Cold Circumstellar Dust in Evolved Stars in the LMC

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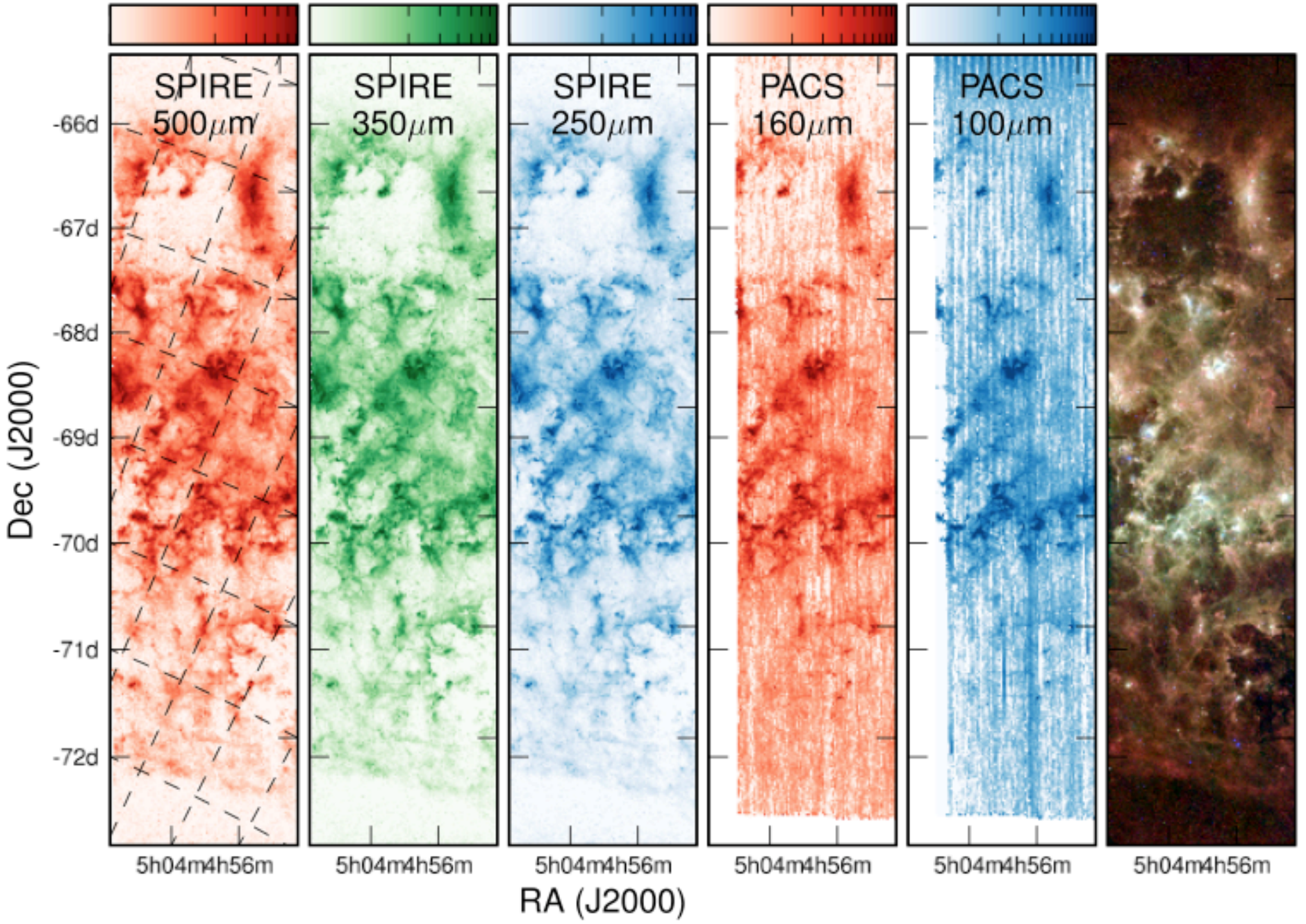
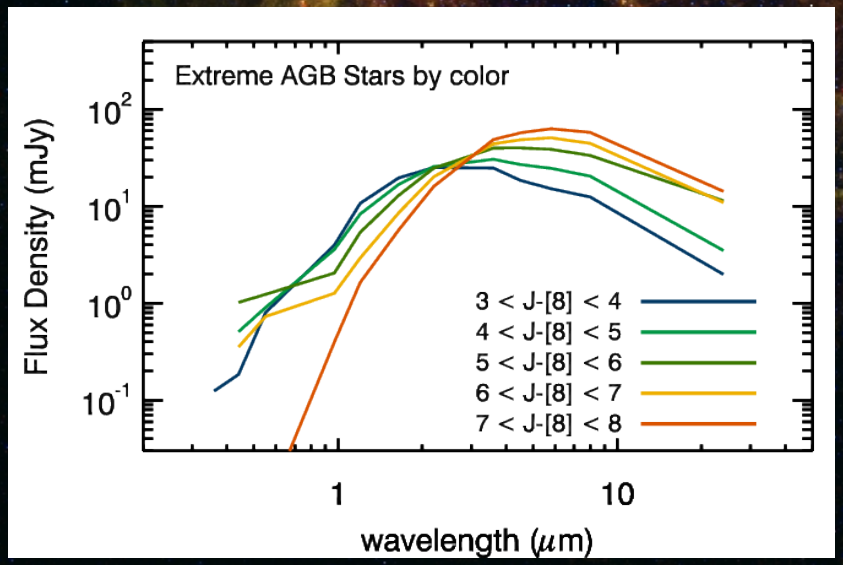
ESLAB 2010: Herschel First Results Symposium

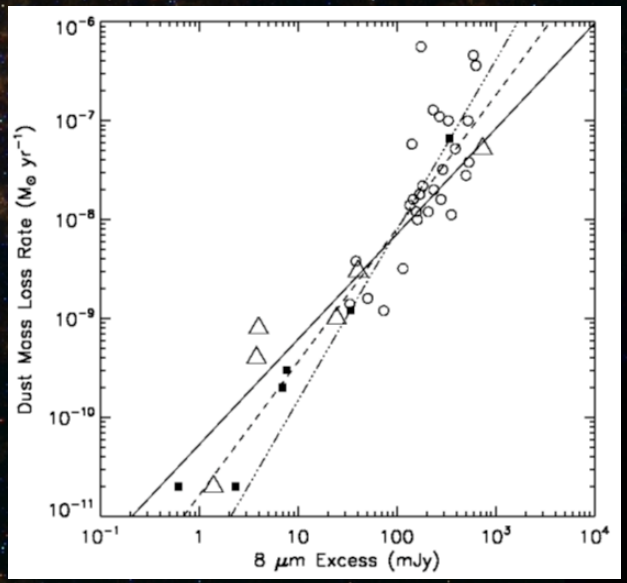

SPIRE
500μm
SPIRE
350μm
SPIRE
250μm
PACS
160μm
PACS
100μm
-66d
-67d
-68d
-69d
-70d
-71d
-72d
Dec (J2000)
5h04m4h56m
5h04m4h56m
5h04m4h56m
5h04m4h56m
5h04m4h56m
5h04m4h56m
RA (J2000)

Motivation:

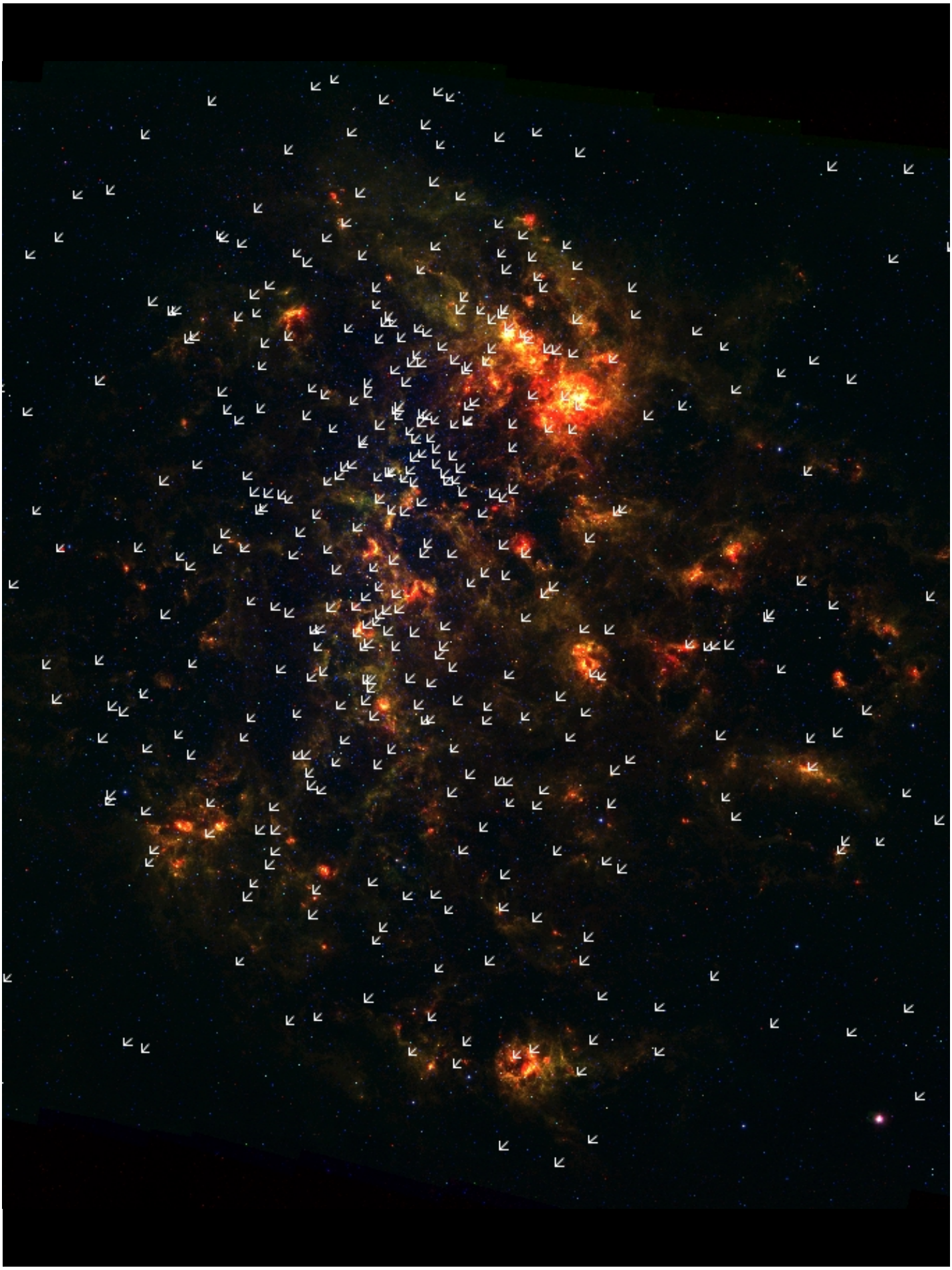
Extreme AGB stars in Spitzer SAGE



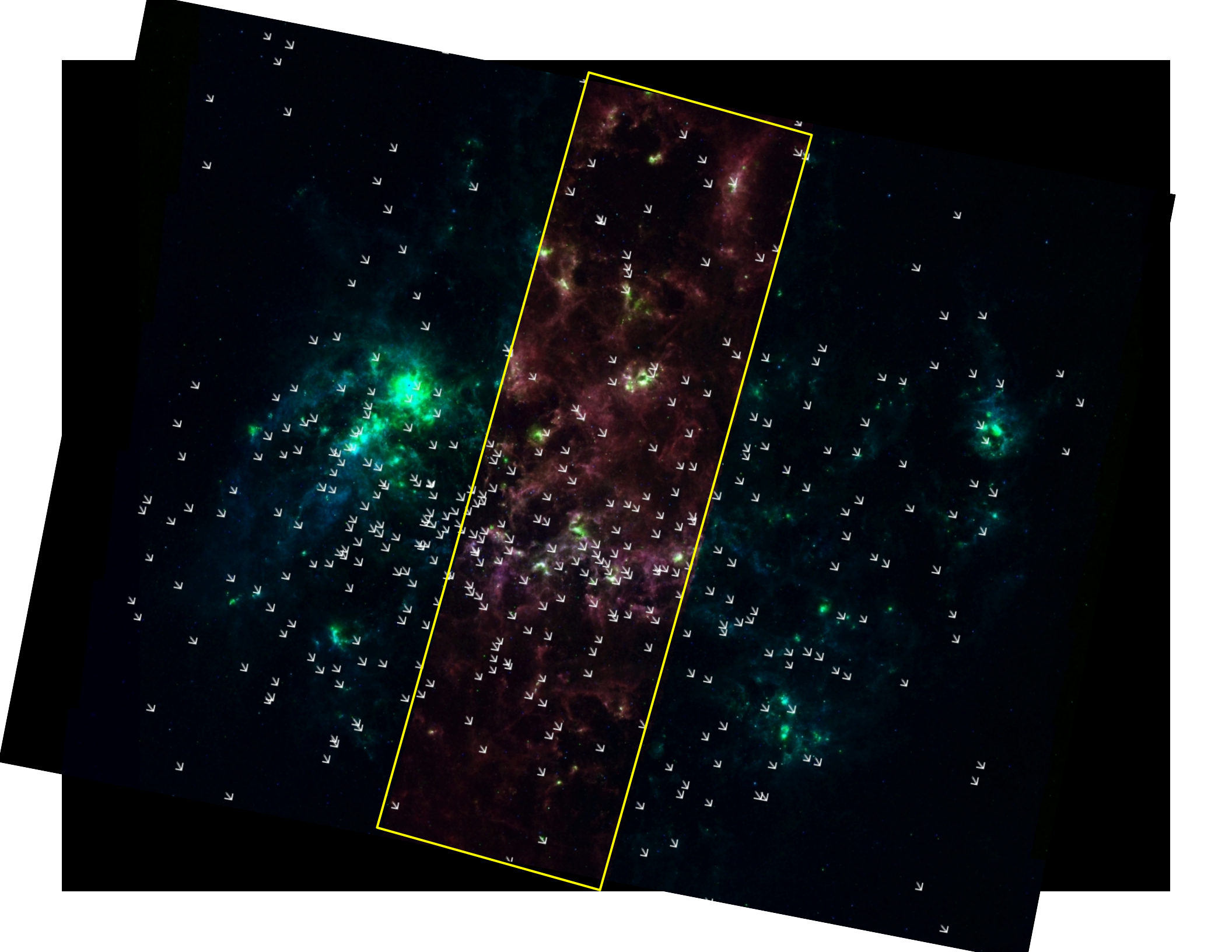
Above: Boyer et al. (2010, in prep.)

