

The history of Δa photometry

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Magnetic chemically peculiar stars (aka Bp/Ap, mCP)

B- to F-type main sequence stars
detected in 1897 by Antonia Maury

they combine many important properties:

- strong magnetic fields
- variability
- various chemical peculiarities

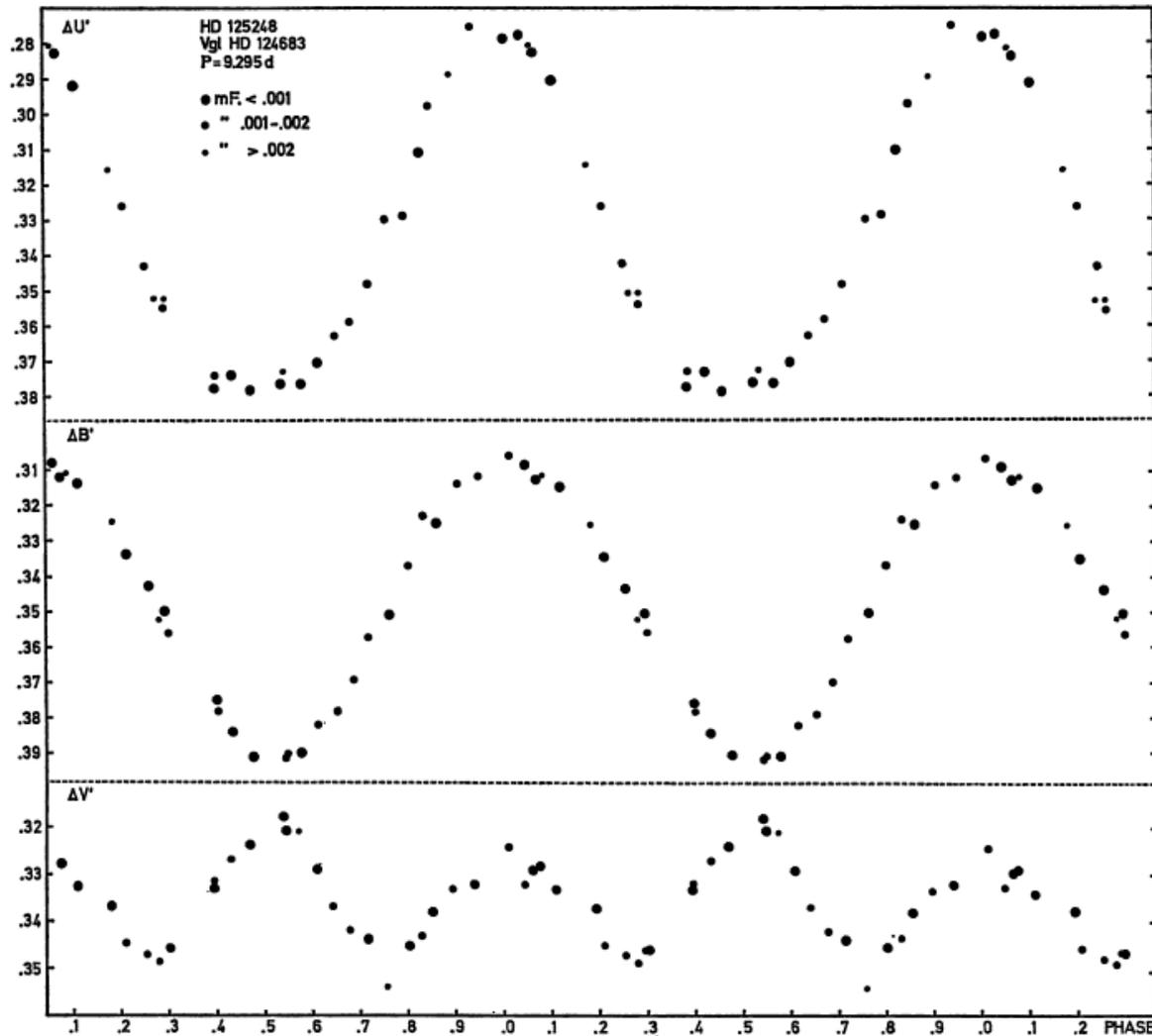
They can be detected either by spectroscopy, polarimetry, but also using **photometric methods**.

