Photometry and astrometry with the effective-PSF

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Traditional PSFs:

- Analytical functions
- integration over pixel
- not flexible method

The goal:

- high-precision photometry (r.m.s ~0.01 mag)
- high-precision astrometry (r.m.s. ~0.01-0.02 pixel)

The effective PSF

Anderson & King 2000, PASP 112, 1360

The **instrumental PSF:**

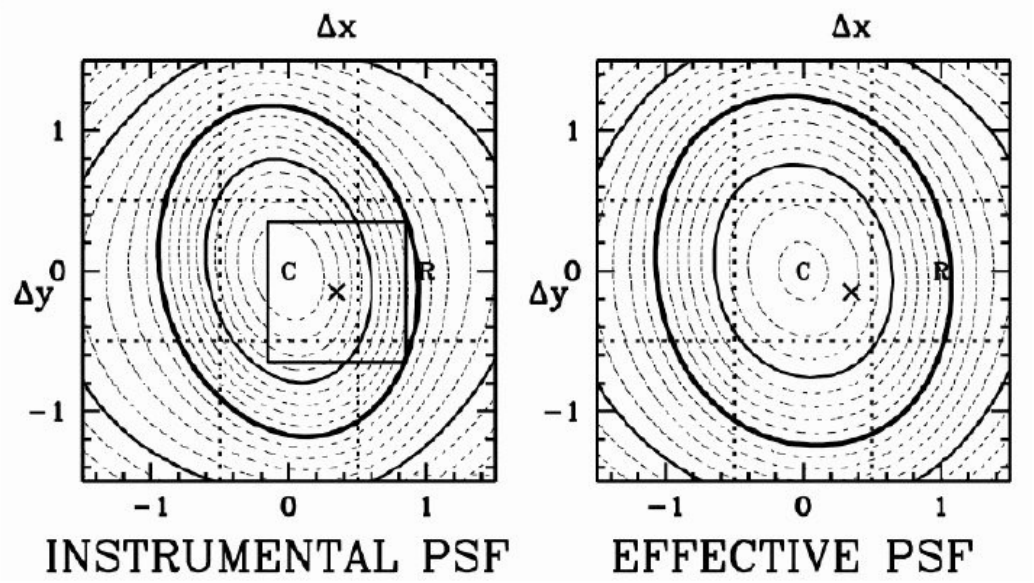
is the profile that the instrument renders when the input is a point source.

We never see the iPSF: what we see instead is the array of pixels that result from it.

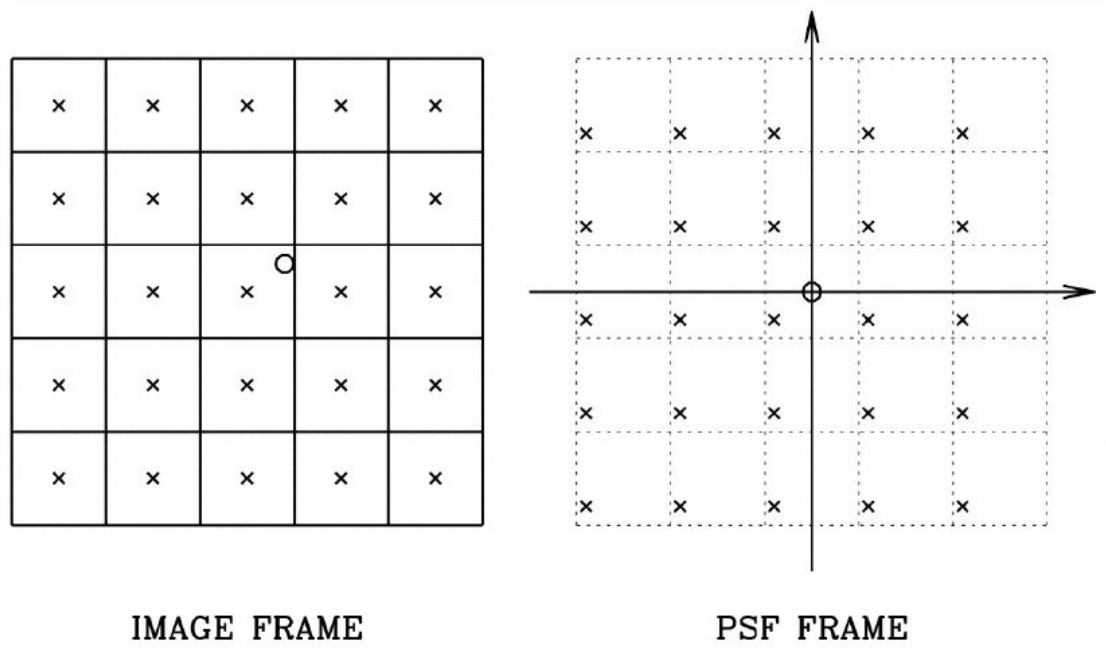
The **effective PSF:**

- Mathematically, the ePSF is the iPSF convolved for the pixel-response function.
- It is a 2-d smooth function of (Δx,Δy).
- Tells us the fraction of light that falls in a pixel at (Δx,Δy).

