Mapping Dust Extinction at Parsec-Scales in the SMC & LMC

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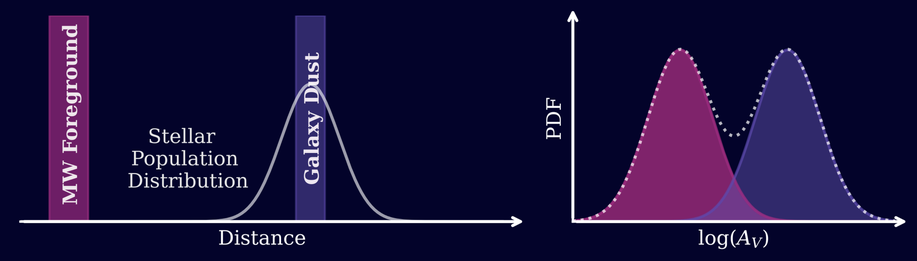
Background

Dust serves as a crucial tracer of the interstellar medium (ISM), allowing us to measure the combined gas column density across gas-phases. While dust emission is highly sensitive to the local radiative environment, dust extinction provides a radiation-independent tracer of the ISM.

Using multi-band HST photometry from the Scylla survey (Murray+24b), we model the line-of-sight extinction (A_V) towards +500k individual stars in 68 fields across the SMC and LMC (Lindberg+25). Using these A_V measurements, we construct a pipeline to isolate background stars and geostatistically map A_V within each field.

Method

1. Split each field into bins with a minimum of N stars (where N=10, 20, …, 100)
2. Isolate foreground stars from background stars using log-A_V distribution

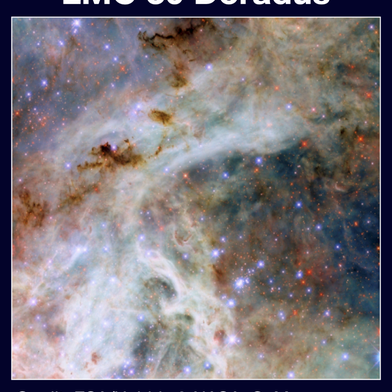


3. Interpolate between background sources using kriging, a geostatistical technique for 2D mapping

An Example Result

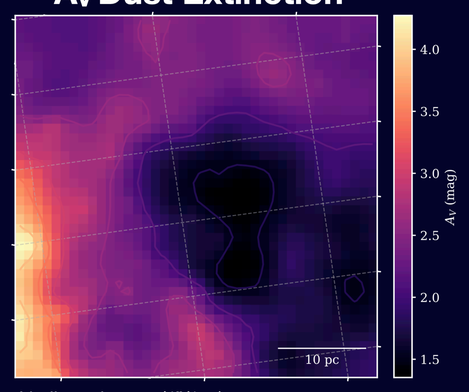
Dust extinction matches FIR dust emission and ^{12}CO(2-1) emission tracing dense molecular gas and captures structures with $A_V > 4$ mag at small scales.

LMC 30 Doradus



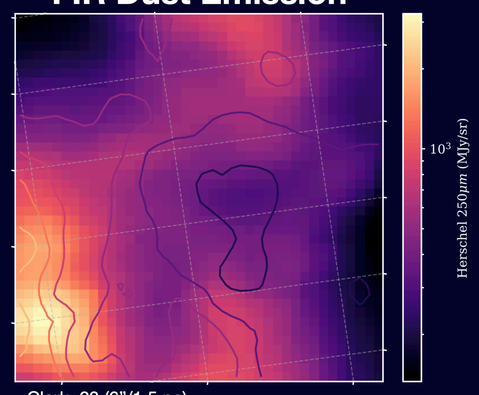
Credit: ESA/Hubble & NASA, C. Murray

A_V Dust Extinction



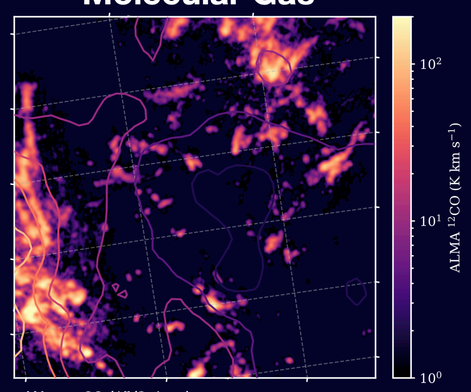
Lindberg+in prep (4"/1pc)