Kodaira 1969 (ApJ, 157, 59):

detected flux depressions in the continuum of HD 221568
at $\lambda 4200$, 5300 , and 6300 \AA

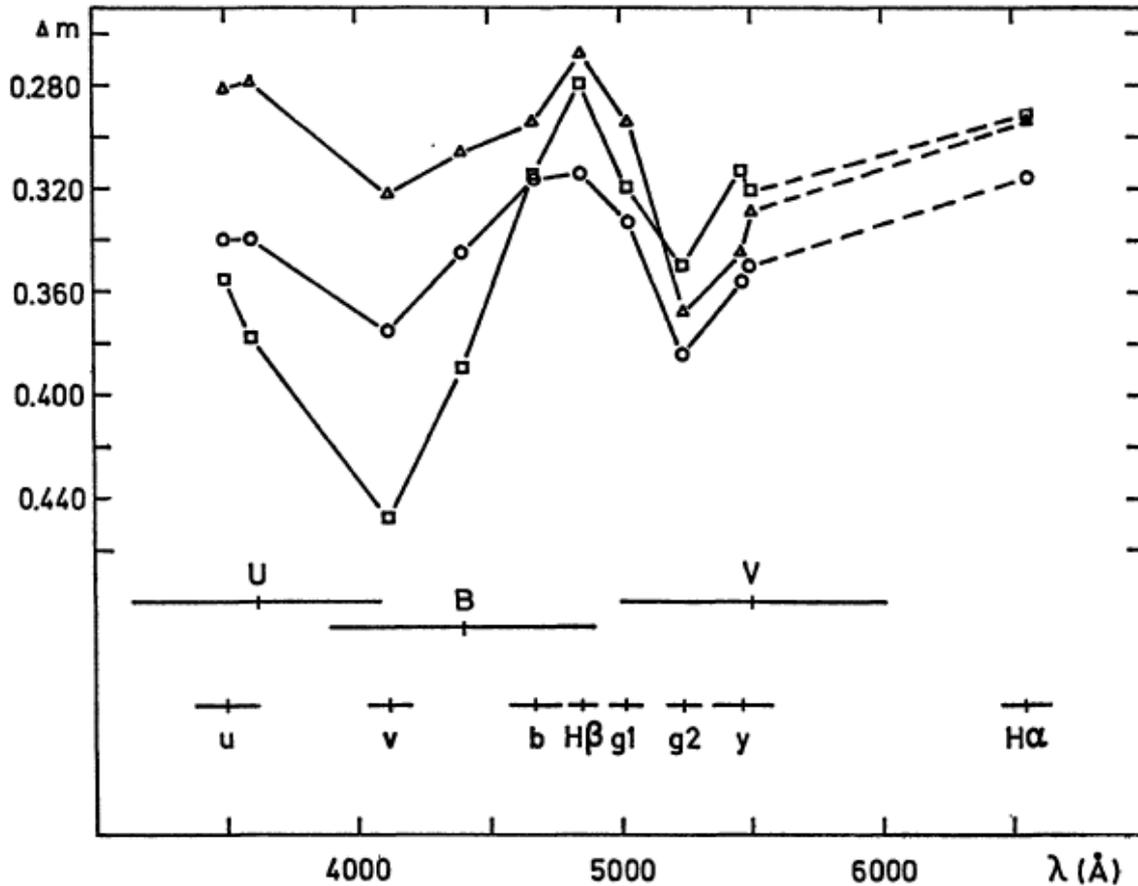
later, **$\lambda 5200 \text{ \AA}$** turned out as the most important region,
valid for almost all Ap stars.

Photometric variability of Ap stars



HD 125248 (CS Vir)
in UBV

Flux depression of Ap stars

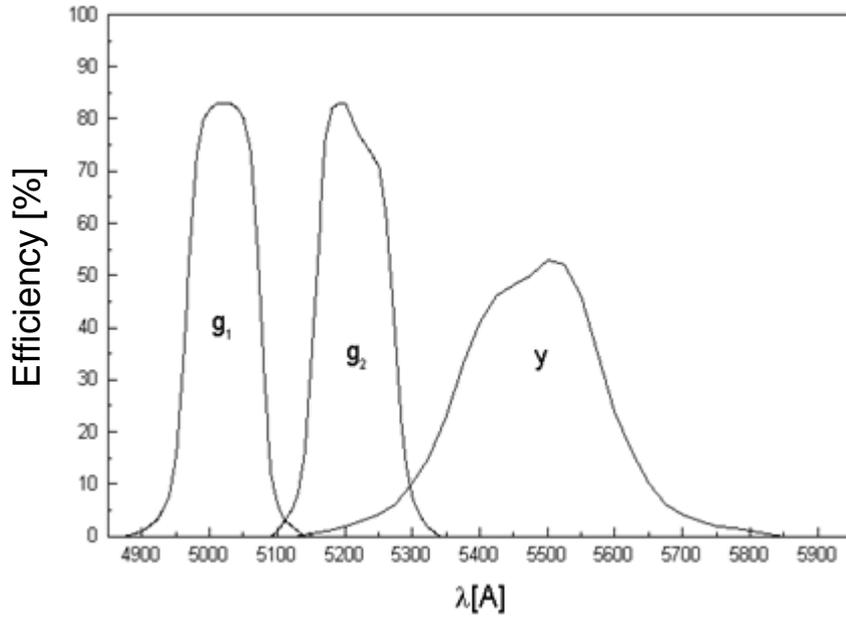


magnitudes as a function of wavelength for the star HD 125248 (CS Vir) at different phases

spec. type: ApSi(Cr)

resulting in the invention of Δa photometry (Maitzen, 1976, A&A, 51)

