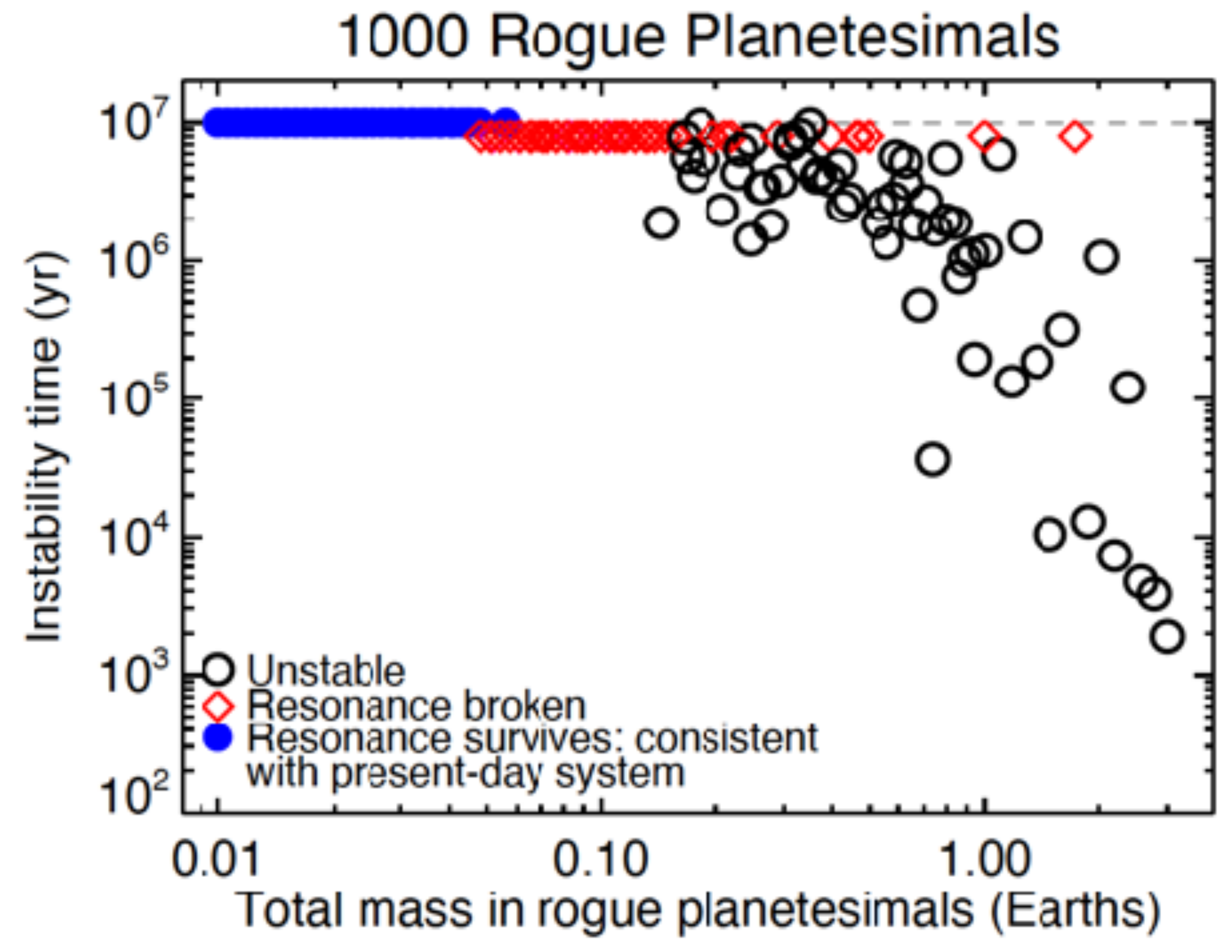
共鳴軌道 8:5, 5:3, 3:2, 3:2, 4:3, 3:2

外から微惑星が乱入したら共鳴が壊れる→共鳴を保つ静穏な環境→水が供給されない

Planet	Mass ($M_\oplus$)	Radius ($R_\oplus$)	Semimajor Axis a (AU)	Eccentricity e	Longitude of periastron ϖ (°)	Mean Anomaly M (°)
Fiducial (Set 1)						
b	1.3925	1.1174	0.011551	0.002344	253.61247	105.78489
c	1.2943	1.0967	0.015820	0.001224	132.62793	54.89836
d	0.3958	0.7880	0.02229	0.005045	202.45580	171.39157
e	0.6824	0.9200	0.02930	0.007013	52.42997	30.97582
