

Tricks of Resolution and Dynamics

A disk-like object that isn't: IRAS 23033+5951

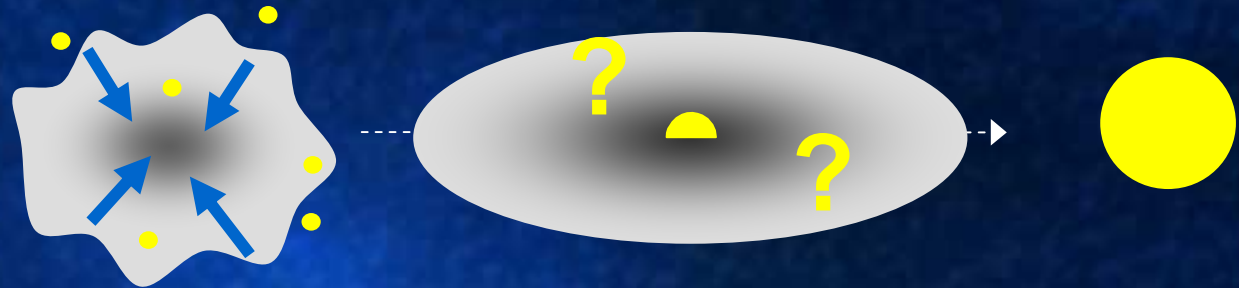
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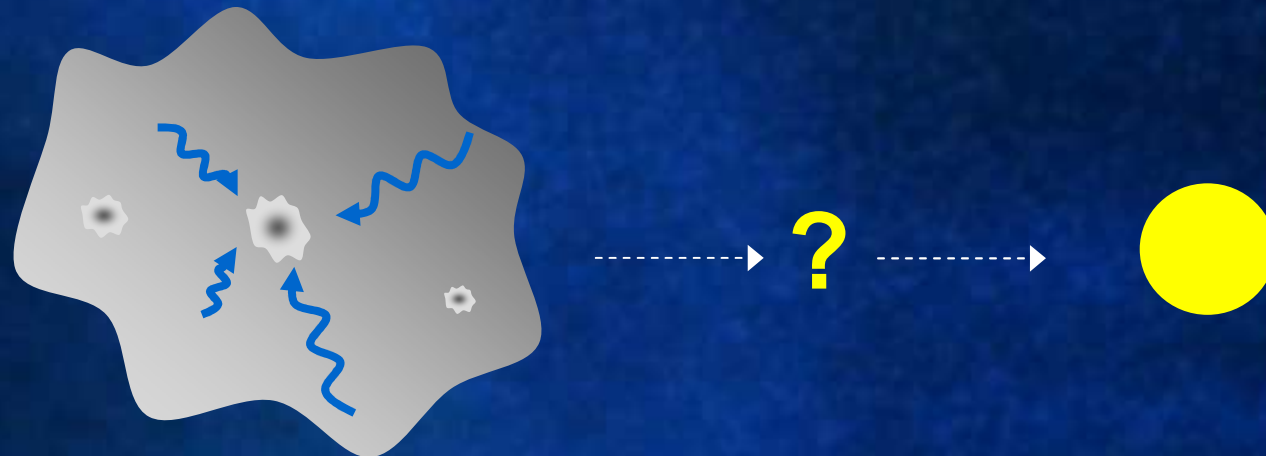
Reid & Matthews, 2007, submitted to ApJ

