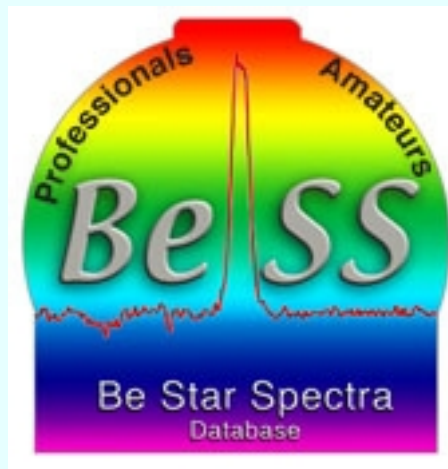


# The BeSS database: Current state and ideas for the future



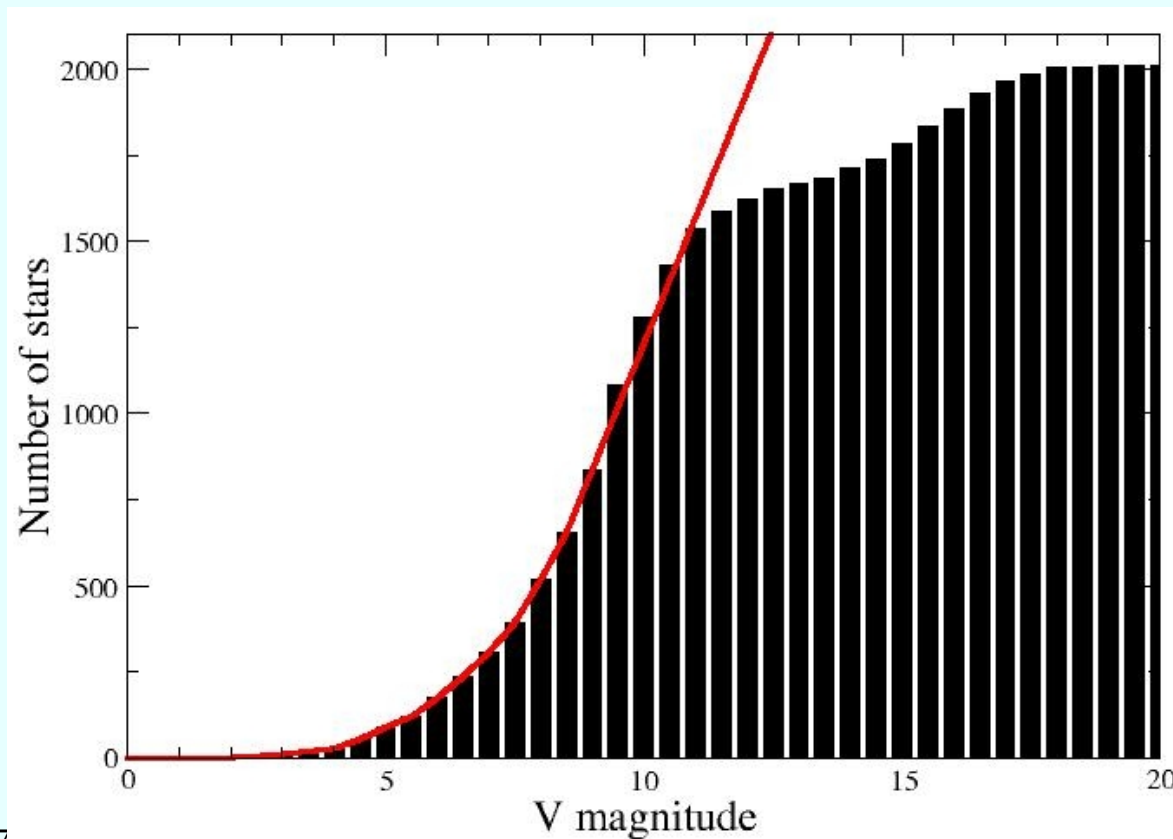
Coralie Neiner  
LESIA, Paris Observatory

with inputs from Michaela Kraus (B[e] stars)  
and Evelyne Alecian (Herbig Be stars)

# BeSS: Be Stars and their Spectra

## Catalogue of Be stars

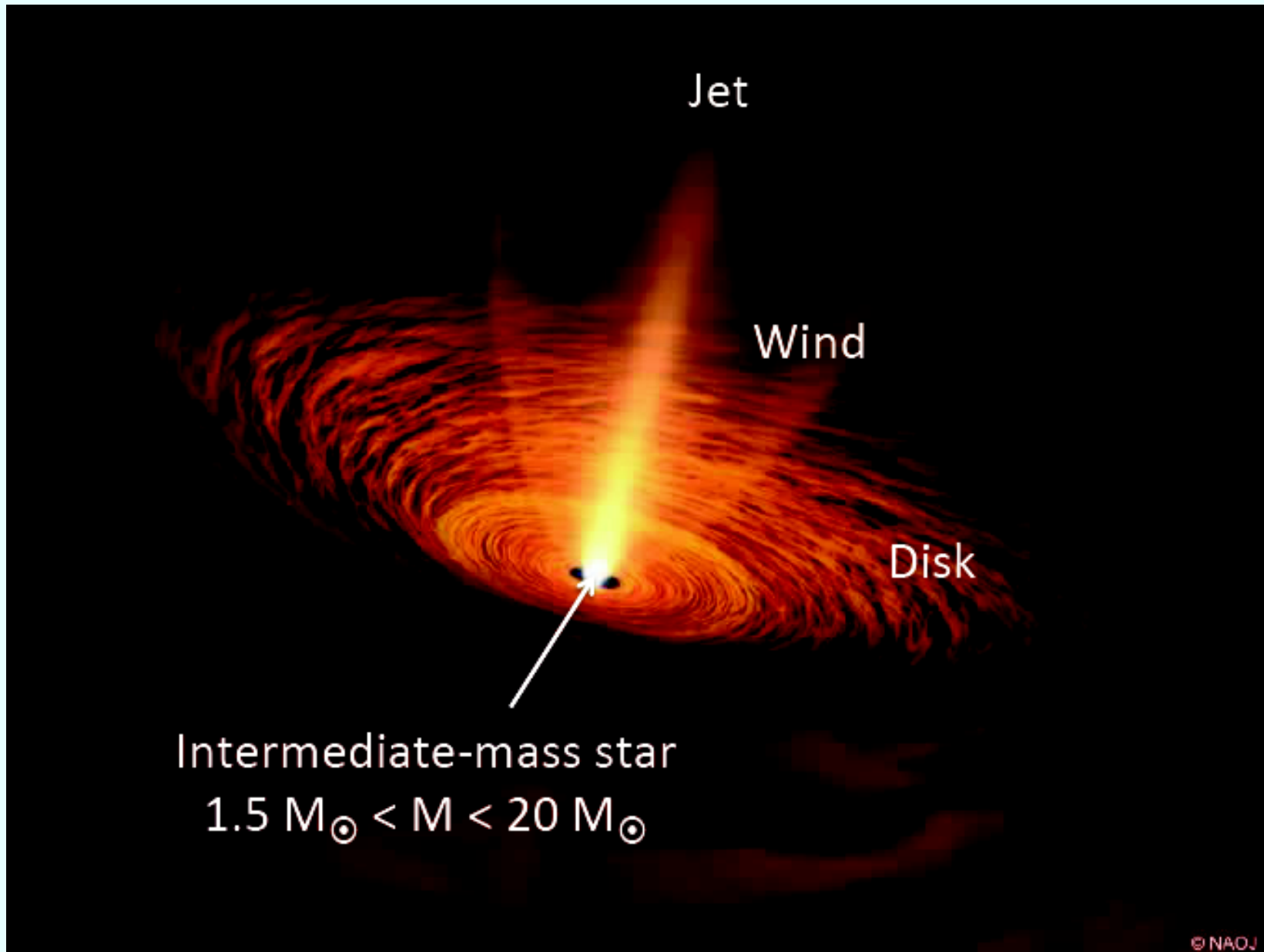
- 2256 classical Be stars (but probably includes some Oe stars with emission due to wind)
- 64 Herbig Be stars
- 9 stars either classical Be or Herbig Be



