The "UV-route" to Search for Blue Straggler Stars in Globular Clusters: First Results from the HST UV Legacy Survey

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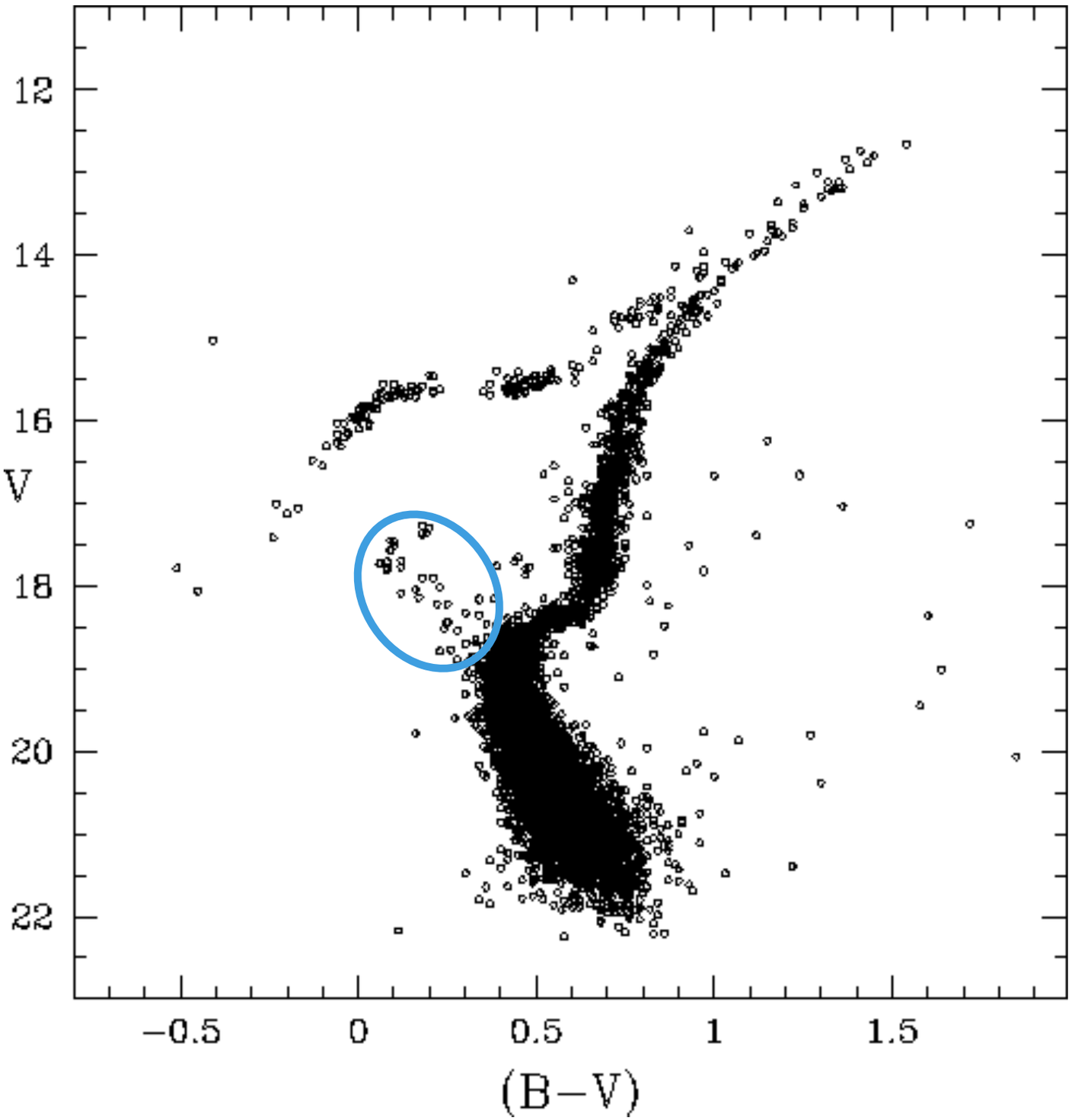
The amazing life of stars: from the Main Sequence to the Gravitational Wave emission
September 5th, 2017 - Cefalù

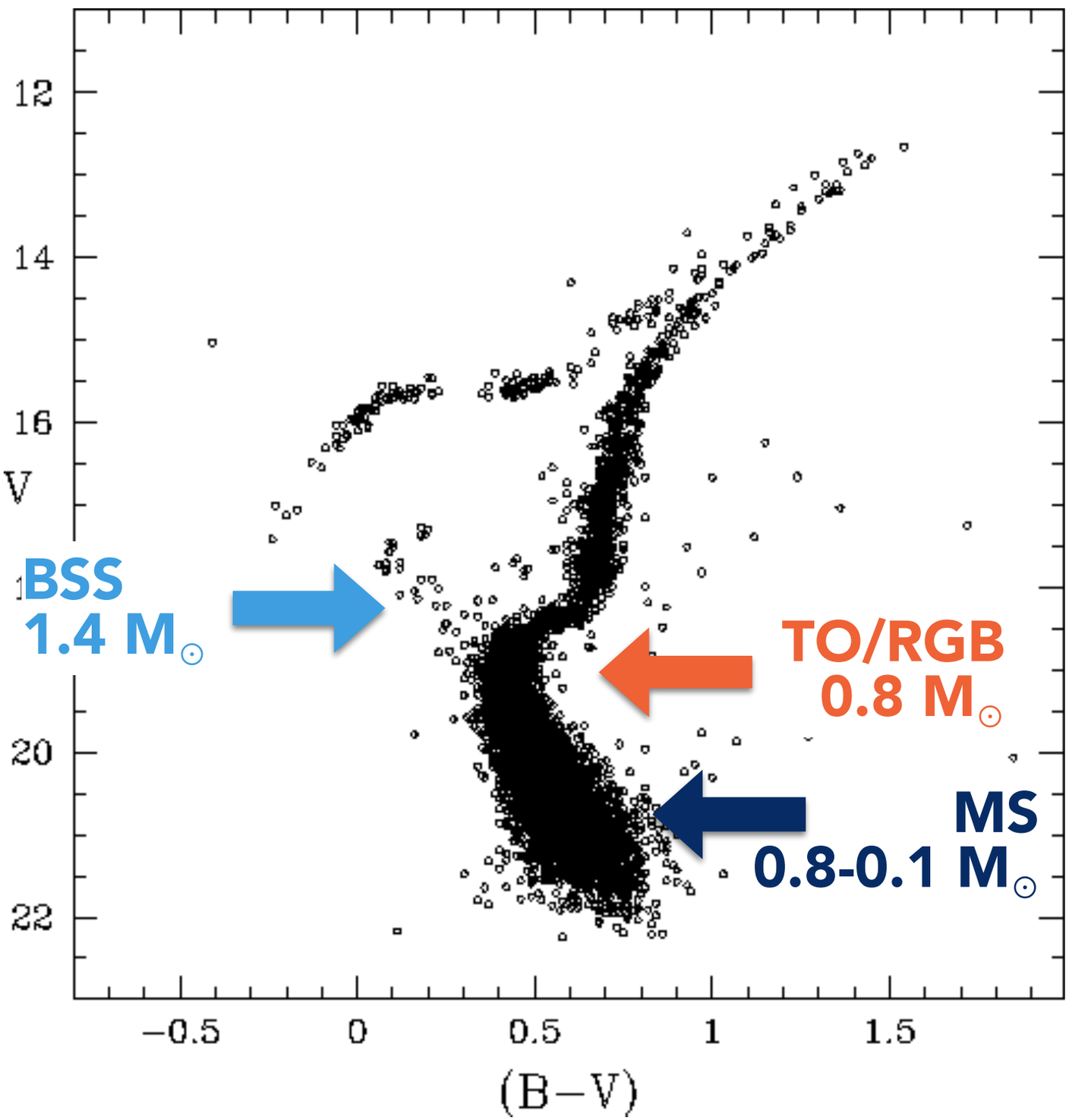
Blue Straggler Stars (BSS)



A PECULIAR stellar population: stars brighter and bluer (hotter) than the cluster MS-TO, along an extension of the main sequence

Their existence CANNOT be interpreted in terms of the evolution of a “normal” single star

Blue Straggler Stars (BSS)



