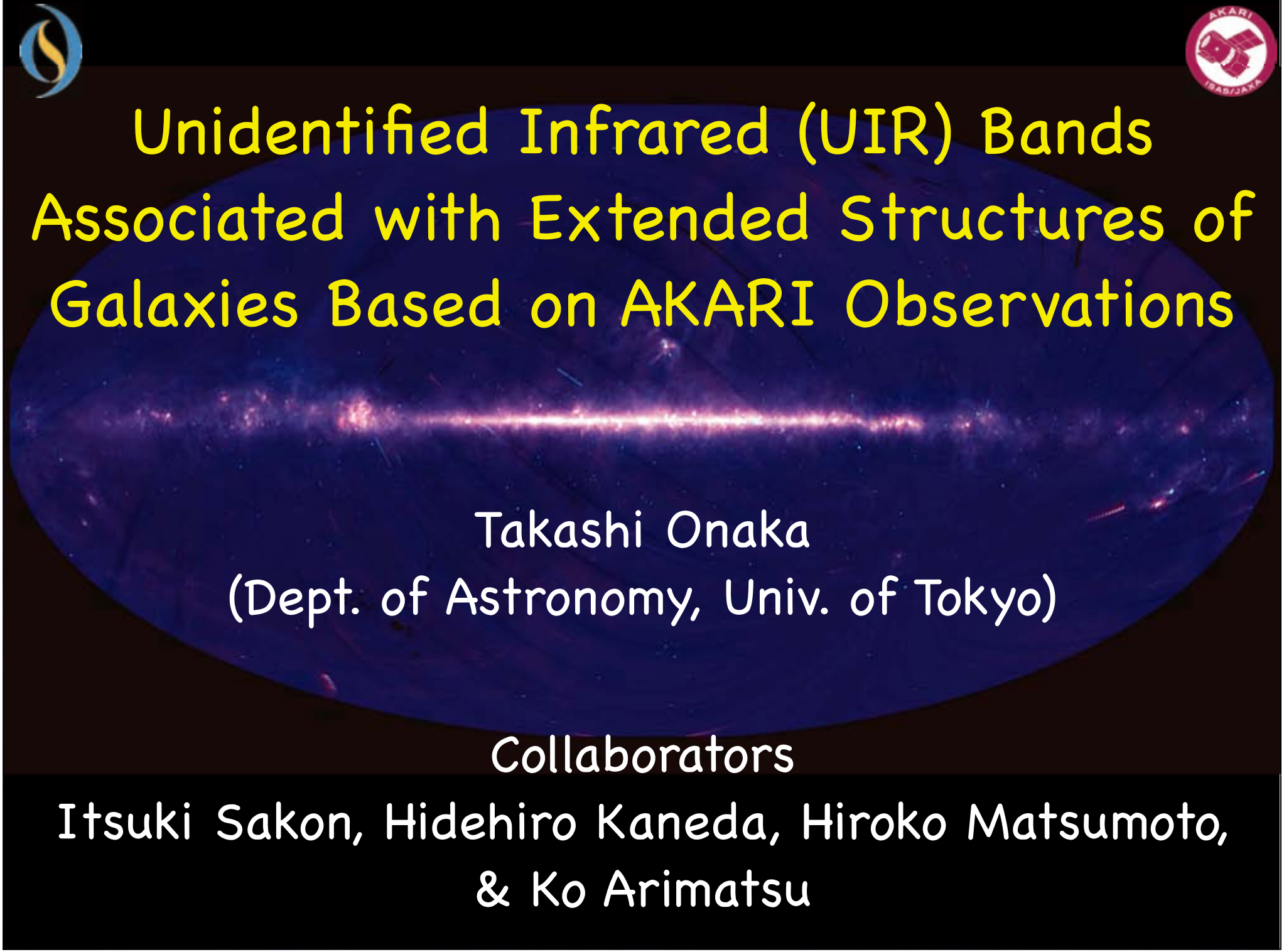

Unidentified Infrared (UIR) Bands Associated with Extended Structures of Galaxies Based on AKARI Observations

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Collaborators

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AKARI Mission

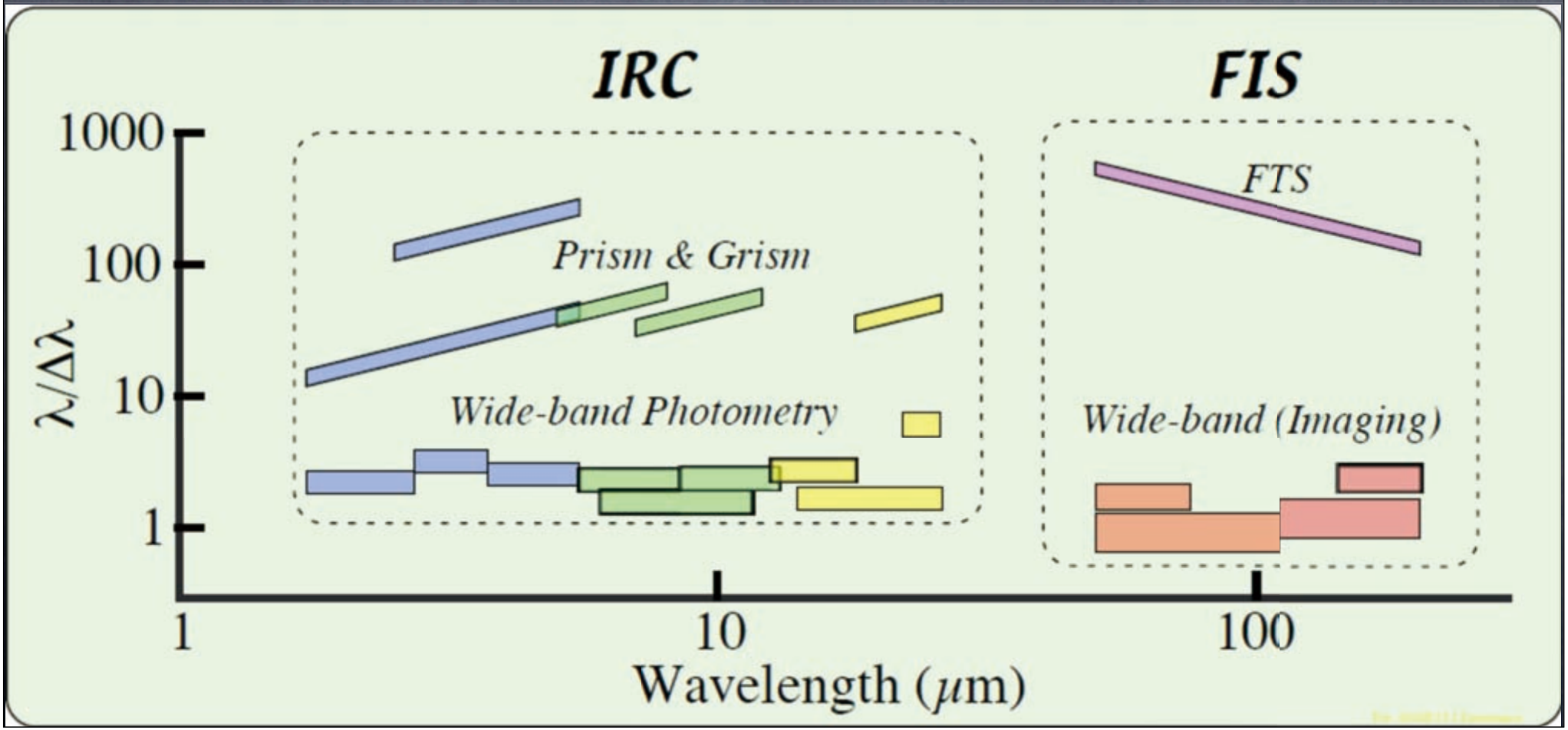
70cm SiC mirror
180L LHe + cryocoolers
on a 700km sun-synchronous polar orbit
18 month cold mission
(2006.2-2007.8)

All-sky survey surpasses IRAS database
+
Pointing observations of imaging and spectroscopy in 2-180μm