Functionality of Δa

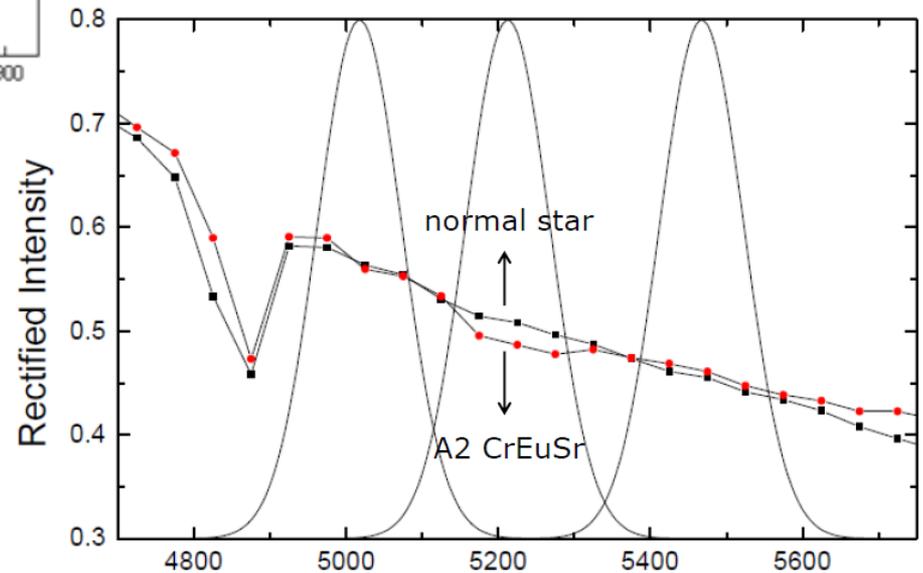


$$a = g_2 - [(g_1 + y)/2]$$

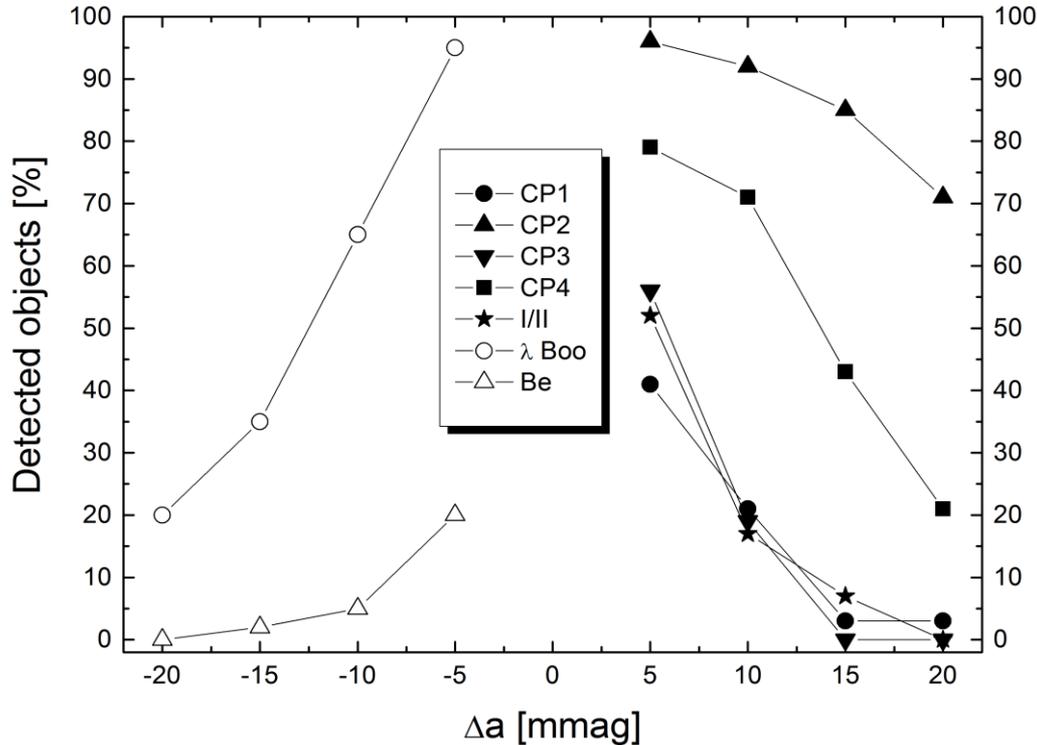
$$\Delta a = a(\text{star}) - a_0$$

a_0 : reference value of ,normal' stars

an additional presentation of the characteristic flux depression at $\lambda \sim 5200 \text{\AA}$



Detection efficiency of Δa



Paunzen et al., 2005, A&A, 441, 631

Almost all Bp/Ap stars
(in particular CP2) can be detected.

Also a large fraction of λ Boo's.