BSS more massive than normal stars

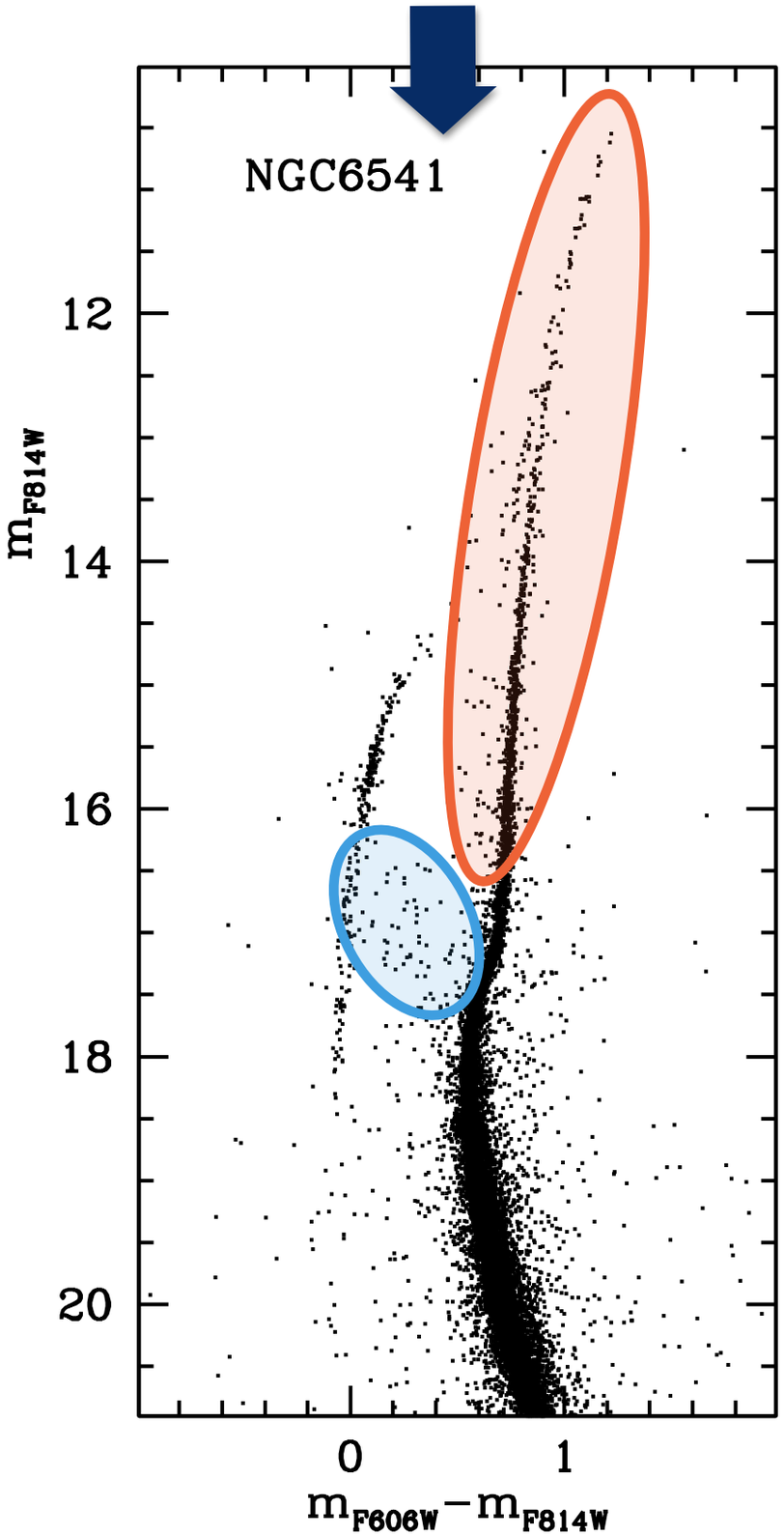
(see Shara et al. 1997, Fiorentino et al. 2014)

They are crucial **gravitational probe-particles** to test GC internal **dynamical processes.**

We study their **radial distribution** because dynamical friction (DF) progressively makes them sink towards the cluster center

BSS observations in GCs

The "classical" optical diagram



Cool giants (RGB/AGB) are much brighter than **BSS**

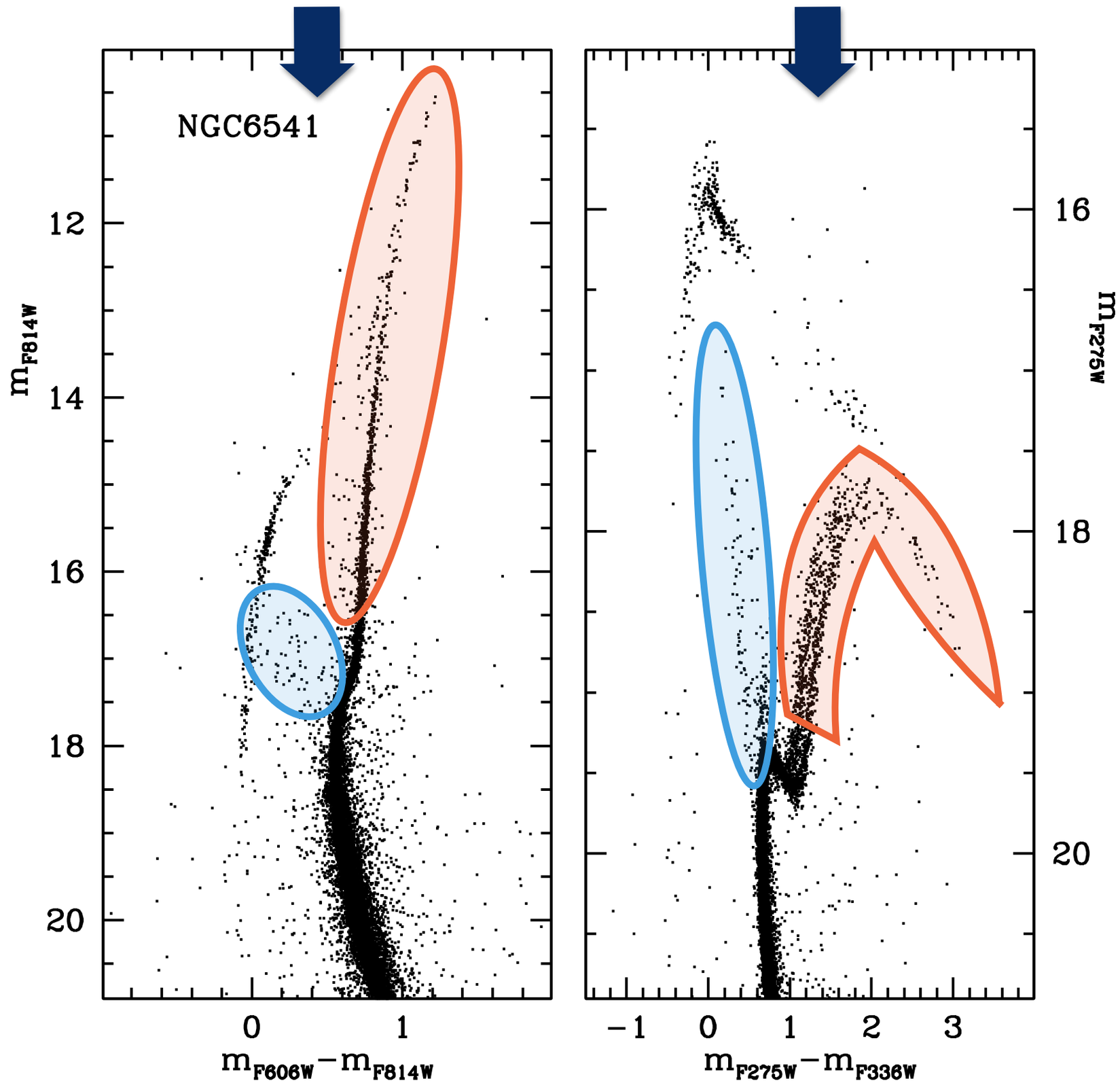
How to switch them off?