Motivation: Understanding High-mass Star Formation

monolithic collapse

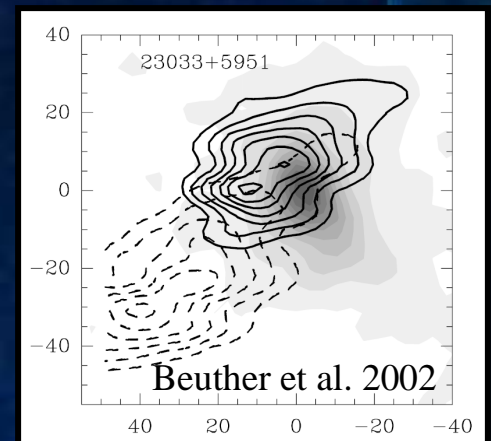


competitive accretion

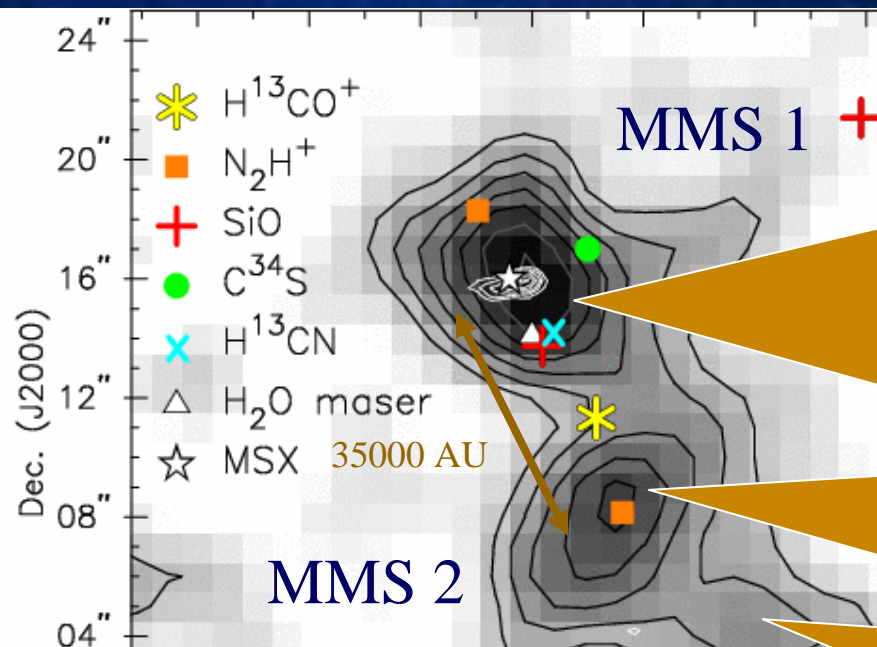


Deconstructing a High-mass SFR

- IRAS 23033+5951 ($10^4 L_{\odot}$; $2300 M_{\odot}$)
 - Discovered by IRAS (d=3.5 kpc)
 - Relatively quiescent (no HII region)
 - Potential to easily interpret data at moderate resolution
- BIMA array observations (2003-2004)
 - HCO^+ , H^{13}CO^+ , H^{13}CN , N_2H^+ , C^{34}S , SiO & CH_3OH
 - 3 mm continuum



