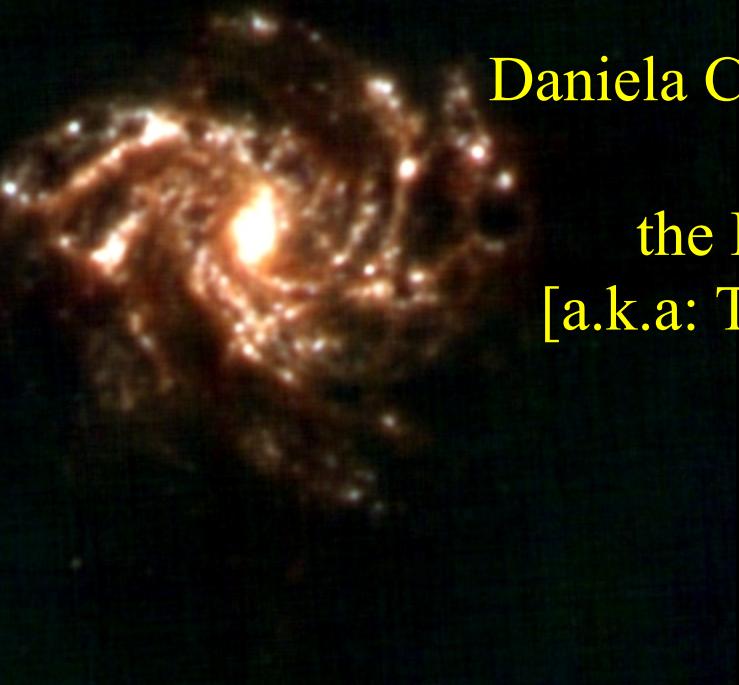


Overview of Early Results from KINGFISH

(Key Insights on Nearby Galaxies: a Far- Infrared Survey with Herschel)



Daniela Calzetti (Umass - USA),
and
the KINGFISH Team
[a.k.a: The Logo-Less Team]

ESLAB2010, 5 May 2010

The TEAM

UK: Rob Kennicutt (PI), Paul Alexander, Dave Green, Ben Johnson, John Richer

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France: Helene Roussel, Marc Sauvage, Sundar Srinivasan, Laurent Vigroux

Germany: **Oliver Krause**, Sharon Meidt, Hans-Walter Rix, Karin Sandstrom, Eva Schinnerer, Fabian Walter

