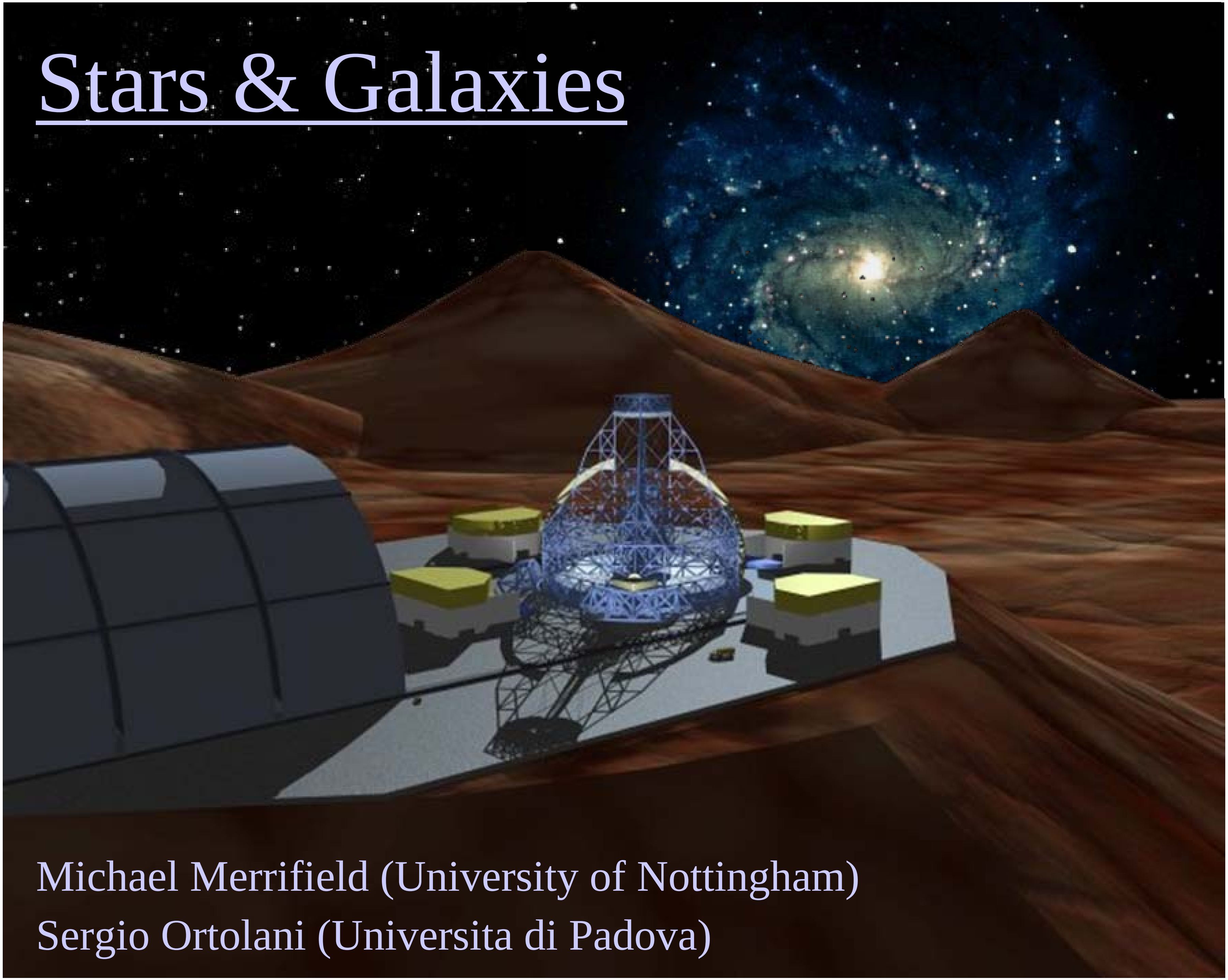
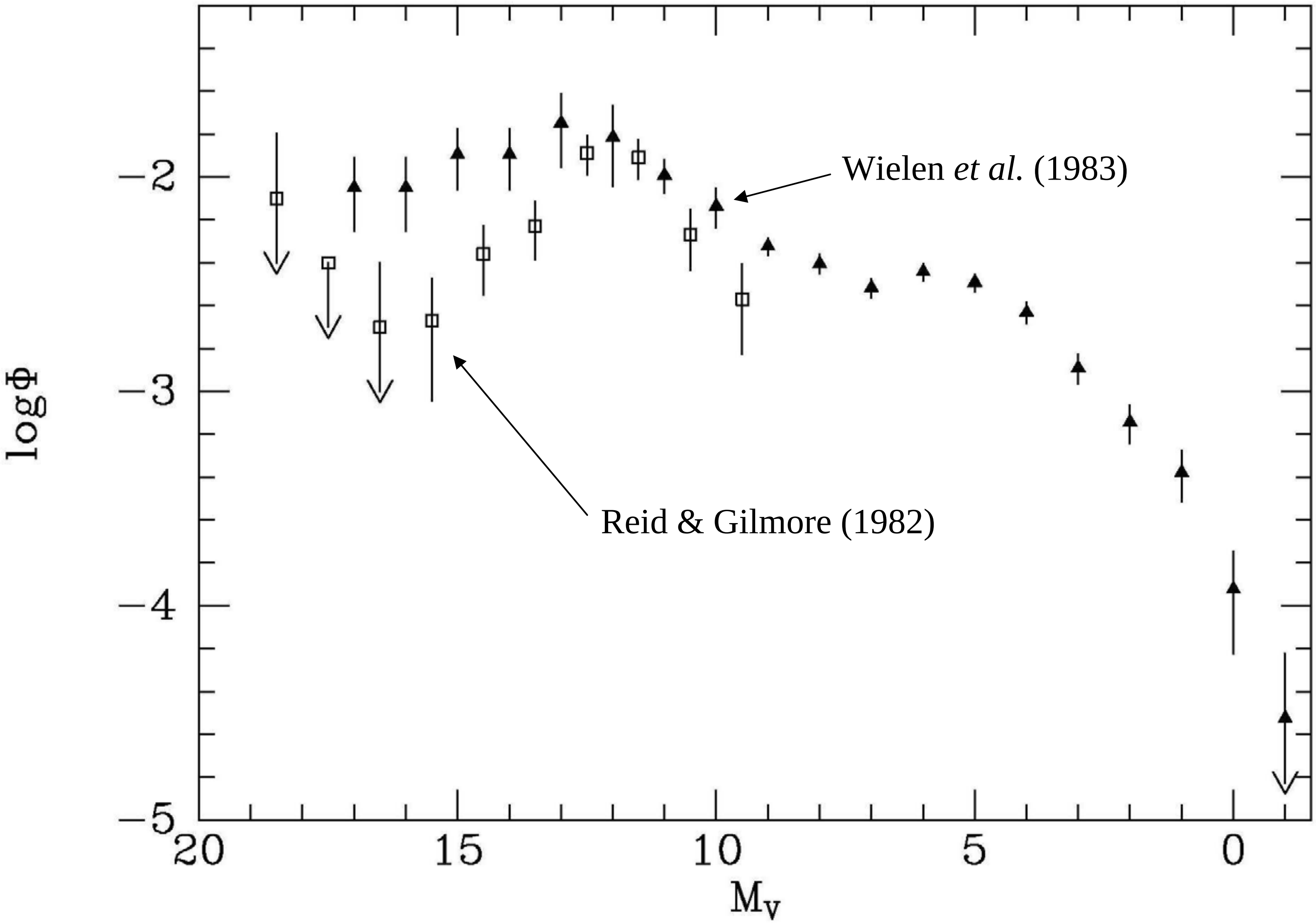
Stars & Galaxies



