AGB stars in Galactic Globular Clusters – Are They Chemically Distinct to Their Fellow RGB and HB Stars?

M5: SDSS

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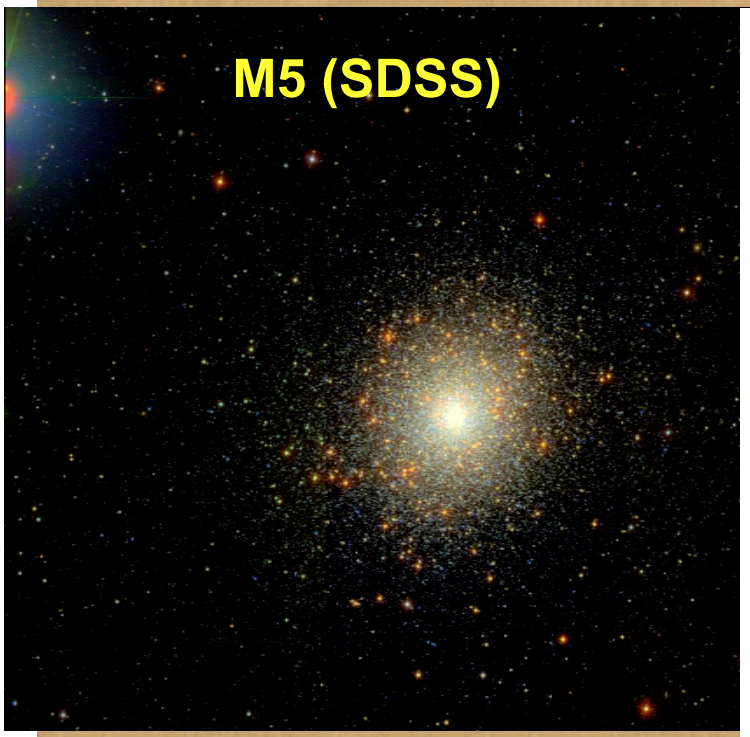
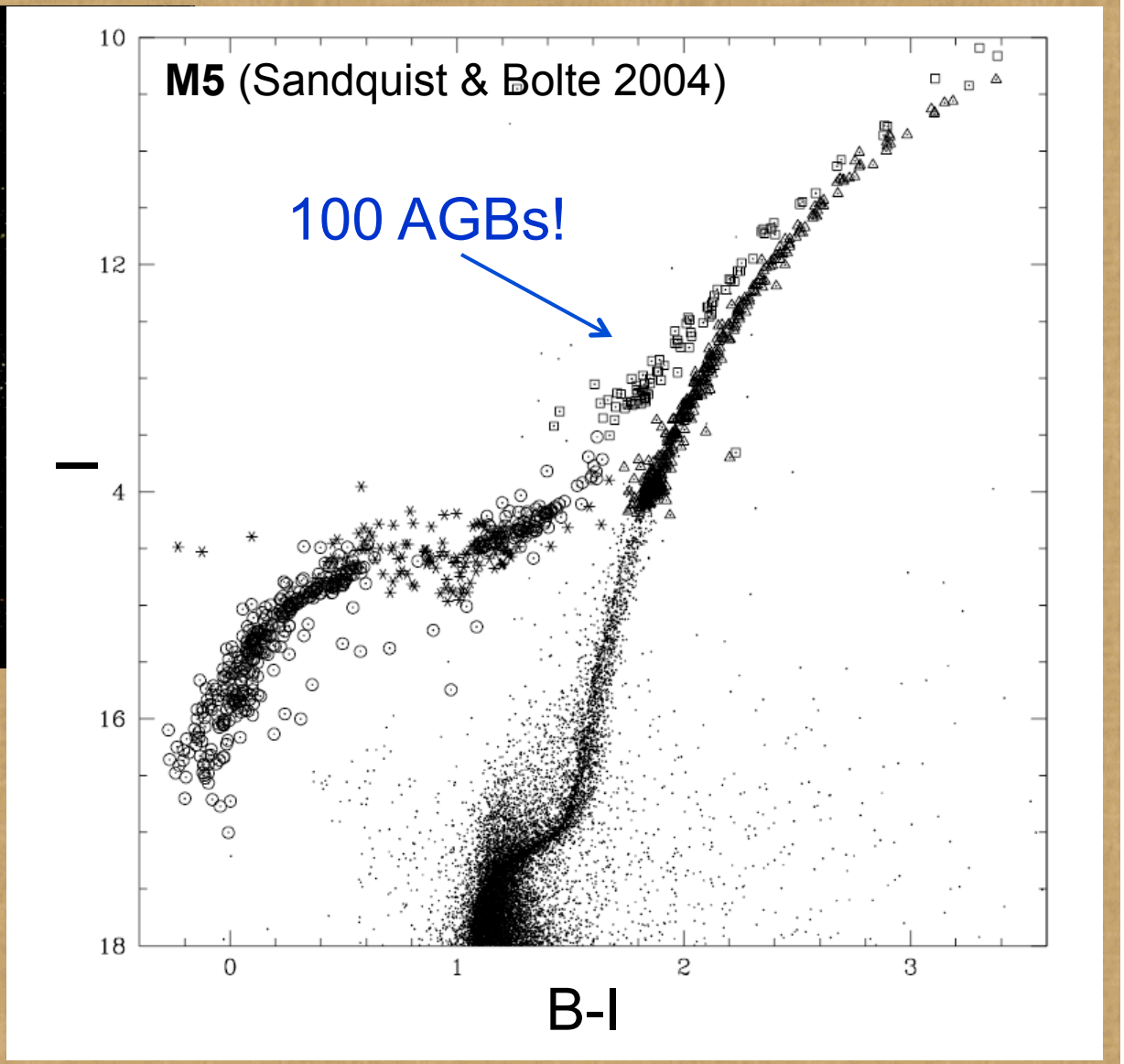
AGBs in Globular Clusters

