

Galactic Surveys with APEX

- The APEX telescope and instrumentation
- ATLASGAL: unbiased continuum survey of the Galactic Plane
- Surveys of nearby molecular complexes
- Spectral line surveys

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Atacama Pathfinder Experiment



- Single antenna, 12 m diameter
- Copy of VERTEX antenna for ALMA
- + surface accuracy $15\ \mu\text{m}$
 $\Rightarrow \lambda = 200\ \mu\text{m} - 2\ \text{mm}$
- + Nasmyth cabins
various instrumentation
- collaboration MPIfR/MPG + ESO +
OSO (Sweden) + Chile

Atacama Pathfinder Experiment



Current Data

Temperature (C)	:	-11.09
Radiometer (mm PWV)	:	0.04
Dewpoint (C)	:	-46.81
Humidity (%)	:	2.17
Pressure (hPa)	:	549.89
Wind Speed (m/s)	:	1.5
Wind Direction (deg)	:	323.0
Last Update :		Tue Aug 28 05:51:00 2007

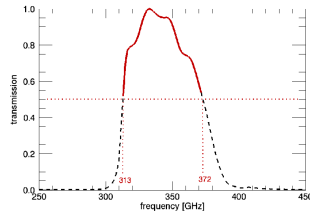
LABOCA Large APEX Bolometer CAmera

- Bolometer array with 295 pixels

$\lambda = 870 \mu\text{m}$ (345 GHz)

$\Delta\nu = 60 \text{ GHz}$

Field of view: 11 arcmin



- APEX beam size at $870 \mu\text{m} = 18''$
- Instrumental NEFD $\sim 60 \text{ mJy s}^{1/2}$
- Observing modes:
 - linear on-the-fly maps (degree size), any angle on sky
 - spirals and rasters of spirals
 - spiral **pointing** on few Jy source **in 20 sec**

- Coming soon: **37-element 350 μm** array (MPIfR)
Field of view: 2 arcmin
Super-conducting bolometers (TES), multiplexing SQUIDS
- PI instrument (Berkeley): APEX SZ Camera (SZ effect)
330 TES bolometers, **$\lambda = 1.4$ and 2 mm**
Field of view: **20 arcmin** at 2 mm
- Under development (Saclay):
ARTEMIS, filled array (PACS / Herschel technology)
 $\lambda = 450 + 200 \mu\text{m}$
- Heterodyne instruments:
APEX-2A (345 GHz), CHAMP+ (7 pixels, 670 + 860 GHz)
More coming soon (250 GHz to 600 GHz, + 1.3 THz)

APEX Telescope Large Area Survey of the Galaxy

- Collaboration MPIfR (F. Schuller, K. Menten, P. Schilke), ESO (M. Walmsley et al.) and Chile (L. Bronfman et al.)
- **Unbiased** mapping of the inner Galaxy at $870\ \mu\text{m}$ (LABOCA)
- Complete census of massive cold dusty cores in the Galaxy
- Derive column densities and spectral indices
- Compute pre-stellar initial mass function
- Explore **large scale structure** of cold dust

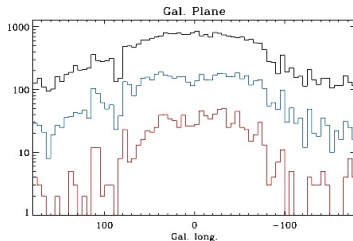
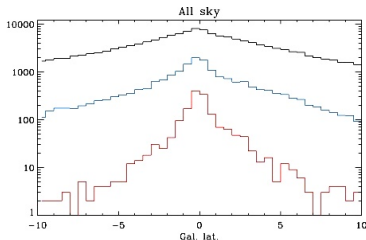
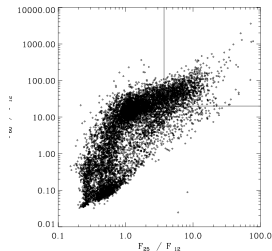
ATLASGAL - Definition

High mass stars:

→ (ultra) compact HII regions

cf. **IRAS**:

Wood & Churchwell (1989) criteria



- WC89 sources: mostly in $|l| \leq 80^\circ$, $|b| \leq 1^\circ$ ($|b| \leq 2.5^\circ$)