Summary of Core Observations



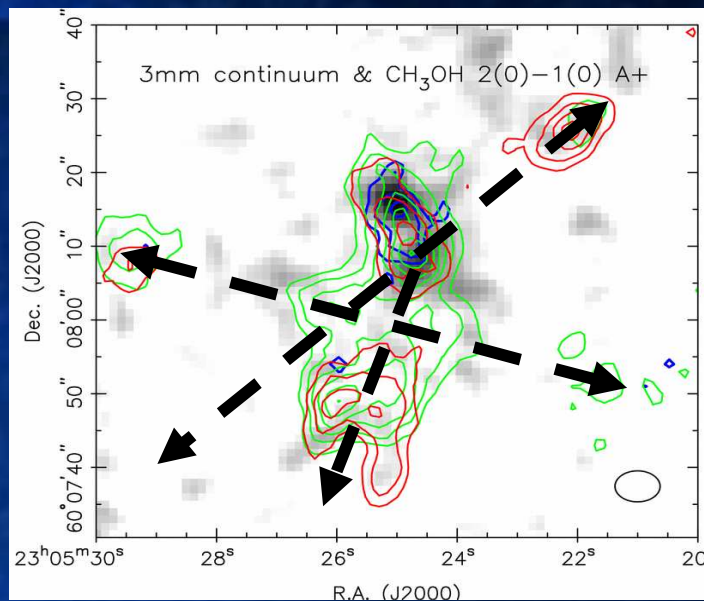
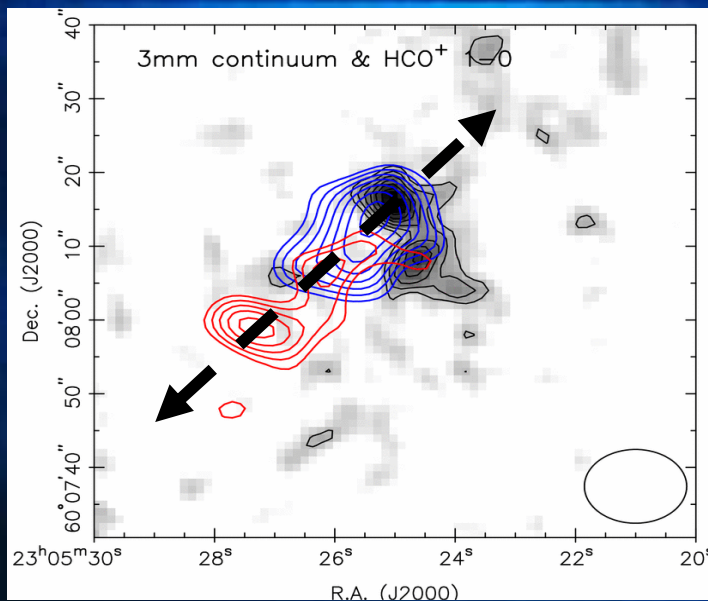
- $225 M_{\odot}$
- associated with an MSX source, radio continuum (Sridharan et al. 2002) and maser emission (Beuther

- $205 M_{\odot}$
- N_2H^+ emission is strongly

- $51 M_{\odot}$
- Point-source
- Second potential starless core

Densities are $N_{\text{H}_2} \sim 10^{24} \text{ cm}^{-2}$
 $\gg N_{\text{H}_2} \sim 10^{21.5} \text{ cm}^{-2}$ for ρ Oph
 Typical of massive star-forming clumps
 (i.e., Plume et al. 1997)

