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MASSIVE STAR FORMATION IN THE LMC. I. N159 AND N160 COMPLEXES

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ABSTRACT

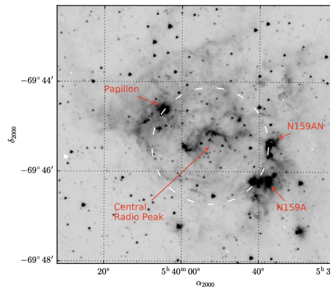
- LMCの3つのHII領域 (N159A, N159Papillon, N160) における massive young stellar object の撮像観測。
- 3つの領域のYSOの年齢やdustの特性からそれらの星形成のシナリオを議論。

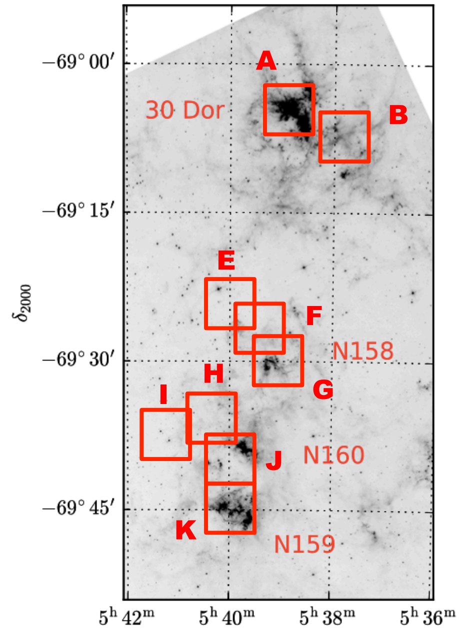
- この領域の大質量星の形成起源は様々…

-- 30 Dor からHII領域の膨張により N160, N159の星形成が起きた説。

-- N159 の HII 領域の膨張による internal triggered star formation。

→ SOFIAを始めとする観測データからSEDを作成し、YSOの年齢、dustの情報から星形成を議論。





▲図1：SST/IRAC 5.8um画像。赤い□はminiTAO/ANIRでの観測領域。

2. OBSERVATIONS

- SOFIA/ FORCAST 25.3-37.1 μm
- Spitzer/IRAC 3.6-8.5 μm
- 2MASS
- Herschel/PACS 100 μm

3. Results

- **YSO model fit**

→ 星の年齢、dust model fit → dust 温度、質量。

-- N159A: 0.03Myr、Tdust~60 K、Mdust~10^{-3}M◎

-- N159Papillon: 0.7Myr、Tdust~100 K、Mdust~10^{-2}M◎

-- N160: 0.2Myr、Tdust~90 K、Mdust~10^{-1}M◎

→ 先行研究で求められた YSO の年齢が~3Myr。

→ 本研究のSEDで求めた年齢と矛盾。

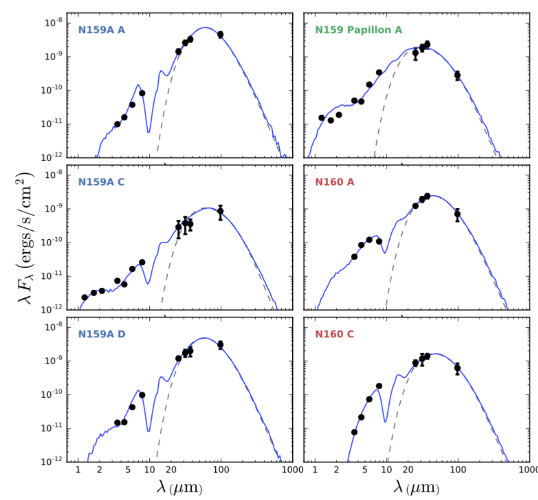


Figure 6. Photometry and Robitaille et al. (2007) YSO model fits (solid line) for selected sources in all three H II regions. Gray dashed lines represent modified graybody fits to the models for $\lambda > 20\ \mu$m (see Section 3). The average dust temperatures for sources in N159A, N159 Papillon, and N160 are ~60, 100, and 90 K, respectively. The best-fitting dust temperatures for individual sources are included in Table 3.

