GASTON: The NIKA2 Galactic Star formation Large Programme

Dust properties and star formation at the extremes

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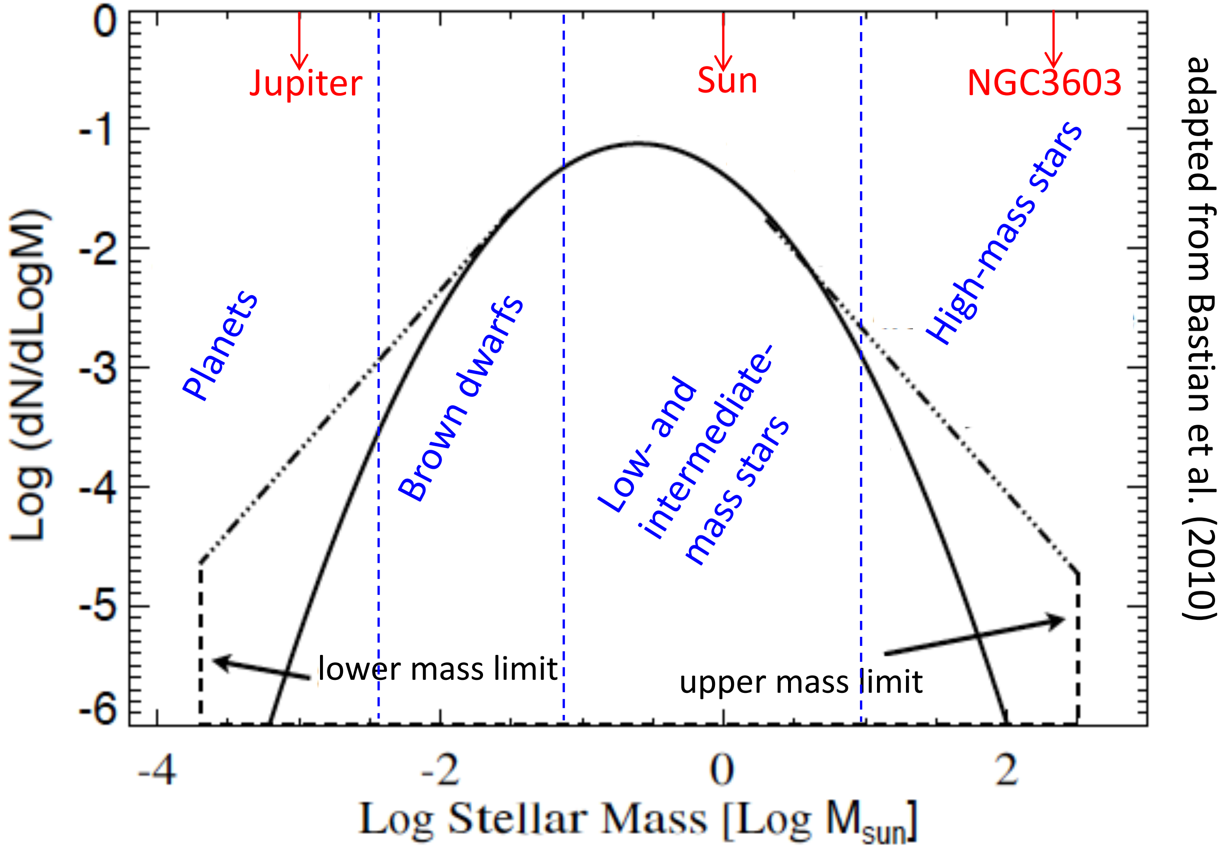
The mm Universe @ NIKA2 conference – Grenoble – 3rd – 7th of June 2019

The GASTON large programme: Motivation

A schematic view of the Initial Mass Function of stellar objects

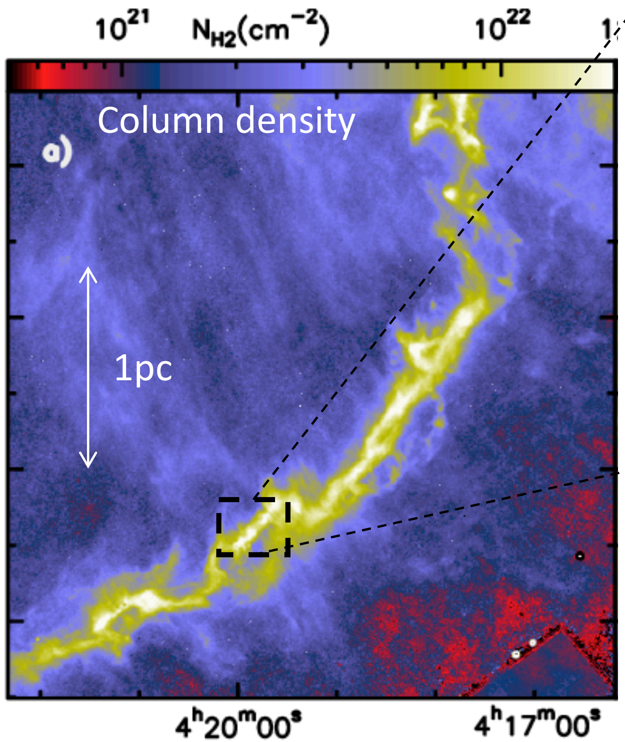


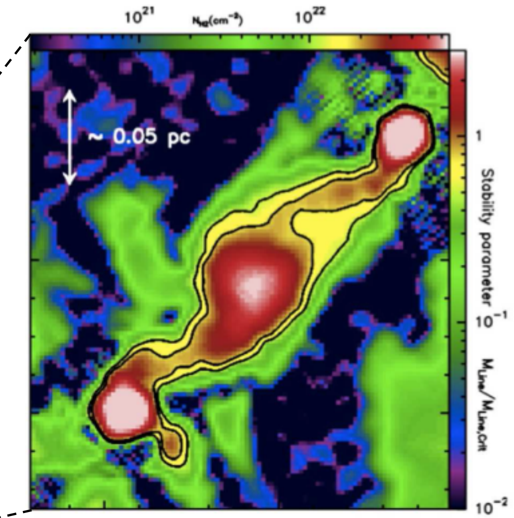
Do different stellar mass regimes correspond to different "modes" of star formation?

The GASTON large programme: Motivation

Images of Taurus B211/213: From filaments to cores

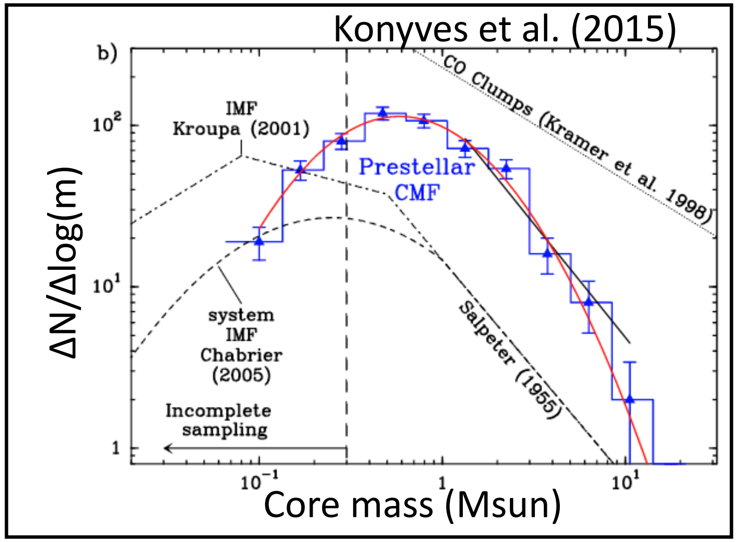
Palmeirim et al. (2013)





Bracco et al. (2017)