UV

UV observations

The "classical" optical diagram

The UV diagram



UV sensitivity

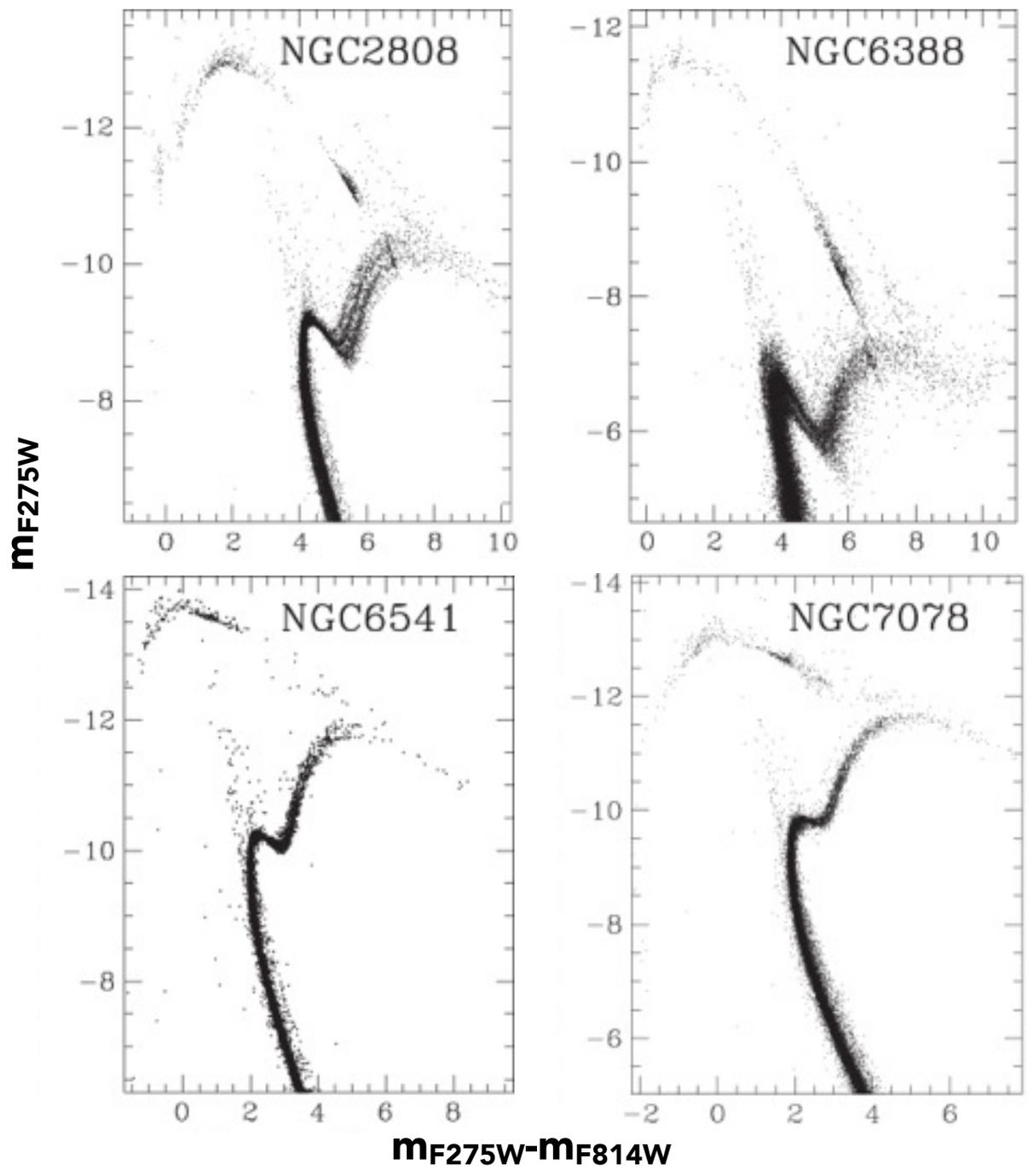
+

High resolution:

allow systematic studies of hot stellar populations even in the core of **high density** GCs

The UV route to search for BSS in GGCs

Exploiting the HST UV Legacy Survey of GGCs: 57 GGCs observed in **3 blue filters** (F275W, F336W, F438W; GO-13297; PI: Piotto)



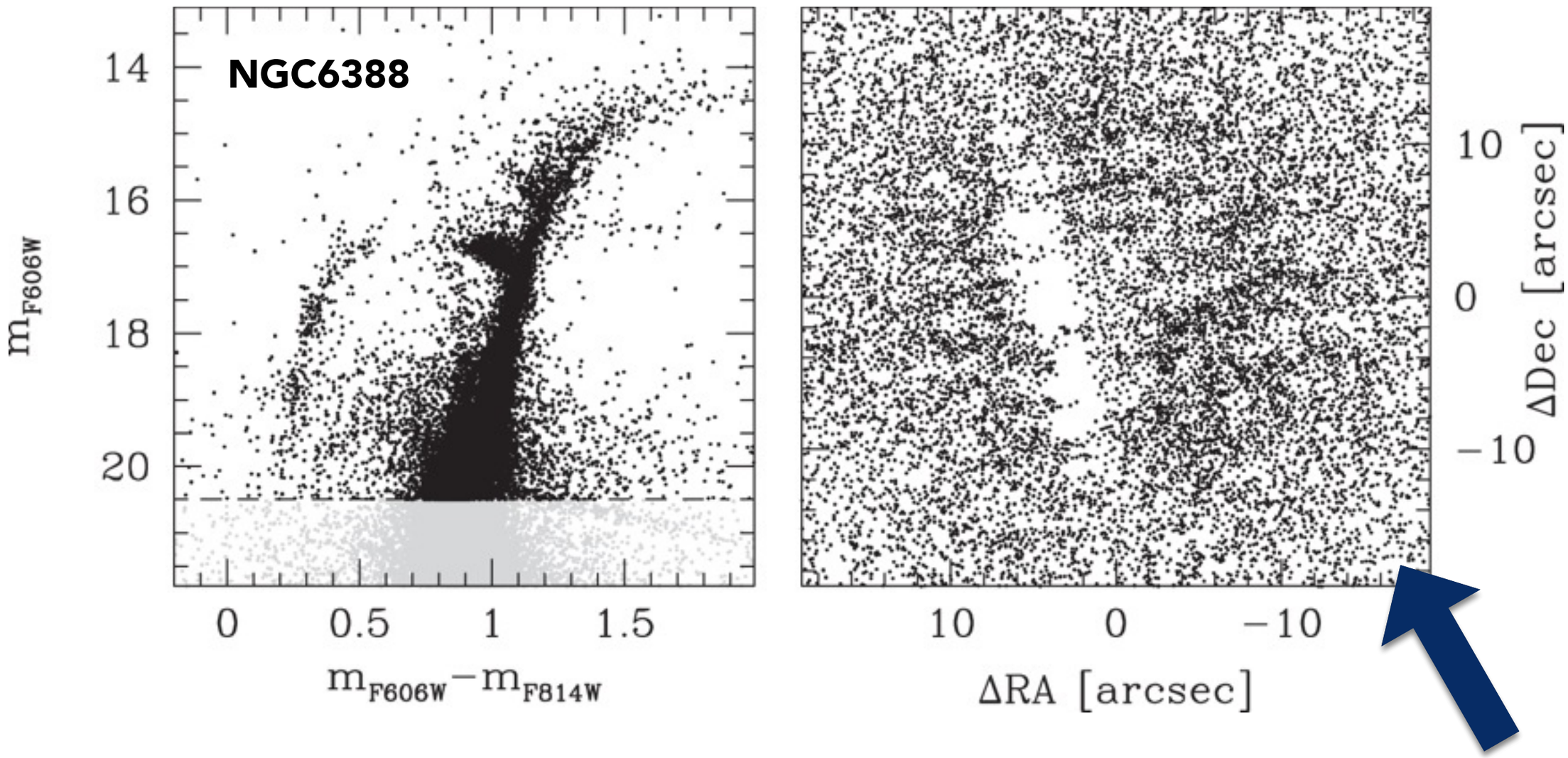
CMDs from Piotto et al. 2015, AJ, 149, 91

First results for 4 **high central density** GGCs:

NGC2808, NGC6388, NGC6541, NGC7078 (M15)

(Raso et al. 2017, ApJ, 561, 337)