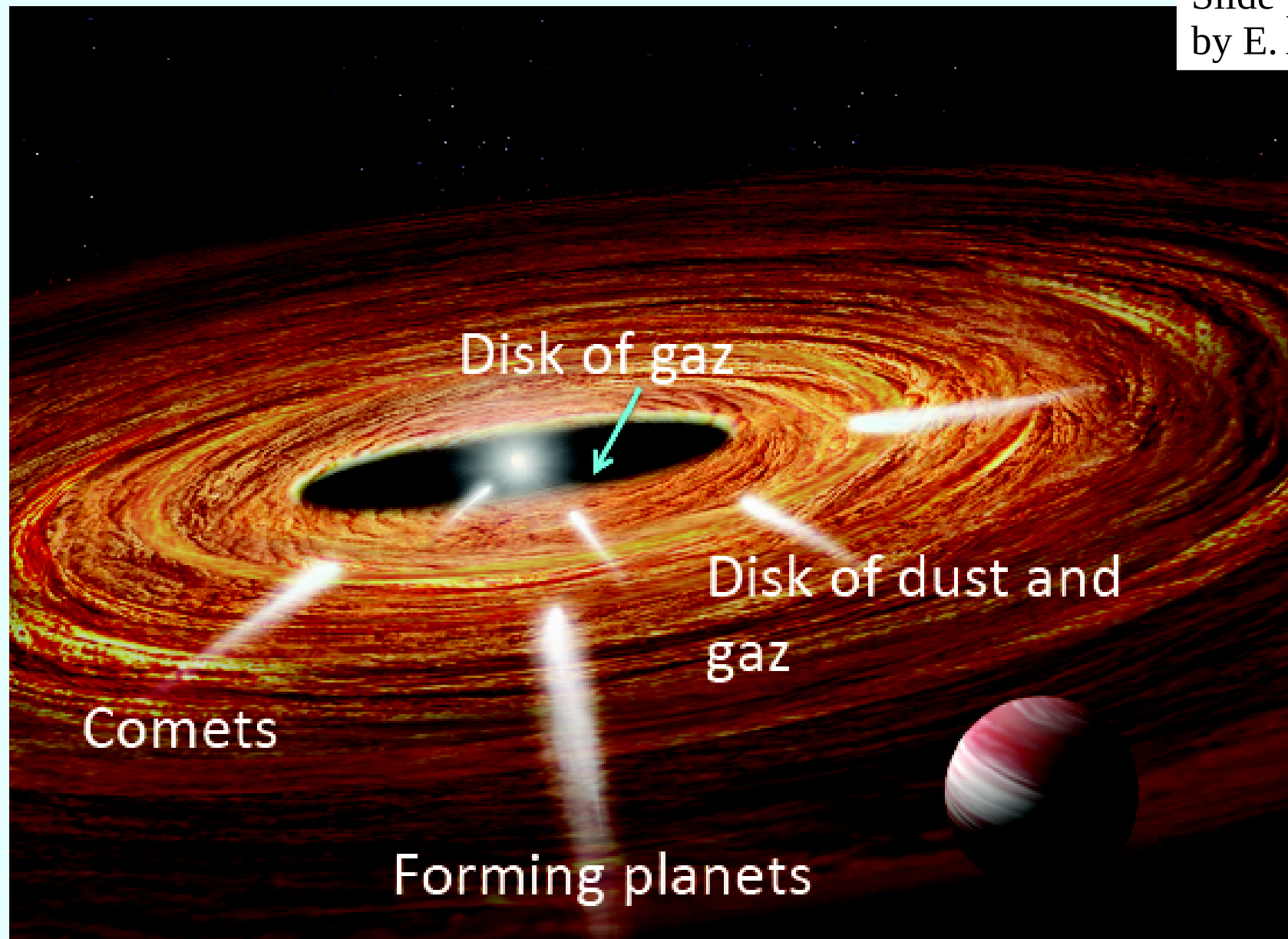
→ complete up to  
 $V \sim 11$

# Herbig Ae/Be Stars

Slide provided  
by E. Alecian



Artist impression (NAOJ)