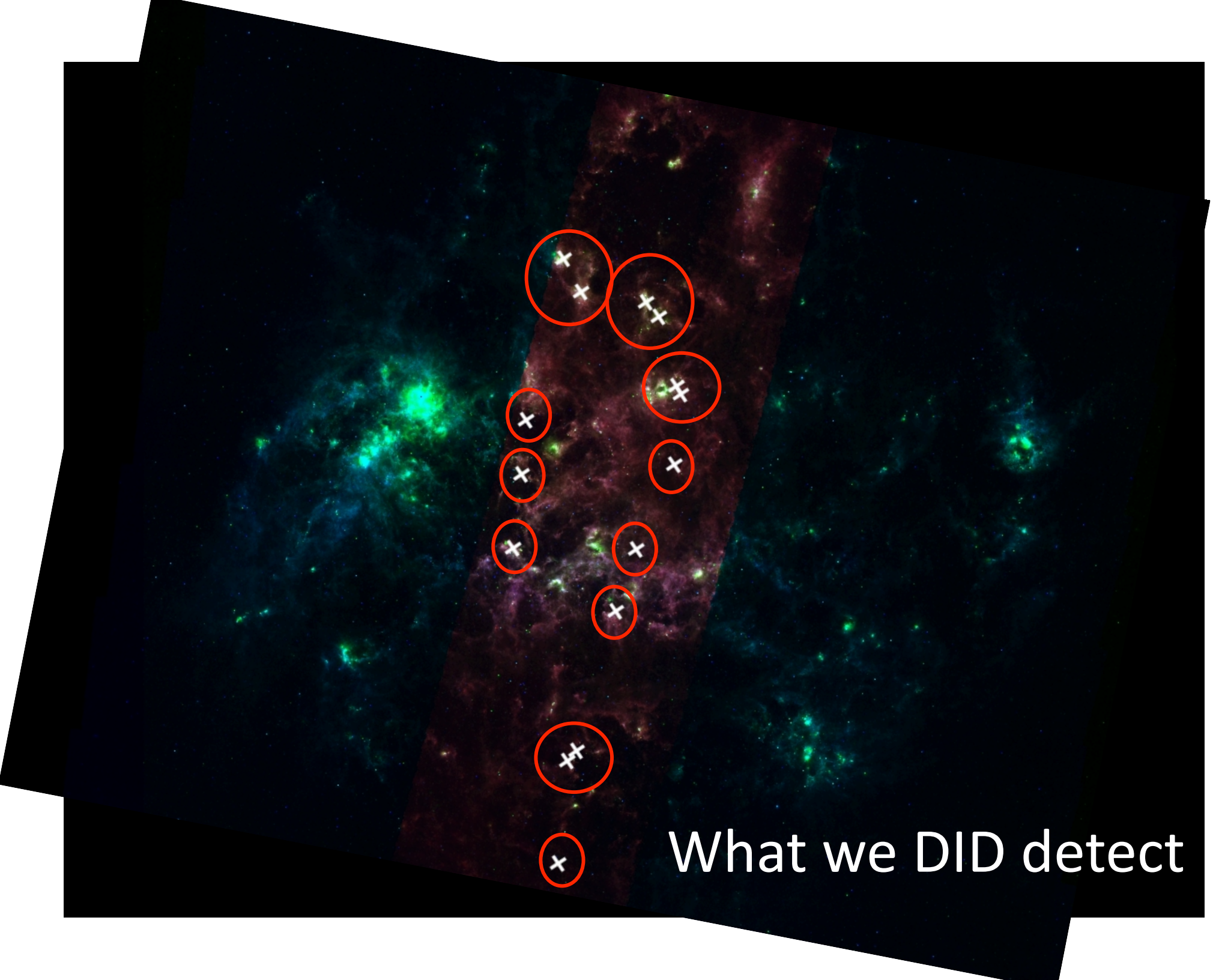


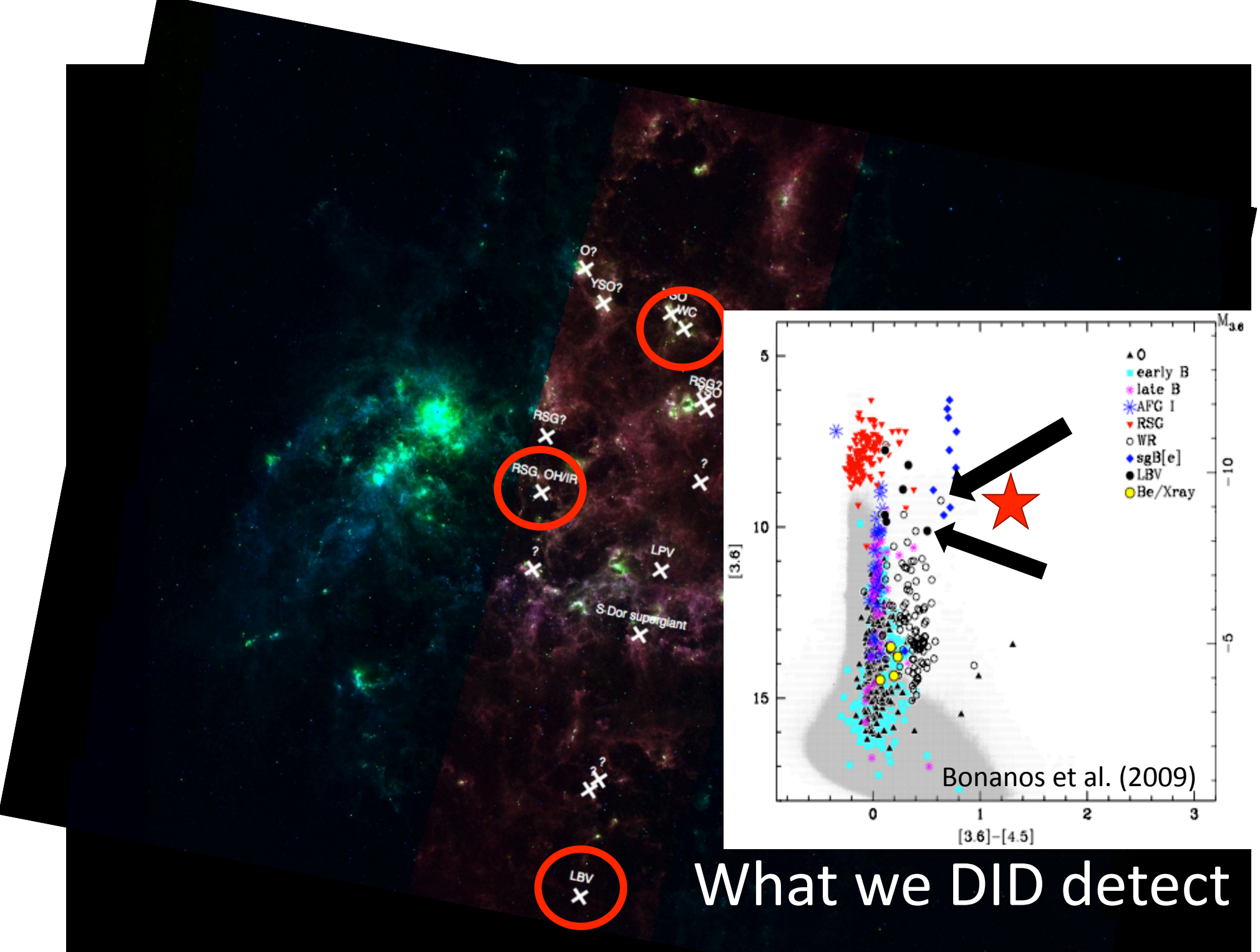
Above: Srinivasan et al. (2009)