Italy: Leslie Hunt

Netherlands: Bernhard Brandl, Brent Groves

Spain: Amando Gil de Paz

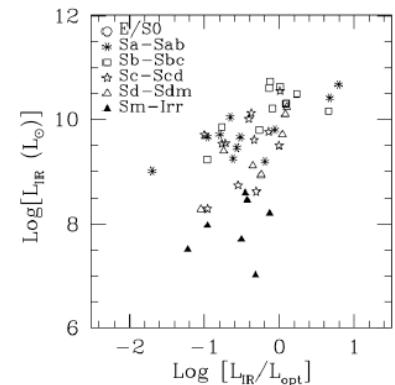
Canada: Christine Wilson, Brad Warren

China: Caina Hao

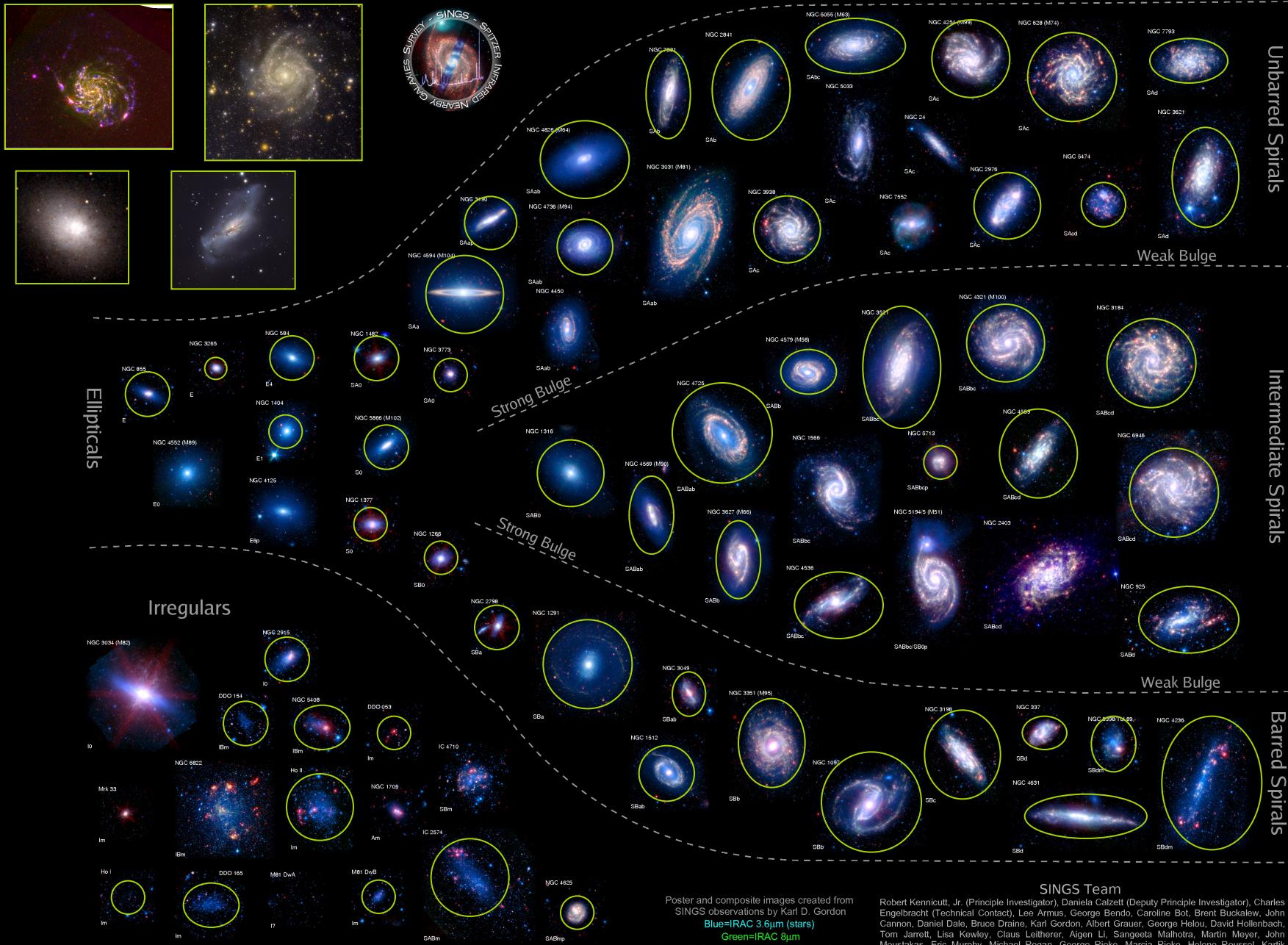


The ‘Basics’ of KINGFISH

- Multi-wavelength observations of 61 galaxies
 - Basic sample from SINGS (*Spitzer Infrared Nearby Galaxies Survey, one of 6 original Spitzer Legacy Projects*)
+ M101, IC 342, NGC 3077, NGC 2146
 - Local galaxies within ~30 Mpc, covering a representative range of properties (morphology, mass, luminosity, SFR, etc.)
- Planned Observations (total of ~537 hours):
 - Deep PACS/SPIRE mosaicing:
 - 70, 100, 160, 250, 350, 500 μm
 - PACS spectroscopy (centres, strips, HII regions)
 - [CII]158, [OI]63, [OIII]88, [NII]122,205 μm
- Additional/Ancillary Data:
 - Spitzer (3-160 mm) images and spectra
 - Additional (X-ray-to-radio) images/data