Summary of Outflow Observations

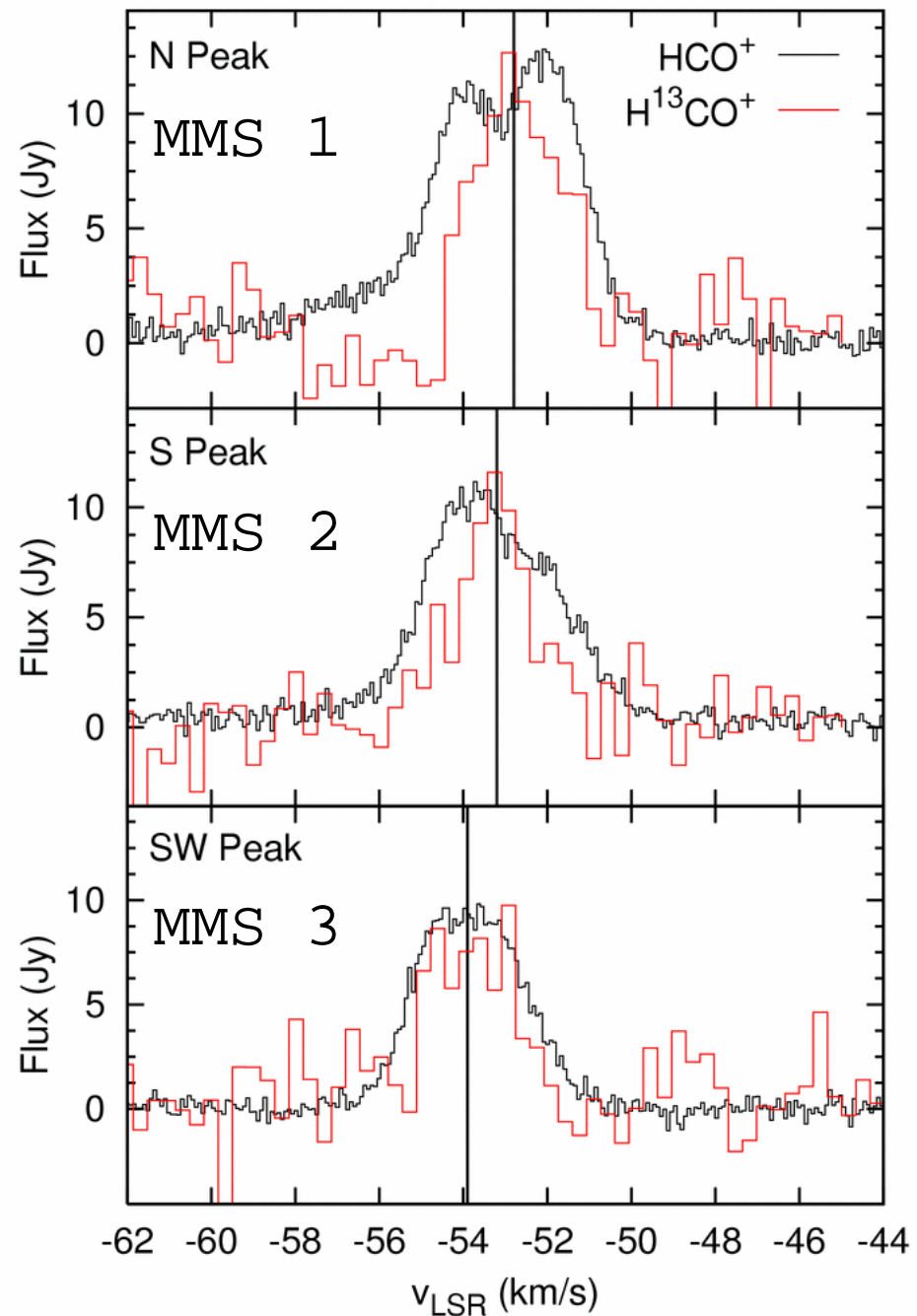


- HCO⁺ traces the known, dominant outflow in the region
 - Centre seems offset from continuum peaks
- Evidence for other possible outflows is seen in CH₃OH and SiO, i.e., multiple sources per continuum core?

