Sub-mm observations of compact cores associated with a massive young stellar object in NGC 3603

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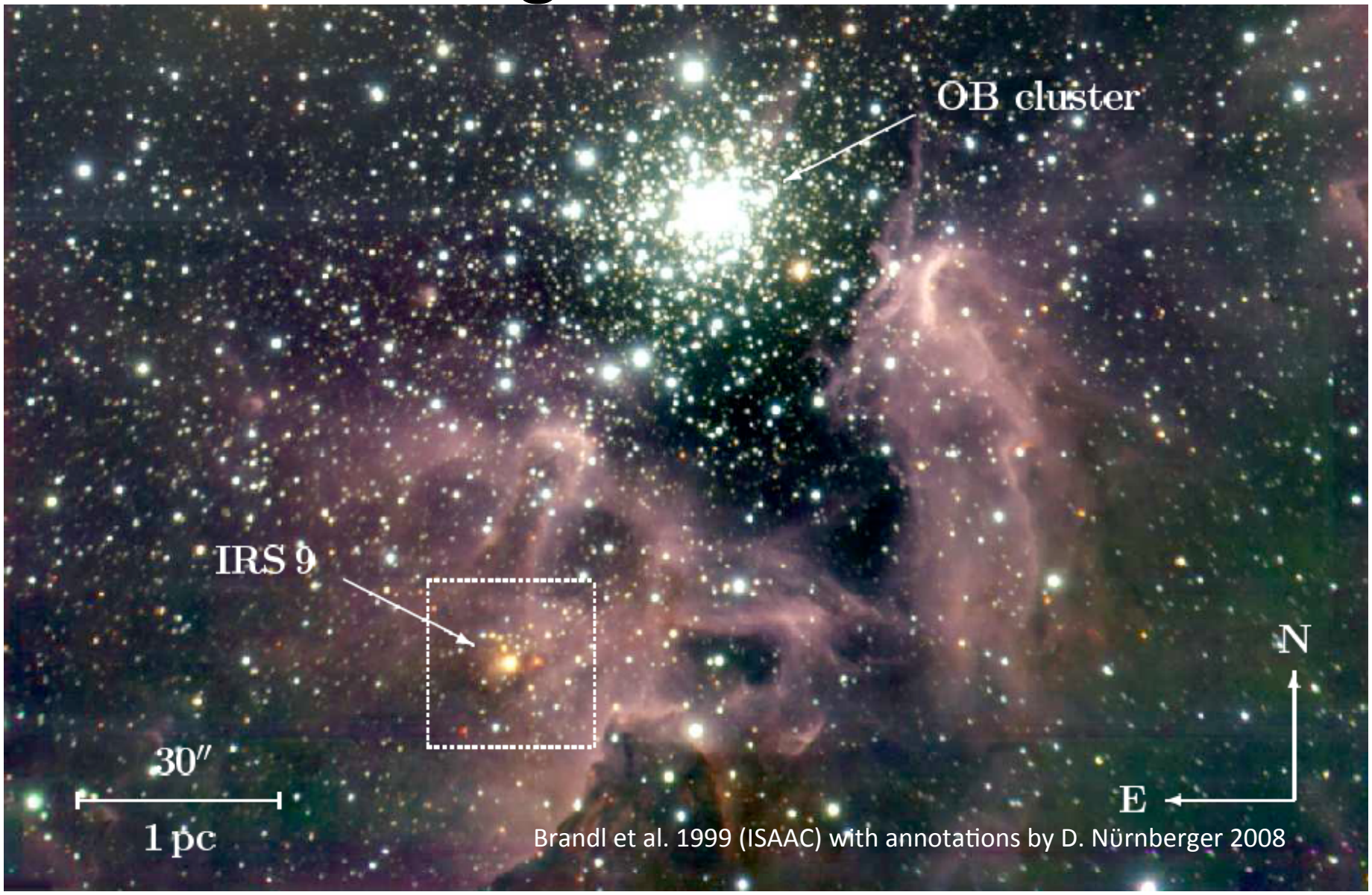
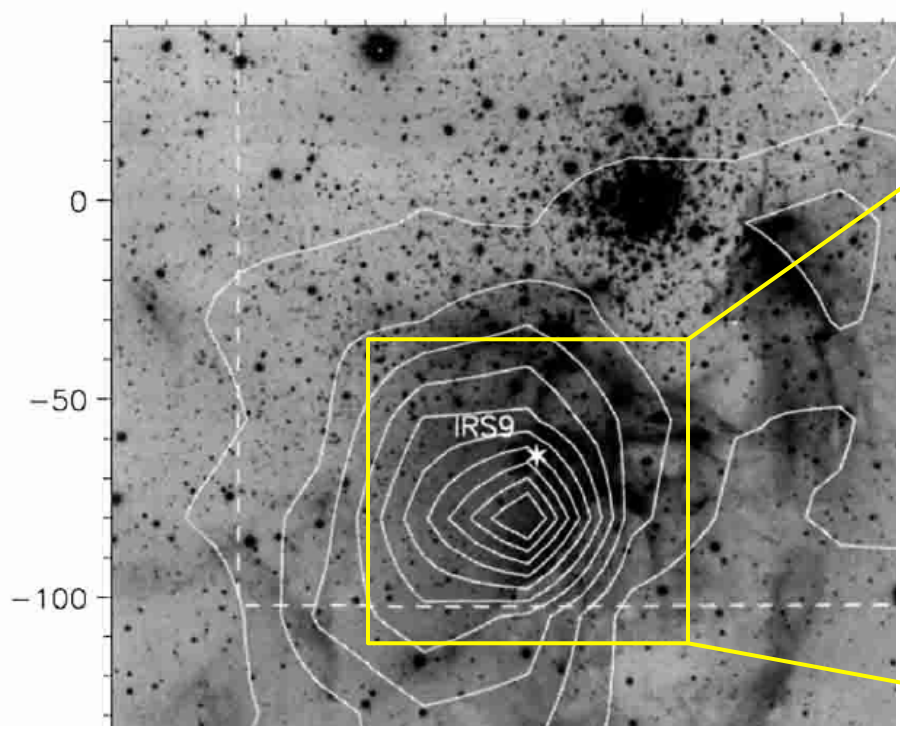
HII region NGC 3603



