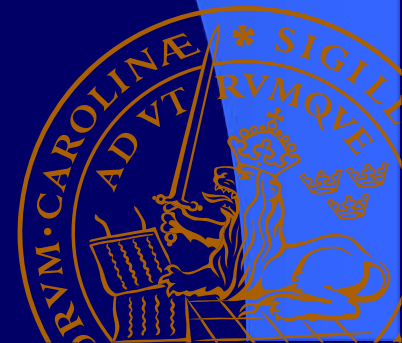
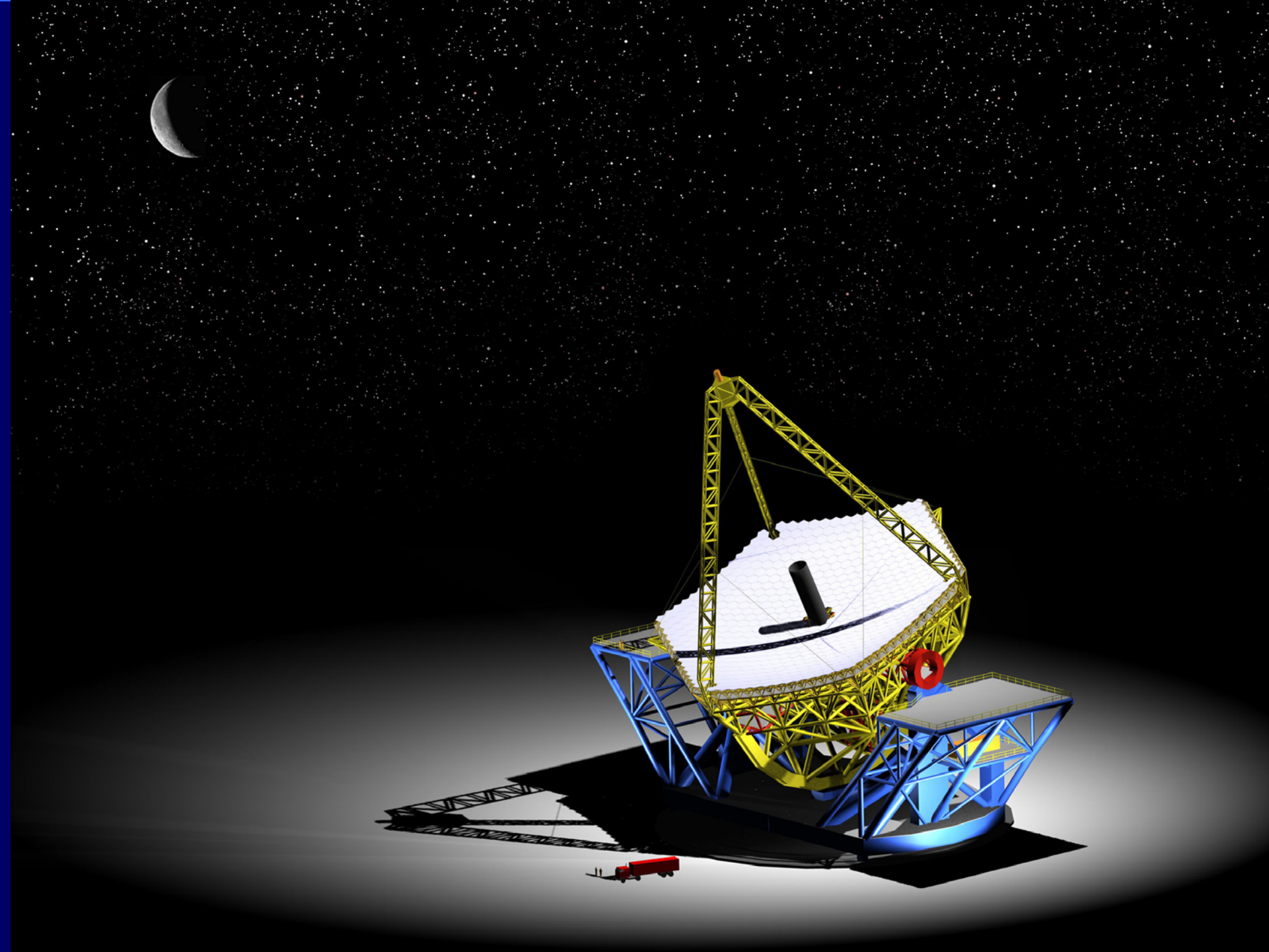




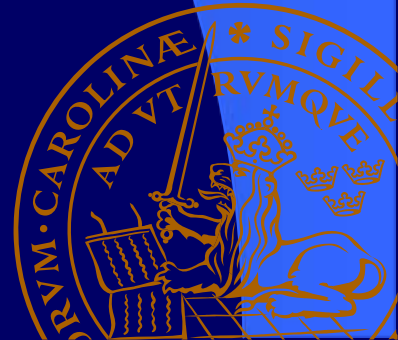
LUND UNIVERSITY





Evolution of Galaxies and Stellar Clusters

Arne Ardeberg Peter Linde



Evolution of Galaxies

Still rather poorly understood

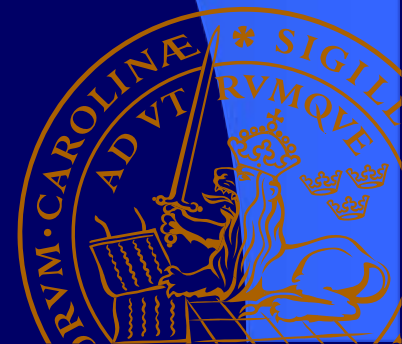
Resolved Stellar Populations

★ *HST (0.1 arcsec): LMC, SMC and M31*

★ *AO VLTs (0.015): Complete Local Cluster*

Local Cluster: No Representative Sample

Outside Local Cluster: Unresolved



Stellar Clusters

Co-Eval

Co-Distant

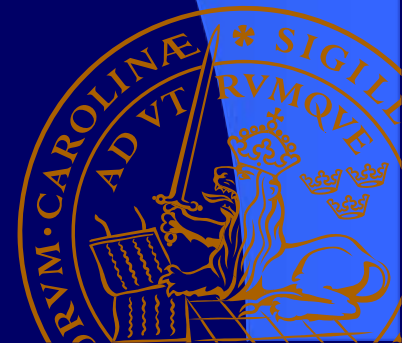
Co-Absorbed

Easy to Identify

Easy to Separate from Background

Little Dependent on Galaxy Orientation

... however ...



Stellar Clusters

Volume Density of Stars High

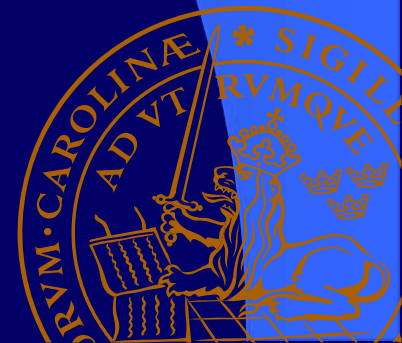
Image Crowding Pronounced

No Spatial Resolution - No Use

Outside Local Cluster of Galaxies

★ *Anything but an ELT Useless*

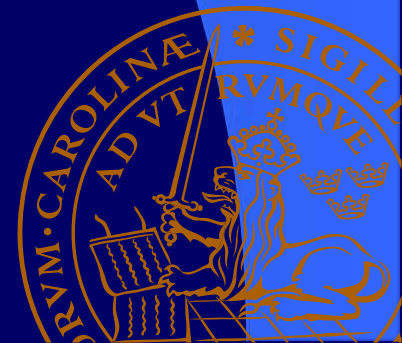
★ *What about an ELT ?*



Euro50 - A Modest European ELT

Photometry in Strömgren (u)vby System

| | | |
|--------------------------------|-------|----|
| ★ vby PSF FWHM | 0.003 | '' |
| ★ Seeing Disc FWHM | 0.3 | '' |
| ★ Strehl Ratio | 0.7 | |
| Deformable M2 Actuator Spacing | 7 | mm |



Euro50 - Angular Size of Cluster

Open Cluster Diameter typically 5 pc

★ **500 kpc: Diameter \approx Isoplanatic Angle**

★ **SCAO Ideal**

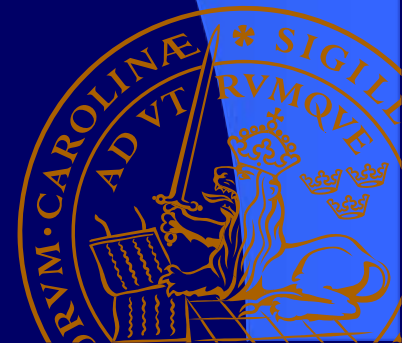
★ **NGSs ?**

★ **Complete Cluster Guiding Reference ?**

LGS - Several LGSs required

★ **Cone Effect**

★ **Perspective Elongation**



Open Stellar Cluster - NGC 6192

Modelling and Simulation Template

Age

★ Determined: 700 Myr \pm 500 Myr

★ Adopted: 700 Myr

Abundance of Heavy Elements - [Me/H]

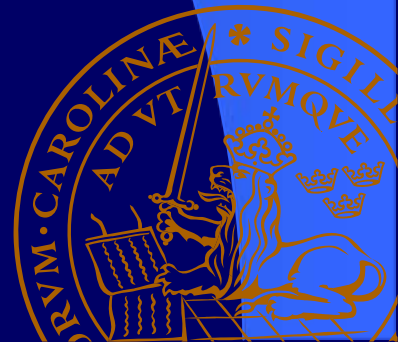
★ Determined from vby data: - 0.1

★ Adopted: - 0.1



Simulated stellar population

- **Background population:**
 - **65 % 3 Gyr, [Me/H] = -0.3**
 - **35 % 9 Gyr, [Me/H] = -1.1**
 - **stellar density set to appr mimic LMC halo**



Photometry of Cluster Stars

Cluster Located at Distances 1 - 30 Mpc

Photometry in y , b and v

CMDs Constructed [y versus $(b-y)$]

MDs Constructed [m_1 versus $(b-y)$]

Cluster Located at Distances 10 Mpc - 1 Gpc

Integral Photometry of $(b-y)$

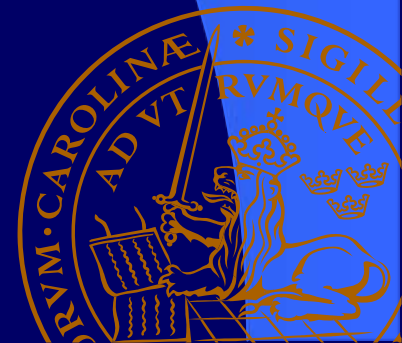
(Age-Dependent Morphology Recorded)

(Lata et al., 2002)