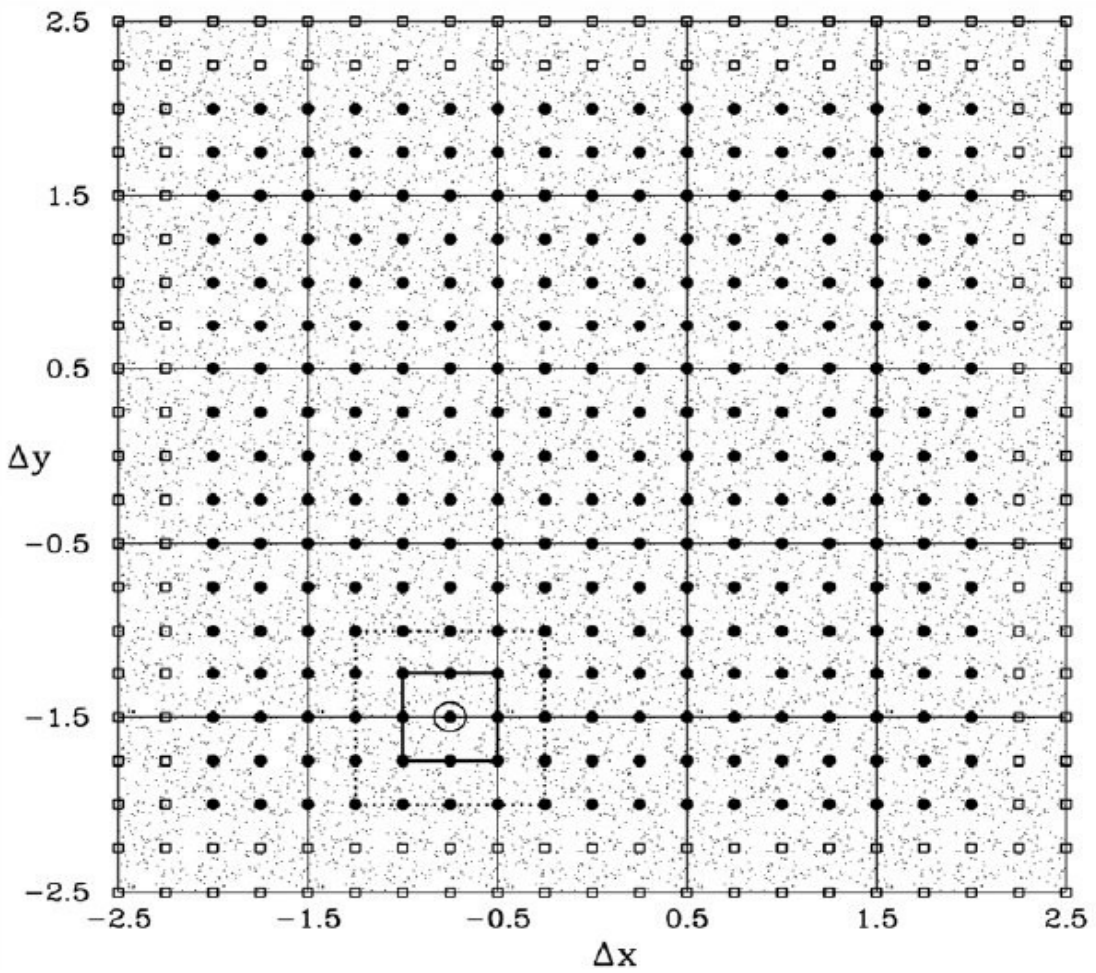
iPSF to ePSF



Each star samples the ePSF at an array of points

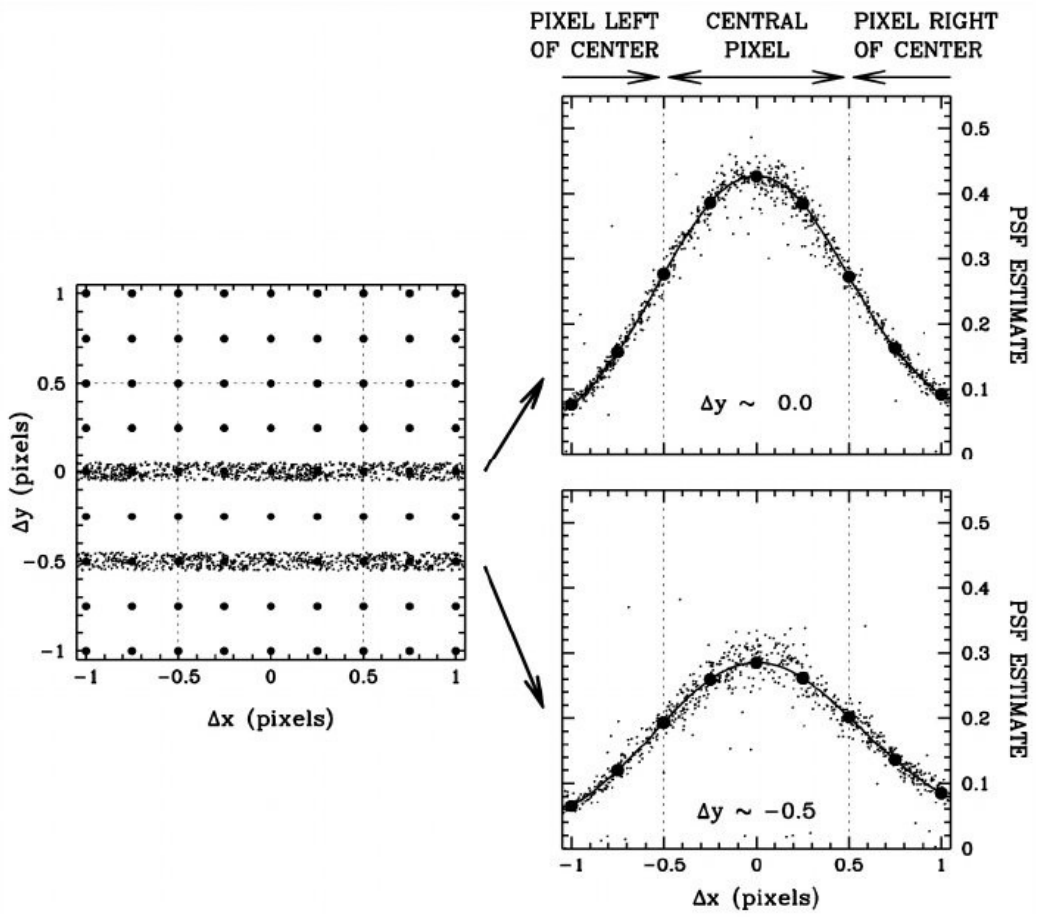


Many ePSF point-samplings from many stars



4) Modeling the ePSF

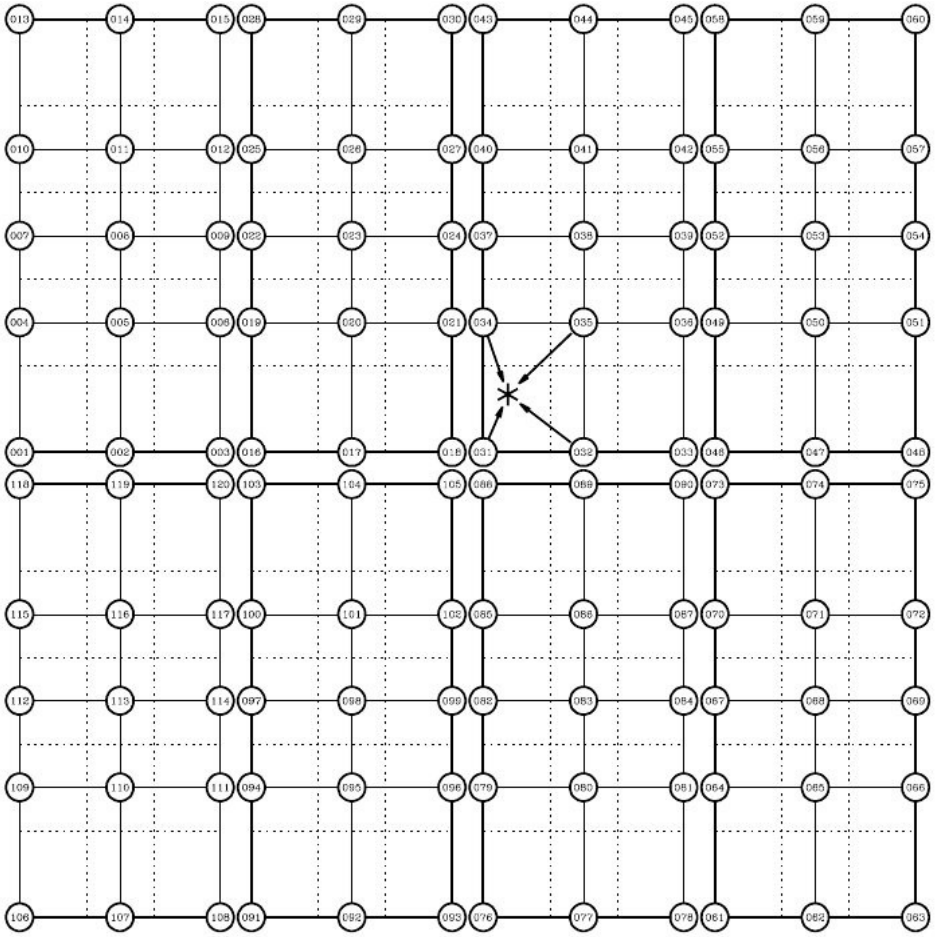
- How to go from a myriad of point sampling to a simple predictive model?
- Analytical functions?
- We adopt a simple empirical grid, supersampled x4
  - Distill information from many samplings into grid points
  - Constraints
    1) overall normalization
    2) sub-pixel normalization
    3) centering
    4) smoothness