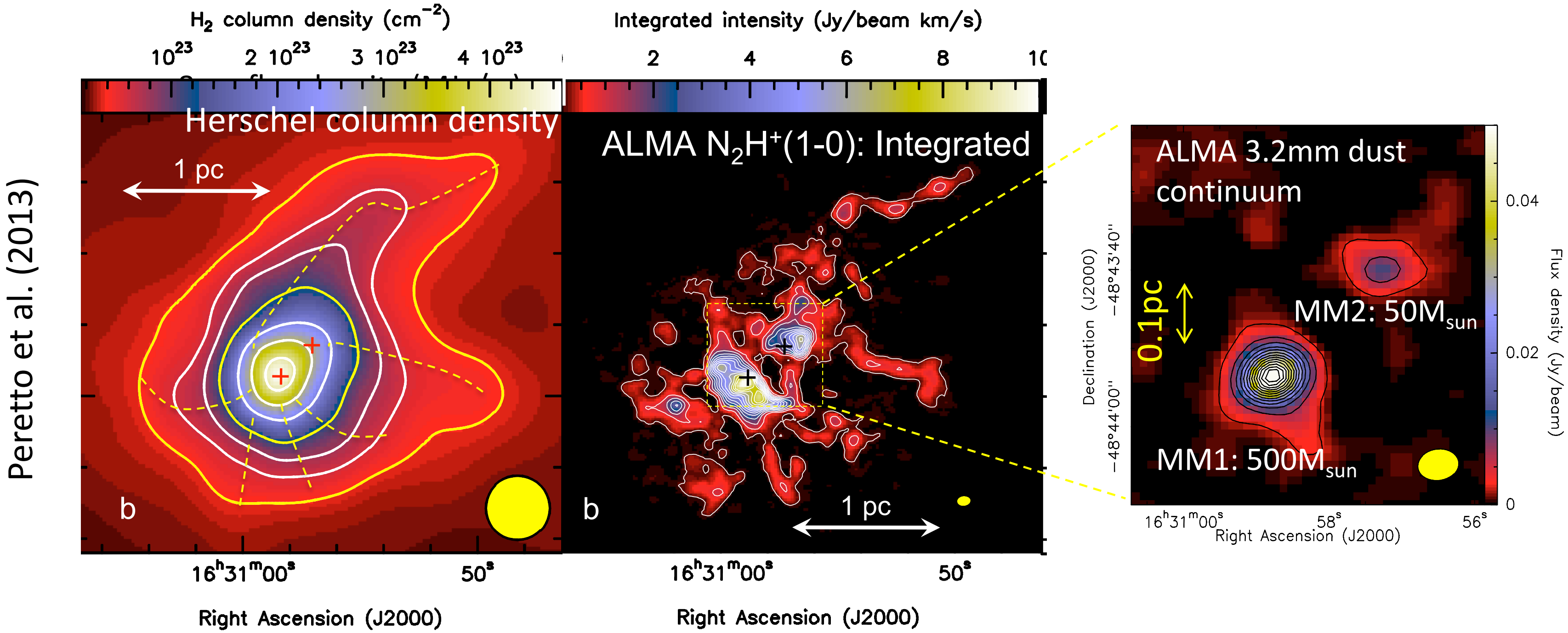
Core Mass Function in Aquila



Peak of the CMF/IMF is probably determined by gravo-turbulent fragmentation of critical filaments whose typical Jeans mass is $1M_{sun}$ (André+ 2010, 2014)

The GASTON large programme: Motivation

The massive star forming infrared dark cloud SDC335



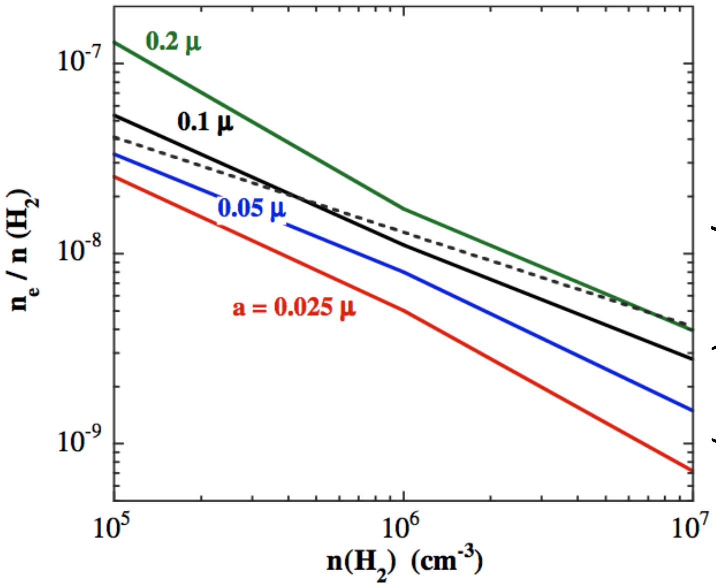
Very massive cores/stars form at the centre of rapidly globally collapsing cloud (e.g. Peretto+2006,2013; Schneider+2010; Wang+2010; Motte+2017).

-> Massive stars are clump-fed ,while low-mass stars are core-fed

The GASTON large programme: Motivation

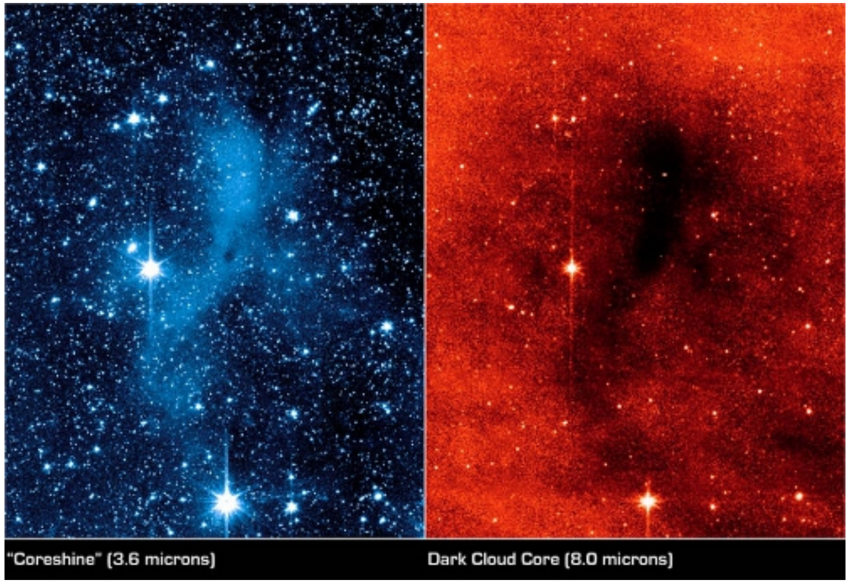
Dust properties are important in many aspects, but dust properties vary

Influence of dust grain sizes on ionisation fraction



Walmsley et al. (2004)

L183: Coreshine effect showing the growth of dust grain in cold environment

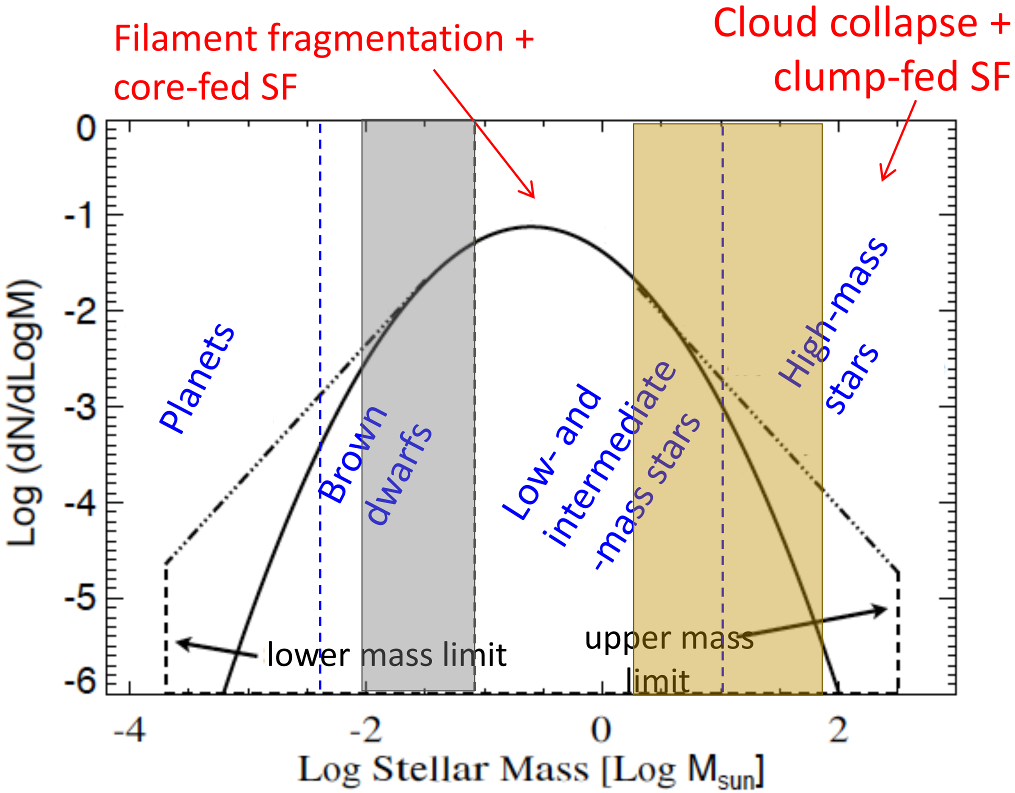


Steinacker et al. (2010)

Understanding how dust properties change as a function of environment is important in itself but also as a surrogate mass tracer of H_2

The GASTON large programme: Goals

<u>GASTON</u>: Exploiting the high-sensitivity and fast mapping capability of NIKA2 to identify large populations of low-brightness sources in galactic star forming-regions and constrain **three key star-formation-related questions**.