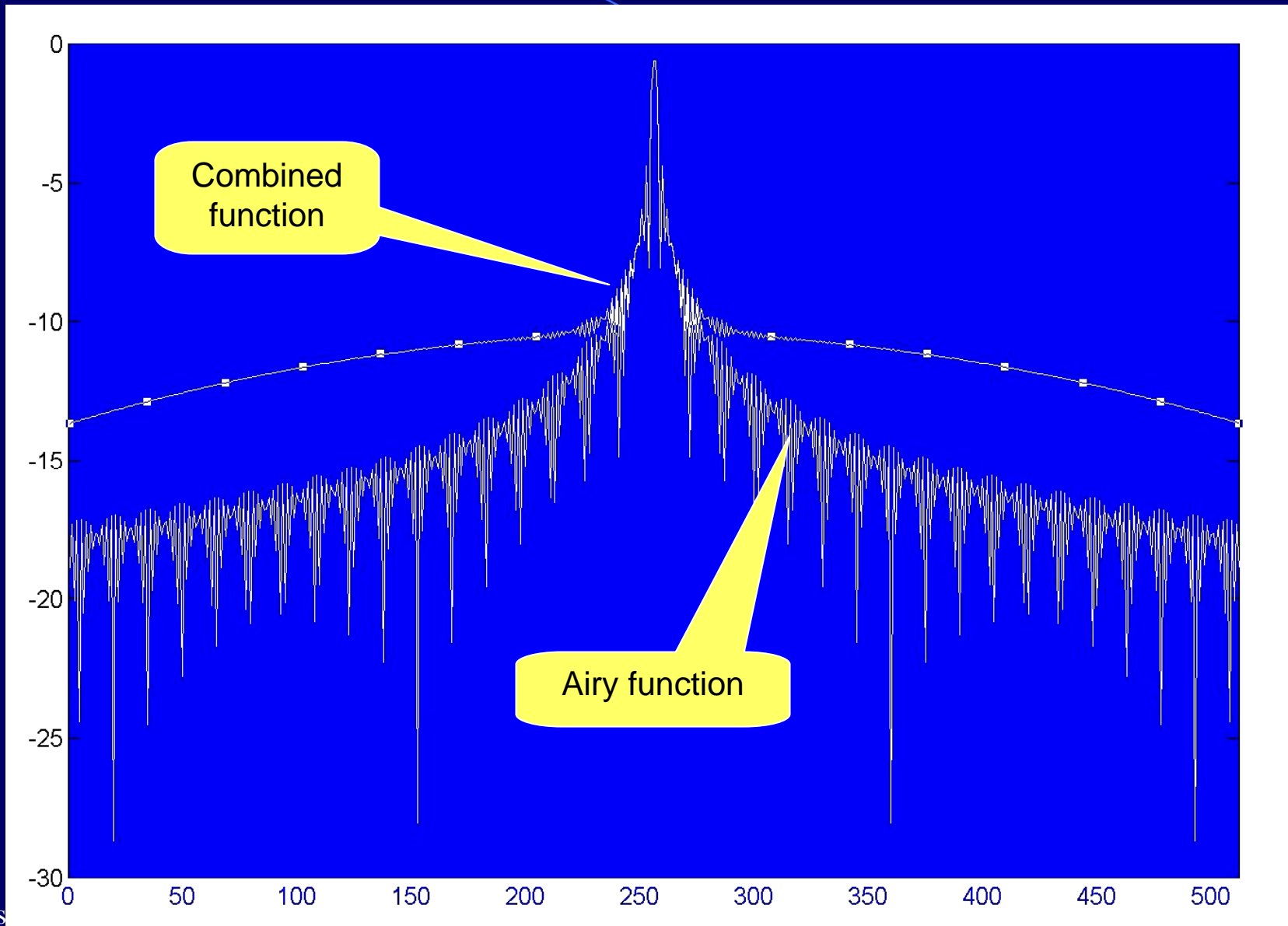


Simulation parameters

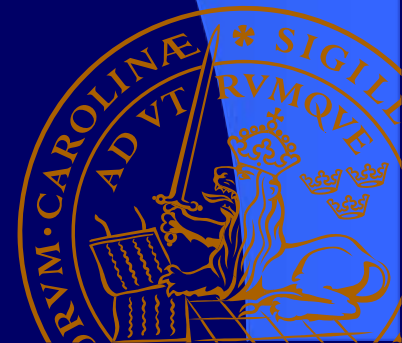
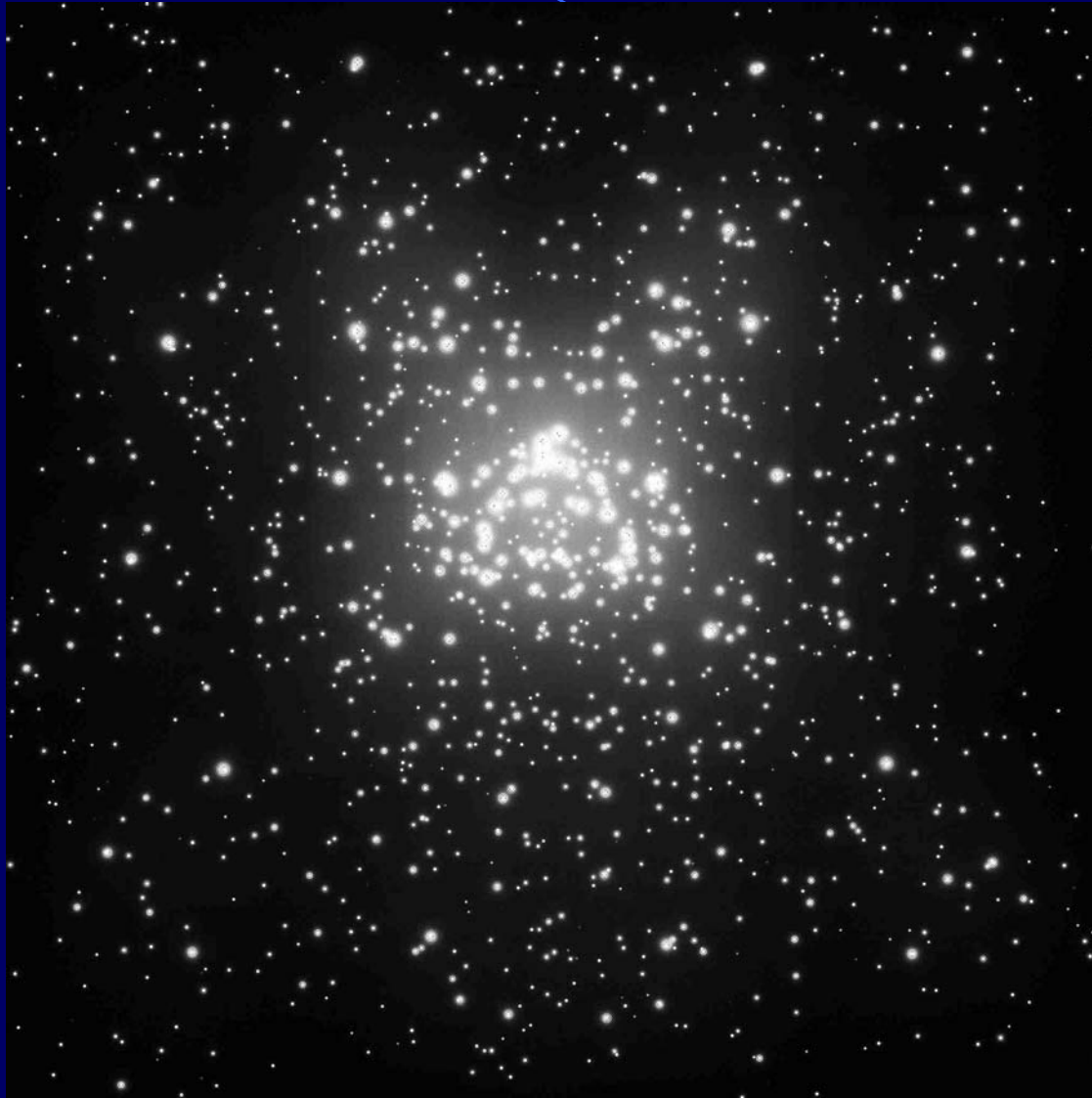
- **Exposure: 36 000 sec / passband**
- **Circular aperture PSF**
- **Image size: 2048x2048 pixels**
- **Image scale: 0."001 / pixel**
- **FOV: 2"x2"**
- **ESO ELT exposure meter used**



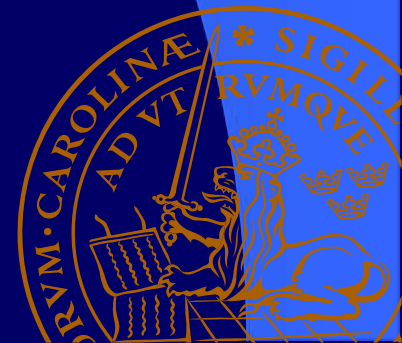
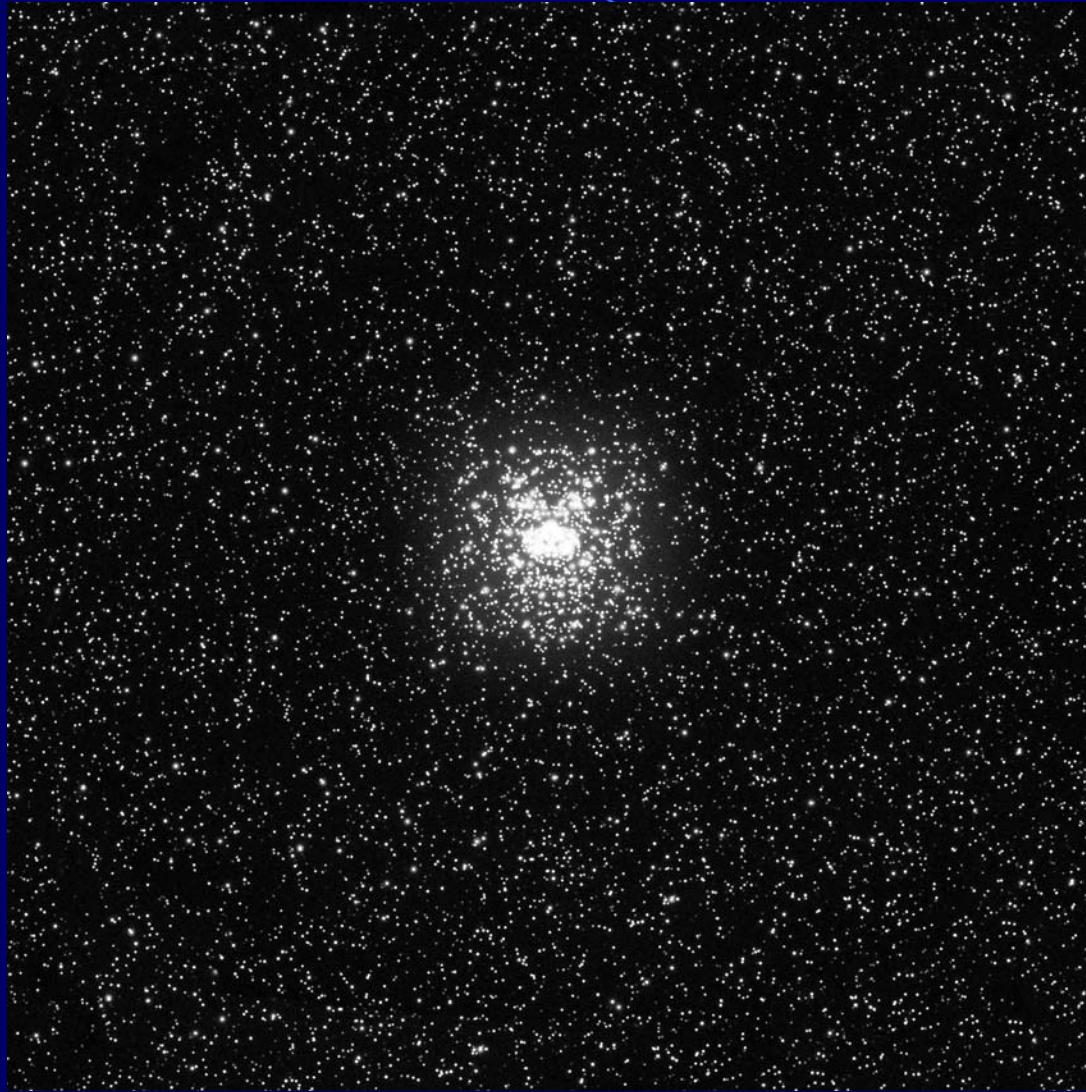
Seeing and diffraction limited PSF (log scale)