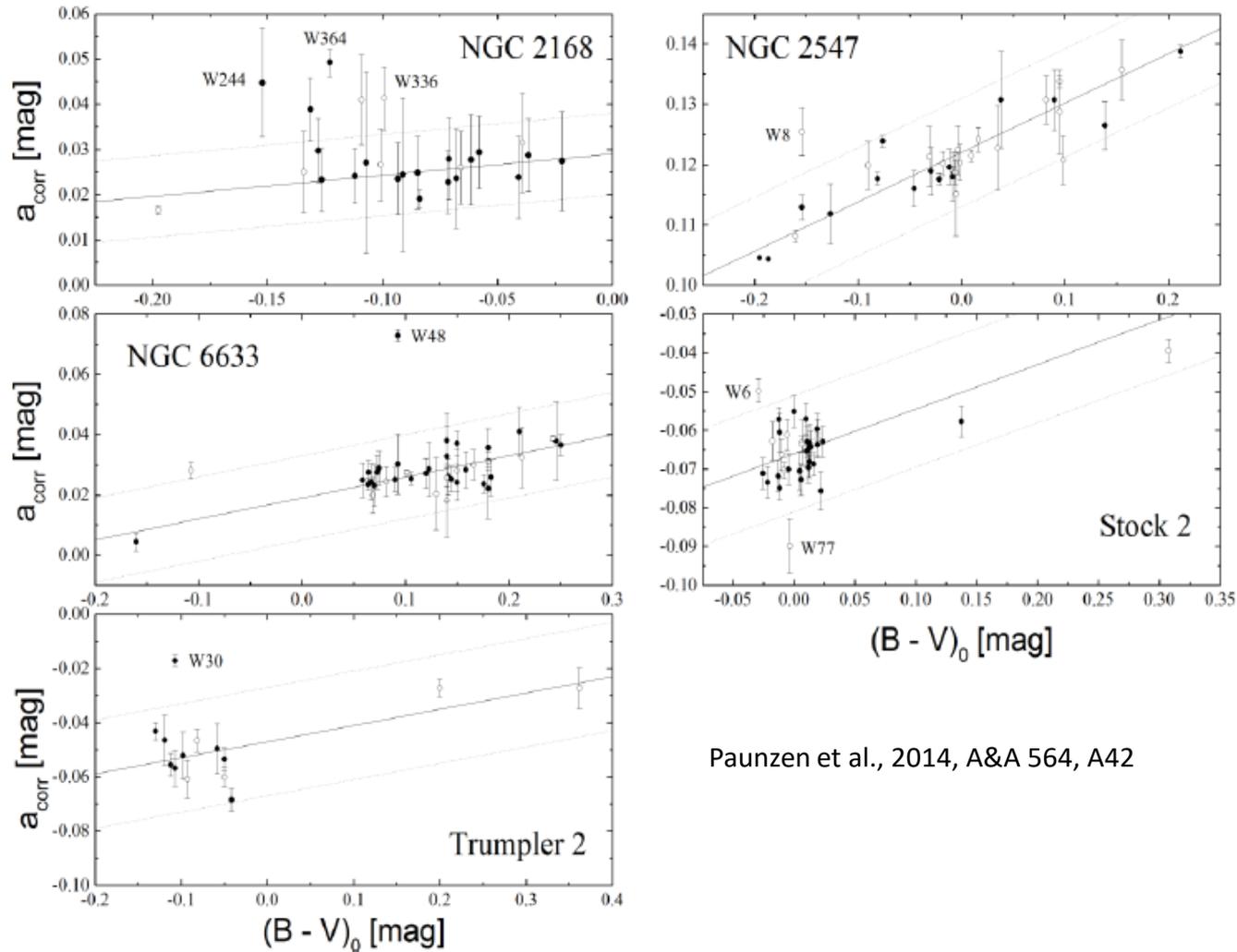
For other non-magnetic peculiar
stars only a smaller percentage.

Note that Be stars change between
emission and shell phase.

Δa is also often used as pre-selection tool for polarimetric follow-up observations, e.g. at the 6m SAO (Russia, Iosif Romanyuk et al.)