Goal #1: Constrain the dominant mode of brown-dwarf formation

Goal #2: Constrain the transition from core-fed to clump-fed star formation

Goal #3: Constrain dust properties from A_v=3 to A_V> 100

The GASTON large programme: Survey design

Summary of proposed observations:

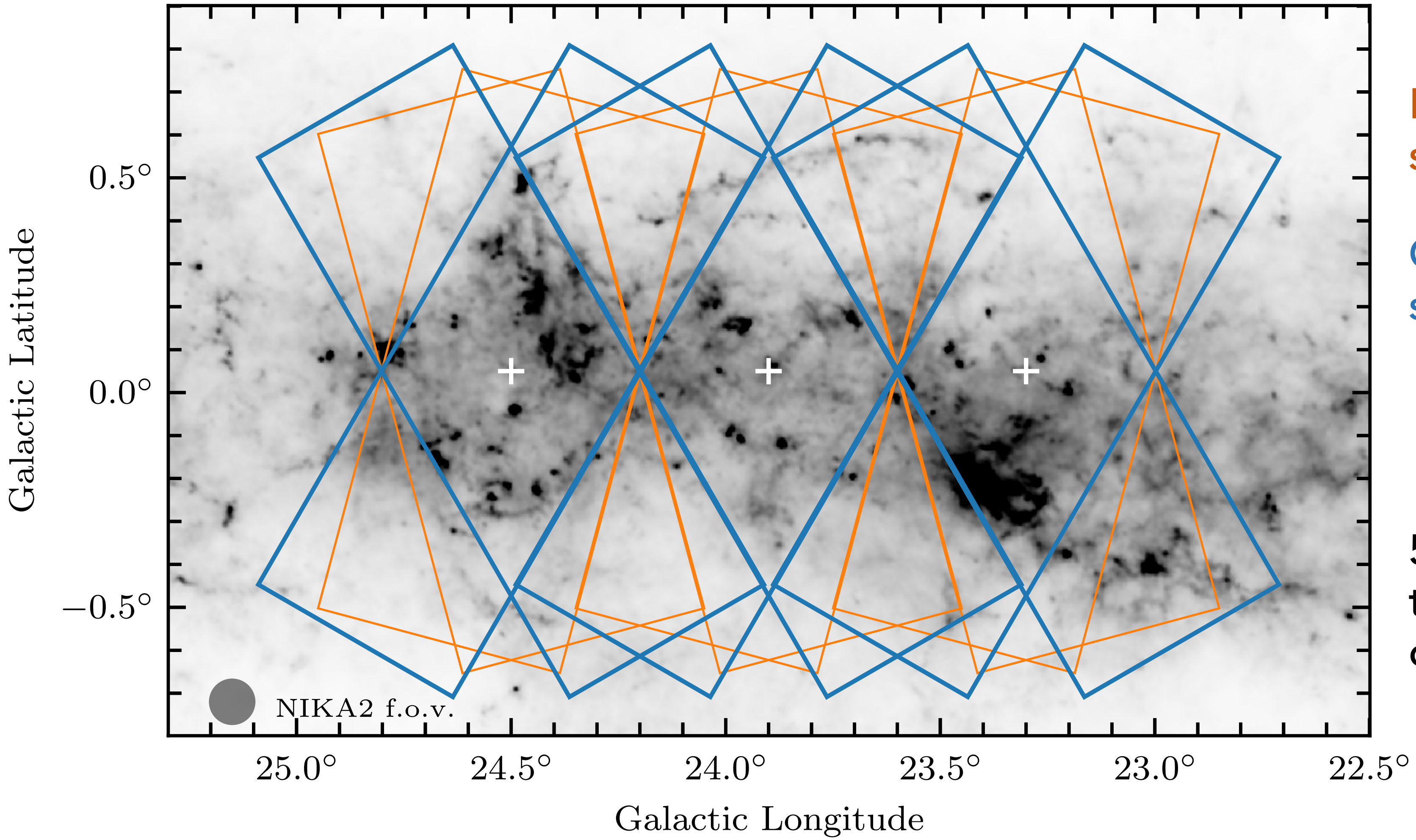
	Fields	area $(arcmin^2)$	$\sigma_{1.2mm}$ $(mJy/beam)$	σ_{2mm} $(mJy/beam)$	elevation (deg)	f_{filter}	time (h)	d (kpc)
High-mass	*l*24	8,640	1.5	0.93	40	1	70.3	3 to 5
Pre-brown dwarf	L1688	380	0.54	0.30	25	1	34.6	0.14
	Taurus	530	0.54	0.30	45	1	41.4	0.14
Dust prop	L1689B	65	0.20^2	0.17^2	25	2	23.7	0.14
	L1521E	65	0.15^2	0.14^2	45	2	30.0	0.14

Summary of GASTON's current status (25% complete):

Fields	Time (h)	$\sigma_{1.2mm}$ (mJy/beam)	$\sigma_{1.2mm}$ (mJy/beam)
l24	35	3.7	1.2
L1688	6	1.8	0.7
Taurus	0	--	--
L1689B	10		
L1521E	0	--	--

GASTON: Galactic Plane Mapping Strategy

Herschel/HiGAL 250micron image (Molinari et al. 2016)

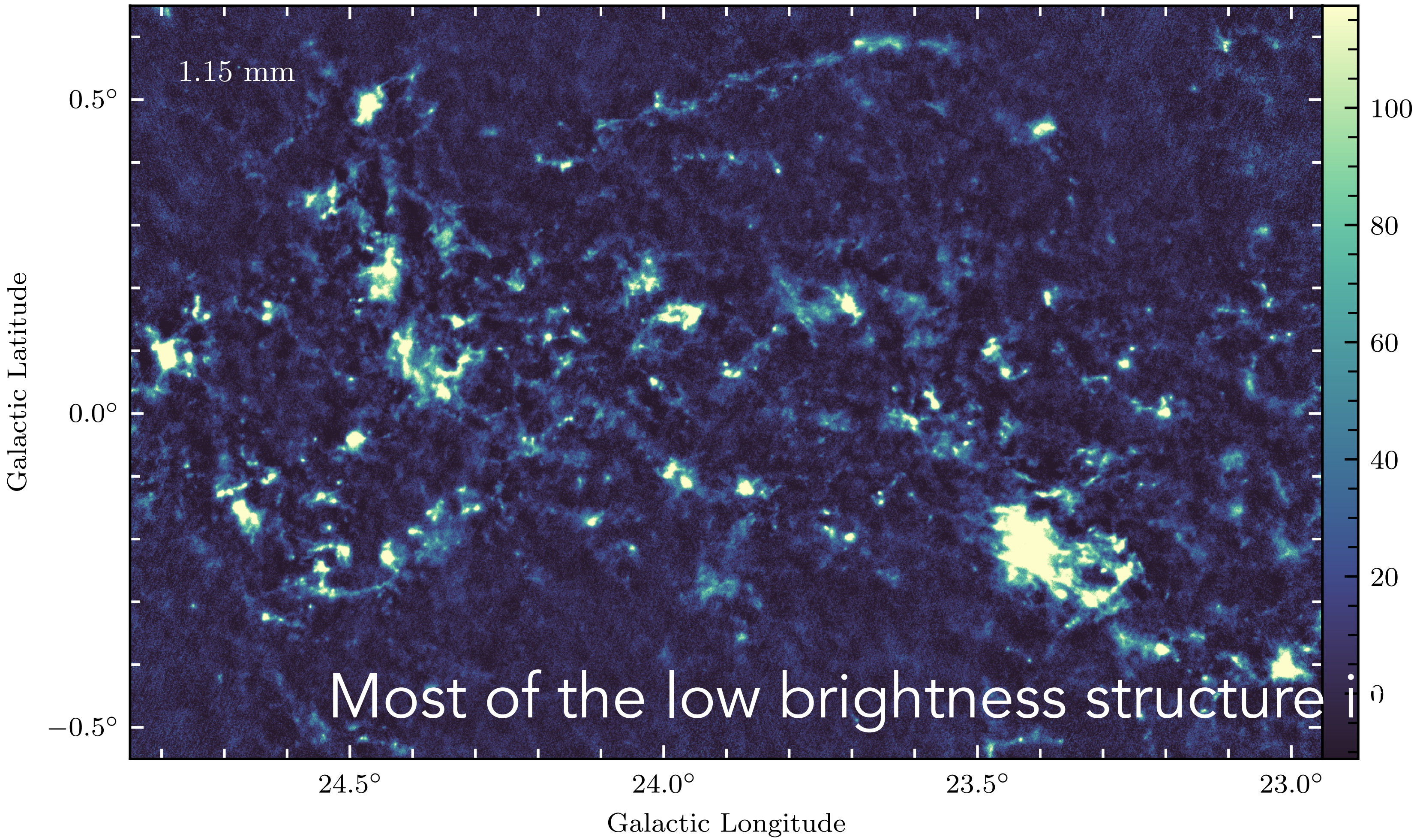


Initial mapping strategy (+/- 15deg)

Current mapping strategy (+/-30deg)