Incompleteness of optical-driven catalogs

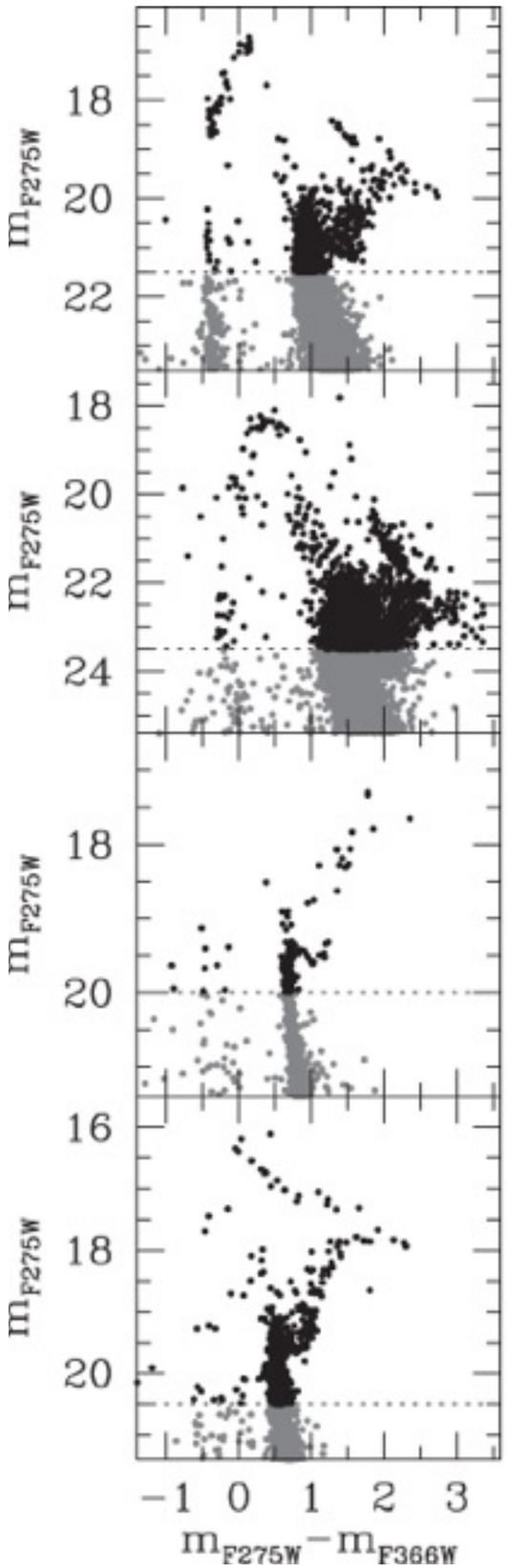


Available **optical** surveys of GGCs (as for example the ACS survey, PI: Sarajedini) **are not optimized to search for BSS**

Map of the central region of NGC6388 obtained from all the stars **brighter** than m_{F606W}=20.5

Raso et al. 2017, ApJ, 561, 337

Advantages of UV-driven approach

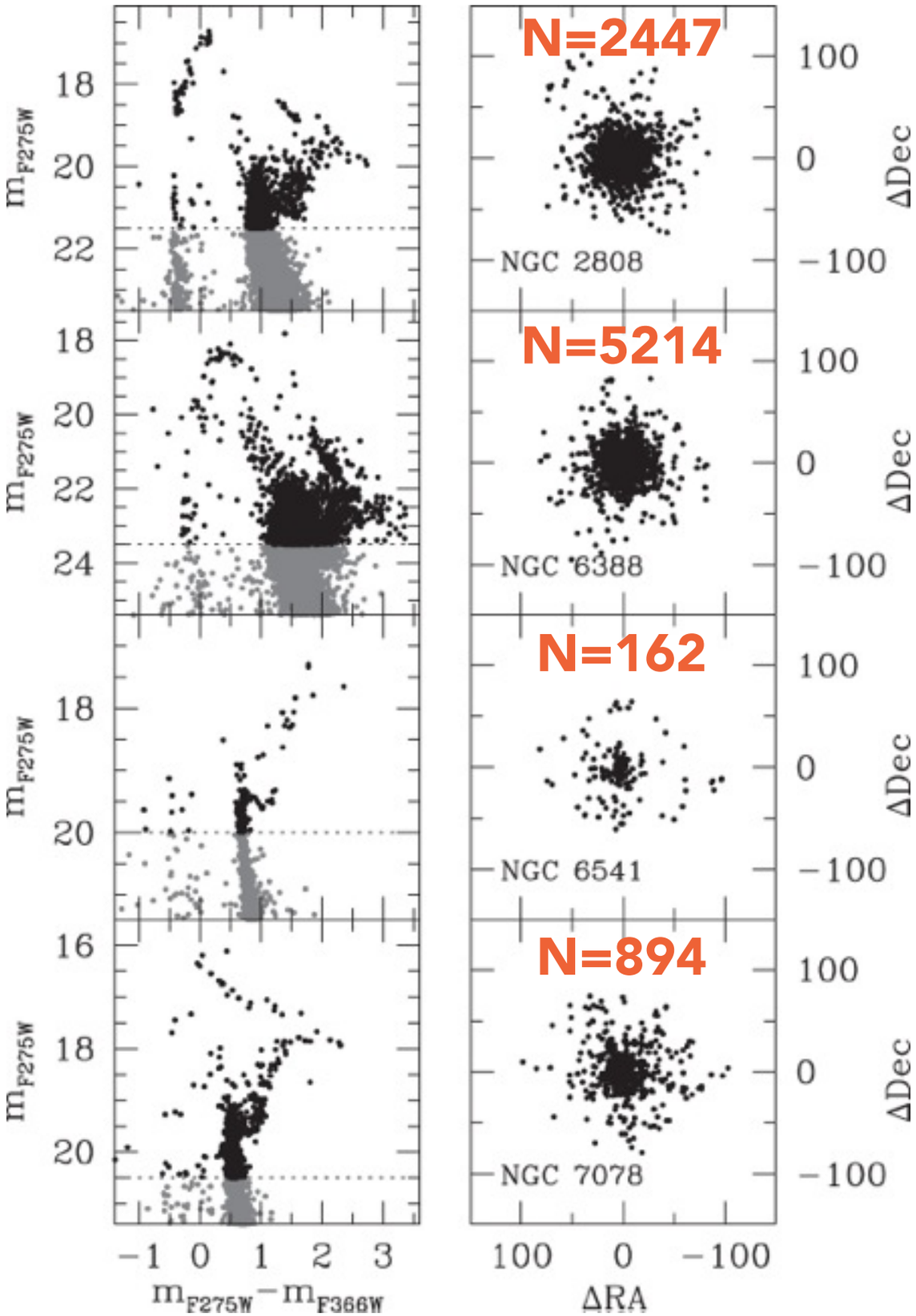


Left: CMDs of the **stars lost** in the optical-driven photometric reduction with respect to the UV-driven reduction.

Stars recovered along all evolutionary sequences

Raso et al. 2017, ApJ, 561, 337

Advantages of UV-driven approach



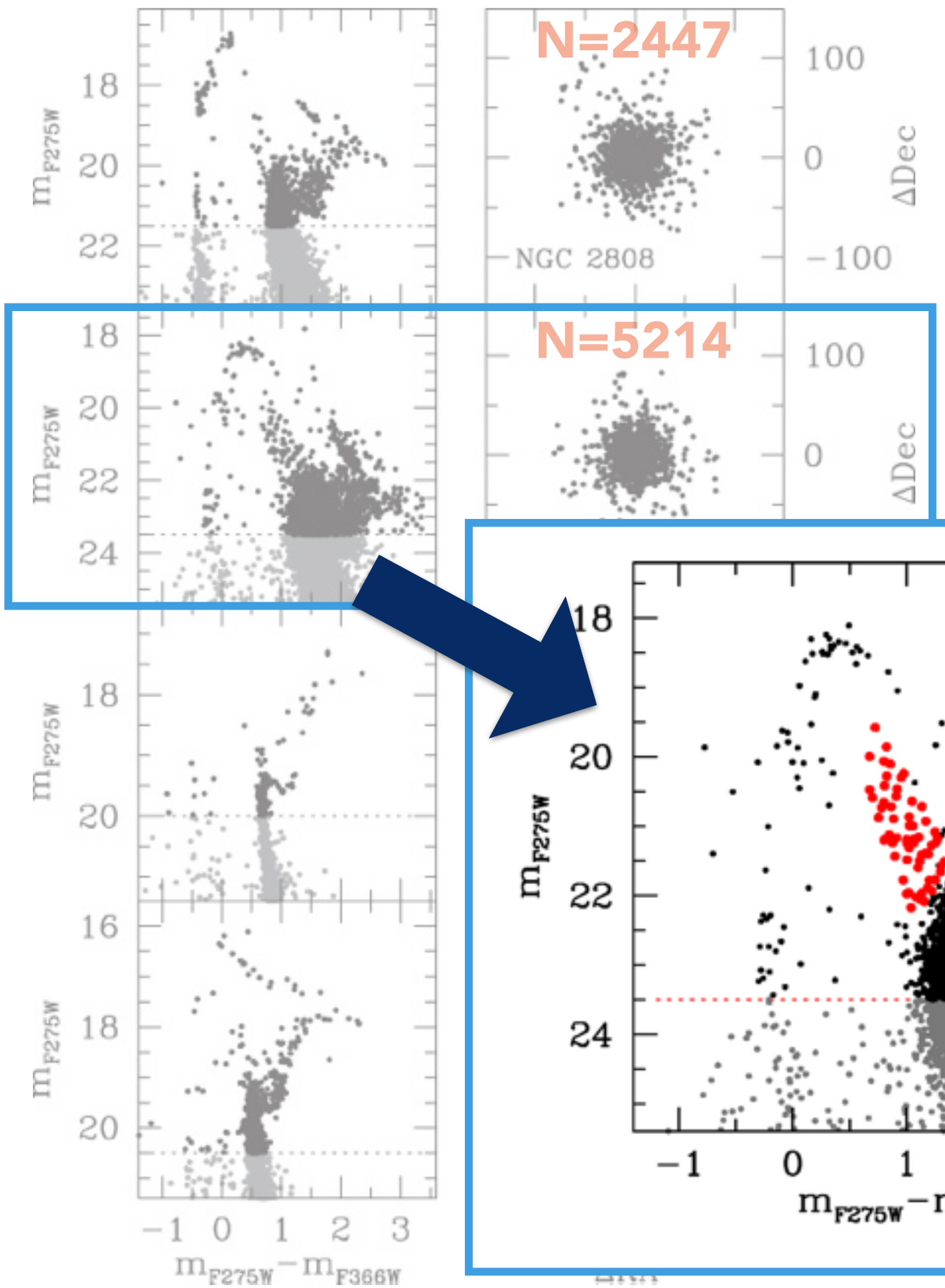
Left:

the optical-driven photometric reduction with respect to the UV-driven reduction.

