A MUSE Adaptive Optics view of the SMC cluster NGC 330

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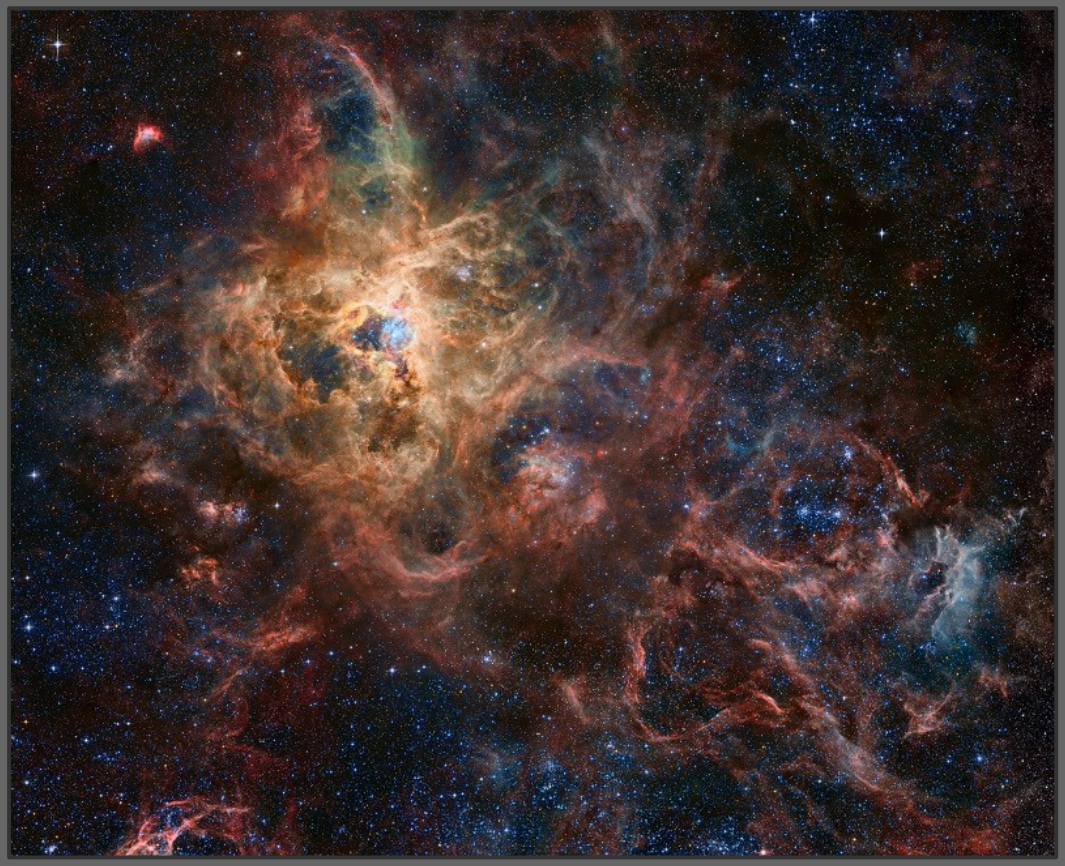
Massive Stars and Supernovae, 5th November 2018, Bariloche Argentina

Introduction & Background

- importance of massive stars
  - strong winds
  - highly energetic radiation
  - SNe & GRBs

  → feedback triggers star formation

- massive stars live in binaries
  - strong impact on standard theory of stellar evolution
  - outcome and end products still poorly understood

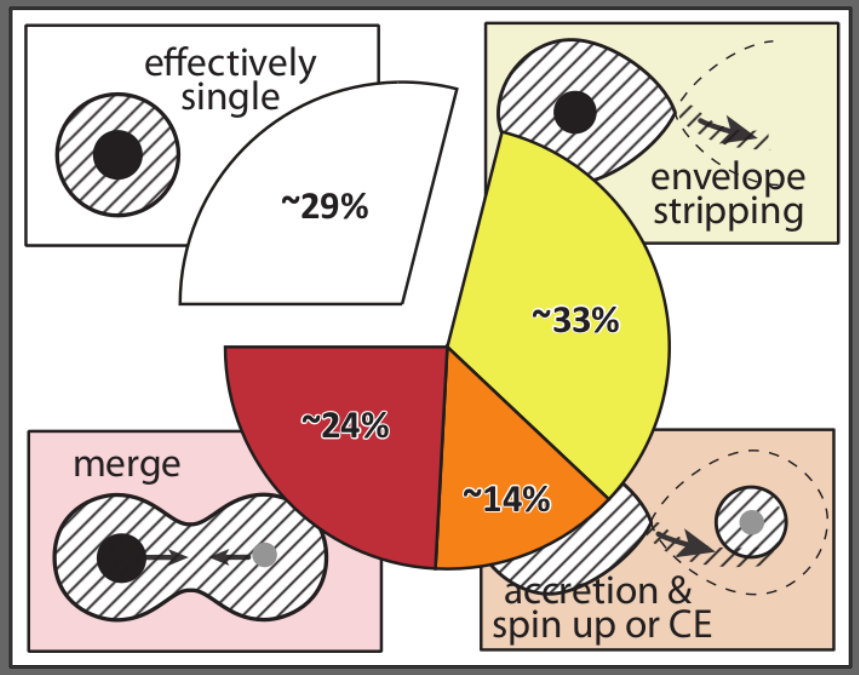


https://apod.nasa.gov/apod/ap160226.html

Abbott et al. 2017, Bromm et al. 2009, De Rossi et al. 2010, Langer 2012, Robertson et al. 2010, Sana et al. 2012, Schneider et al. 2018, …

Goals

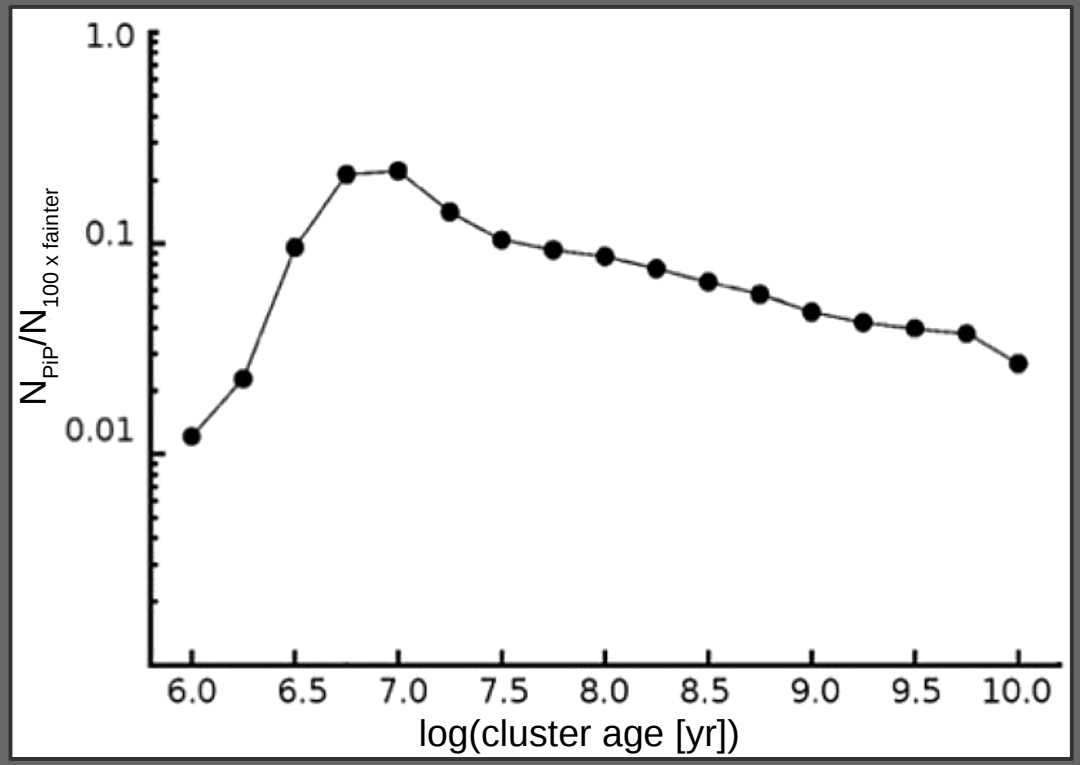
- identify massive (pre-supernova) post-interaction products (PiPs)
- characterize their physical and chemical properties
- better understand the impact of binary interaction on the evolution of massive stars



de Mink et al. 2013; 2014, Sana et al. 2012

Target selection

- PiPs live longer and appear younger than their sibling stars
- number of PiPs in a single-starburst cluster peaks at ~8 – 40 Myrs