f	1.0634	1.0448	0.038551	0.008298	170.04247	247.44087
g	1.3464	1.1294	0.046896	0.003760	355.97714	87.27858
h	0.3198	0.7552	0.061963	0.003571	172.18673	118.58431

Rogue planetesimal: (1) 単一の微惑星が落下, (2) 多数の微惑星の落下

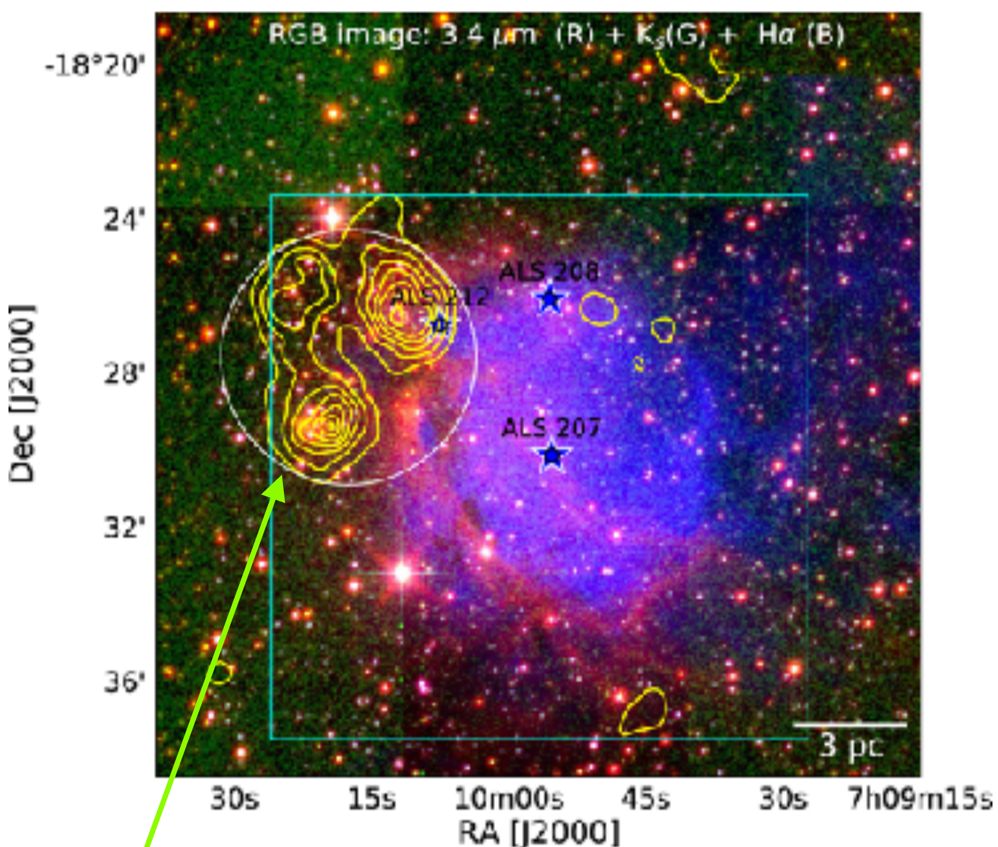




Planet	Orbital radius (AU)	Maximum bombardment mass ($M_\oplus$)	Maximum water delivered (Earth oceans)
b	0.0115	0.00038	0.15
c	0.0158	0.0015	0.64
d	0.0223	0.0016	0.68
e	0.0293	0.0035	1.54
f	0.0385	0.008	3.41
g	0.0469	0.018	7.62
h	0.0620	0.012	6.16