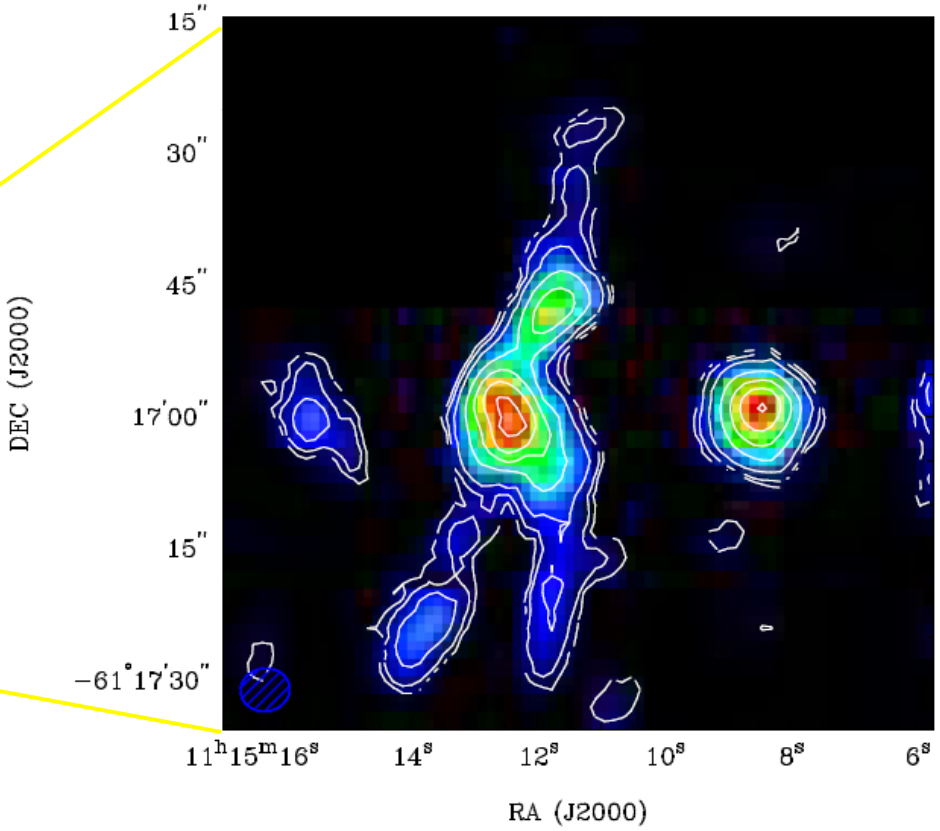
Brandl et al. 1999 (ISAAC) with annotations by D. Nürnberger 2008

CS (2-1) high density tracer

SEST 3 mm



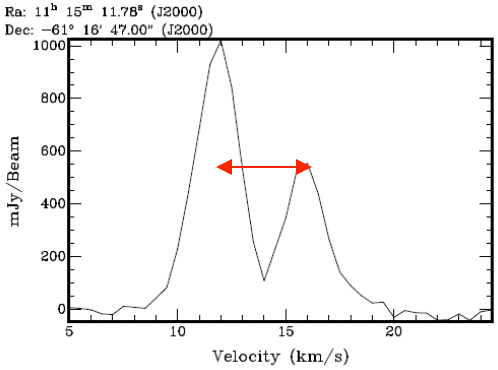
ATCA 3 mm



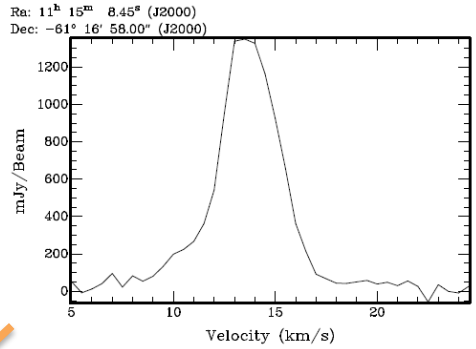
Nürnberger and Petr-Gotzens 2002

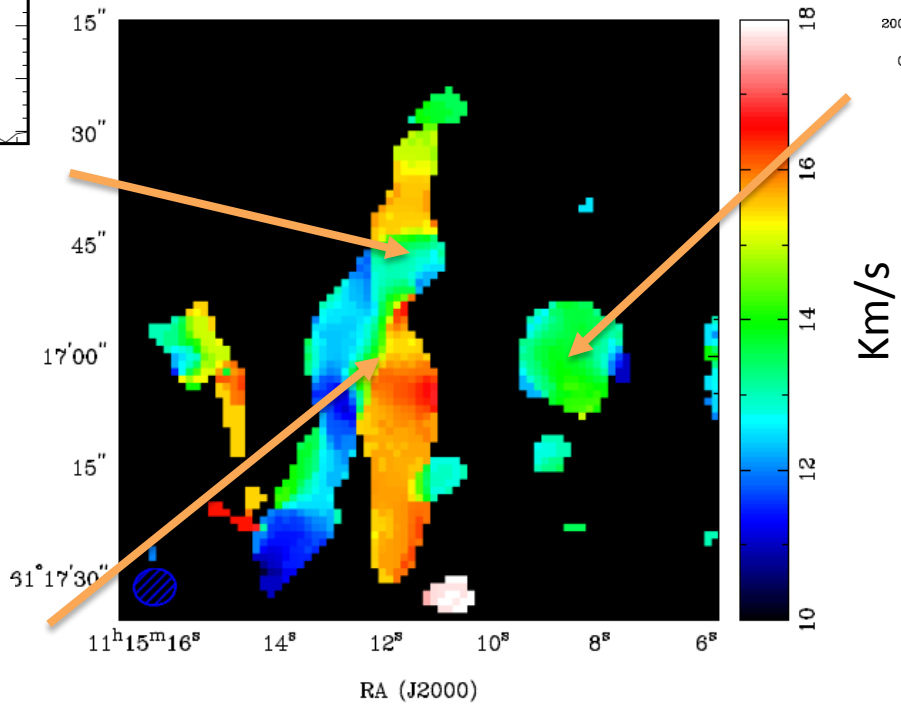
Hummel et al. (submitted)
Map by Bärbel Koribalski