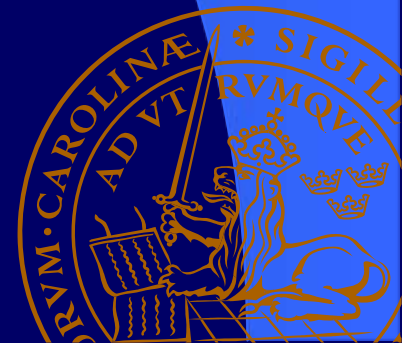
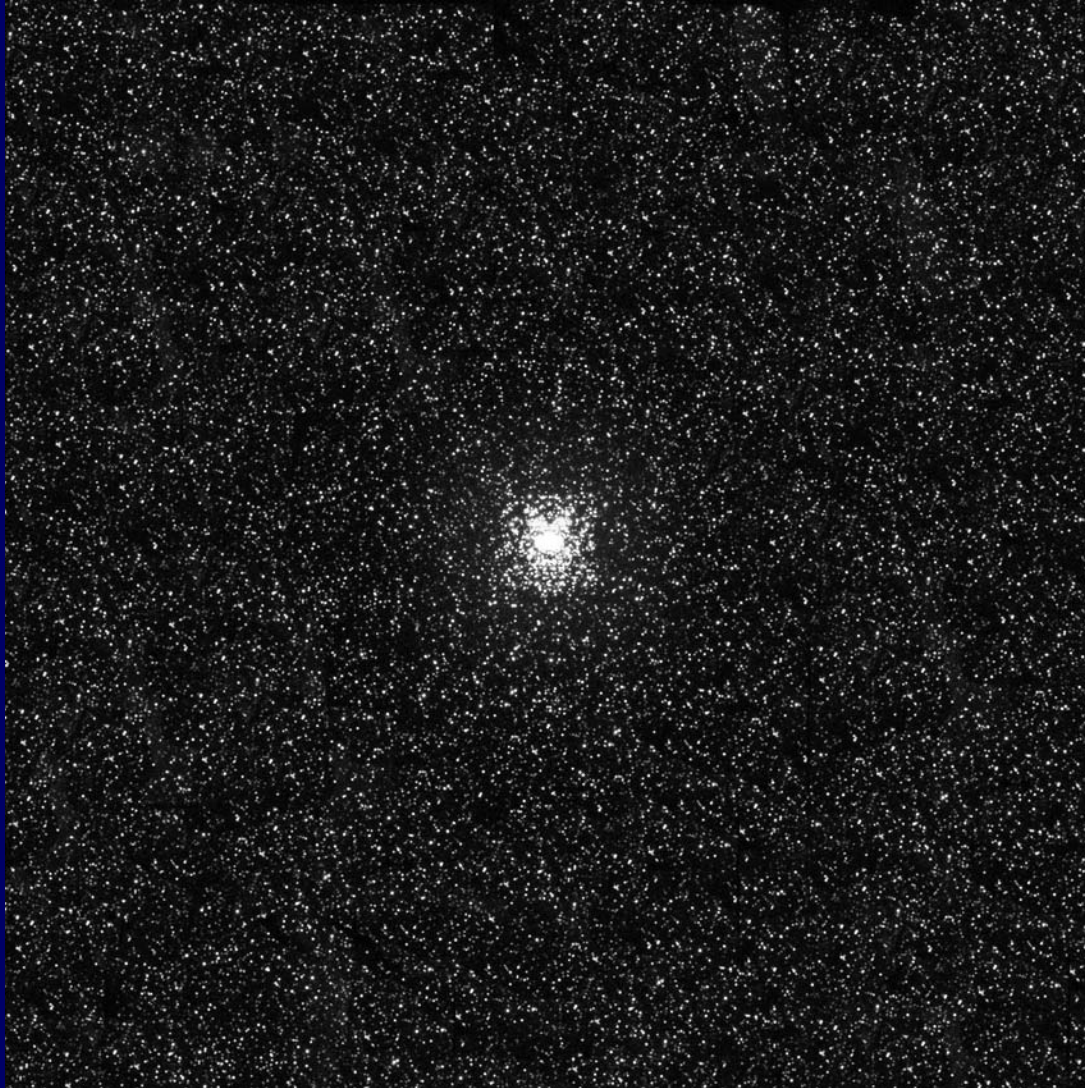
1 Mpc



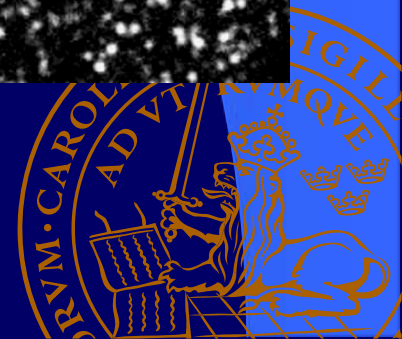
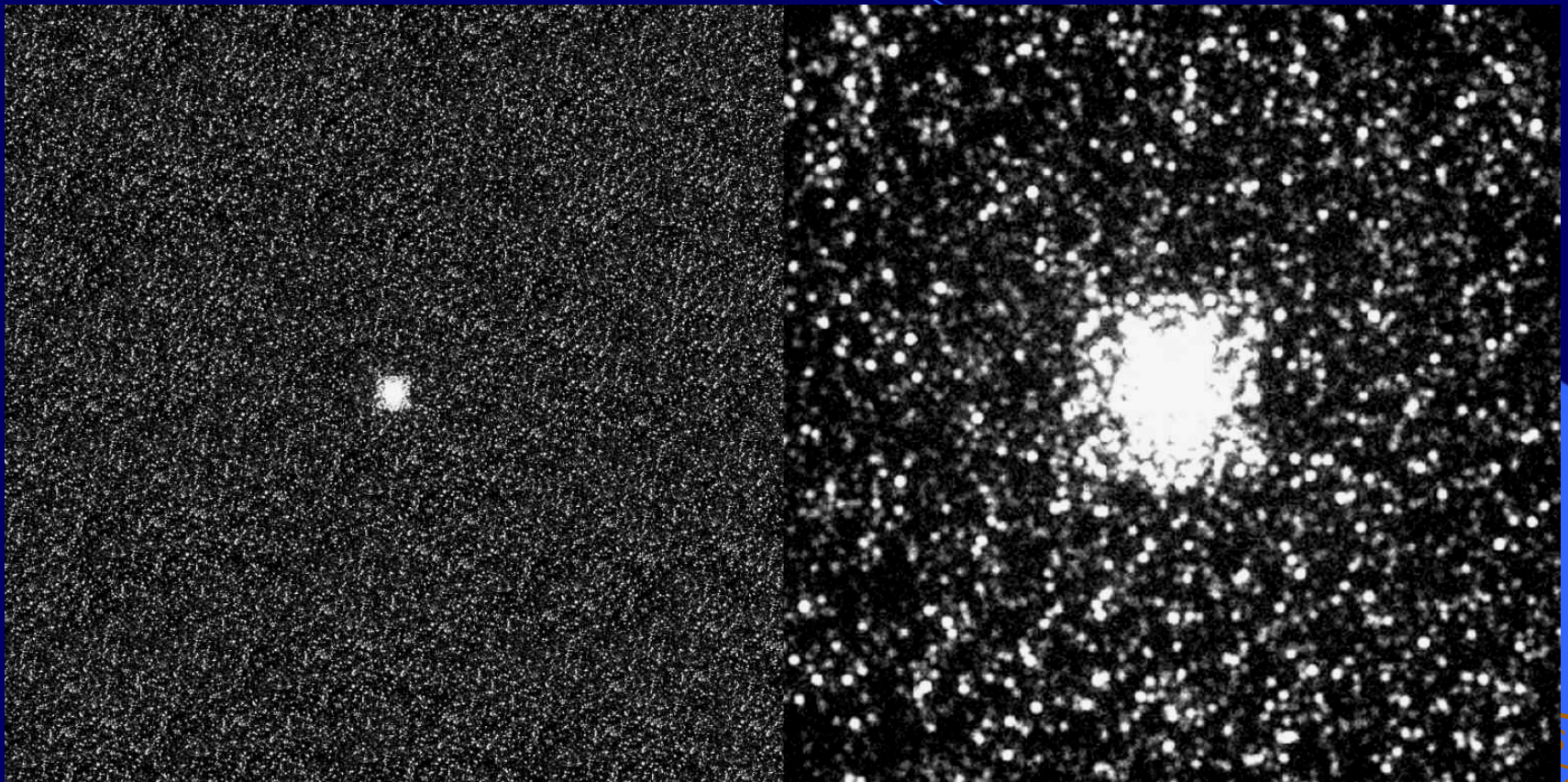
5 Mpc