50% of allocated time has been observed

GASTON: First 1.2mm and 2mm maps of the l24 field



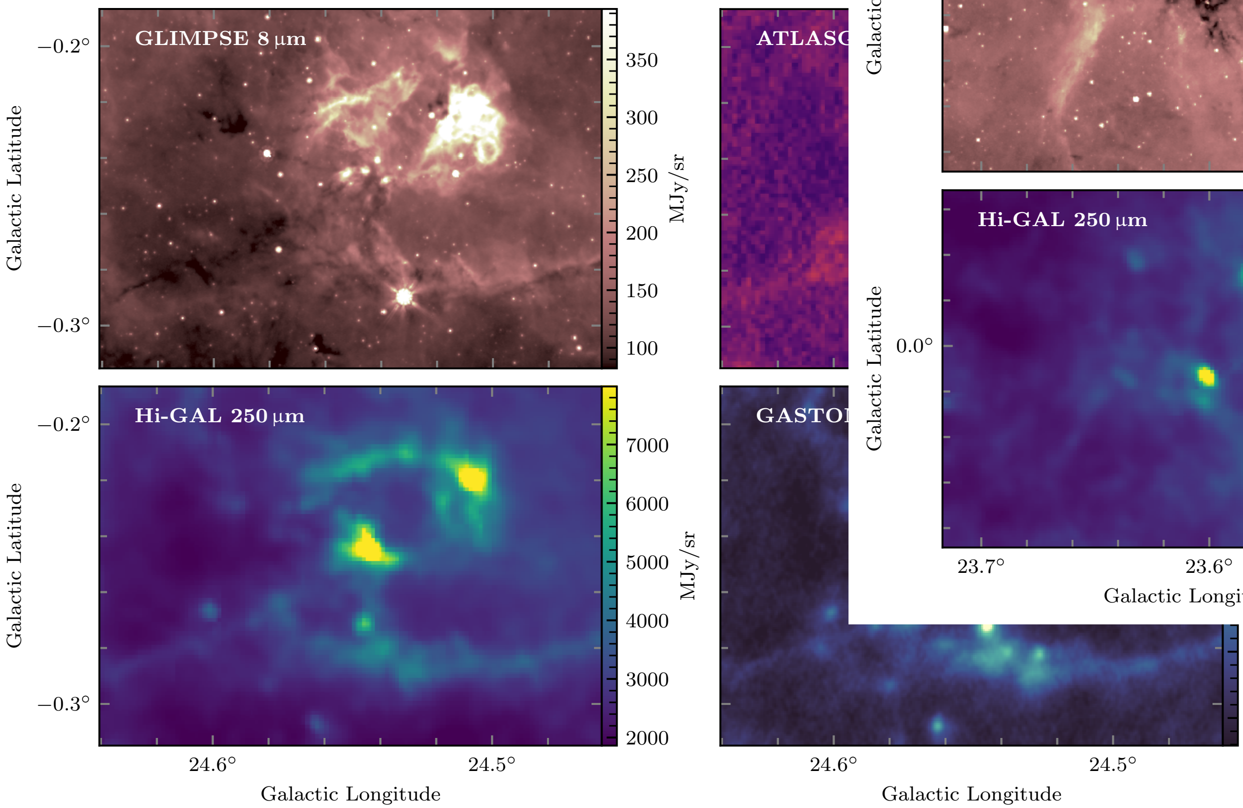
Data reduction with N. Ponthieu's IDL pipeline (iterative mode - 55 iterations)

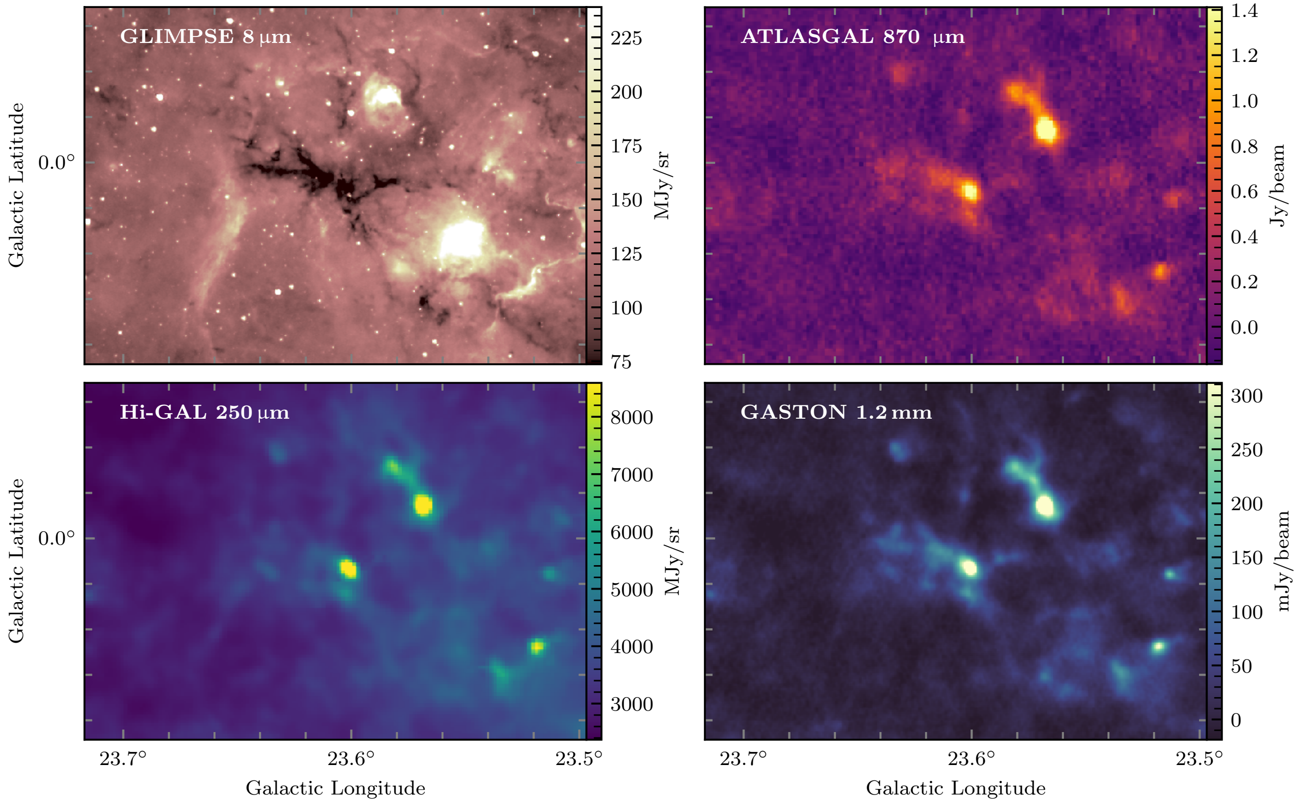
Tests have been made using Scanamorphos (H. Roussel) and R. Zylka's pipeline