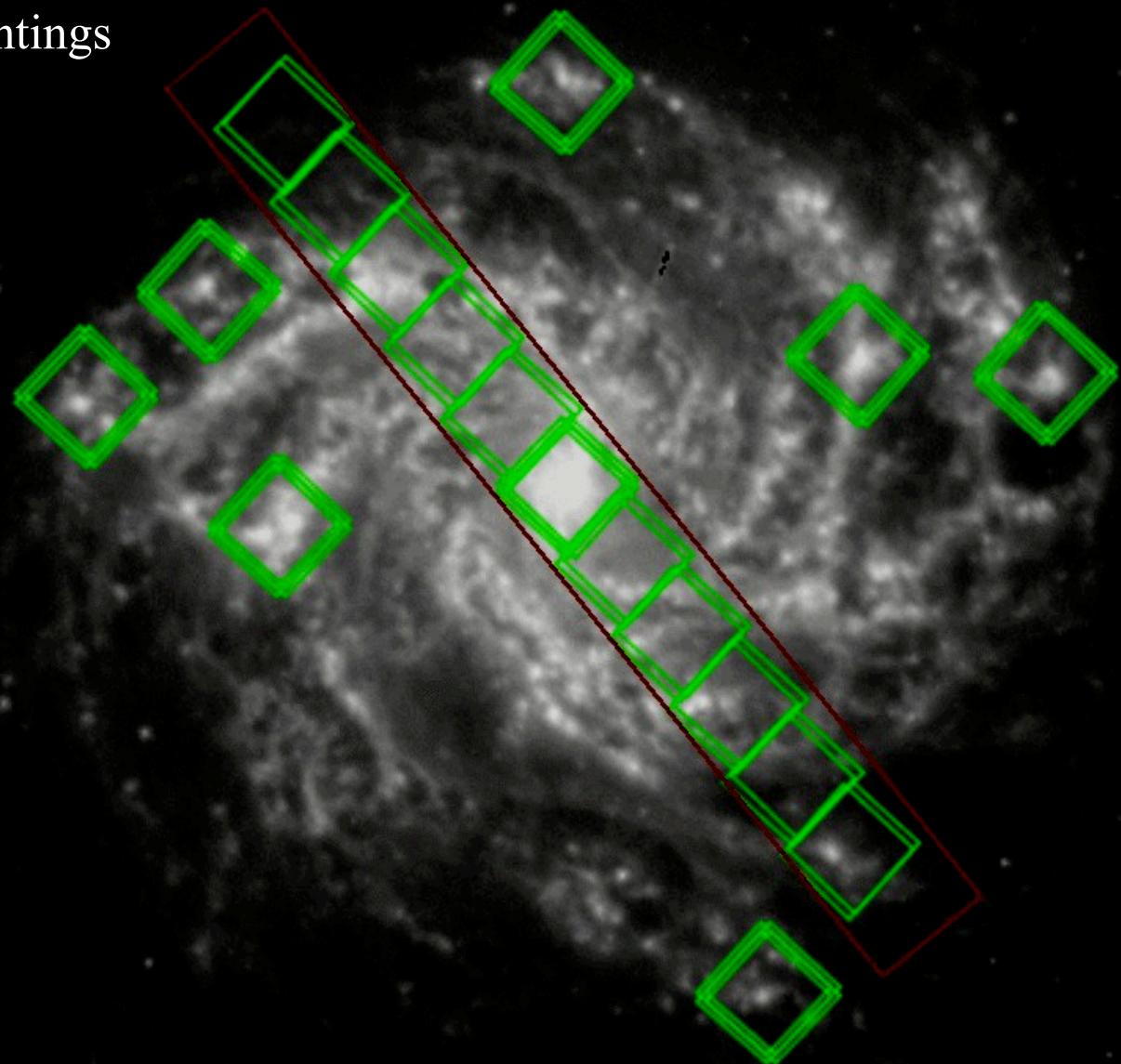


The Spitzer Infrared Nearby Galaxies Survey (SINGS) Hubble Tuning-Fork



NGC 6946

PACS spectroscopic pointings



Main Science Goals

- ◆ Mapping of dust emission at peak energy over ~300-500 pc scales, combined with UV/optical/IR(Spitzer) images:
 - ◆ Spatially-resolved dust temperature distributions and masses; improved modeling; correlations between heaters (stellar populations) and emitters (dust components);
 - ◆ Calibration of SFR diagnostics on sub-kpc scale; accurate determinations of the SFR-gas densities relation and SFR thresholds;
 - ◆ Sub-kpc radio-FIR correlation;
 - ◆ Full inventory of cold (< 15 K) dust
- ◆ PACS spectroscopy of main ISM cooling lines to map temperatures, densities, pressures, local UV radiation strength and hardness:
 - ◆ Investigate range of physical conditions of the ISM
 - ◆ [CII] and other lines as SFR indicators;
 - ◆ Solve the discrepancy in the metal abundance scale.

Current Status of Observations

- ❖ SDP mosaics (PACS and SPIRE) for two targets: NGC1097 and NGC4559
- ❖ SDP spectra (PACS, both WS and Chopping) for both galaxies
- ❖ Currently:
 - ❖ about 70% of all SPIRE mosaics obtained (processed);
 - ❖ about 1/3 of PACS mosaics (currently under re-processing);
 - ❖ spectroscopy awaiting (imminent) release of specific AOR, currently called: Chopless Scan Mode (**see talk by J.D. Smith, session B3, this afternoon**).

This talk mainly centers of the First
Results for the **Imaging** portion of
the **KINGFISH** Project

