Observatório Nacional

CNPq
Conselho Nacional de Desenvolvimento Científico e Tecnológico

Accretion processes in symbiotic stars and related objects
First Chile-Korea-Gemini workshop on stellar astrophysics
La Serena, 4 - 7 December 2016

Reclassifying symbiotic stars using the 2MASS and WISE catalogues: An Atlas of symbiotic star spectral energy distribution

Stavros Akras

National Observatory of Brasil

Lizette Guzman-Ramirez, Marcelo Leal-Ferreira, Gerardo Ramos-Larios

Symbiotic stars Catalogue

Allen D. A., (1984) → 104 known and 15 candidate SySts

Kenyon S. J., (1986) → 133 known and 20 candidate SySts

Belczynski+ (2000) → 188 known and 30 candidate SySts

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16 years

??? → ??? known and ??? candidate SySts

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EuroConference on

SYMBIOTIC STARS PROBING STELLAR EVOLUTION

Supported by the European Commission, High-Level Scientific Conferences.

27-31 May 2002
La Palma, Canary Islands, Spain

14 years

An updated catalogue of SySts

Akras et al. in prep., 316 known and 82 candidate SySts

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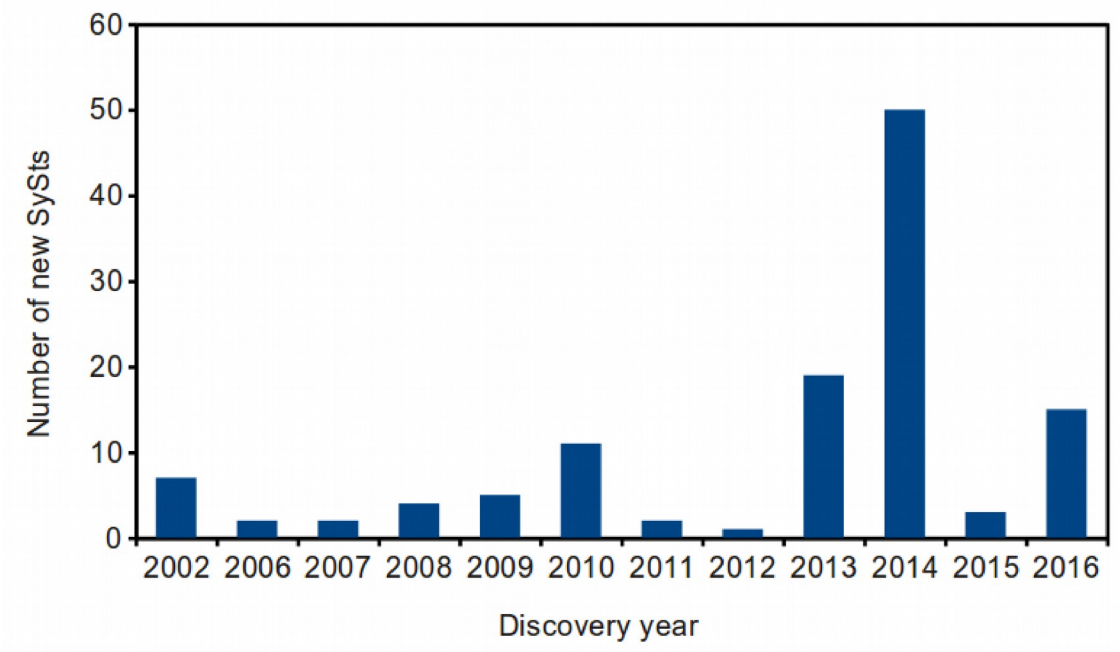
Galactic SySts

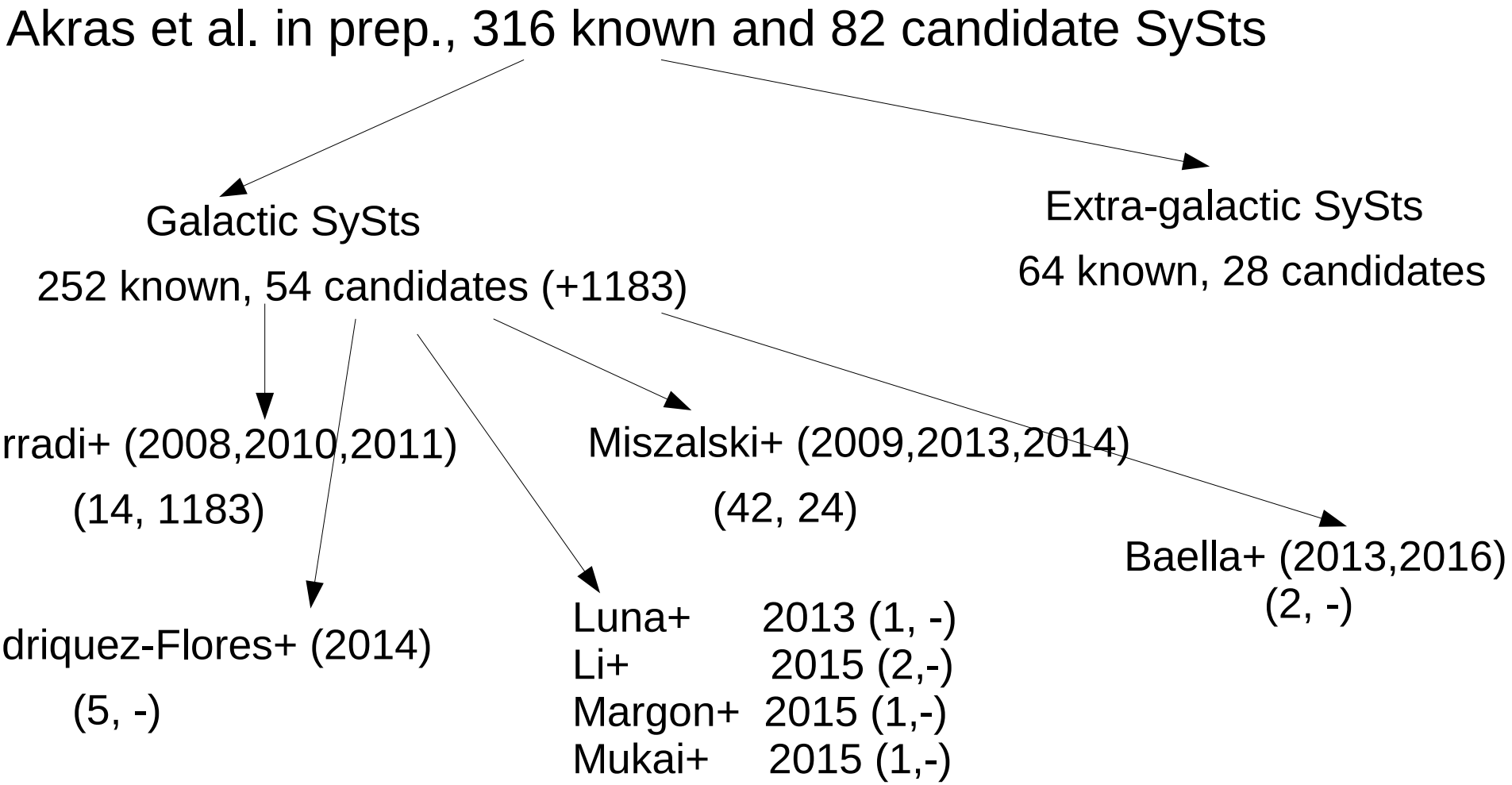
252 known, 54 candidates (+1183)