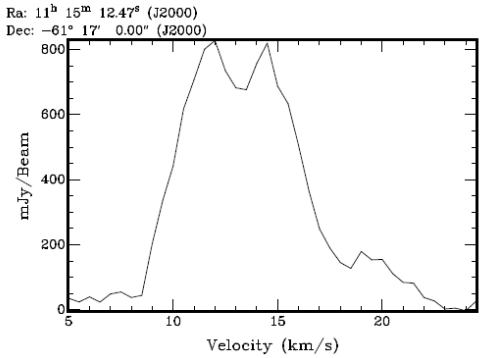
Filaments



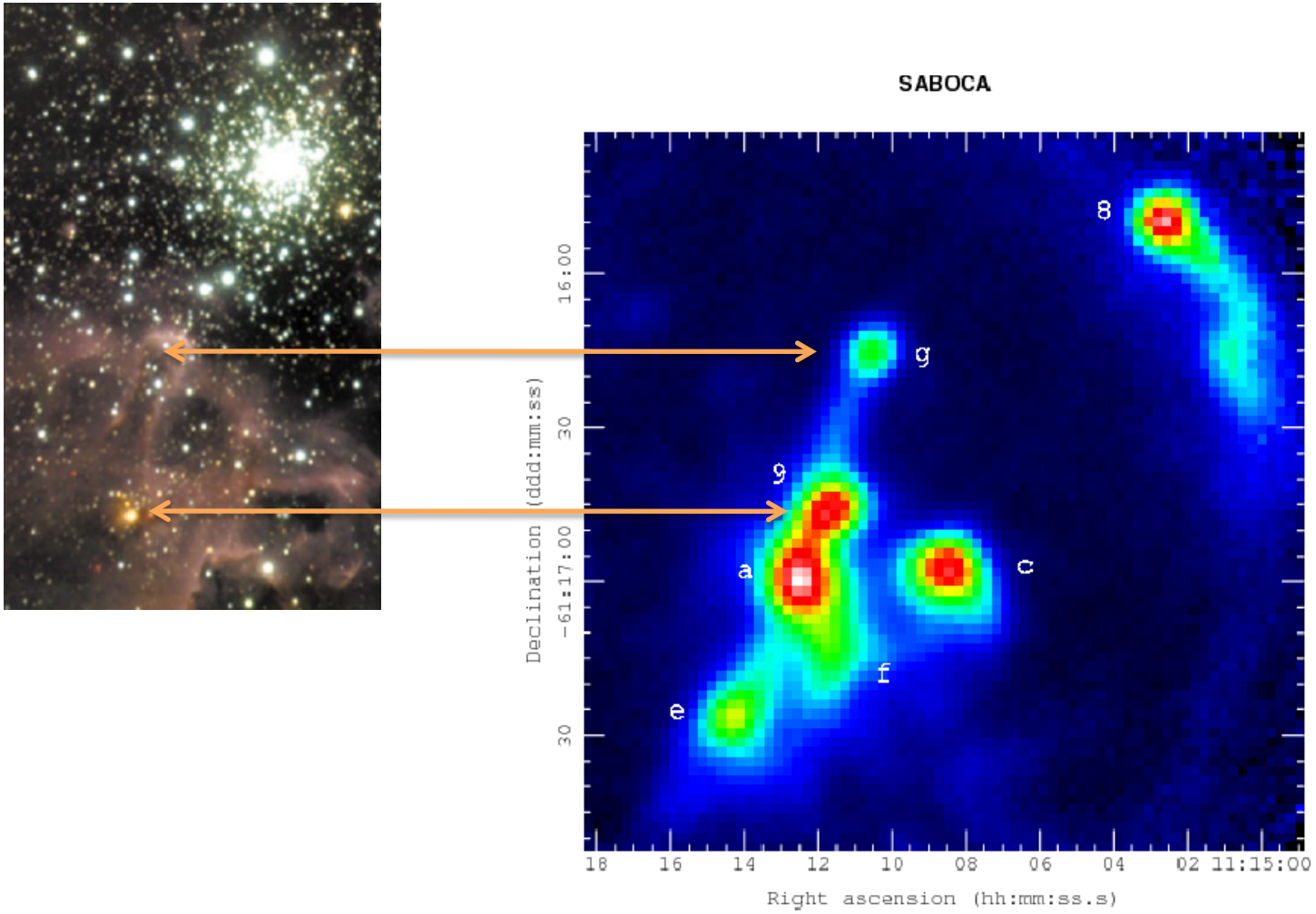
4 km/s







350 µm continuum w/SABOCA



Hummel et al. (submitted)

Compact core properties

	RA	Dec	F Jy	θ "	Δv km/s	M_F $M_\odot$	M_V $M_\odot$
a	11:15:12.07	-61:16:58.8	90	13.1	2.5	385	175
8	11:15:02.88	-61:15:51.5	55	9.8	–	237	–
c	11:15:08.41	-61:16:57.2	67	11.7	3.2	285	255
9	11:15:11.34	-61:16:45.2	59	10.8	2.5	254	145
e	11:15:13.73	-61:17:24.3	46	12.3	2.5	199	165
f	11:15:11.25	-61:17:12.0	45	13.6	–	192	–
g	11:15:10.33	-61:16:16.4	22	8.3	–	94	–