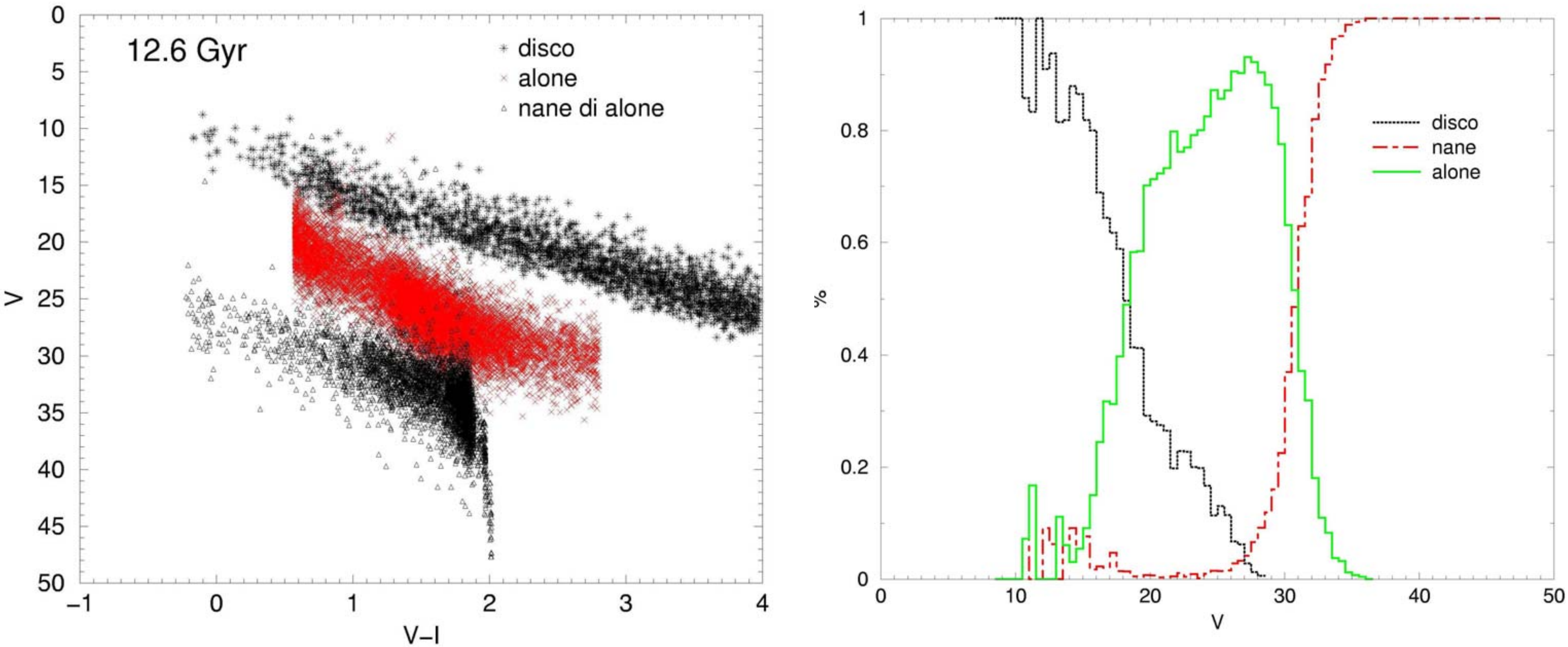
Michael Merrifield (University of Nottingham)
Sergio Ortolani (Universita di Padova)