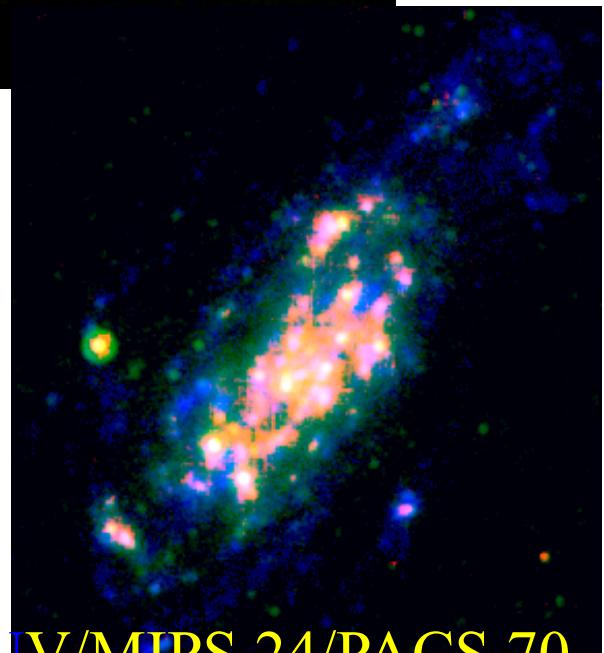
PACS 70/100/160

NGC4559

SABcd

D=8.5 Mpc

Spitzer 3.6/8/24



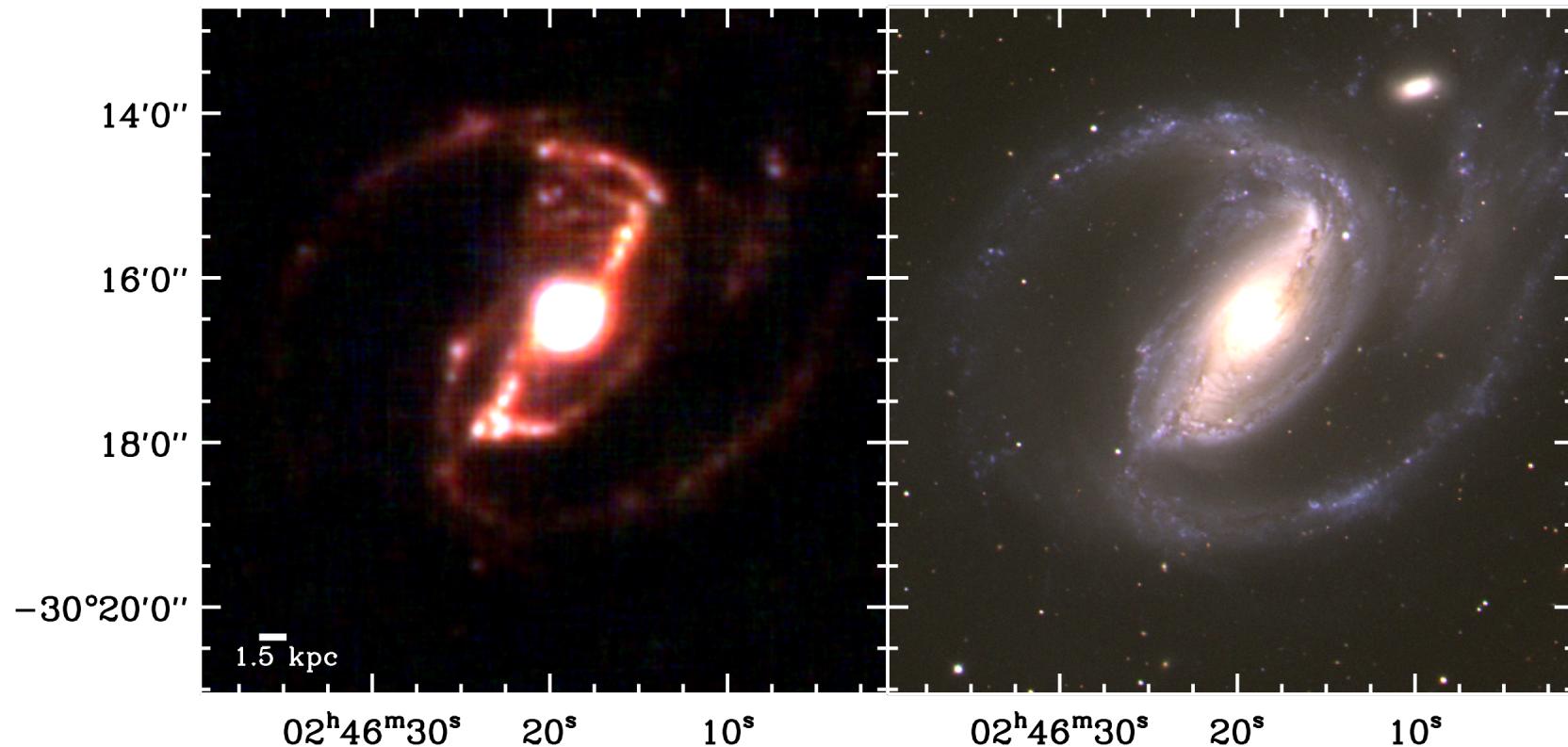
GALEX FUV/MIPS 24/PACS 70

SPIRE 250/350/500

NGC1097

SBb

D=19.1 Mpc

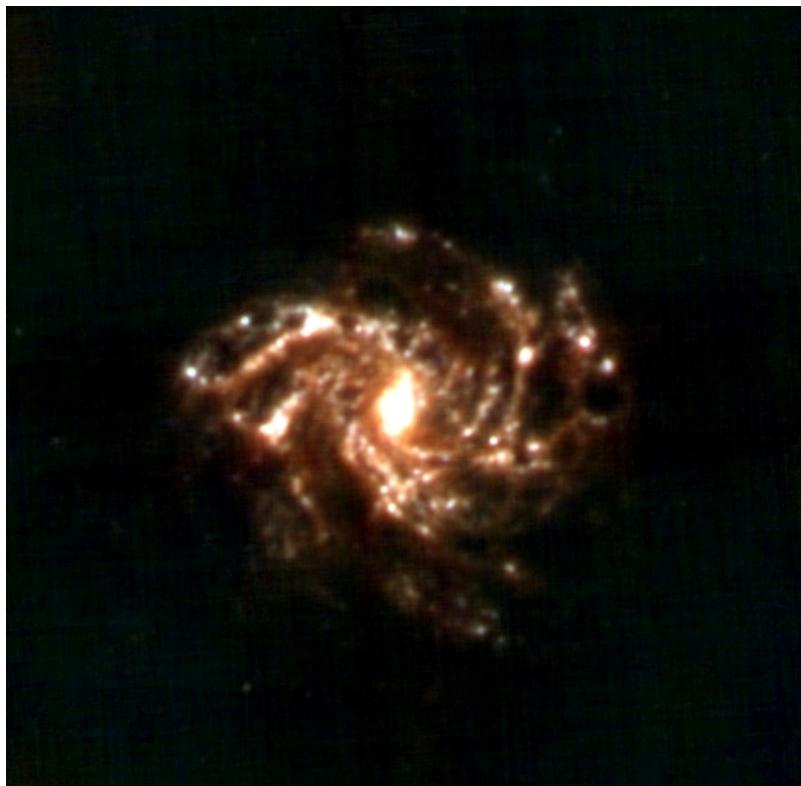


PACS 70/100/160

Optical

NGC6946

SABcd
D=6.8 Mpc

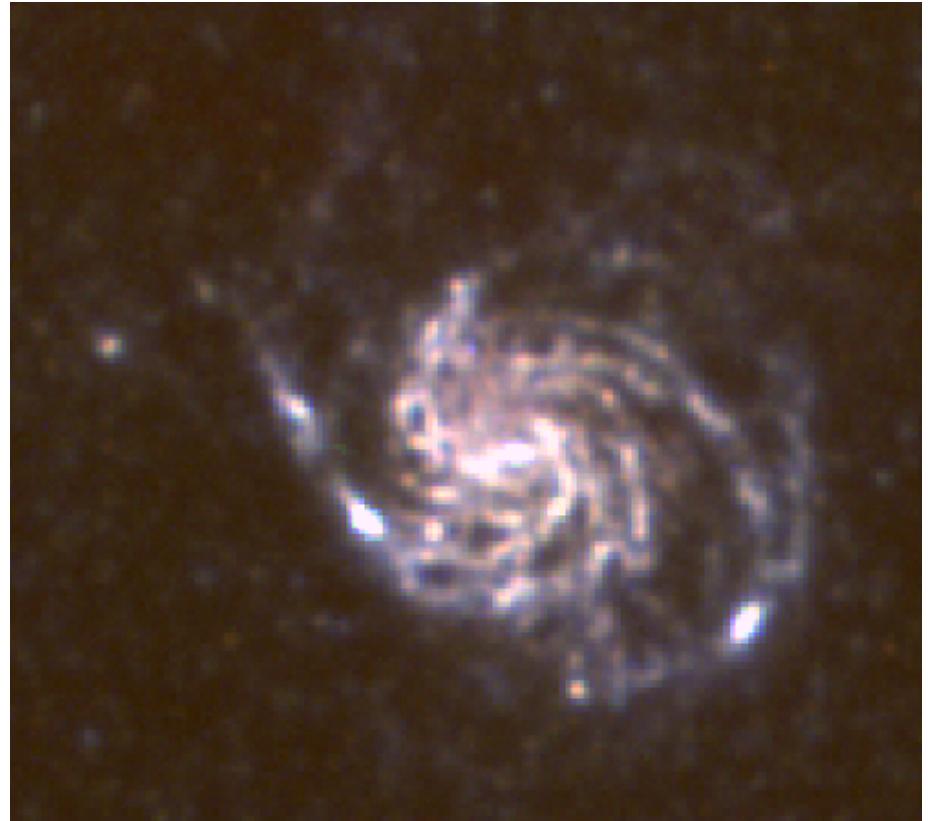


PACS 70/100/160