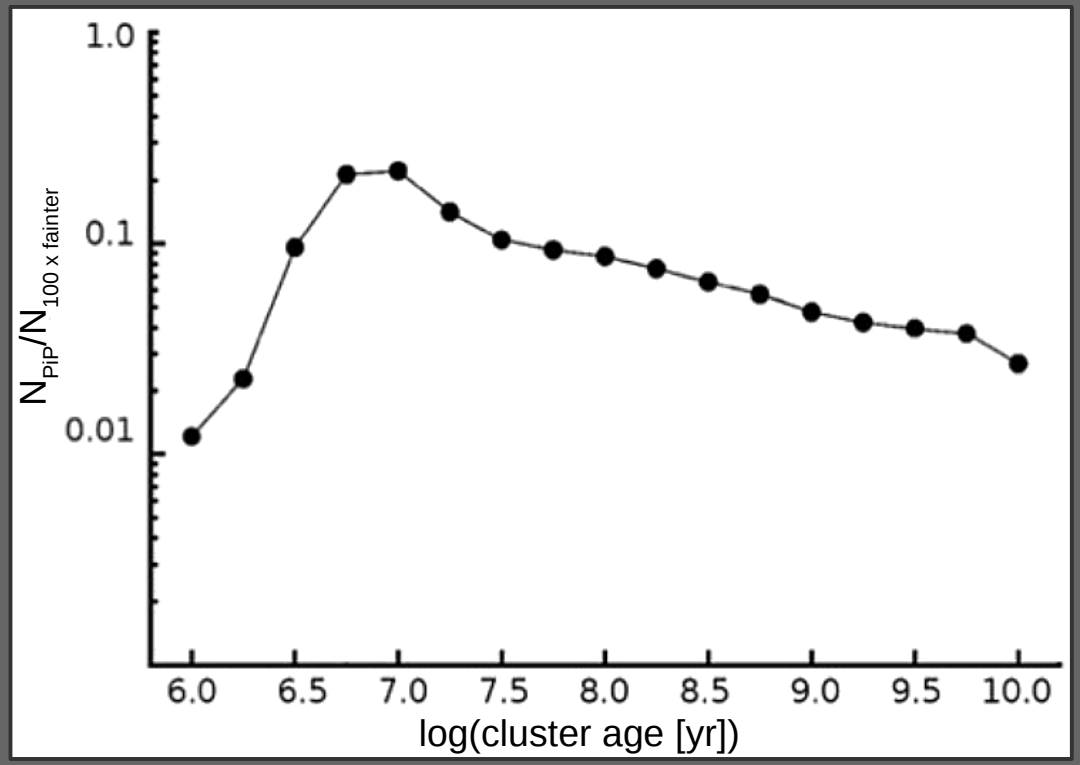
Schneider et al. 2015

Target selection

- PiPs live longer and appear younger than their sibling stars
- number of PiPs in a single-starburst cluster peaks at ~8 – 40 Myrs

→ study NGC 330 (SMC)
age: 30 – 40 Myrs

Milone et al. 2018
Martayan et al. 2007
Sirianni et al. 2002



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Previous studies of NGC 330

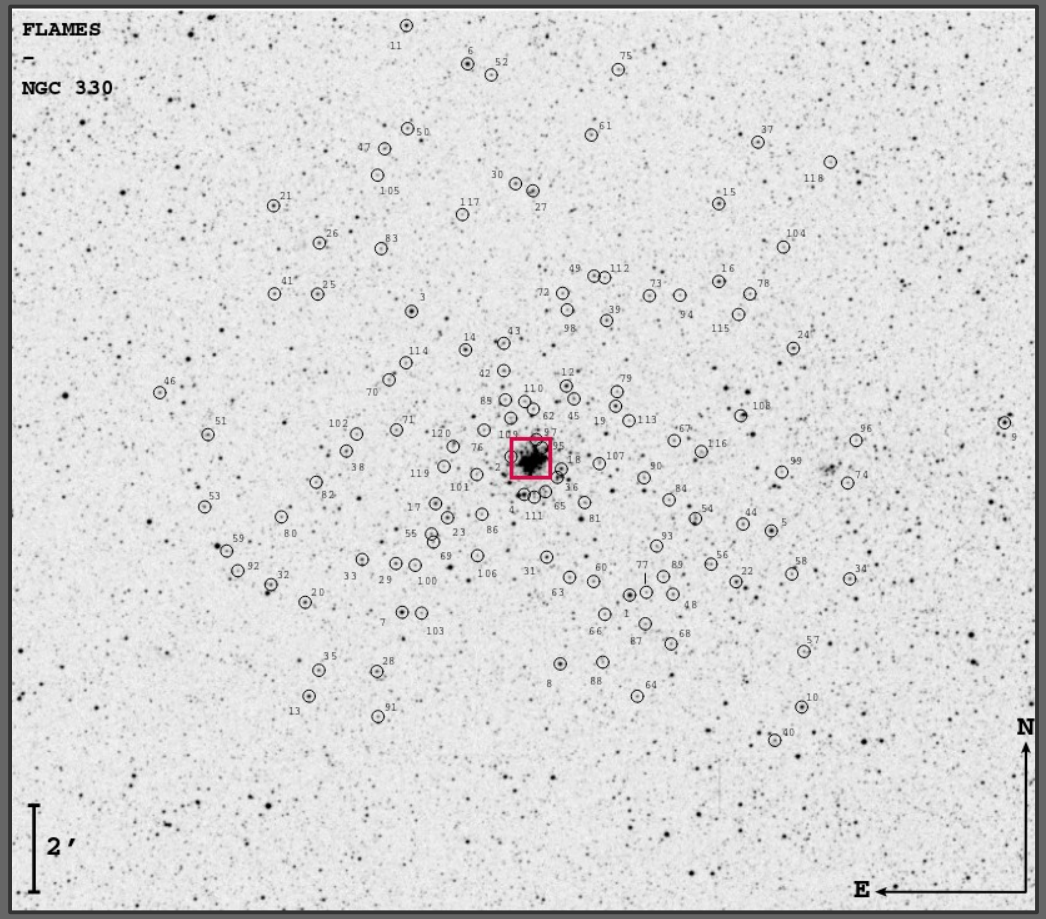
FLAMES spectroscopy of 125 stars

→ 6 O stars (5 ± 2%)

→ high Be star fraction (23 ± 4%)

→ low binary fraction (4 ± 2%)