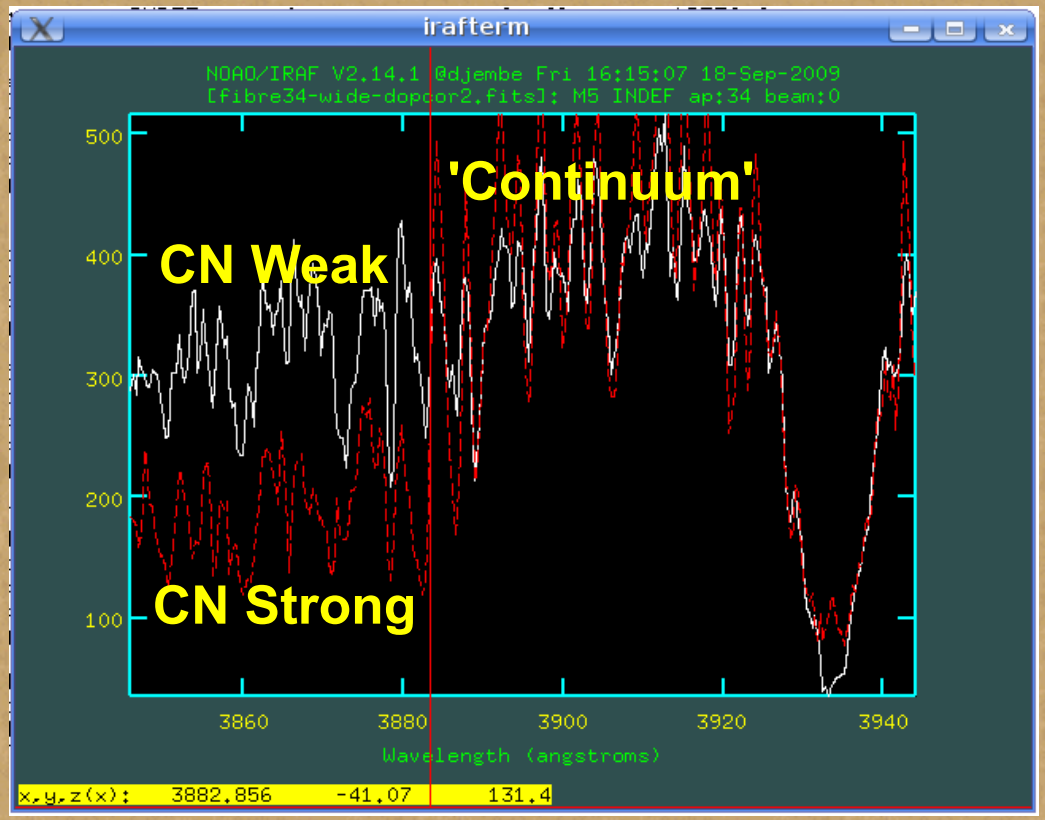


- High quality photometry is now making the AGB accessible in GCs, we can now get good numbers of AGBs.



Quantifying Cyanogen Abundance: The S(3839) CN Index

- Cyanogen (CN) is a molecule whose abundance is thought to track that of Nitrogen. It absorbs over a few regions in the spectrum. Here we consider the Blue CN bands.



Blue CN Index:

$$S(3839) = -2.5 \log \frac{\int_{3846}^{3883} I_\lambda \, d\lambda}{\int_{3883}^{3916} I_\lambda \, d\lambda}$$

Norris et al. (1981)

- So basically you see how much flux is missing in a wavelength region due to CN absorption by comparing to piece of 'continuum' nearby. Only need fairly low (~2 Ang) resolution.

CN Bimodality in GC Giants

This is not observed in halo field stars!

(see eg. Langer et al, 1992)