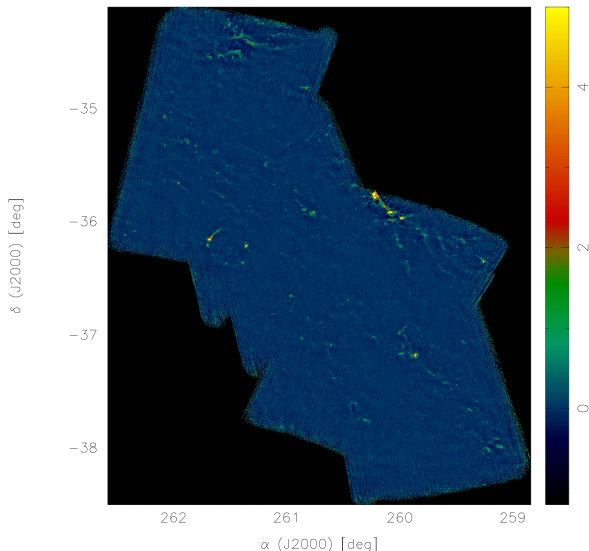
- **First look survey:** $|l| \leq 30^\circ$, $|b| \leq 1^\circ$ - $1\sigma = 50$ mJy
120 deg² - telescope time **< 100 hours**
Detection (3σ) : $1 M_\odot$ at 500 pc, $35 M_\odot$ at 3 kpc
2007 August 30 - 80 deg² observed !
- **Shallow survey:** $|l| \leq 80^\circ$, $|b| \leq 1^\circ$ - $1\sigma = 50$ mJy
320 deg² - telescope time ~ 200 hours
- **Deep survey:** $|l| \leq 30^\circ$, $|b| \leq 1^\circ$ - $1\sigma = 10$ mJy
Detection (3σ) : $0.8 M_\odot$ at 1 kpc, $50 M_\odot$ at 8 kpc
 ~ 1000 hours
- **Follow-up:**
 - bolometer arrays (350 μ m, 2 mm)
 - heterodyne receivers

- Calibrated images covering 120 deg^2 (and more)
- Point / compact source catalogue
- Extended source catalogue
- Cross-identifications with 2MASS, GLIMPSE, MSX, MIPS GAL, Hi-GAL...