Extra-galactic SySts

64 known, 28 candidates



An updated catalogue of SySts



An updated catalogue of SySts

~50% more Galactic SySts

Akras et al. in prep., 316 known and 82 candidate SySts

Galactic SySts

252 known, 54 candidates (+1183)

Extra-galactic SySts

64 known, 28 candidates

Corradi+ (2008,2010,2011)

(14, 1183)

Rodriquez-Flores+ (2014)

(5, -)

Miszalski+ (2009,2013,2014)

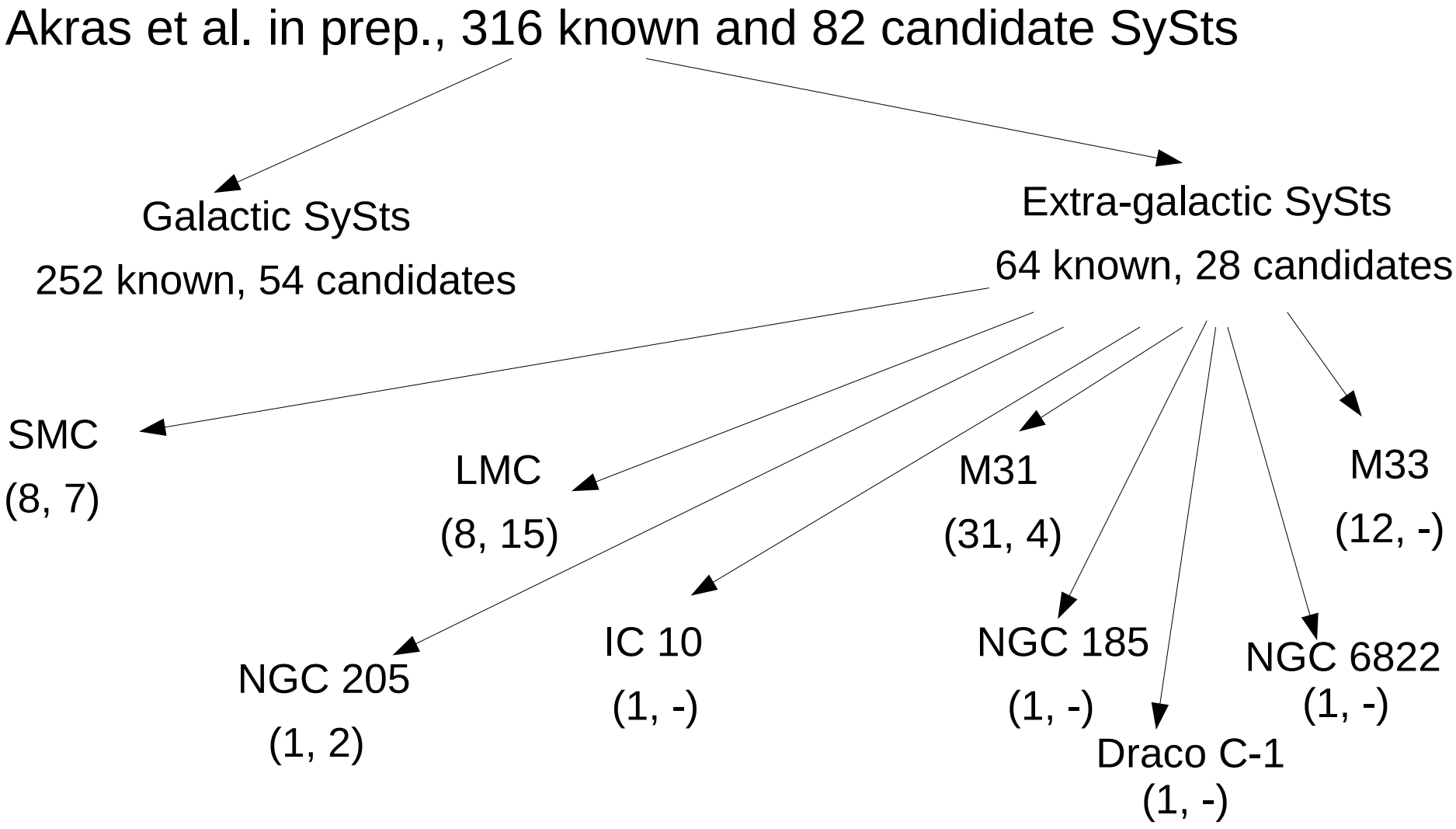
(42, 24)

Luna+ 2013 (1, -)
Li+ 2015 (2,-)
Margon+ 2015 (1,-)
Mukai+ 2015 (1,-)

Baella+ (2013,2016)

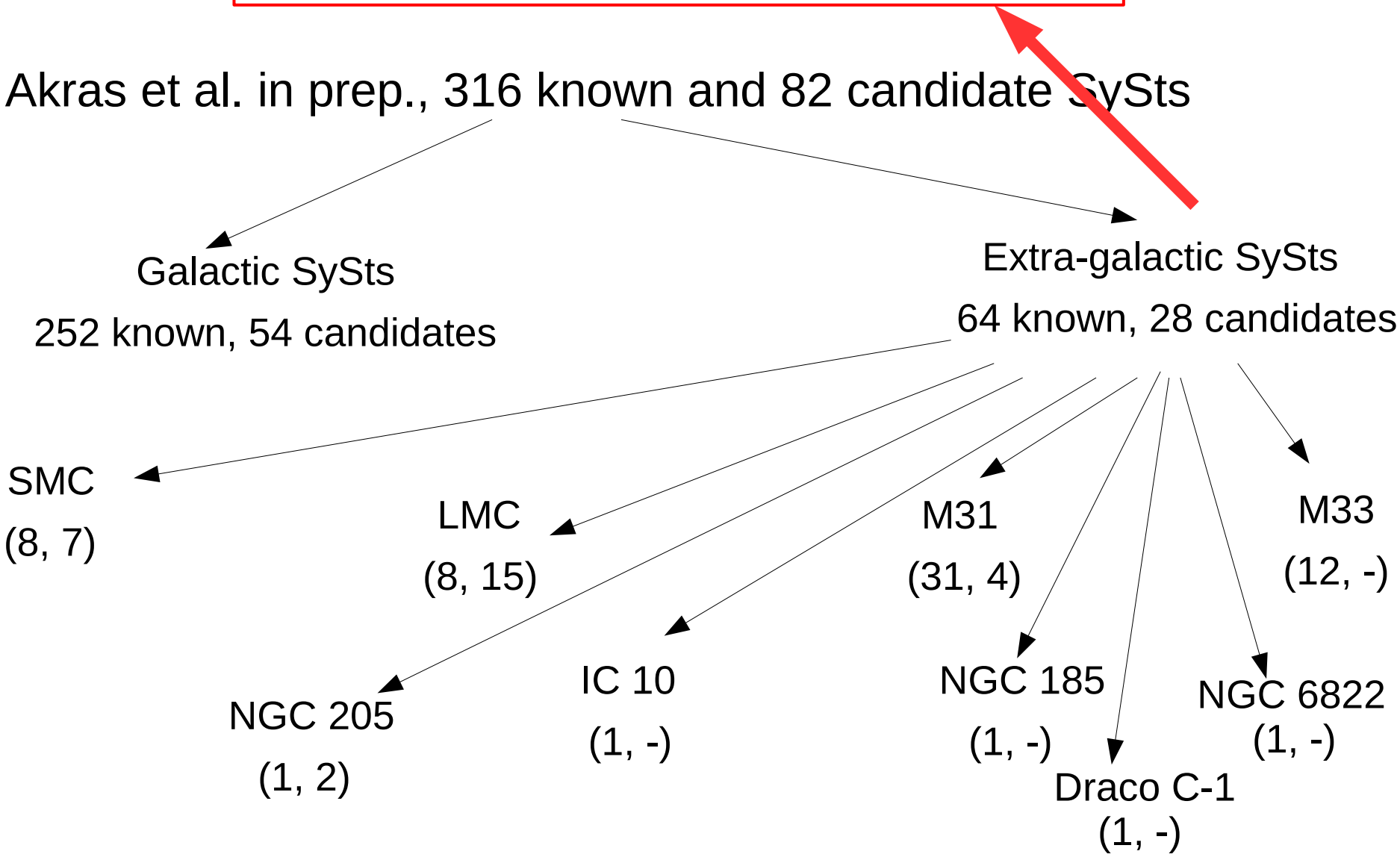
(2, -)