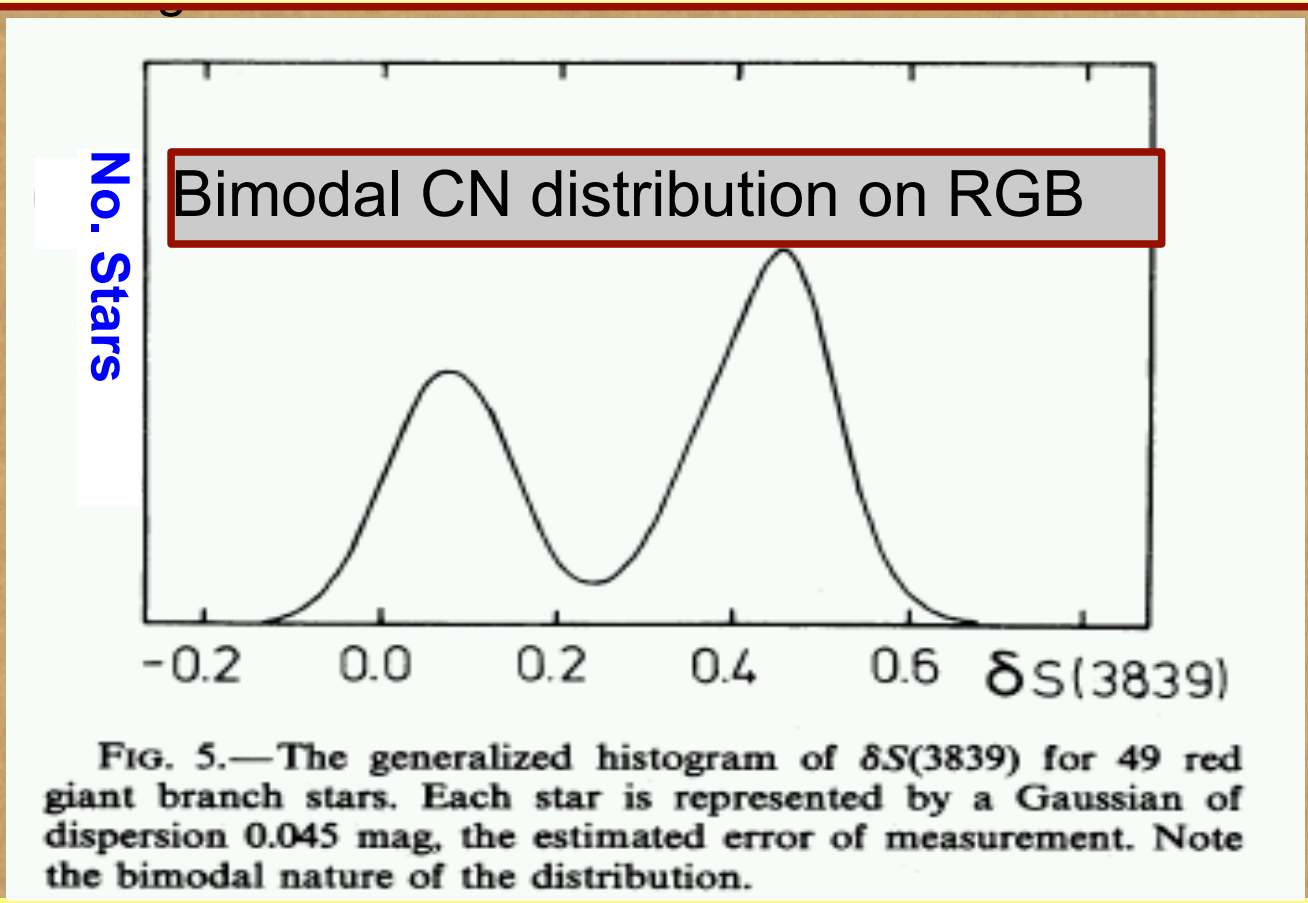


FIG. 5.—The generalized histogram of $\delta S(3839)$ for 49 red giant branch stars. Each star is represented by a Gaussian of dispersion 0.045 mag, the estimated error of measurement. Note the bimodal nature of the distribution.

- Note trend with Temp.

References: eg. ***Bell & Dickens 1974, Da Costa & Cottrell 1980, Norris et al. 1981.***

giant branch and asymptotic giant branch stars, respectively. The upper diagram is used to define CN strong and CN weak groups within the cluster by filled and open symbols. (The half-filled

CN Bimodality on MS/SGB

More recent work has shown that the CN bimodality extends down to the Main Sequence, suggesting that the bimodal composition has primordial origens.