Evans et al. 2006



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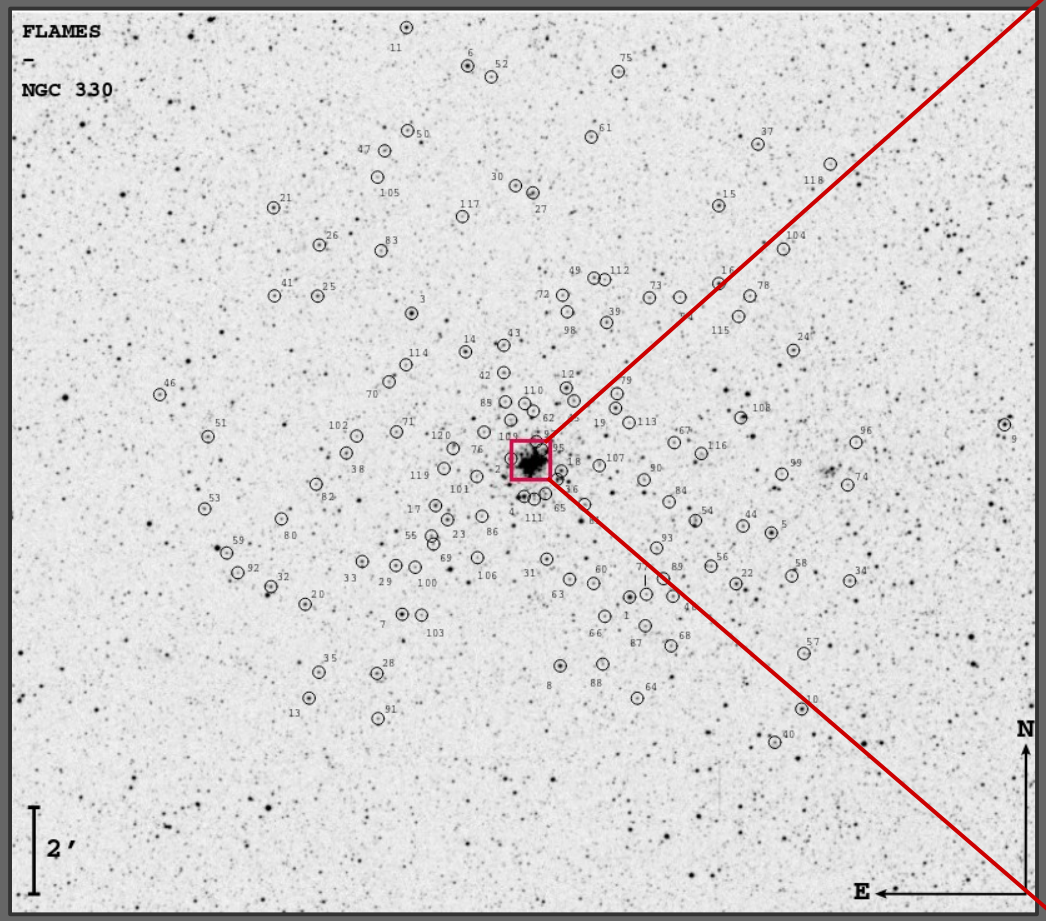
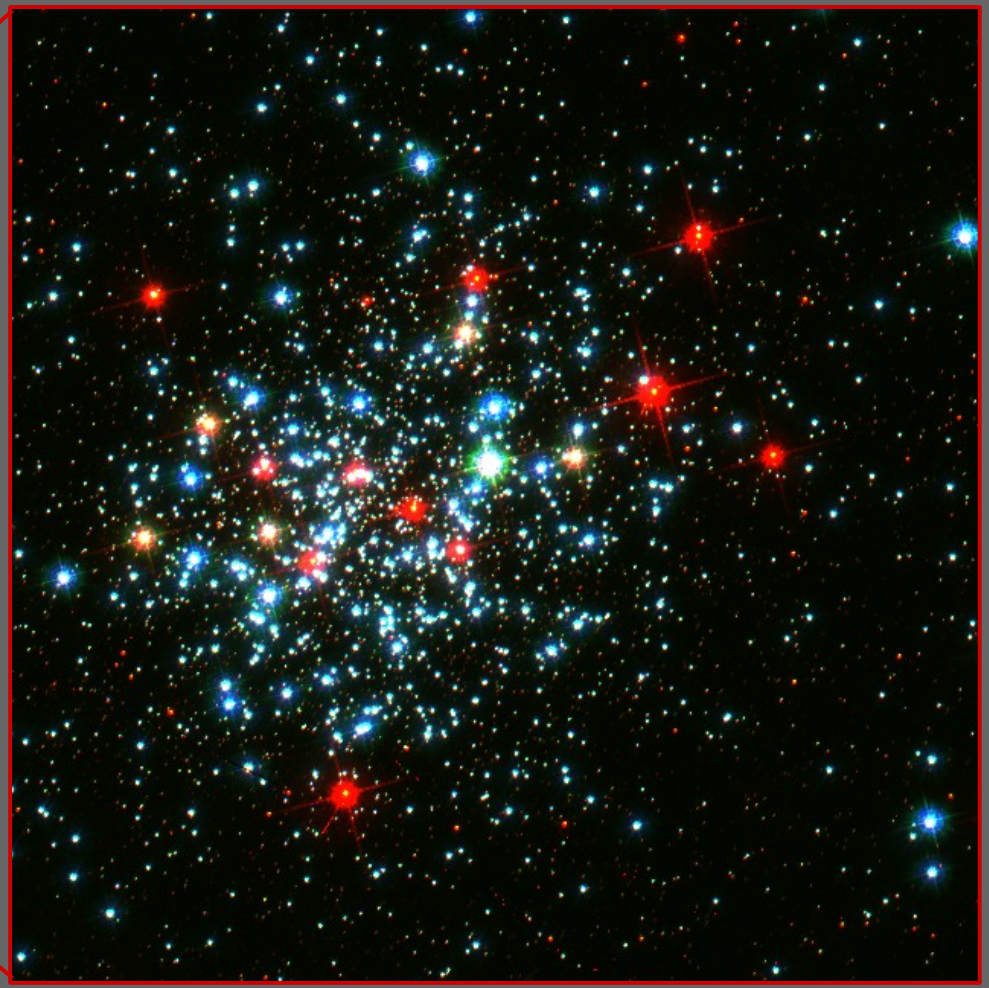


HST photometry

→ 3 broad- and 1 narrow-band filters

→ high fraction of stars with Hα-emission

Milone et al. 2018



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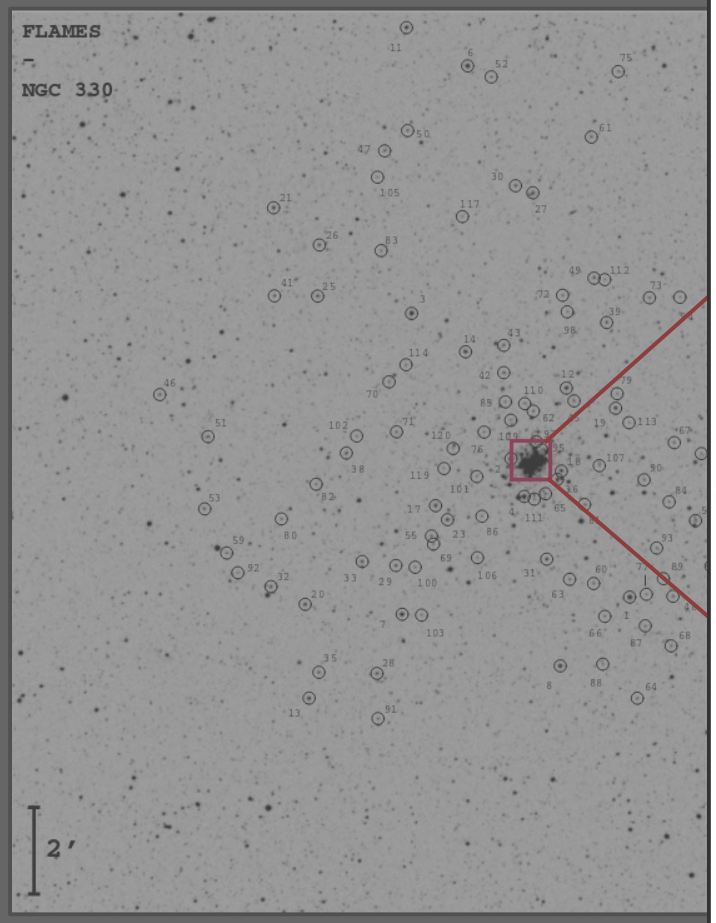
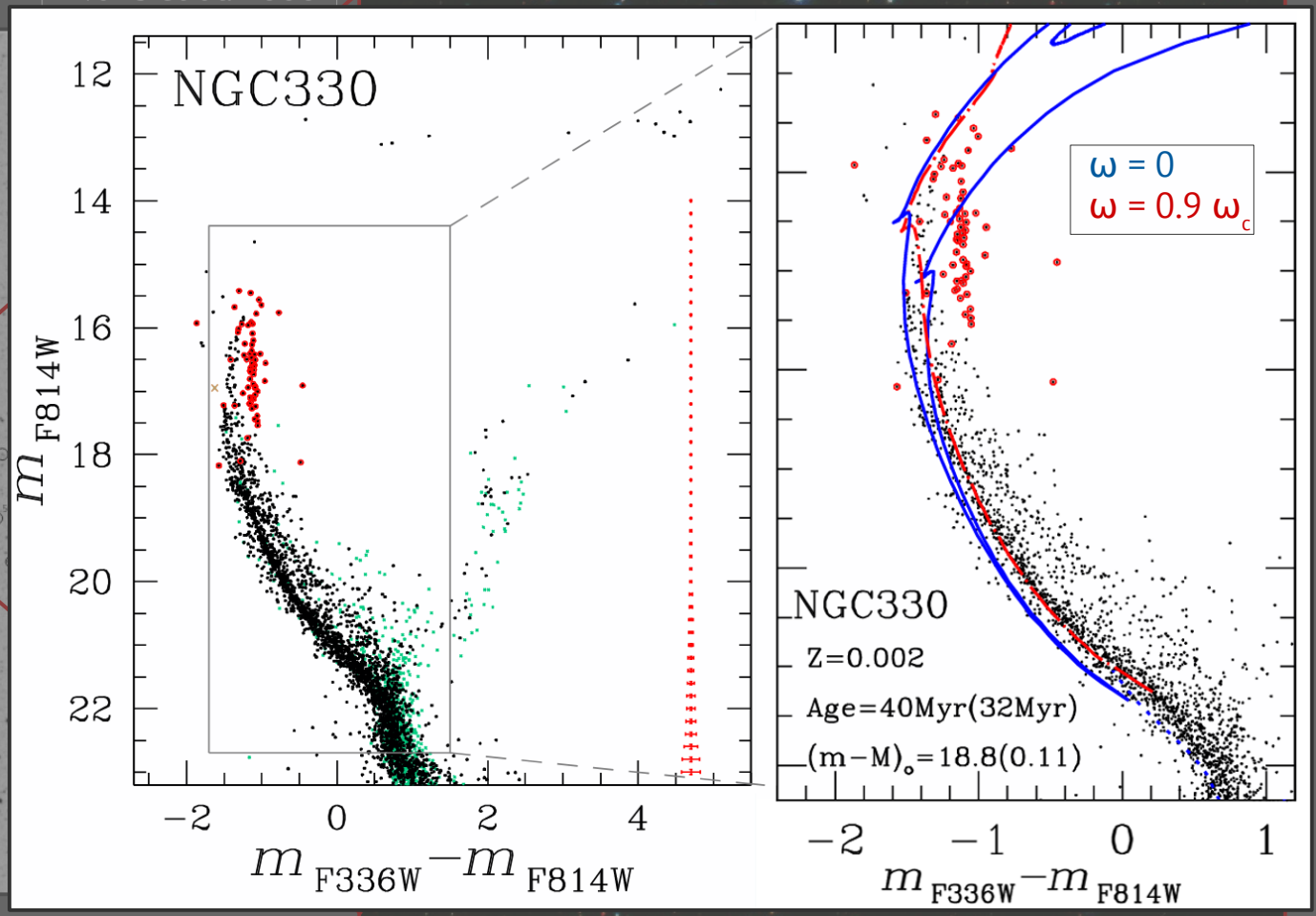