2-5μm continued

AKARI Onboard Instruments & Capabilities

Two instruments onboard
IRC (Infrared Camera: 2-26μm)
& FIS (Far-Infrared Surveyor: 50 - 180μm)



AKARI Catalogues & Results

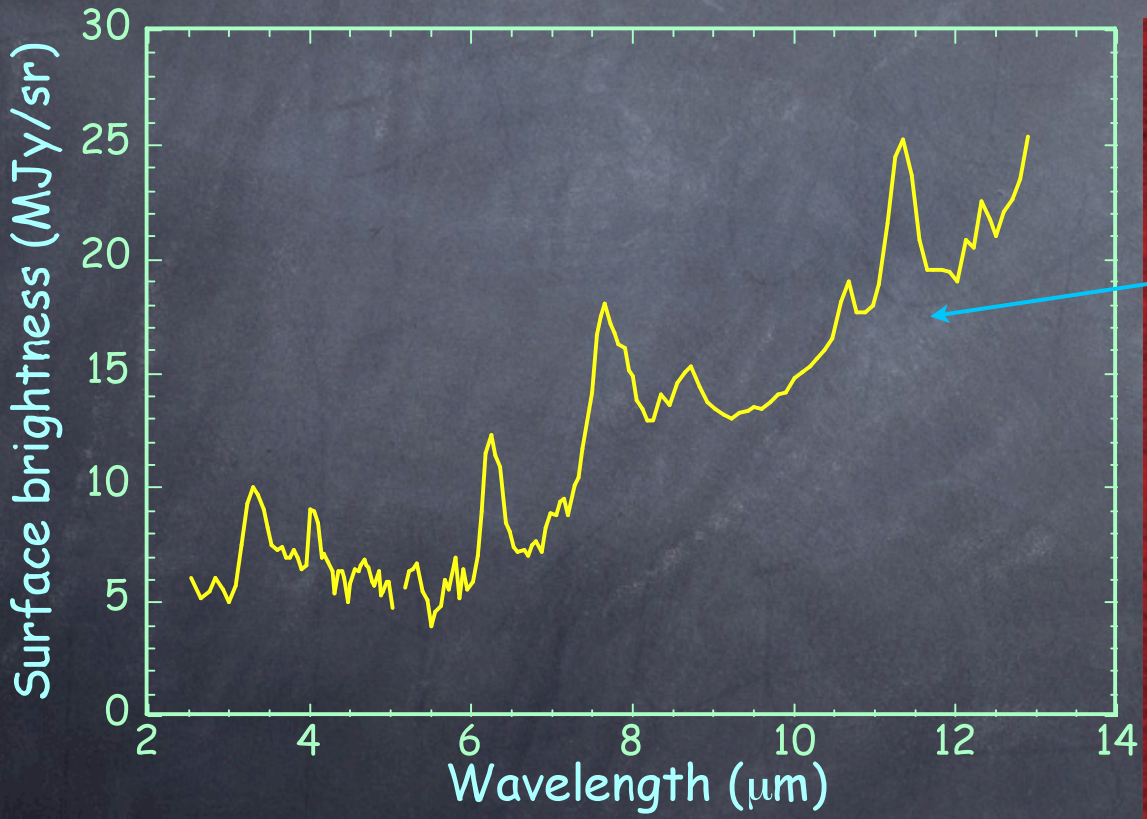
Point Source Catalogues (9, 18, 65, 90, 140, & 160μm bands) released in March
870,000 in MIR & 430,000 in FIR

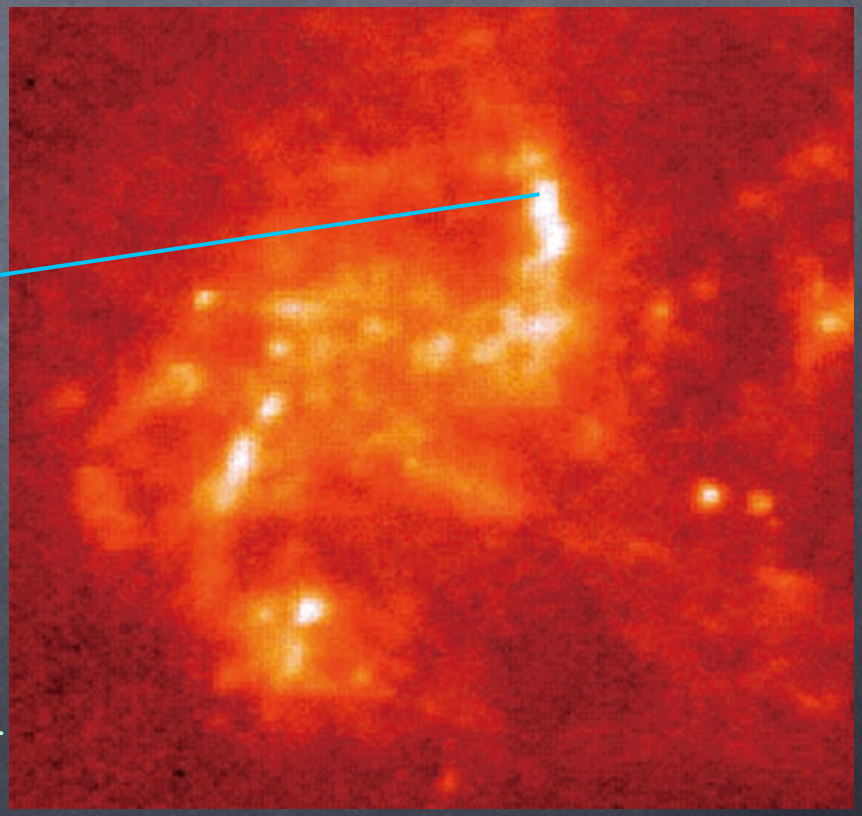
The 3rd special issue of AKARI published in A&A this month

Kaneda et al. on M82
Onaka et al. on NGC1569
+

UIR Bands in Galaxies

Unidentified Infrared Bands (UIR bands or PAH bands) at 3.3, 6.2, 7.7, 8.6, 11.3μm are ubiquitously seen in normal spiral galaxies. But the formation and destruction processes are not well understood.