Open cluster survey in Δa

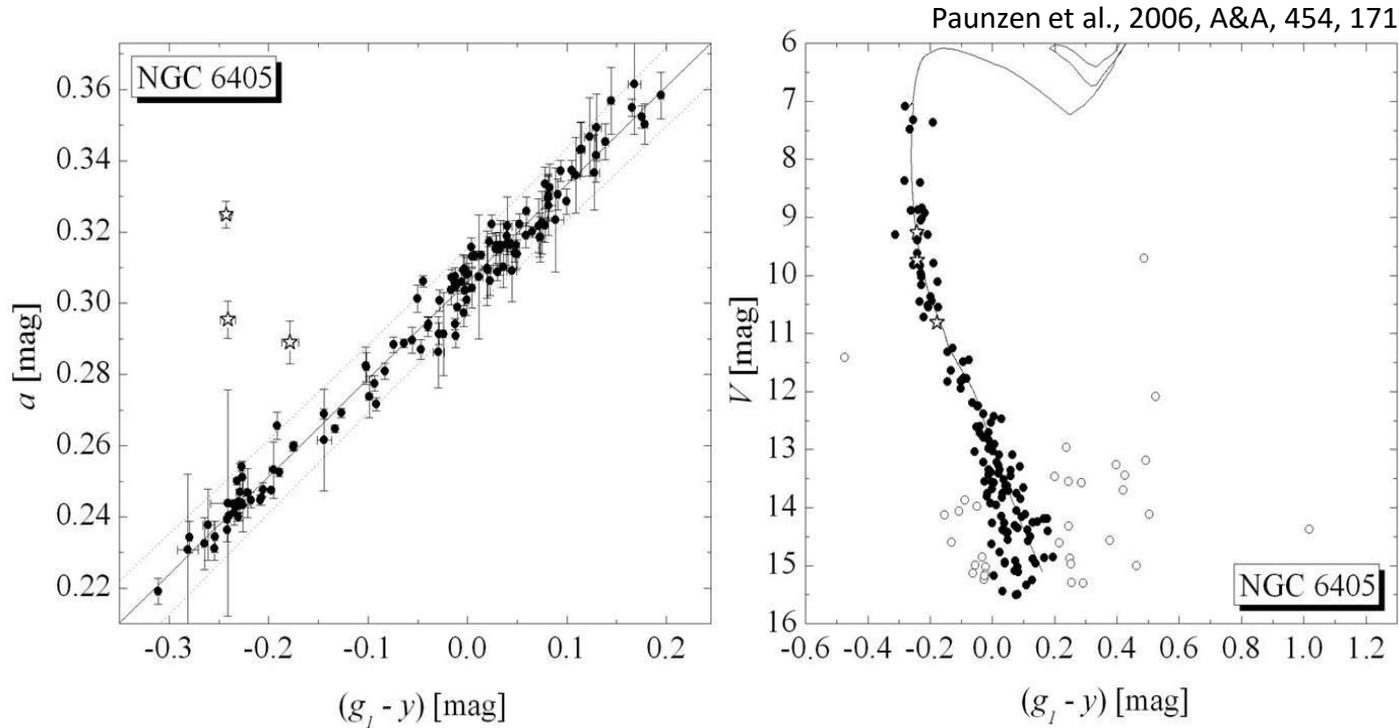
48 open clusters with photoelectric technique



Paunzen et al., 2014, A&A 564, A42

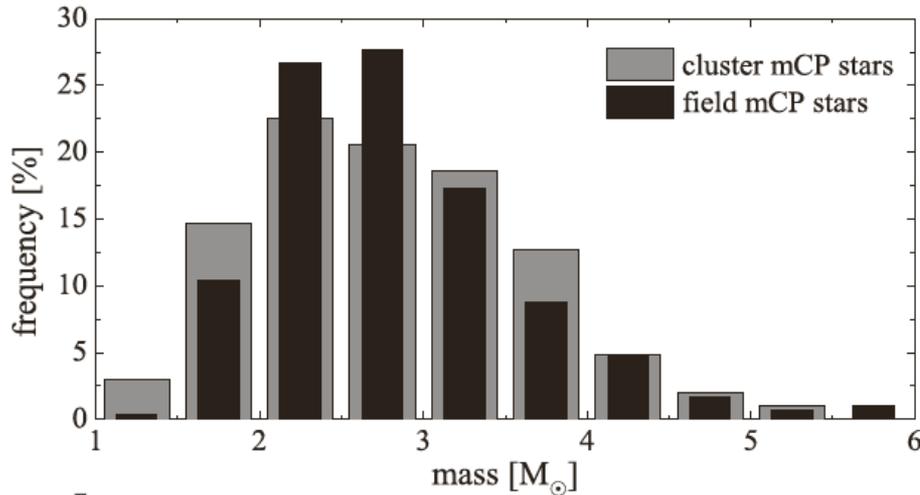
Open cluster survey in $\Delta\alpha$

47 open clusters with CCD



Advantages: constraints for age and distance, useful for evolutionary studies. $\Delta\alpha$ is slightly reddening dependent, but clusters show in general a uniform reddening. Though, **cluster membership is still a challenging topic** (but soon full astrometric parameters by Gaia).