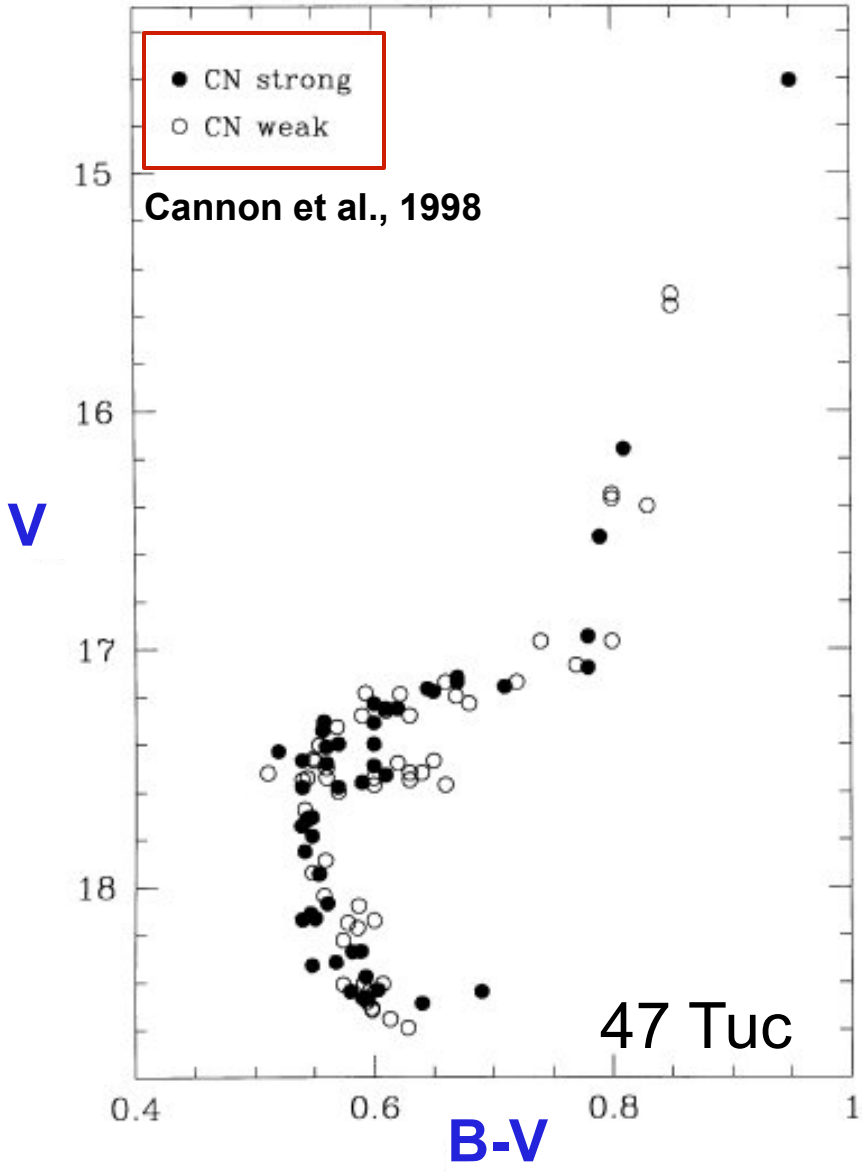
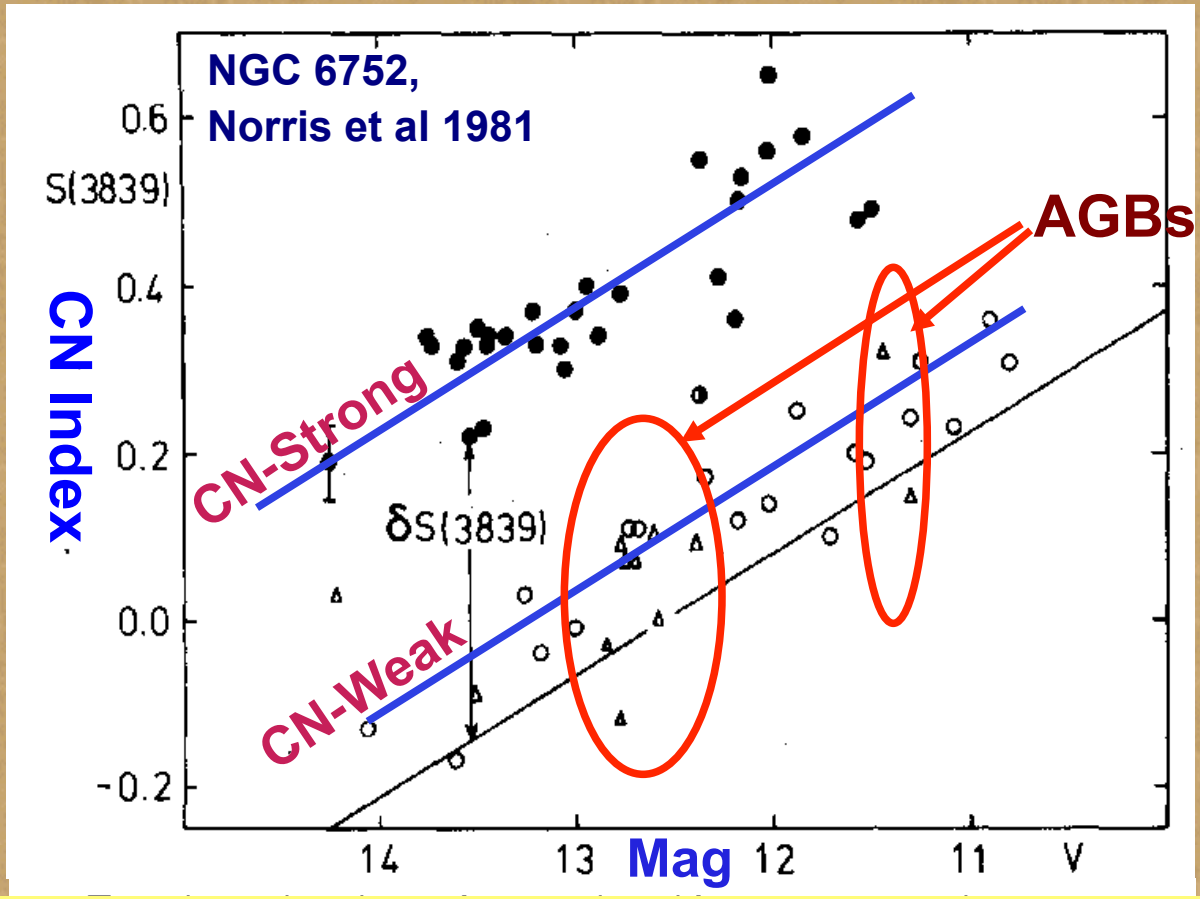


Figure 6. The 47 Tuc colour–magnitude diagram, using the same data as Fig. 2 but with the symbols of Fig. 4 to distinguish between the CN-strong and CN-weak stars.

More GC Weirdness? – CN in AGBs

- Norris et al. 1981 noted that their sample of *AGB stars* in NGC 6752 were *all CN-weak* (triangles = AGBs).
- Could this be chance, due to the small sample size – or is *something strange happening on the AGB??*



AGBs: all CN-weak

- Note trend with Temp.