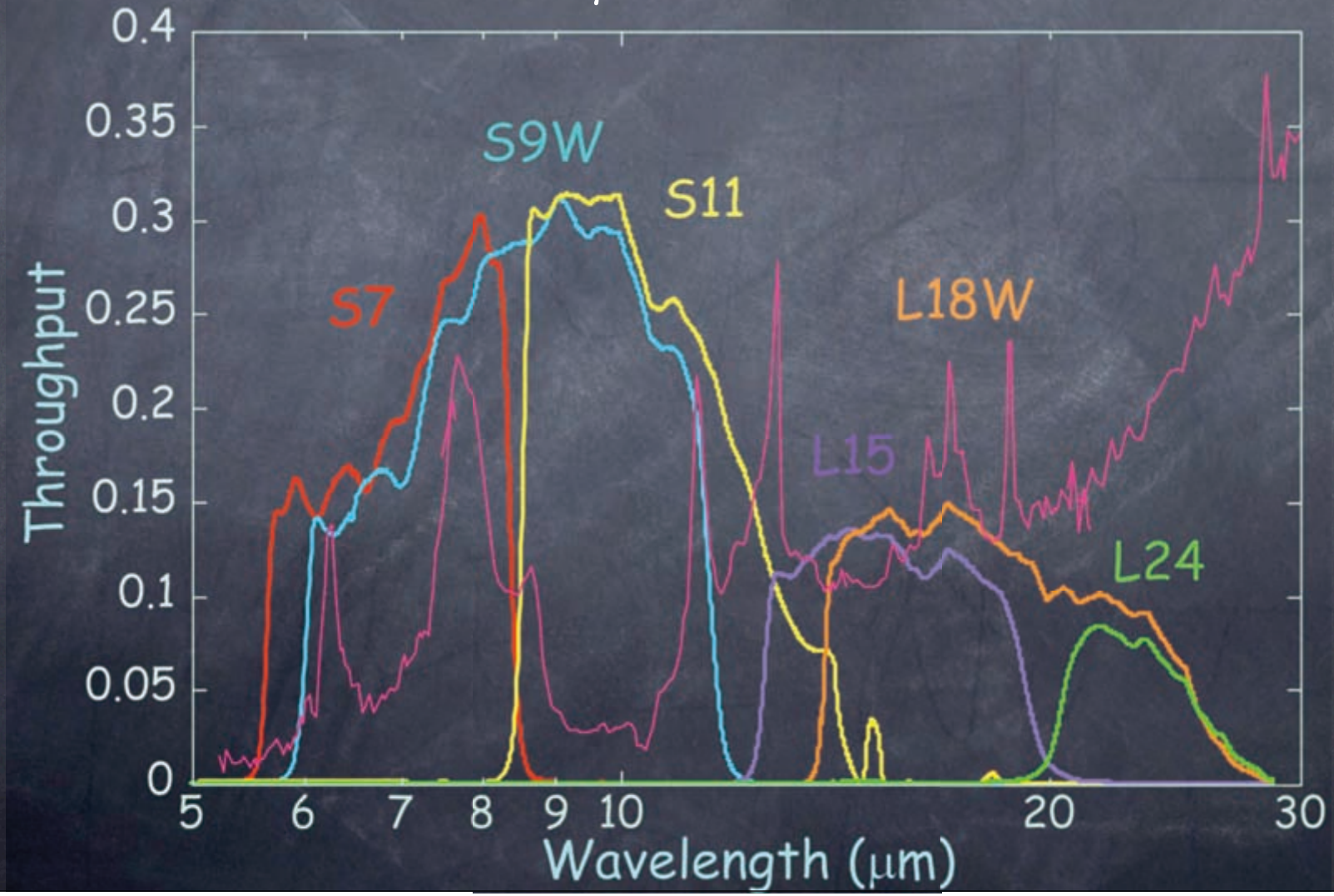


NGC1313@7μm

AKARI Infrared Camera (IRC) Imaging Bands

S7: 6.2 & 7.7μm UIR bands

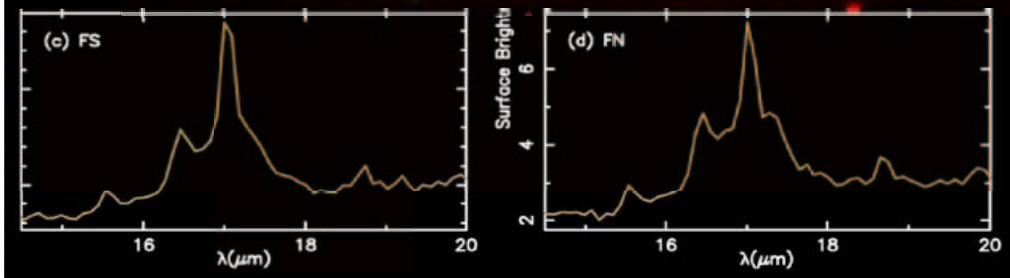
S11: 11.3μm UIR band



M82

Red Hα, Green 7μm

3.2μm (B), 7μm (G), & 15μm (R)



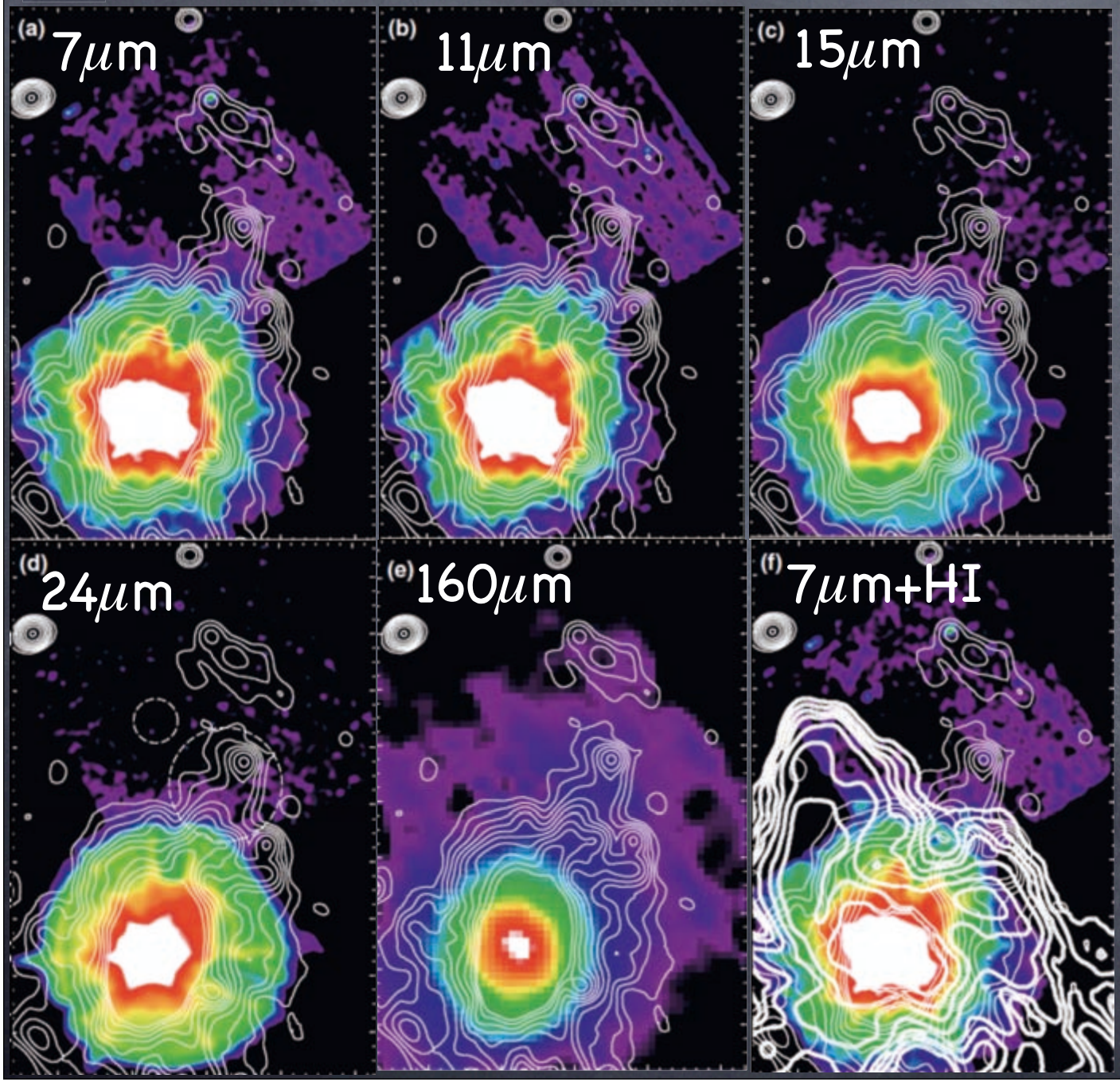
Engelbracht et al. (2006)

Very Extended emission in MIR & PAH

Good correlation between 7μm and Hα at low flux level(R ~ 0.8)

Kaneda et al. (2010)

IR Emission in Halo



Contours: X-ray

Faint emission in 7 and 11μm at the X-ray cap

If dust is entrained by outflow, it takes ~5Myr to reach the halo (~3kpc).
How do grains and PAHs survive?