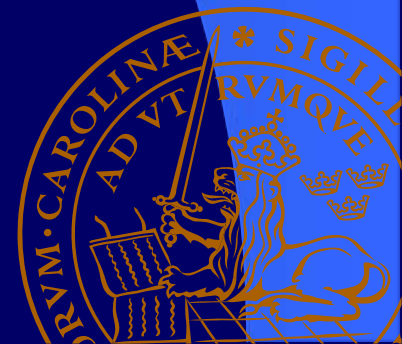
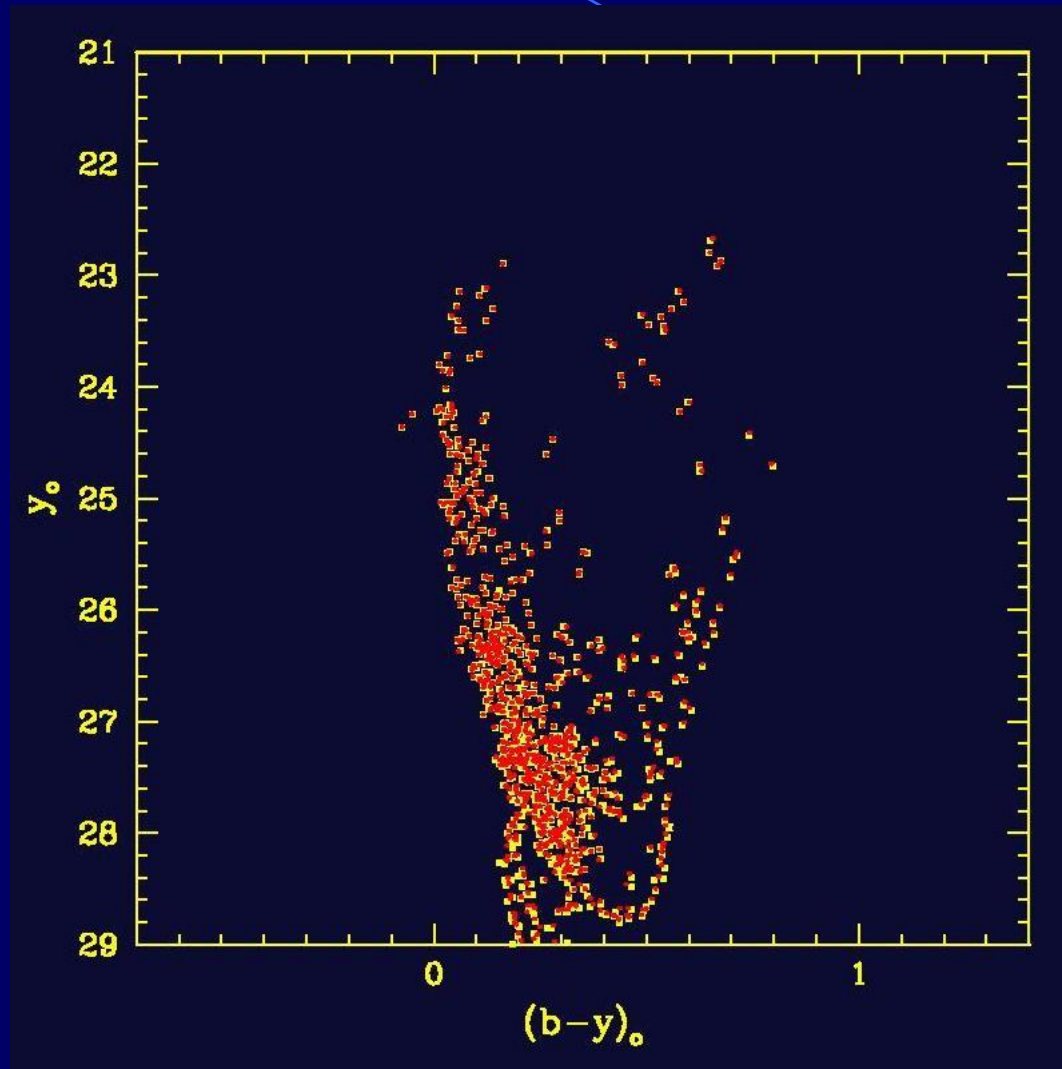
12 Mpc



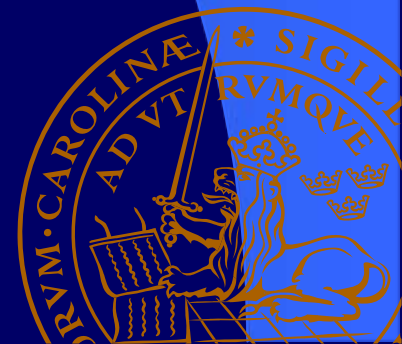
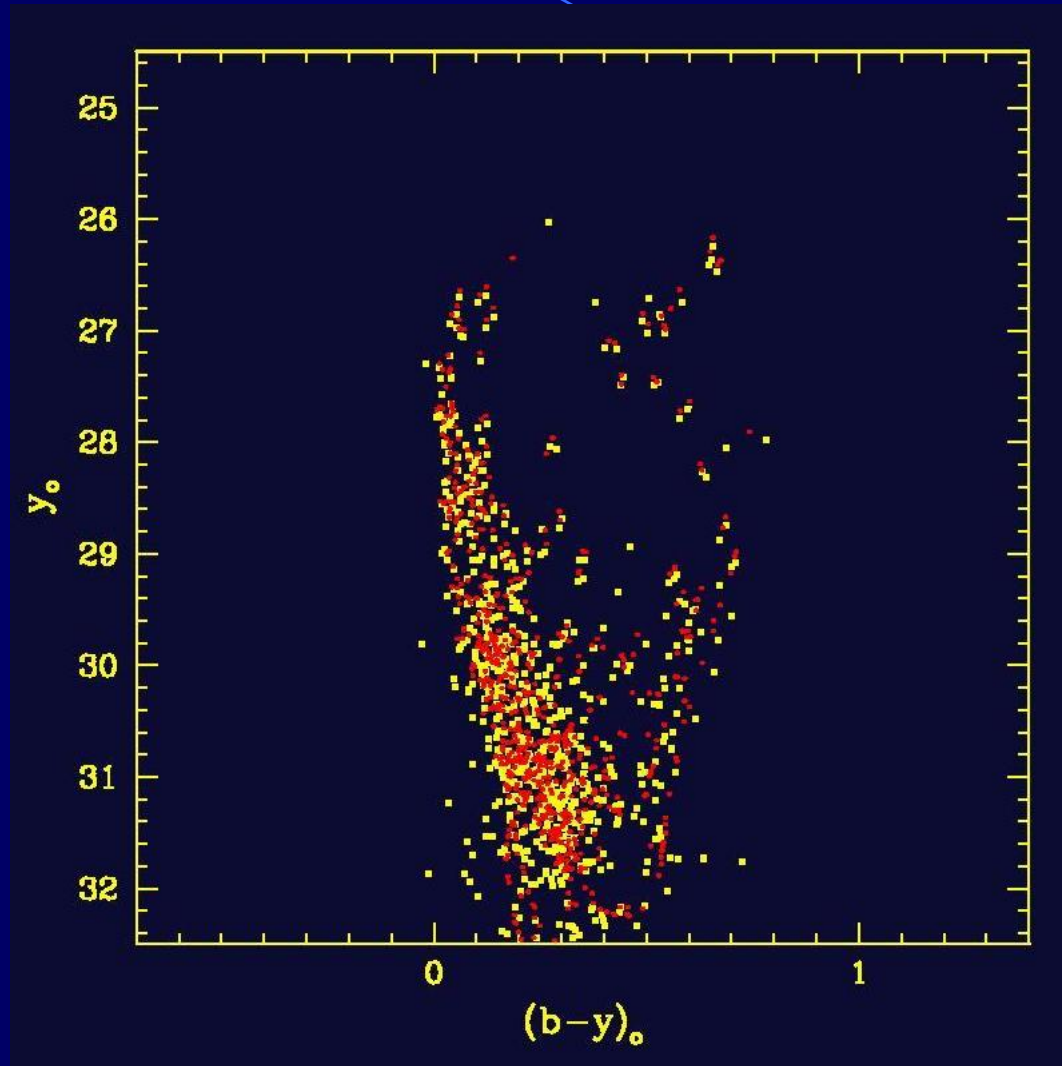
20 Mpc