Maps with 2.5″ pixel size

GASTON: Comparison with other Galactic plane surveys

Zoom-in images

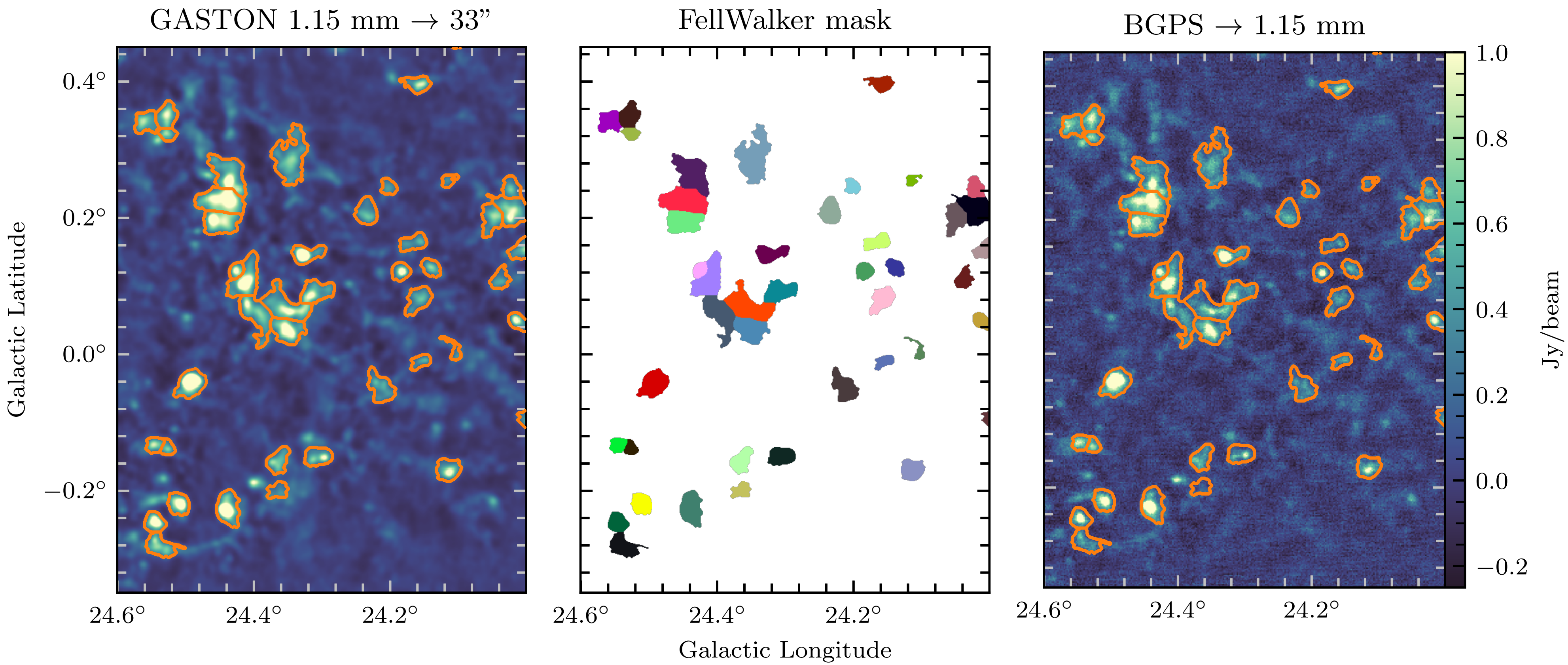




- Overall-structure is recovered
- Additional low-brightness sources are spotted

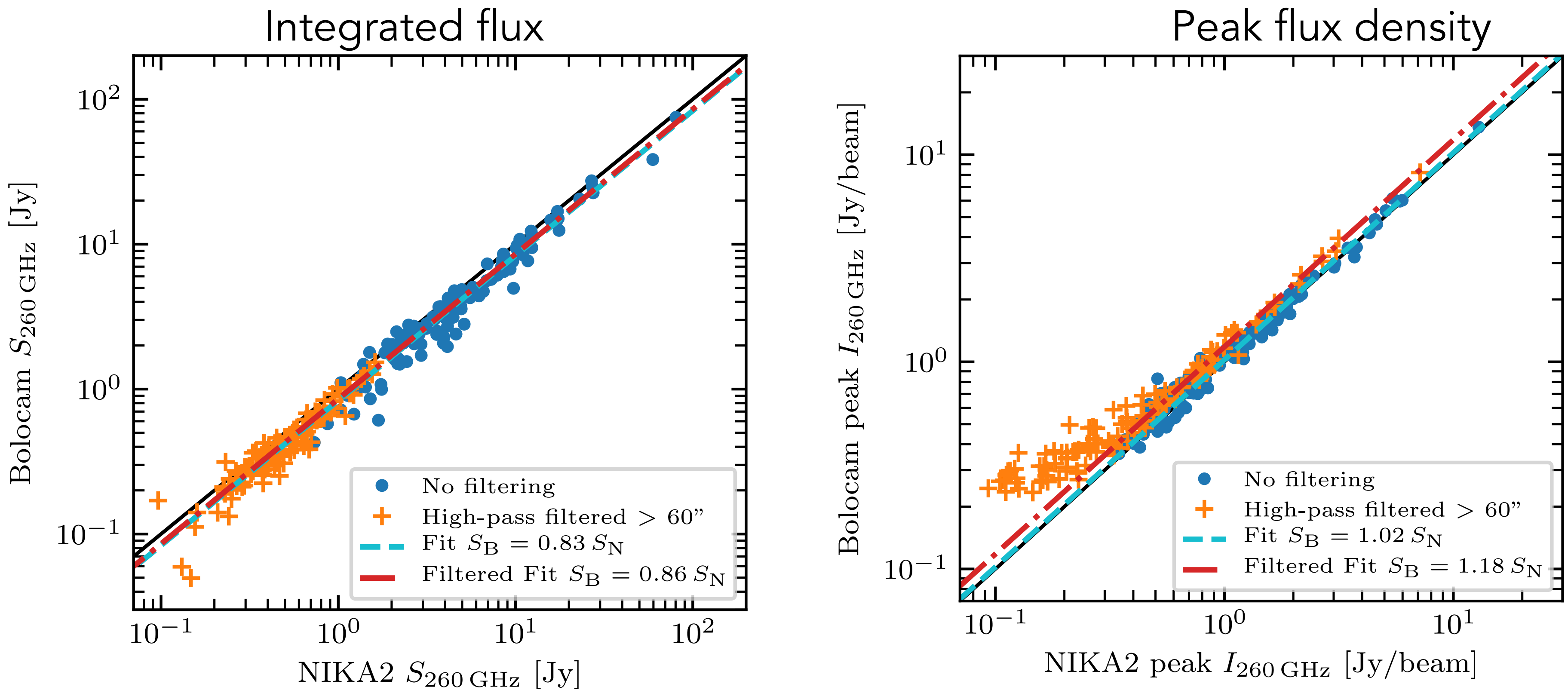
GASTON: Calibration check against BGPS (Aguirre+2011)

Bolocam Galactic Plane Survey at 1.1mm against GASTON at 1.15mm in fixed apertures



(resolution and colour correction taken into account)

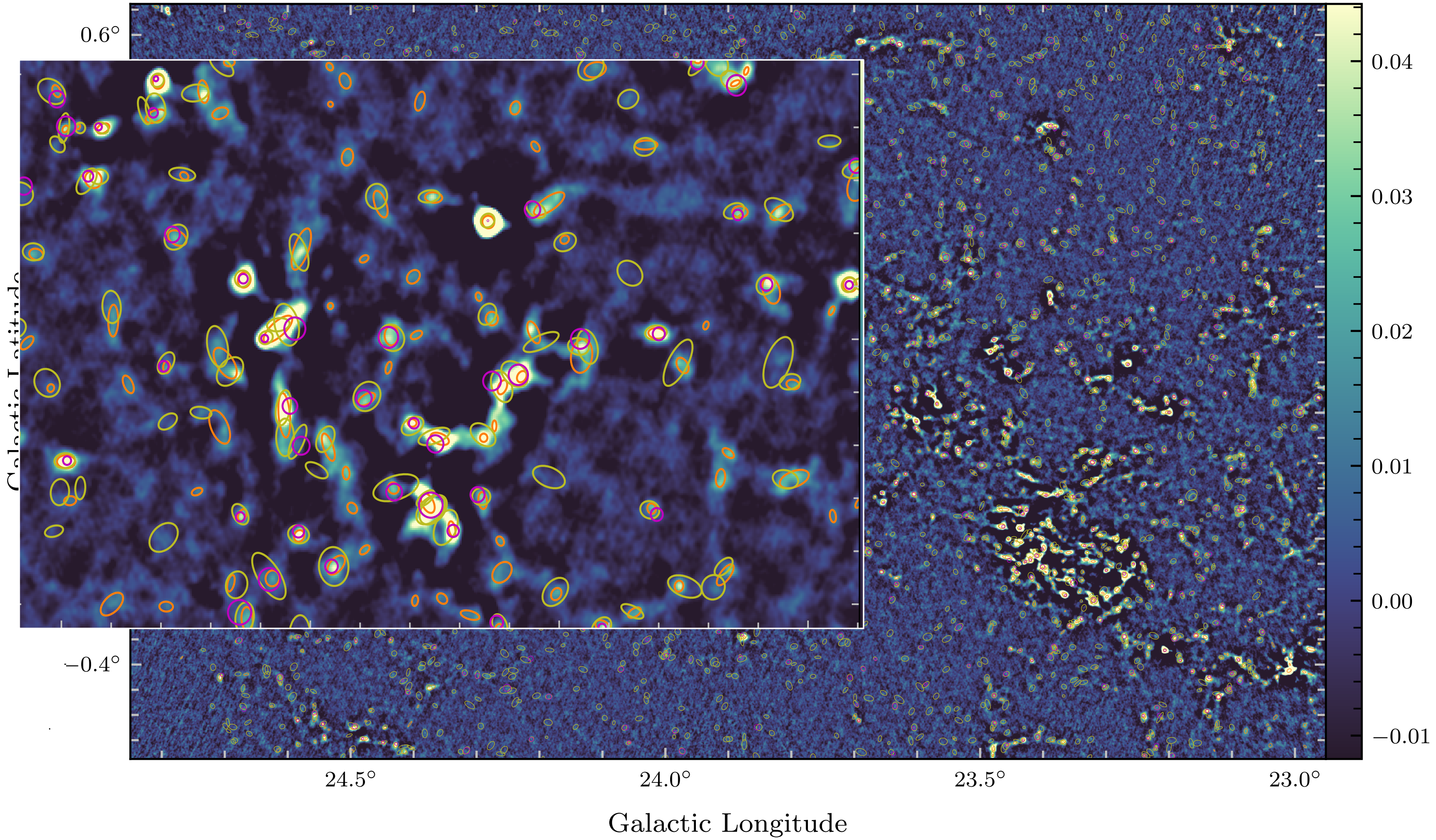
GASTON: Calibration check against BGPS (Aguirre+2011)



Integrated flux and peak flux density agree within 20%
Possible reason: extended- versus point-source emission calibration

GASTON: Compact sources identification

Filtering at 60″ + dendrogram of what is left: Compact sources are the **leaves**