The Luminosity Function in the Solar Neighbourhood



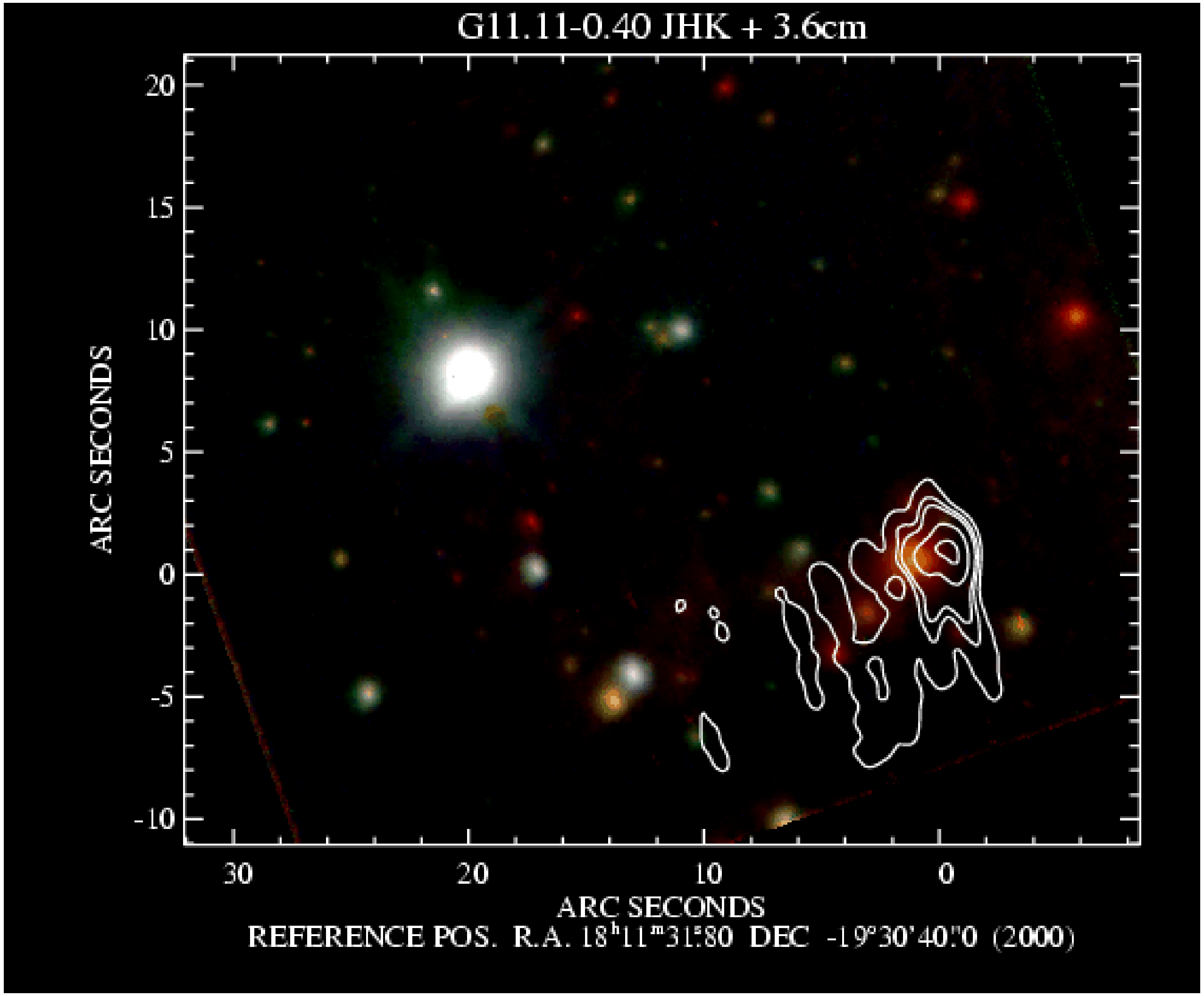
(Binney & Merrifield 1998)

Star Counts Toward the North Galactic Pole



(Castellani 2003)

Resolving Star Formation



(Henning *et al*. 2001)