SPIRE 250/350/500

SABcd
D=7.1 Mpc

M101

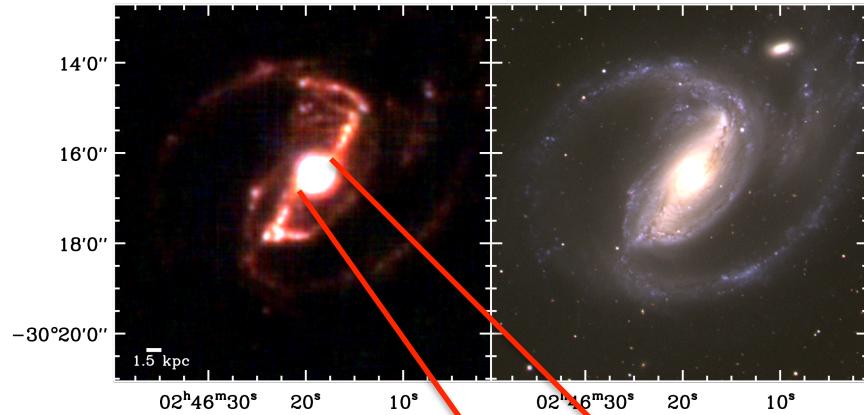


Optical

SPIRE 250/350/500

The Starburst Ring in NGC1097

Sandstrom et al. 2010, A&A Special Issue, accepted



Inner $\sim 45''$

$T_{\text{dust,ring}} > T_{\text{dust,disk}}$

$T_{\text{dust,ring}} \sim 29 \text{ K}$

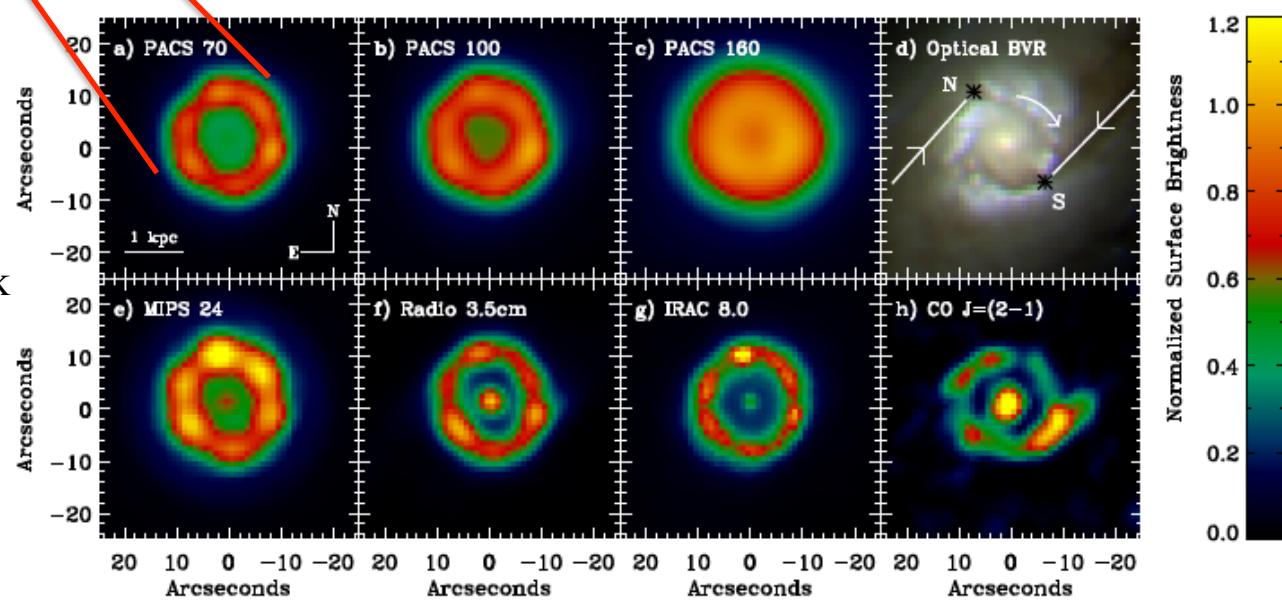
$T_{\text{dust,disk}} \sim 23 \text{ K}$