MIR Color of M82

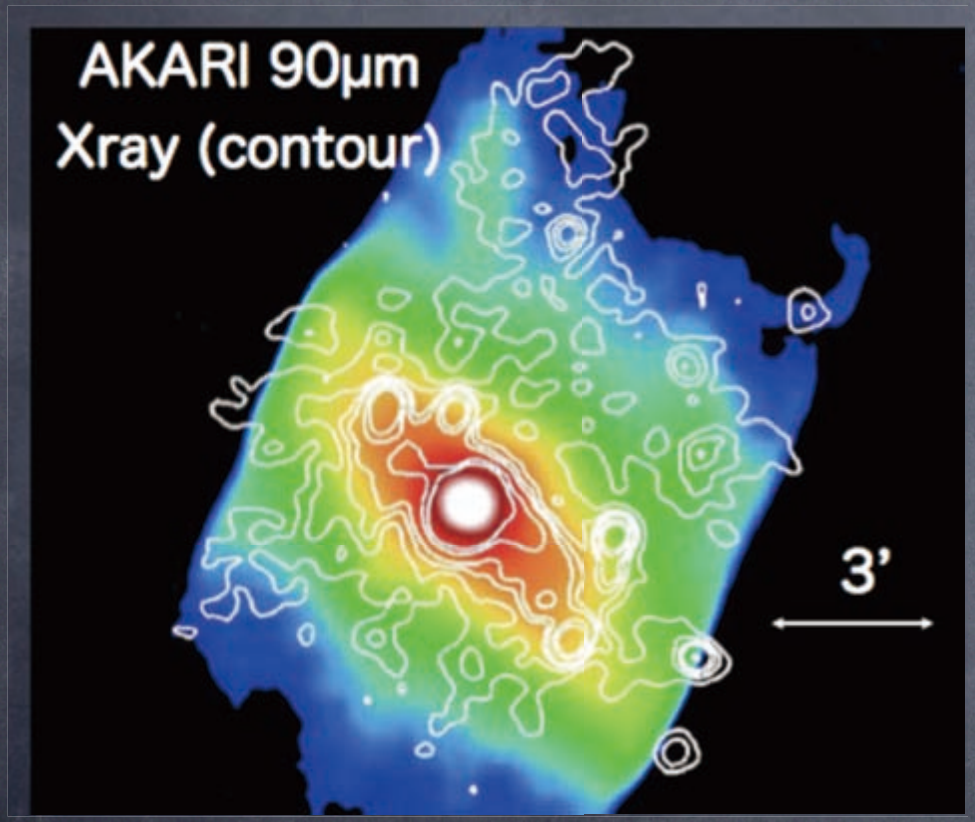
Relatively constant MIR color of the extended emission

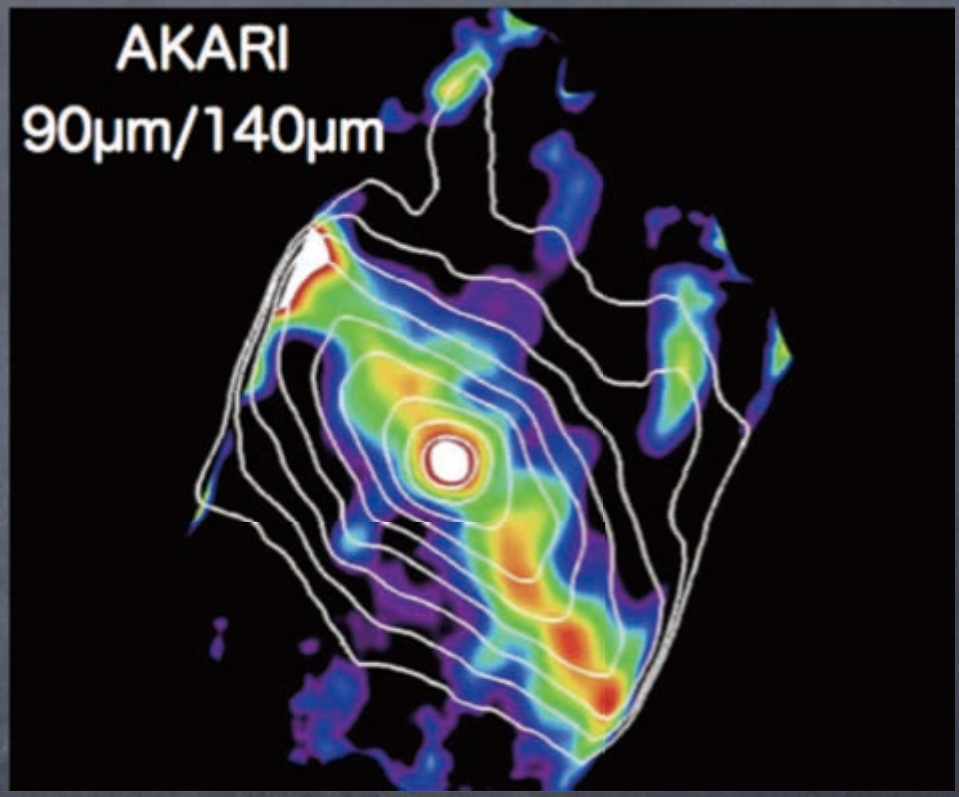
7/15μm is lower at the X-ray emitting region

Destruction of smaller grains?

Extended FIR emission in NGC253

Kaneda et al. (2009)
ApJL, 698, L125





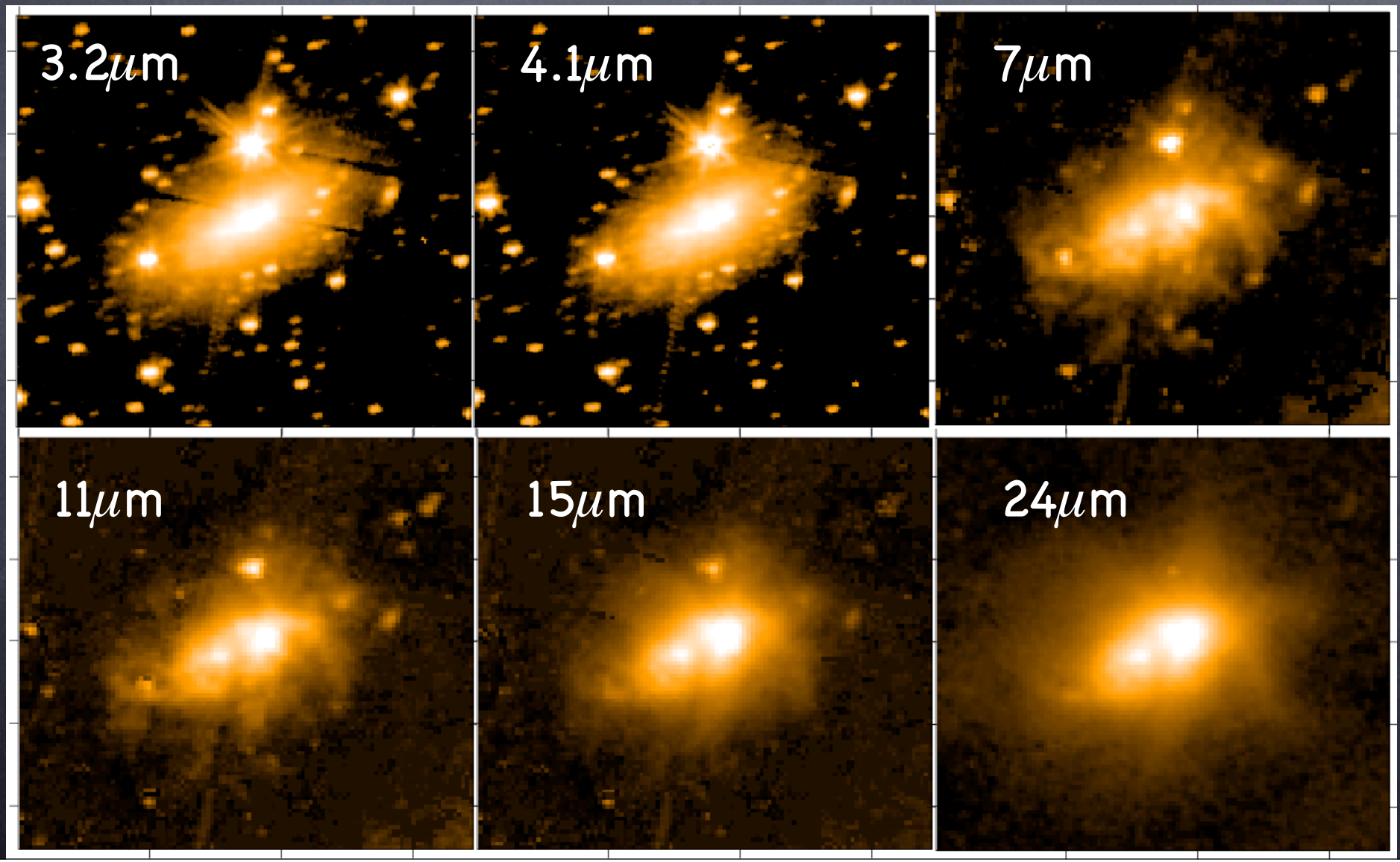
FIR emission associated with X-ray
Dust entrained by outflow must survives for 4-30Myr
Energy may come from interaction with HI or plasma heating?