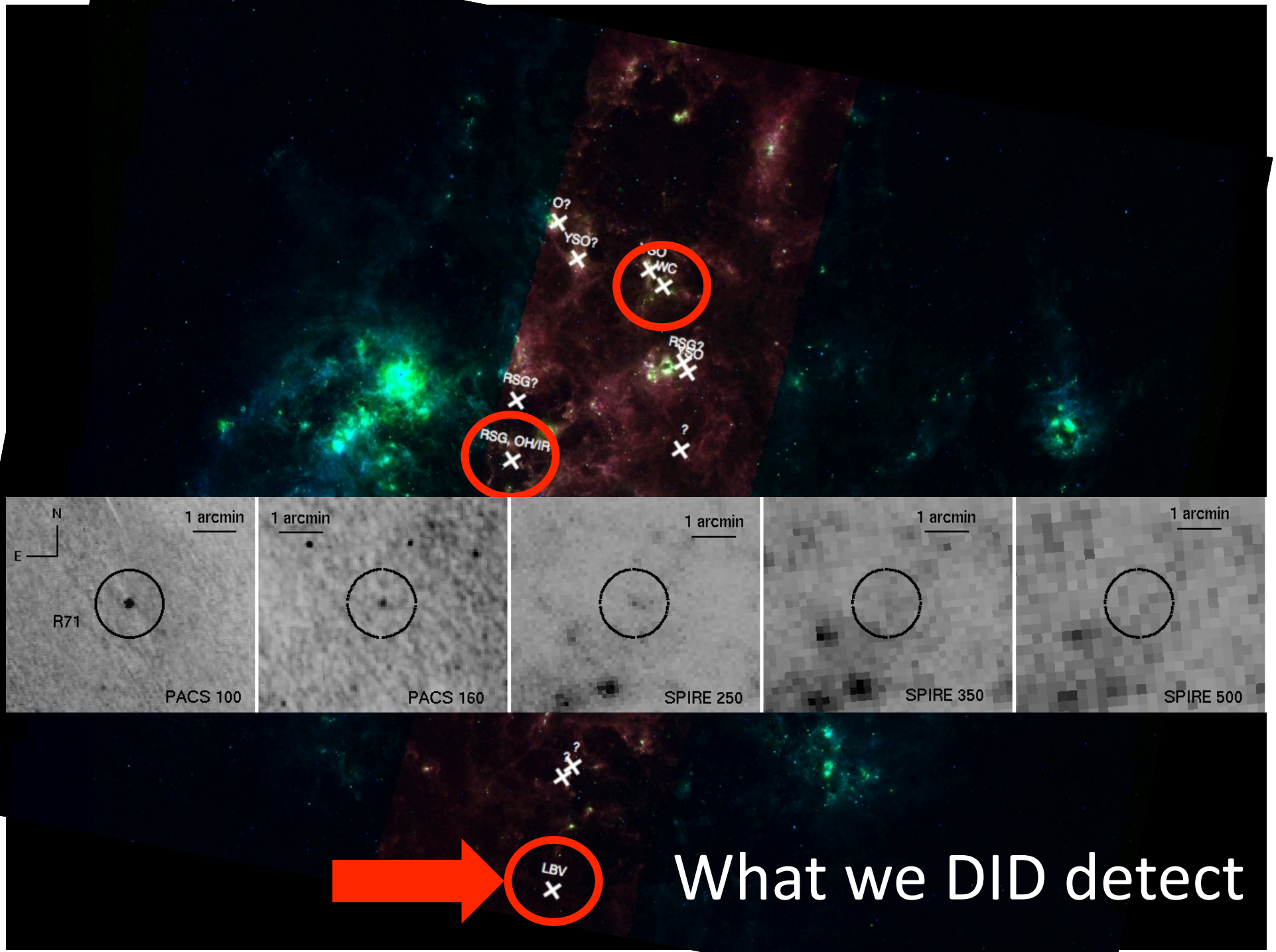

What we DID detect



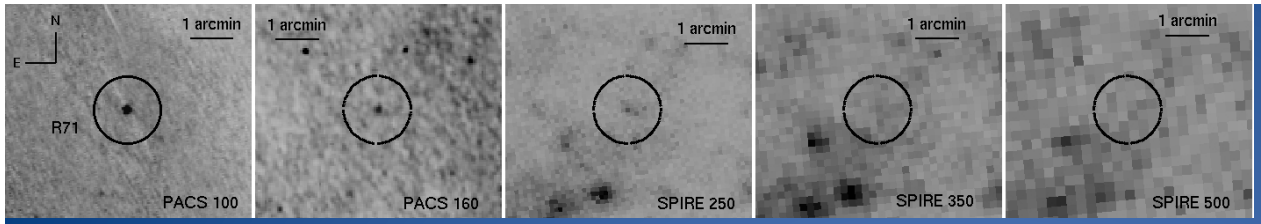

What we DID detect



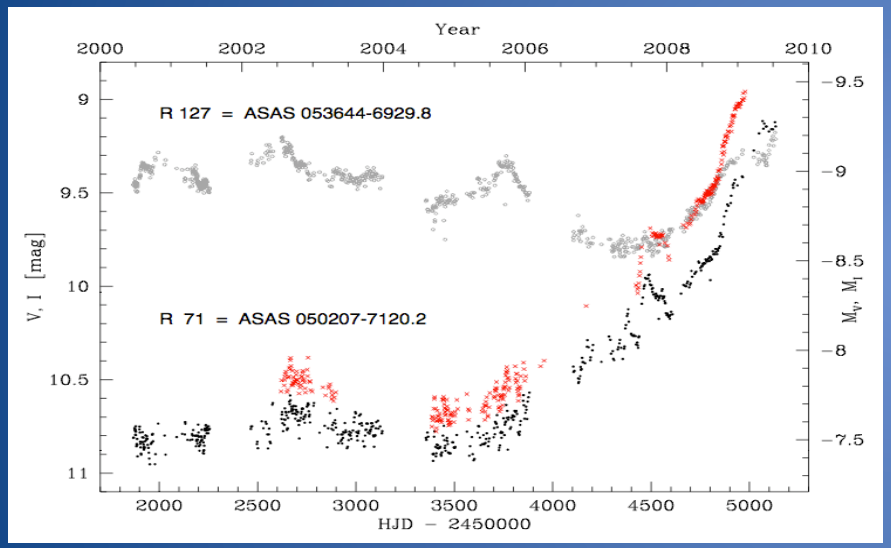
What we DID detect

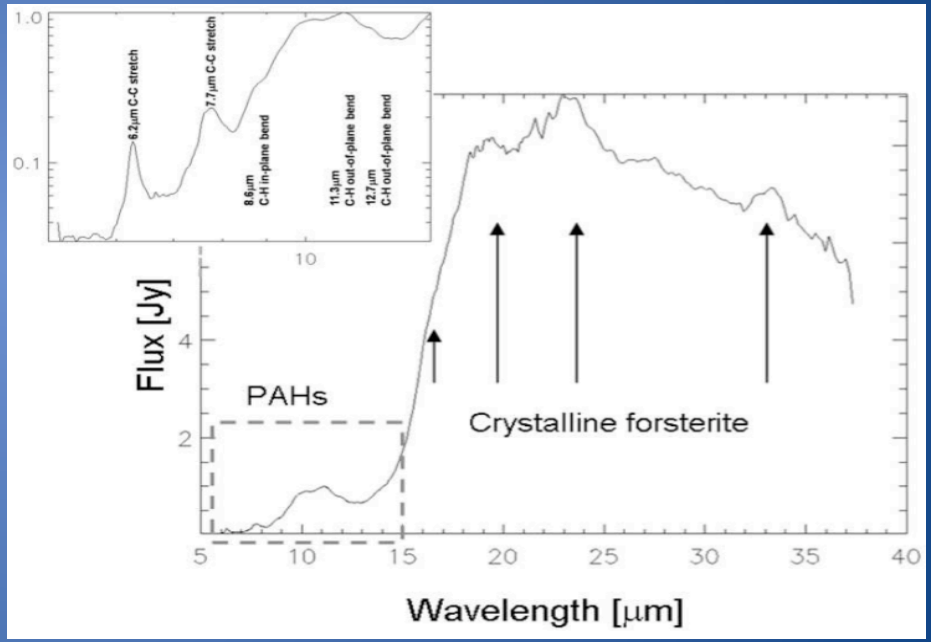


What we DID detect



R71 (HD269006)