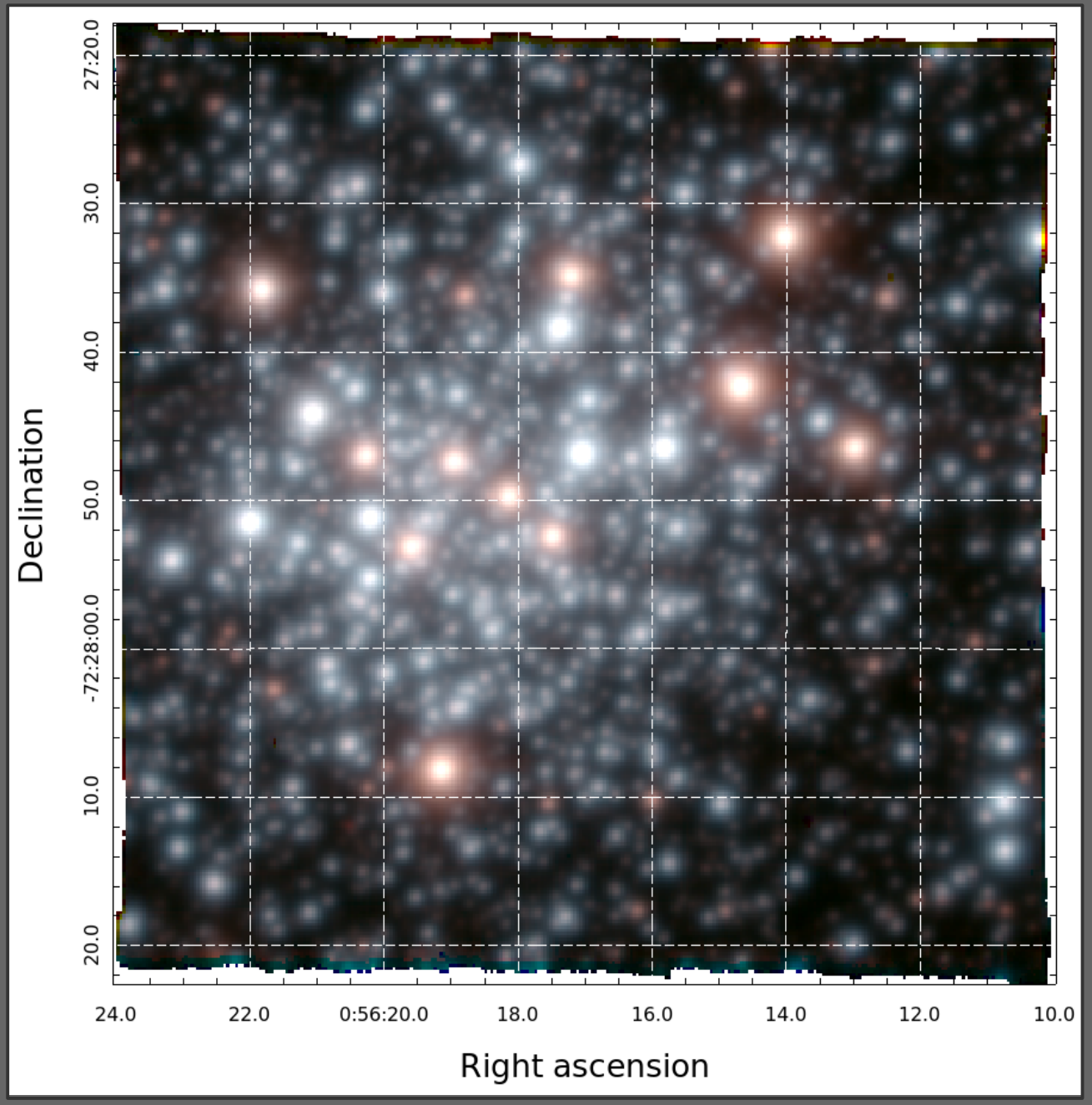
MUSE SV data with new Adaptive Optics

https://www.eso.org/public/teles-instr/paranal-observatory/vlt/vlt-instr/4lgsf/

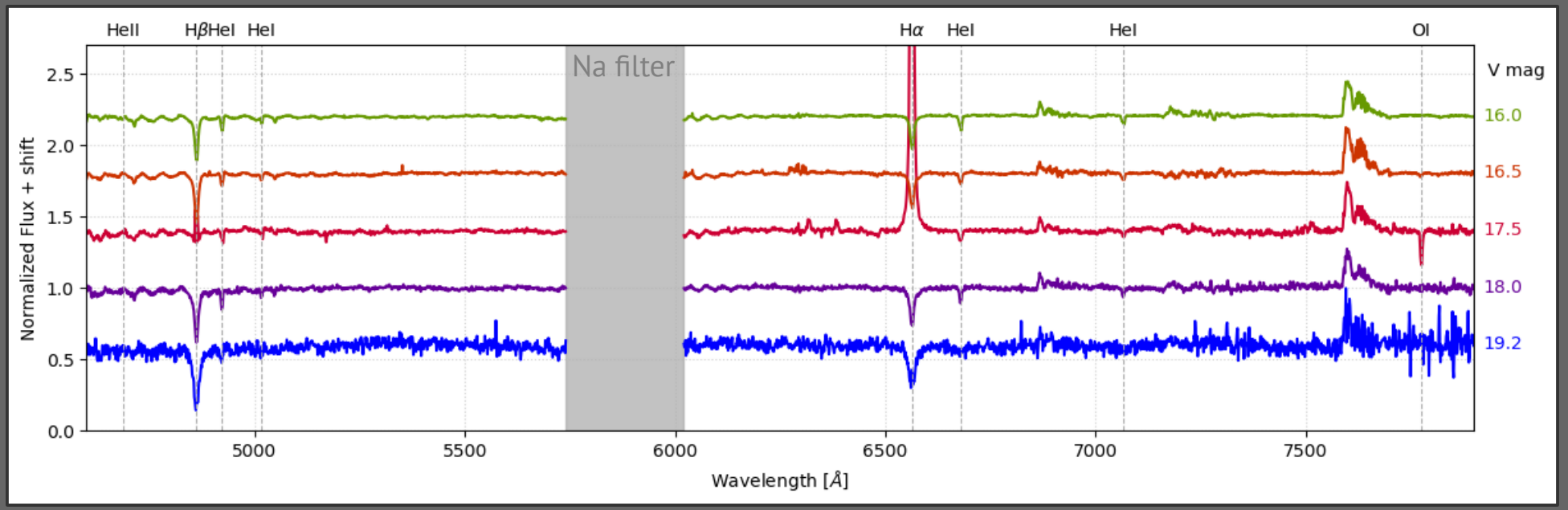
FoV	1’ x 1’
Δx	0.2”
λ	4650 – 9300 Å
R	2000 – 4000