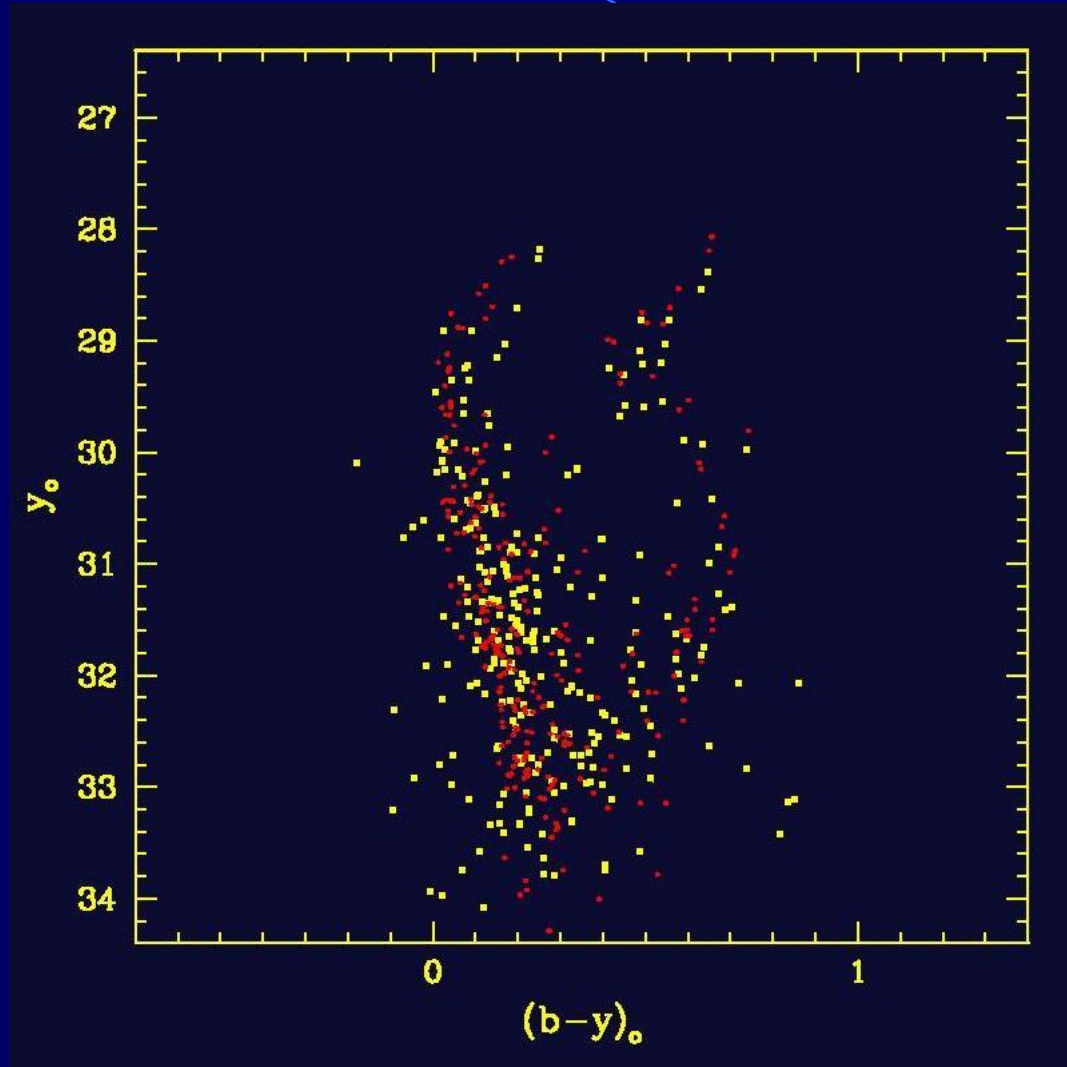
1 Mpc



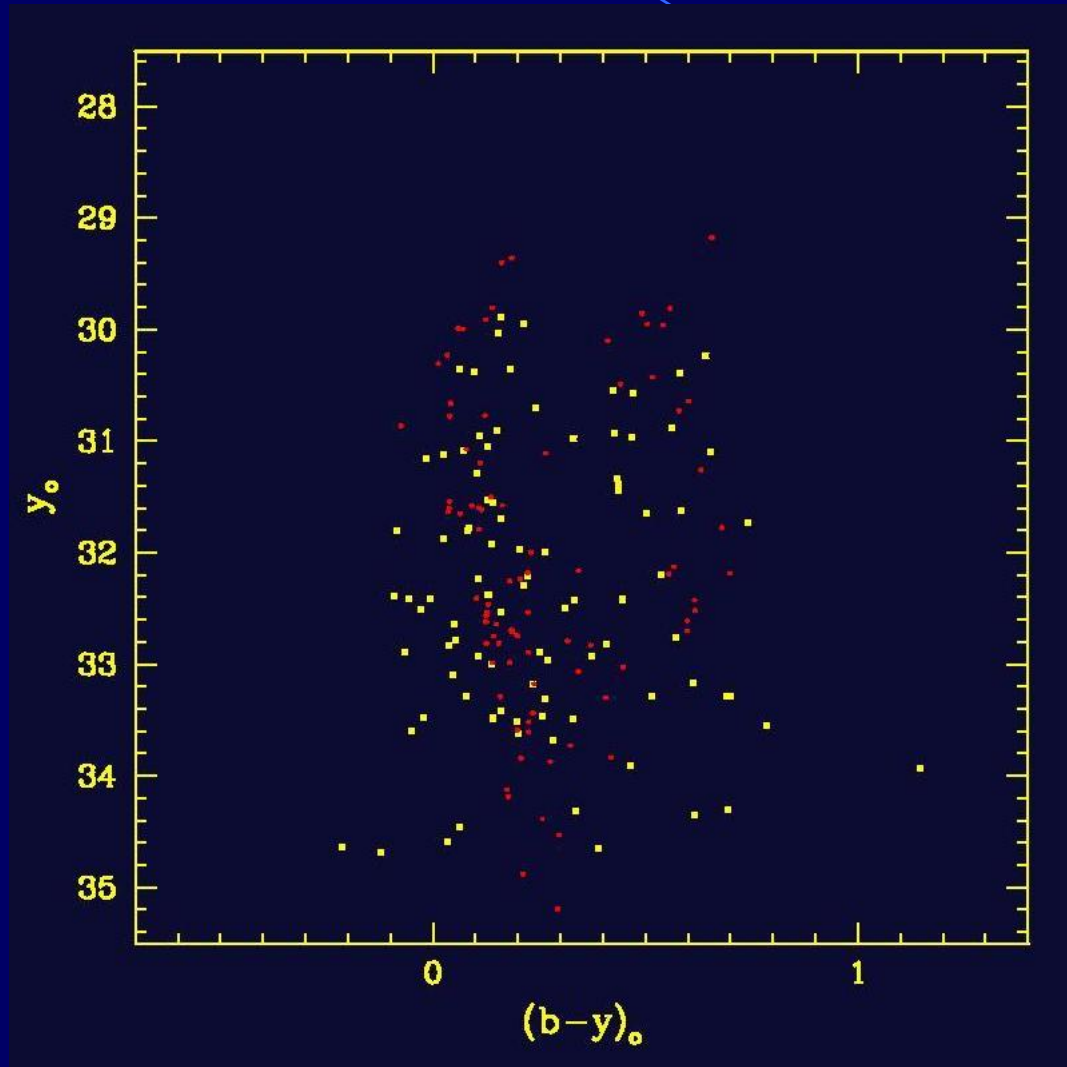
5 Mpc



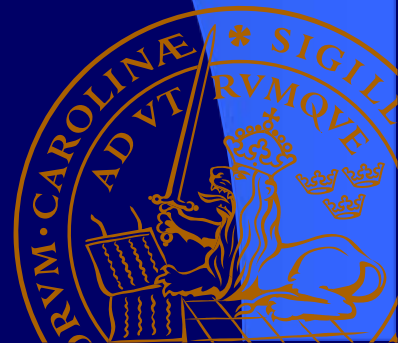
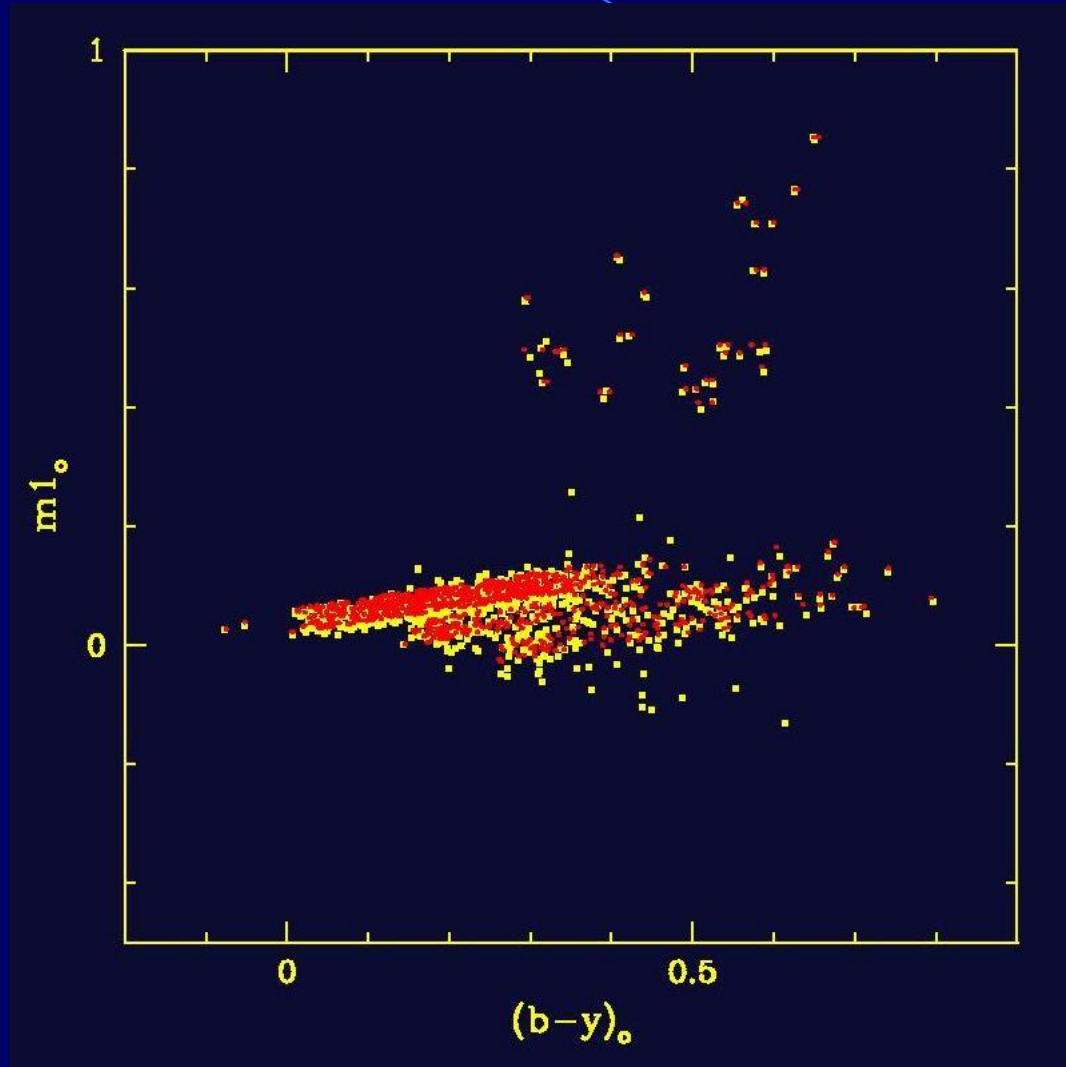
12 Mpc