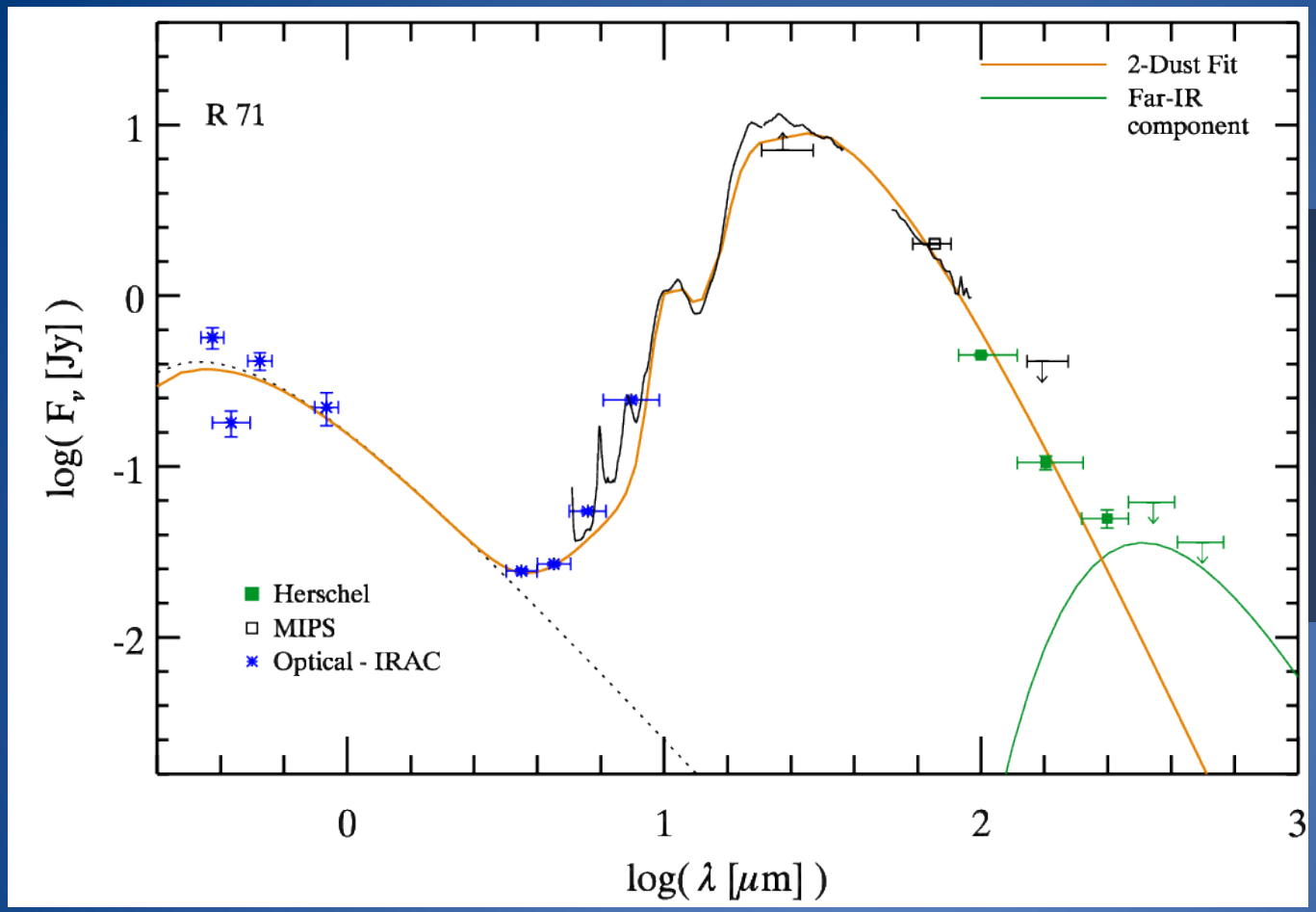




Left: Szczygiel et al. (2010)

Right: Morris et al. (2008); Waters et al. (2010); Buchanan et al. (2009)

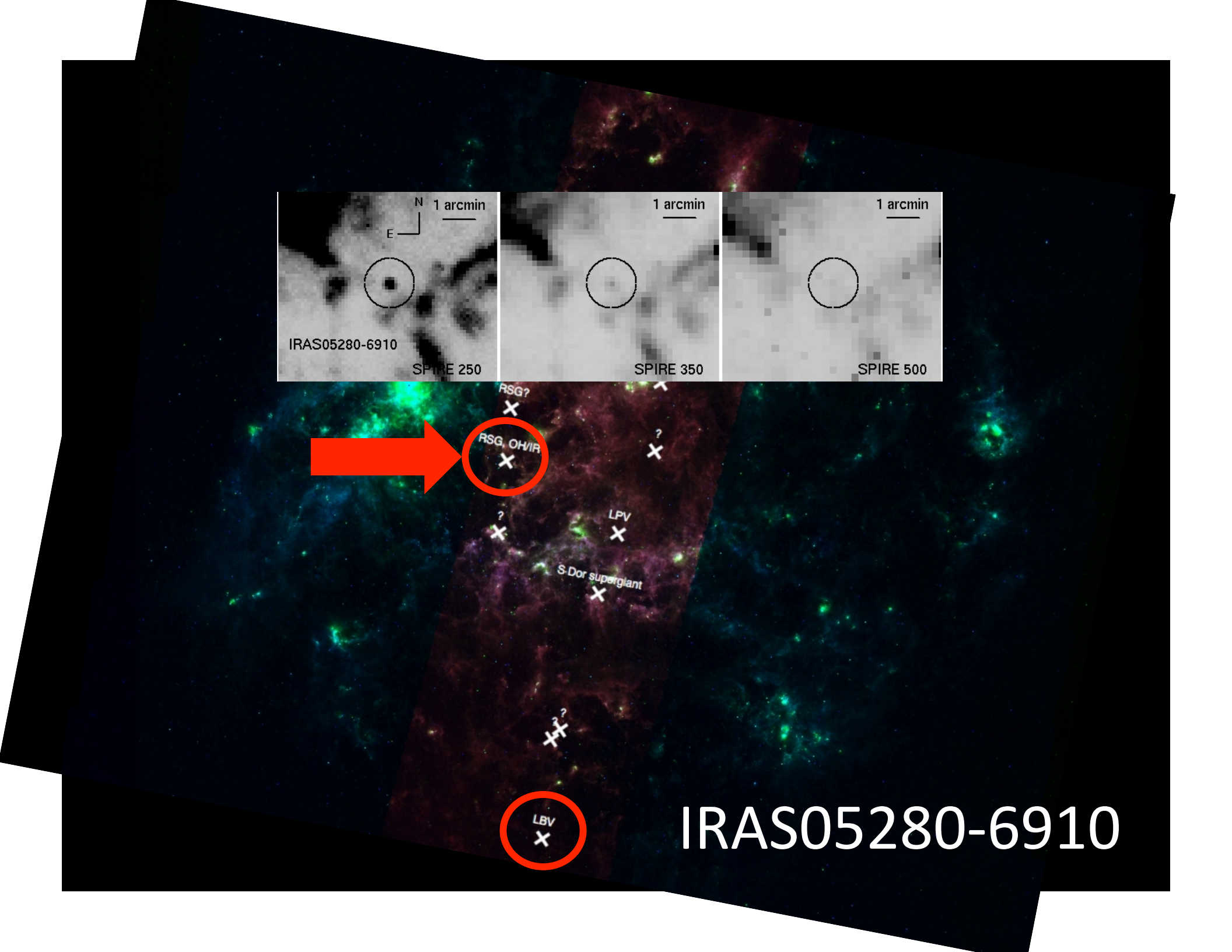
MIPS-SED: van Loon et al. (2010)