2 epochs during SV
in Aug/Sep 2017 with AO

Bacon et al. 2010



Spectral classification



example MUSE spectra

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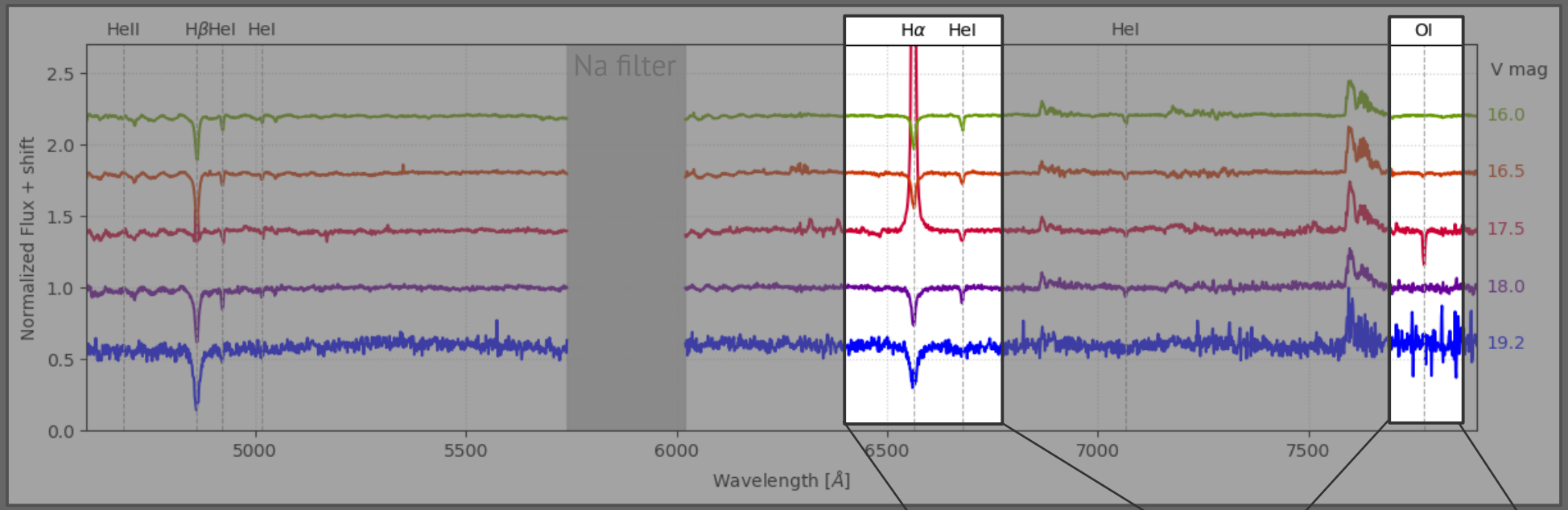

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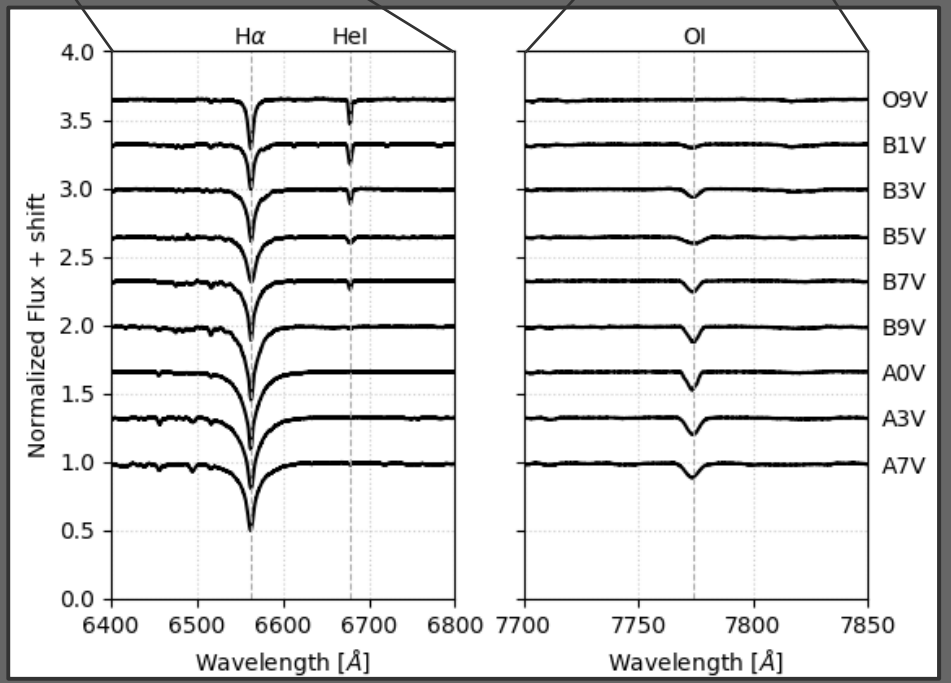