SBb galaxy at 19.1 Mpc;
Active nuclear ring:

$$\text{SFR} = 5 \text{ M}_\odot/\text{yr}$$

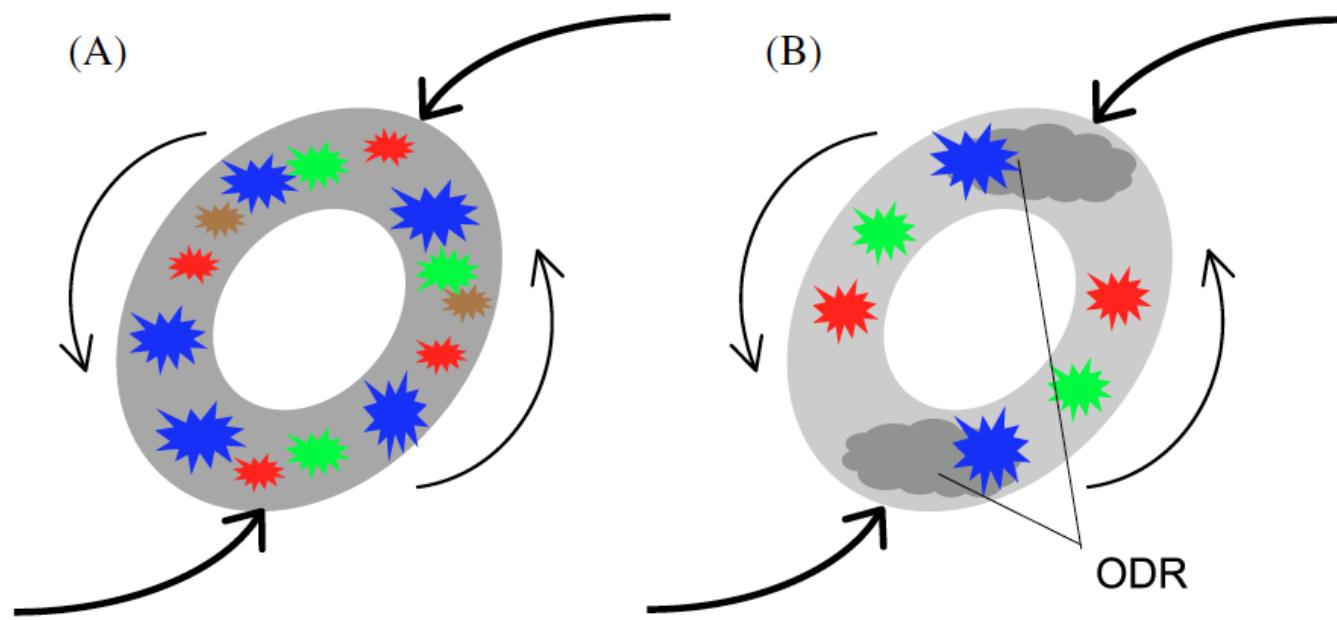
$$R \sim 900 \text{ pc}$$

$$\tau_{\text{rotation}} \sim 18 \text{ Myr}$$



Star Formation in the Ring: Popcorn or String of Pearls?

(Boeker et al. 2008)



"Popcorn"

Possibly a gradient in T_{dust}

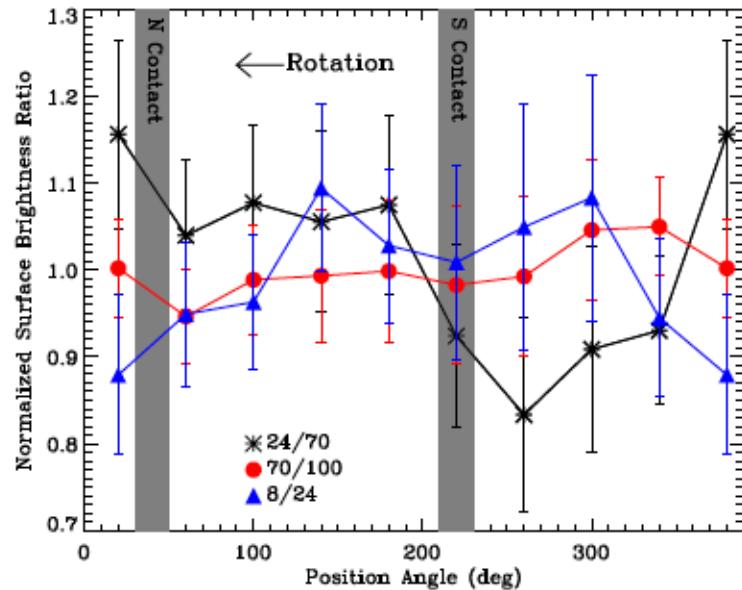
"Pearls on a string"

No gradient in T_{dust} expected

SF regions in 1-10 Myr range should show T_{dust} gradient corresponding to variation 24/70~7x and 70/100~3x (Groves et al. 2008)

Star Formation in the Ring: What Is Observed?