Observations of NGC1569

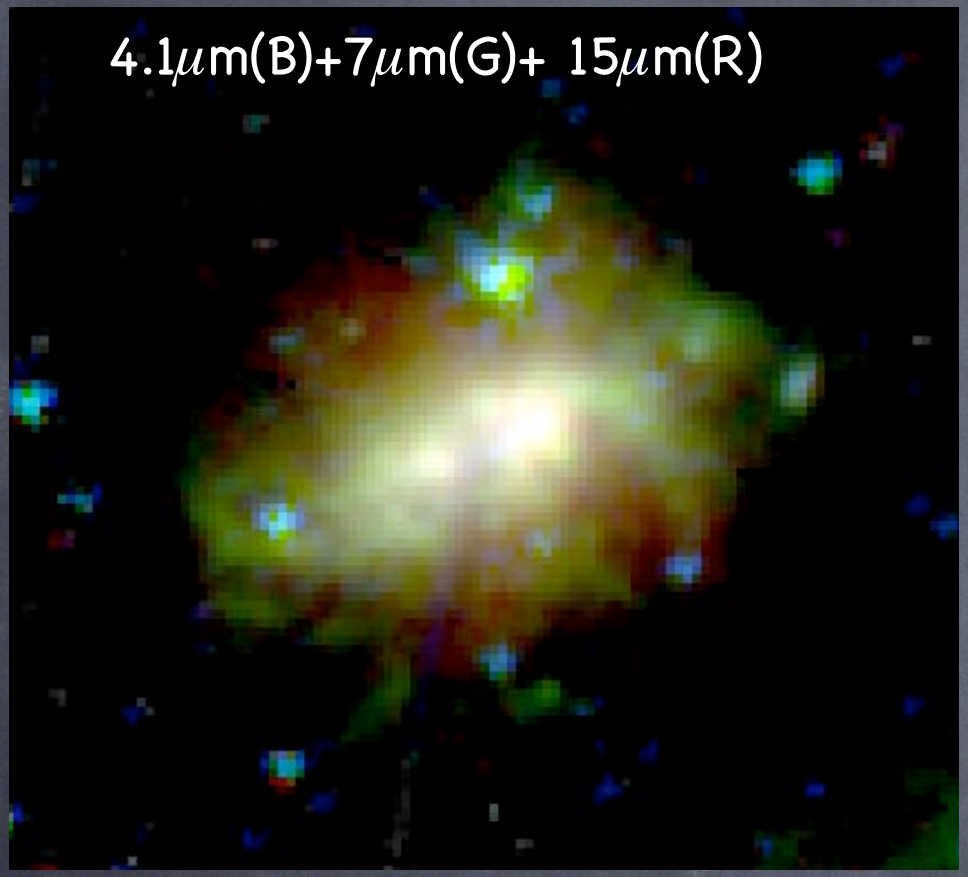
Nearby starburst dwarf (12+log(O/H) = 8.13)

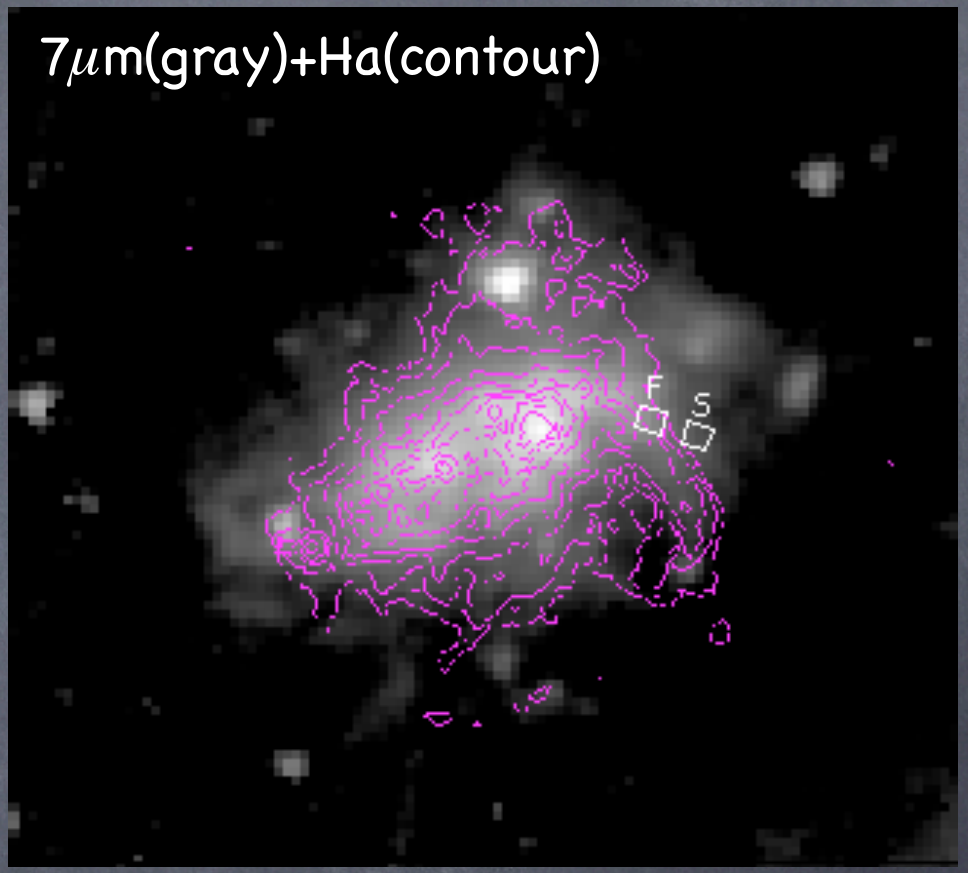
Several Ha filaments produced by galactic wind

TO, H. Matsumoto et al. (2010)



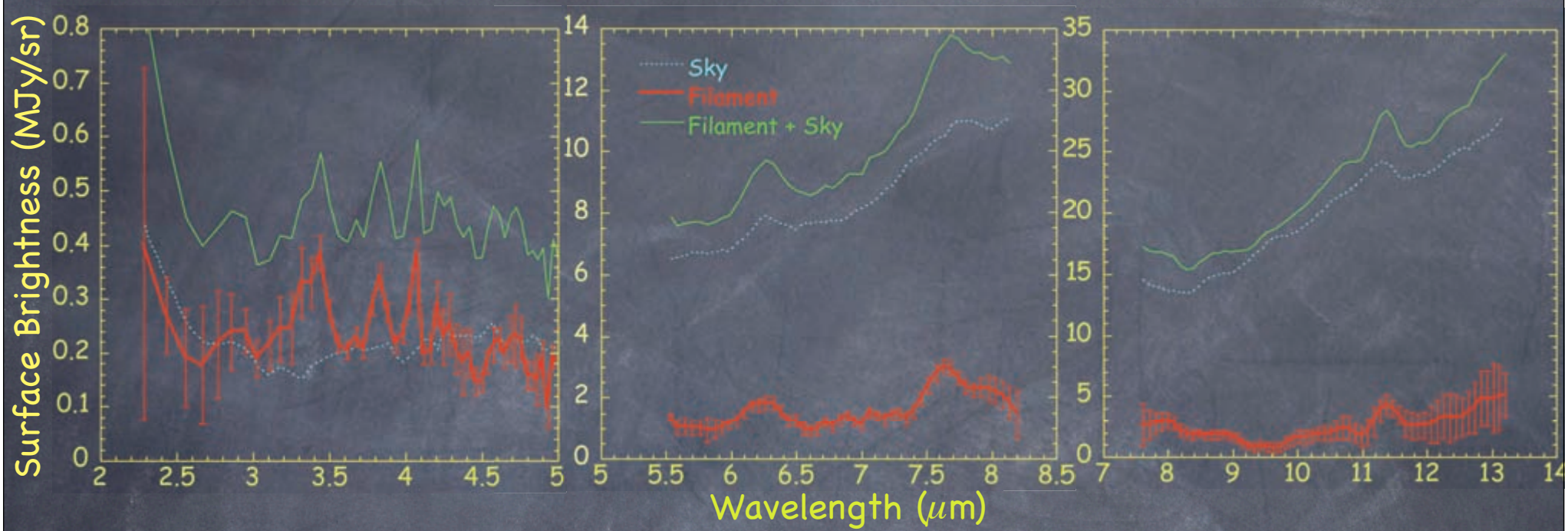
UIR band emission associated with Hα filament