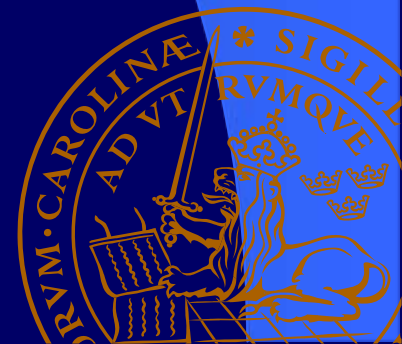
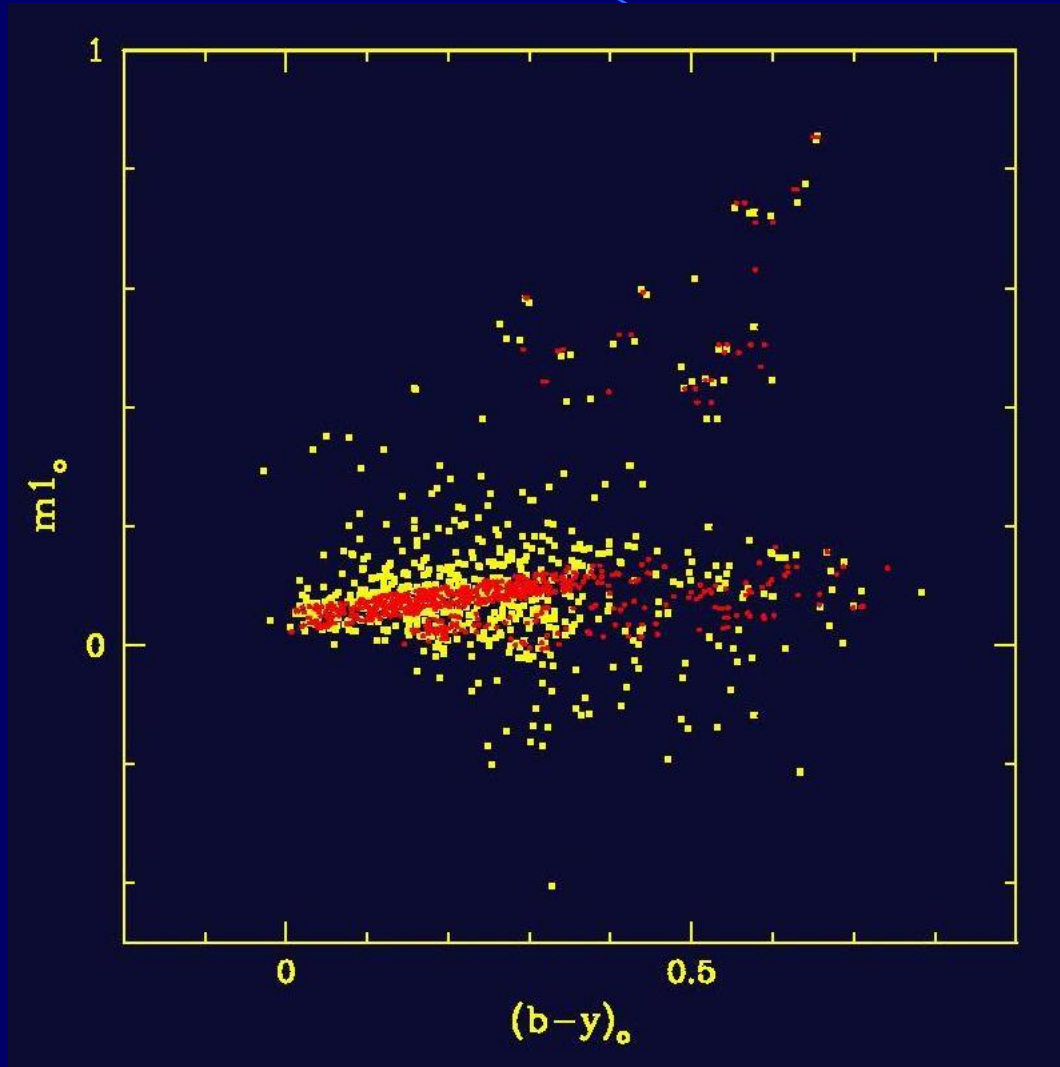
20 Mpc



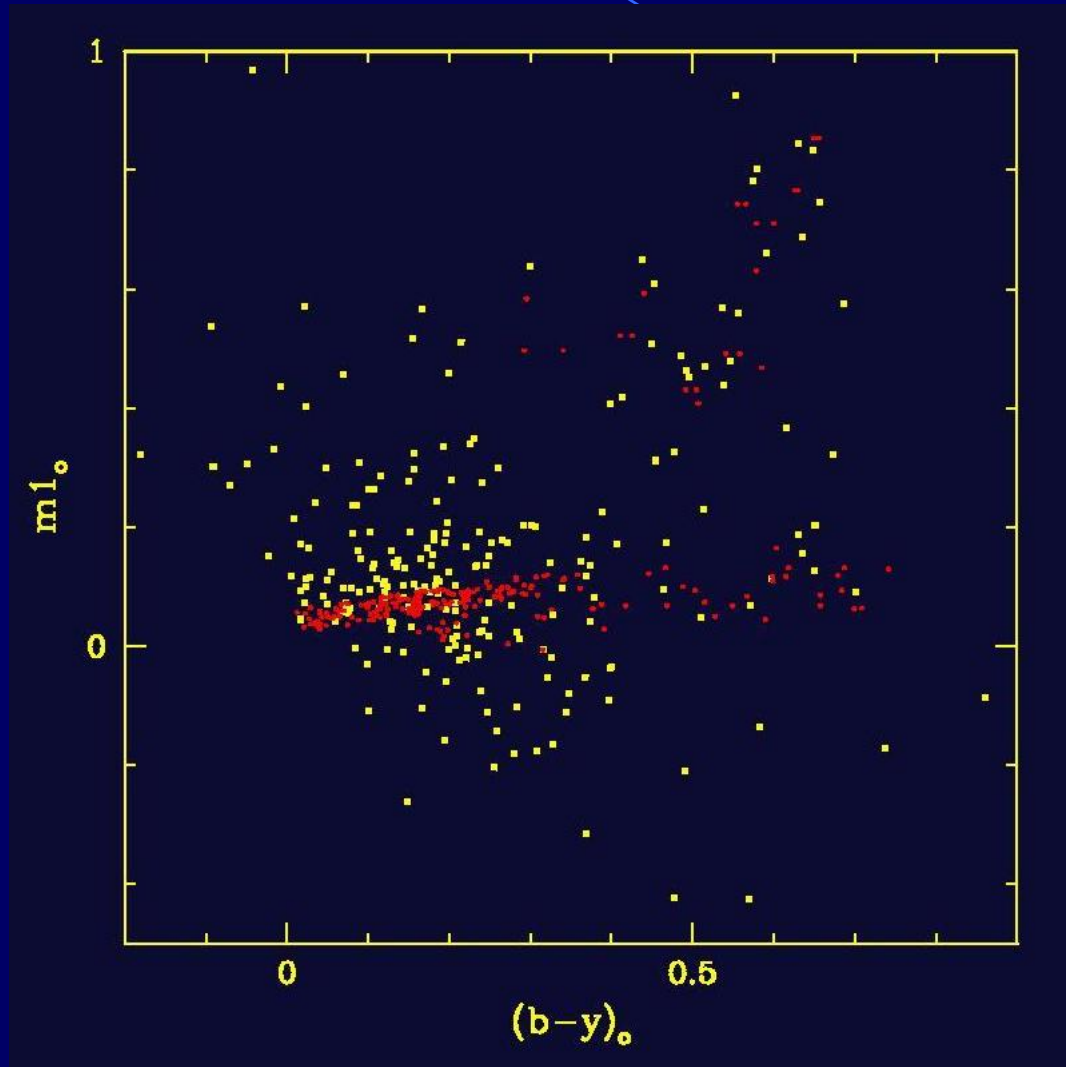
1 Mpc



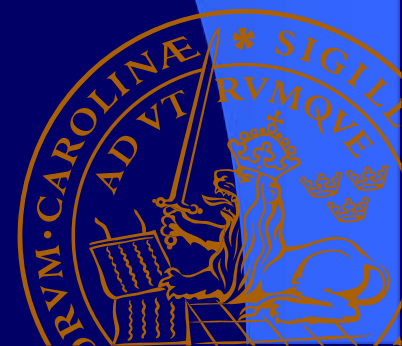
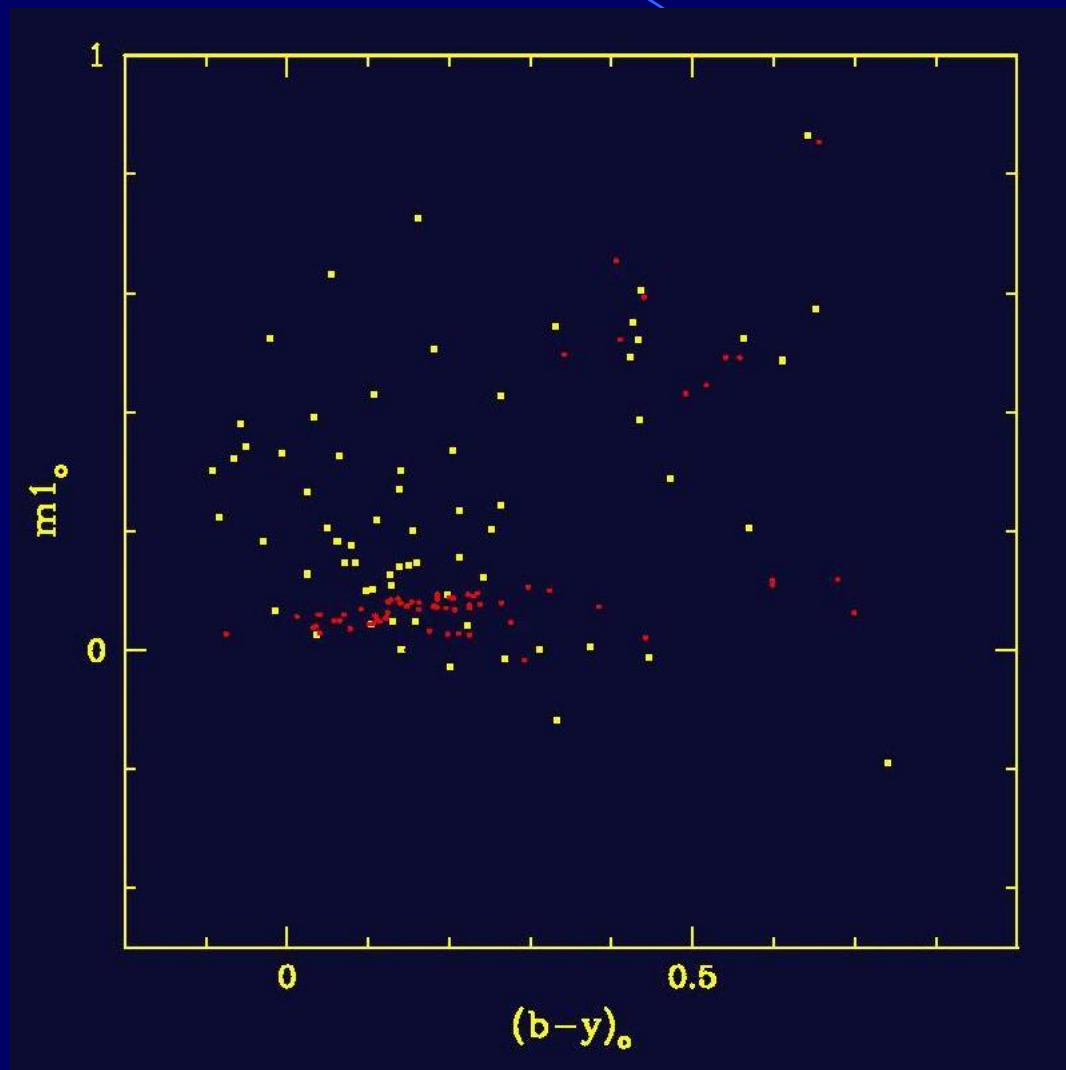
5 Mpc



