

Star Formation Newsletter

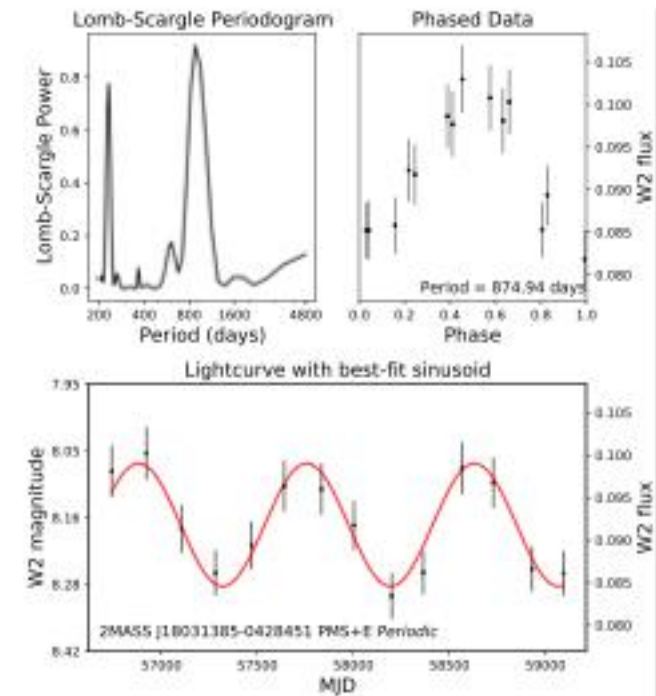
#345 30-35

Yusuke Aso (KASI)

Quantifying Variability of YSOs in the Mid-IR Over Six Years with NEOWISE

WOOSEOK PARK,¹ JEONG-EUN LEE,¹ CARLOS CONTRERAS PEÑA,^{2,3} DOUG JOHNSTONE,^{4,5} GREGORY HERCZEG,^{6,7}
SIEUN LEE,¹ SEONJAE LEE,⁸ ANUPAM BHARDWAJ,⁹ AND GERALD H. MORIARTY-SCHIEVEN⁴

- 変光←突発降着、非一様円盤、磁気リコネクション、連星、星の高温低温スポット。
- 全光度の変化を見るならMIR。
- Spitzer+WISEで若いほど原始星アウトバーストが多い。
- NEOWISEはClass 0-IIIをカバー。
- 0.5-6.5年のMIR測光。1700/5400 (原始星0/Iの55%, 円盤IIの33%, PMS IIIの15%)で変光。
- WISE W1 3.4 μm , W2 4.6 μm , W3 12 μm , W4 22 μm , 6"-12"、半年毎に全天, 14 epochs, 10-20 exposures/epoch~数日。
- W2で5 epochs, 不確かさ<0.2 mag, 座標が既知のものを使用。
- 光度曲線全体の偏差/観測誤差>3、 $\Delta W2 > 3\sigma$ で変光同定。
- Lomb-Scargle periodogram解析と線形フィット。
- 雑音による誤報率が線形フィットで低ければ線形。