An updated catalogue of SySts



An updated catalogue of SySts

~400% more extragalactic SySts



SySts classification+SEDs

- S-type → either a K or M spectral type giant
- D-type → a Mira giant + dust shell
- D'-type → G spectral type giant with far-infrared excess

Spectral energy distribution (SED)

- S-type → the red star dominates the SED : SED peaks at 1-2 mu
- D-type → the dusty shell dominates the SED : SED peaks at 5-15 mu
- D'-type → resemble those of post-AGB/PNe : SED peaks at 20-30 mu

(Ivison et al. 2015)

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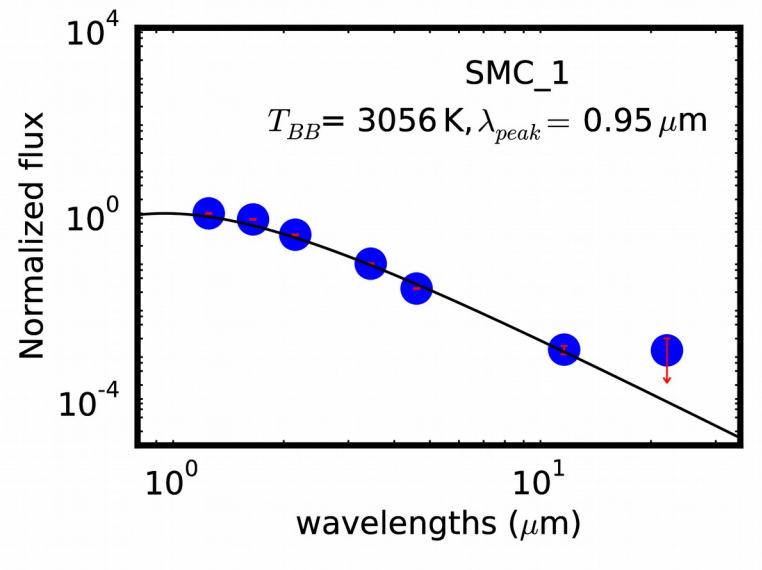
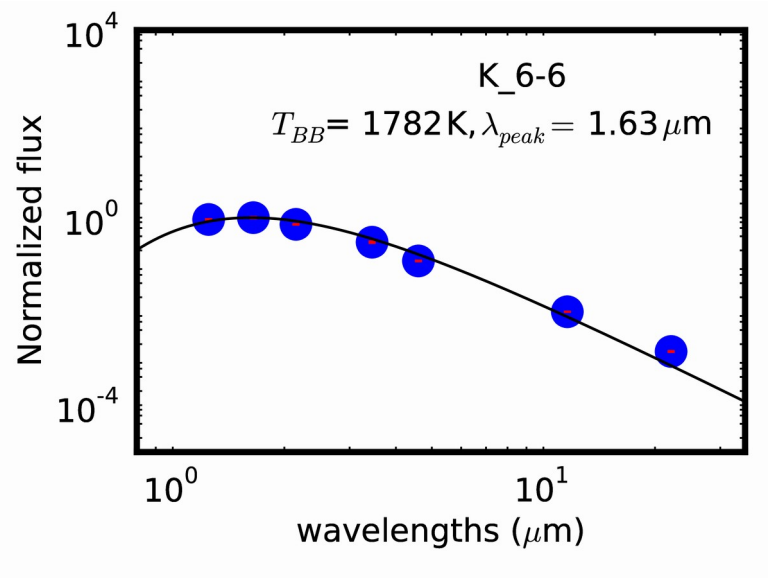
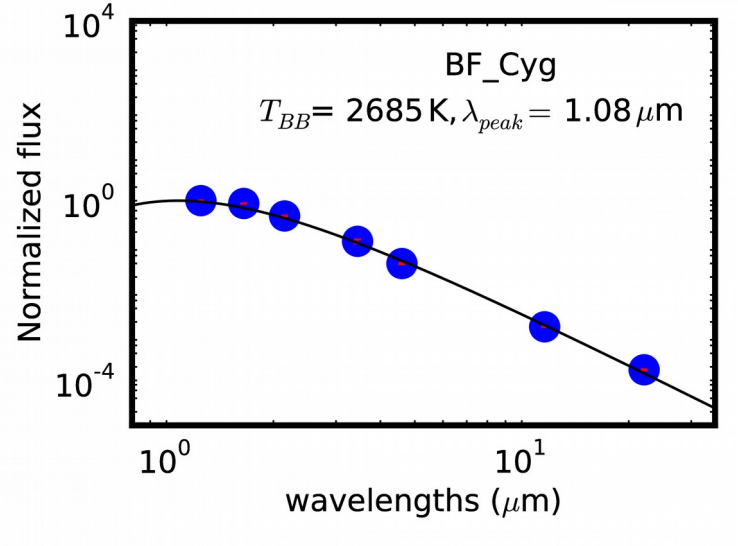
(Ivison et al. 2015)

The WISE survey with four IR bands at 3.4, 4.6, 11.2, 22.1 mu + the 2MASS survey with three near-IR bands at 1.25, 1.65 ,2.16 mu are ideal to construct and study the SED profile of SySts