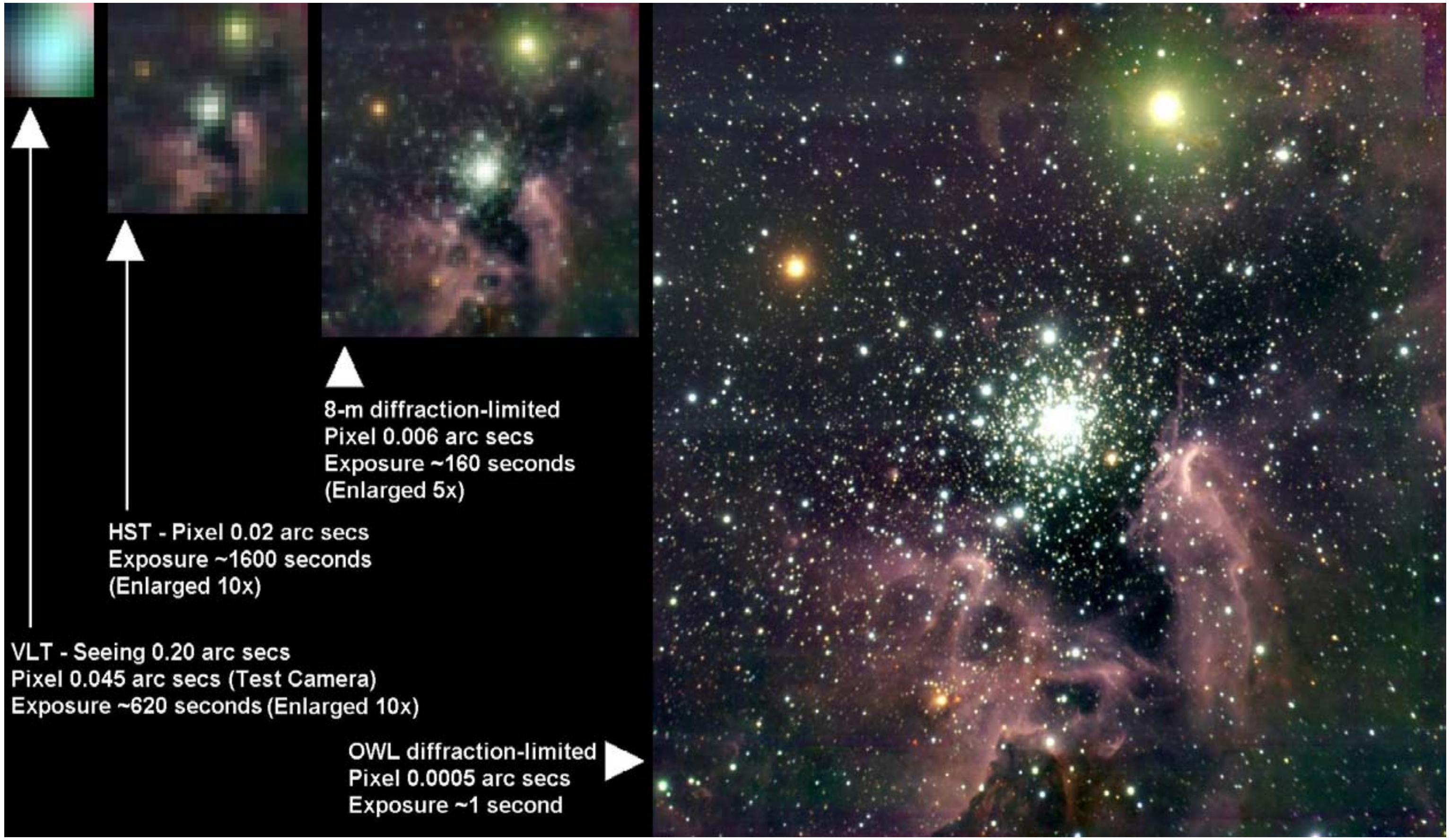
With a 100m telescope, can resolve the stars in even compact HII regions throughout Local Group.

— test universality of IMF

— calibrate SFR measures

— investigate feedback, chemical enrichment, etc.

Star Formation
in Rich Clusters



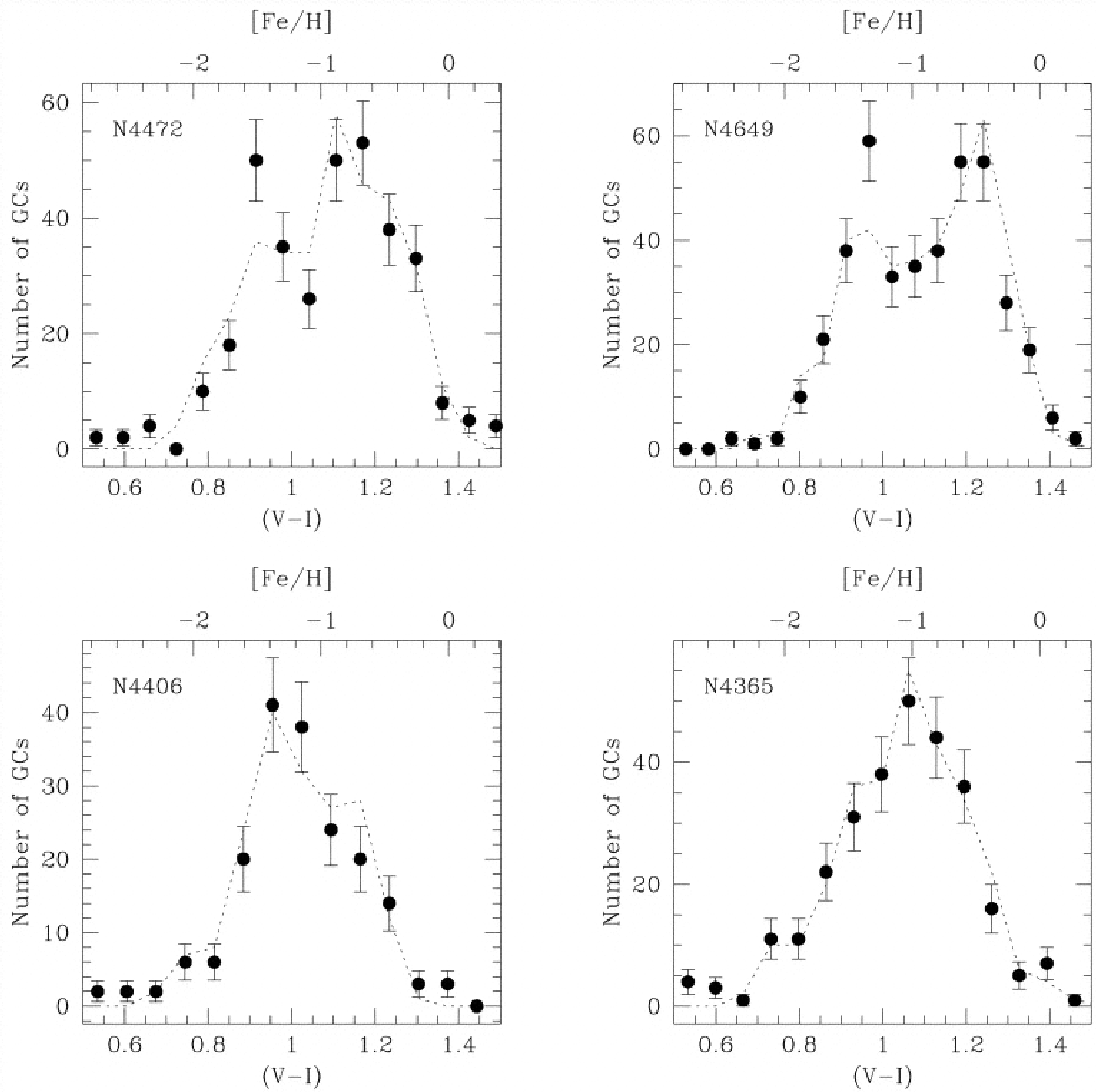
With a 100m telescope:

— Can spatially and spectrally resolve rich star clusters in all environments (normal galaxies of all types, starburst and post-starburst systems)

— Can explore extremes of feedback microphysics in starburst systems

— Can compare IMF, etc, to “field” star formation

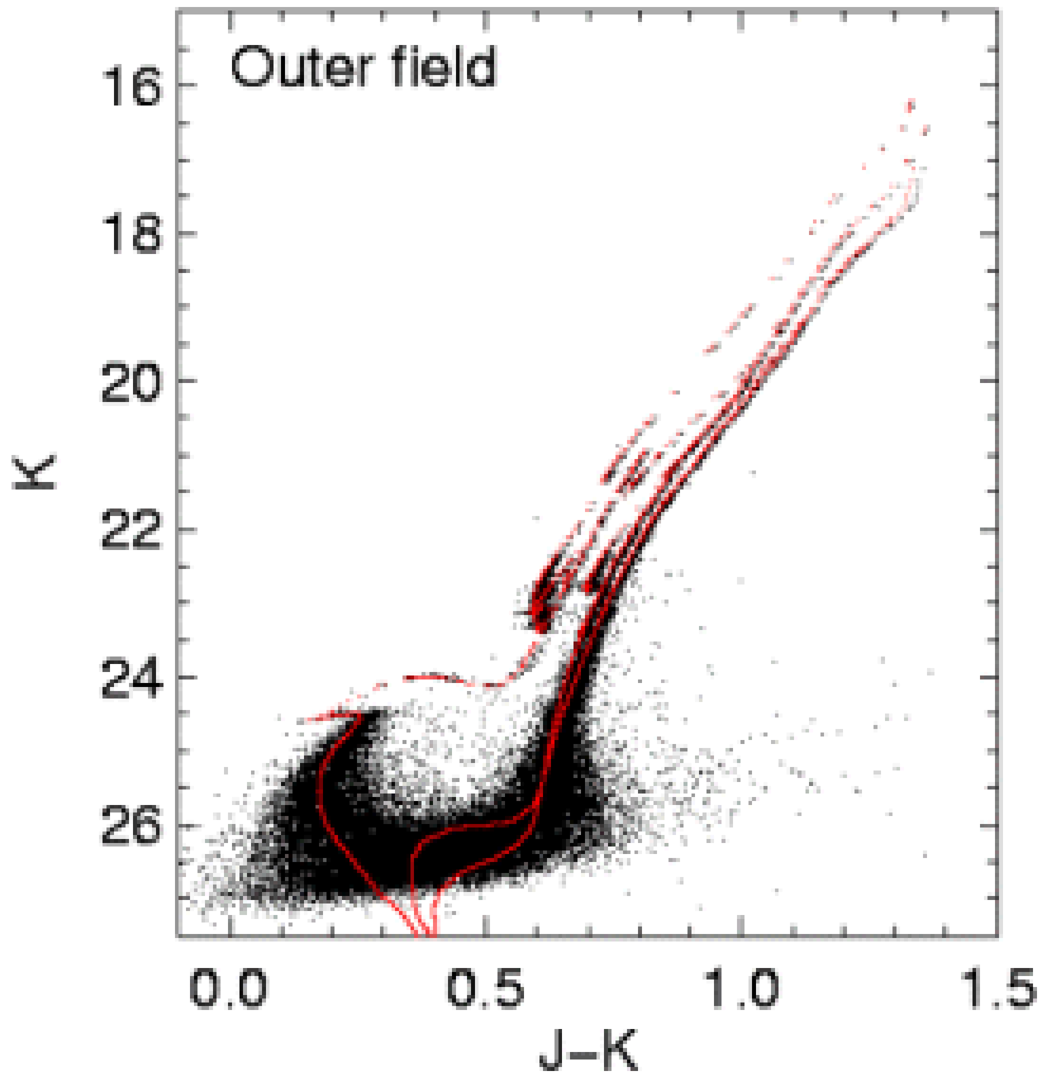
Globular Cluster Colours



Cote *et al.* (2002)

With a 100m telescope, these studies could be made out to cosmological distances.