Right: spatial distribution of the **missed stars brighter than the dashed lines** in the left panel.

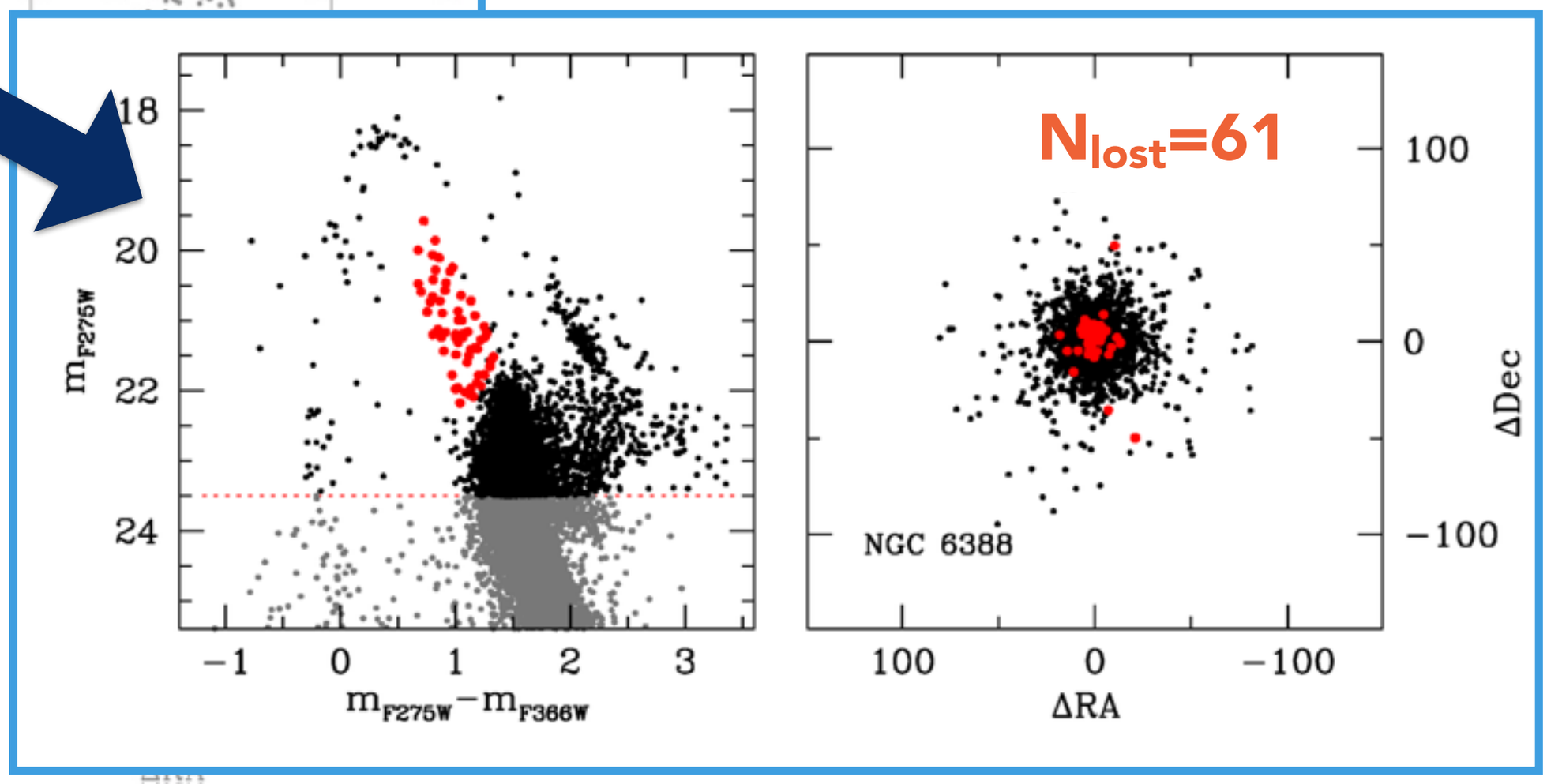
Raso et al. 2017, ApJ, 561, 337

Advantages of UV-driven approach



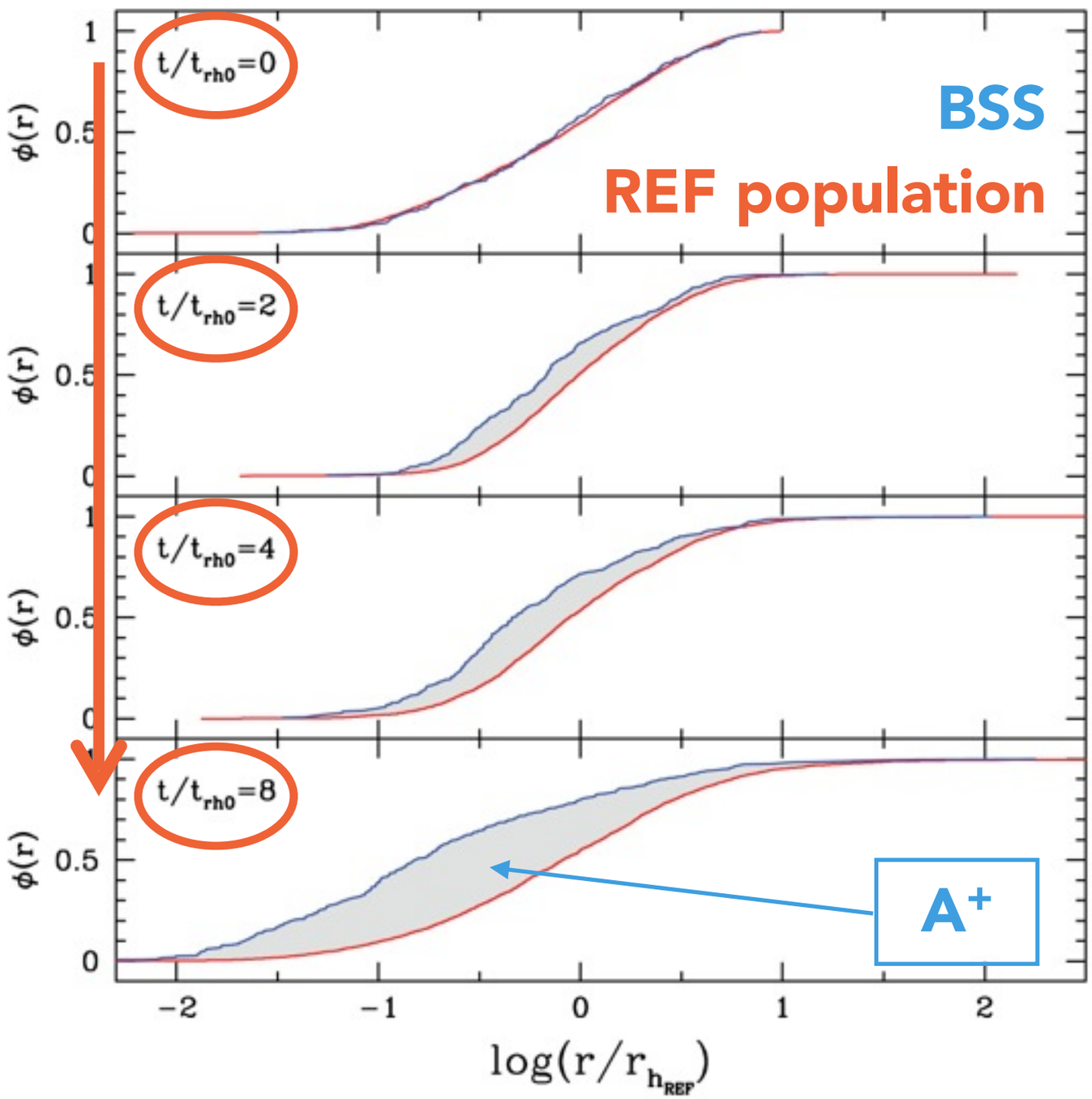
NGC6388: N_{BSS}=288

61 BSS (~20%) missed in the optical-driven catalog with respect to the UV-driven reduction



Refining the dynamical clock

10^5-particles N-body simulations to study the BSS segregation process as a function of time, using the **cumulative** radial distribution