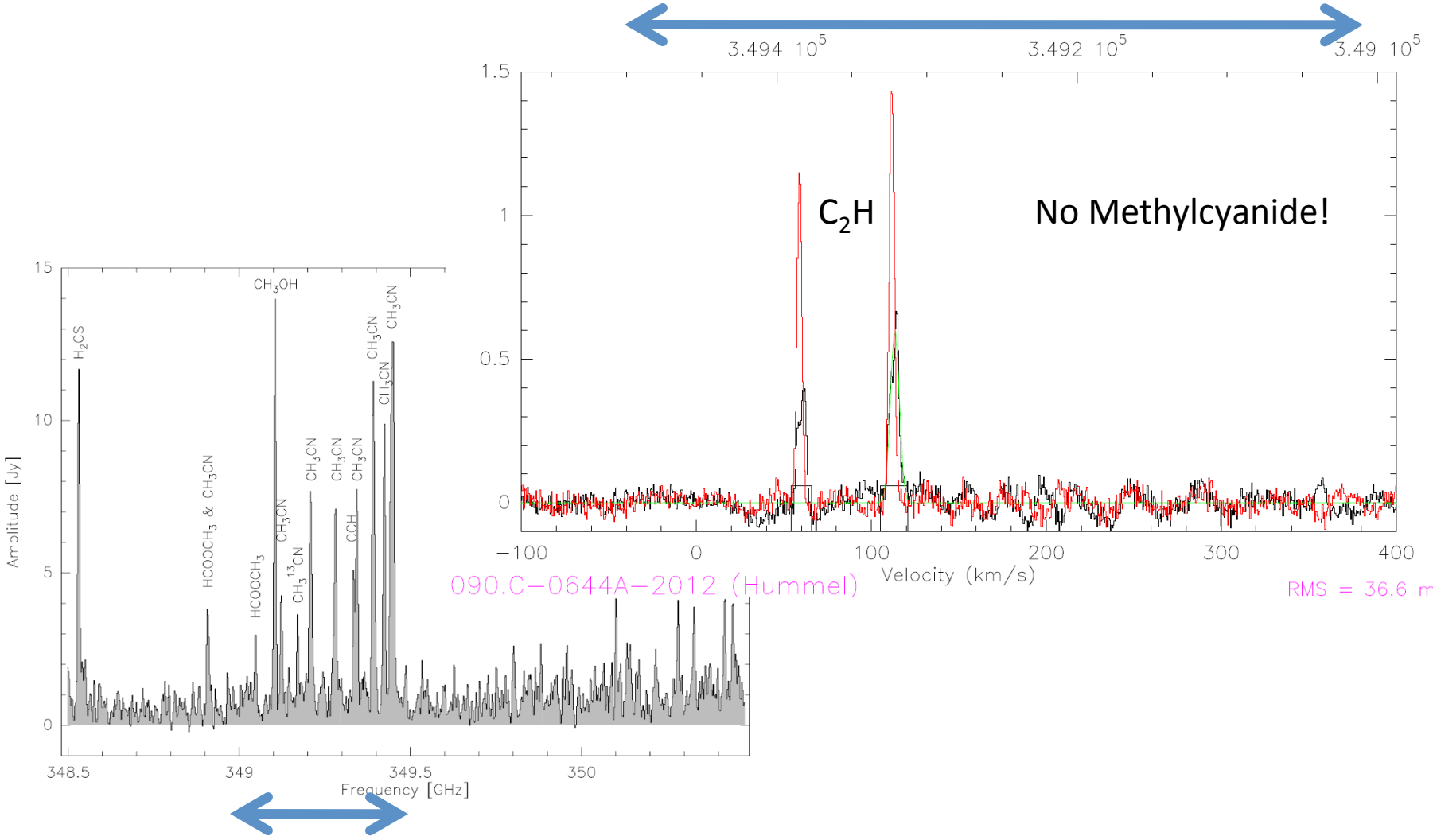
10” = 0.33 pc

$$\mathcal{M}_{\rm vir} = k \cdot \mathcal{R} \cdot \Delta v^2_{FWHM}$$

SHFI sub-mm spectroscopy: aims

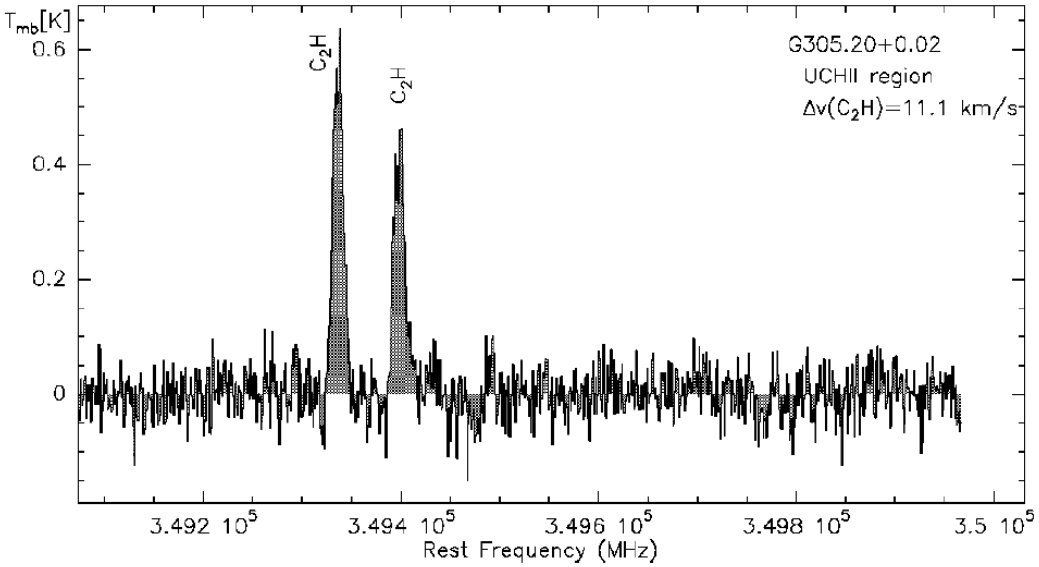
- Hot cores: CH_3CN (K-series of methylcyanide)
- Temperature: H_2CO (formaldehyde)
- Outflows: SiO (shock tracer), CO (3-2)
- Infall: HCO+ and $H_{13}CO+$
- HII region: H26α, H30α (recombination lines)

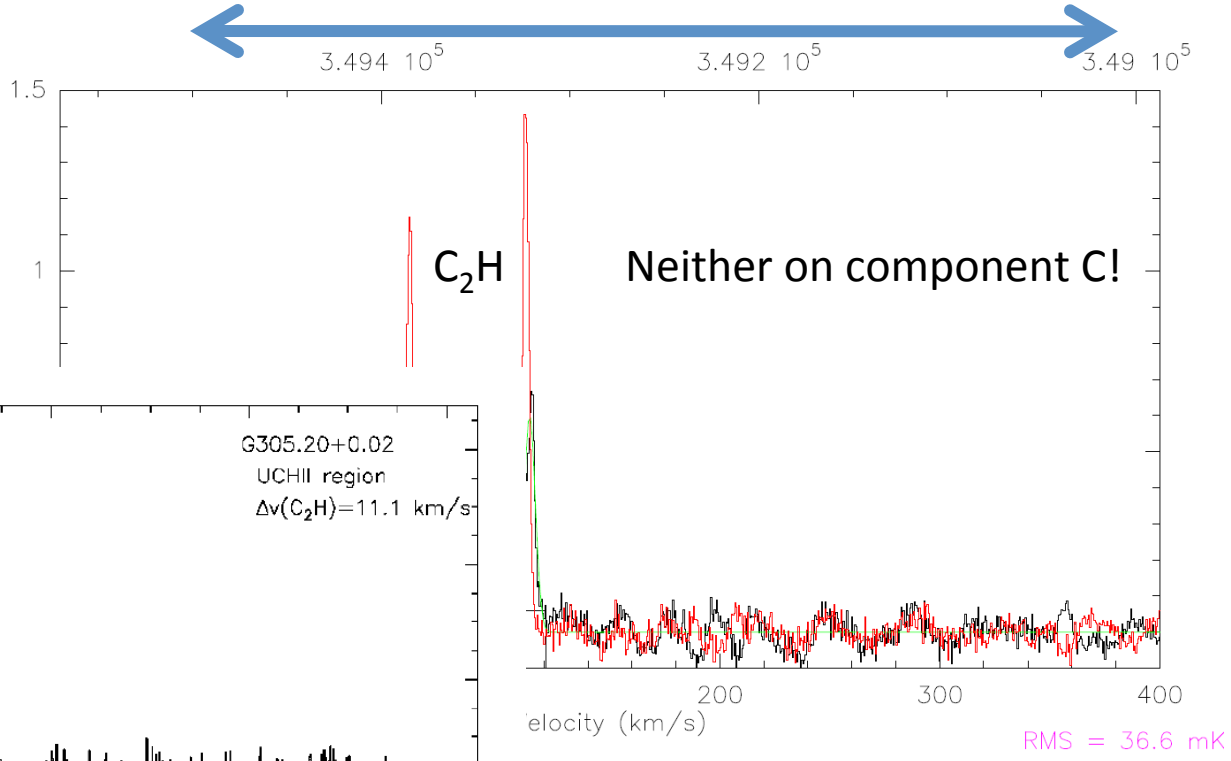
SHFI Setting 3



Beuther et al. 2005 (IRAS 18089-1732)