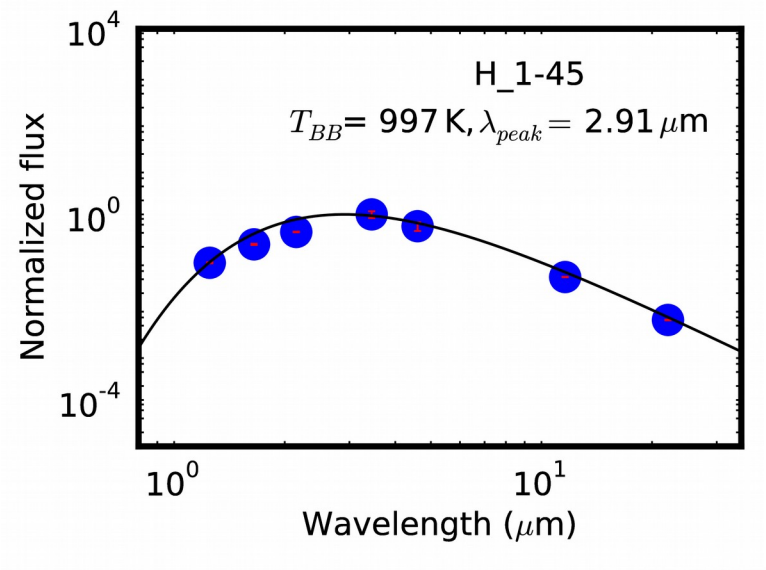
S-type SEDs

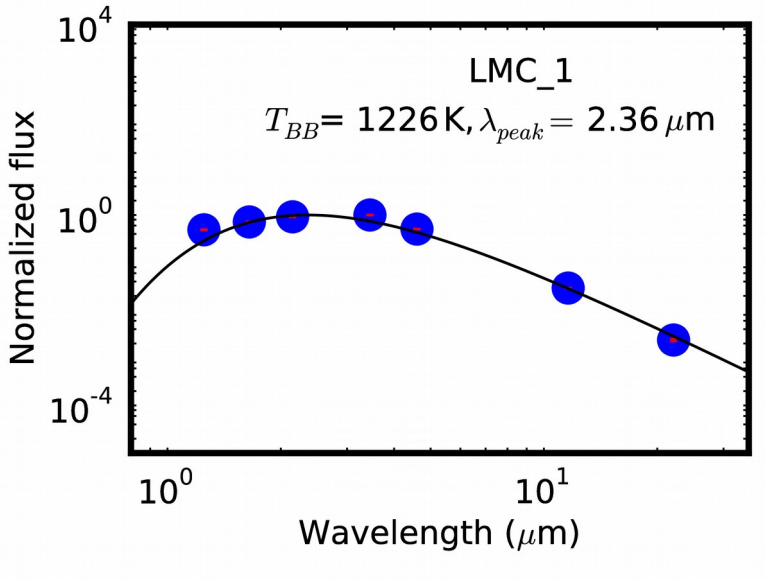

SMC_1
T_{BB}= 3056 K, λ_{peak} = 0.95 μm
Normalized flux
wavelengths (μm)

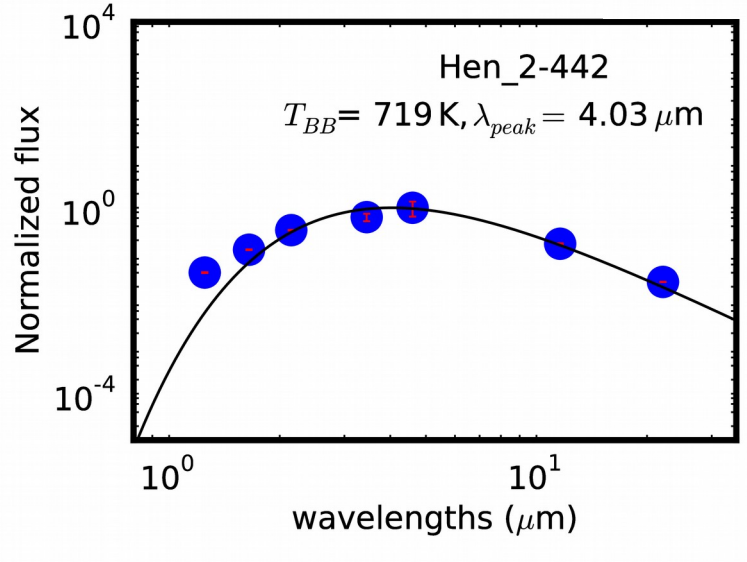

K_6-6
T_{BB}= 1782 K, λ_{peak} = 1.63 μm
Normalized flux
wavelengths (μm)


BF_Cyg
T_{BB}= 2685 K, λ_{peak} = 1.08 μm
Normalized flux
wavelengths (μm)

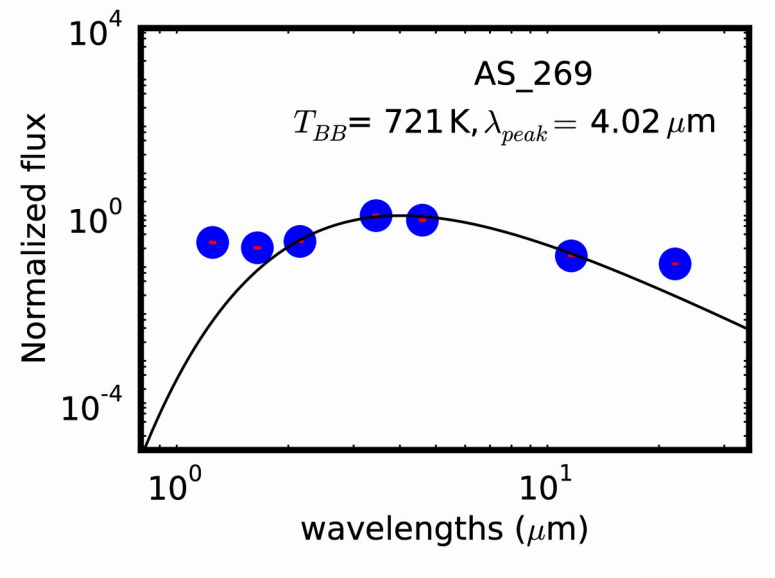
D-type SEDs

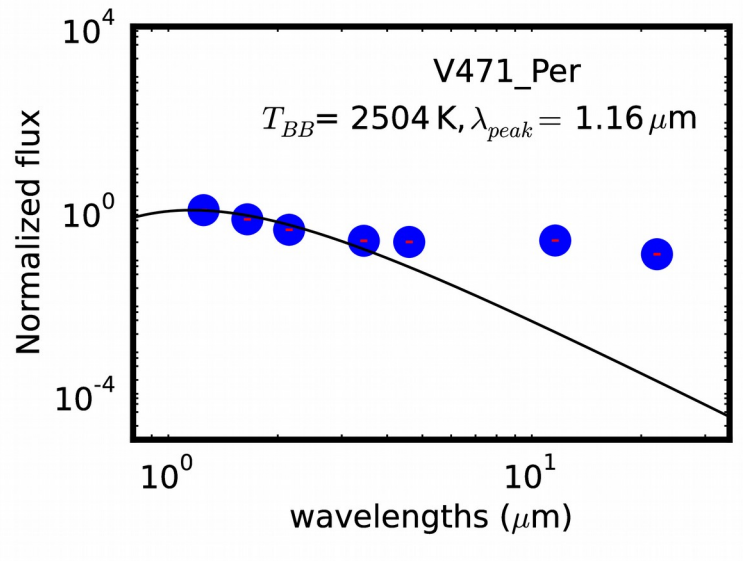

H_1-45
T_{BB}= 997 K, λ_{peak} = 2.91 μm
Normalized flux
Wavelength (μm)

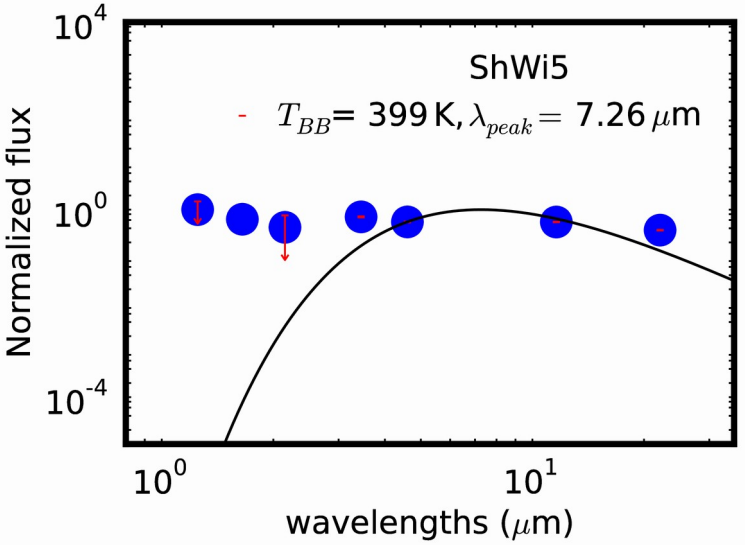

LMC_1
T_{BB}= 1226 K, λ_{peak} = 2.36 μm
Normalized flux
Wavelength (μm)