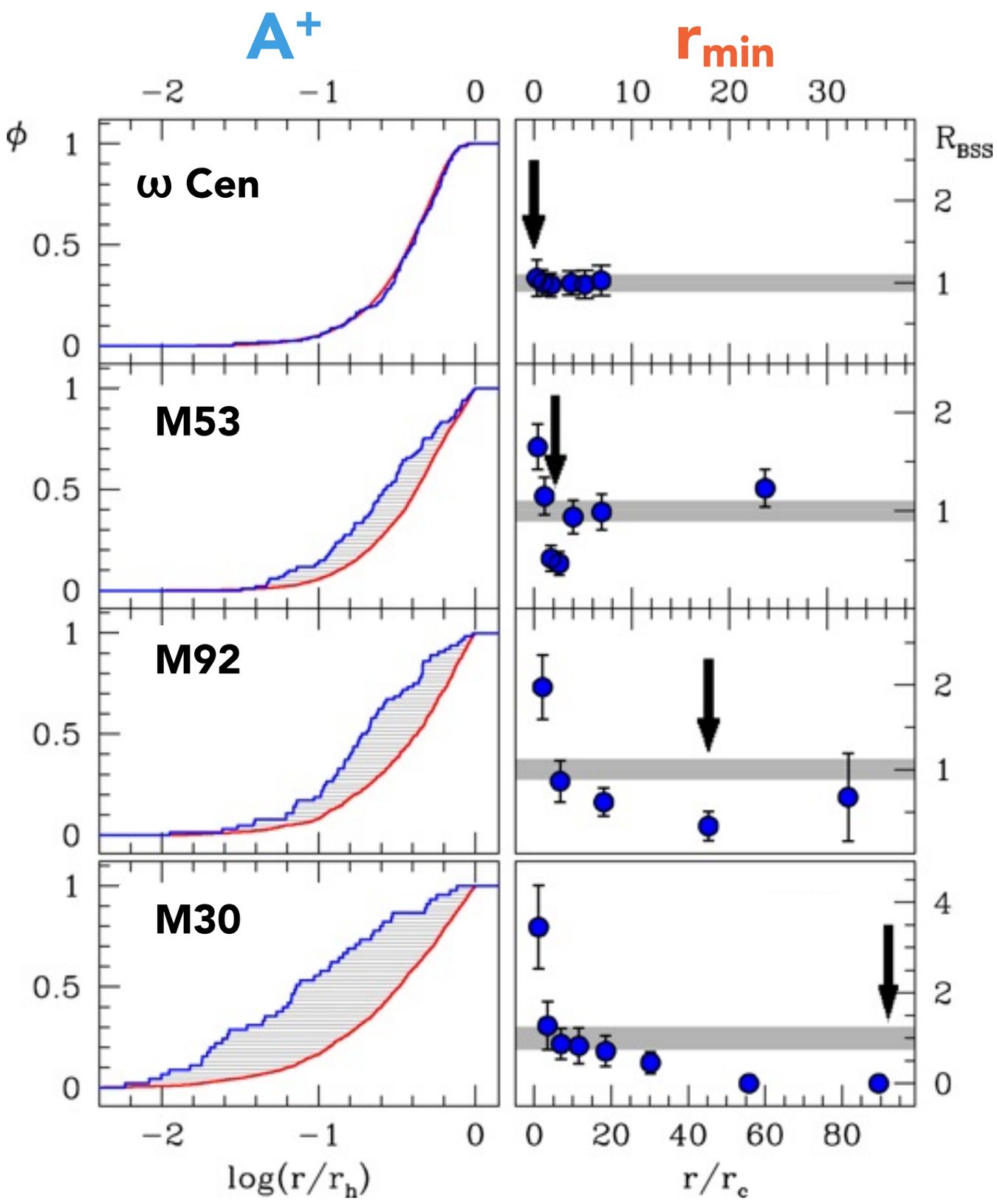
The area between the **BSS** cumulative radial distribution and that of a **reference population** **increases monotonically** with time.

Definition of A^+:

$$A^+(x) = \int_{x_{min}}^{x} [\phi_{BSS}(x') - \phi_{REF}(x')]dx'$$

Alessandrini et al. 2016, ApJ, 833, 252

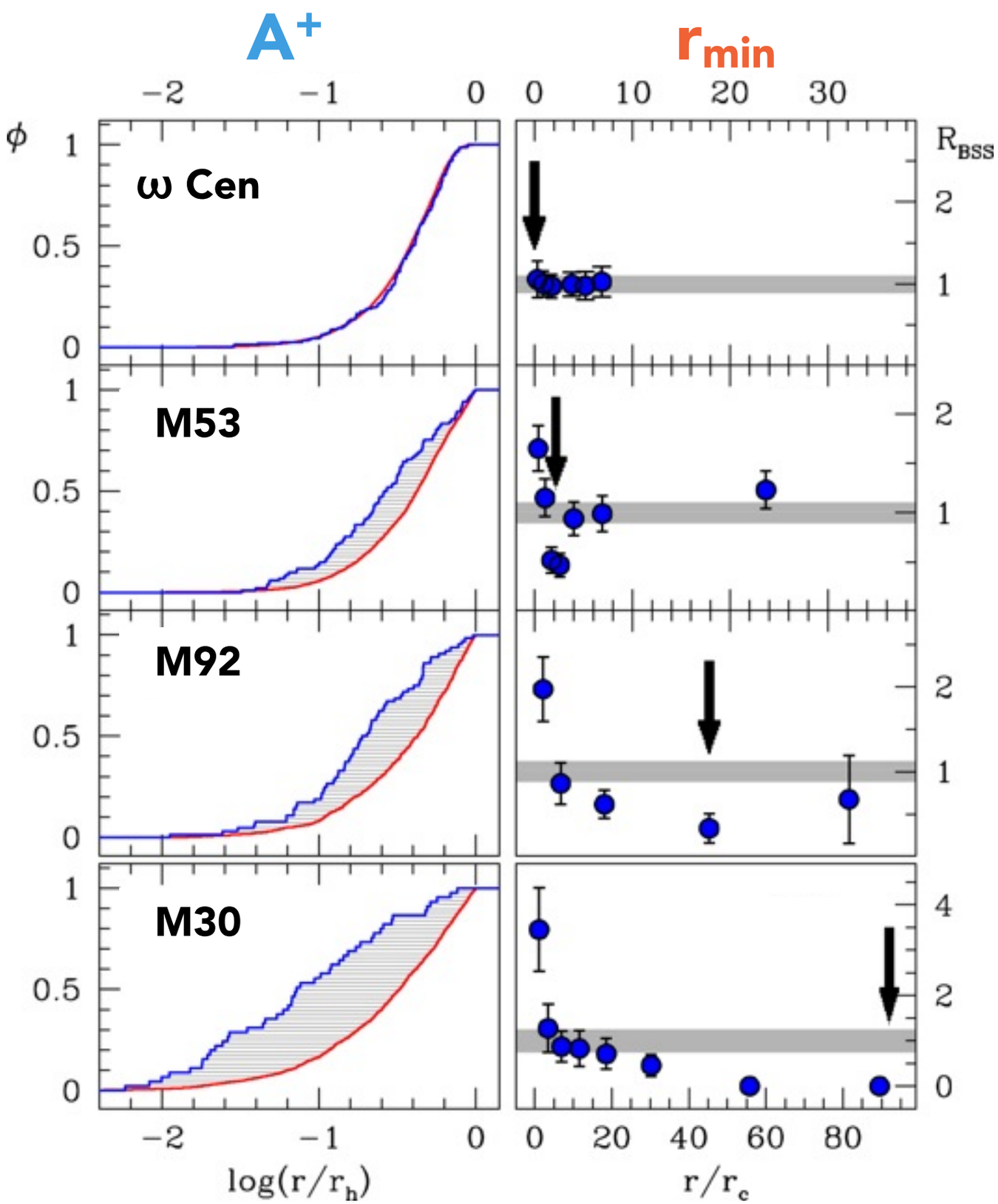
Refining the dynamical clock



Values of A+ in 25 GCs used for the definition of the **dynamical clock** in Ferraro et al. 2012, Nature, 492, 393