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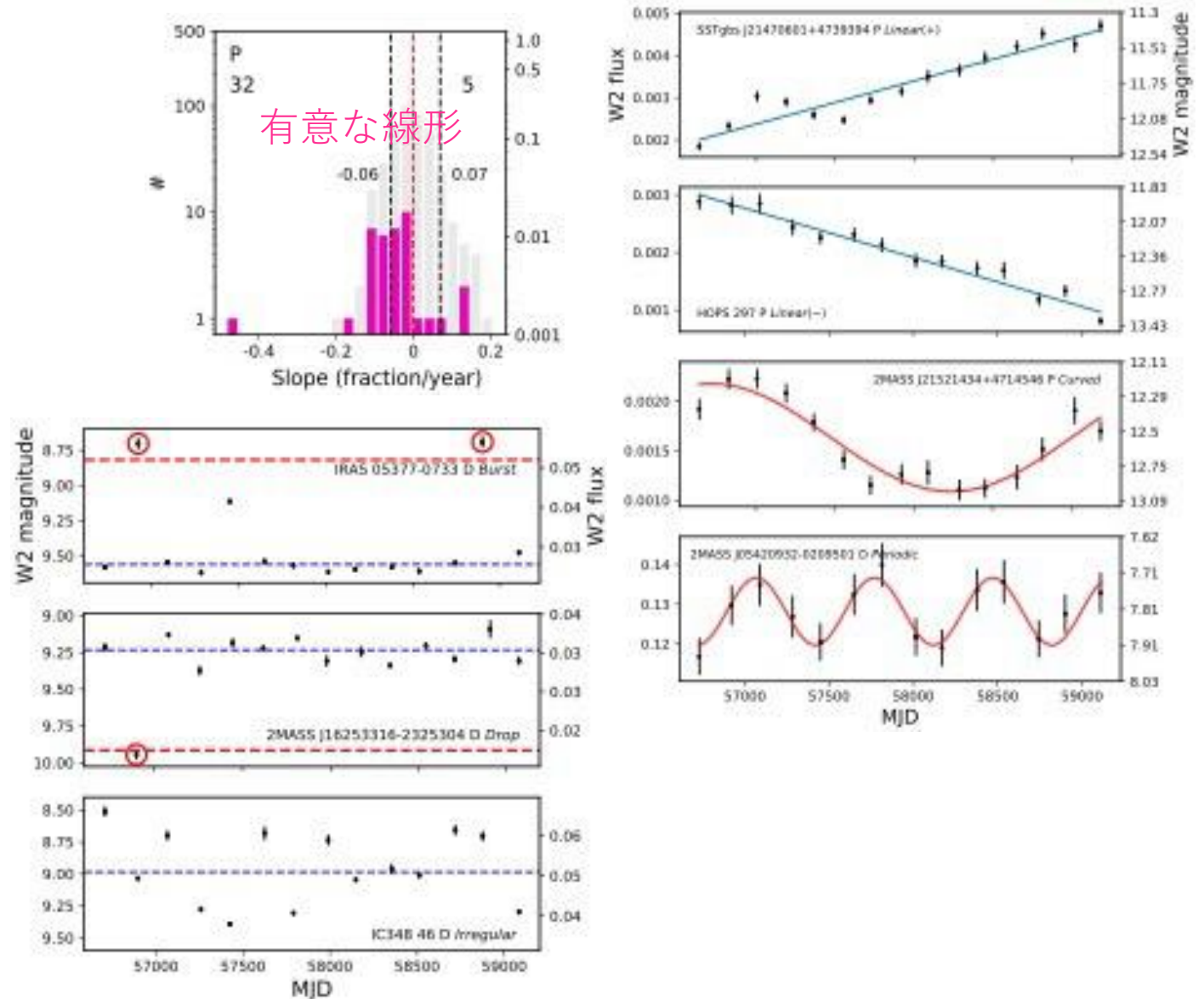
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Secular (29%)

- Linear。負勾配が多い→減衰が長い。
- 周期3-13年Curved。
- 周期<3年Periodic。

Stochastic (71%)

- 数epochs (1-2年) のみの変光。
- (med - min or max)>0.8(max - min) Burst or Drop。
- その他Irregular。



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の続き

- Dropは不均一物質、Burstは粘性磁気不安定。Linearは円盤上の降着率変化。Periodic, Curvedは連星や内円盤の高さ変化。
- 変光率は0/I, II, IIIで55, 33, 15%、強度変化も0/Iが~3倍高い→進化。
- FUor/EXorの60%, VeLLO/LLSの55%→6.5年スケールで同じ。
しかしFUor/EXorはほぼSecular、VeLLO/LLSは半分がIrregular→変光では分けられない。