References: eg. *Bell & Dickens 1974, Da Costa & Cottrell 1980, Norris et al. 1981.*

giant branch and asymptotic giant branch stars, respectively. The upper diagram is used to define CN strong and CN weak groups within the cluster by filled and open symbols. (The half-filled

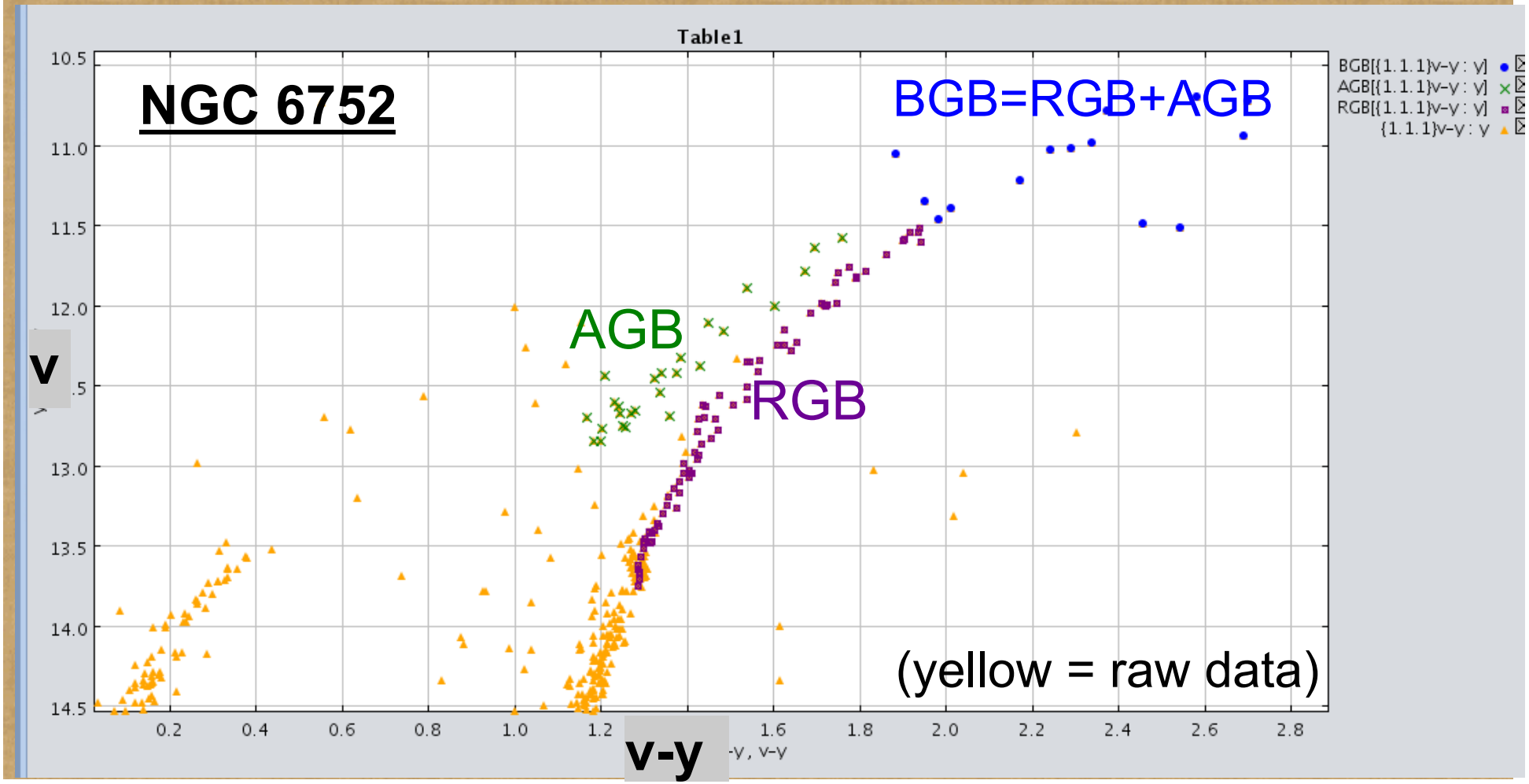
An Interesting Proposition

- Nothing on the HB should change the CN abunds
- So RGB stars should have the same distribution as AGB stars
- Not much data on AGB stars
- Need to be able to separate AGB and RGB…
- Try a systematic approach

Excellent Photometry Needed

- Excellent photometry is needed in order to split the two giant branches.
- v versus v-y CMD gave good AGB-RGB splitting fro NGC 6752.

(NGC 6752 data from Frank Grundahl)