GASTON sources

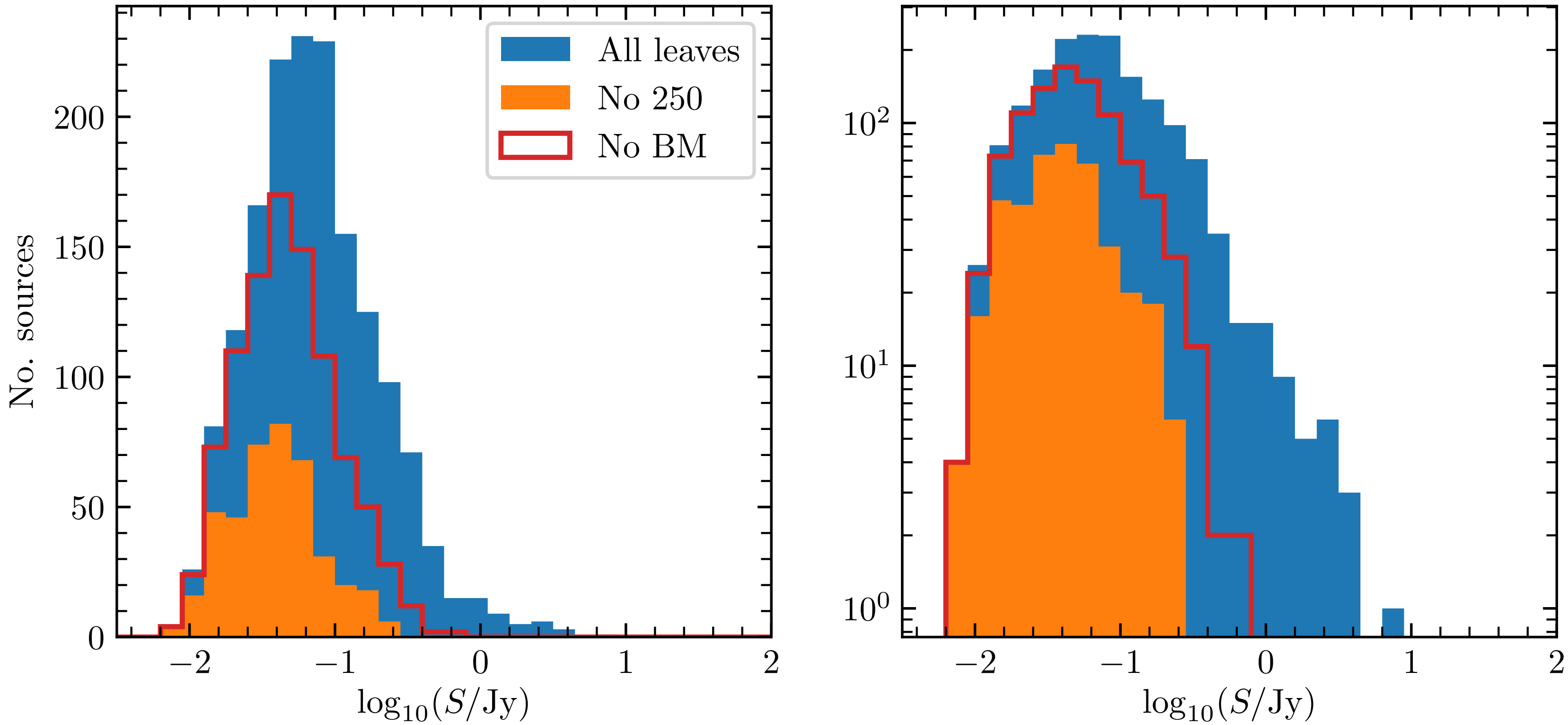
HiGAL 250micron (Molinari+2016)

HiGAL clumps (Elia+2017)

GASTON: Compact sources flux distributions

In total: 1615 compact sources – 940 with no HiGAL BM sources – 413 with no 250μm sources

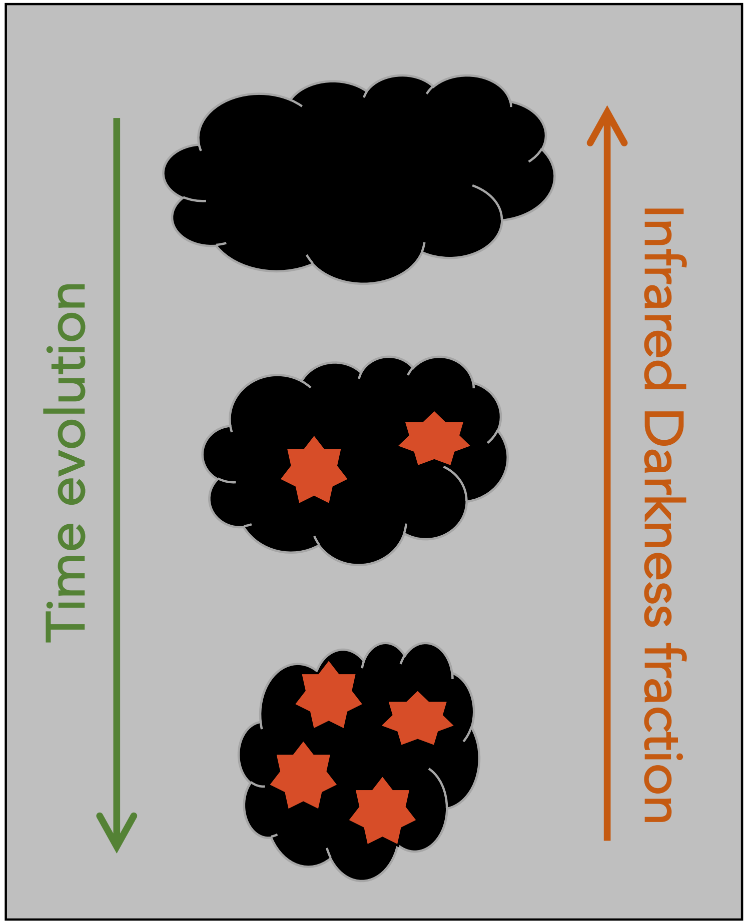
Flux distributions



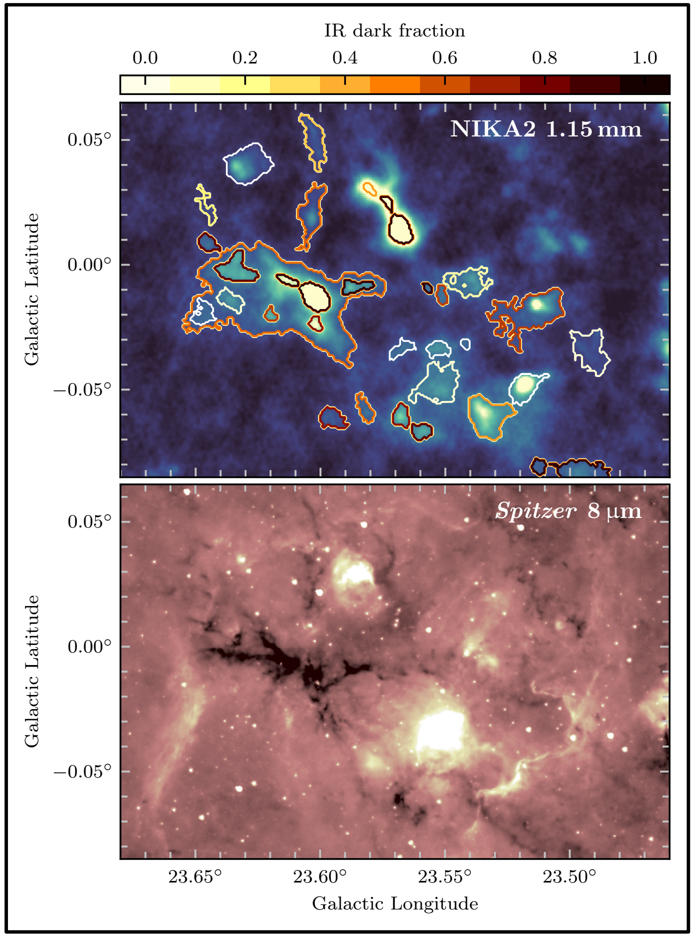
As expected, GASTON identifies a new population of low brightness sources