No. 20 Sh 2-301: a blistered Hii region undergoing star formation, R. Pandey et al., ApJ, 926, 22 (2022)

Fig. 1



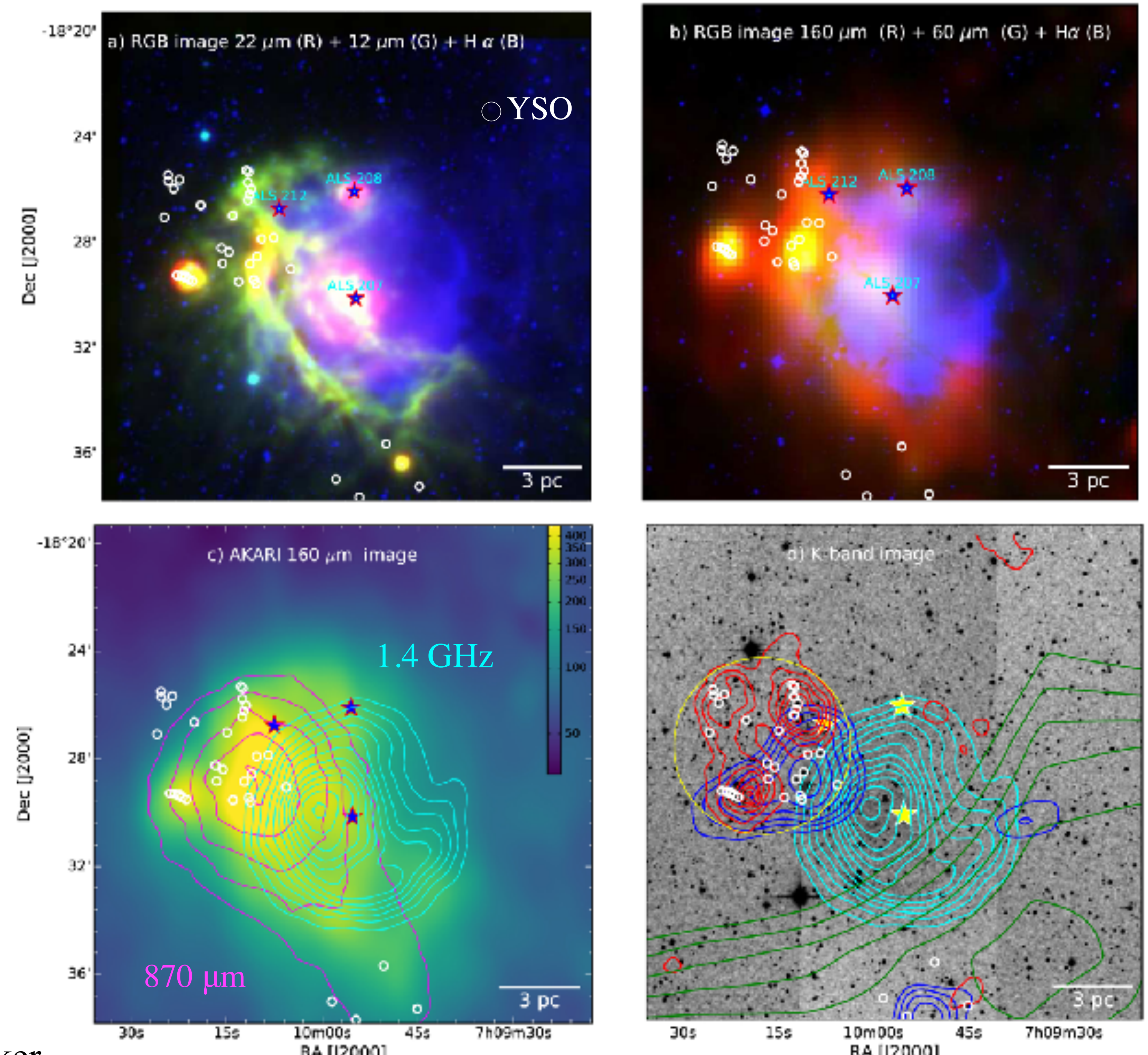
NE cluster
星の面密度

ALS 207 O6.5V
5 Myr
ALS 208 B1III
ALS 212 B1V
若い ～1.5 Myr

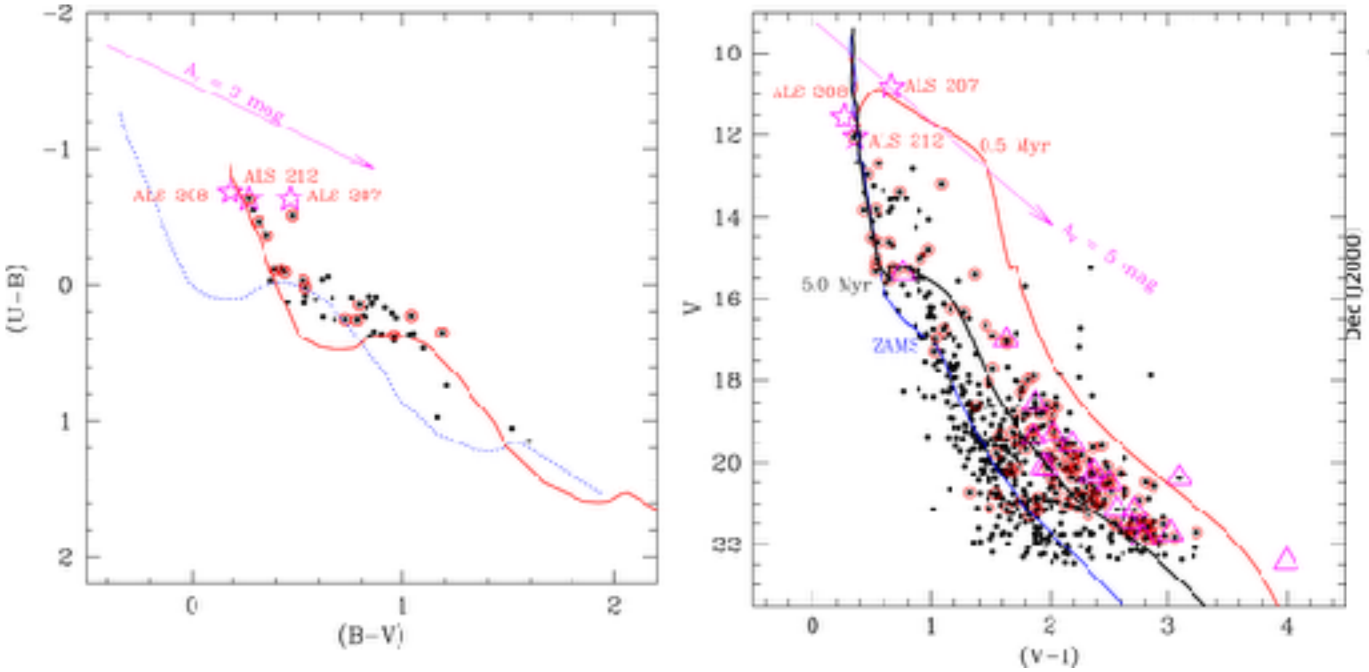