SHeFI APEX 2





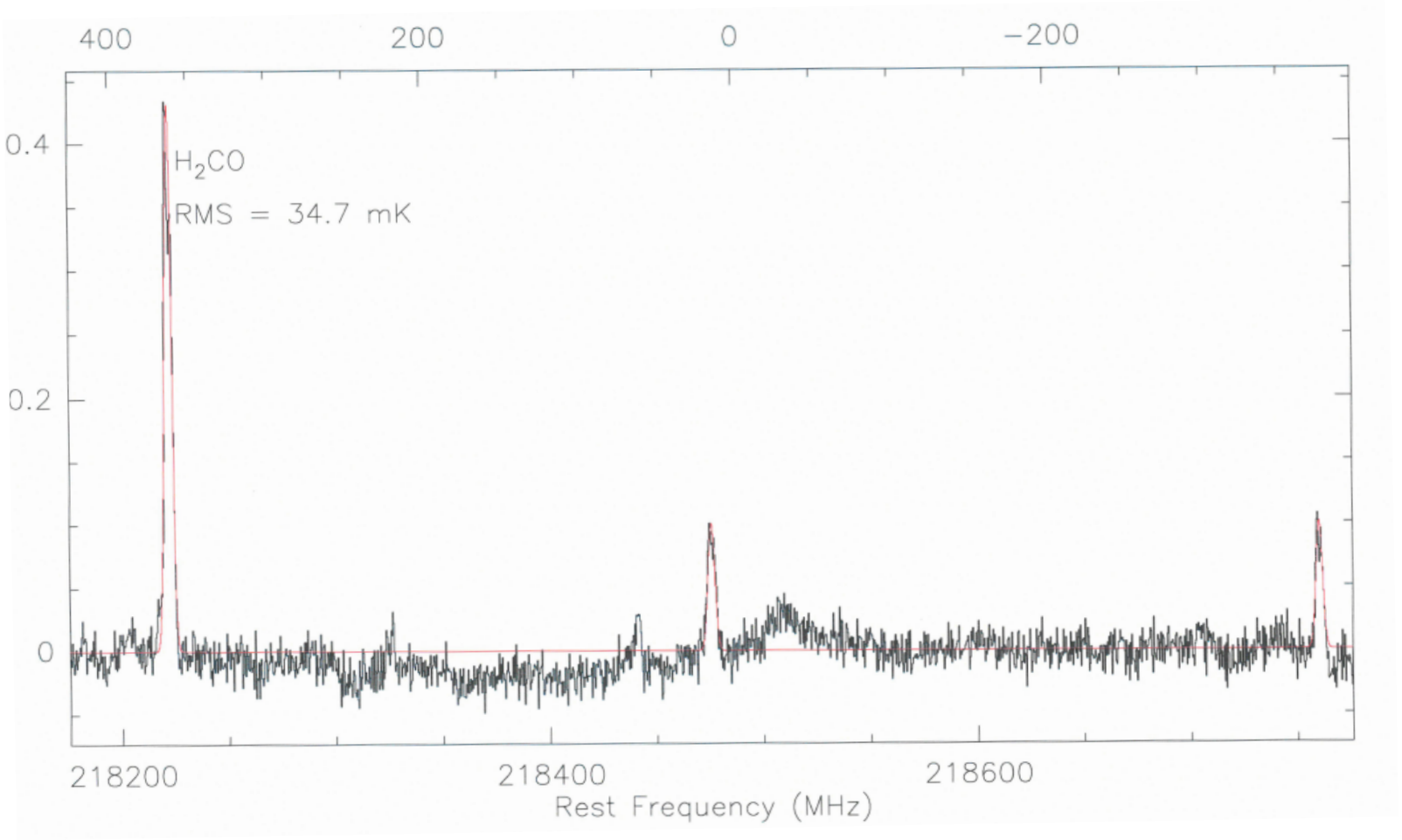
Beuther et al. 2008 (G305.20+0.02)