- FUor ($\Delta W1, W2 > 3$ mag, linear) から間隔を推定。

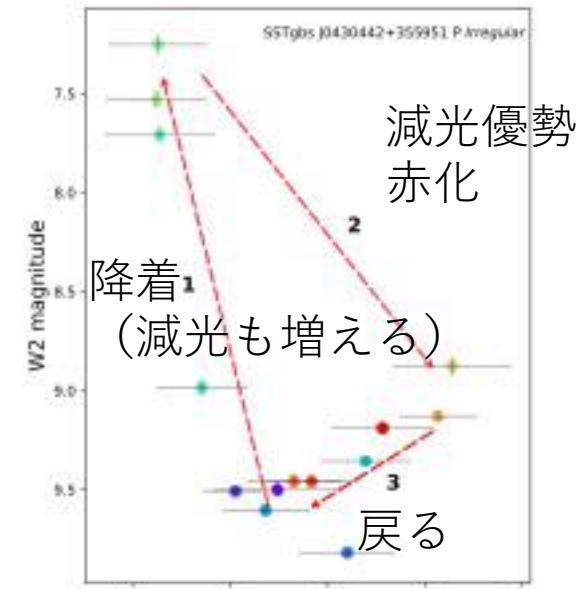
N: 観測原始星数=735-1059

t: 観測時間=6.5 yr

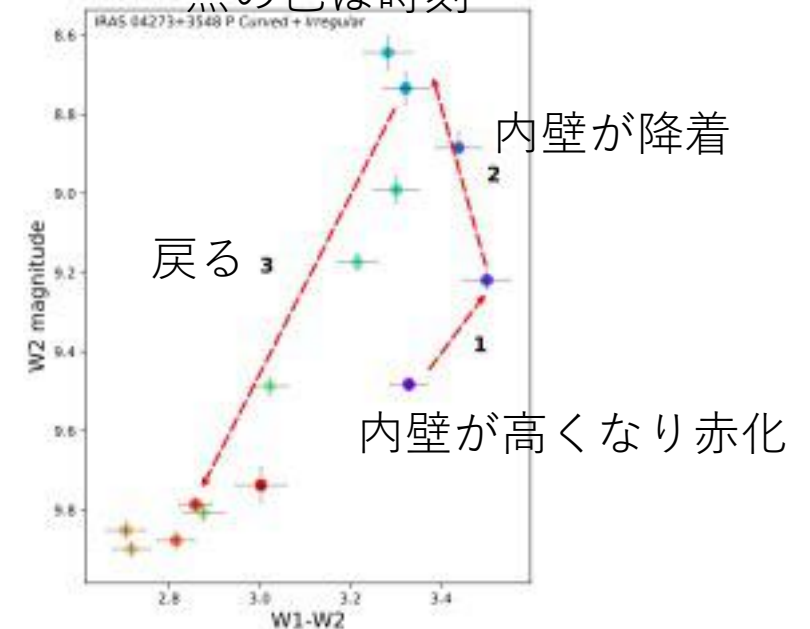
k: 観測FUor数=2-9

τ : バースト間隔

$\tau = Nt/(k+1) = 500-2300$ yr



点の色は時刻



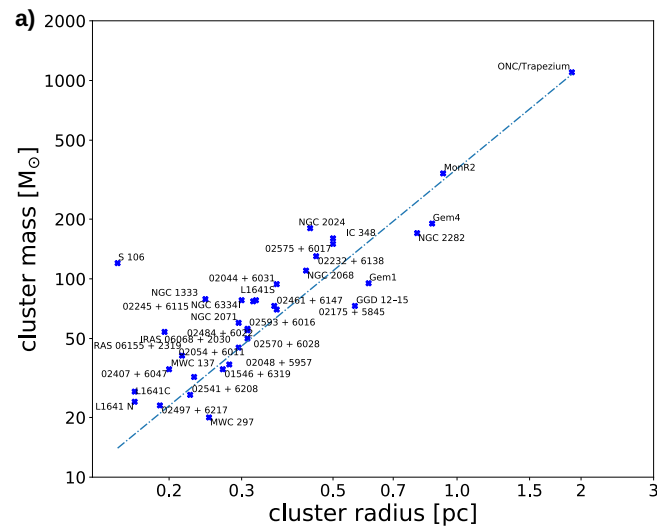
Close stellar flybys common in low-mass clusters