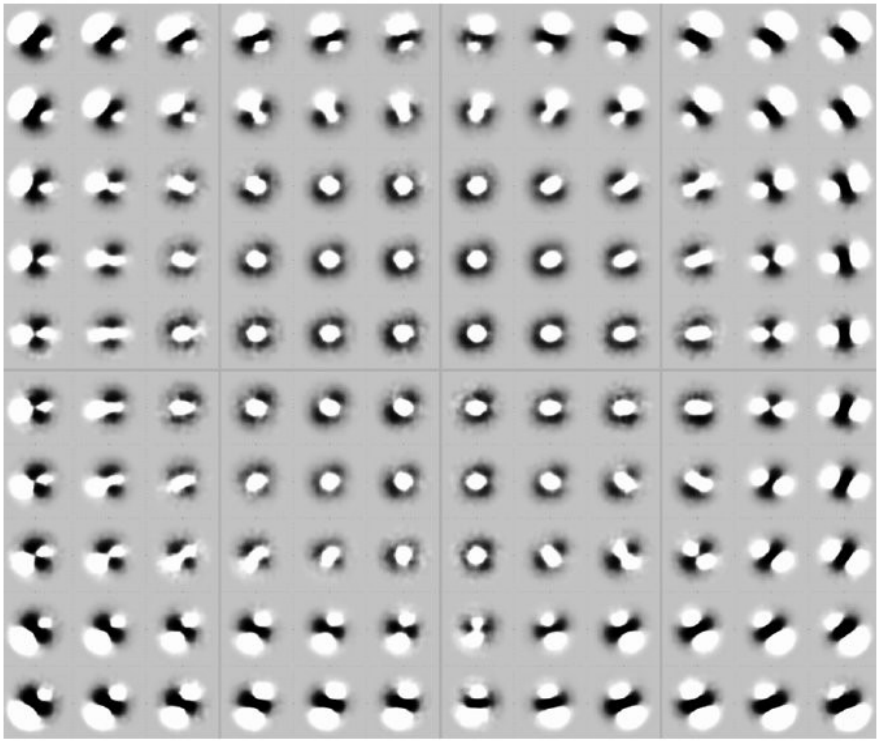


PSF variability: array of PSFs for each chip.

Color variability: must derive one PSF for each filter

Temporal stability: ???

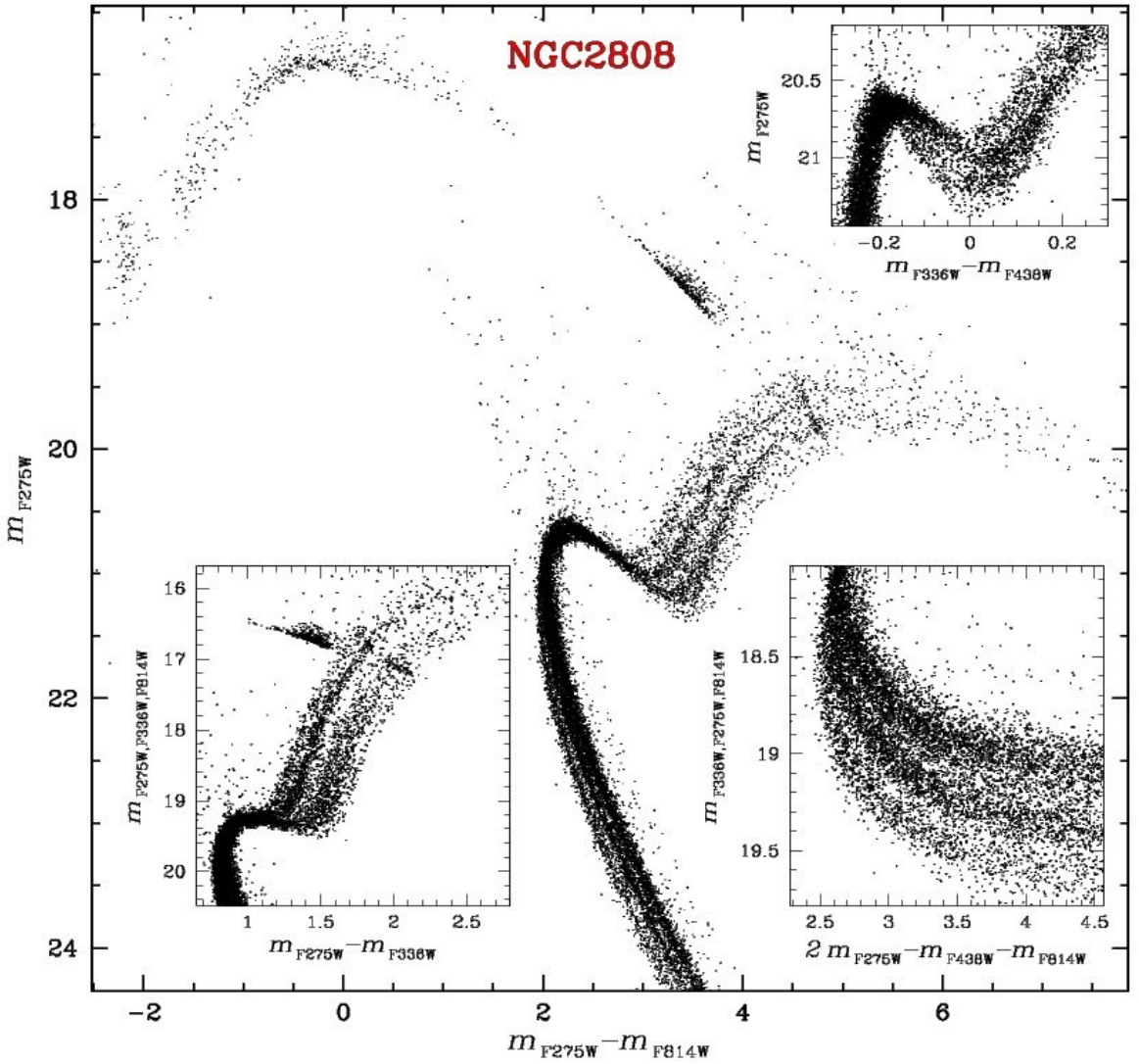




Anderson et al. (2006)

Scientific possibilities:

- High-precision photometry



Milone et al. (2014, in prep.)