Temperature from Formaldehyde lines

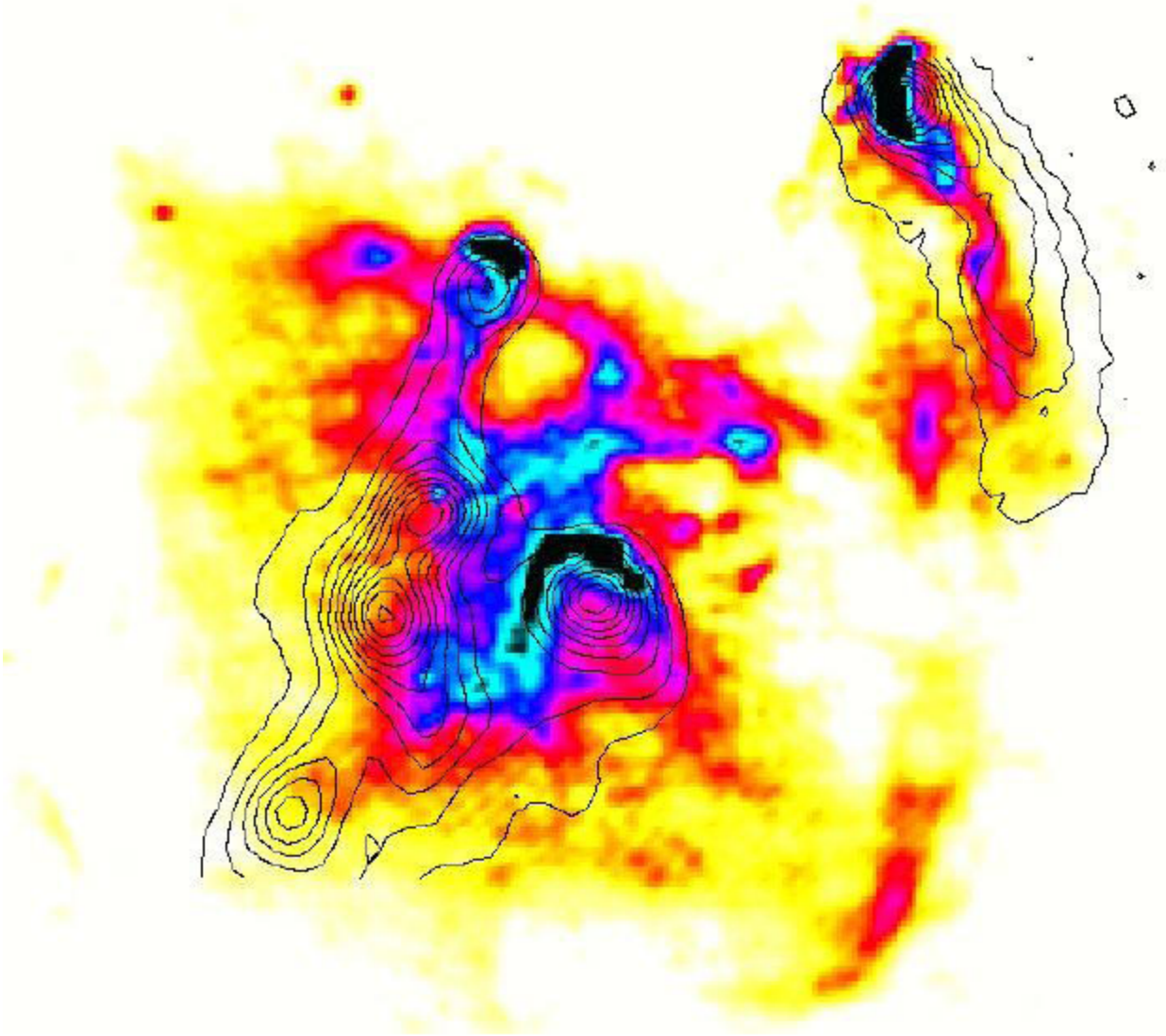
45 K

ΔV=5 km/s

V_{LSR} = +14 km/s



SABOCA 350 µm + ATCA 6 cm



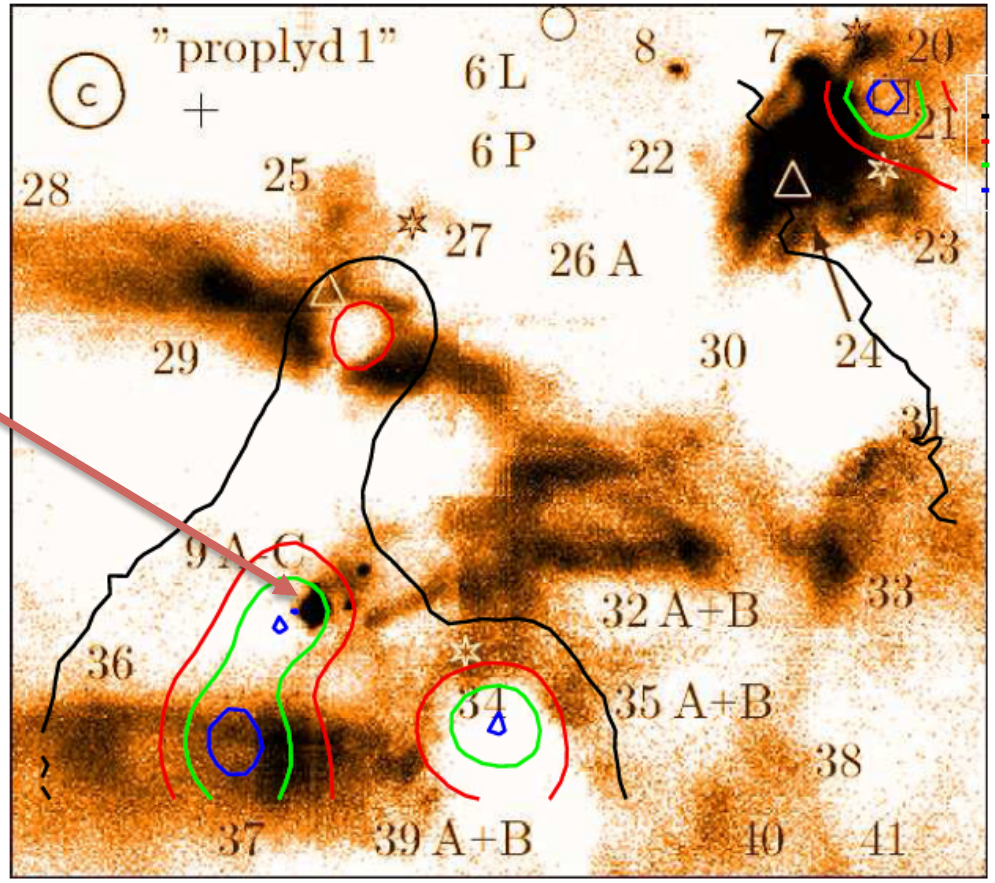
ATCA: Mücke et al. 2002

…back to IRS 9A: MIR and sub-mm

IRS 9A

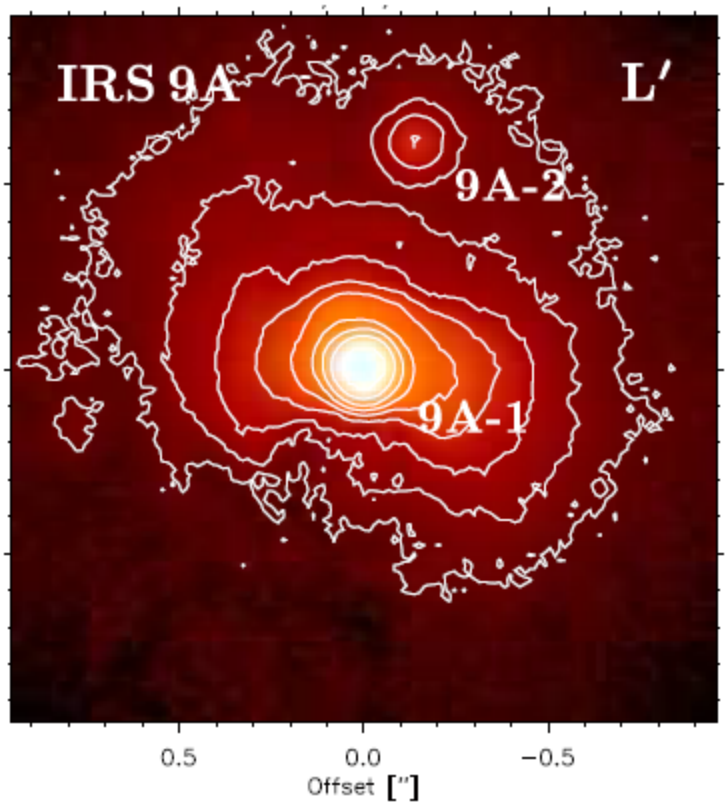
D = 7 kpc
$L = 10^5 L_\odot$

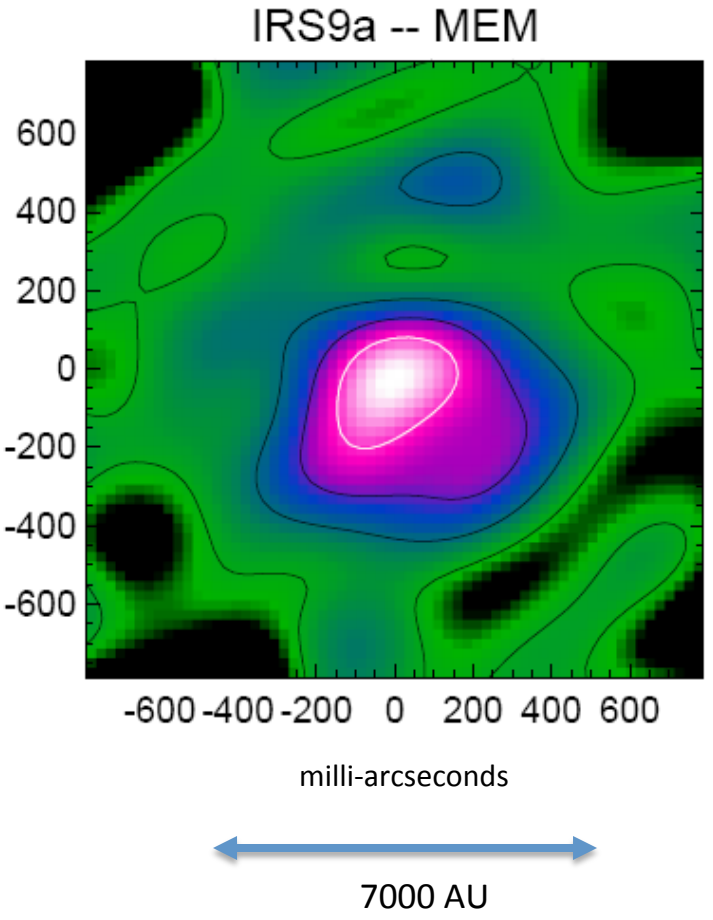
Image: 10 µm (TIMMI2)
Contours: 350 µm (SABOCA)



Contours: SABOCA, grey scale: Nürnberger and Stanke 2003 (TIMMI2)