Disk of gaz

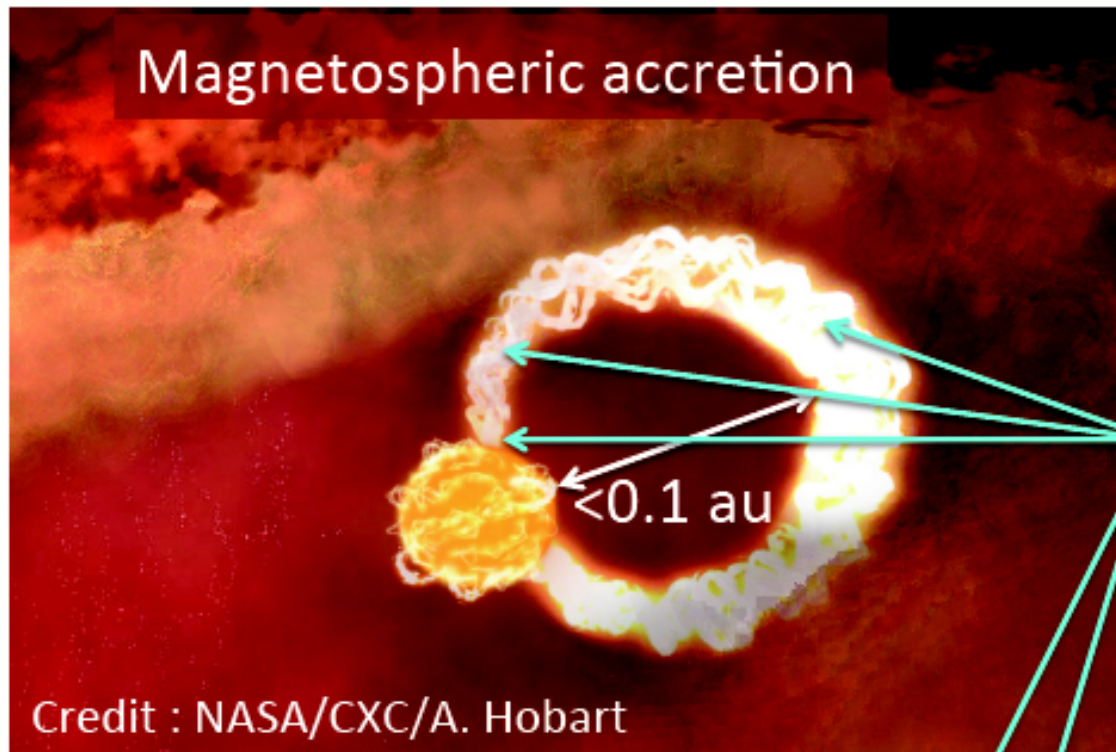
Disk of dust and  
gaz

Comets

Forming planets

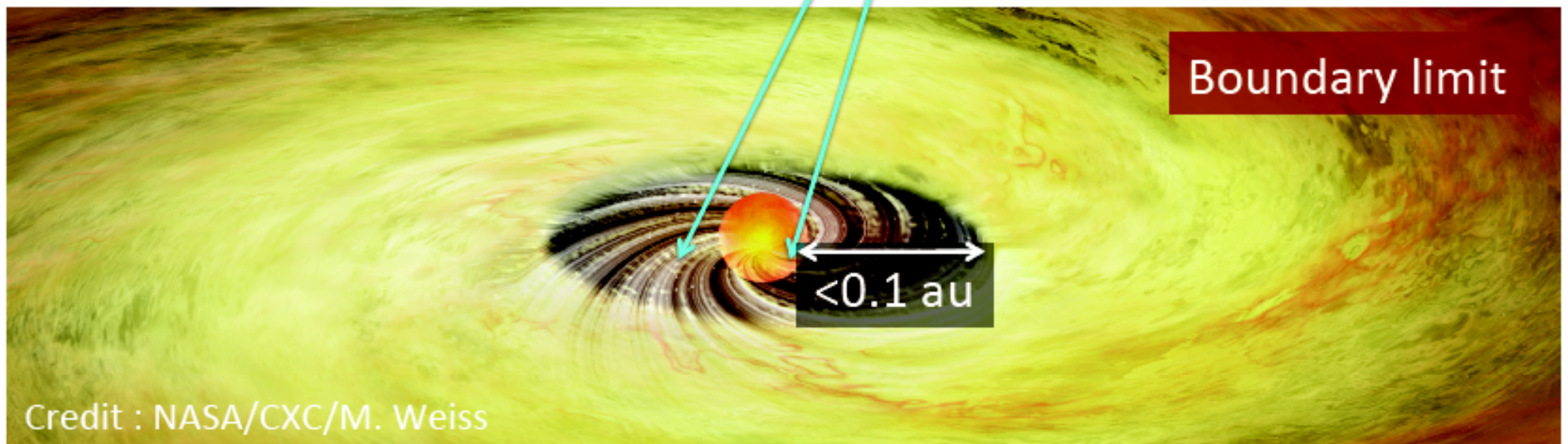
**Artist view**

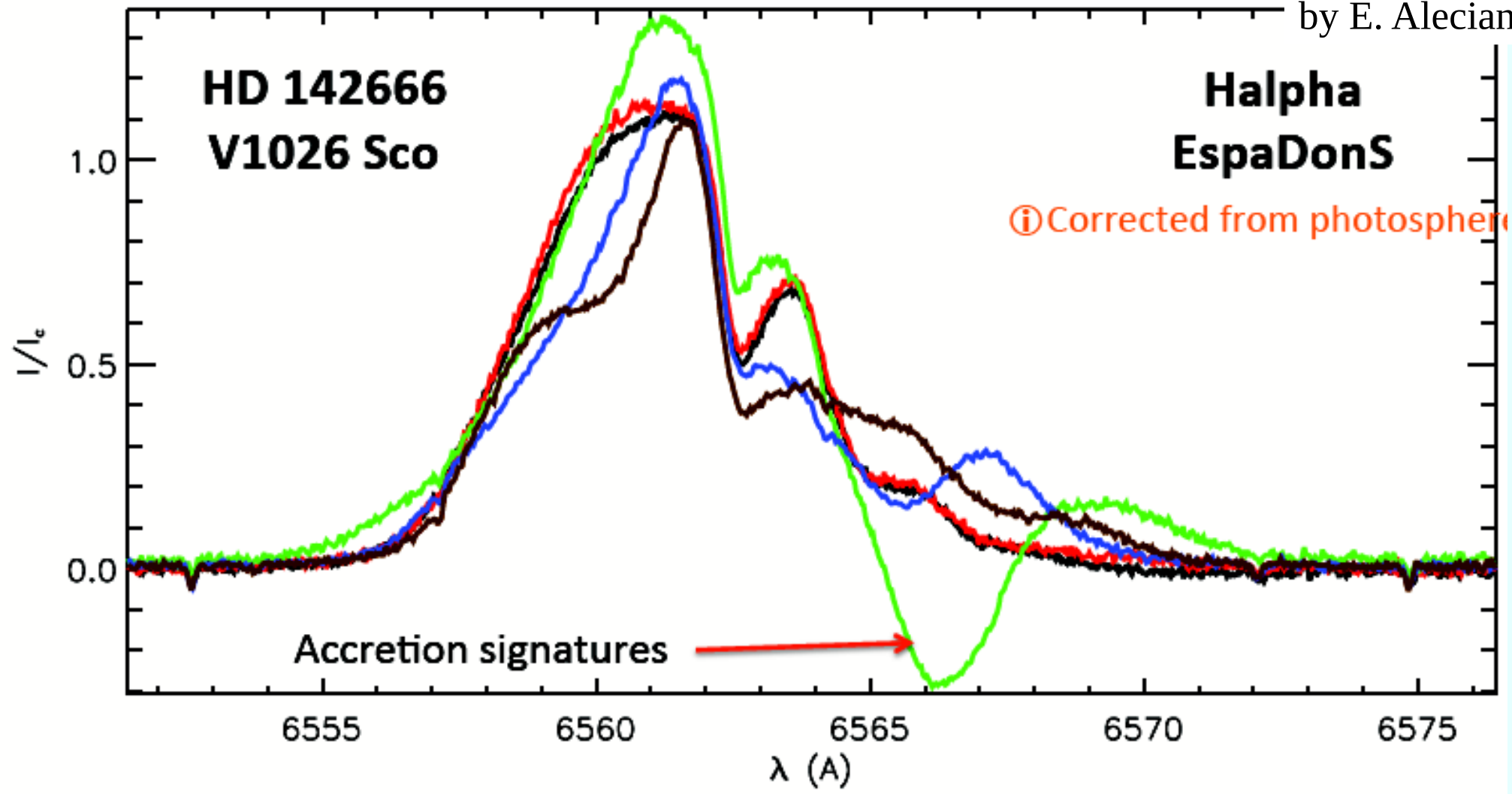
**Credit : NASA/ESA/A. Feild/G. Bacon (STScI)**