7μm emission well correlated with a Hα filament, which is created by galactic wind as indicated by X-ray emission

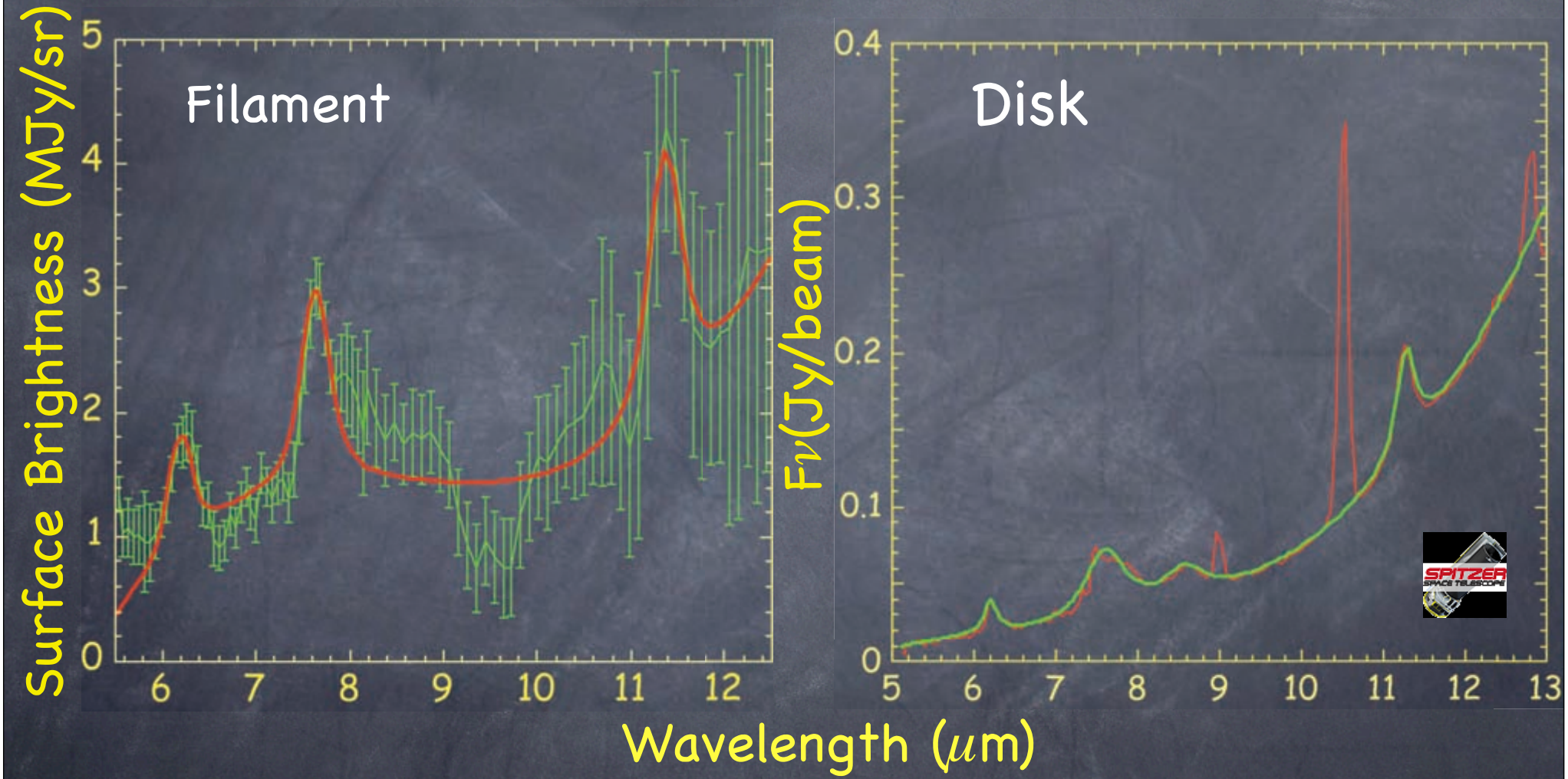
IRC spectroscopy of the filament



3.3, 6.2, 7.7, (8.6), 11.3μm emission detected in the filament

The filament age is ~ 1Myr
PAH destruction timescale ~ 1000yr
PAHs produced by fragmentation in shocks?

