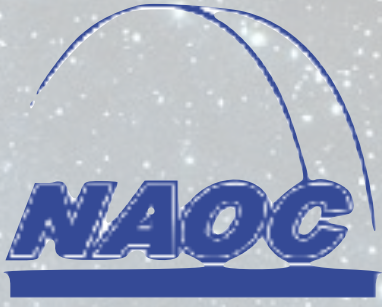


A deep SCUBA2 survey for inter-arm GMCs in M31

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Introduction and motivation

Giant molecular clouds (GMCs) are the primary sites of star formation in our Galaxy and represent the fundamental structural units observable in other galaxies. Understanding how the physical properties of GMCs vary within galaxies is a critical step toward unraveling the processes of star formation and galaxy evolution.

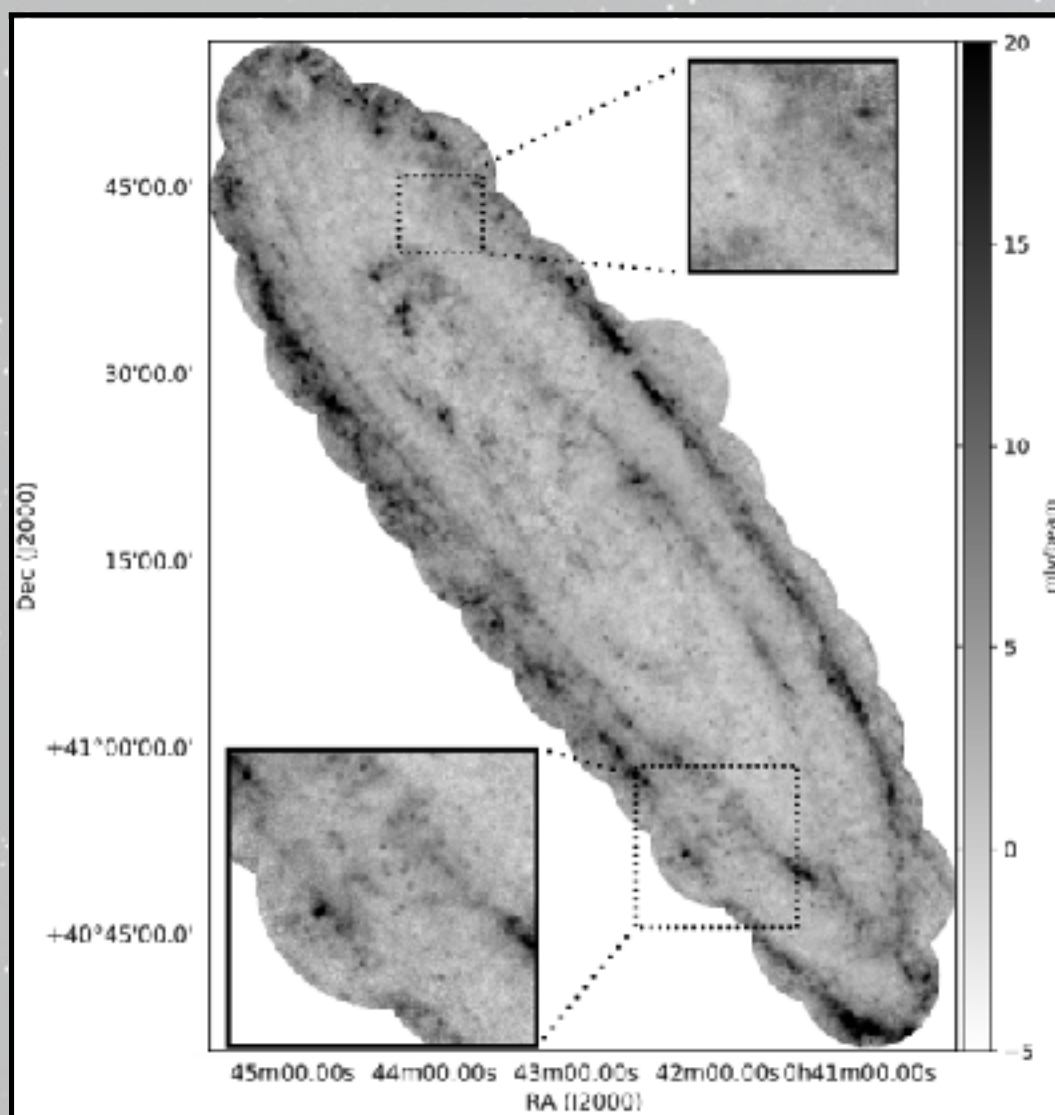
However, observational limitations present a significant "bottleneck" to achieving a comprehensive understanding of GMC properties (including temperature) across diverse environments:

(1) **Milky Way studies:** Obtaining a complete view of GMCs is extremely challenging due to the edge-on projection of the Milky Way and the ambiguity in determining line-of-sight distances.