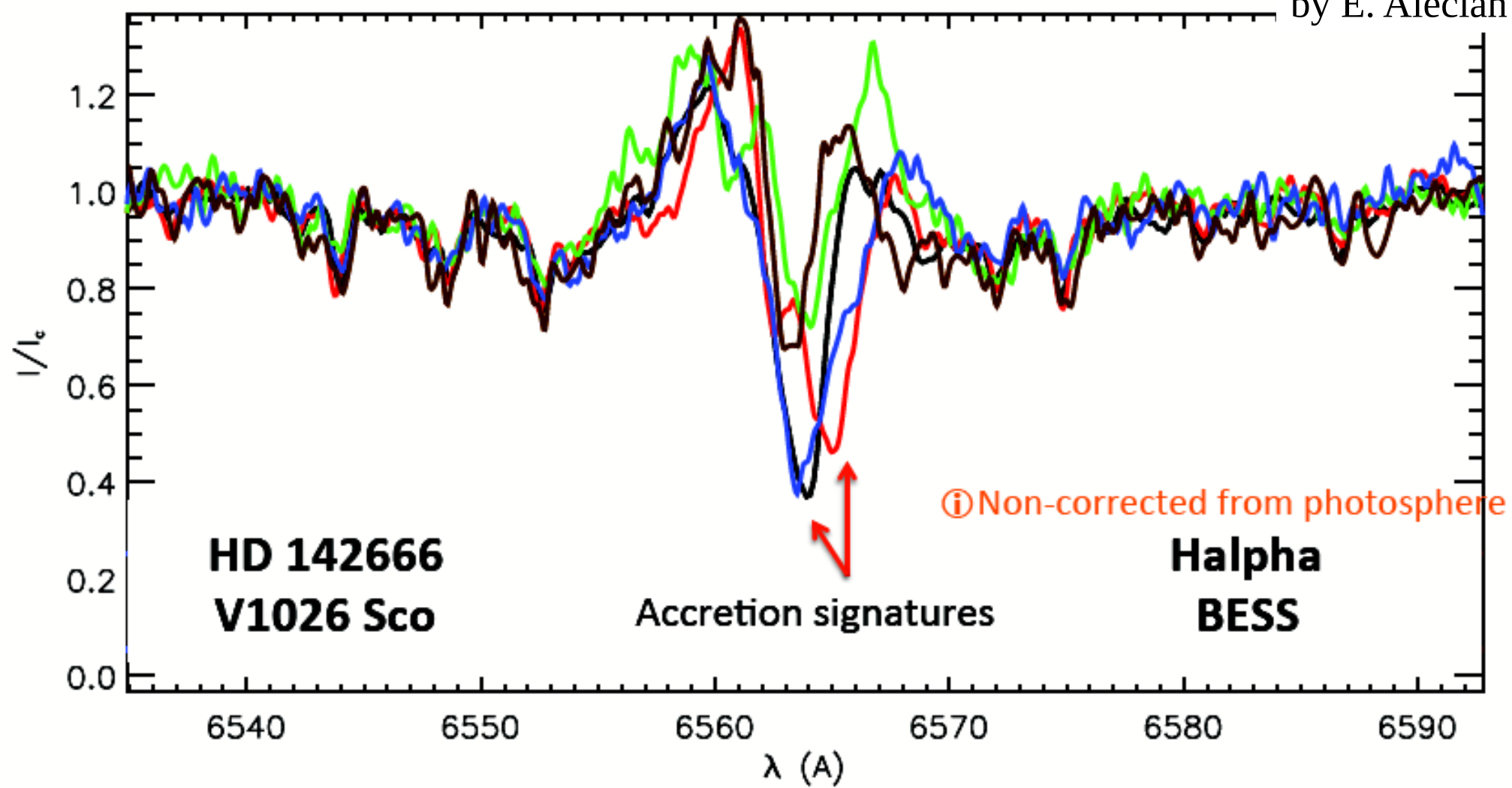
#### Internal region

- ⇒ Heating
- ⇒ UV, visible emission
- ⇒ Continuum, lines





- 21/05
- 21/05 +1h
- 22/05
- 23/05
- 24/05



- 24/05/17
- 21/06/15
- 14/06/13
- 06/06/16
- 30/06/14

# Herbig stars in and with BESS

- 64 stars in total
  - 16 with  $4 < V < 8$  mag
    - ⇒ Are not necessary the most interesting ones
  - 14 with  $8 < V < 9$  mag
- What are we looking for?
  - Stars with accretion signatures
  - Temporal variability at small scales (< a few days)
- When accretion signatures is detected:
  - Organise an observing campaign



# BeSS 2017: adding Be stars?

- Newly discovered classical Be stars (only some added since 2007)
- Newly discovered Herbig Be stars

*2010A&A...517A..67C - Astron. Astrophys., 517, A67-67 (2010) - 07.09.10 18.10.17 July(I) 2010*

## New Herbig Ae/Be stars confirmed via high-resolution optical spectroscopy.

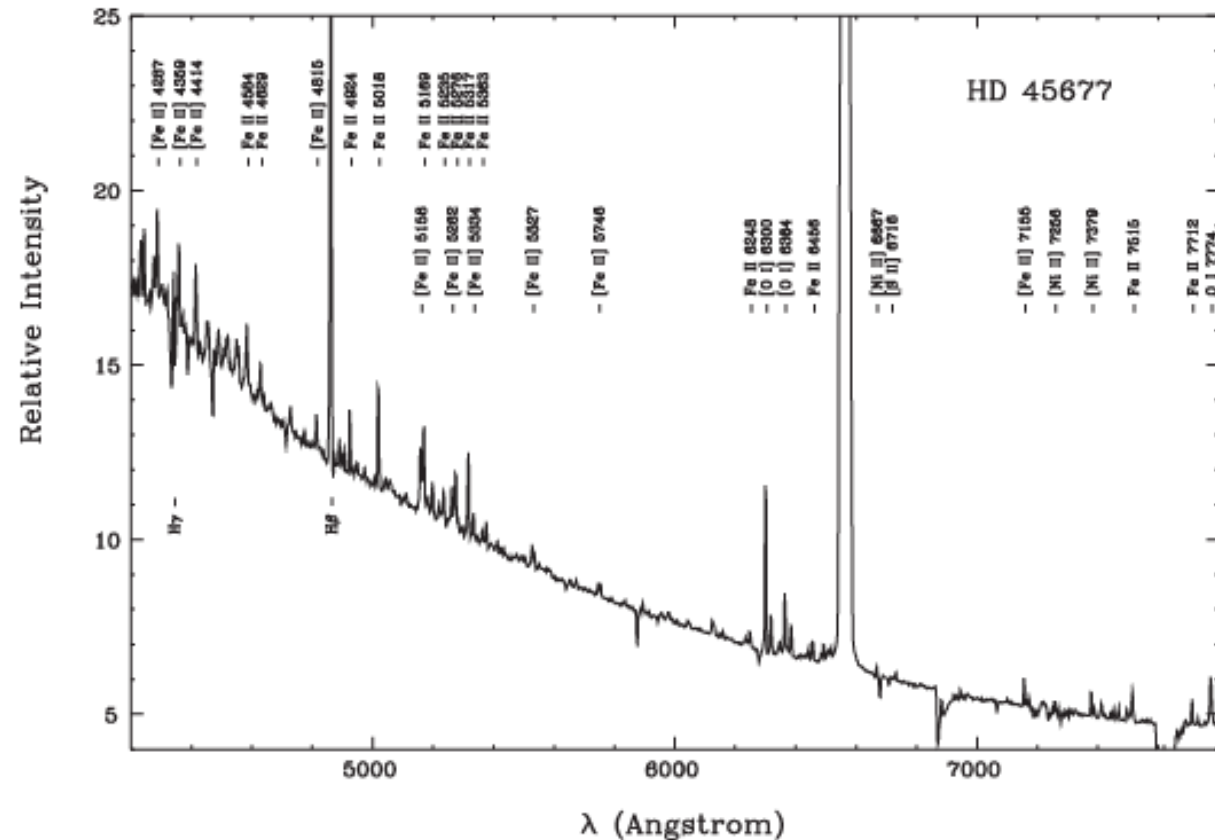
*CARMONA A.; VAN DEN ANCKER M.E.; AUDARD M.; HENNING T.; SETIAWAN J.; RODMANN J.*