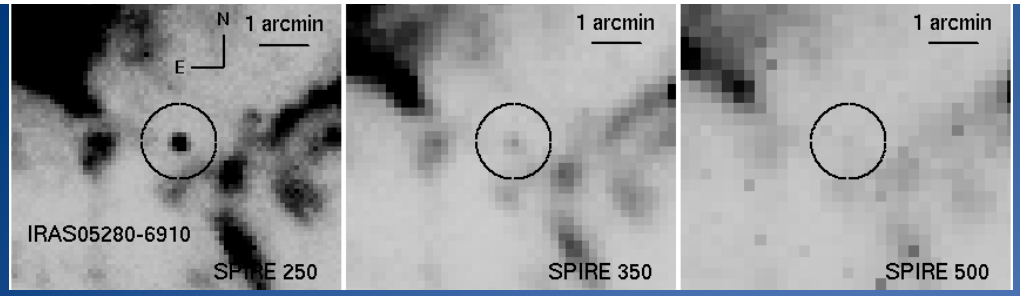


Circumstellar dust?

ISM dust?

	T_* (10^4 K)	L_* (10^5 $L_\odot$)	T_{in} (K)	R_* ($R_\odot$)	R_{out}/R_{in}	R_{in} (km)	$\dot{M}_{total}$ ($M_\odot$ yr^{-1})	M_{dust}^{mid-IR} ($M_\odot$)	T_{dust}^{sub-mm} (K)	M_{dust}^{sub-mm} ($M_\odot$)
R71 (inner/outer shell)	1.5	4.6	490/120	100	2/1.6	$\sim10^{11}/10^{12}$	$\sim10^{-6}/10^{-3}$	$\lesssim10^{-6}/0.02$	9 ± 1	$\gtrsim10^{-1}$

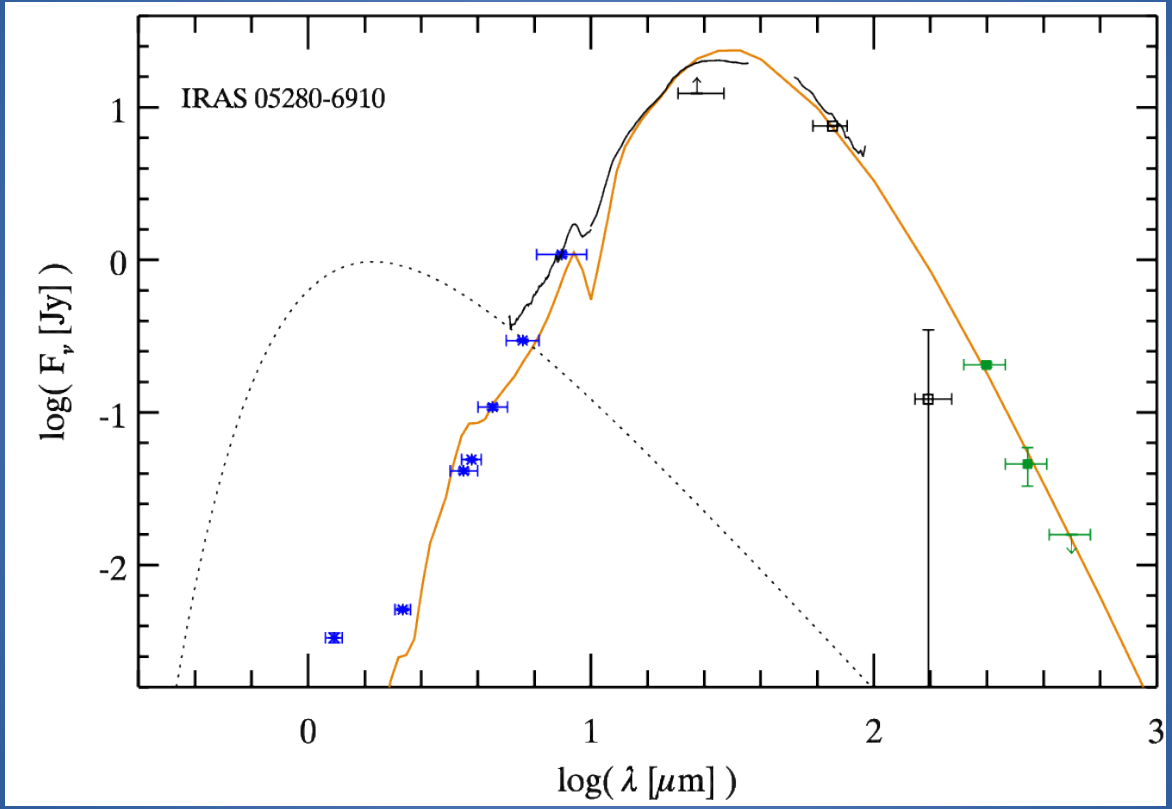

N
E
1 arcmin
IRAS05280-6910
SPIRE 250
1 arcmin
SPIRE 350
1 arcmin
SPIRE 500
RSG?
RSG, OH/IR
?
?
LPV
S Dor supergiant
? ?
LBV
IRAS05280-6910



IRAS05280-6910

IRS: Kemper et al. (2010)

MIPS-SED: van Loon et al. (2010)