The structure of the MYSO IRS 9A



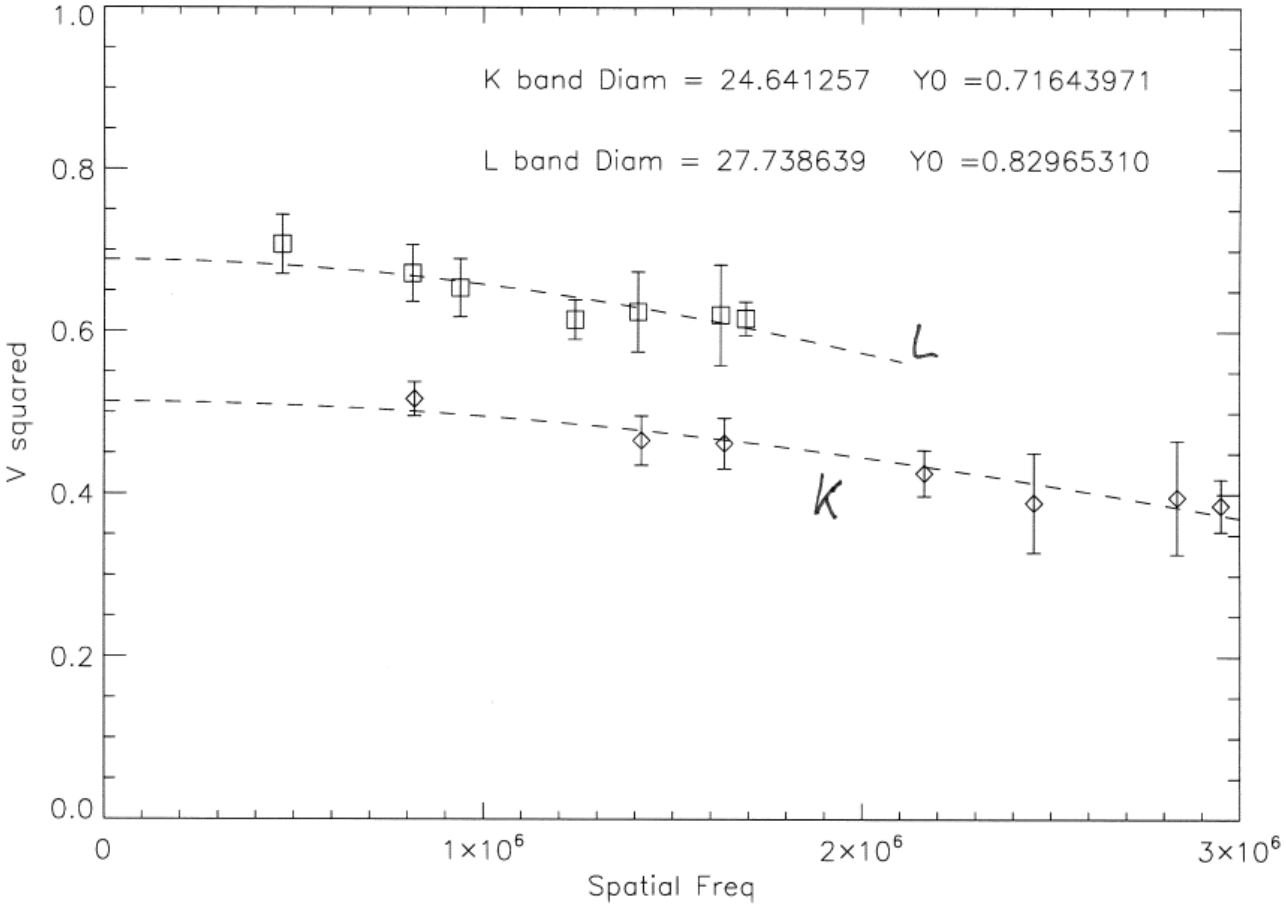


Nürnberger 2008 (NACO @ VLT)

Vehoff et al. 2010 (T-ReCS @ Gemini S)

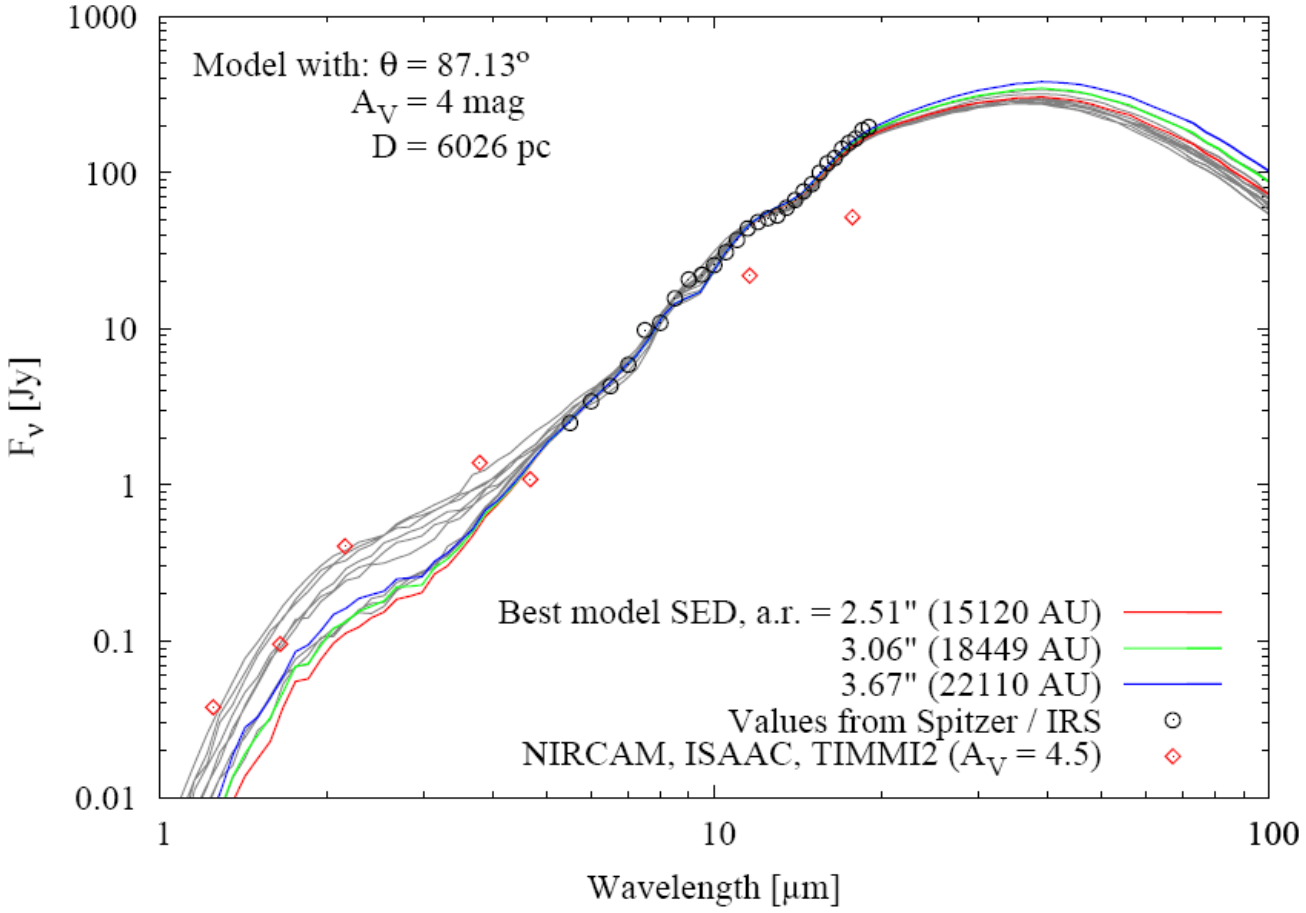
NACO Ks & Lp aperture masking

Diameters @ 7 kpc:
K band: 170 AU
L band: 190 AU



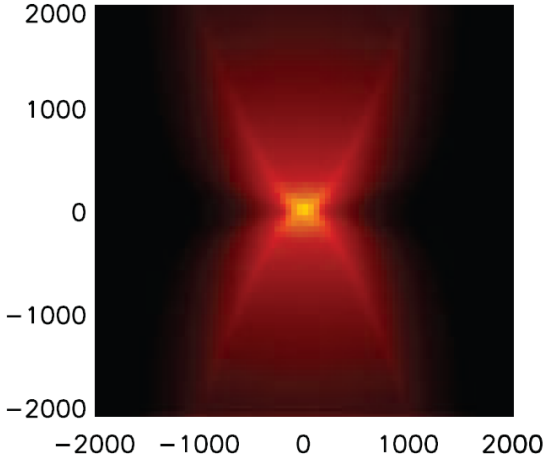
Sanchez et al. 2015 (submitted)