SUSANNE PFALZNER^{1,2} AND AMITH GOVIND^{1,2}

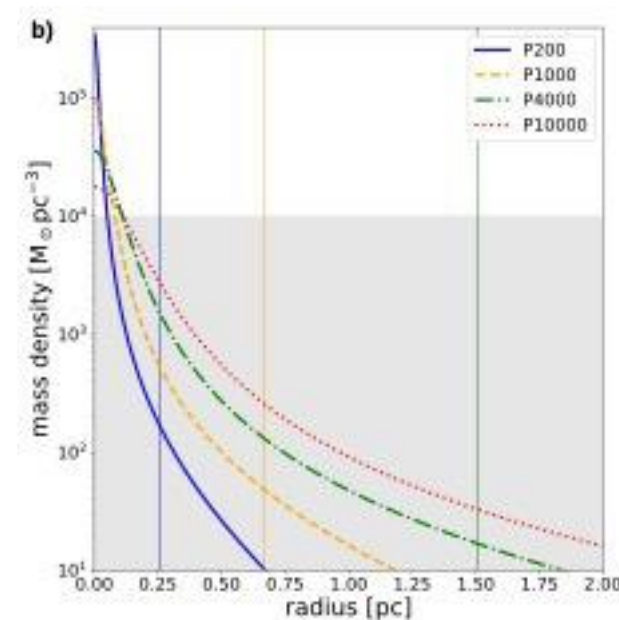
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- 小質量星形成領域の円盤で渦状腕やtruncationがよく見つかるが、flybyは稀とされていた。
- それを確かめるためにクラスターをシミュレーション。
- 環境的影響は $>10^4/\text{pc}^{-3}$ で顕著。半質量半径を1.3 pcに固定すると >1000 個の大質量クラスターでのみ可能。しかし太陽系近傍では $M_c \propto R_{\text{hm}}^{1.6-2.1}$ なので、小質量ほど高密度になる。



クラスター質量と半径の相関



グレーより上は青が赤より多い。
King W=9プロファイル。

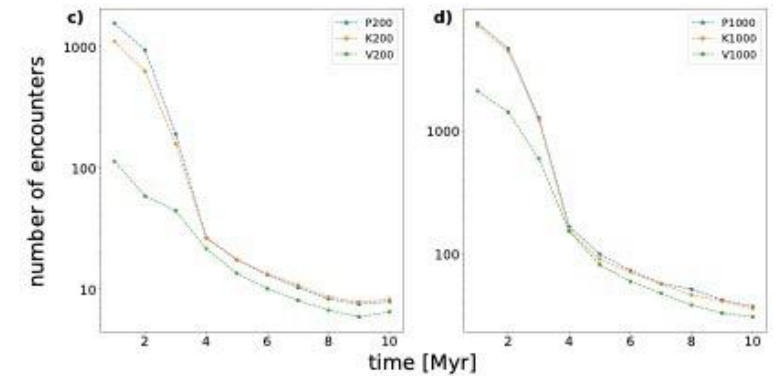
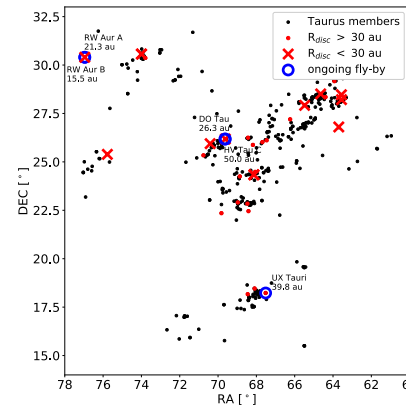
Close stellar flybys common in low-mass clusters