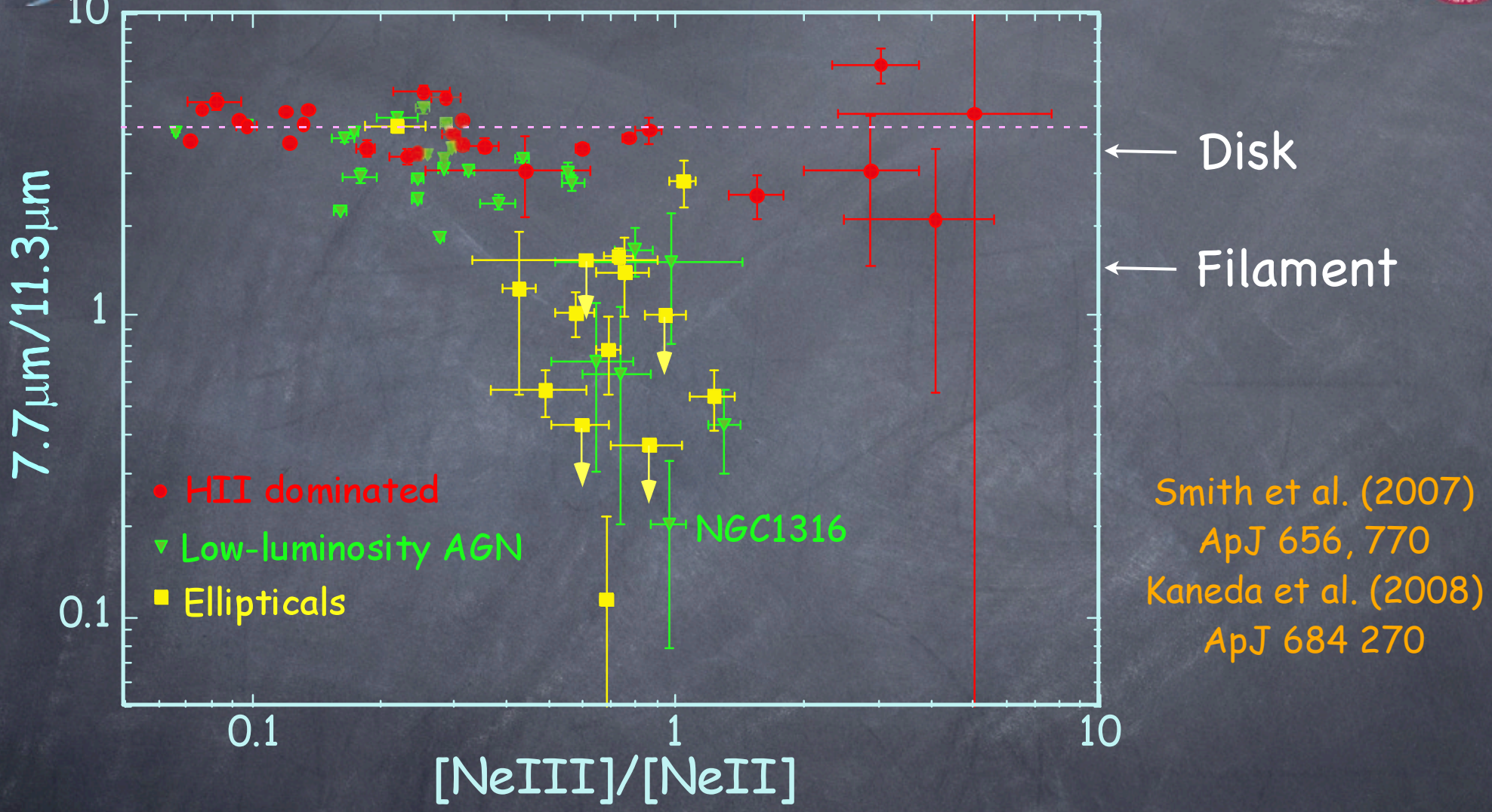
Spectra of filament and disk



The 7.7/11.3μm ratio is smaller & the 7.7μm band is narrower in the filament than in the disk

Environmental effects (low ionization) or else ?

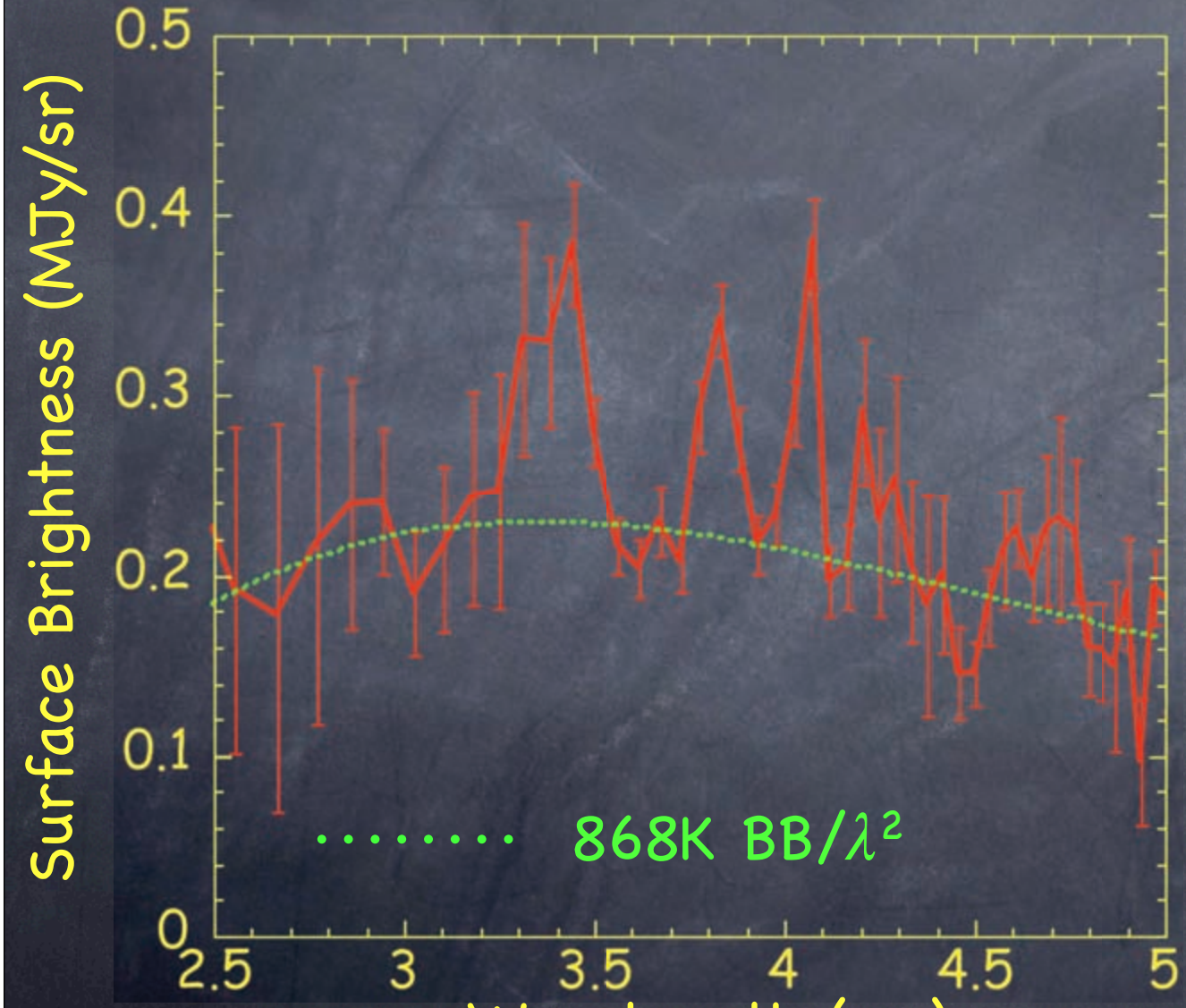
Comparison with other galaxies



Smith et al. (2007)
ApJ 656, 770
Kaneda et al. (2008)
ApJ 684 270

Lower ratios are seen in elliptical galaxies and galaxy halos attributable to a common mechanism?

NIR Excess Emission in the filament



NIR excess emission seen in normal galaxies

(Lu et al. 2003, ApJ, 588, 199)

Not stellar photosphere nor free-free

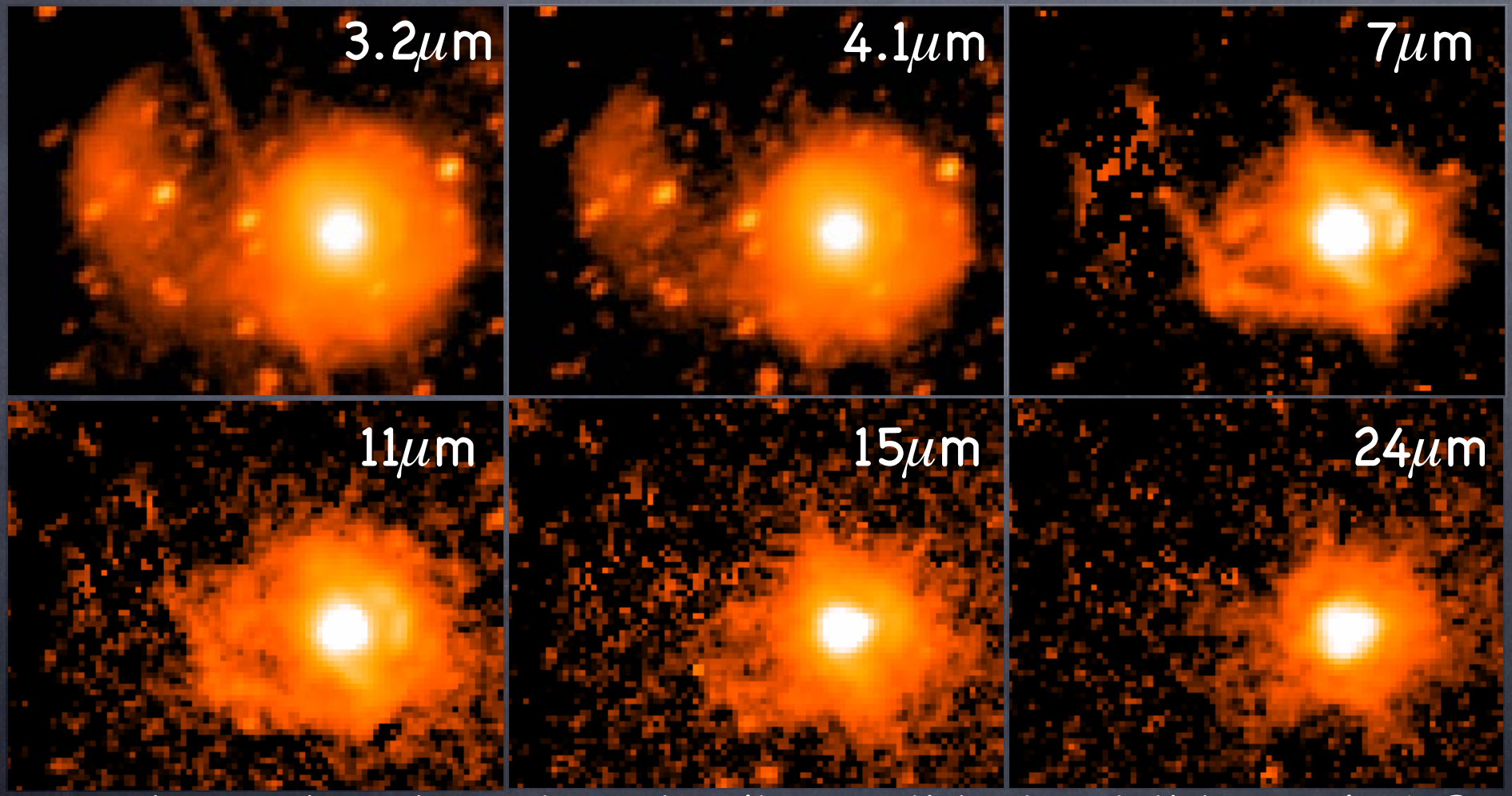
Hot dust emission?