Infrared darkness of GASTON sources

Sketch of Infrared darkness evolution

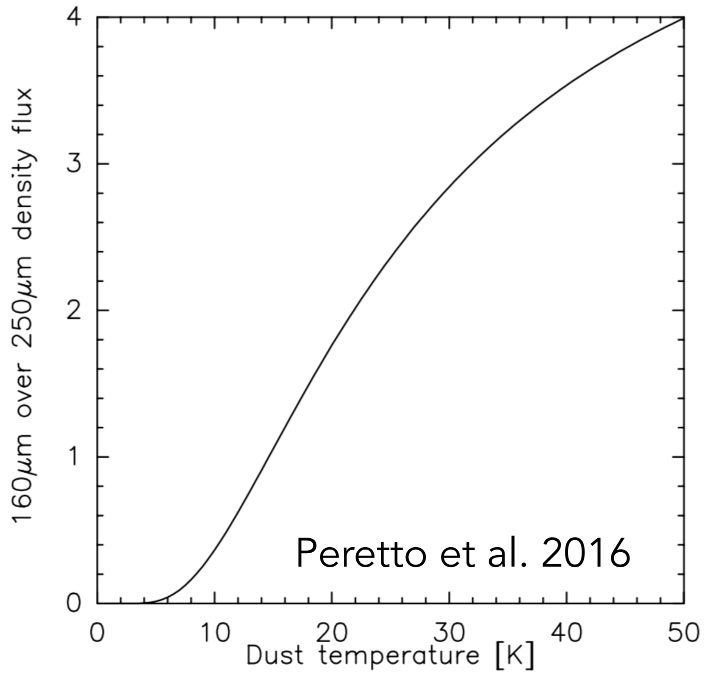


Examples of IR darkness in GASTON

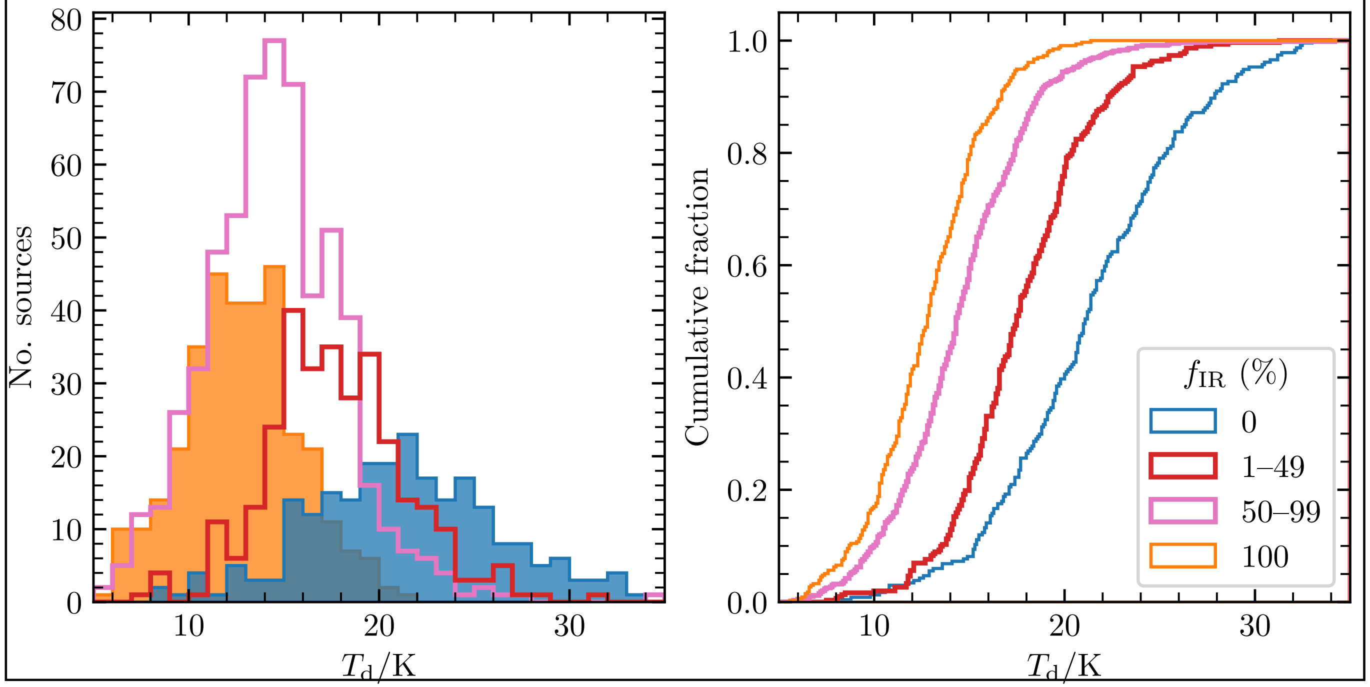


Dust temperatures of GASTON sources

Dust temperatures estimated from Herschel 160/250μm ratios



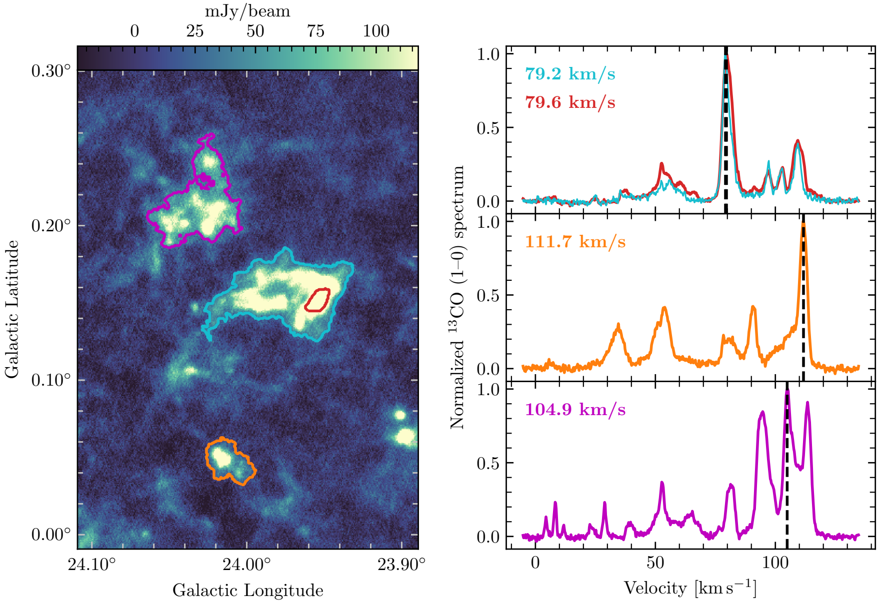
GASTON compact sources dust temperatures estimated from filtered Herschel 160/250μm ratios



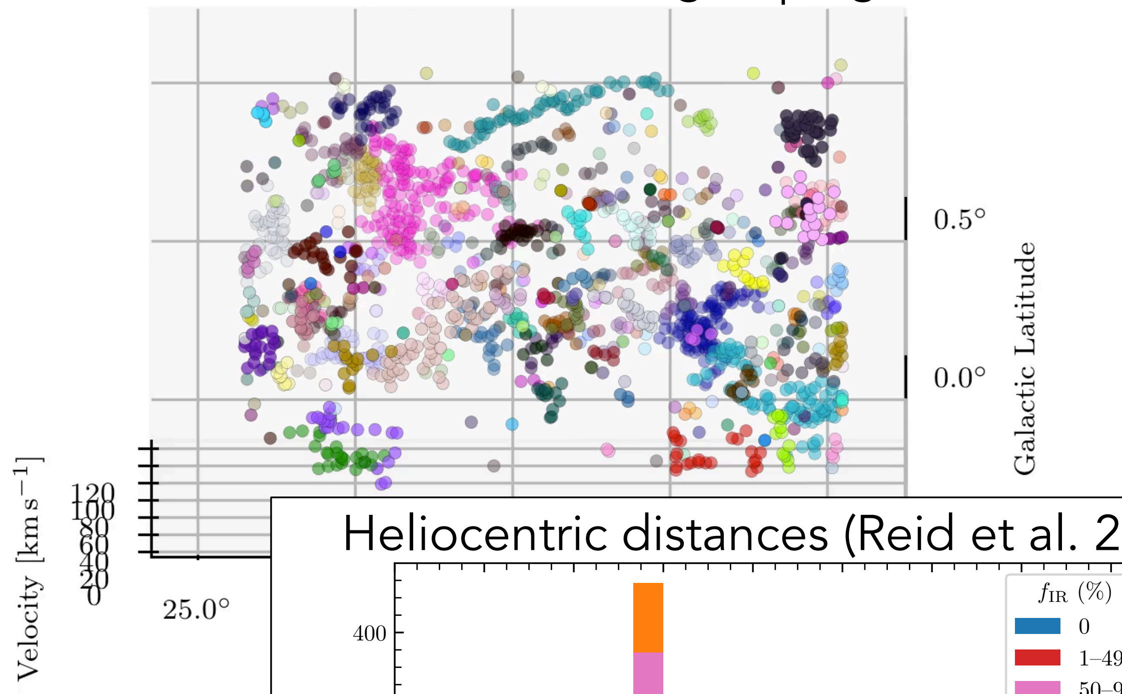
Expected evolution of dust temperatures as a function of infrared darkness fractions

Distances of GASTON sources

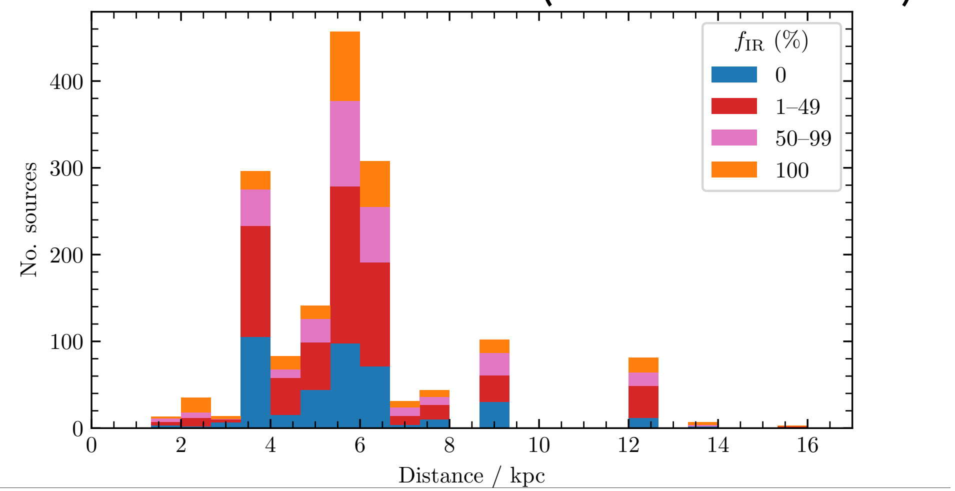
Use of ^13^CO(1-0) GRS survey (Jackson 2006) to get velocities