撮像と分光(λ/Δλ=1200)はインドの望遠鏡

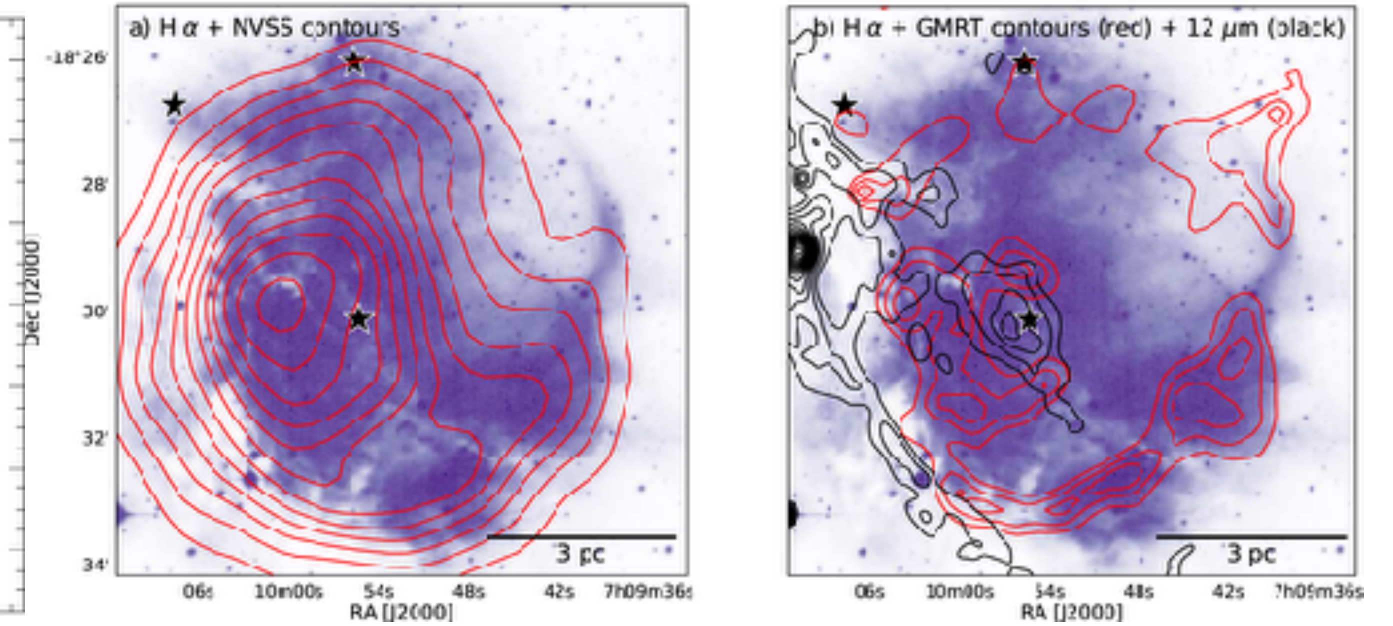
2MASS, Spitzer, AKARI, WISE, Planck, Parker