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- シミュレーションは全星ができた状態で始め、2 Myr後にガスが無くなってクラスターが膨張。Nbody6++。
- King W=9に従って星を配置。星質量はあるIMFを使用。0.08-150 Msun。primordial singleのみ。
- ビリアル平衡を仮定してマクスウェル速度分布。
- モデルP: $\gamma=1.7$, K: $\gamma=2.0$, V: $R_c=1.3$ pc。
- flyby発生時の質量比と近星点距離を記録。シミュレーション後にトランケーションを評価。
- 初めは円盤半径は全て1000 au。
$$r_{\text{disc}} = \begin{cases} 0.28 \cdot r_{\text{peri}} \cdot M_{21}^{-0.32}, & \text{if } r_{\text{disc}} < r_{\text{previous}} \\ r_{\text{previous}}, & \text{if } r_{\text{disc}} \geq r_{\text{previous}} \end{cases}$$
 M21=M2/M1, M1: host
- V以外は大小質量で同じ。
- 小質量Vは95%, Pは13%が1000 auのまま。
- Pは10-30%が30 au以下に。
- 配置をPlummer (～小W) にしても同じ。
- スパイラルが見つかったTaurusで<30 auはクラスター中心にいて、割合も合う。
- 端が鋭利なら光蒸発とも区別可能。
- 今まで知られていないのは小質量の10%だと統計的に不足、0.1 Myrで中心から離れるため。

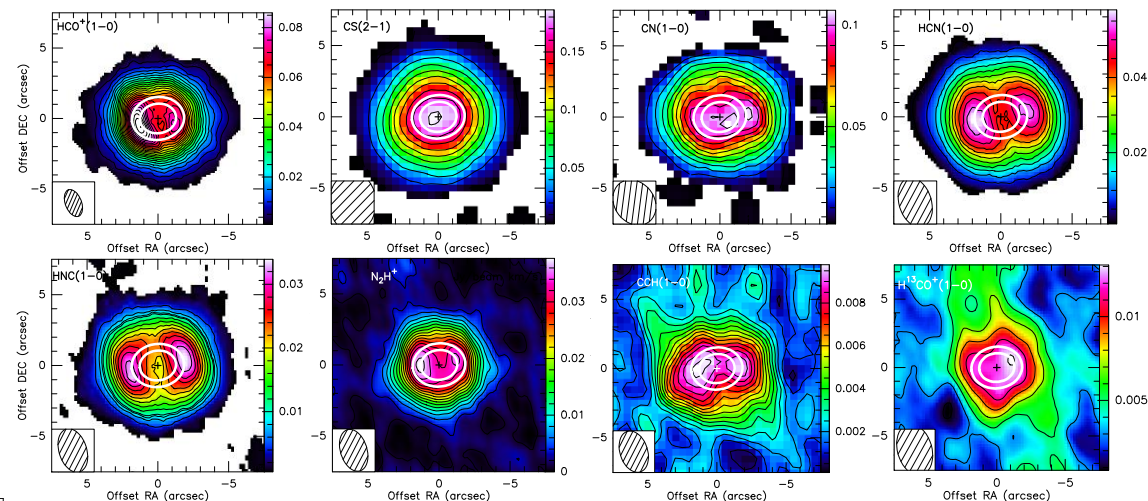


100 au以下になるエンカウント

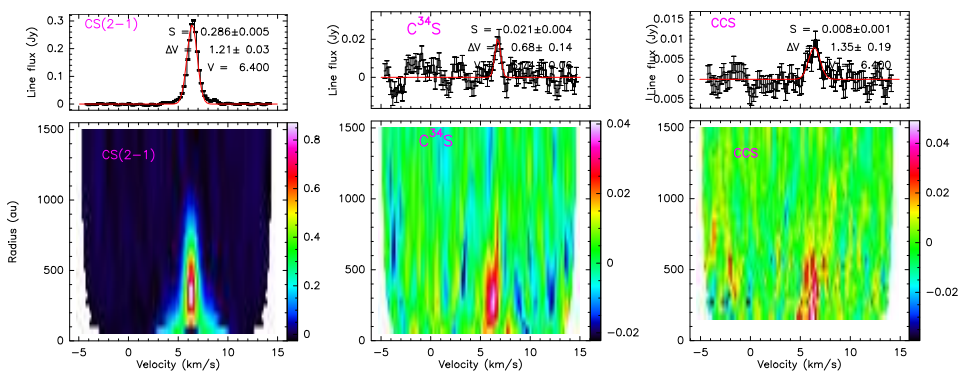
An unbiased NOEMA 2.6 to 4 mm survey of the GG Tau ring: First detection of CCS in a protoplanetary disk