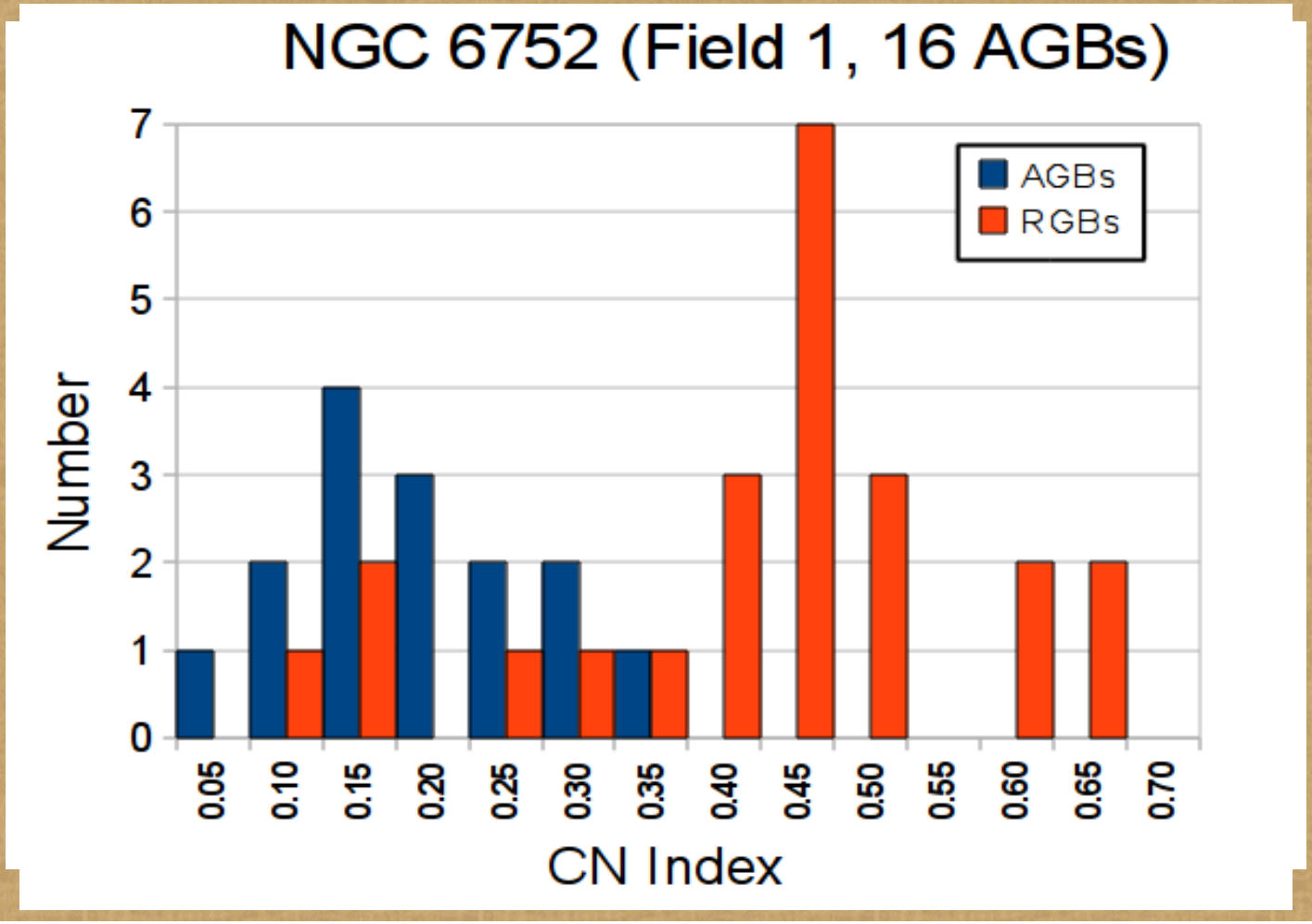
Spectra Collected: Number of AGBs

- 5 nights on AAT Multi-object spectrograph 2dF/AAOmega
- Data collected for 241 AGB stars across 9 clusters (plus many RGB & HB stars).

	Identified	Observed	Other Work
NGC 1851	34	20	?
NGC 288	15	14	?
NGC 362	27	20	?
NGC 6752	26	24	12
M2	25	22	?
M4	10	9	11
M5	79	49	8
M10	34	29	?
47 Tuc	56	54	?
Omega Cen	102	0	?

Results: NGC 6752

- The cluster that Norris et al 1981 investigated.
- RGB nicely bimodal, as expected.
- And on the AGB....