**Abstract (from CDS):** We present FEROS high-resolution ( $R \sim 45000$ ) optical spectroscopy of 34 Herbig Ae/Be star candidates with previously unknown or poorly constrained spectral types. Within the sample, 16 sources are positionally coincident with nearby ( $d < 250$  pc) star-forming regions (SFRs). All the candidates have reported infrared excess. We determine the spectral type and luminosity class of the sources, derive their radial and projected rotational velocities, and constrain their distances employing spectroscopic parallaxes and photometry from the literature. We confirm 13 sources as Herbig Ae/Be stars and find one classical T Tauri star. Three sources are emission line early-type giants (B, A, and F stars with luminosity class III) and may be Herbig Ae/Be stars. One source is a main-sequence A-type star. Fourteen sources are post-main-sequence giant and supergiant stars (7 with H $\alpha$  emission and 7 without). Two sources are extreme emission-line stars and no accurate spectral classification was possible because of strong veiling. Most of the sources appear to be background stars at distances over 700 pc. We show that high-resolution optical spectroscopy is a crucial tool for distinguishing young stars (in particular Herbig Be stars) from post-main sequence stars in samples taken from emission-line star catalogs based on low-resolution spectroscopy. Within the sample, three young stars (CD-38 4380, Hen 3-1145, and HD 145718) and one early-type luminosity class III giant with emission lines (Hen 3-416) are at distances closer than 300 pc and are positionally coincident with a nearby SFR. These 4 sources are likely to be nearby young stars and are interesting for follow-up observations at high-angular resolution. Furthermore, seven confirmed Herbig Ae/Be stars at  $d > 700$  pc (Hen 2-80, Hen 3-1121 N&S, HD 313571, MWC 953, WRAY 15-1435, and Th 17-35) are inside or close ( $< 5'$ ) to regions with extended 8  $\mu$ m continuum emission and in their 20' vicinity have astronomical sources characteristic of SFRs (e.g., HII regions, molecular clouds, dark nebulae, masers, young stellar-objects). These 7 sources are likely to be members of SFRs.

# BeSS 2017: adding Be stars?

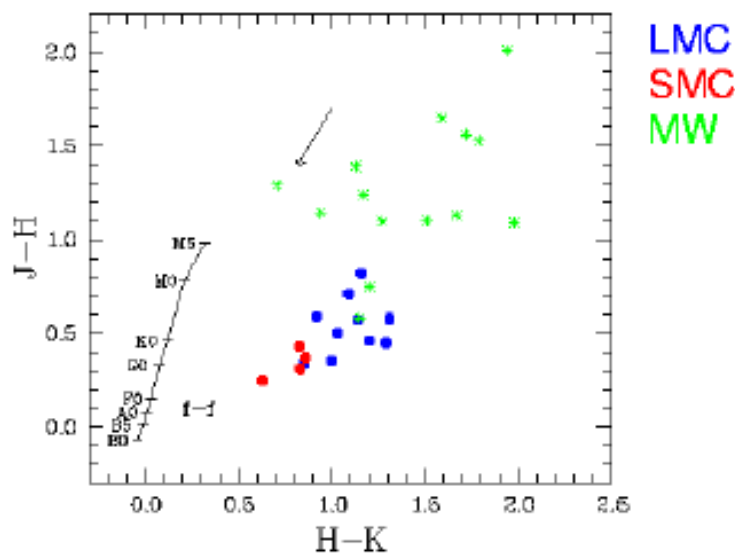
- Newly discovered classical Be stars (only some added since 2007)
- Newly discovered Herbig Be stars
- Magnetic Be stars (~60)
- Wind Oe stars (probably some already in BeSS)
- B[e] stars and B[e] supergiants (only a few tens known)

- Optical spectra indicating a B-type star.
- Strong Balmer emission lines
- Low-excitation permitted emission lines, predominantly of singly ionized metals, in particular of Fe II



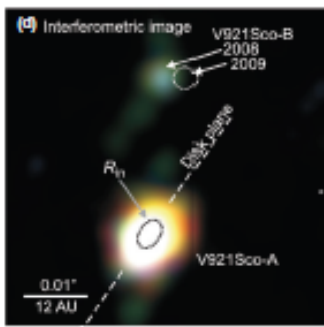
- Appearance of forbidden emission lines of [O I] and [Fe II] in optical spectrum
- Strong near/mid IR excess due to hot ( $T \approx 1000$  K) circumstellar dust

## Near-IR excess of B[e] stars

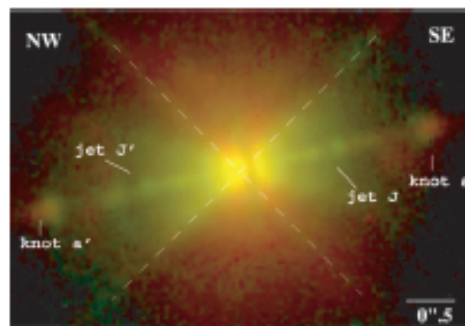


Criteria apply to stars in **different evolutionary phases !**

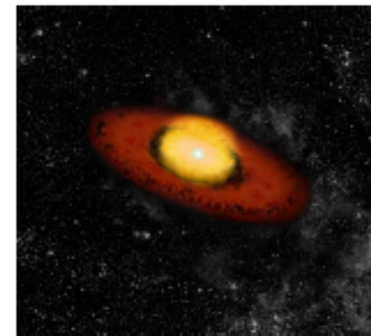
	Herbig B[e] (pre-main sequence)	compact PNe (evolved med-mass)	B[e] supergiant (evolved high-mass)	symbiotic stars (binaries)
B-type spectrum	B-type PMS star	obscured O-type white dwarf	B-type supergiant	obscured hot compact obj.
forbidden emission lines	reflection nebula	planetary nebula	high-density non-spherical wind	associated nebula
dust and Balmer lines	PMS <b>accretion disk</b>	high-density <b>dusty disk</b>	high-density <b>(outflowing ?) disk</b>	<b>accretion disk</b>