N. T. Phuong^{1,2}, A. Dutrey³, E. Chapillon^{3,4}, S. Guilloteau³, J. Bary⁵, T. L. Beck⁶, A. Coutens⁷,
O. Denis-Alpizar⁸, E. Di Folco³, P. N. Diep², L. Majumdar⁹, J.-P. Melisse^{3,4}, C.-W. Lee^{1,10}, V. Pietu⁴,
T. Stoecklin¹¹, and Y.-W. Tang¹²

- PPDの化学は分子雲からとその場。GG Tau Aa-Ab1/b2の円盤は大きく、低温で重いので分子化学向き。
- NOEMA, 2.6-4.2 mm, $dv=0.2-0.3$ km/s
 - この8つは超微細構造の比とピークから光学的に薄い。
 - 南東ホットスポットによる非対称



白は連続波リング



dprj半径対速度

$R < 200$ auの分離はtidal cavity

An unbiased NOEMA 2.6 to 4 mm survey of the GG Tau ring: First detection of CCS in a protoplanetary disk

の続き

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- DiskFitで Σ_{150} をフィット。S系以外CO温度 ($T_0=25$ K)、CSは赤道面近くなのでS系はダスト温度 ($T_0=15$ K)。この仮定は軽い分子でも Σ_{150} を2倍変える程度の影響。
- CCSを初検出。 $\Sigma_{150}=1.5e12$ cm⁻²。3層気体粒子化学モデルNautilusの予想より20倍高い。
- SO, SO₂, HC₃Nはモデルと合うが、H₂Sはモデルの1%。
- H₂Sがダスト粒子上で複雑な分子になるなど、S化学モデルに不完全な点があることを示唆。

Geometry		Law	
Inclination	35°	$V(r) = 3.4 \left(\frac{r}{100 \text{ au}}\right)^{-0.5}$	(km s ⁻¹)
Orientation	7°	$T(r) = T_0 \left(\frac{r}{200 \text{ au}}\right)^{-1.0}$	(K)
Systemic velocity	6.4 km s ⁻¹	$\Sigma(r) = \Sigma_{250} \left(\frac{r}{250 \text{ au}}\right)^{-1.5}$	(cm ⁻²)

- dark cloud TMC1、遷移円盤LkCa 15と比較。
- ラジカル (CN, CCH) がLkCa 15より少ないのはGG TauのリングがUVを遮断するから。
- CCSがTMC1より少ないのはCCSがCSになる一方で、円盤でS⁺からCCSを作る経路の効率が悪いから。

Mol.	TMC-1	LkCa 15	GG Tau	Mol.	TMC-1	LkCa 15	GG Tau
C ¹⁸ O	1.1 × 10 ⁴ (1)	2.8 × 10 ⁴ (7)	2.2 × 10 ⁴	C ³⁴ S	10 ± 1
CN	2250 (1)	3100 (8)	660 ± 30	CS	1500 (3)	520 (8)	230 ± 10
¹³ CN	25 ± 10	¹³ CS	11 (4)	2.8 (10)	2.2 ± 0.6
CCH	5960 (2)	1200 (8)	600 ± 30	CCS	240 (3)	...	13 ± 2
N ₂ H ⁺	7680 (1)	19.1 (9)	10.5 ± 0.5	OCS	1500 (1)	...	0.4 ± 0.2
HCN	1500 (2)	300 (8)	57 ± 3	DCN	22 (6)	7.5 (9)	1.6 ± 1.0
HNC	1500 (2)	...	29 ± 2	DNC	124 (6)	3.5 (9)	2.3 ± 1.1
HCO ⁺	596 (2)	350 (8)	125 ± 5	DCO ⁺	30 (5)	4.5 (11)	3.5 ± 0.2 (13)
H ¹³ CO ⁺	8.3 (1)	5.0 (12)	3.4 ± 0.2				
H ₂ CO	1500 (2)	13.6 (9)	33 ± 2 (*)	HC ₃ N	473 (2)	7.3 (12)	4.6 ± 0.9