- **Color-Magnitude diagram**

-- N159Aが一番赤い

→ 冷たいダストやガスがまだたくさんある。

→ N159Aが一番若い領域。

- **Color-Color diagram**

-- YSOの進化段階を探る。

-- 先行研究（Reach+2004, Rho+2006）のYSO分類を適応。

--- Class I/0：原始星

--- Class II：diskを伴う若い星

--- hot excess: 活動的な降着を伴う前主系列星

→ N159 Papillonが最も進化が進んだYSO。

→ SED model fitの結果とconsistent。

4. Discussion

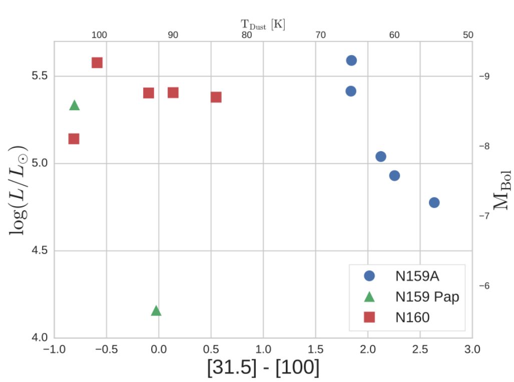
- 年齢

-- N159P > N160 > N159A

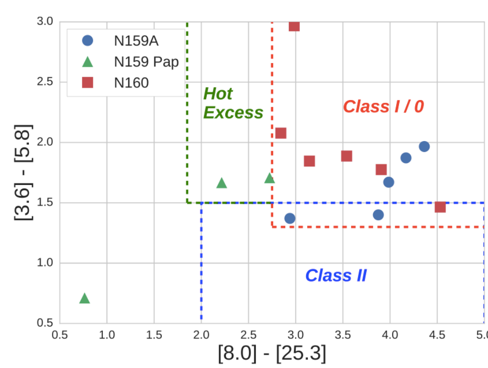
- 進化

-- NorthからSouthに向ってYSOが進化（30Dor起源のTriggered Starformation)の傾向は見られず。

-- N159PとN159AのYSOの年齢の違いは、N159のHII領域の拡がりによるTriggered Starformationで説明できる。



▲図7：Color-Magnitude diagram



▲図8：Color-Color diagram

Table 2
Photometry of IR Sources

Source	2MASS ID	Other ID[a]	α_{2000}	δ_{2000}	J[b] (mJy)	H (mJy)	K_s (mJy)	3.6[c] (mJy)	4.5 (mJy)	5.8 (mJy)	8.0 (mJy)	25.3[d] (Jy)	31.5 (Jy)	37.1 (Jy)	100[e] (Jy)
N159A															
A	…	C5, J84.905917-69.757105	05:39:37.44	−69:45:25.5	…	…	…	11.75	23.54	71.88	217.39	12.09	27.31	40.89	149.14
B	05393712-6945370	…	05:39:37.03	−69:45:36.7	0.96	2.04	1.35	7.46	18.48	41.84	61.26	2.85	7.38	9.62	58.93
C	05393608-6946039	DCL 240, C4	05:39:35.97	−69:46:04.2	0.97	1.78	2.65	8.69	8.51	31.56	68.34	2.43	3.97	4.42	28.06
D	…	C3	05:39:37.56	−69:46:09.3	…	…	…	17.51	22.65	81.56	256.64	10.08	18.32	24.65	99.53
E	05394188-6946122	P2, C2	05:39:41.80	−69:46:11.9	1.22	2.48	9.12	43.71	78.13	154.49	232.54	3.48	6.75	9.07	76.5
N159 Papillon															
A	05400448-6944375	MSX6C, M371	05:40:04.34	−69:44:37.3	6.35	7.15	13.55	59.06	69.2	284.78	900.28	11.06	19.39	28.44	9.22
B	…	…	05:40:09.43	−69:44:53.9	…	…	…	5.52	3.67	25.62	65.05	0.50	1.29	2.20	1.26
C	05395936-6945263	P1, M210	05:39:59.32	−69:45:26.4	0.42	2.64	12.24	47.11	59.60	90.72	140.06	0.28	…	…	…
N160															
A	…	J84.932653-69.642627, H46-48	05:39:43.78	−69:38:33.4	…	…	…	44.98	125.64	230.77	283.14	10.34	20.30	29.71	23.02
B	…	H56, H58	05:39:46.00	−69:38:38.9	20.83	20.46	31.90	59.68	87.31	230.05	600.17	38.99	69.98	97.46	40.64
C	…	H36, H41	05:39:44.40	−69:38:47.4	…	…	…	9.14	31.70	140.40	477.1	7.45	12.32	17.27	20.41
D	…	H35	05:39:43.19	−69:38:53.9	17.71	13.38	20.22	34.58	68.84	189.28	593.95	10.76	14.73	18.75	6.97
E	…	H24	05:39:38.99	−69:39:11.7	2.45	5.51	7.21	24.65	27.86	140.24	380.45	9.91	21.59	34.51	19.73
F	…	…	05:39:38.70	−69:39:04.0	…	0.49	2.22	17.20	15.99	116.55	339.00	4.65	8.21	12.46	…

Notes. Photometric error is included in the online version of this table.
[a] Sources labeled C2–C5 in N159A are identified as compact clusters in Bernard et al. (2016). N159A A and N160 A are in Seale et al. (2014; see Section 2.3). N160 sources are matched to sources in Heydari-Malayeri et al. (2002).
[b] JHK_s: 2MASS.
[c] 3.6–8.0 μm: *Spitzer*/IRAC.
[d] 25.3–37.1 μm: SOFIA/FORCAST.
[e] 100 μm: *Herschel*/PACS.
(This table is available in its entirety in machine-readable form.)