(2) **Extragalactic studies:** Resolving individual GMCs at extragalactic distances requires high spatial resolution, typically achievable only through interferometric observations, which are dominated by CO observations, e.g., PHANGS-ALMA^[1].

Observations and Method

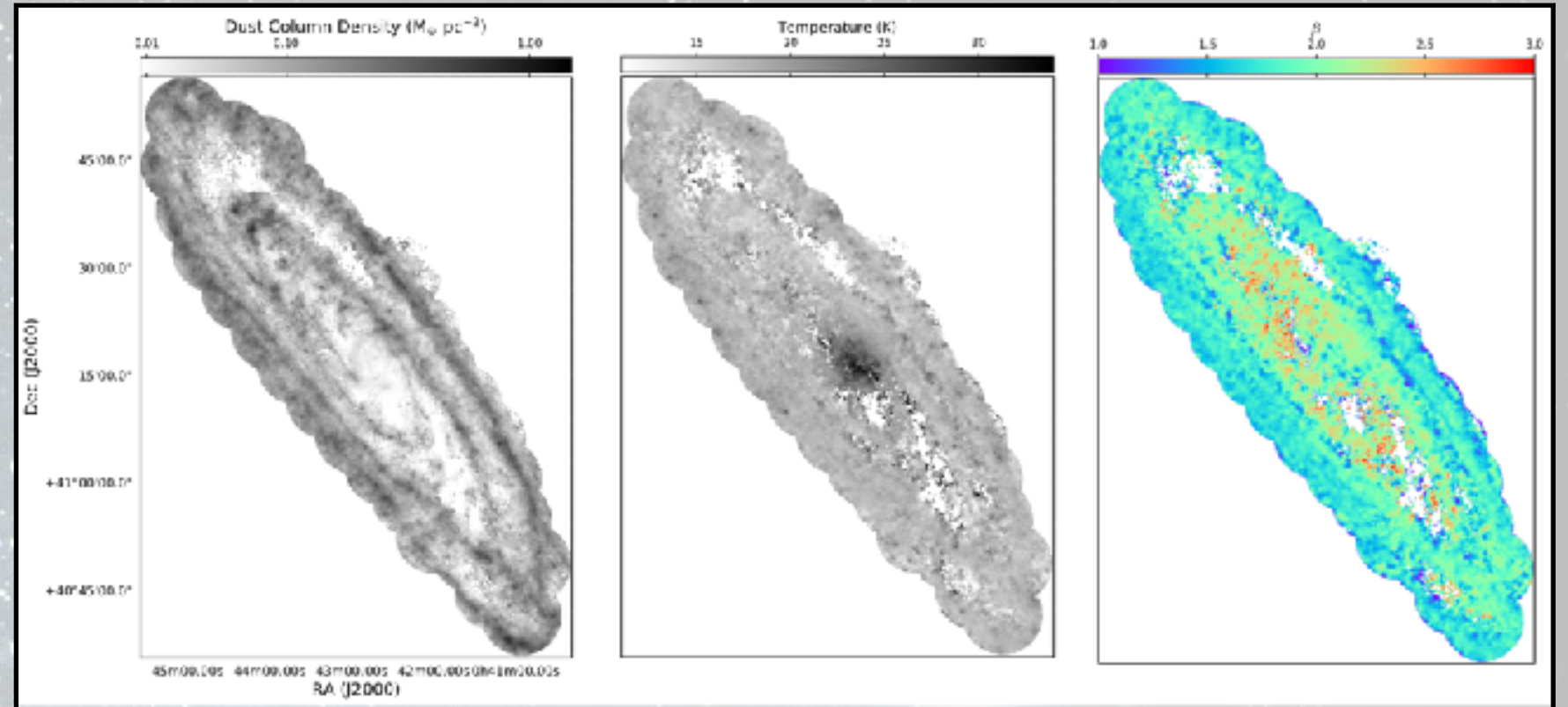
To establish a comprehensive and detailed survey of inter-arm GMCs in M31, a JCMT large PI project was conducted, to survey the M31 inter-arm regions with **280 hours** SCUBA2 observations reaching a similar sensitivity of **<1.5 mJy beam⁻¹** and a spatial resolution of **~50 pc** at 850 μm band. The observed region covers an area of $\sim 1.7^\circ \times 0.6^\circ$, extending from galactic center to the galactocentric radius of $R \sim 15$ kpc. The data were combined with *Herschel* and *Planck* archive images to recover large-scale missing flux using the J-comb algorithm^[2].