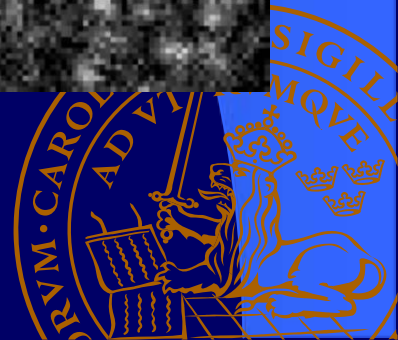
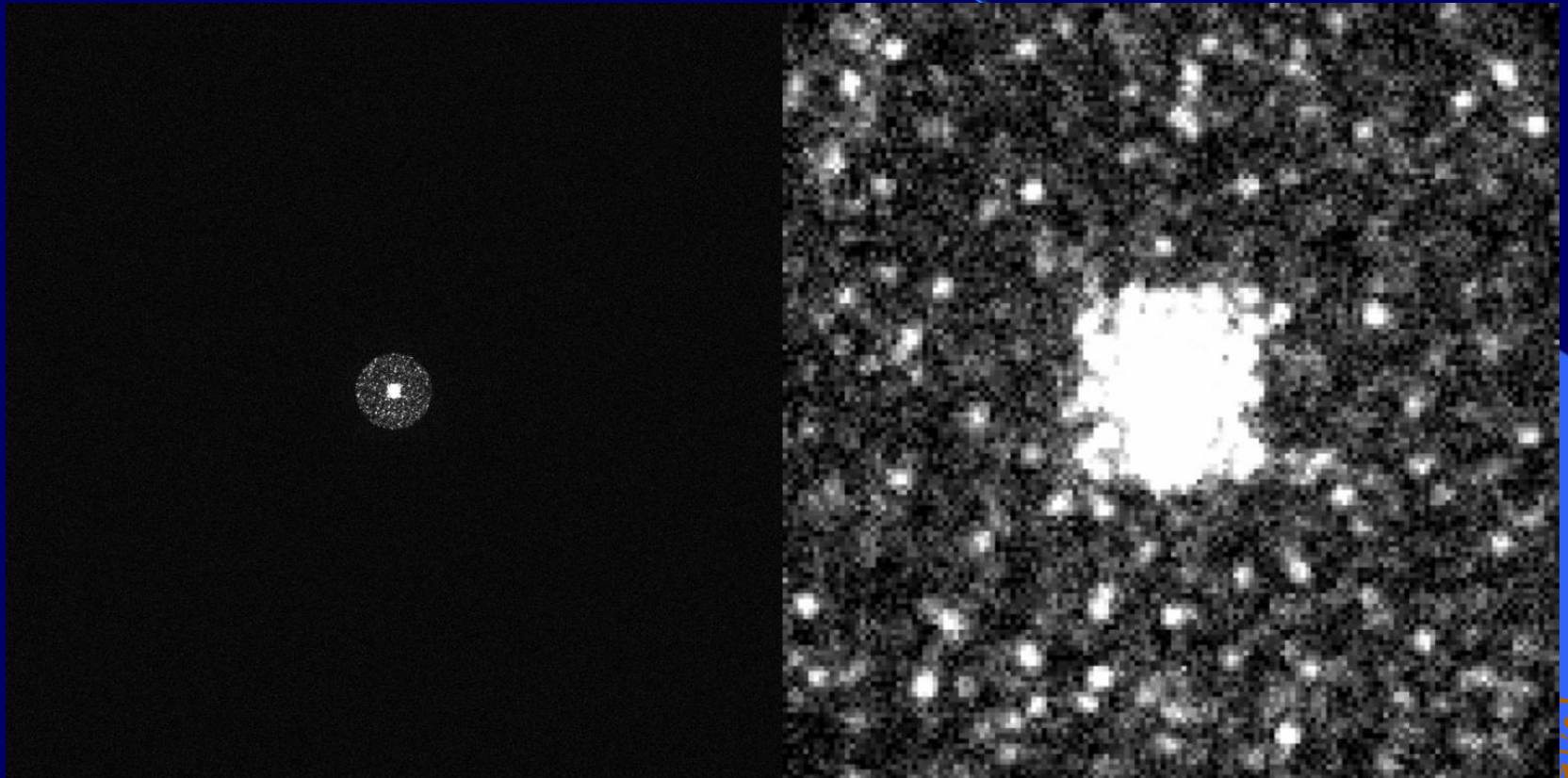
12 Mpc



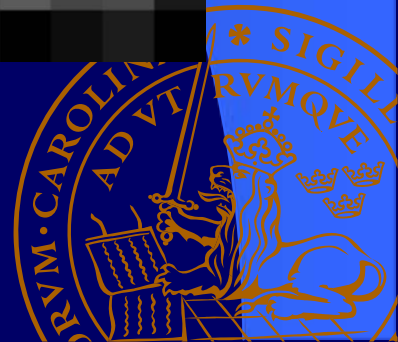
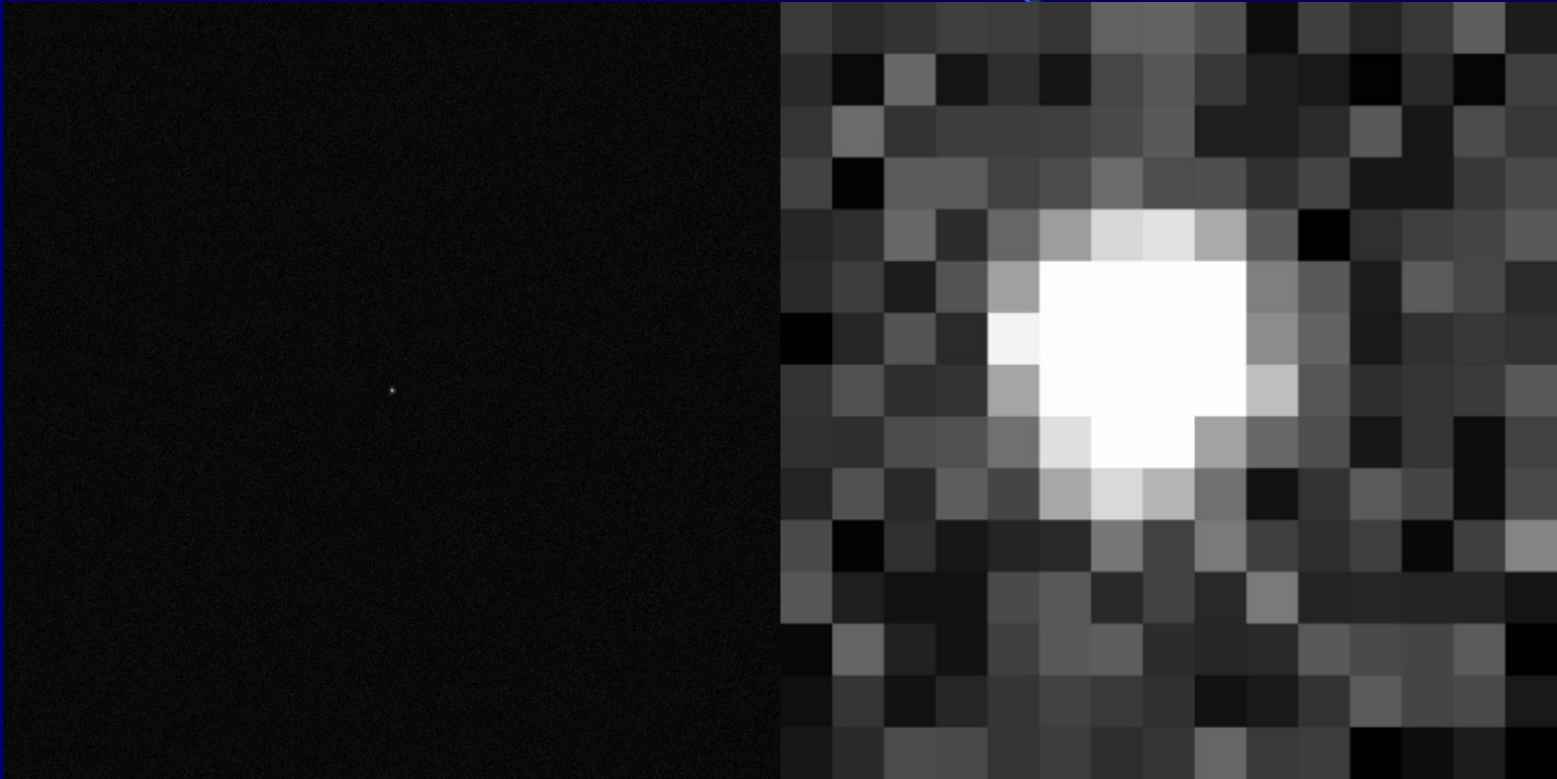
20 Mpc