Merging galaxy NGC2782

Nearly head-on merger of 200Myr ago

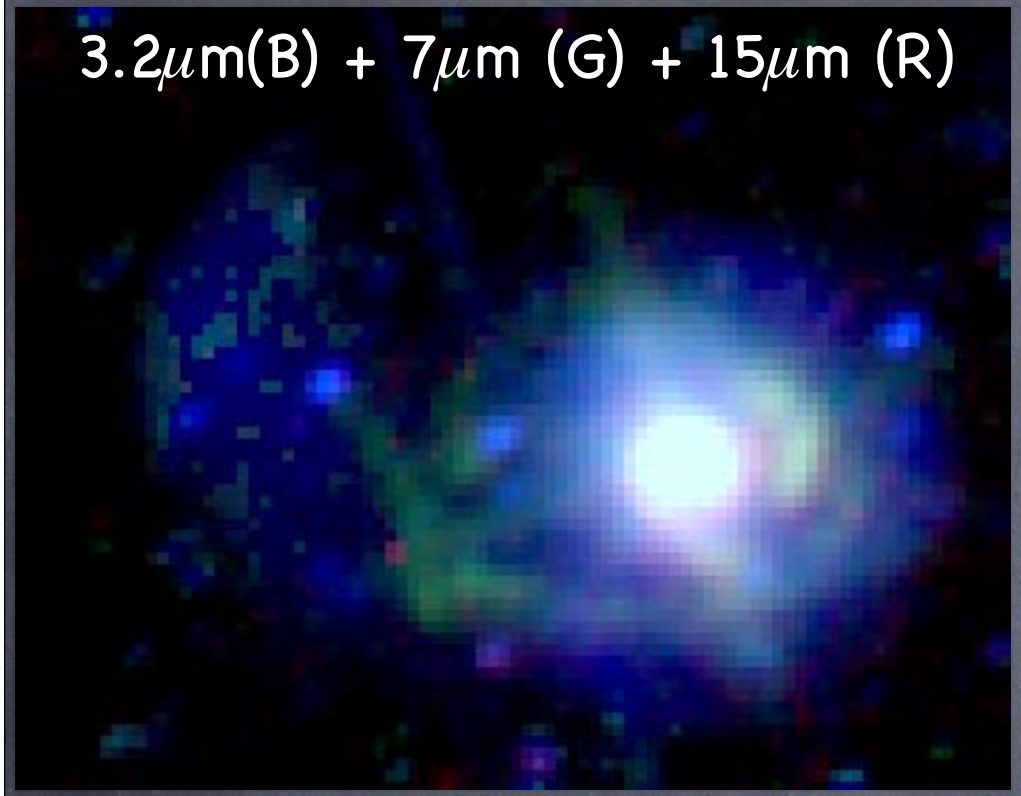
A less massive galaxy collides from west

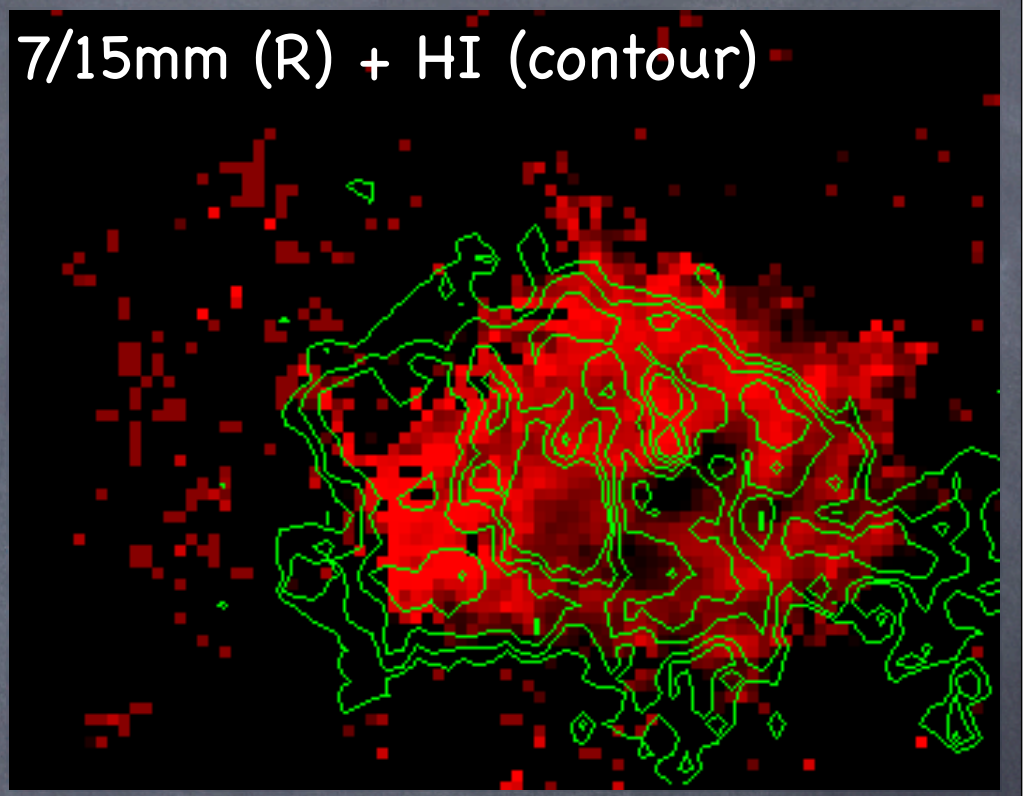
Smith 1991 AJ, 378, 39



Eastern structure is only discernible in visible and NIR
(stellar component without ISM)

UIR bands associated with HI





Filamentary structures in the east side are only seen in 7 and 11μm and well correlated with HI emission

HI and PAHs are stripped together in merger and/or PAHs are formed by fragmentation in cloud-cloud collisions?

Star-formation is active in the western part, seen in structures in 15μm

Brief Summary

Several MIR and FIR features are seen in extended structures of galaxies, which are thought to be produced by outflow

If dust grains and PAHs are entrained by outflow,
then how do they survive in hot plasma environments
or PAHs are formed by shocks?

Observations suggest that 7.7/11.3μm band ratio is smaller in halos and/or filaments than in disk
Formation process or plasma processing make the difference?

MIR spectroscopy of faint extended emission (with JWST and SPICA) and high spatial-resolution observations of Herschel would be valuable for the dust processing and formation


SPICA
Thank you for your attention
SOGO
Panasonic
EPSON
TOSHIBA
LG
Haier
ITAT
HITACHI