	T_* (10^4 K)	L_* ($10^5\,L_\odot$)	$T_{\rm in}$ (K)	R_* ($R_\odot$)	$R_{\rm out}/R_{\rm in}$	$R_{\rm in}$ (km)	$\dot{M}_{\rm total}$ ($M_\odot$ yr^{-1})	$M_{\rm dust}^{\rm mid-IR}$ ($M_\odot$)	$T_{\rm dust}^{\rm sub-mm}$ (K)	$M_{\rm dust}^{\rm sub-mm}$ ($M_\odot$)
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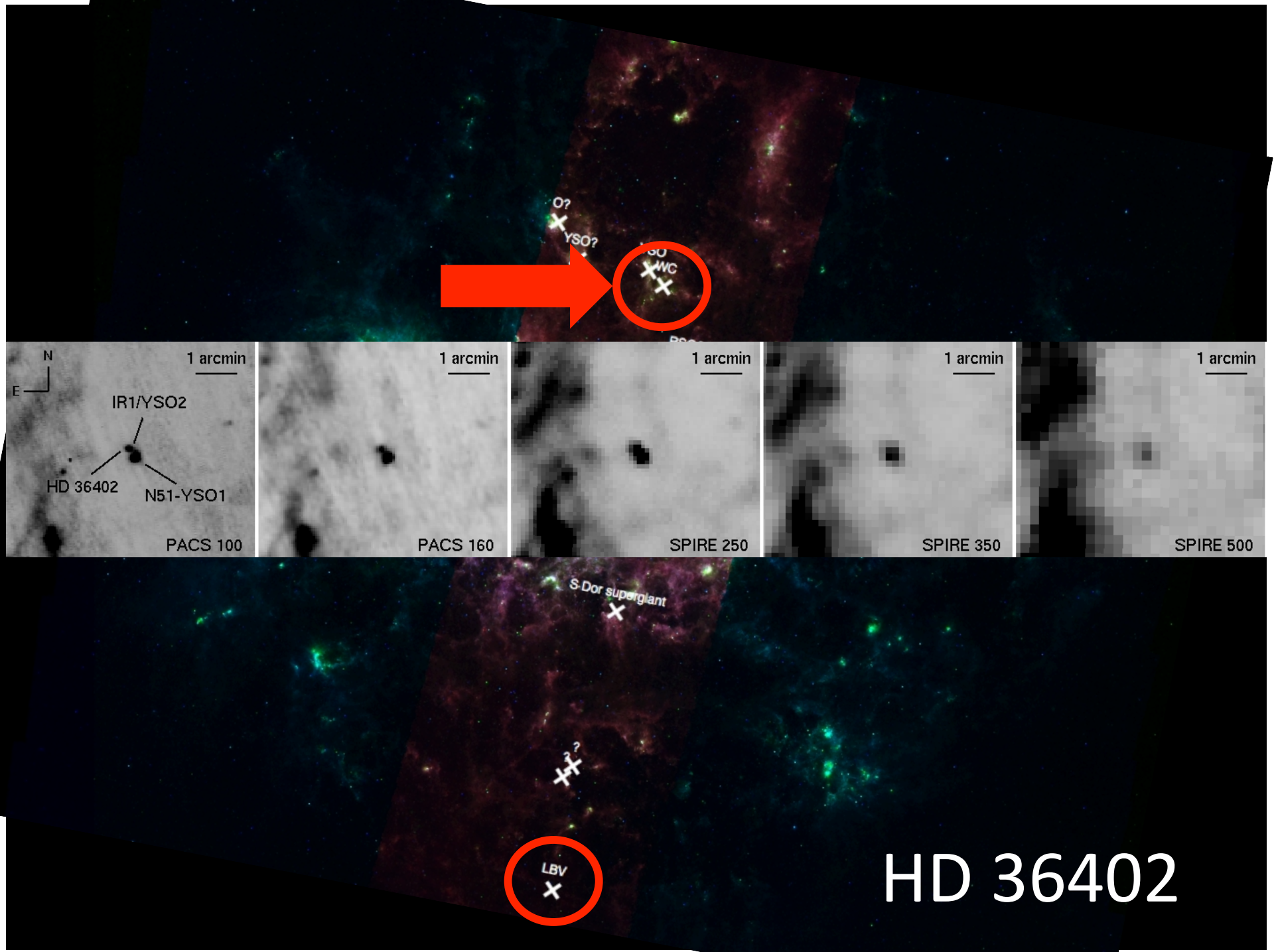
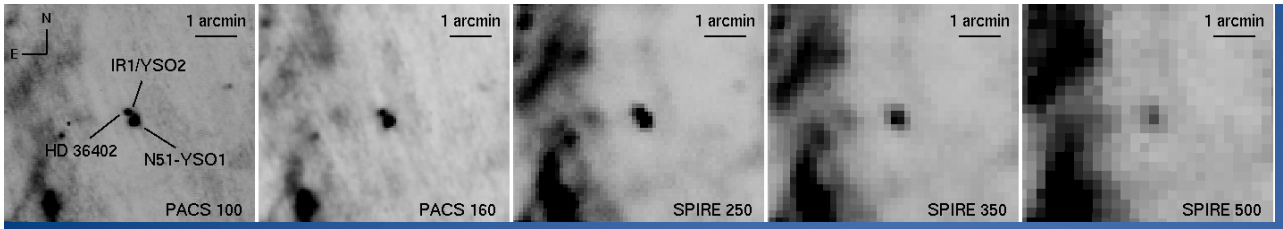
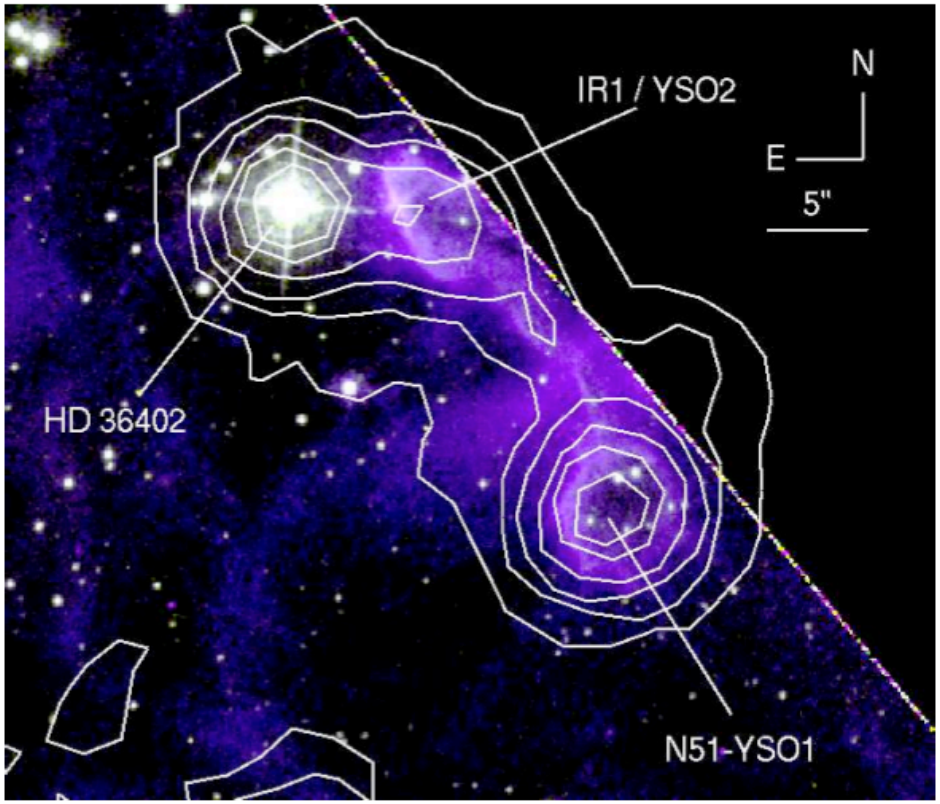
IRAS05280−6910	0.3	2.2	250	1700	30	$\sim10^{11}$	8×10^{-3}	$\lesssim0.3$	...	...