Sandstrom et al. 2010, A&A Special Issue, accepted



No gradient in T_{dust} ;
No much variation at all! (At most
 $\pm 15\%$)

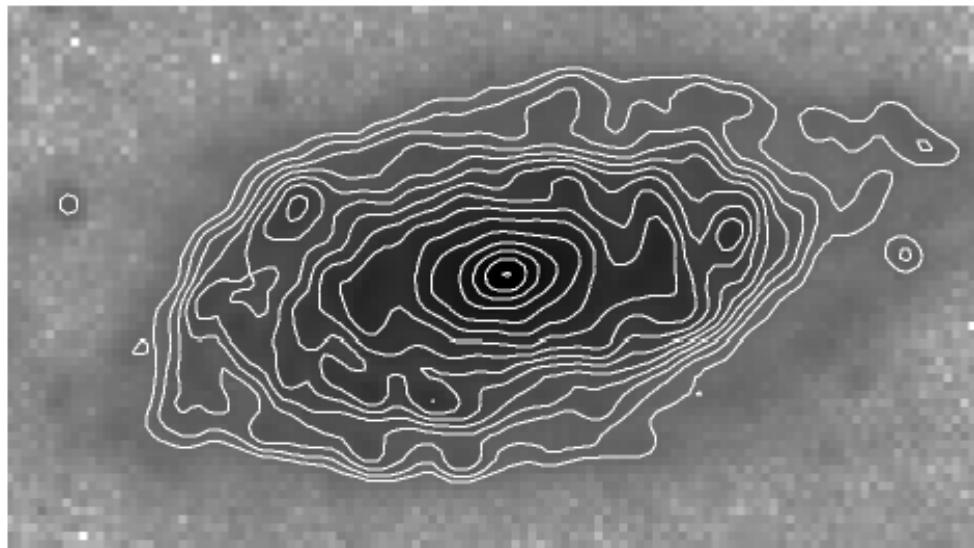
Possible reasons for absence of gradient/variation in T_{dust} :

1. Contribution to dust heating by background star population; B-stars contribute significantly to UV emission in ring;
2. Dynamical timescale between contact points is ~ 9 Myr; 'smearing' of HII regions;
3. (D.C.): very young/embedded HII regions would be self-shielded: cooler dust.

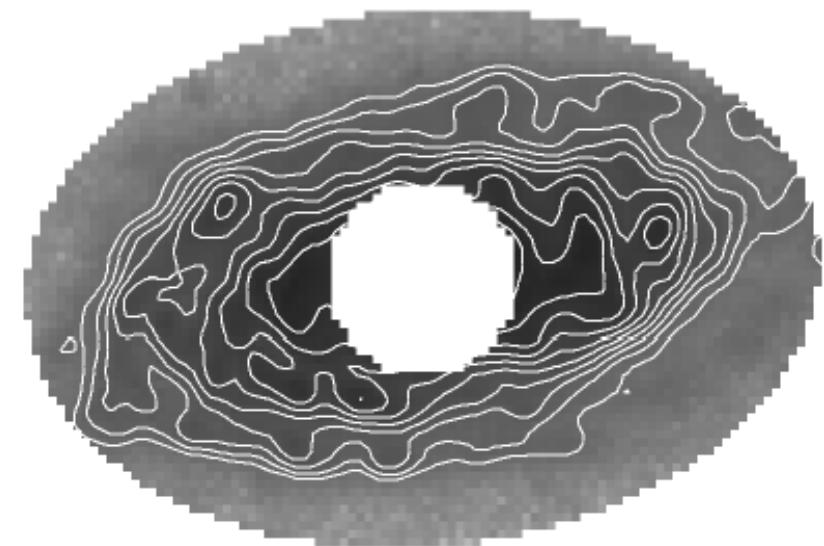
Dust Temperatures of Disks and Bulges

Engelbracht et al. 2010, A&A Special Issue, accepted

Goal of investigating whether the ‘cool’ ($T \sim 20-30$ K) dust shows different temperatures in the (bulge-dominated) centers of galaxies as opposed to disks.