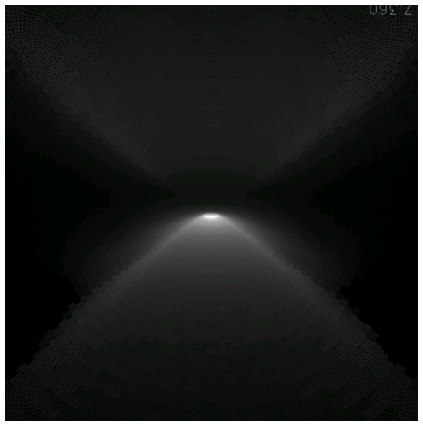
SEDs for disk-envelope model grid



Grid by: Robitaille et al. 2006

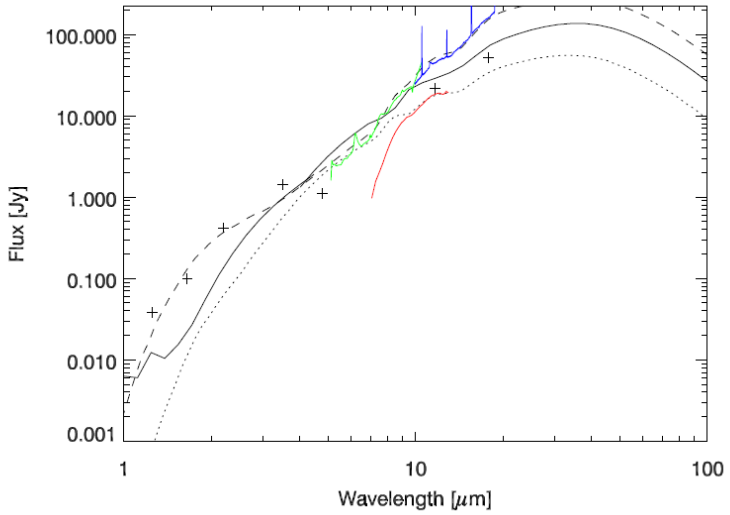
Disk-envelope models

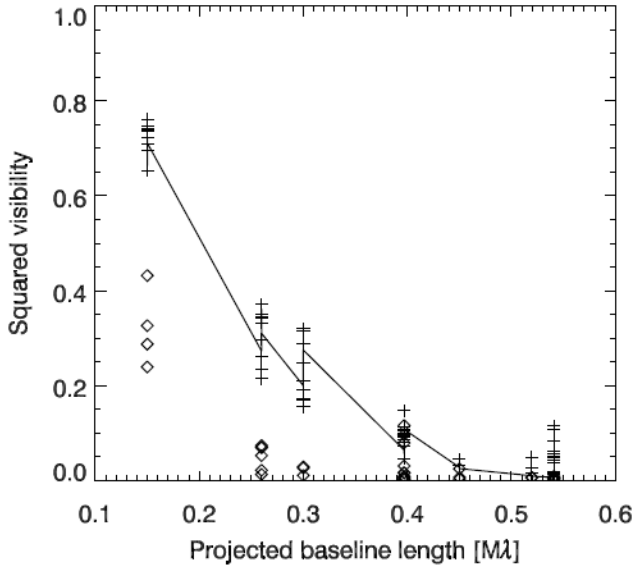




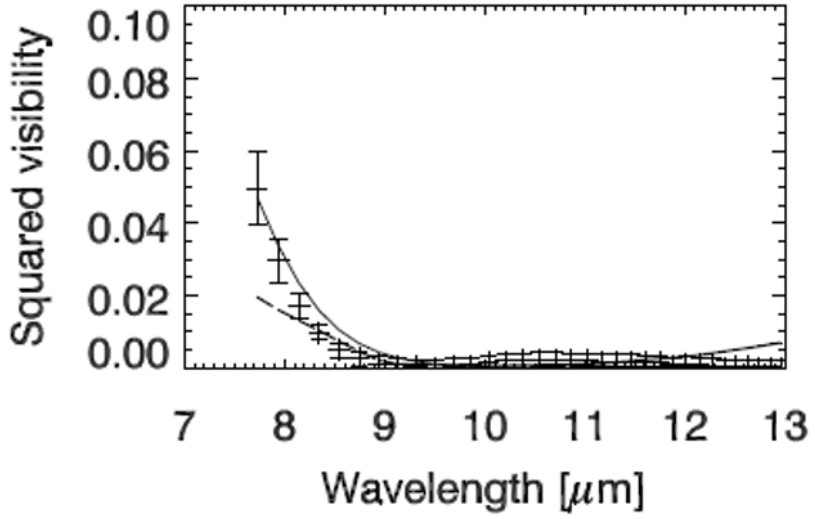
Whitney et al. 2003

Wolf 2003





Diamonds: model values



Dashed: Whitney; solid: MC3D

Summary (1)

- Massive compact cores
  - No hot cores (no methyl-cyanide lines detected)
  - Spectral features consistent with IRDCs
  - Formaldehyde lines give T = 45 K
  - Cores do not contain HII regions

Summary (2)

- IRS 9A
  - younger than compact cores
  - located on cluster-facing side
  - Consistent with sequential star formation scenario in NGC 3603
  - Line of sight into compact region: MIR imaging with the MATISSE interferometer at VLTI in 2017?

Detected lines

Species	Transition	ν_0 (GHz)	E_u (K)	T_c/T_9
SiO	5-4	217.104984	31.2	–
DCN	3-2	217.238531	20.9	1.32
c-HCCCH	6(1,6)-5(0,5)	217.822141	38.6	1.47
CH_3OH	4(2,2)-3(1,2)	218.440047	45.5	–
H_2CO	3(0,3)-2(0,2)	218.222188	21.0	1.39
...	3(2,2)-2(2,1)	218.475641	68.1	1.30
...	3(2,1)-2(2,0)	218.760078	68.1	1.41
$C^{18}O$	2-1	219.5603	15.8	1.19
SO	5,6-4,5	219.949438	35.0	1.45
^{13}CO	2-1	220.3986	15.86	0.97
CO	2-1	230.538	16.6	0.75
^{13}CS	5-4	231.220688	33.3	–
Hα	H30α	231.900930	Rec.	–
SO	8,9-7,8	346.528594	78.8	2.40
$H^{13}CO+$	4-3	346.998347	41.6	3.37
H_2CS	10(1,9)-9(1,8)	348.534250	105.2	–
C_2H	4(7/2,4)-3(5/2,3)	349.399342	41.9	2.88
...	4(9/2,4)-3(7/2,3)	349.339067	41.9	2.5
Hα	H26α	353.622747	Rec.	–
HCN	4-3	354.505469	42.5	1.80
HCO+	4-3	356.734250	42.8	1.62