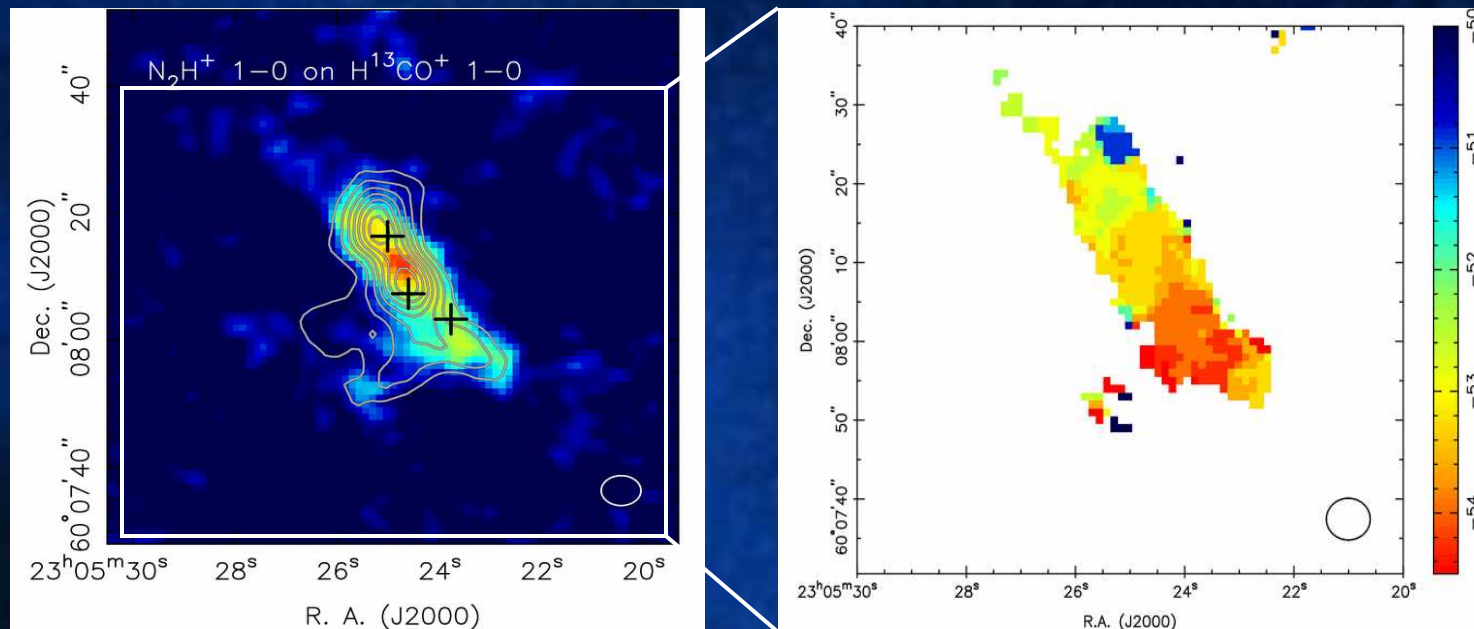
Infall

- Expect optically thick lines skewed to the blue (MMS 2)
- MMS 1 profile is skewed to the red (outflow contamination?)

Infall is not clear in these cores. MMS 2 is the strongest case.



A disk-like object in IRAS 23033



- The disk-like morphology appears in H¹³CO⁺ 1-0 and N₂H⁺ 1-0
- The first moment of H¹³CO⁺ shows a distinct velocity gradient from -50 km/s in the north to -55 km/s in the south
- Position velocity diagrams of N₂H⁺ and H¹³CO⁺ along the long axis show the same gradient.

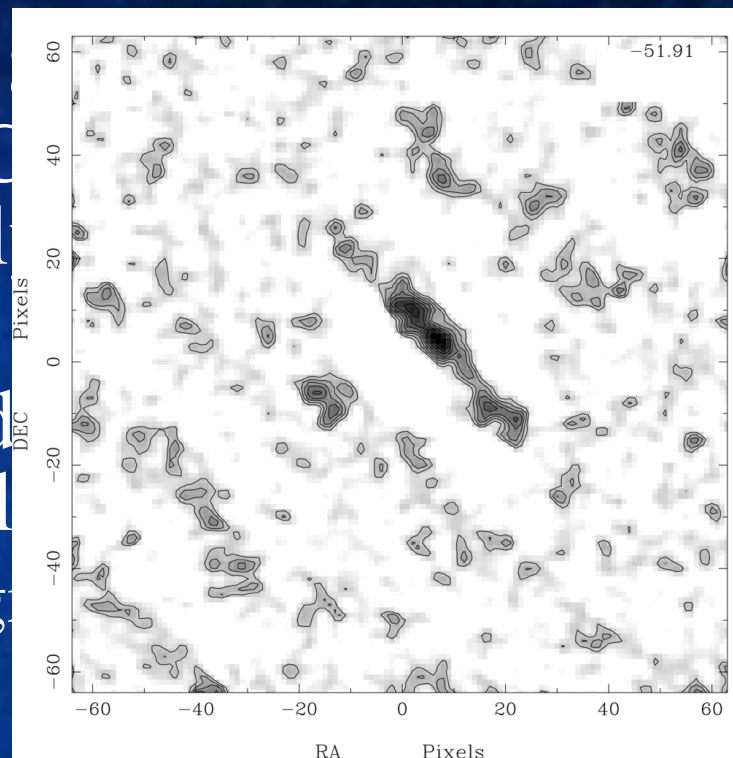
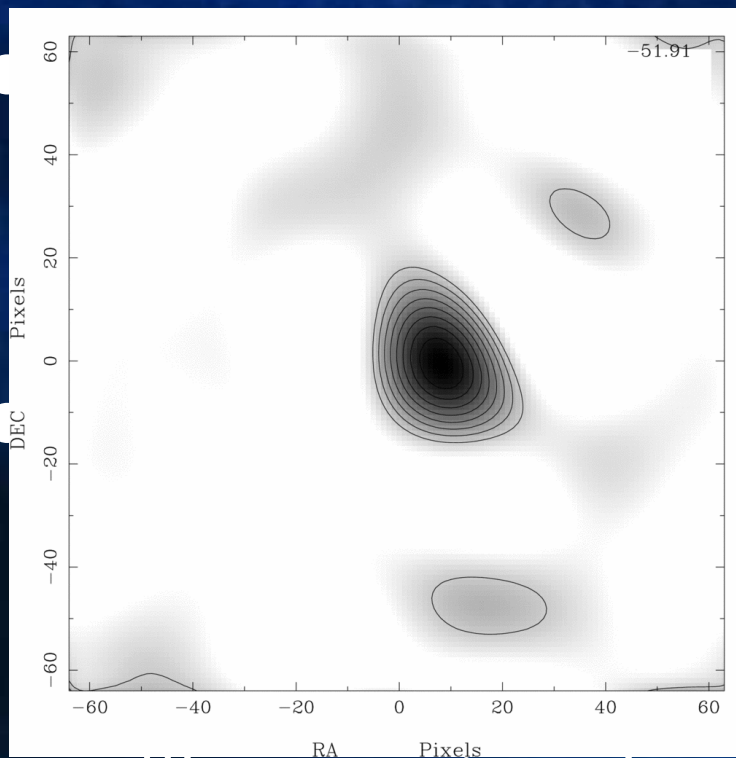
When is a disk not a disk?