FIR Dust Emission



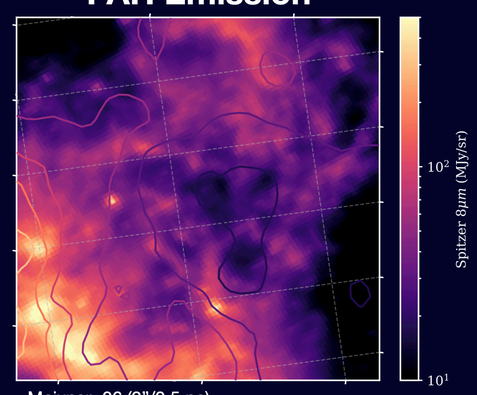
Clark+23 (6"/1.5 pc)

Molecular Gas



Wong+22 (1"/0.4 pc)

PAH Emission

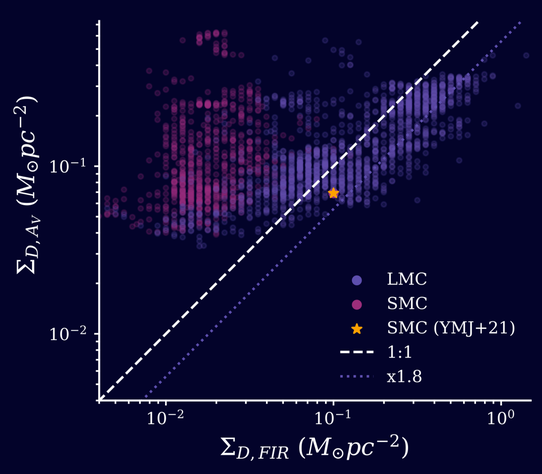


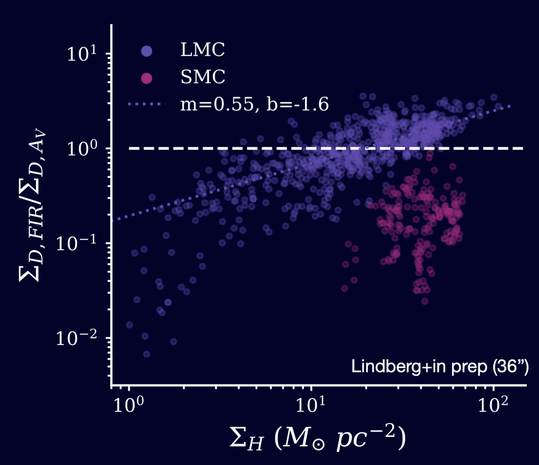
Meixner+06 (2"/0.5 pc)

Implications for Dust Opacity

Theory predicts dust grains should produce more emission per unit mass (opacity) as they grow larger/ coagulate in denser environments.

With new maps, we can directly compare the inferred dust mass from dust extinction, Σ_{D,A_V}, vs FIR dust emission, $\Sigma_{D,FIR}$, to measure how dust opacity evolves across different galactic environments.





Take-Away

With multi-band photometry, we can map small-scale (1-5 pc) dust extinction structures to an accuracy of ~10%, probing A_V = +4 mag in nearby galaxies.

These maps can be used to (1) measure the CO-dark fraction of molecular gas at low metallicity, (2) constrain feedback from massive stars, (3) calibrate FIR dust emissivity and PAH models across a diverse range of galactic environments.

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