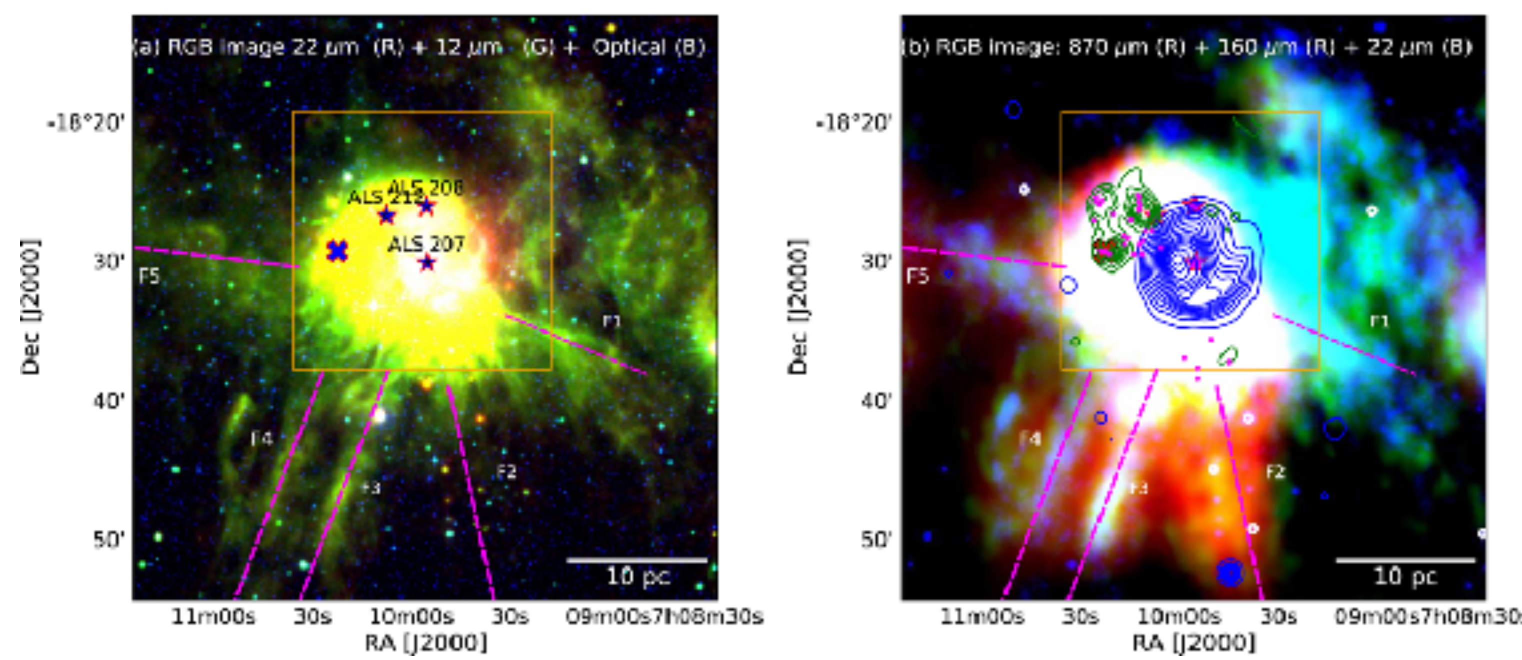
Fig. 11



Star Extinction 1.4 GHz HI







- NE cluster 194 メンバー　距離は 3.54 kpc Sh 2-301 と同じ ALS 207により trigger され形成
- Sh 2-301 の従来の距離 5.8 kpc は過大評価 (赤化側が異常 $R_V = 3.7$)
- Mass function $N \propto M^{-0.87\pm0.07}$ $(0.4 < M/M_\odot < 7)$ やや平坦
- NW側はガス密度が極端に低い
- ALS 207からのUVは漏れている
- ALS 207はHFS で出来た(かも)

No. 22 A new method for measuring the 3D turbulent velocity dispersion of molecular clouds, M. Stewart & C. Federrath, MNRAS, 509, 5237 (2022)

観測された線幅から乱流の強さを見積もる方法の開発

速度分散で視線方向の成分だけが見える．$\sqrt{3}$ 倍するだけで良い??

$$\sigma_{\mathrm{i,los}} = \sqrt{\frac{\sum_p \sigma^2_{v_{\mathrm{los}}\,p}}{N_p}}, \quad \sigma_{v_{\mathrm{los}}\,p} = \left(\left\langle v^2_{\mathrm{los}} \right\rangle_p - \langle v_{\mathrm{los}} \rangle^2_p\right)^{\frac{1}{2}} \quad \forall p. \quad \langle v_{\mathrm{los}} \rangle_p = \frac{\sum_{i=1}^{N_{\mathrm{los}}} \rho_i v_{\mathrm{los}\,i}}{\sum_{i=1}^{N_{\mathrm{los}}} \rho_i} \quad \forall p, \quad \left\langle v^2_{\mathrm{los}} \right\rangle_p = \frac{\sum_{i=1}^{N_{\mathrm{los}}} \rho_i v^2_{\mathrm{los}\,i}}{\sum_{i=1}^{N_{\mathrm{los}}} \rho_i} \quad \forall p.$$

著者がお薦めの推定法

$$\sigma^2_{\mathrm{(p-grad),los}} = \sigma^2_{\mathrm{i,los}} + \sigma^2_{\mathrm{(c-grad),los}}.$$

天球面での速度勾配

$$\sigma_{\mathrm{(c-grad),los}}, \qquad (\langle v_{\mathrm{los}} \rangle - \mathrm{grad}_{\mathrm{los}})_p = \langle v_{\mathrm{los}} \rangle_p - \mathrm{grad}_{\mathrm{los},p}, \qquad \mathrm{grad} = a + bx + cy$$