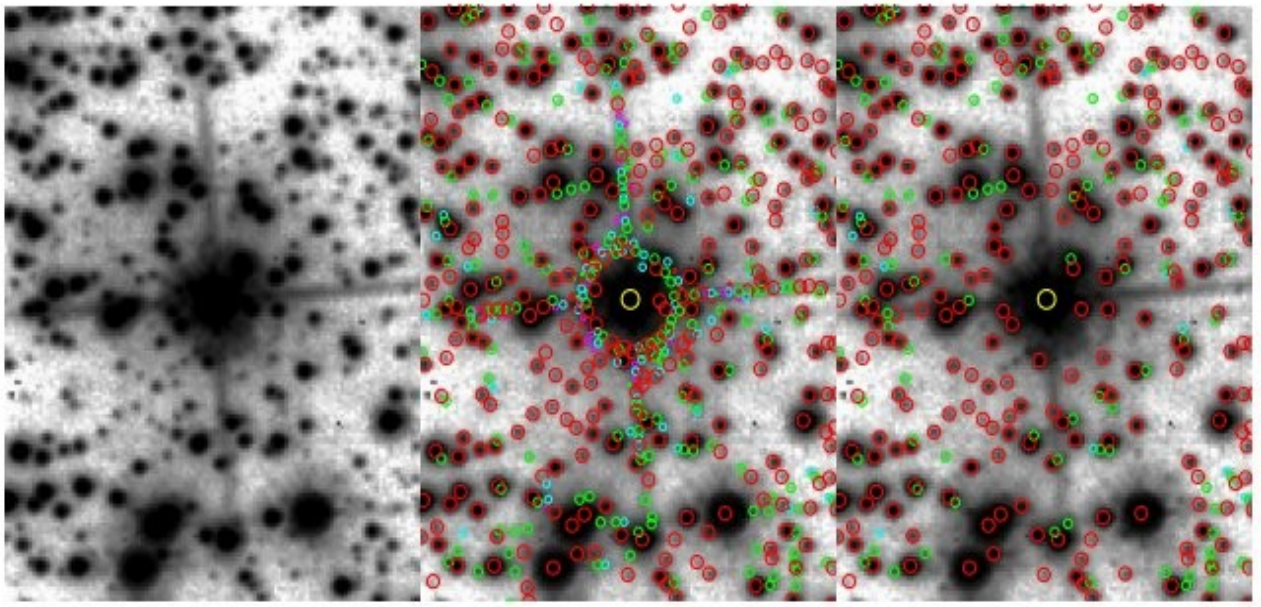
Deep photometry

There are two ways to measure stars in multiple exposures.

1) We can either measure each star independently in each exposure and later combine observations,

or

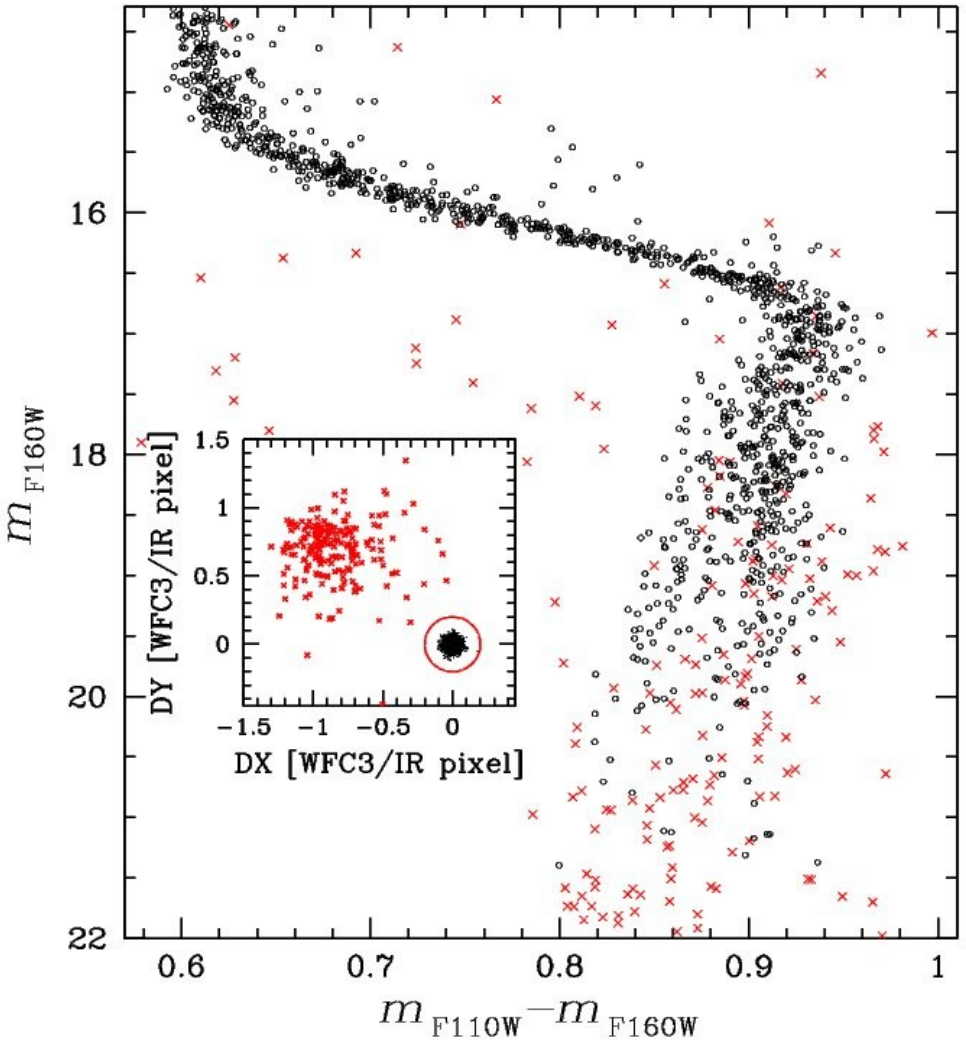
2) we can fit for a single flux and position for each star simultaneously to all the pixels in all the exposure. The latter approach is better for very faint stars, which cannot always be robustly found and measured in every individual exposure