- comparison to standard stars

  Gray – Stellar Spectral Classification, 2009

- observed by HERMES @ Mercator, downgraded and rescaled

Spectral types

FLAMES spectroscopy of 125 stars

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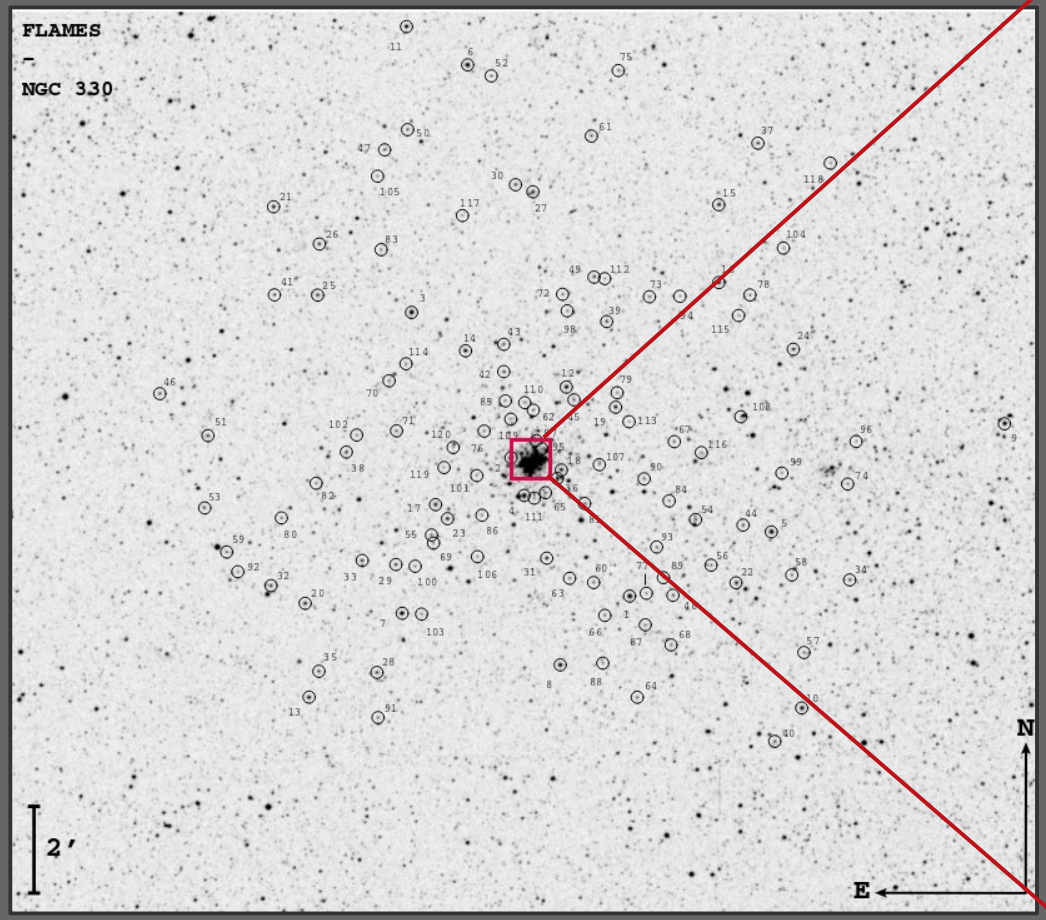
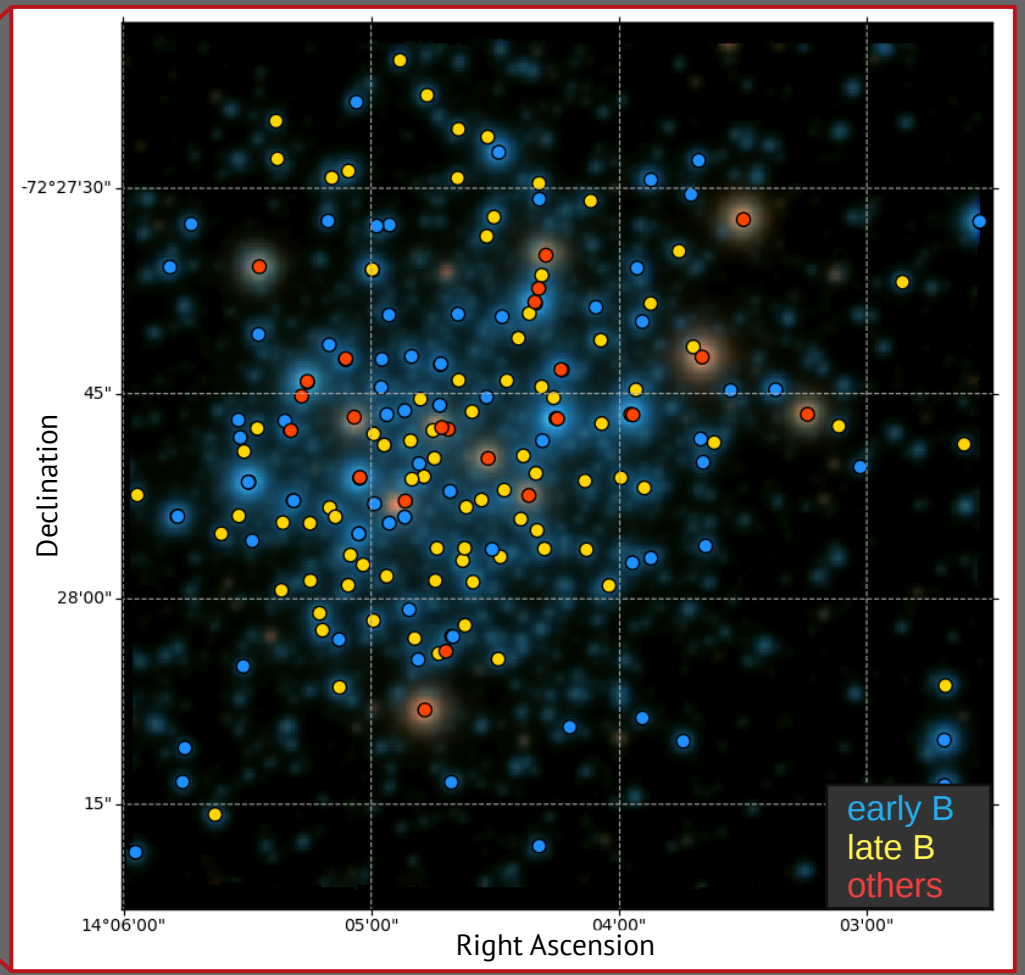
MUSE spectroscopy of 194 stars (V < 18)

→ no O stars

Evans et al. 2006





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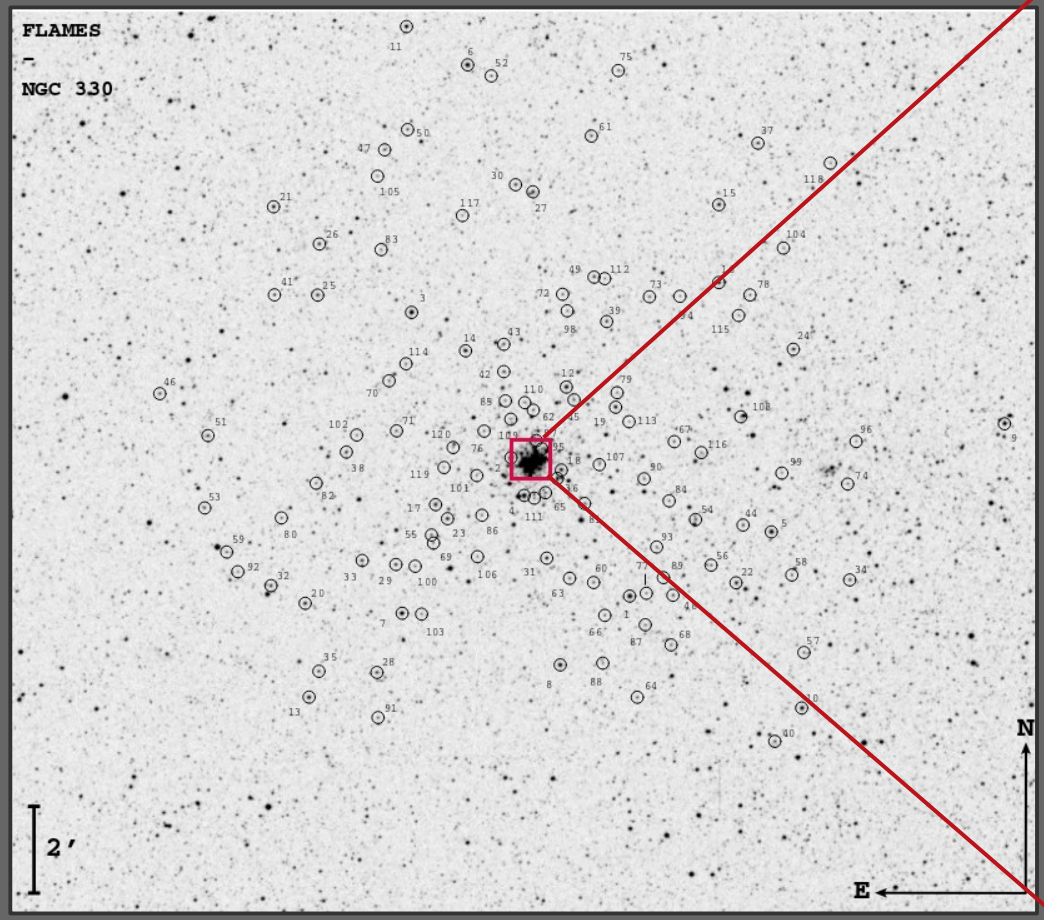
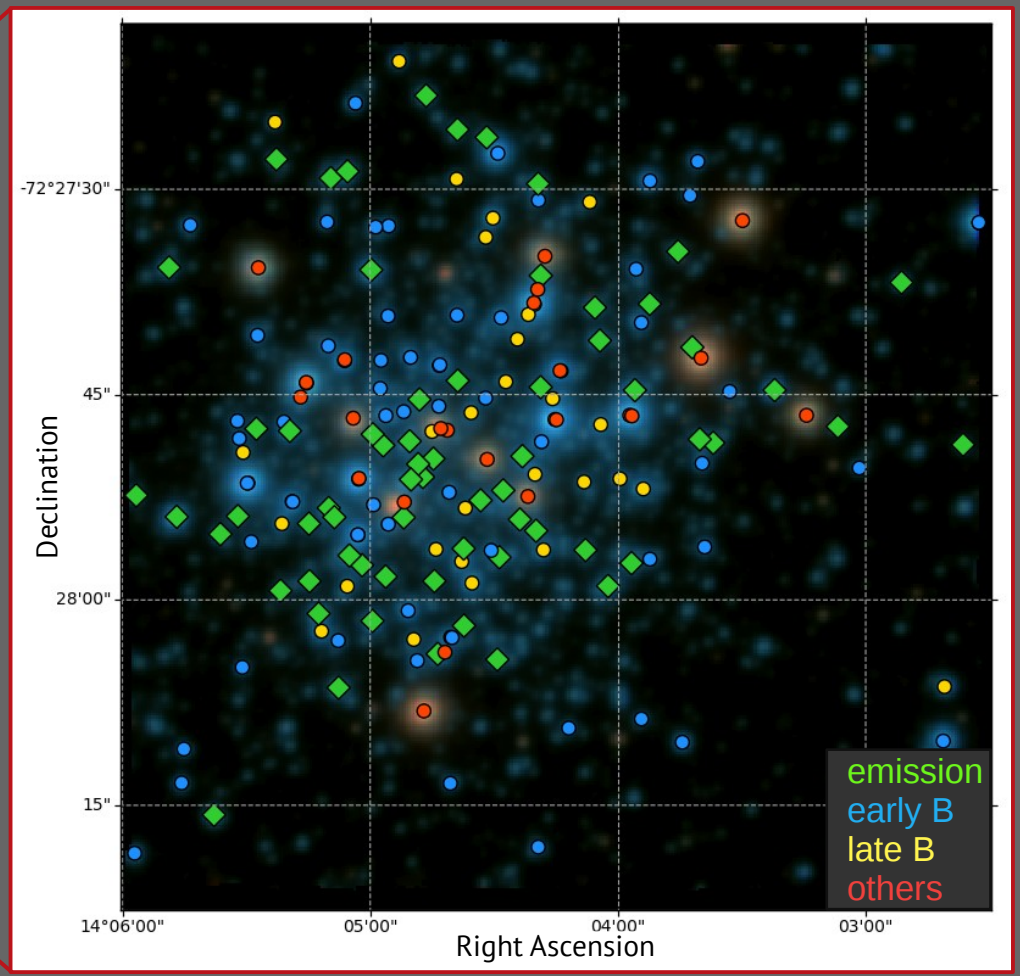