Source	Distance (kpc)	Disk Radius (AU)	Disk Mass (M_{\odot})	Reference
G192.16-3.82	2	130	3	Shepherd et al. 2001
Ceph A HW2	0.73	330	1-8	Patel et al. 2005
BNO	0.46	800	?	Zhibo et al. 1995
NGC 7538 IRS	2.8	1000	?	Pestalozzi et al. 2004
¹ N IRAS20126+410	1.7	1700	10	Cesaroni et al. 1997
⁴ G24.78 A1	7.7	4000	23	Beltran et al. 2004
G24.78 A2	7.7	4000	4	Beltran et al. 2004
G24.78 C	7.7	8000	5	Beltran et al. 2004
G31.41	7.9	8000	87	Beltran et al. 2004
NGC 7538S	2.8	15000	400	Sandell et al. 2003
IRAS 23033+5951	3.5	HUGE! (~43500)	520	Reid & Matthews 2007 (submitted to ApJ)

An Inside-out Picture: Cores in a Disk

- A “disk” of diameter 80,000 AU with a centrally peaked H^{13}CO^+ distribution but no density peak (unlikely to be a Galli & Shu “pseudodisk”)
- Cores with associated outflows have likely condensed along the length of the “disk”
 - Despite the velocity gradient, the object is likely a remnant of the natal cloud
 - Short-spacings data are critical to assessing the large-scale structure

An Inside-out Picture: Cores in a Disk



- Short-spacings data are critical to assessing the large-scale structure

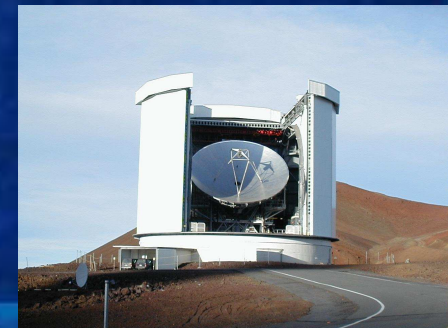
Familiar lessons...

- Multi-scale, multi-transition observations matter!
- ALMA will be able to search for circumstellar disks within the IRAS 23033 cores ($100 \text{ AU} = 0.03''$ at 3.5 kpc)
 - (max resolution $0.015''$ at 300 GHz)
- Targets needed!
 - Need more isolated, quiescent high-mass star-forming regions to observe
 - Identification of candidates can precede ALMA

Identifying New Isolated SFRs

- One component of the JCMT Legacy Survey is 850 micron mapping of the Galactic Plane
 - $+10 < l < +65; -1 < b < +1$
 - $+102.5 < l < +141.5; -1 < b < +1$
- 334 hours in first two years
- Mass limit: $40 M_{\odot}$ to the edge of the Galaxy
- New insights ...