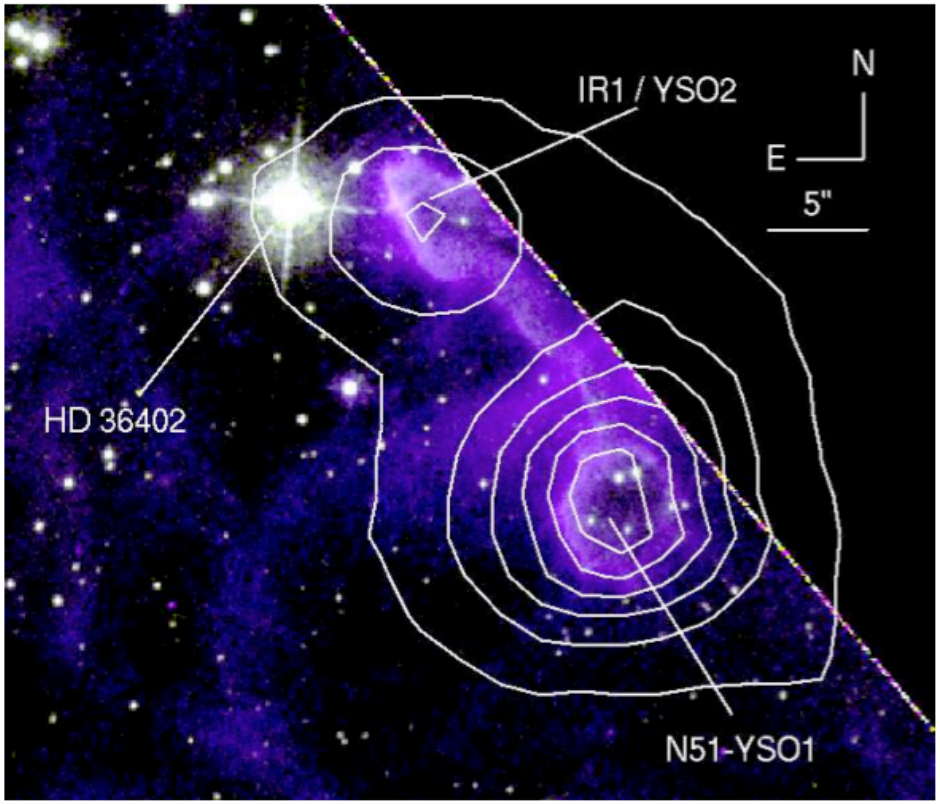

O?
YSO?
WC
N
E
1 arcmin
IR1/YSO2
HD 36402
N51-YSO1
PACS 100
1 arcmin
PACS 160
1 arcmin
SPIRE 250
1 arcmin
SPIRE 350
1 arcmin
SPIRE 500
S Dor supergiant
?
LBV
HD 36402



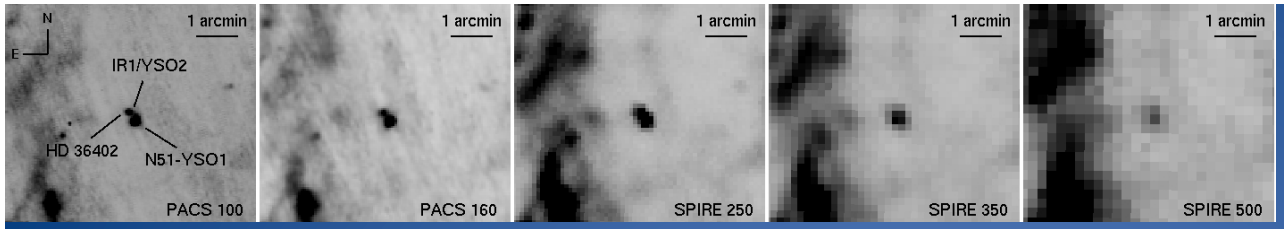
HD 36402

HST: Chu et al. (2005)

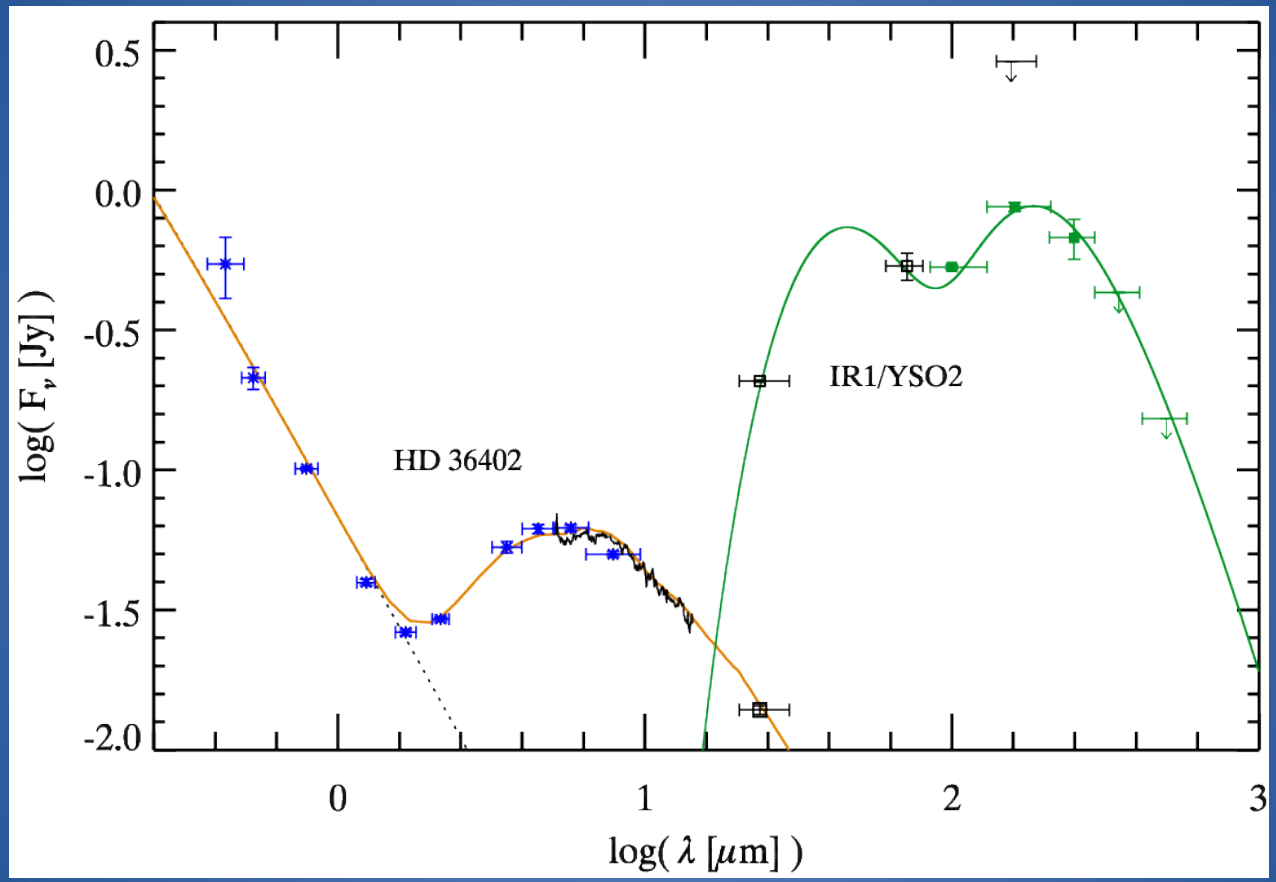




HST image: S [II] & Hα. *Left:* 8 μm contours. *Right:* PACS 100 μm contours.



HD 36402



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IRAS05280−6910	0.3	2.2	250	1700	30	$\sim 10^{11}$	8×10^{-3}	$\lesssim 0.3$	...	...
HD 36402	18	4.6	960	15	300	$\sim 10^{10}$	7×10^{-6}	$< 3 \times 10^{-6}$	...	...
HD 36402 IR1/YSO2	...	...	...	...	...	...	...	10^{-2} (64 K)	15 ± 1	$> 1.5 \pm 0.4$

Summary:

- Cold dust (T < 100 K) does not contribute significantly to the total dust mass in evolved stars of any mass.
- Massive evolved stars are important contributors to the life-cycle of dust.
  - Will this dust survive a supernova blast? Maybe…
- Follow-up required: more Herschel, SOFIA?