MUSE spectroscopy of 194 stars (V < 18)

→ no O stars

→ very high Be star fraction (40 ± 3%)

→ binary fraction ??



Results

- interpreting Be stars as PiPs supports the target selection strategy

- in the outskirts:
  → few O stars
  → high Be star fraction

Evans et al. 2006

- in the core:
  → no O stars
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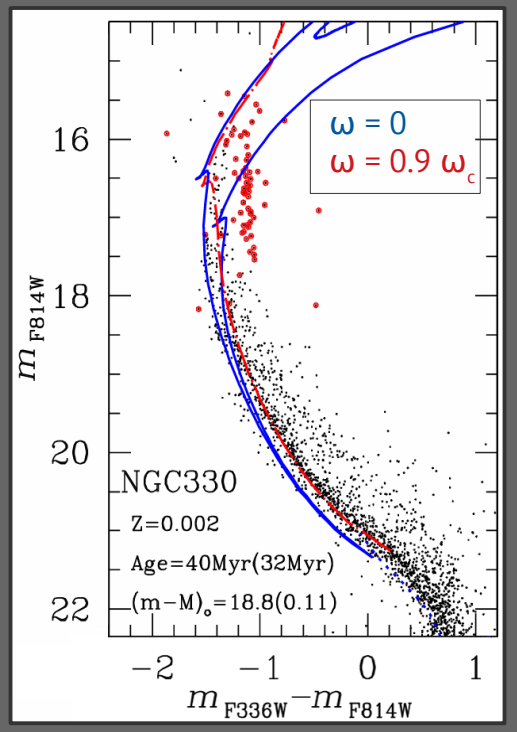
possible scenarios:

1) age difference between cluster outskirts and core
   → 2 phases of star formation
   → see Milone et al. 2018



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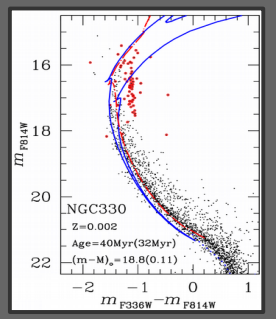


2) binary interaction
   → Be stars are accretors / mergers
   → O stars are blue stragglers ejected from the core (“runaways / walkaways”)

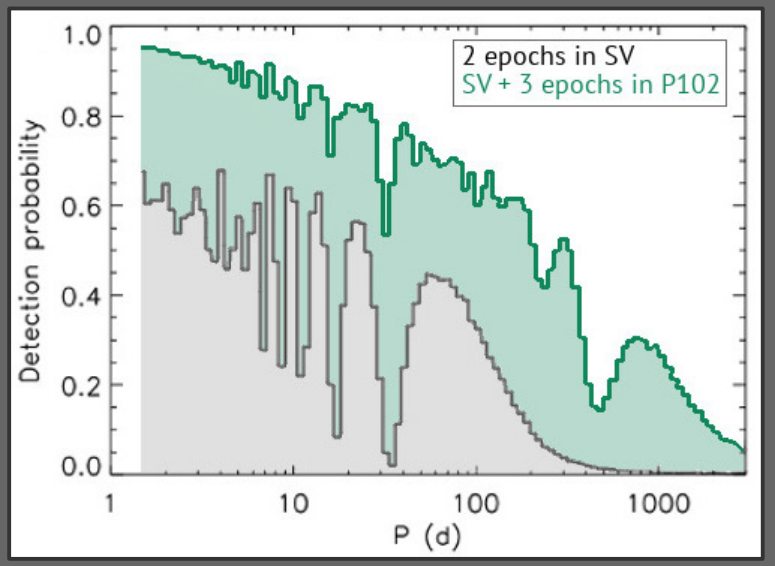
TBD

Future work

- waiting for 3 additional epochs

  → determine current binary fraction

- estimate T_{eff}, log g , v_{rot} and surface abundances for all stars with V < 18