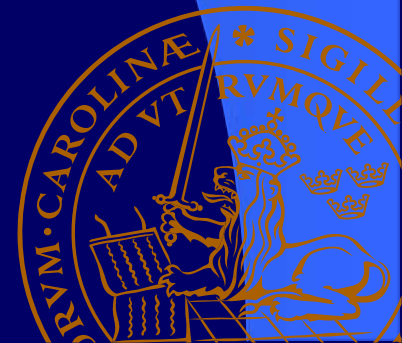
50 Mpc



500 Mpc

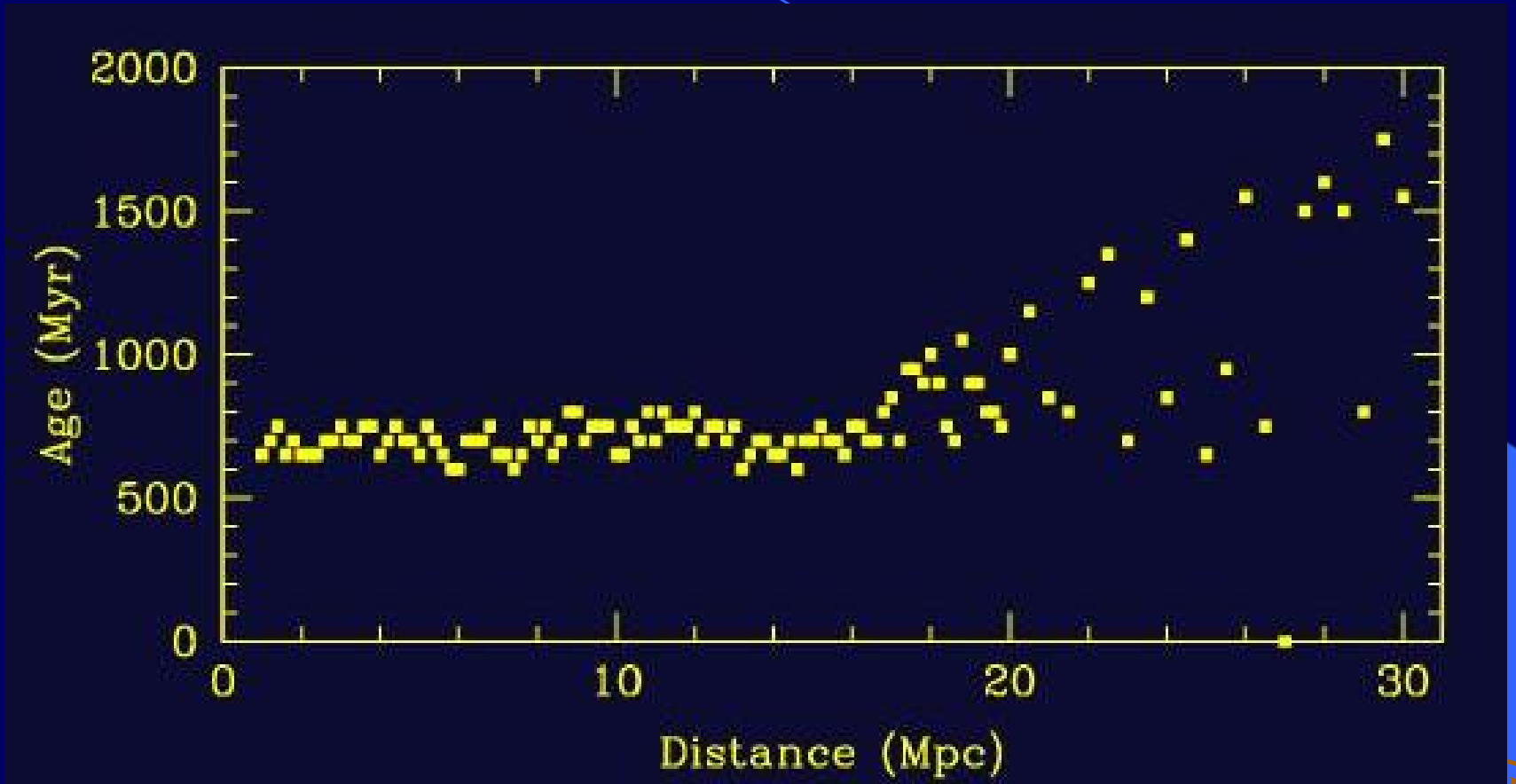


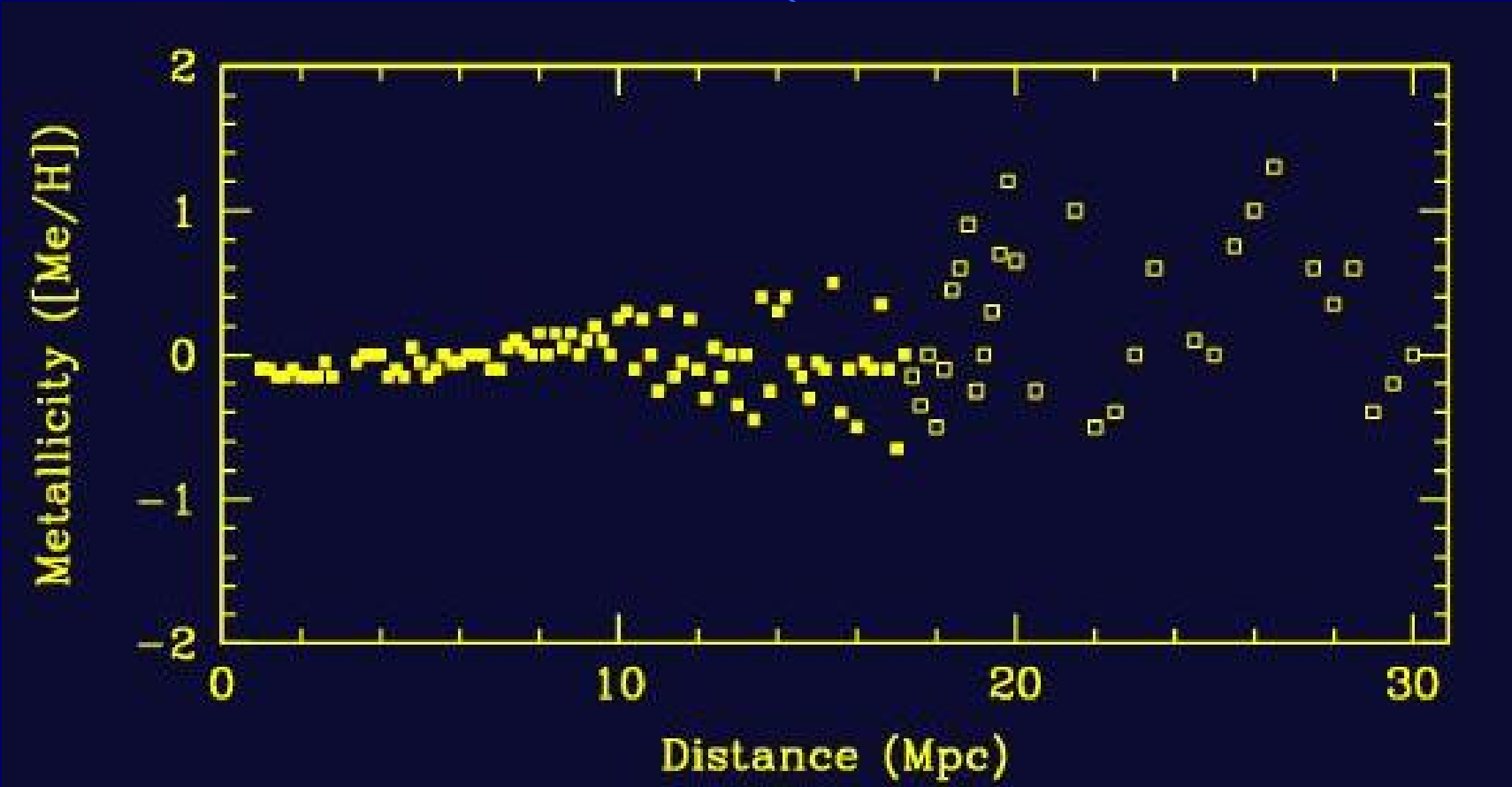
Over to Simulations

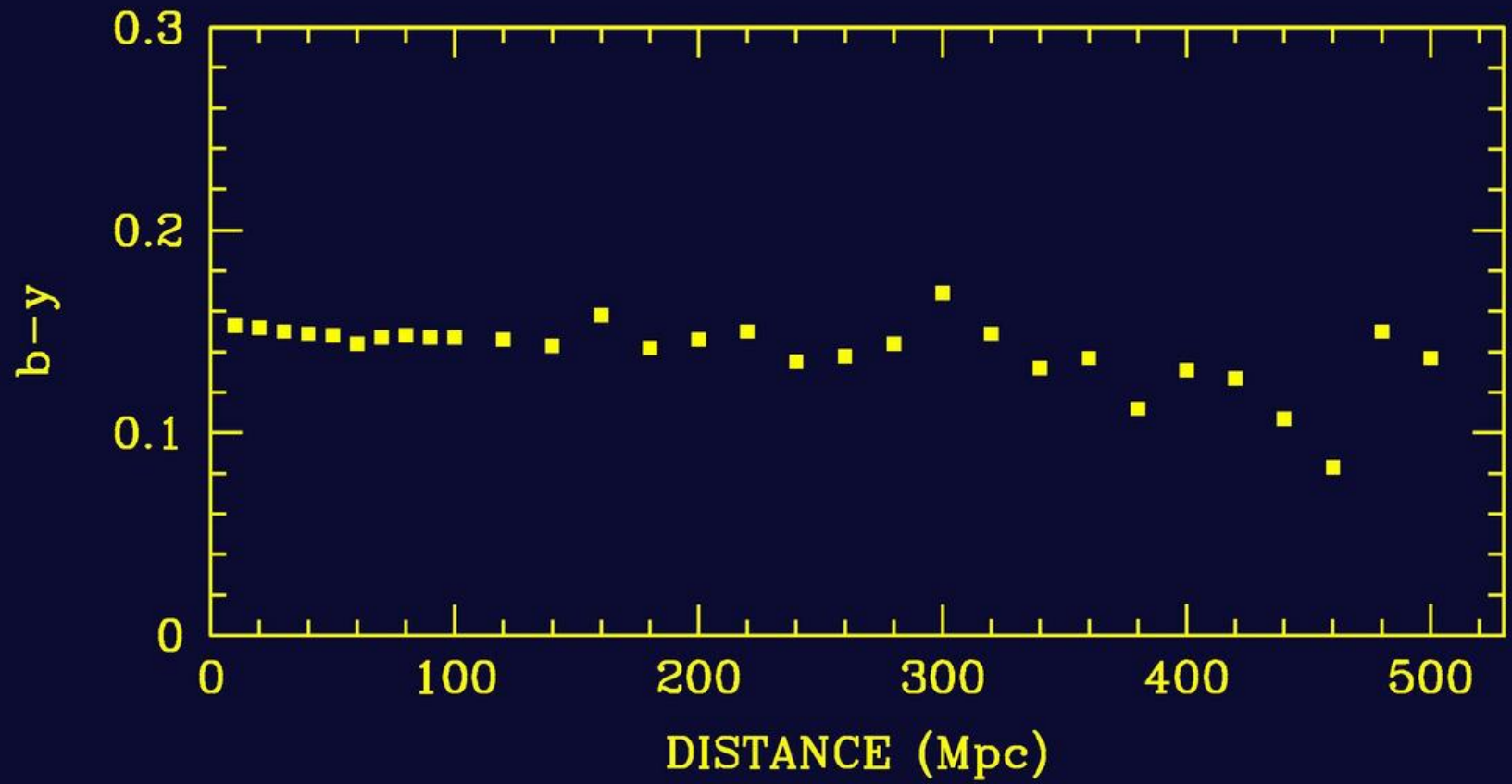


Some Comments



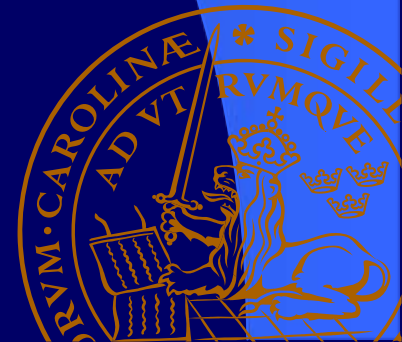






Some conclusions

- **Good CMD precision out to Virgo**
- **Reasonable m_1 – values out to Virgo**
- **Crowding more serious than photon starvation**
- **Integral age photometry out to 1 Gpc possible**
- **Photometric analysis should be further optimised**



Thank you for your patience !