Hen_2-442
T_{BB}= 719 K, λ_{peak} = 4.03 μm
Normalized flux
wavelengths (μm)

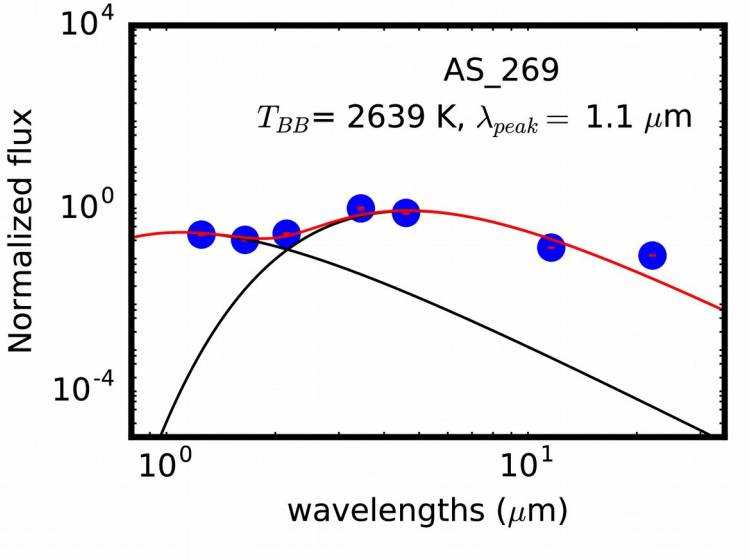
D'-type SEDs

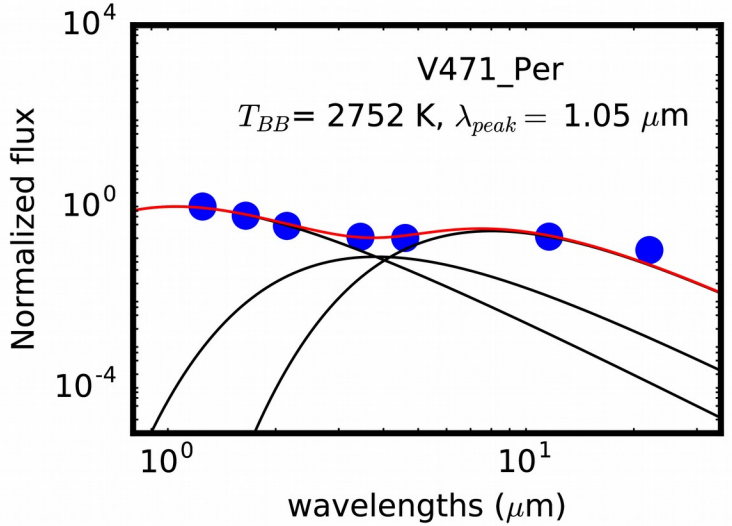

AS_269
T_{BB}= 721 K, λ_{peak} = 4.02 μm
Normalized flux
wavelengths (μm)


V471_Per
T_{BB}= 2504 K, λ_{peak} = 1.16 μm
Normalized flux
wavelengths (μm)

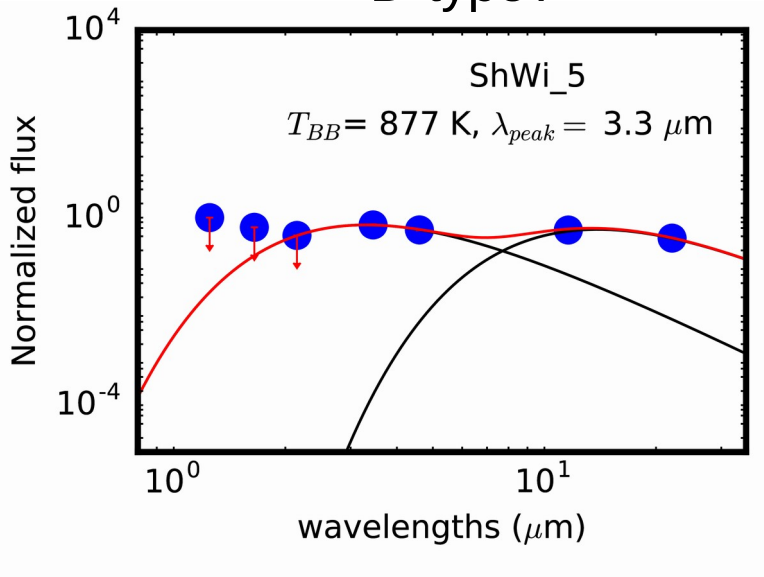

ShWi5
T_{BB}= 399 K, λ_{peak} = 7.26 μm
Normalized flux
wavelengths (μm)