188 sq. degrees

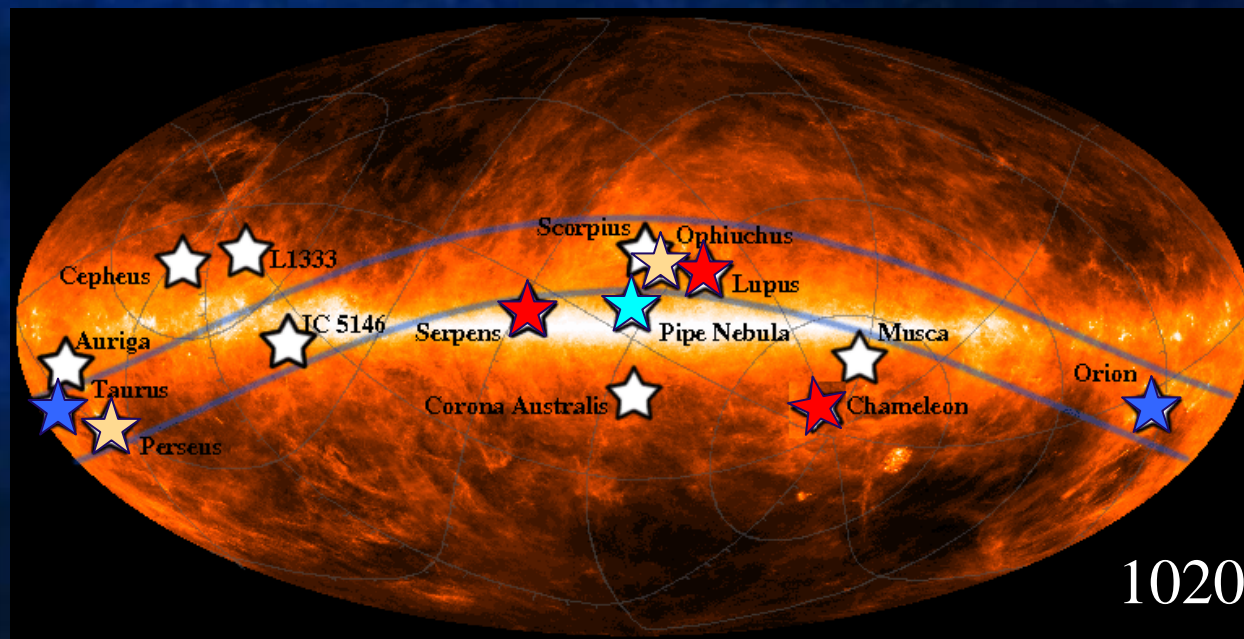


Identifying New Isolated SFRs

- One com
is 850 m
 - + 10 <
 - +102.5
 - 334 hour
 - Mass lim
1. Evolutionary Sequence of High-mass Star Formation
 2. Triggering and the star-forming content of molecular clouds
 3. Cold Dark Clouds and Molecular Cloud Formation
 4. Galactic Structure
- New insights ...



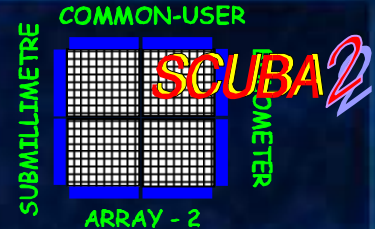
Closer to home... The Gould Belt



1020 hours!