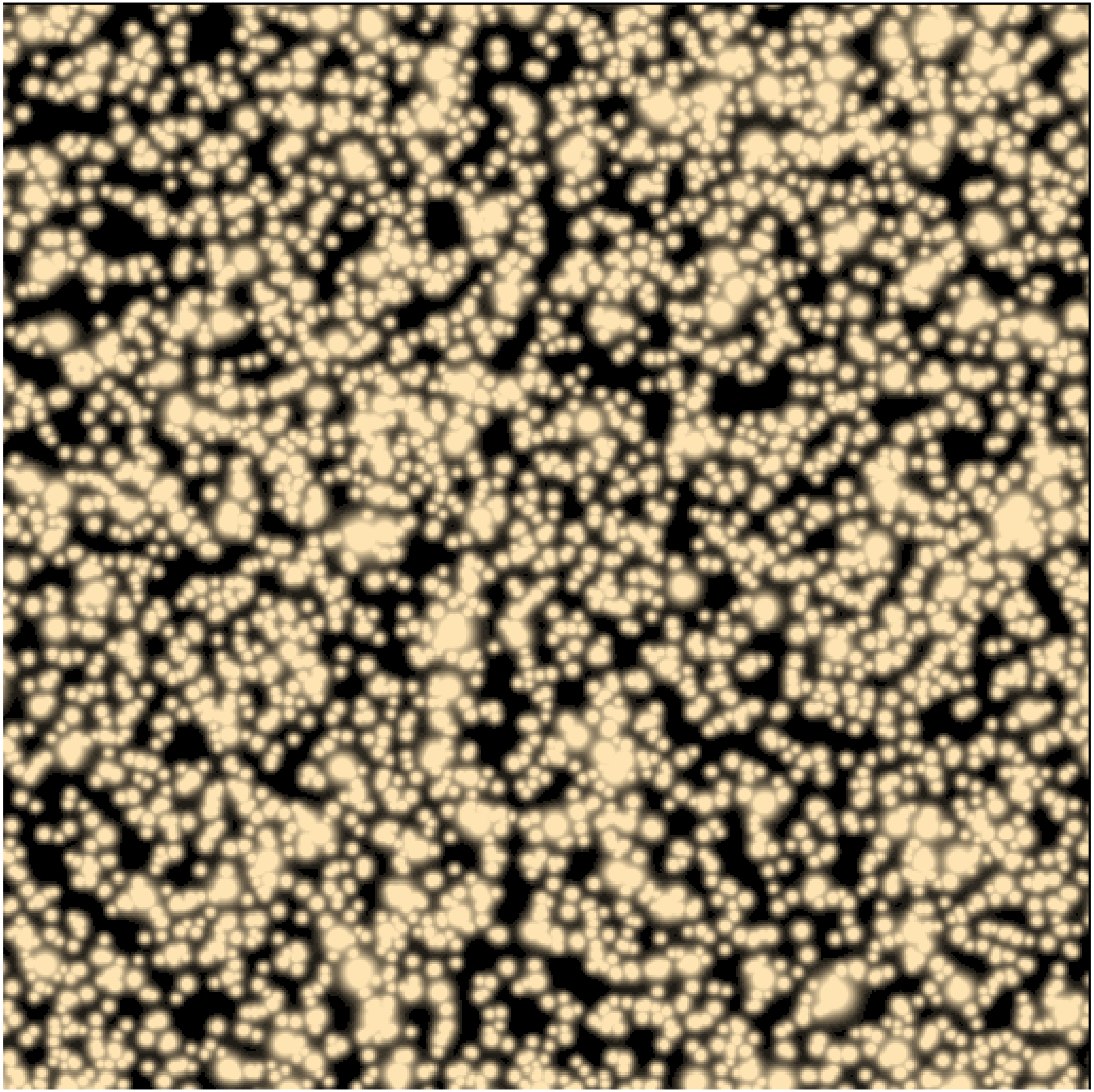
Simulated M32 CM Diagram Observed with 30-m Telescope



(from GSMT study)

- We can learn a lot about the formation and evolution of our nearby neighbours with a 30-m telescope

- What about a more representative slice of the Universe?



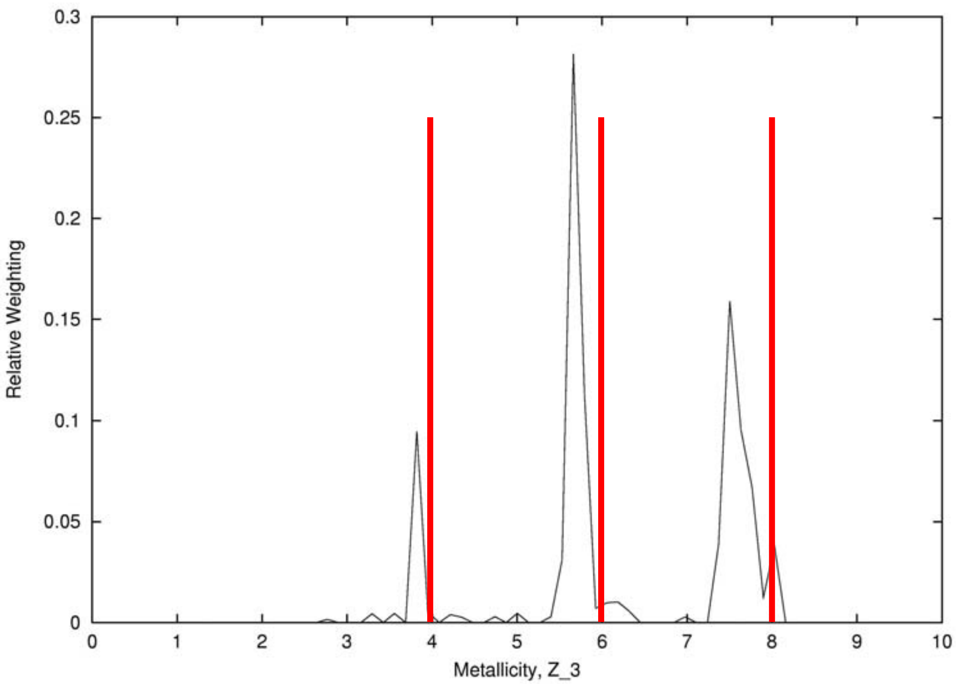
Simulated M87 field observed with 100-m telescope