D'-type SEDs

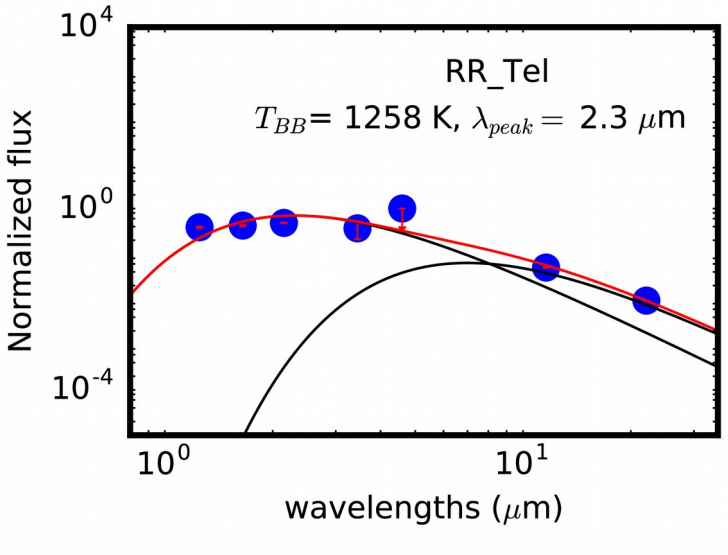


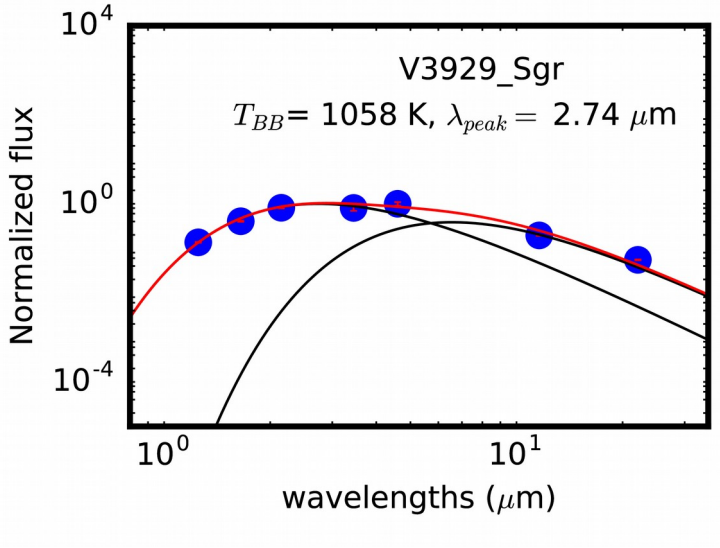


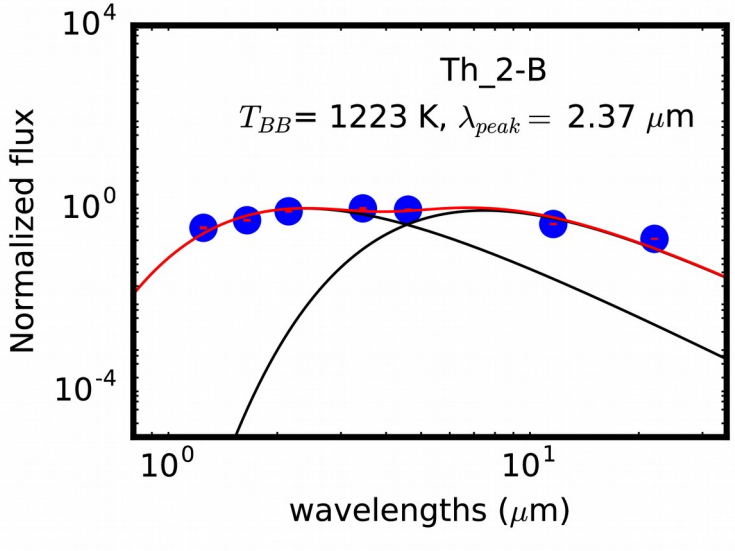
D-type?



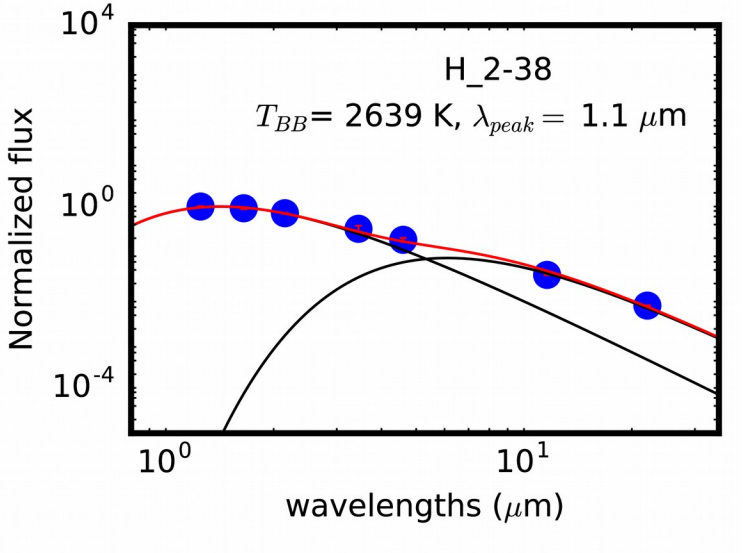
D-type SEDs

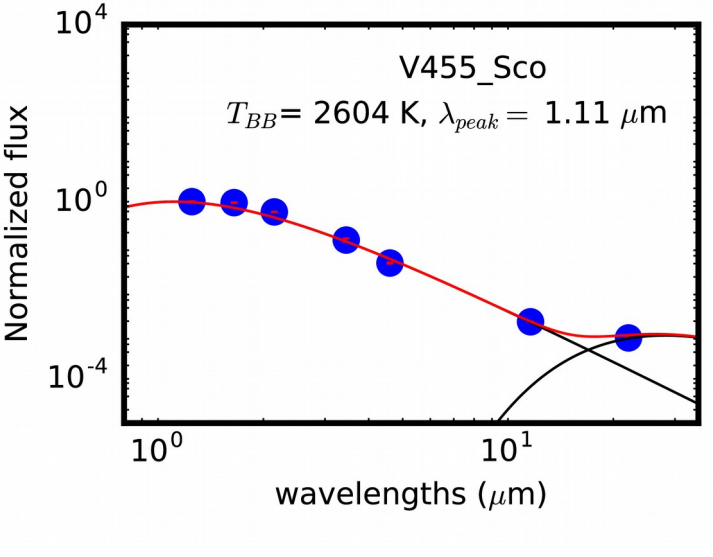

RR_Tel
T_{BB}= 1258 K, λ_{peak} = 2.3 μm
Normalized flux
wavelengths (μm)

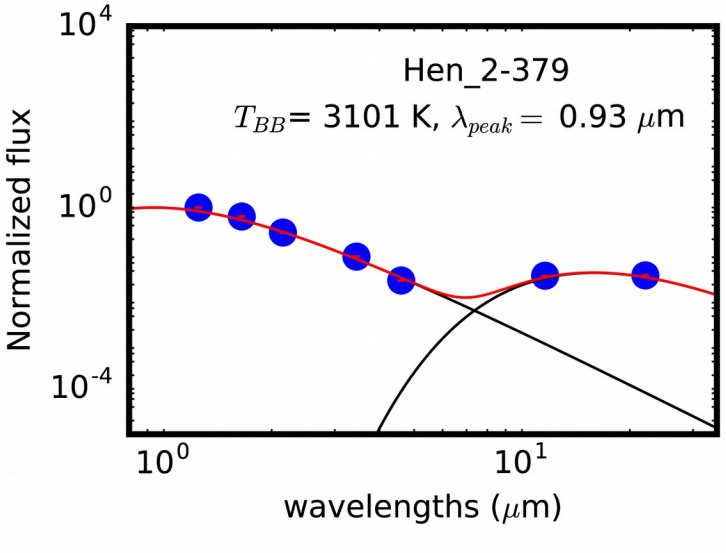

V3929_Sgr
T_{BB}= 1058 K, λ_{peak} = 2.74 μm
Normalized flux
wavelengths (μm)


Th_2-B
T_{BB}= 1223 K, λ_{peak} = 2.37 μm
Normalized flux
wavelengths (μm)