Strong to Weak Ratios

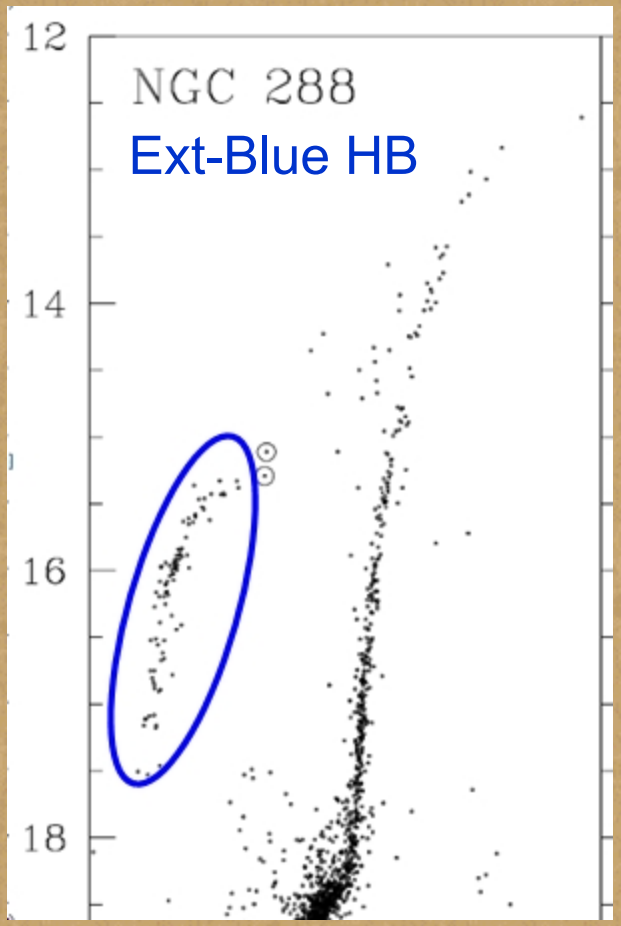
RGB = 80:20

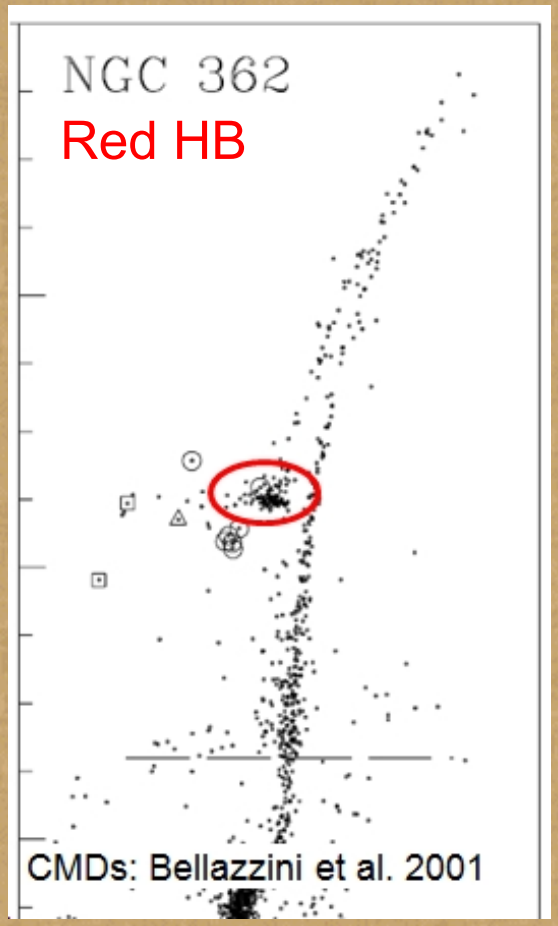
↓

AGB = 0:100

Results: GC Pair Comparison

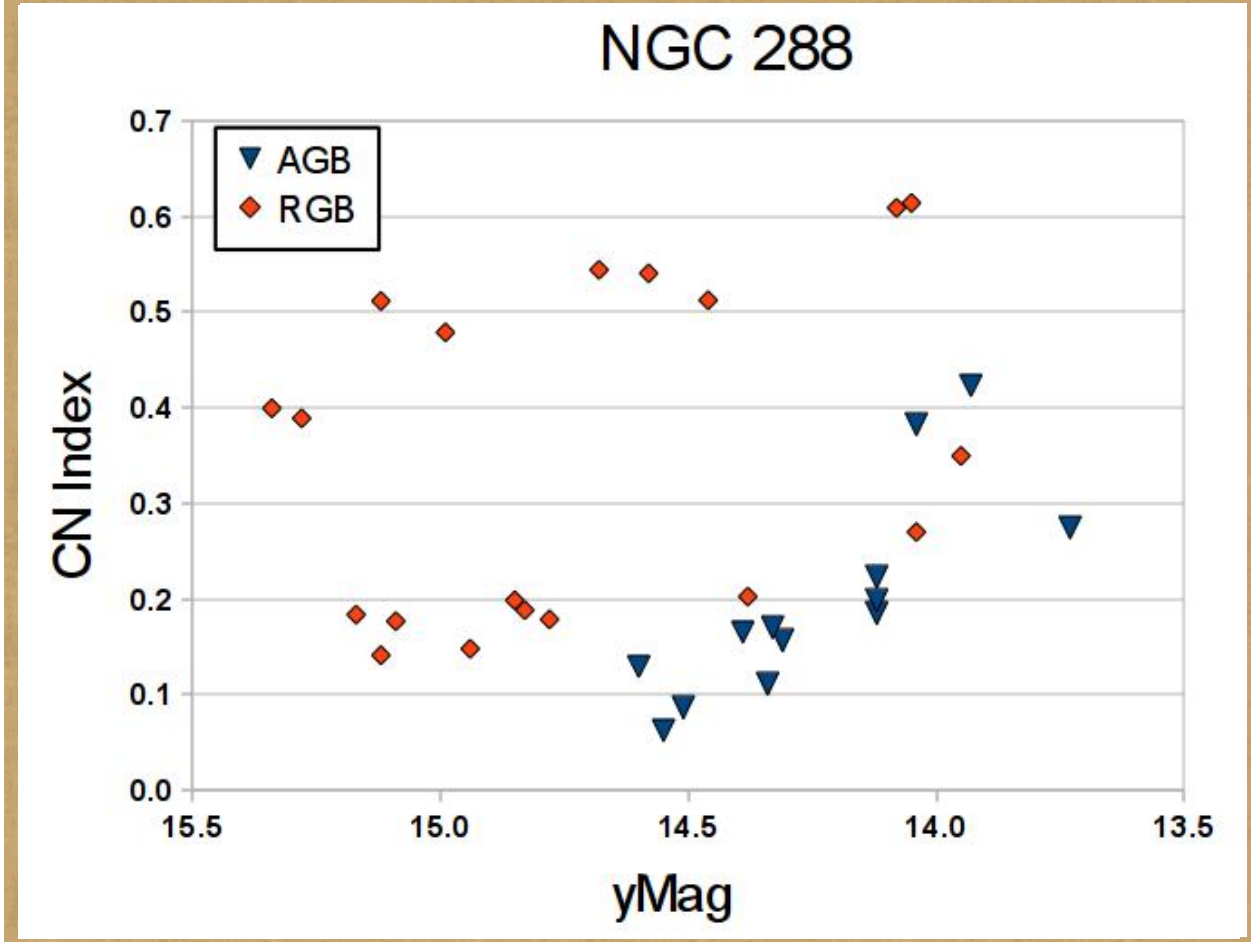
- NGC 288 and 362 have similar metallicities ([Fe/H] ~ -1.2) but different HB morphologies → compare CN behaviour.