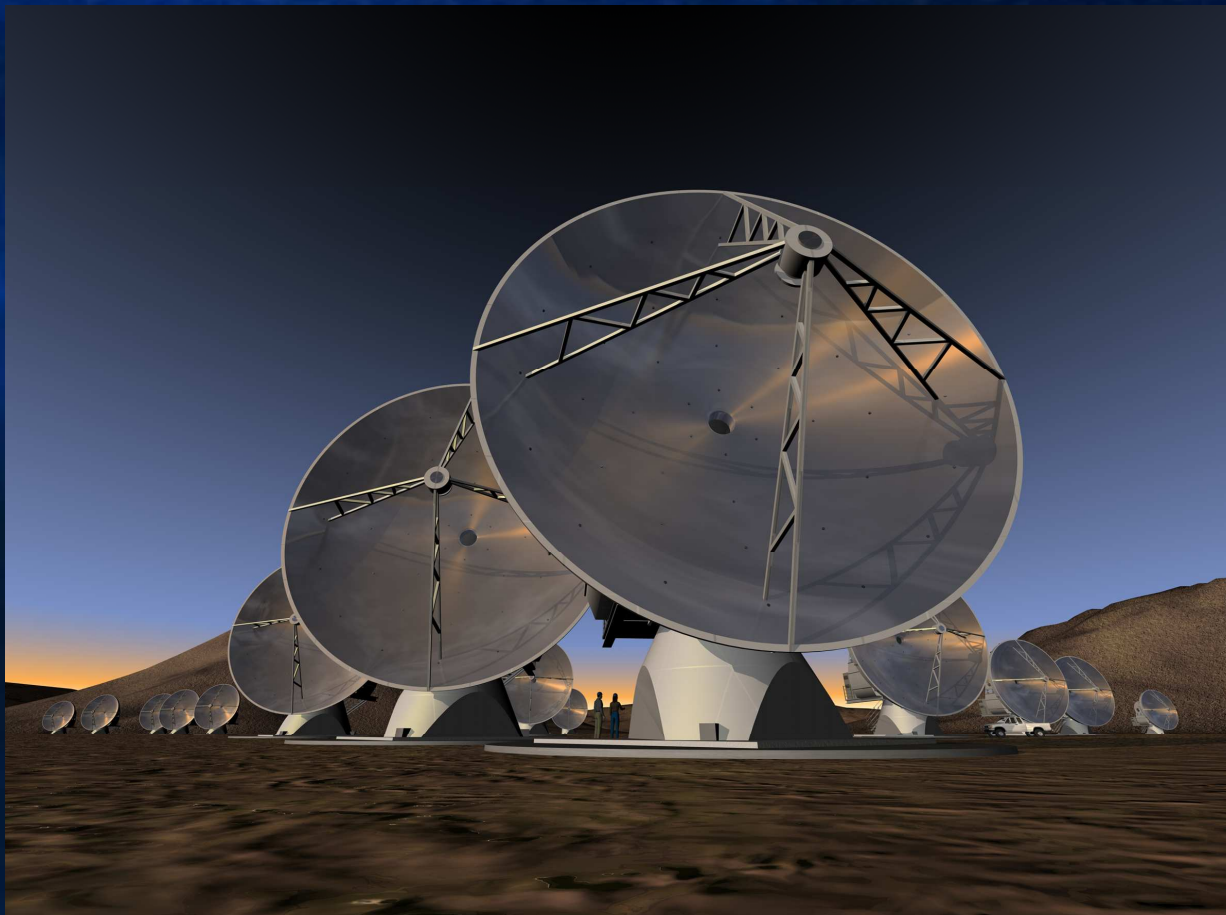
- SCUBA-2: 80 sq. deg. ($A_v > 3$) + 565 sq. deg. ($1 < A_v < 3$)
- HARP-B: CO, ^{13}CO , C^{18}O 3-2 in cores and clouds
- POL-2: continuum polarimetry of cores and clouds

A SCUBA-2 Update



- ❖ Scheduled to arrive in Hawaii Sept 24
- ❖ Commissioning arrays, at least one at 850 micron and one at 450 micron
- ❖ Full complement of sub-arrays (4 per λ)
 - ❖ Early 2008
- ❖ Full survey science - **August 2008**
- HARP-B observing is in SV stage
- POL-2 com./science will follow SCUBA-2

Thanks!



22 June, 2007

Transformational Science with ALMA: Through Disks to Stars and Planets