S-type + infrared excess SEDs

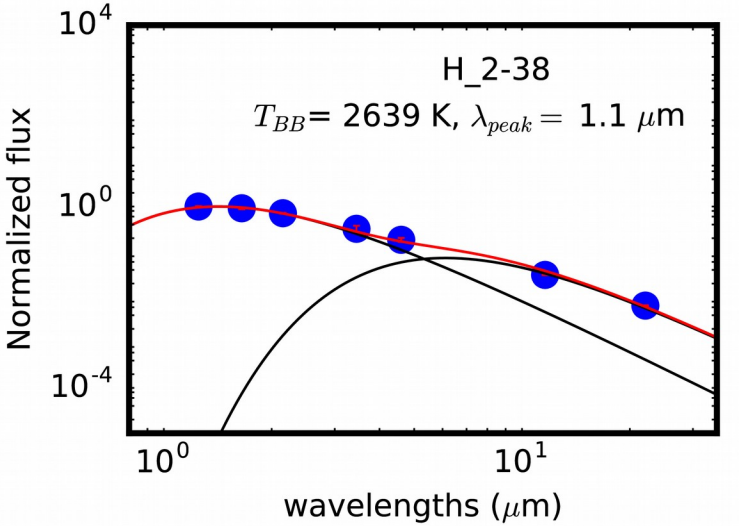


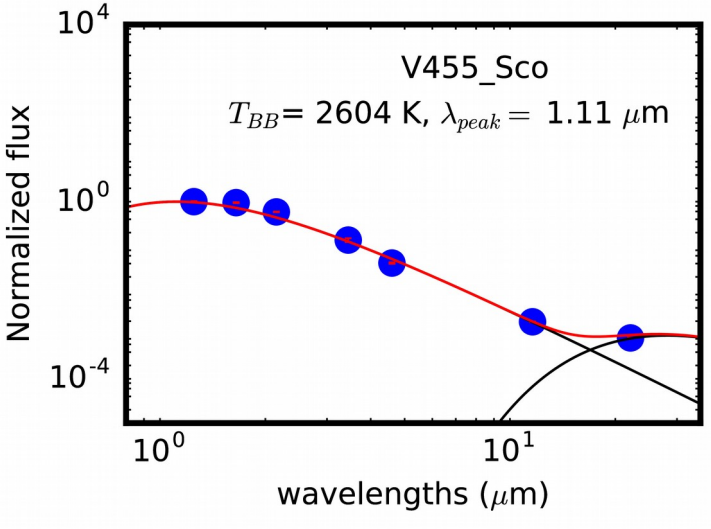




Akras et al. in prep.

S-type + infrared excess SEDs

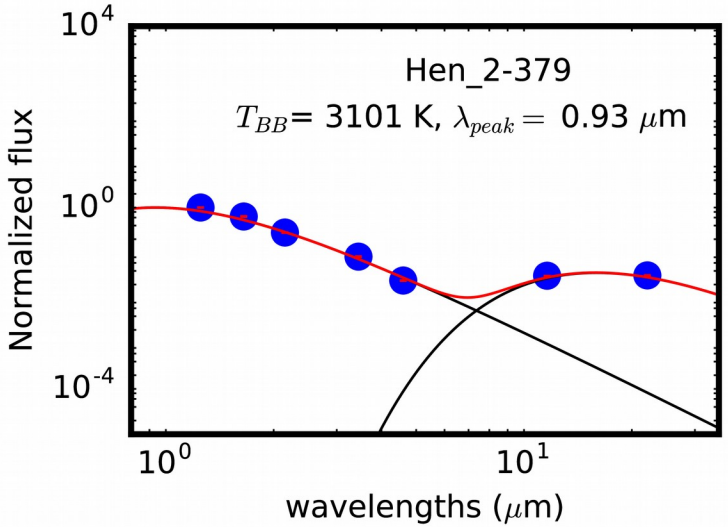




- Previous classification as D-type

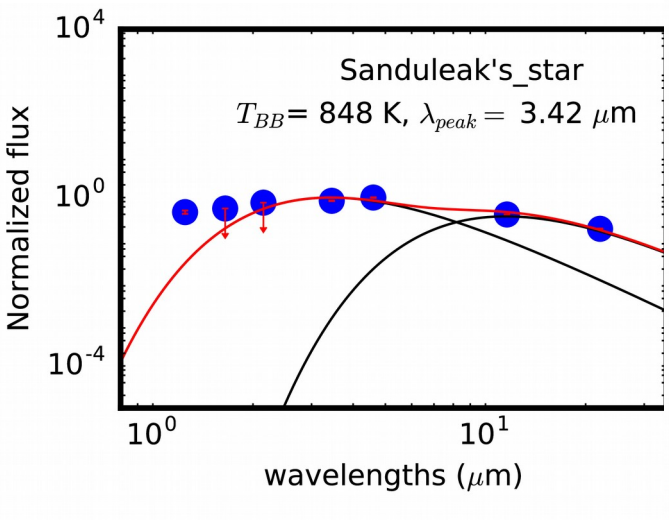
- Ha emission line profile is similar to S-type (Ivison+ 1994)

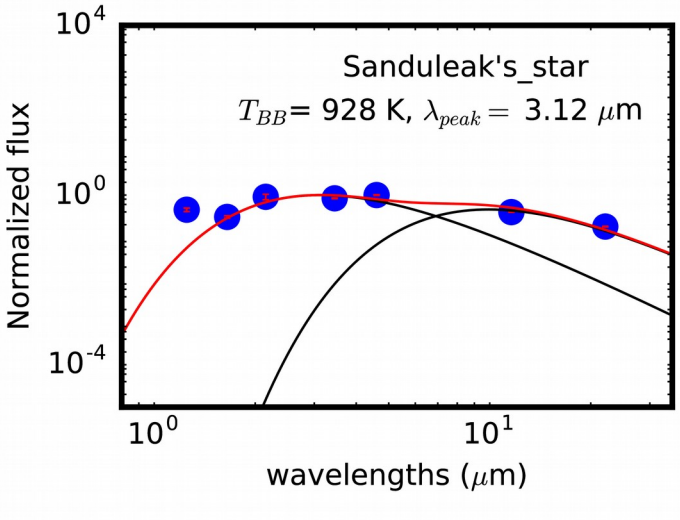
- Webster & Allen (1975) give a D and S classification

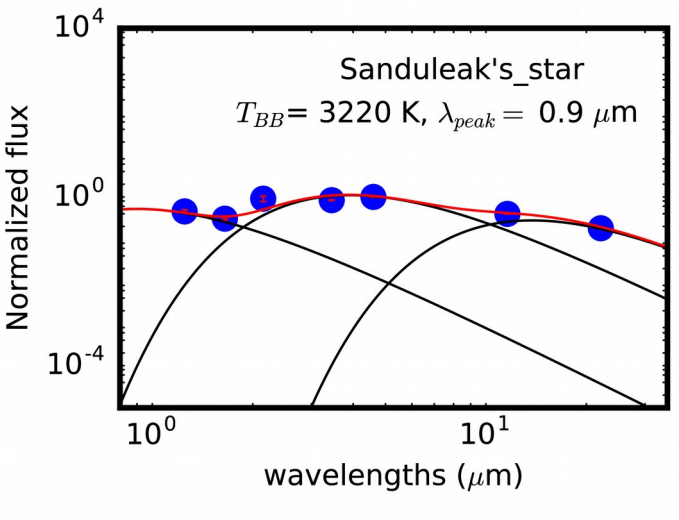


Akras et al. in prep.

Sanduleak's star







Tdust1=848±71K

Tdust2=252±22K

Tdust1=928±73K

Tdust2=292±28K

Tdust1=738±-K

Tdust2=211±-K

T_BB=3220±-K

Akras et al. in prep.