Results: NGC 288 (Blue HB)

- The normal CN bimodality is seen on the RGB.
- And on the AGB....



Strong to Weak Ratios

RGB = 50:50

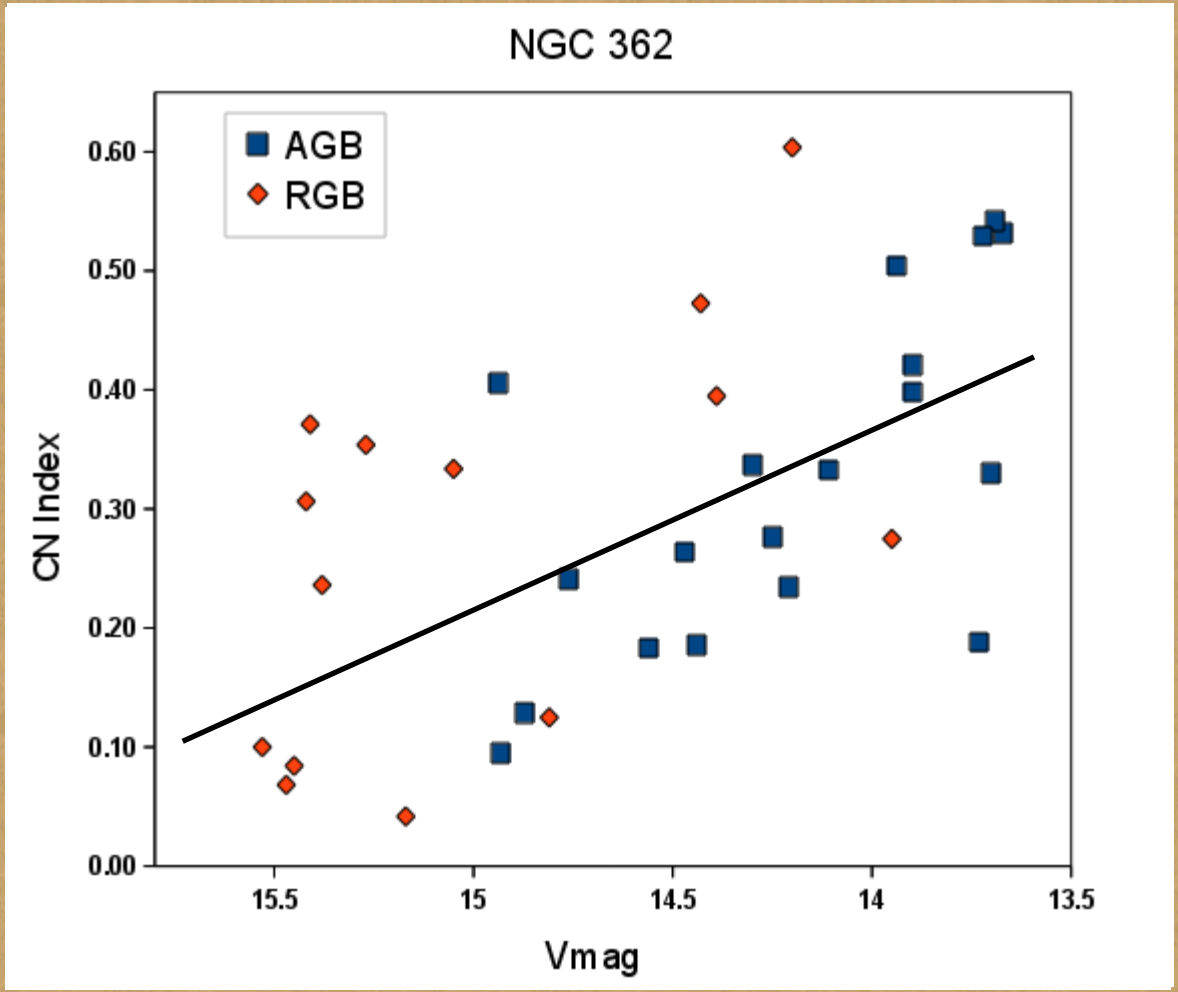
↓

AGB = 0:100

➔ A totally CN-weak AGB! – just like NGC 6752, which also has a very blue HB…

NGC 288 photometry: Grundahl et al., 1999.

Results: NGC 362 (Red HB)



Strong to Weak Ratios

RGB = 60:40

↓

AGB = 40:60 to 60:40

➔ Either a CN-weak dominated AGB, or no change from RGB (hard to define the bimodal split)

NGC 362 photometry: Bellazzini et al., 2001.

Summary/Discussion

- Our preliminary results clearly show there is *something strongly effecting the numbers of CN-strong and CN-weak stars between the RGB, HB and AGB.*
- It appears to be *related to the HB morphology of the GCs.*
- GCs with red HBs show little or no change in the ratio of CN-strong to CN-weak stars going from the RGB to AGB.
- However in GCs with very blue HBs it is amazing to find that there are *zero CN-strong stars on the AGB* (eg. 6752, 288) – the CN-strong stars seem to 'disappear' when moving from the RGB to AGB.
- ***So what is happening??***
  - *Maybe the CN-strong stars don't ascend the AGB at all?* (an idea also suggested by Norris et al. 1981). The fact that this feature is (mainly) seen in GCs with blue HBs suggests this may be the case, since the blue HB stars should have low masses.
  - Primordial abundance variations (eg. He, N) may affect mass loss or other evolution.