Lanzoni et al. 2016, ApJ, 833, L29

Refining the dynamical clock



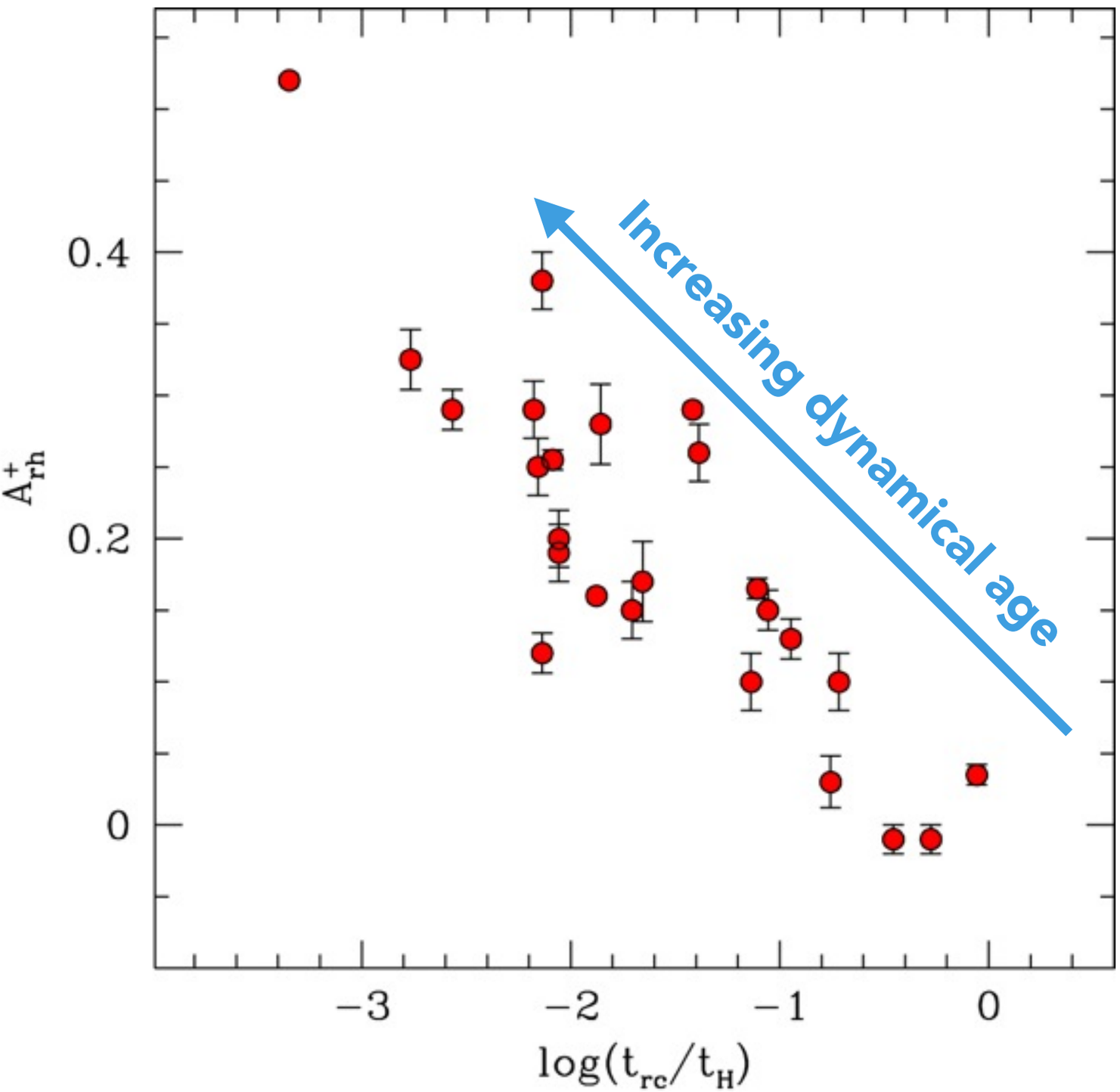
Values of A+ in 25 GCs used for the definition of the **dynamical clock** in Ferraro et al. 2012, Nature, 492, 393

Why defining a different indicator?

- easier to measure
- no binning
- "high signal" feature

Lanzoni et al. 2016, ApJ, 833, L29

Refining the dynamical clock

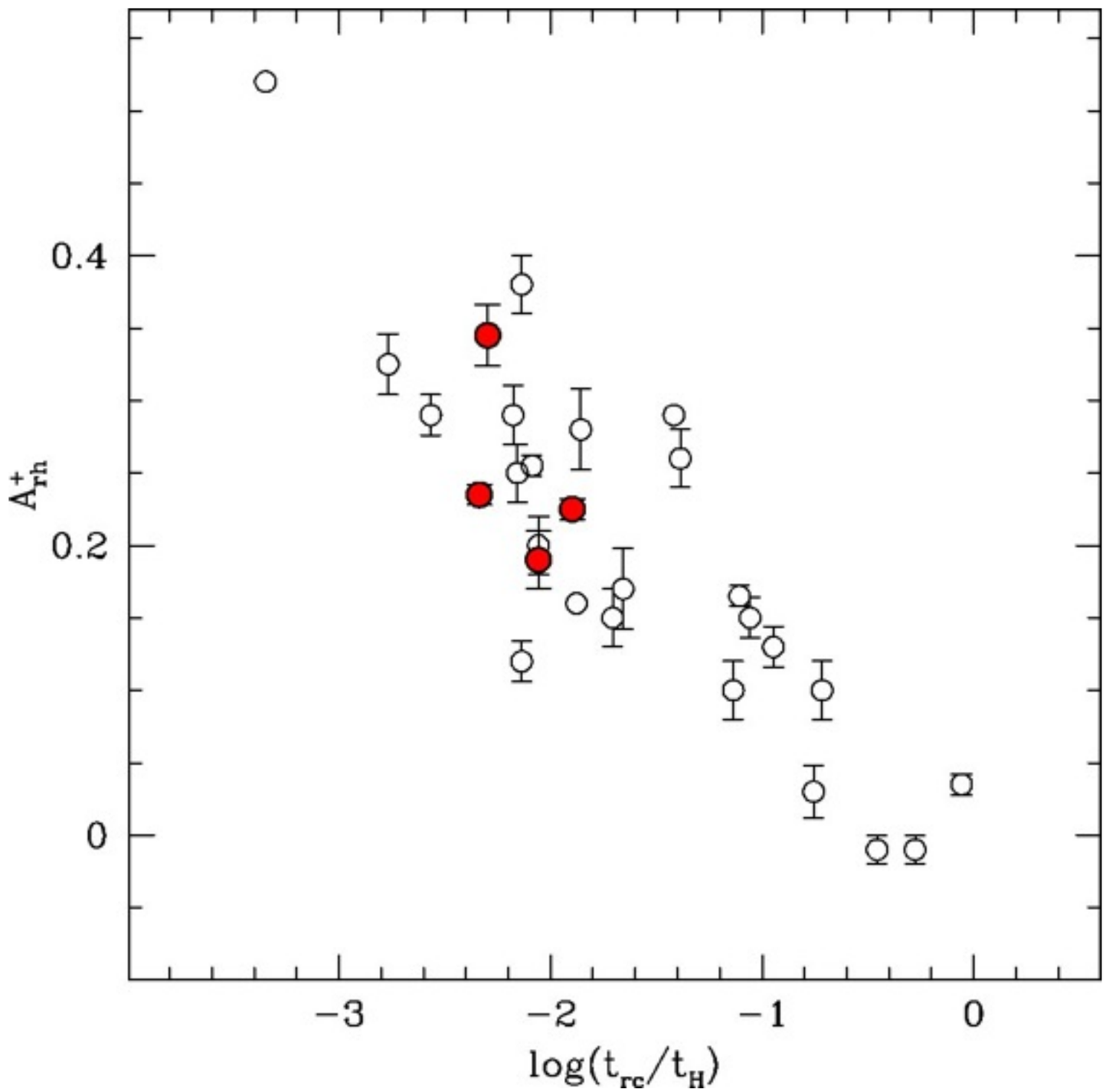


A^+ correlates with the **central relaxation time** (t_{rc})

efficient tool to rank stellar systems as a function of their dynamical age.