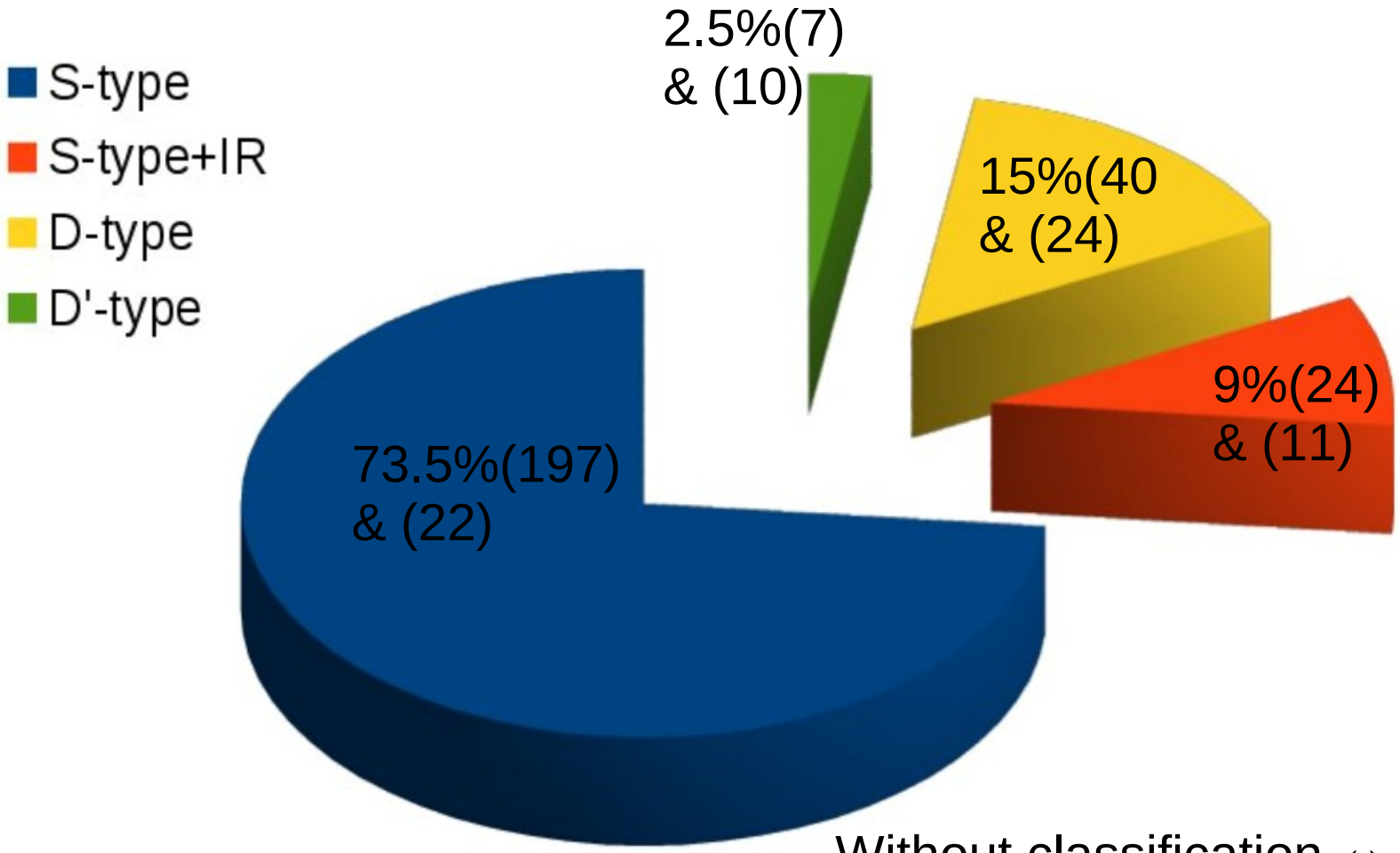
SySts classification+SEDs

We have SEDs for 268 known and 68 candidate SySts

Spectral energy distribution (SED)

- S-type → dominated by the SED of a red giant : SED peaks at 0.8-1.6 mu
- D-type → dominated by the SED of a dusty shell : SED peaks at 1.6-5 mu
- D'-type → resemble those of post-AGB/PNe : SED plateau? mu

New classification



Without classification ↔ 36 & 15

OVI Raman-scattered line

Name	R.A. J2000	Dec. J2000	Old Type	New Type	T_{BB} (K)	T_{fit} (K)	λ_{peak} (μm)	Raman line	Ref
354.98-02.87[10]	17 44 53.12	-34 42 40.7	D	D	$1047\pm164^{644\pm-}_{349\pm-}$		2.77±0.45	✓	12
355.39-02.63[10]	17 44 55.68	-34 14 18.9	S	S	2675±84		1.08±0.03	✓	12
AS 241[1,2]	17 45 14.24	-38 17 25.9	S	S+IR excess	$2303\pm124^{388\pm25}$		1.26±0.07	✓†	3
Hen 2-275[1,2]	17 45 30.74	-38 39 45.8	S	S	2869 ±131		1.01±0.05	✓	4
2MASSJ17463311-2419558[12]	17 46 33.12	-24 19 55.7	S	S+IR excess	$2206\pm151^{301\pm17}$		1.31±0.08	✗	13
355.28-03.15[10]	17 46 48.25	-34 36 03.1	S	S	2568±81		1.13±0.03	✗	12
V917 Sco[1,2]	17 48 04.28	-36 08 17.3	S	S	2740±100		1.06±0.04	✓	3
PN H 1-36[1,2]	17 49 48.20	-37 01 28.0	D	D	$1043\pm-^{617\pm-}_{278\pm-}$		2.78±-	✓,(✗)	1,(3,20)
JaSt2-6[10]	17 50 01.90	-29 33 25.0	D	D	$840\pm19^{218\pm16}$		3.45±0.03		
RS Oph[1,2]	17 50 13.20	-06 42 28.5	S	S	2552±94		1.14±0.04	✗,(✓)	1,2,(3)
WRAY 16-312[1,2]	17 50 16.66	-30 57 34.6	D	D	842±60		3.44±0.07	✓	1,3

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55% of galactic SySts show the 6830 Å line (119 out of 218).
37 SySts without available spectra.

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37 SySts without available spectra.

≥50% of galactic SySts show the 6830 Å line (Allen 1980)

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355.28-03.15[10]	17 46 48.25	-34 36 03.1	S	S	2568±81		1.13±0.03	✗	12
V917 Sco[1,2]	17 48 04.28	-36 08 17.3	S	S	2740±100		1.06±0.04	✓	3
PN H 1-36[1,2]	17 49 48.20	-37 01 28.0	D	D	$1043\pm-^{617\pm-}_{278\pm-}$		2.78±-	✓,(✗)	1,(3,20)
JaSt2-6[10]	17 50 01.90	-29 33 25.0	D	D	$840\pm19^{218\pm16}$		3.45±0.03		
RS Oph[1,2]	17 50 13.20	-06 42 28.5	S	S	2552±94		1.14±0.04	✗,(✓)	1,2,(3)
WRAY 16-312[1,2]	17 50 16.66	-30 57 34.6	D	D	842±60		3.44±0.07	✓	1,3

55% of galactic SySts show the 6830 Å line (119 out of 218).
37 SySts without available spectra.

≥50% of galactic SySts show the 6830 Å line (Allen 1980)

In types

- 91 out of 158 S-type (57.6%)
- 8 out of 21 S-type + infrared excess (38%)
- 19 out of 35 D-type (54%)
- 1 out of 4 D'-type (25%)

OVI Raman-scattered line

≥50% of galactic SySts show the 6830 Å line (Allen 1980)

55% of galactic SySts show the 6830 Å line (119 out of 218).
37 SySts without available spectra.

Extragalactic SySts

- SMC → 8 out of 8 (100%) [Fe/H]=-0.99 (Dobbie+ 14)
- LMC → 4 out of 7 (57%) [Fe/H]=-0.60 (Salaris & Girardi 05)
- M31 → 16 out of 31 (52%) [Fe/H]=-0.83 (Brown+ 08)
- M33 → 5 out of 12 (41.7%) [Fe/H]=-1.6 (Cioni+ 09,13)
- Milky Way → 119 out of 218 (55%) [Fe/H]=-0.11 (Sadler+ 96)

Thank you for your attention