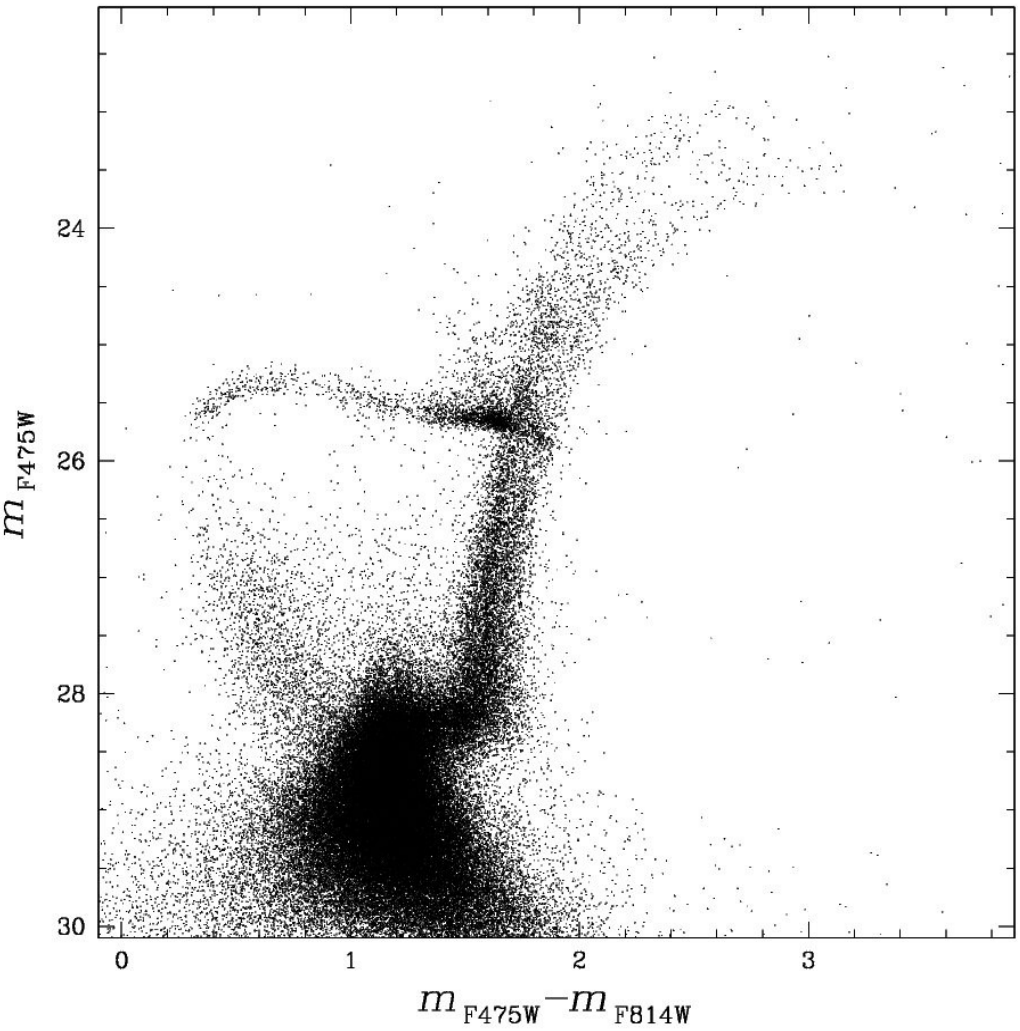


Anderson et al. (2008)

Scientific possibilities:

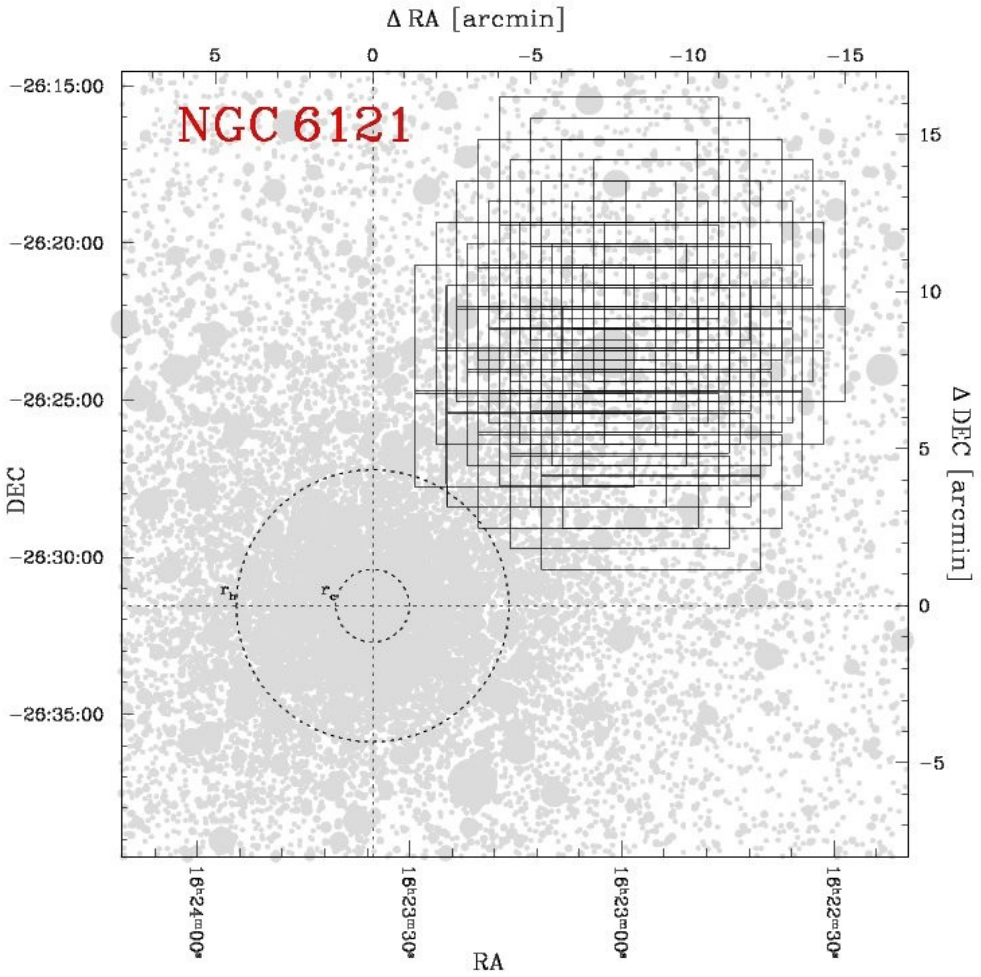
- Very deep photometry



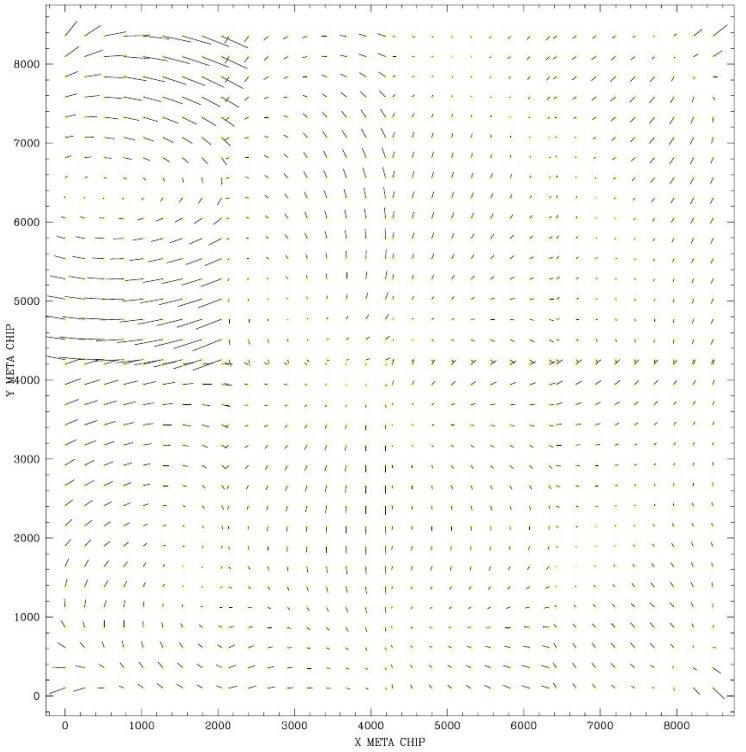


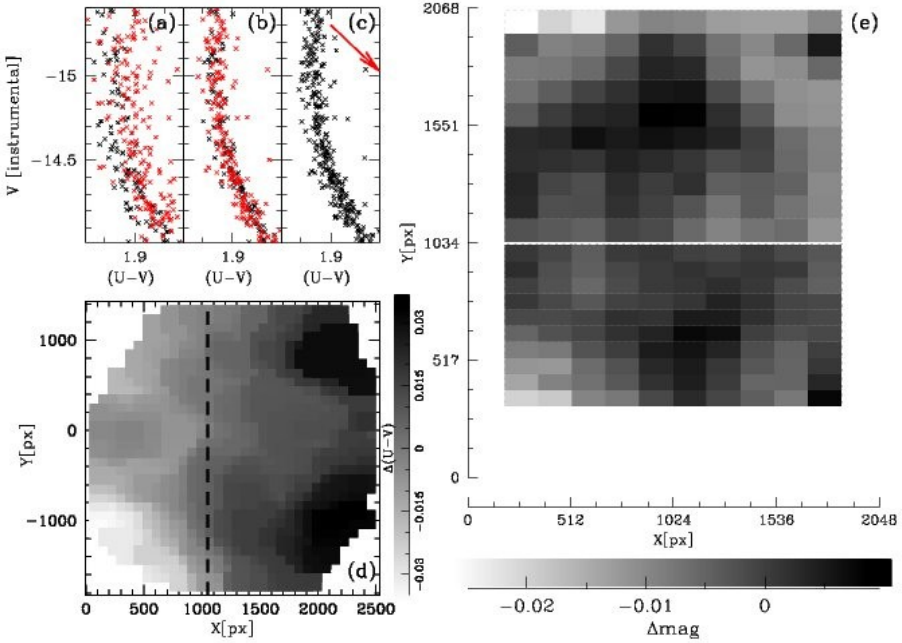
Milone et al. (2014)

Geometric distortion and zero-point variation

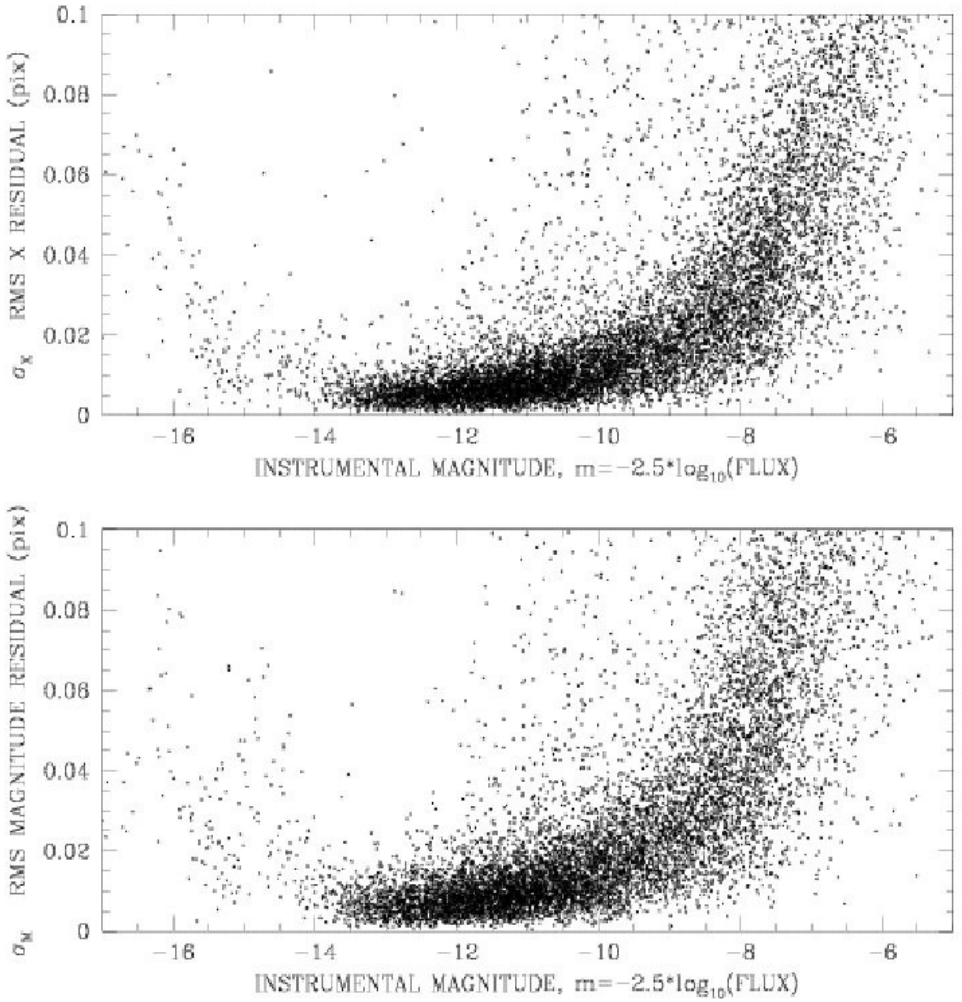


Nardiello et al. (2014, in prep.)