V921 Sco-A  
Herbig B[e]



Hen 2-90  
cPNe



Artist's view  
supergiant

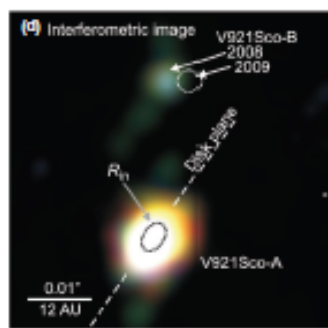
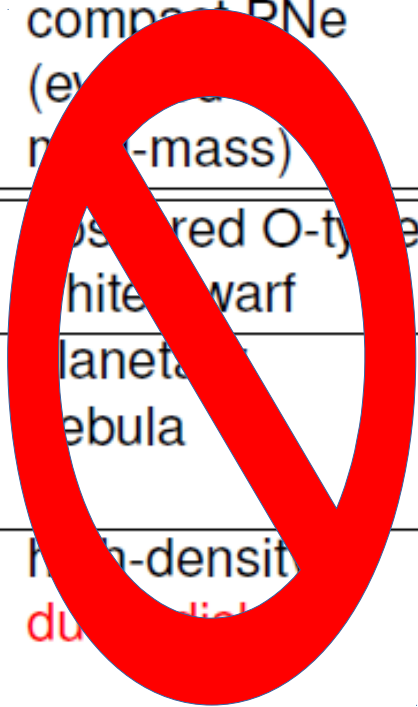


Ant nebula  
symbiotic

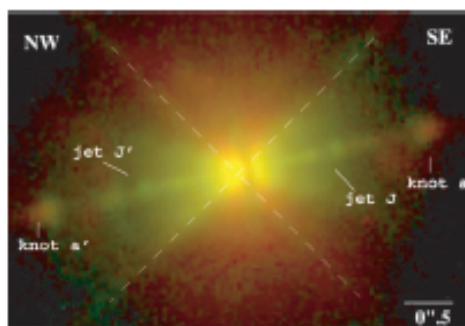
# The Zoo of B[e] Stars

Criteria apply to stars in **different evolutionary phases !**

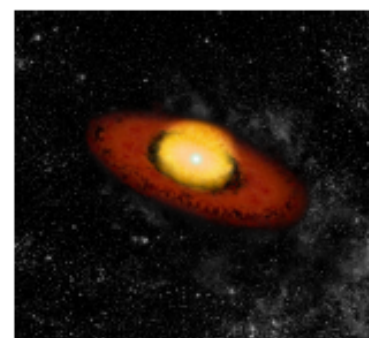
	Herbig B[e] (pre-main sequence)	compact PNe (evolved high-mass)	B[e] supergiant (evolved high-mass)	symbiotic stars (binaries)
B-type spectrum	B-type PMS star	obscured O-type white dwarf	B-type supergiant	obscured hot compact obj.
forbidden emission lines	reflection nebula	planetary nebula	high-density non-spherical wind	associated nebula
dust and Balmer lines	PMS accretion disk	high-density dust shell	high-density (outflowing ?) disk	accretion disk



V921 Sco-A  
Herbig B[e]



Hen 2-90  
cPNe



Artist's view  
supergiant



Ant nebula  
symbiotic

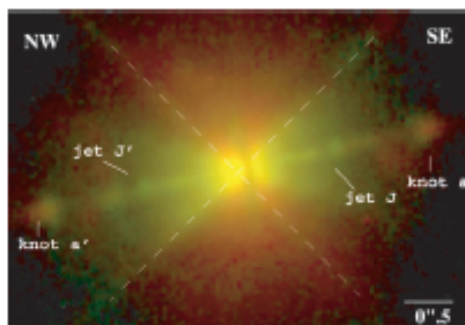
# The Zoo of B[e] Stars

Criteria apply to stars in **different evolutionary phases !**

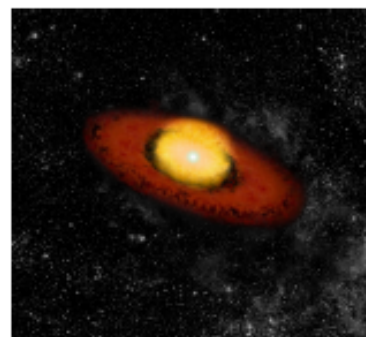
	Herbig B[e] (pre-main sequence)	compact PNe (evolved low-mass)	B[e] supergiant (evolved high-mass)	symbiotic star (binary)
B-type spectrum	B-type PMS star	observed O-type white dwarf	B-type supergiant	observed hot compact obj.
forbidden emission lines	reflection nebula	planetary nebula	high-density non-spherical wind	associated nebula
dust and Balmer lines	PMS accretion disk	high-density dust shell	high-density (outflowing ?) disk	accretion disk



V921 Sco-A  
Herbig B[e]



Hen 2-90  
cPNe



Artist's view  
supergiant



Ant nebula  
symbiotic

- Our research focuses on the evolution of massive stars
- B[e] Supergiants are currently not predicted by stellar evolution models
- With their release of huge amounts of energy and chemically processed material into their environments **B[e] Supergiants play a crucial role** for the evolution of their host galaxies

## Main research goals:

- What is the **evolutionary state** of B[e] Supergiants and what is their connection to other phases in the evolution of massive stars?
- Which **physical mechanism** causes the formation of **circumstellar dusty disks** ?
- What are the **physical properties** (structure and dynamics, chemical composition) of these disks ?
- Which objects are in binaries and which role plays binarity for the B[e] phenomenon

## Major tool:

- Regular spectroscopic observations are vital to achieve our science goals
- For such observation campaigns the help of amateur astronomers is crucial, as the needed data cannot be obtained by any other means

## List of suggested B[e] stars for the BeSS database

Object	V [mag]
CI Cam	11.70
HD 62623	3.98
MWC 56	11.65
MWC 137	11.95
MWC 300	10.50
MWC 314	9.89
MWC 342	10.60
MWC 349	13.15
MWC 419	10.64
MWC 728	9.80
MWC 1080	11.85



# B[e] stars

B[e] stars are faint, but amateur observations are feasible:

- $R \geq 10000$
- $SNR \geq 30$  (preferably  $SNR=100$ )
- Echelle spectra if possible, otherwise concentrate on:

$H\alpha$

O[I] at 6300 A

Ca[II] at 7293/7324 A

region of Ca triplet at [8450-8700] A

# BeSS 2017: adding Be stars?

- Newly discovered classical Be stars (only some added since 2007)
- Newly discovered Herbig Be stars
  
- Magnetic Be stars (~60)
- Wind Oe stars (probably some already in BeSS)
- B[e] stars and B[e] supergiants (only few known)
  
- Unclassified Be stars?
- Candidate Be stars? (mostly from surveys)

# BeSS 2017: adding Be candidates?

For example:

**2008A&A...478..659S** - *Astron. Astrophys.*, 478, 659-665 (2008) - 22.01.08 23.05.08 February(I) 2008

A catalogue of Be stars in the direction of the Galactic Bulge.