Lanzoni et al. 2016, ApJ, 833, L29

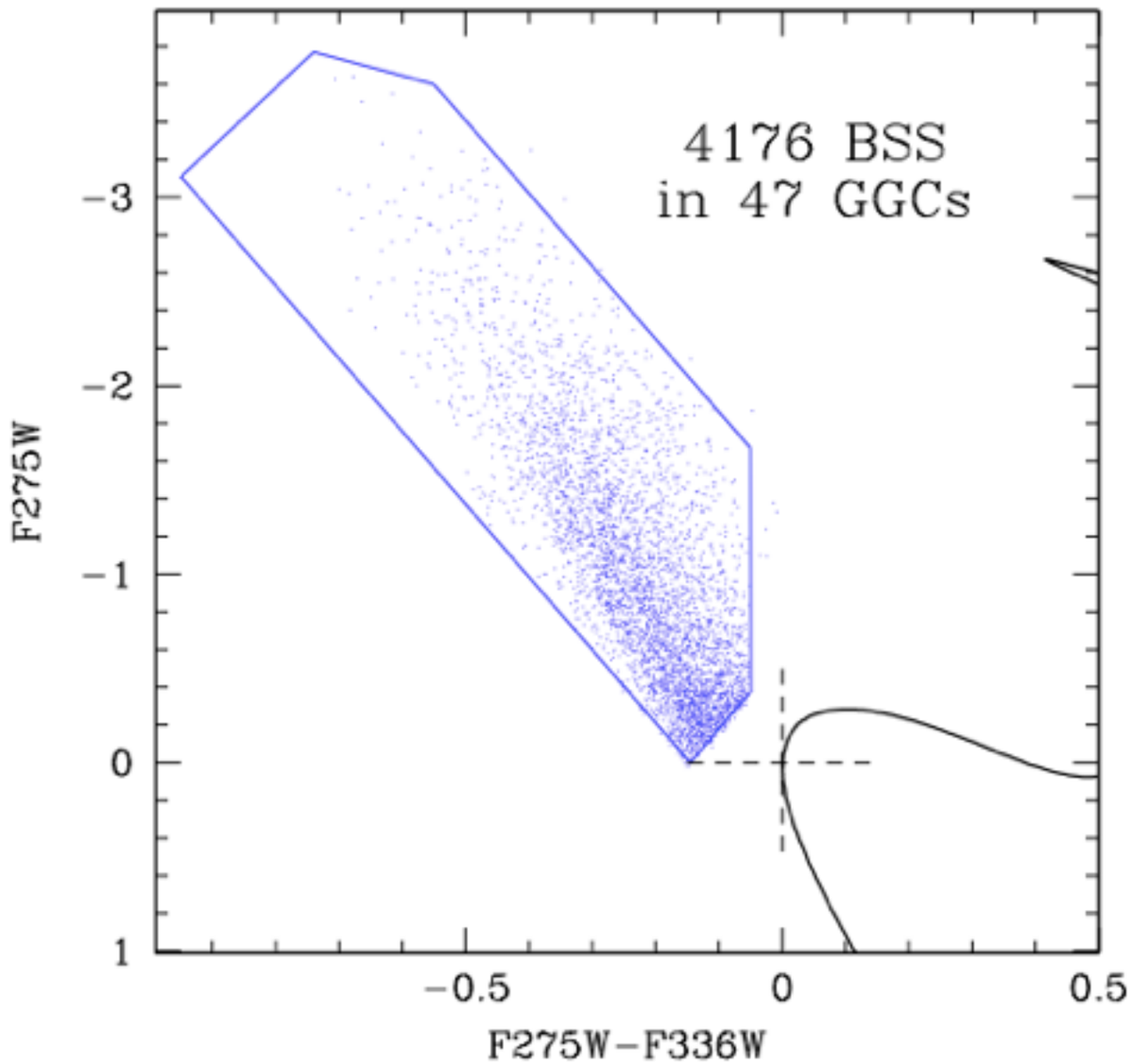
Refining the dynamical clock

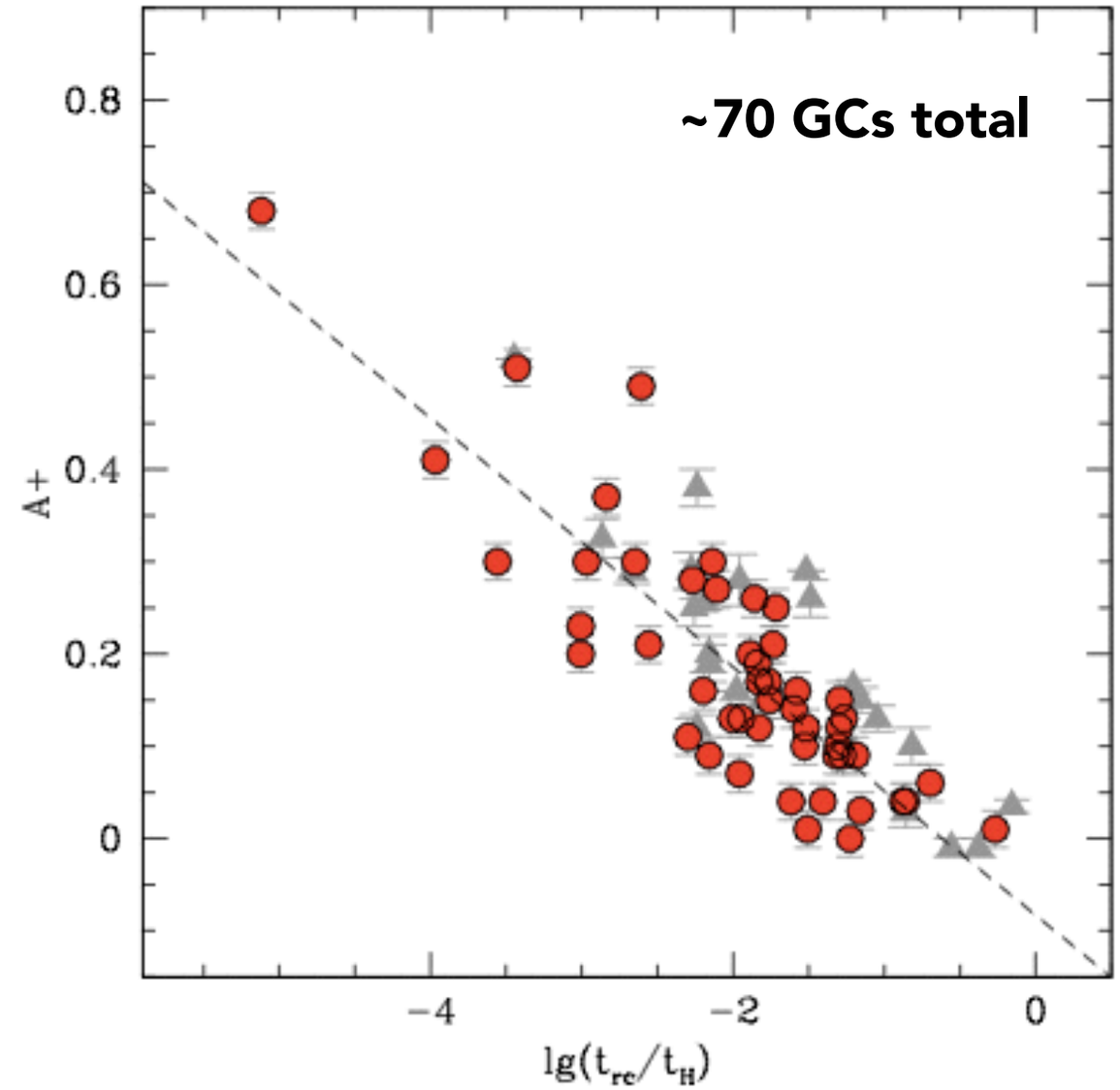


The first results from the HST UV Legacy Survey (red circles) **agrees with the A^+ - t_{rc} correlation** from Lanzoni et al. 2016 (black empty circles)

Raso et al. 2017, ApJ, 561, 337

Future perspectives





Work in progress: using catalogs from the HST UV Survey and the selection boxes defined in Raso et al. 2017 we are going to obtain the **largest sample of BSS ever published**

Ferraro et al. 2017, in preparation

Summary

- BSSs are a peculiar stellar population, brighter and hotter than the turn-off point. They are crucial gravitational probe-particles to test GCs internal dynamics.
- The combination of UV sensitivity and high resolution is essential to study hot stellar populations (such as BSSs) in GCs.
- The UV-driven search is the most efficient way to obtain complete samples of BSSs.
- A+ is a new indicator of dynamical evolution defined as the area enclosed between the cumulative radial distribution of BSSs and that of a reference population. It correlates tightly with the central relaxation time, thus providing an efficient tool to rank stellar systems as a function of their dynamical age.

Thank you for your attention!