Astrometric and photometric errors



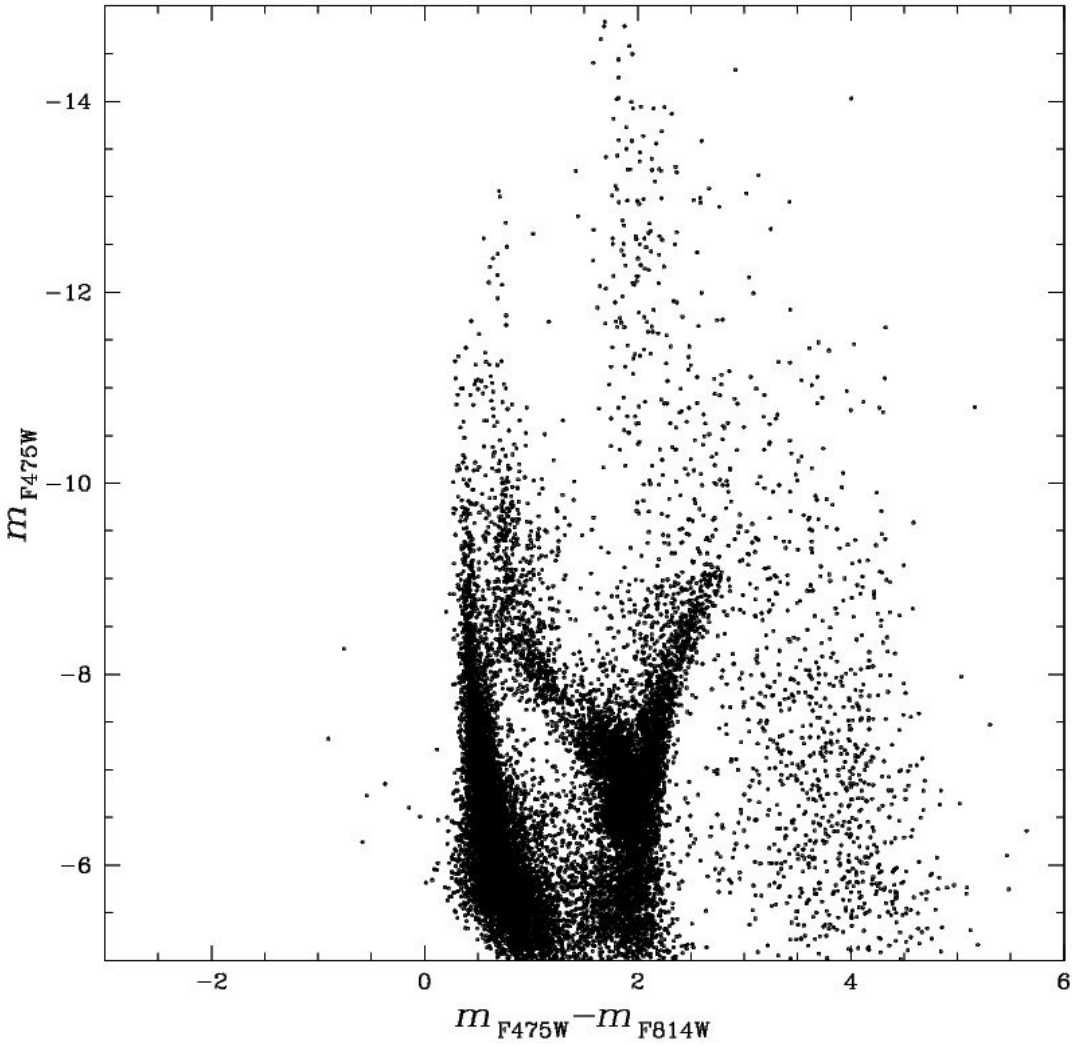
Photometry:
rms ~0.01 mag

Astrometry:
Rms <0.02 pix

Scientific possibilities:

Proper motions:

- cluster-membership
- internal motions
- absolute motions (orbits)
- parallax



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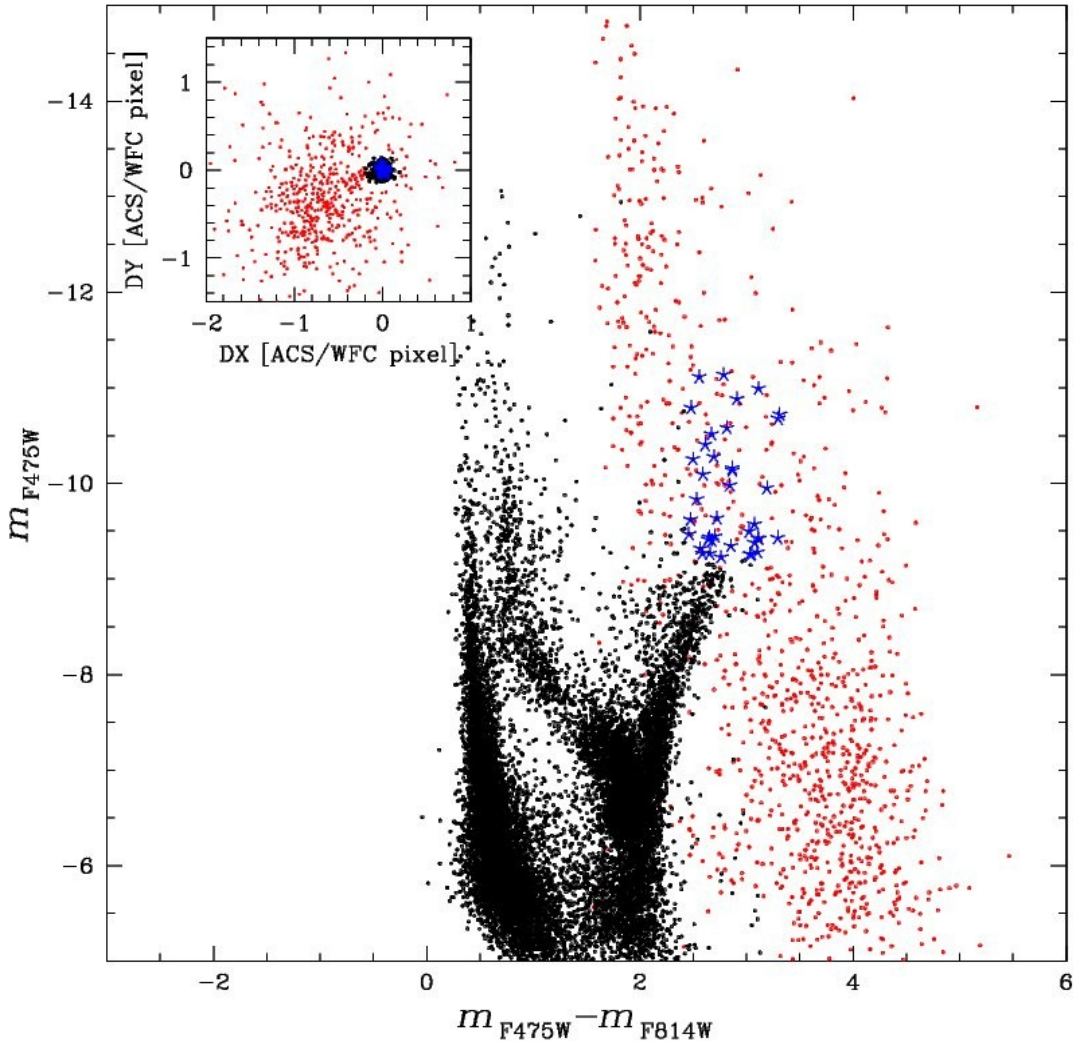
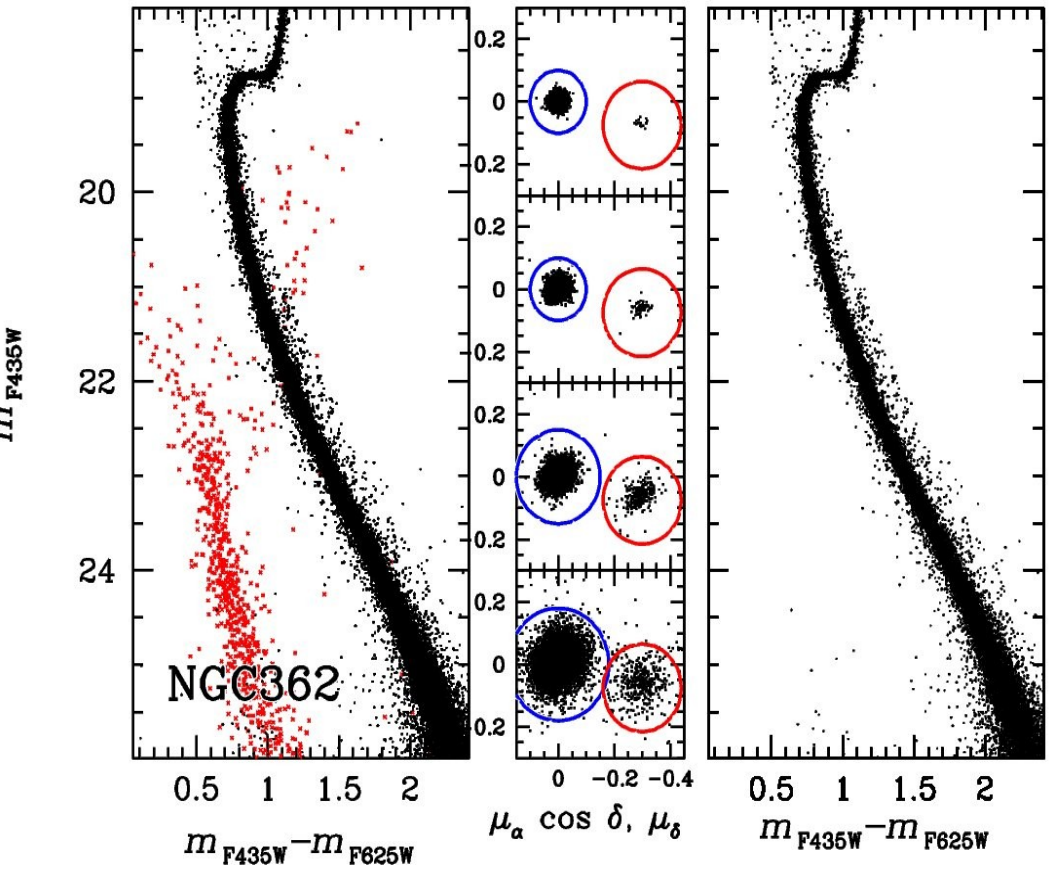
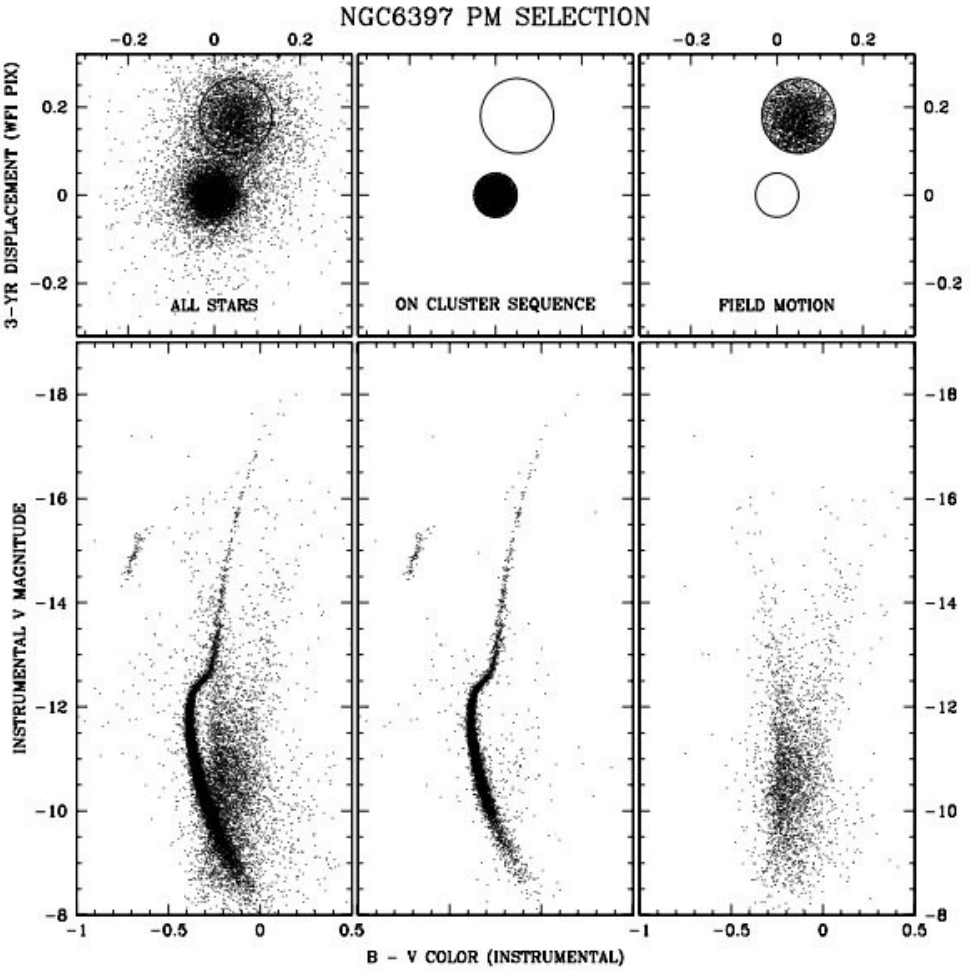


Scientific possibilities:



Milone et al. (2012)



Anderson et al. (2006)