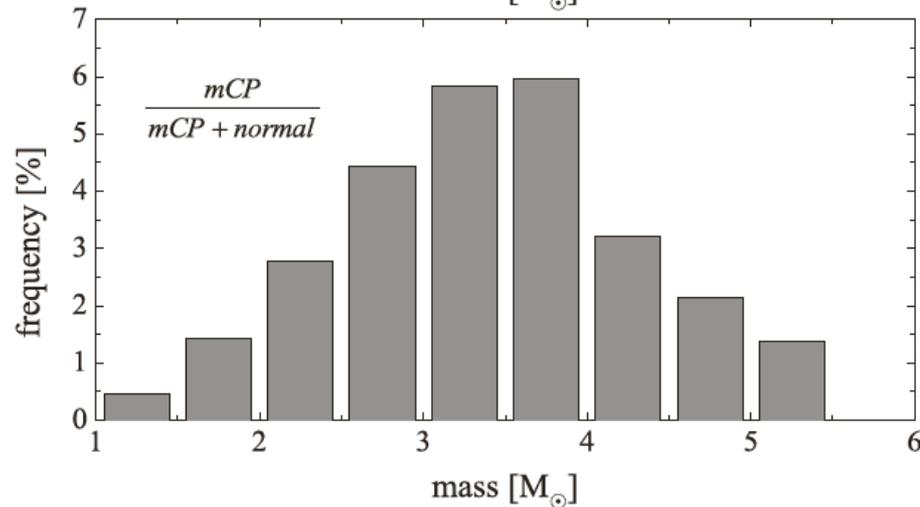
Open cluster survey in Δa



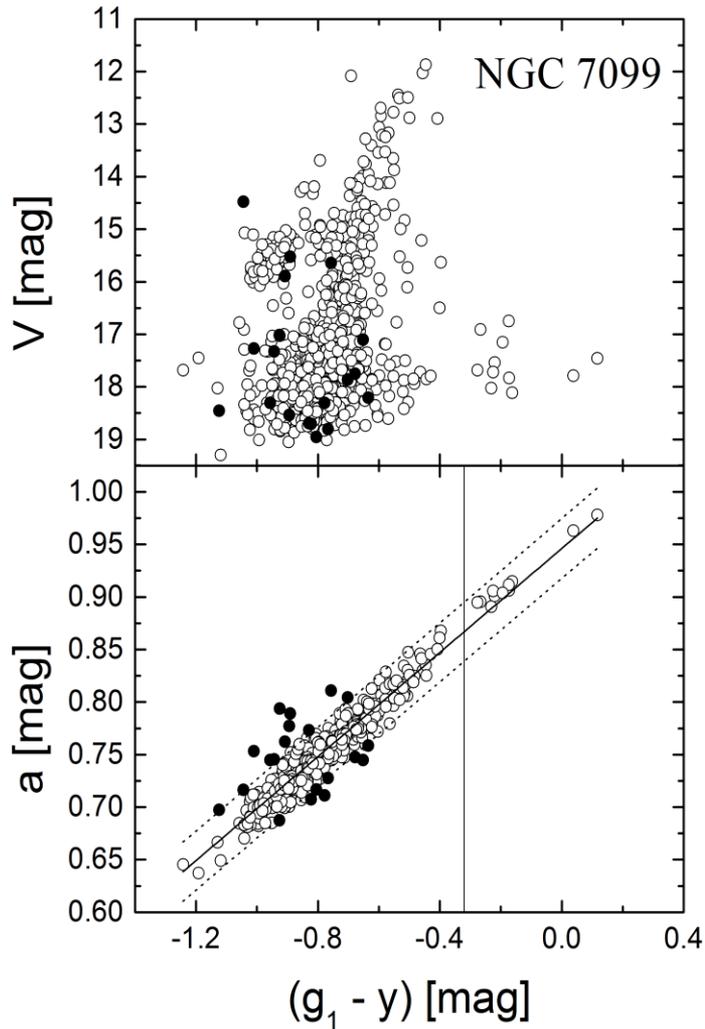
About 100 Ap cluster stars detected.

Mass distribution similar to field stars.

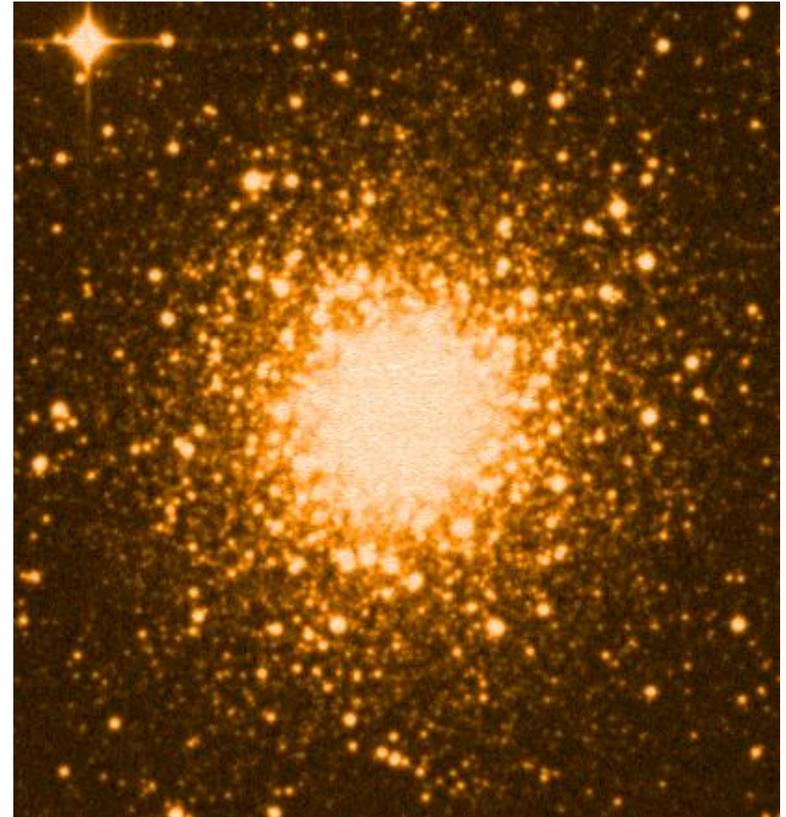
Observed mass peak around $2-3 M_{\odot}$, but if compared with normal stars a shift is noticeable. Thus, the formation of Ap stars is more efficient in the range $3-4 M_{\odot}$.