Reference

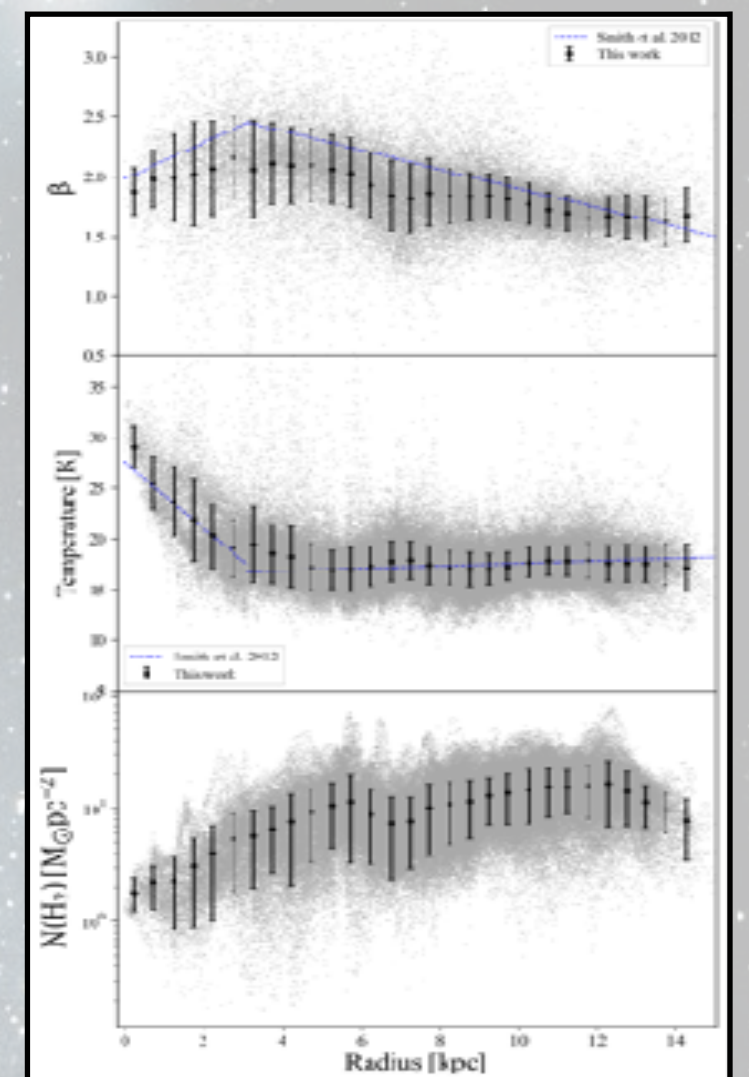
- [1] Leroy et al. 2021 ApJS, 257, 43
- [2] Jiao et al. 2022 SCPMA, 65, 299511
- [3] Lin et al. 2016 ApJ, 828, 32
- [4] Smith et al. 2012 ApJ, 765, 40
- [5] Braun et al. 2009 ApJ, 695, 937
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Dust and gas in Andromeda



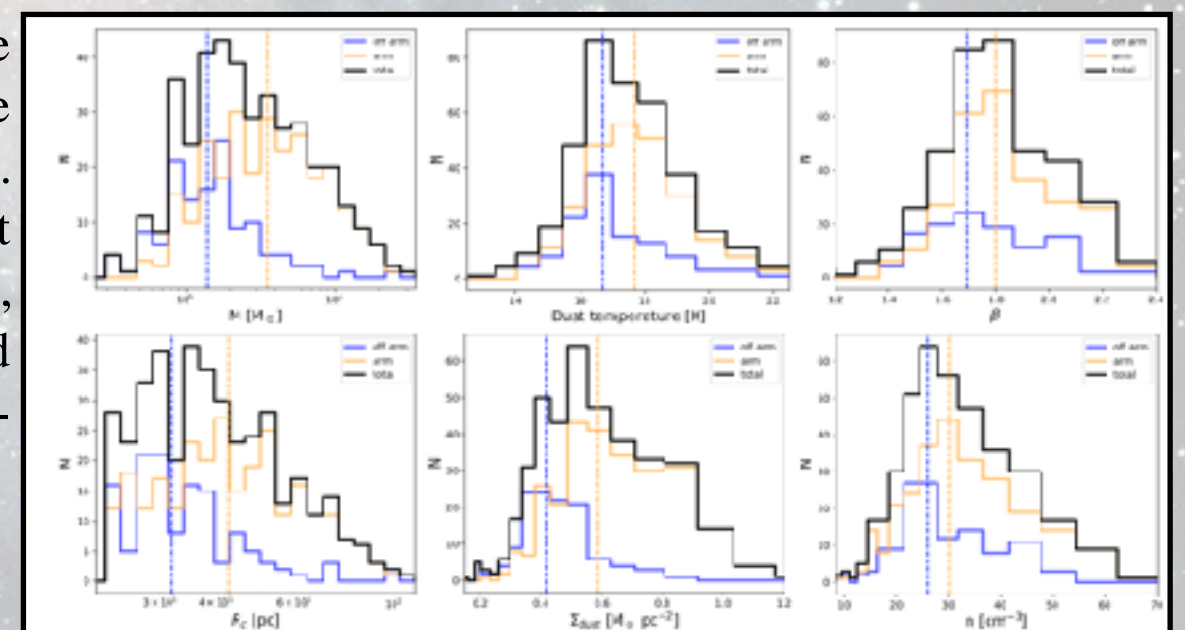
Using an iterative SED fitting procedure^[3], the distribution images of dust column density ($\sim 18''$, left), dust temperature ($\sim 18''$, middle), and dust emissivity index ($\sim 37''$, right) were generated. The dust column density map, with the GMC-scale spatial resolution, clearly reveals the large-scale structures of M31, e.g., spiral arms and rings.