3D friend-of-friend grouping

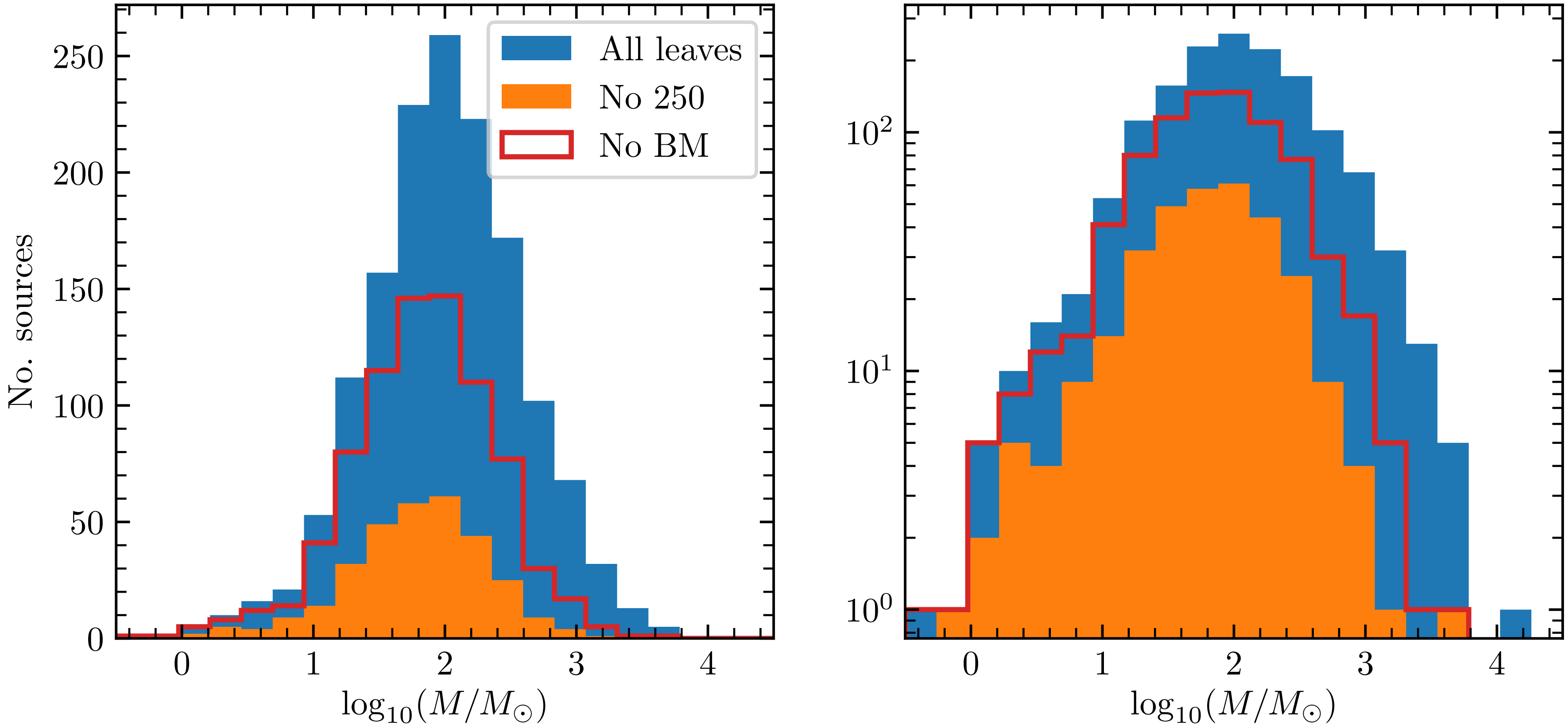


Heliocentric distances (Reid et al. 2014)



Distributions of distances across infrared darkness fraction

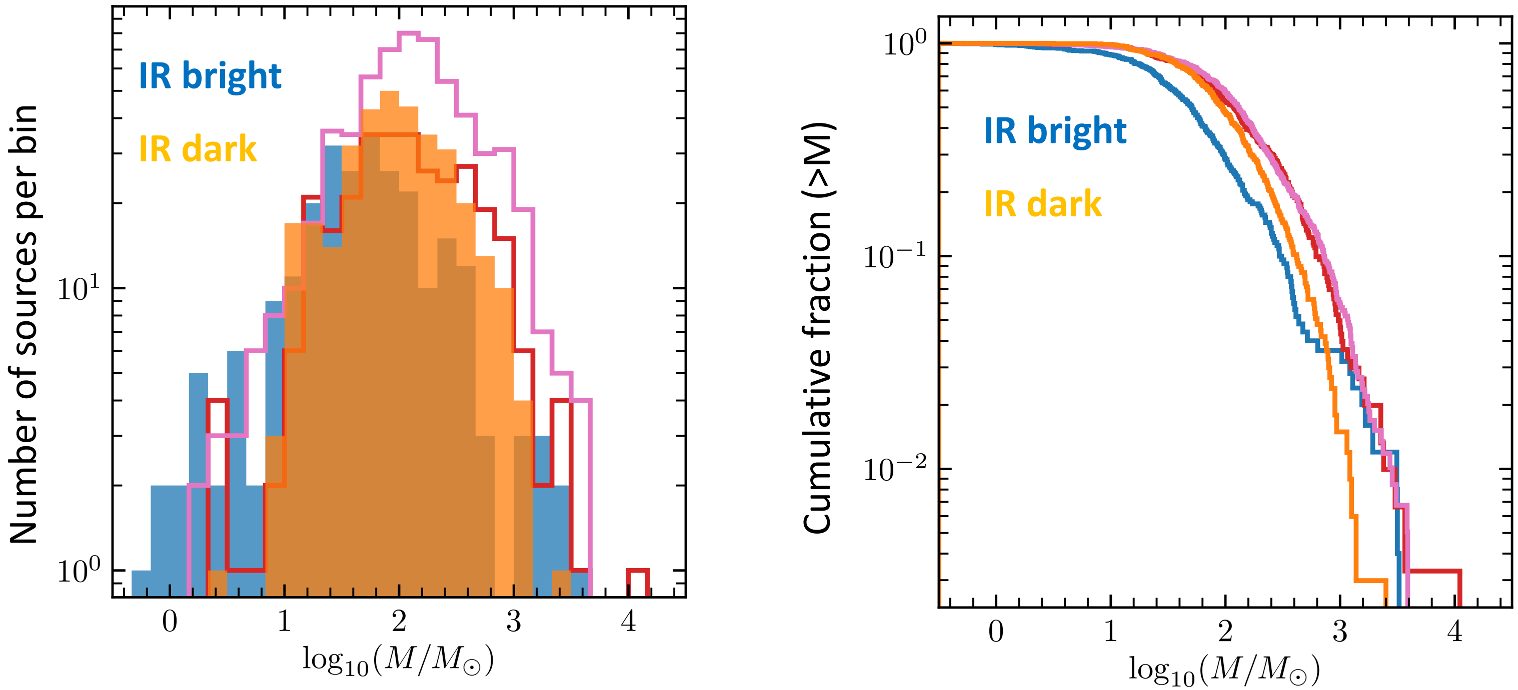
Mass distribution of GASTON sources



New population of sources (orange) has similar mass distribution compared to the global population: **New cold massive sources identified!**

Mass distribution of GASTON sources

Mass distributions as a function of infrared darkness fractions



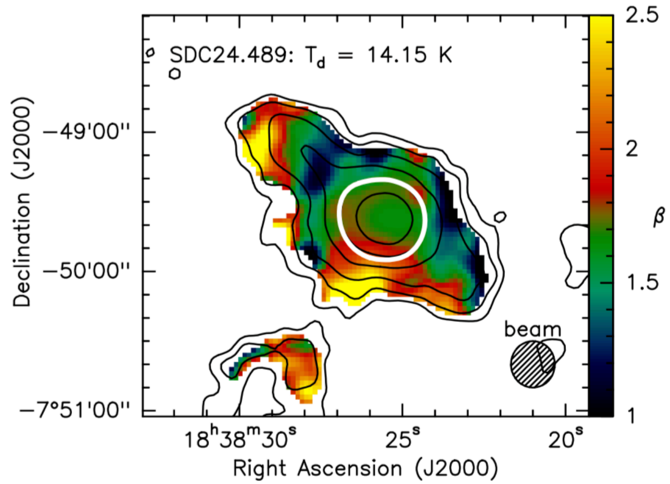
Distributions seem to evolve from IR dark (stepper) to IR bright (shallower) but needs more work to confirm

GASTON: Plans for the l24 field

- More work is needed to confirm the results presented here on the mass distribution evolution, but will be the focus of a first GASTON paper

- A catalogue of GASTON sources and reduced images (and accompanying paper) will be released once all data has been taken

- Possible other science papers:
    - Variation of dust properties as a function of Galactic radius
    - Variability of protostellar sources
    - Detailed multi-wavelength characterisation of dense cores
    - High-resolution follow up observations (NOEMA ALMA) of the new population of sources



Rigby et al. 2018

GASTON: comparison IDL pipeline - Scanamorphos