Δa photometry of globular clusters

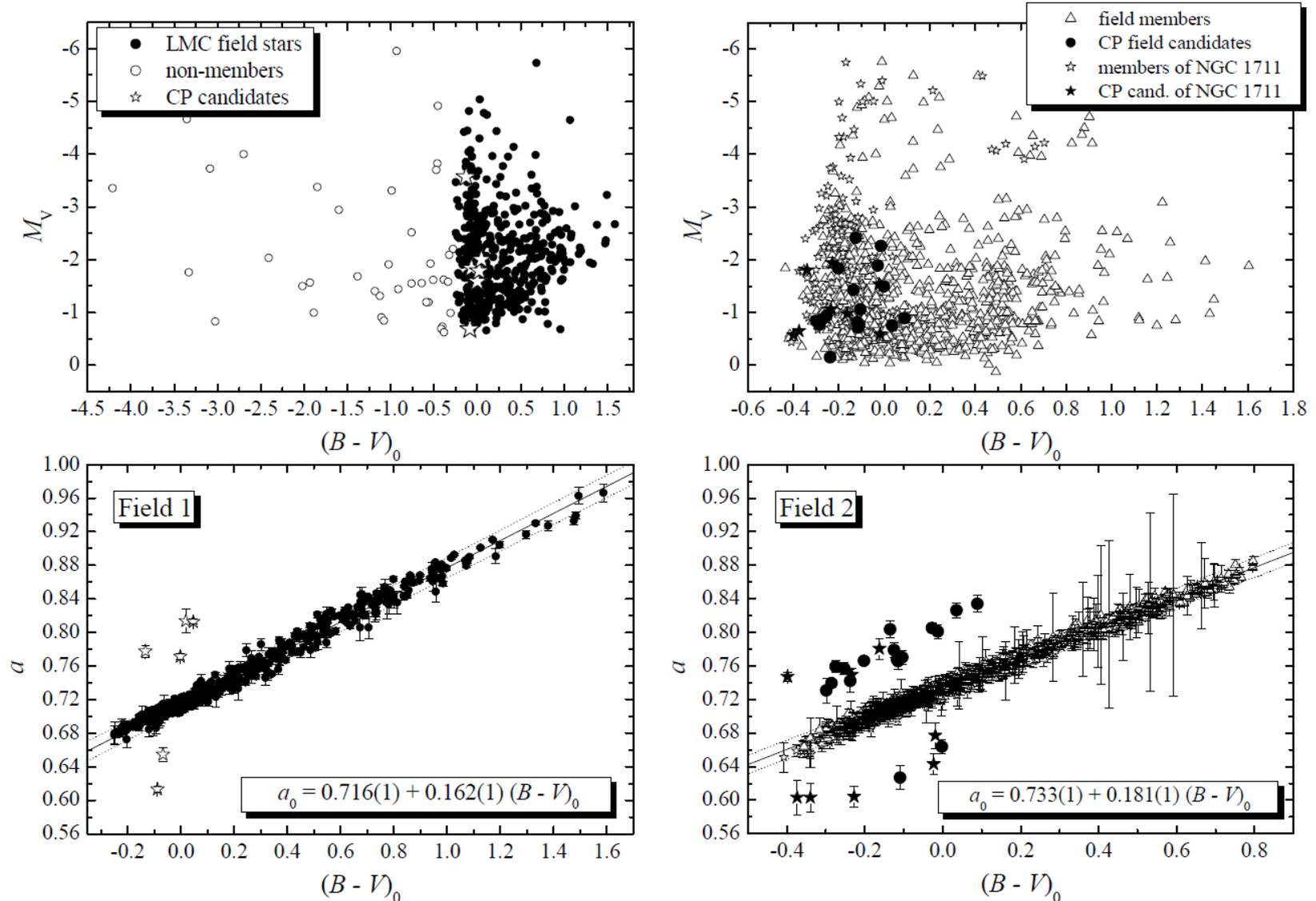


Paunzen et al., 2014, MNRAS, 443, 2492



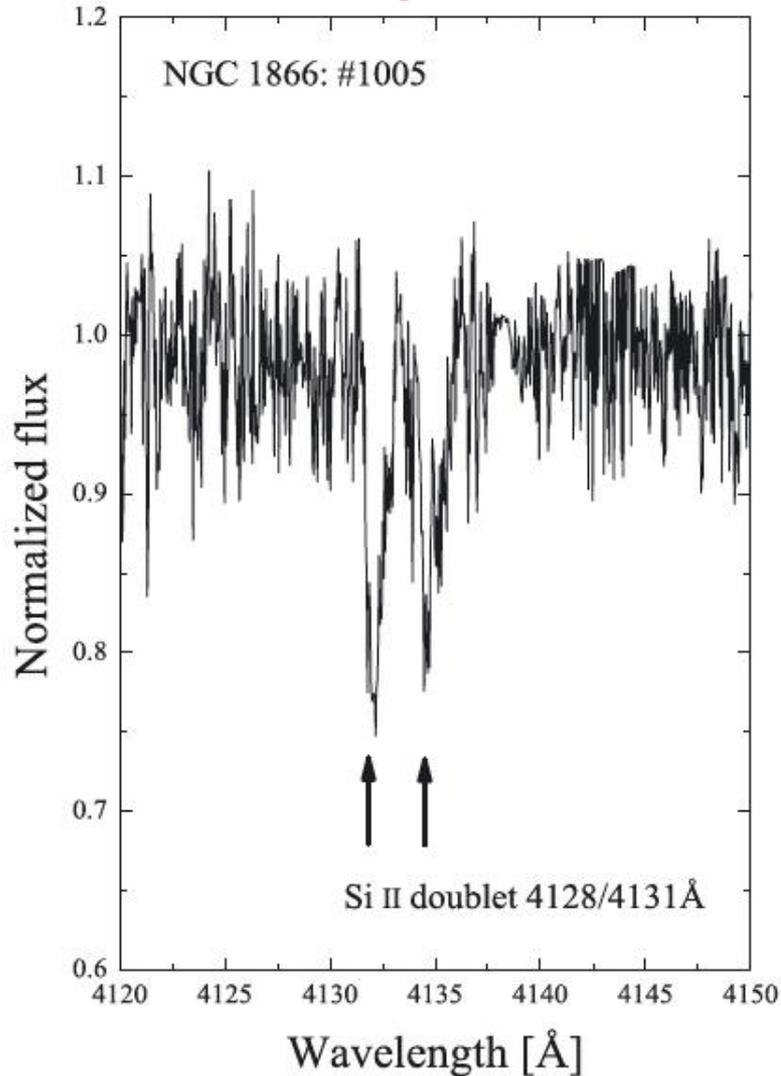
BHB, RHB, main sequence stars with different metallicity

CP stars in the LMC

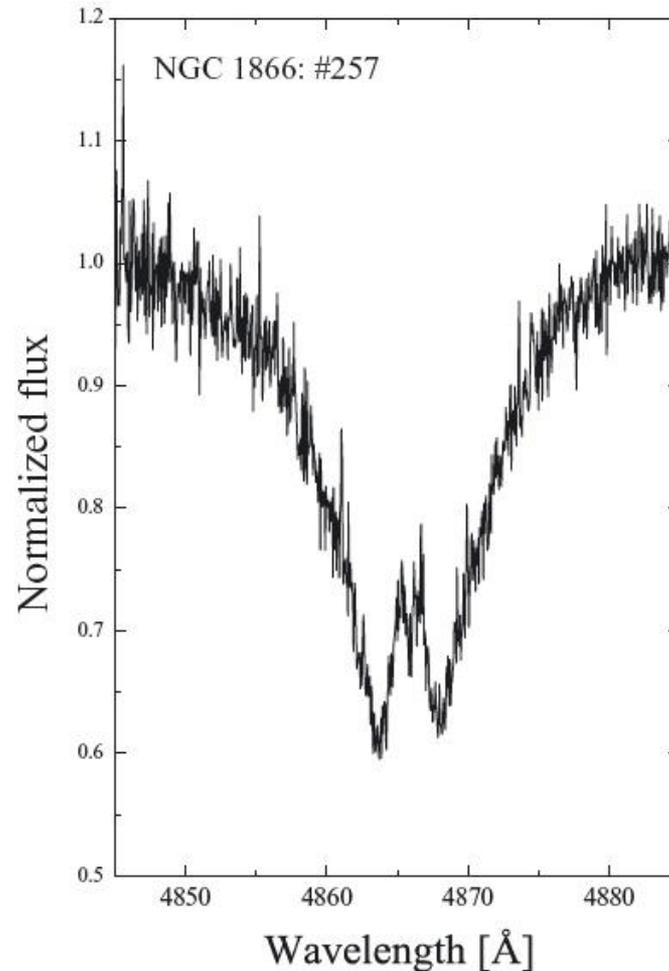


Confirmation of CP stars in the LMC

Classical magnetic CP2 star



Detected via Δa ; spectroscopic confirmation with the 6.5m Magellan II (Las Campanas)



Be star

Summary

- Detection of 5200 Å depression which is enhanced by magnetic field
- Detection rate almost 100% at 5 mmag
- Could be used to detect any anomalies at 5200 Å
- Filters and facilities accessible on both hemispheres
- Collaborations are welcome