**INTERPRETATION OF OPTICAL AND IR LIGHT CURVES
FOR TRANSITIONAL DISKS CANDIDATES IN NGC 2264
USING THE EXTINGUISHED STELLAR RADIATION AND THE
EMISSION OF OPTICALLY THIN DUST INSIDE THE HOLE**

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Draft version: August 30, 2021

ABSTRACT

In the stellar forming region NGC 2264 there are objects catalogued as hosting a transitional disk according to spectra modeling. Four members of this set have optical and infrared light curves coming from the *CoRoT* and *Spitzer* telescopes. In this work, we try to simultaneously explain the light curves using the extinction of the stellar radiation and emission of the dust inside the hole of a transitional disk. For the object Mon-296, we were successful to do this. However, for Mon-314, and Mon-433 our evidence suggests that they host a pre-transitional disk. For Mon-1308 a new spectra fitting using the 3D radiative transfer code Hyperion, allow us to conclude that this object host a full-disk instead of a transitional disk. This is in accord to previous work on Mon-1308 and with the fact that we cannot find a fit of the light curves only using the contribution of the dust inside the hole of a transitional disk.

分光モデルから遷移円盤と思われる4個の穴の光度曲線とダスト放射を説明。
Mon-296はOK。Mon-314とMon-433はpre遷移円盤ではない。Mon-1308は完全な円盤。

The first spectroscopically confirmed brown dwarfs in NGC 2264

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ABSTRACT

We present spectroscopic follow-up observations of 68 red, faint candidates from our multi-epoch, multiwavelength, previously published survey of NGC 2264. Using near-infrared spectra from VLT/KMOS, we measure spectral types and extinction for 32 young low-mass sources. We confirm 13 as brown dwarfs in NGC 2264, with spectral types between M6 and M8, corresponding to masses between 0.02 and 0.08 M_{\odot} . These are the first spectroscopically confirmed brown dwarfs in this benchmark cluster. 19 more objects are found to be young M-type stars of NGC 2264 with masses of 0.08–0.3 M_{\odot} . 7 of the confirmed brown dwarfs as well as 15 of the M-stars have IR excess caused by a disc. Comparing with isochrones, the typical age of the confirmed brown dwarfs is <0.5 –5 Myr. More than half of the newly identified brown dwarfs and very low-mass stars have ages <0.5 Myr, significantly younger than the bulk of the known cluster population. Based on the success rate of our spectroscopic follow-up, we estimate that NGC 2264 hosts 200–600 brown dwarfs in total (in the given mass range). This would correspond to a star-to-brown dwarf ratio between 2.5:1 and 7.5:1. We determine the slope of the substellar mass function as $\alpha = 0.43^{+0.41}_{-0.56}$; these values are consistent with those measured for other young clusters. This points to a uniform substellar mass function across all star-forming environments.

NGC2264の13個のBDを分光同定。M6-M8 (0.02-0.08 Msun)。7個は円盤。大体 <0.5 Myr。
substellar MF $\alpha = 0.43$ 。

An orbital release model for the Orion BN/KL fingers

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ABSTRACT

We present a simple model in which the bullets that produce the “Orion fingers” (ejected by the BN/KL object) are interpreted as protoplanets or low mass protostars in orbit around a high mass star that has a supernova explosion. As the remnant of the SN explosion has only a small fraction of the mass of the pre-supernova star, the orbiting objects then move away in free trajectories, preserving their orbital velocity at the time of release. We show that a system of objects arranged in approximately co-planar orbits results in trajectories with morphological and kinematical characteristics resembling the Orion fingers. We show that, under the assumption of constant velocity motions, the positions of the observed heads of the fingers can be used to reconstruct the properties of the orbital structure from which they originated, resulting in a compact disk with an outer radius of ~ 2.4 AU.

Orion fingersを作る弾丸が超新星爆発した大質量星を周る小質量原始星だというモデル。