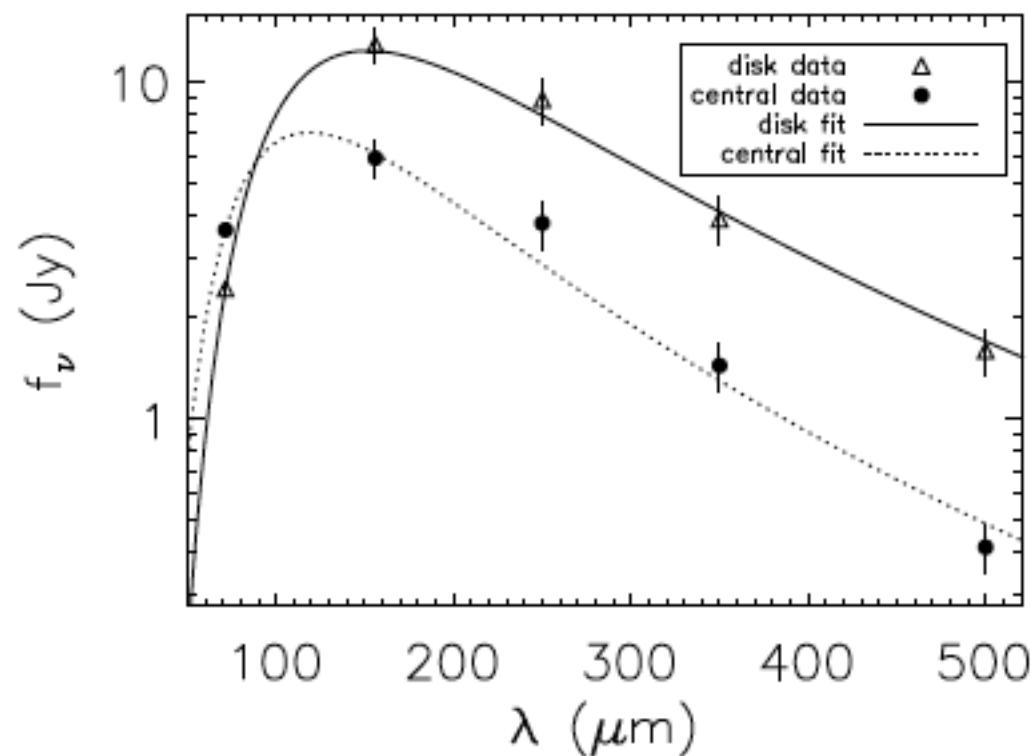


NGC5055, SABc, D=10.2 Mpc,



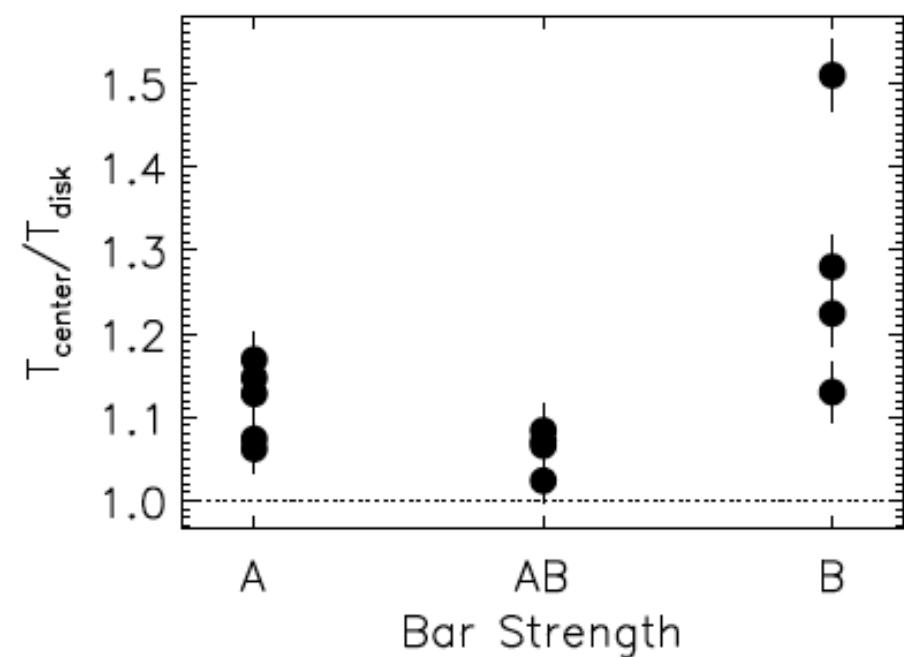
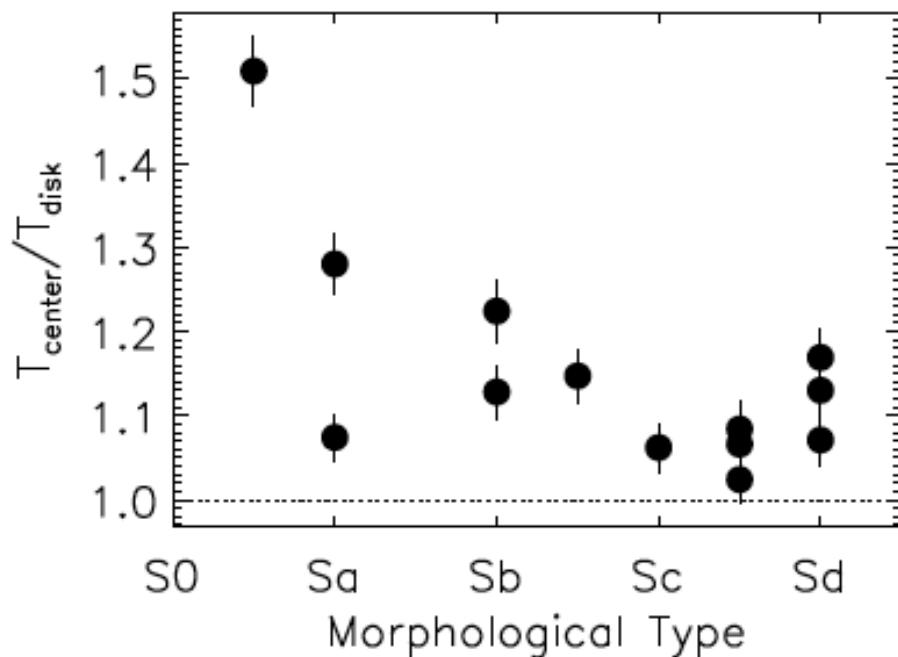
SPIRE images of 13 extended ($> 2'$) KINGFISH galaxies

Dust Temperature of Disks and Centers: Fits



Central regions and disks fit with single temperature modified BB ($\varepsilon = 1.5$, results do not change if $\varepsilon = 1$ or $= 2$ used)

Dust Temperature of Disks and Centers: Results



Discrepancy between T_{dust} in centers and disks higher for earlier Hubble types/barred spirals. Analysis of larger samples needed.

Conclusions

- ✓ Herschel is providing crucial long-wavelength and/or high angular resolution coverage in the IR/sub-mm, both imaging and spectroscopy
- ✓ It is enabling mapping of dust and ISM emission at exquisite detail in many extragalactic environments
- ✓ Recovery of extended emission an undergoing effort (esp. for PACS imaging)
- ✓ Preliminary results already show the strength of the new data:
 - ✓ Can trace dust emission along circum-nuclear star-forming rings in galaxies; can start testing evolution theories;
 - ✓ Can resolve sub-galactic components to start investigating dust temperature variations and dependence on structural parameters.
- ✓ To the Herschel Project and the Instruments' ICCs:

THANK YOU!