By incorporating longer-wavelength observations into the SED fitting, the dust emissivity index (β) shows smaller variations ($1.8 \approx \beta \approx 2.1$, top) compared to previous results based solely on *Herschel* observations^[4], while the gas surface density and dust temperature remain comparable.



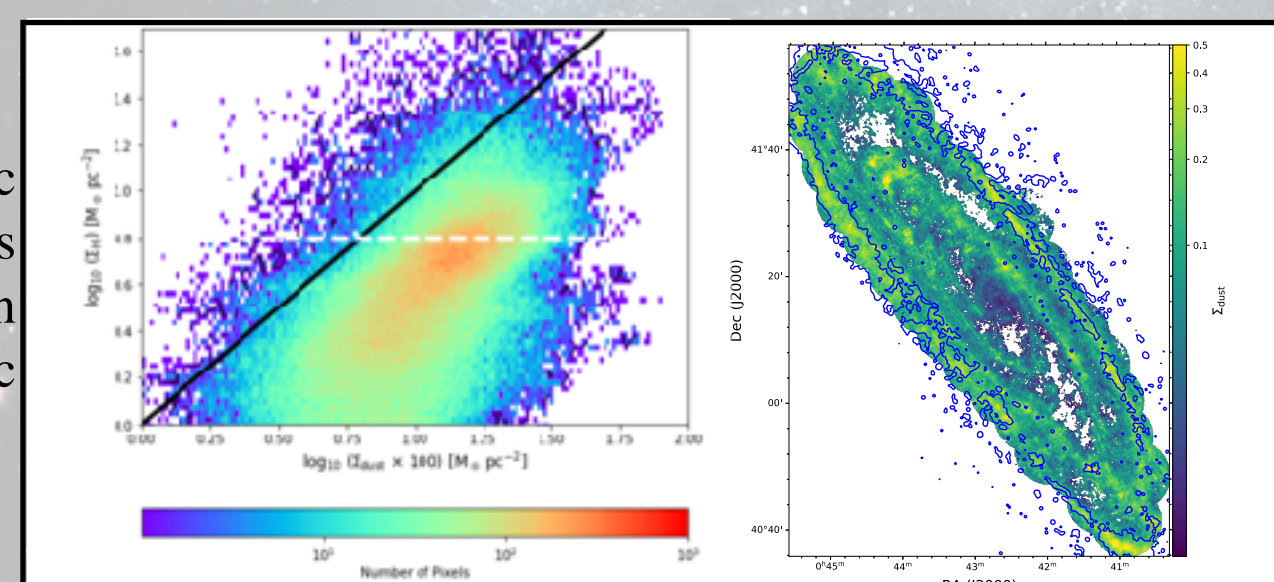
GMCs in Andromeda

A total of 540 GMCs were identified, 185 of which are located in inter-arm regions. The inter-arm GMCs exhibit systematically lower masses, dust temperatures, and densities compared to the on-arm GMCs.



HI-H2 in Andromeda

The conversion of atomic to molecular gas (HI-to-H₂) is a fundamental process in molecular cloud formation. Using the WSRT HI data^[5], the saturation of HI column density is observed to be $\sim 6 M_\odot \text{pc}^{-2}$, consistent with predictions from theoretical models^[6].



In M31, the 10 kpc ring surpasses this saturation of HI column density, while the 5 kpc ring does not.