⇒ SEDs from $2 \mu\text{m}$ to $870 \mu\text{m}$

LABOCA beam = MSX resolution = Herschel at $250 \mu\text{m}$

First observations during Science Verification

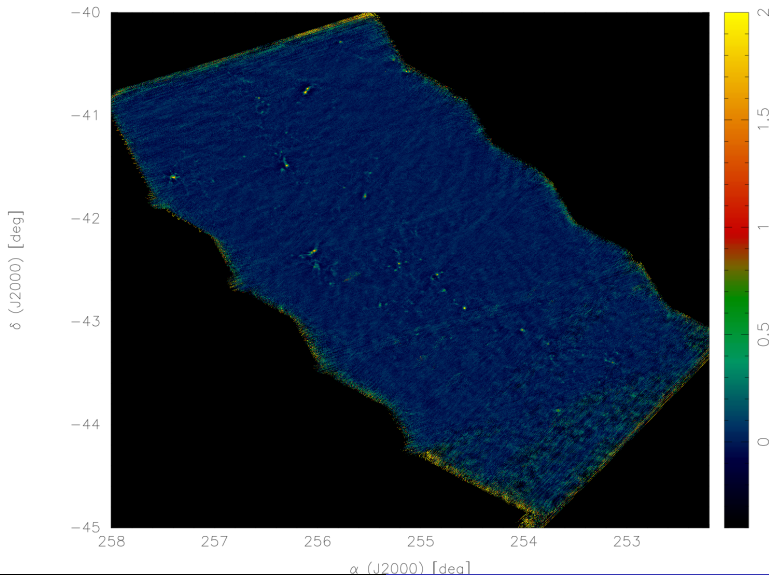


3 hours of integration

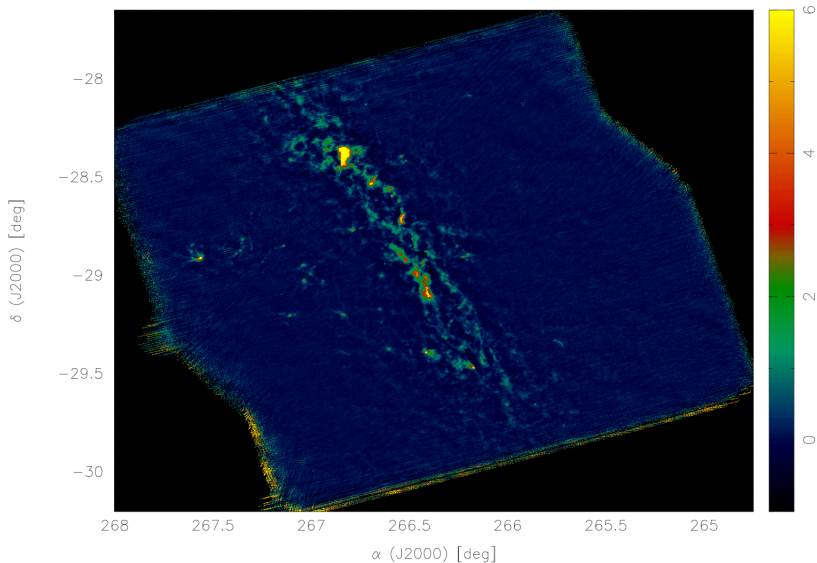
rms in map:
50 mJy/beam

~ 500 sources > 0.3 Jy
 $\Rightarrow 10^5$ in $|l| \leq 30^\circ$

8 maps combined, 4 hours on-source



The Galactic Center - 1.5 hour on source



Monitoring of Sgr A*

- World-wide campaign to monitor Sgr A* at all wavelengths (July 2007)
- Participation of APEX / LABOCA (PI: R. Genzel)
- Observing mode: looping between Sgr A* and nearby calibrators, 2 minutes per source
⇒ **calibration accuracy < 10%**
- Can be repeated whenever LABOCA is on-sky !

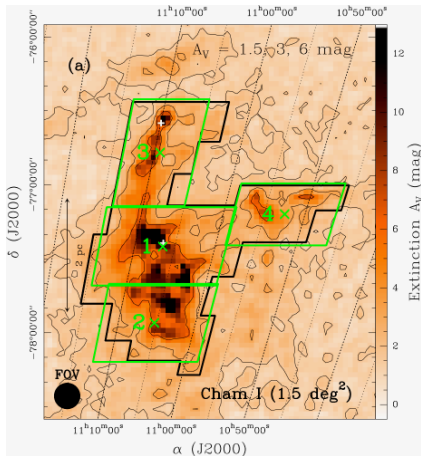
Nearby molecular complexes

- Spitzer Legacy Program to map the **Gould Belt** molecular complexes with IRAC and MIPS (PI: L. Allen)
- Observations planned with SCUBA-2 for the northern clouds
- Joint project ESO + Sweden + MPIfR to map the southern clouds with LABOCA
- In the queue: the Lupus cloud (PI: J. Hatchell)

Nearby molecular complexes

The Chamaeleon complex

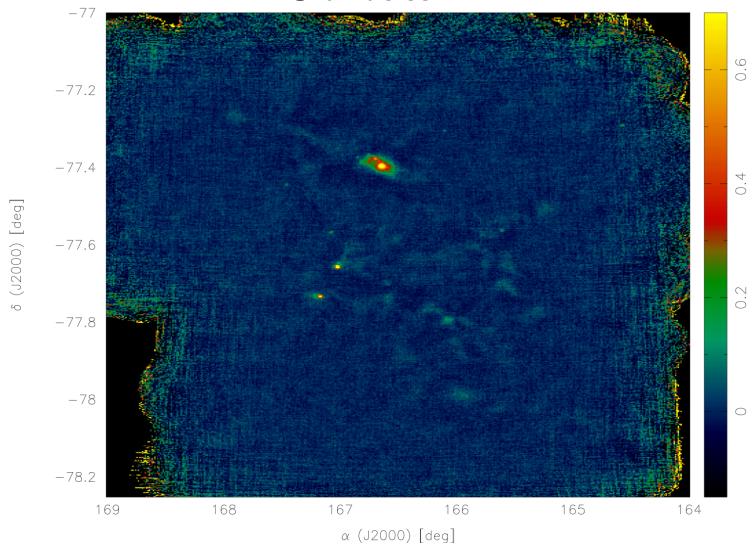
PI: A. Belloche



- Map the $A_V > 3 \text{ mag}$ area
- Start with Cha-I cloud, 1.5 deg^2
- aimed rms 5 mJy/beam
 $\Rightarrow 0.1 M_{\odot}$ cores ($5\text{-}\sigma$)
 $< 100 \text{ hours}$ observing

Nearby molecular complexes

Chamaeleon I



12 hours observing, **rms = 15 mJy/beam**

- **Ongoing:**

- Line survey of the Orion bar (photo-dissociation region)

- Systematic survey of the APEX-2A range (1 mm window)

- Done: 279 to 307 GHz (Leurini et al. 2006)

- Planned: 307 to 354 GHz

- Using 2 FFT spectrometers, **instantaneous BW = 1.8 GHz**

- Higher frequencies: waiting for more instruments to come

- complementarity with Herschel HIFI

- pathfinder for ALMA

- Large scale mapping capabilities of LABOCA
- Southern submm sky unexplored so far
→ thousands of new sources !
- Targets for follow-up studies with ALMA
(chemistry, dynamics...)
- Complementarity with Herschel (and others)
⇒ SEDs from near-IR to mm