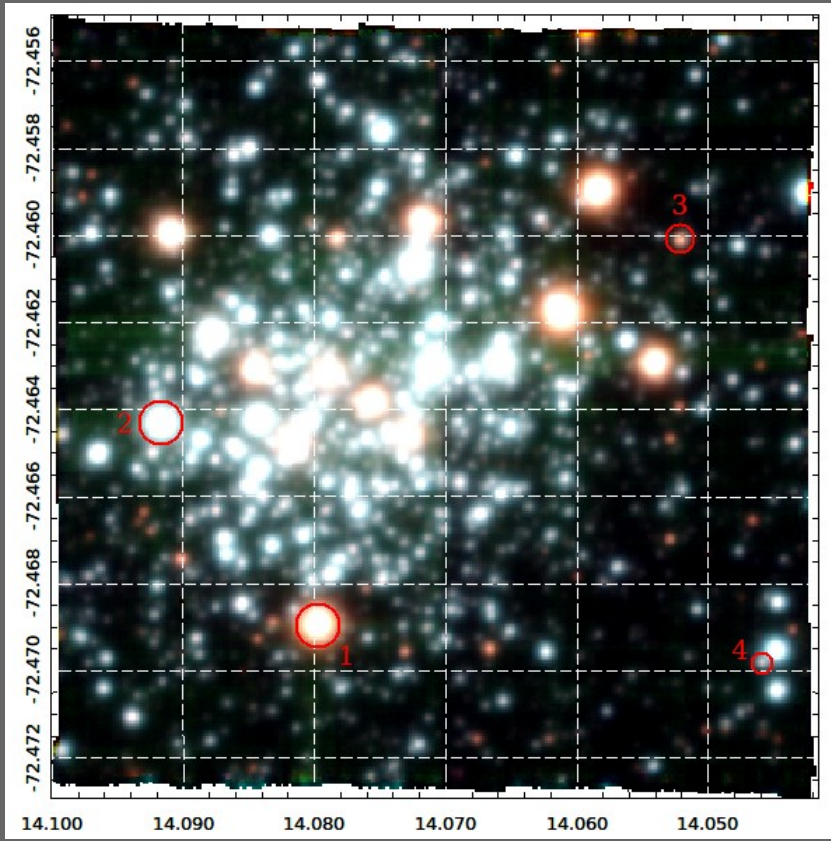


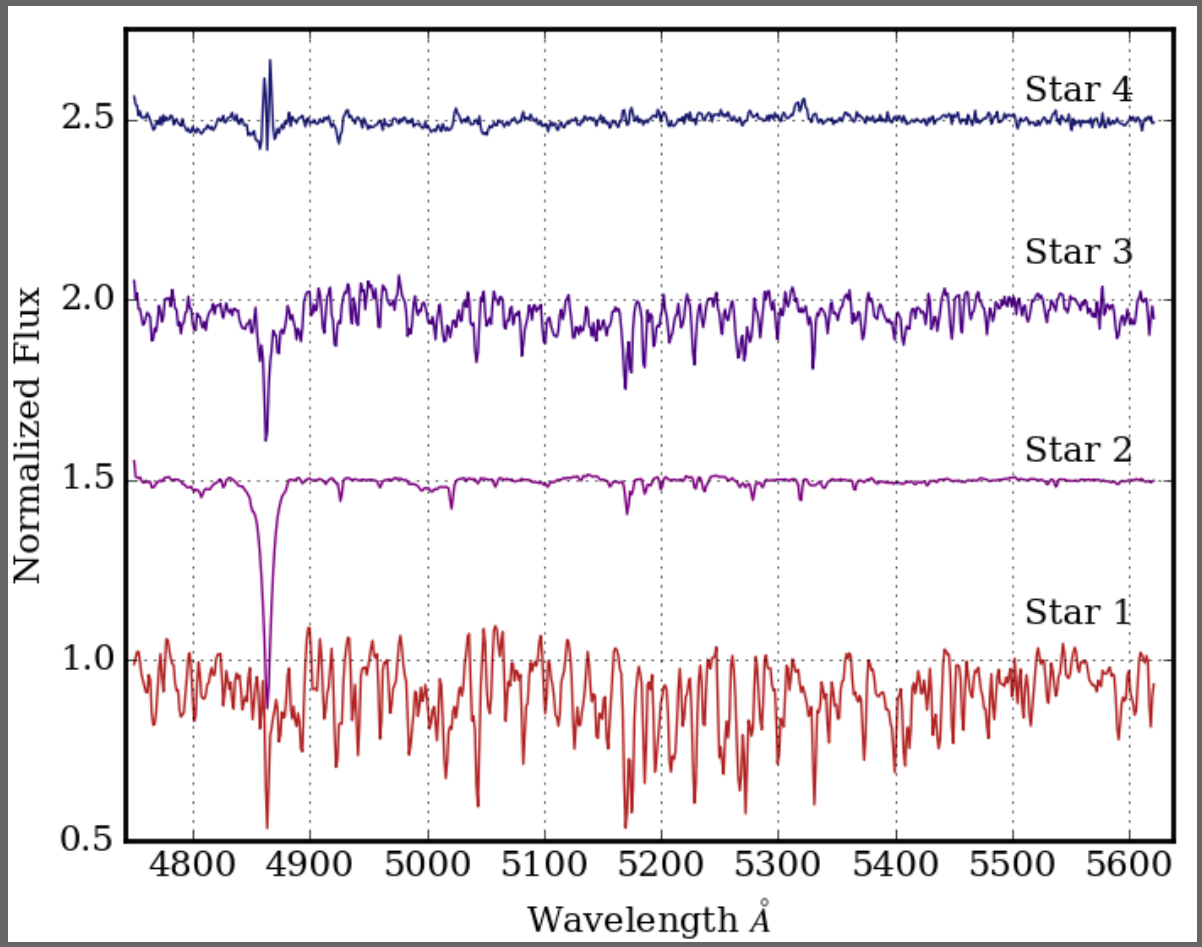
- compare to population synthesis codes with single- and binary-evolutionary models in order to distinguish between the scenarios

Brott et al. 2011, Ekström et al. 2012, de Mink et al. 2014, Eldridge et al. 2017

Extra slides

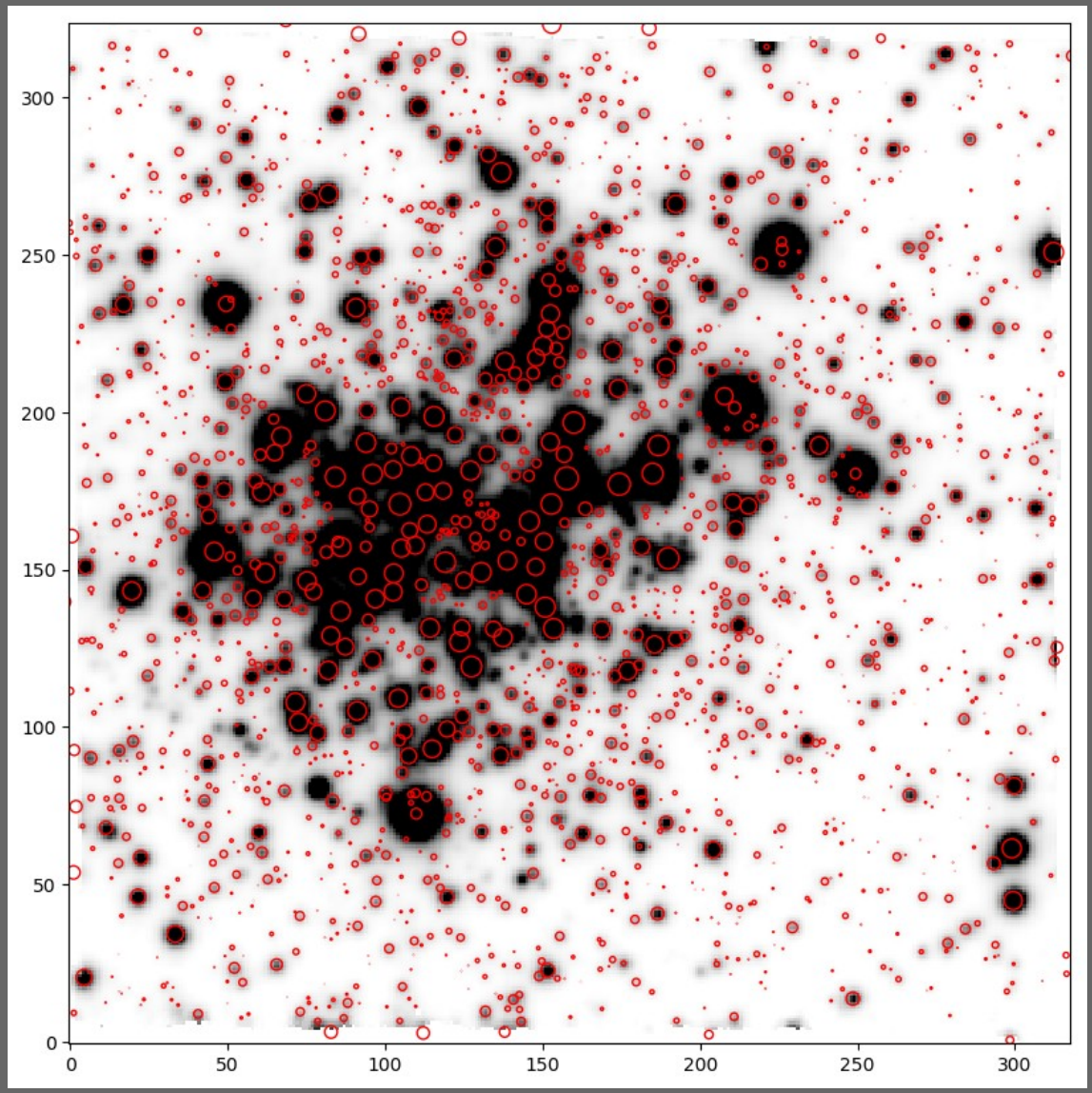
Example spectra





Spectral extraction with PampelMUSE

- PSF fitting approach
- 2000 spectra extracted
- ~ 150 stars with V < 18
  - → ≈ M > 8M_{sun}
  - → S/N = 200 in 5 epochs



Kamann et al. 2013

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