*SABOGAL B.E.; MENNICKENT R.E.; PIETRZYNSKI G.; GARCIA J.A.; GIEREN W.; KOLACZKOWSKI Z.*

**Abstract (from [CDS](#)):** Detailed studies of Be stars in environments with different metallicities like the Magellanic Clouds or the Galactic Bulge are necessary to understand the formation and evolution mechanisms of the circumstellar disks. However, a detailed study of Be stars in the direction of the bulge of our own galaxy has not been performed until now. The aim of this work is to report the first systematic search for Be star candidates in the direction of the Galactic Bulge. We present the full catalogue, give a brief description of the stellar variability seen, and show some light curve examples. We searched for stars matching specific criteria of magnitude, color and variability in the I band. Our search was conducted on the 48 OGLE II fields of the Galactic Bulge. This search has resulted in 29053 Be star candidates, 198 of them showing periodic light variations. Nearly 1500 stars in this final sample are almost certainly Be stars, providing an ideal sample for spectroscopic multi-object follow-up studies.

- 29053 Be candidates...
- 1500 almost certain Be stars ← include those?
- 198 with periodic variations

# BeSS 2017: adding Be candidates?

Other example:

*2015AJ...149...7C - Astron. J., 149, 7 (2015) - 15.01.15 19.06.17 January 2015 2015-01-01*

High-resolution H-band spectroscopy of Be stars with SDSS-III/APOGEE: I. New Be stars, line identifications, and line profiles.

*CHOJNOWSKI S.D.; WHELAN D.G.; WISNIEWSKI J.P.; MAJEWSKI S.R.; HALL M.; SHETRONE M.; BEATON R.; BURTON A.; DAMKE G.; EIKENBERRY S.; HASSELQUIST S.; HOLTZMAN J.A.; MESZAROS S.; NIDEVER D.; SCHNEIDER D.P.; WILSON J.; ZASOWSKI G.; BIZYAEV D.; BREWINGTON H.; BRINKMANN J.; EBELKE G.; FRINCHABOY P.M.; KINEMUCHI K.; MALANUSHENKO E.; MALANUSHENKO V.; MARCHANTE M.; ORAVETZ D.; PAN K.; SIMMONS A.*

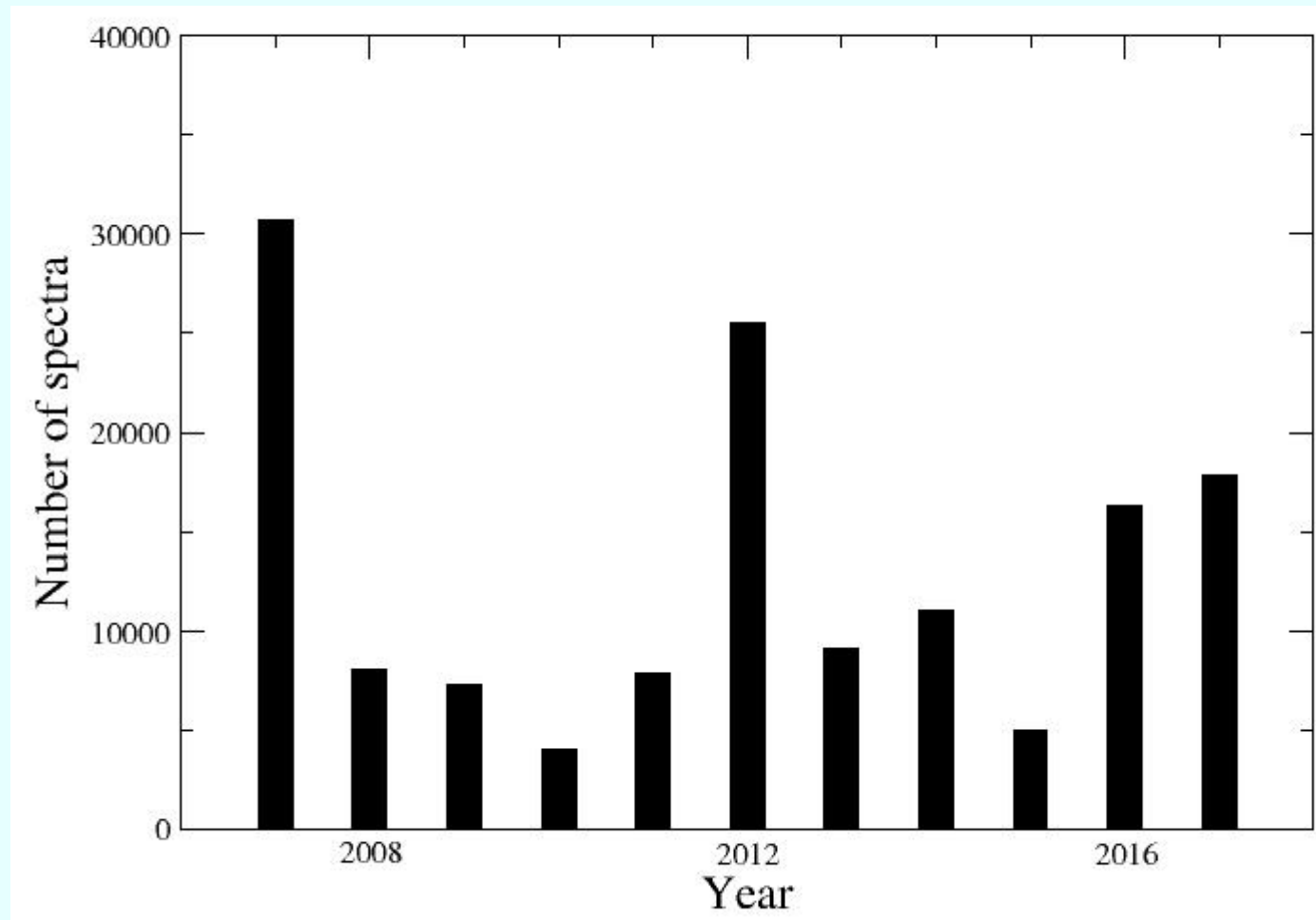
**Abstract (from CDS):** The Apache Point Observatory Galactic Evolution Experiment (APOGEE) has amassed the largest ever collection of multi-epoch, high-resolution ( $R: (22,500)$ , H-band spectra for B-type emission line (Be) stars. These stars were targeted by APOGEE as telluric standard stars and subsequently identified via visual inspection as Be stars based on H i Brackett series emission or shell absorption in addition to otherwise smooth continua and occasionally non-hydrogen emission features. The 128/238 APOGEE Be stars for which emission had never previously been reported serve to increase the total number of known Be stars by : (6%. Because the H band is relatively unexplored compared to other wavelength regimes, we focus here on identification of the H-band lines and analysis of the emission peak velocity separations ( $\Delta v_p$ ) and emission peak intensity ratios (V/R) of the usually double-peaked H i and non-hydrogen emission lines. H i Br11 emission is found to preferentially form in the circumstellar disks at an average distance of : (2.2 stellar radii. Increasing  $\Delta v_p$  toward the weaker Br12-Br20 lines suggests these lines are formed interior to Br11. By contrast, the observed IR Fe ii emission lines present evidence of having significantly larger formation radii; distinctive phase lags between IR Fe ii and H i Brackett emission lines further supports that these species arise from different radii in Be disks. Several emission lines have been identified for the first time including C i 16895, a prominent feature in the spectra for almost a fifth of the sample and, as inferred from relatively large  $\Delta v_p$  compared to the Br11-Br20, a tracer of the inner regions of Be disks. Emission lines at 15760 Å and 16781 Å remain unidentified, but usually appear along with and always have similar line profile morphology to Fe ii 16878. Unlike the typical metallic lines observed for Be stars in the optical, the H-band metallic lines, such as Fe ii 16878, never exhibit any evidence of shell absorption, even when the H i lines are clearly shell-dominated. The first known example of a quasi-triple-peaked Br11 line profile is reported for HD 253659, one of several stars exhibiting intra- and/or extra-species V/R and radial velocity variation within individual spectra. Br11 profiles are presented for all discussed stars, as are full APOGEE spectra for a portion of the sample.

- 128 new (classical?) Be stars → at least 2 are magnetic Be stars...

# BeSS: Be Stars and their Spectra

## Spectra of Be stars

- 139599 spectra of classical Be stars
- 1910 spectra of Herbig Be stars
- 834 spectra of stars which are either classical Be or Herbig Be



# BeSS 2017: adding+validating archival data

## Musicos data:

- 27400 spectra already visible in BeSS
- 47200 spectra still pending validation...

Observer	Instrument	Number of spectra	Last change	Age
<a href="#">tpetit</a>	fs60alpy600600tmmatik16hr	1	18/10/2017 14:41:15	(4 days)
<a href="#">Marco Leonardi</a>	c925l2001800atik314l	2	20/10/2017 21:28:56	(6 days)
<a href="#">kbazan</a>	c11lhires2400atk314	1	22/10/2017 21:50:55	(0 days)
<a href="#">Olivier GARDE</a>	rc400astrosibeshelatik460ex	184	18/10/2017 14:30:49	(6 days)
<a href="#">Patrik Fosanelli</a>	omc300lhires32400atik460ex	1	20/10/2017 18:10:14	(2 days)
<a href="#">Carl Sawicki</a>	51mf10casslhiresiii2400atik314l	4	22/10/2017 17:40:53	(1 days)
<a href="#">Jean-Noël TERRY</a>	c14alpy600atik314	3	21/10/2017 19:17:02	(1 days)
<a href="#">Jean-Noël TERRY</a>	c11lhires129sbigst8300	7	17/10/2017 20:05:53	(6 days)
<a href="#">Olivier Thizy</a>	eshelatik460	759	21/10/2017 08:45:28	(6 days)
<a href="#">Franck HOUPERT</a>	c11lhiresiii1942400t35qsi516s	7	17/10/2017 23:08:43	(7 days)
<a href="#">Keith Graham</a>	lx20012lhires240035ust8xme	7	22/10/2017 21:02:59	(7 days)
<a href="#">Christian Buil</a>	rc10eshel2asi1600mm	84	22/10/2017 02:33:31	(0 days)
<a href="#">Jean-Jacques Broussat</a>	c9lhires32400atik314l	1	19/10/2017 18:10:58	(3 days)
<a href="#">etienne bertrand</a>	c8f2000lhiresiii240035uatik314l	7	21/10/2017 10:33:17	(1 days)
<a href="#">Vincent Lecocq</a>	fsq106edalpy600atik414ex	5	18/10/2017 22:04:09	(7 days)
<a href="#">Coralie Neiner</a>	musicospolartbl__menkhib	5600	16/02/2014 22:28:27	(1344 days)
<a href="#">Coralie Neiner</a>	musicospolartbl__42and	2280	26/01/2014 23:03:35	(1364 days)
<a href="#">Coralie Neiner</a>	musicospolartbl__betcep	23280	07/03/2016 22:44:39	(606 days)
<a href="#">Coralie Neiner</a>	musicospolartbl__omeori	6720	31/01/2014 14:53:39	(1360 days)
<a href="#">Coralie Neiner</a>	musicospolartbl__nugem	1080	14/12/2012 19:27:53	(1773 days)
<a href="#">Coralie Neiner</a>	musicospolartbl__epscas	5800	31/01/2014 17:28:07	(1360 days)
<a href="#">Coralie Neiner</a>	musicospolartbl__hr2855	1	28/04/2013 22:10:28	(1638 days)
<a href="#">Coralie Neiner</a>	musicospolartbl	480	16/10/2017 15:07:46	(32 days)
<a href="#">Coralie Neiner</a>	musicospolartbl__gamcas	1960	30/01/2014 23:03:36	(1638 days)
<a href="#">Terry Bohlsen</a>	lhiresc1135umslit2400lmm	1	20/10/2017 13:11:50	(2 days)
<a href="#">Christian KREIDER</a>	cdk17lhires240035460ex	2	15/10/2017 15:37:49	(7 days)

# BeSS 2017: adding+validating archival data

## Musicos data:

- 27400 spectra already visible in BeSS
- 47200 spectra still pending validation...

## Adding other archival data:

- Be stars observed since 2007 → ESO, OHP,...
- Narval and ESPaDOnS data → Coralie
- FEROS, HEROS,... data → Rivi
- Archives of amateurs? Christian?

# BeSS 2017: adding+validating archival data

## Musicos data:

- 27400 spectra already visible in BeSS
- 47200 spectra still pending validation...

## Adding other archival data:

- Be stars observed since 2007 → ESO, OHP,...
  - Narval and ESPaDOnS data → Coralie
  - FEROS, HEROS,... data → Rivi
  - Archives of amateurs? Christian?
- 
- and all the spectra of newly inserted Be stars (updates, B[e] stars, magnetic Be stars,...)!



# BeSS 2017: new features

Need for:

- **Redesign** of the webpage!
- Additional search **criteria**?
- Additional interactive **plotting** functions?
- Easier/faster **validation** procedure
- Easier/faster update of **observing period** → update of **ArasBeam**,  
**better outburst statistics and follow-up of outbursts**
- **Analysis tools**?
- **BeSS monthly reports / communication**

# Work for this week

- Update the Be star list
- Validate pending spectra
- Discuss new features
- Draft a new website design
- What about ArasBeam?
- Analysis tools?