- Outer field ($\mu_I = 28$)
- Realistic IMF plus population synthesis to two magnitudes below MSTO
- 3 hour exposure
- Diffraction-limited observation

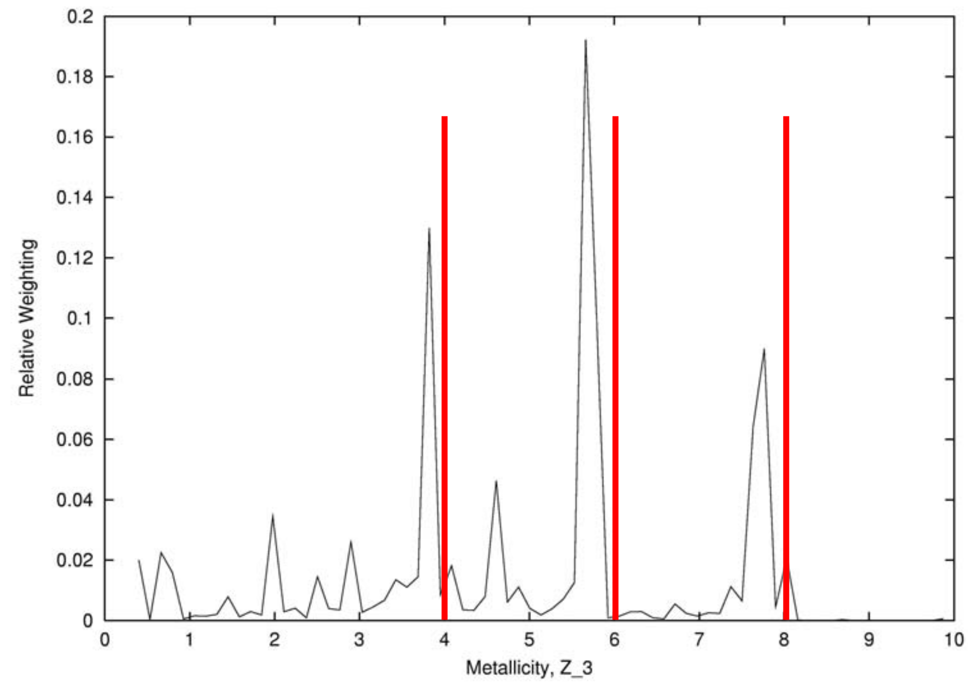
(Frayn 2003)

Recovered metallicity distribution

- Can recover a single metallicity population at Coma-Cluster distances
- At Virgo-Cluster distances we can do rather better:



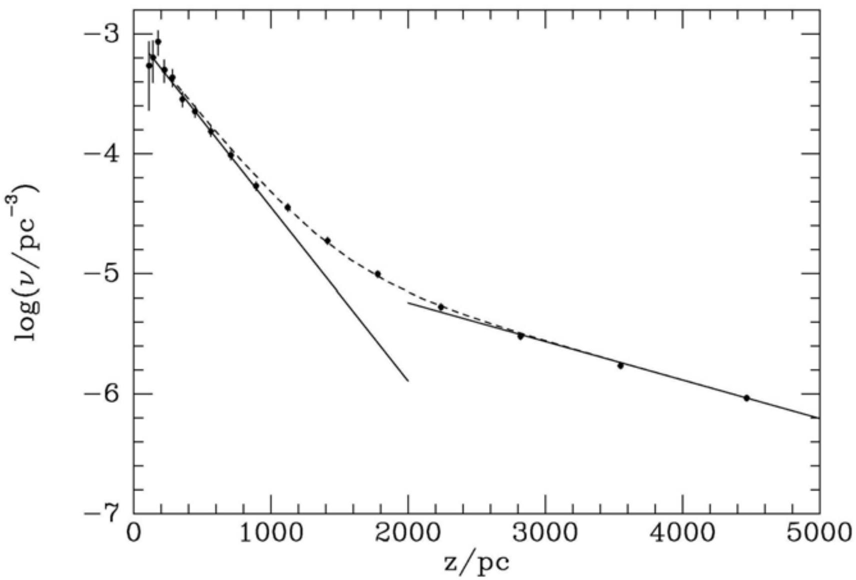
Fit to just RGB stars



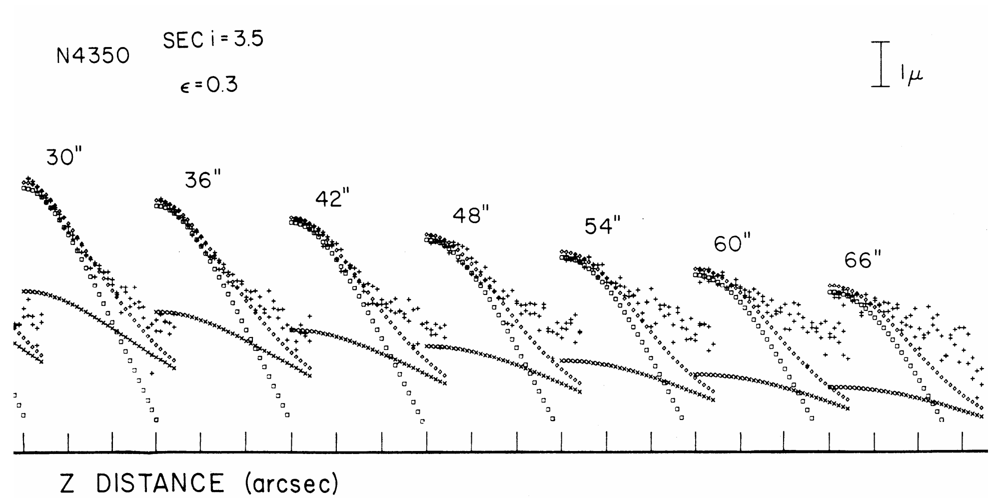
Fit to whole CMD

(Frayn 2003)

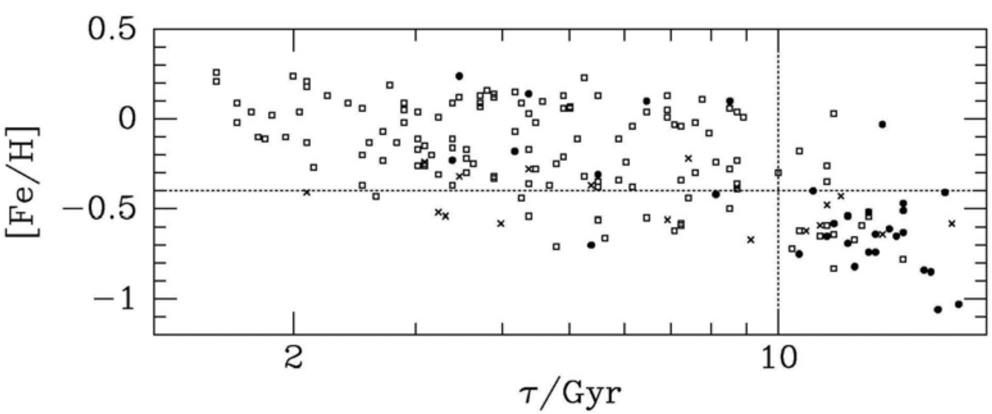
Thick Disks



(Gilmore & Reid 1983)



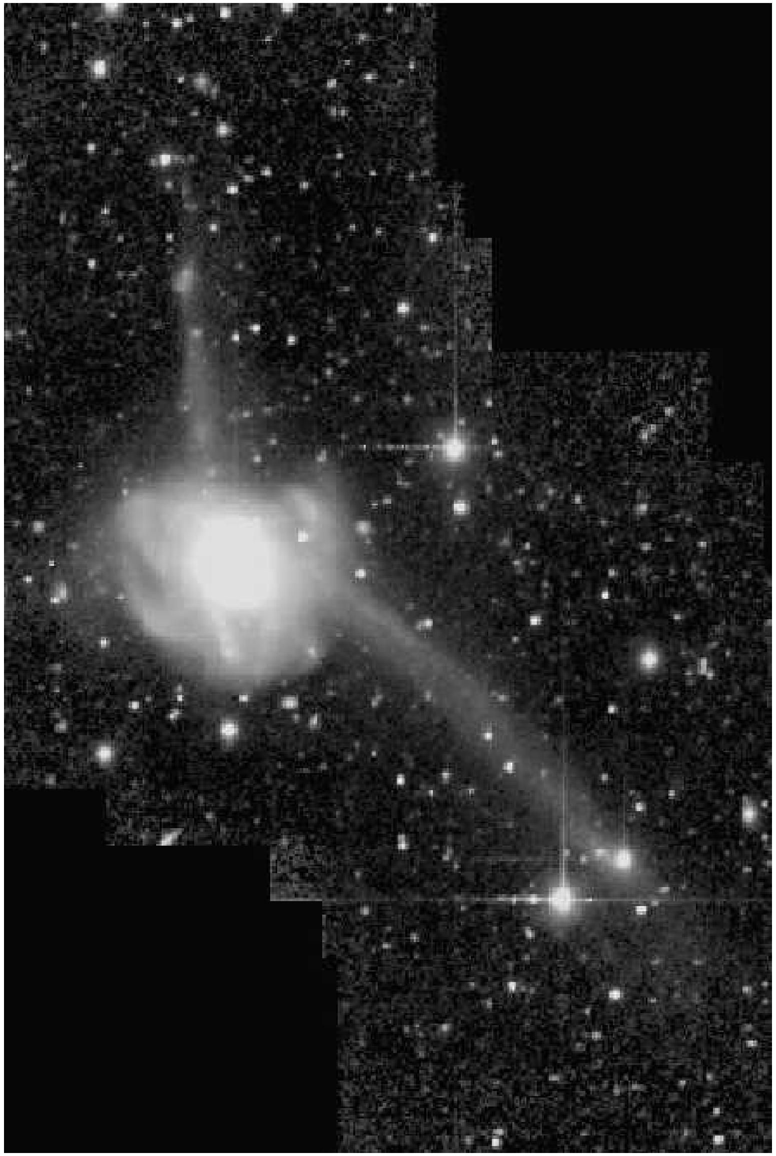
(Burstein 1979)



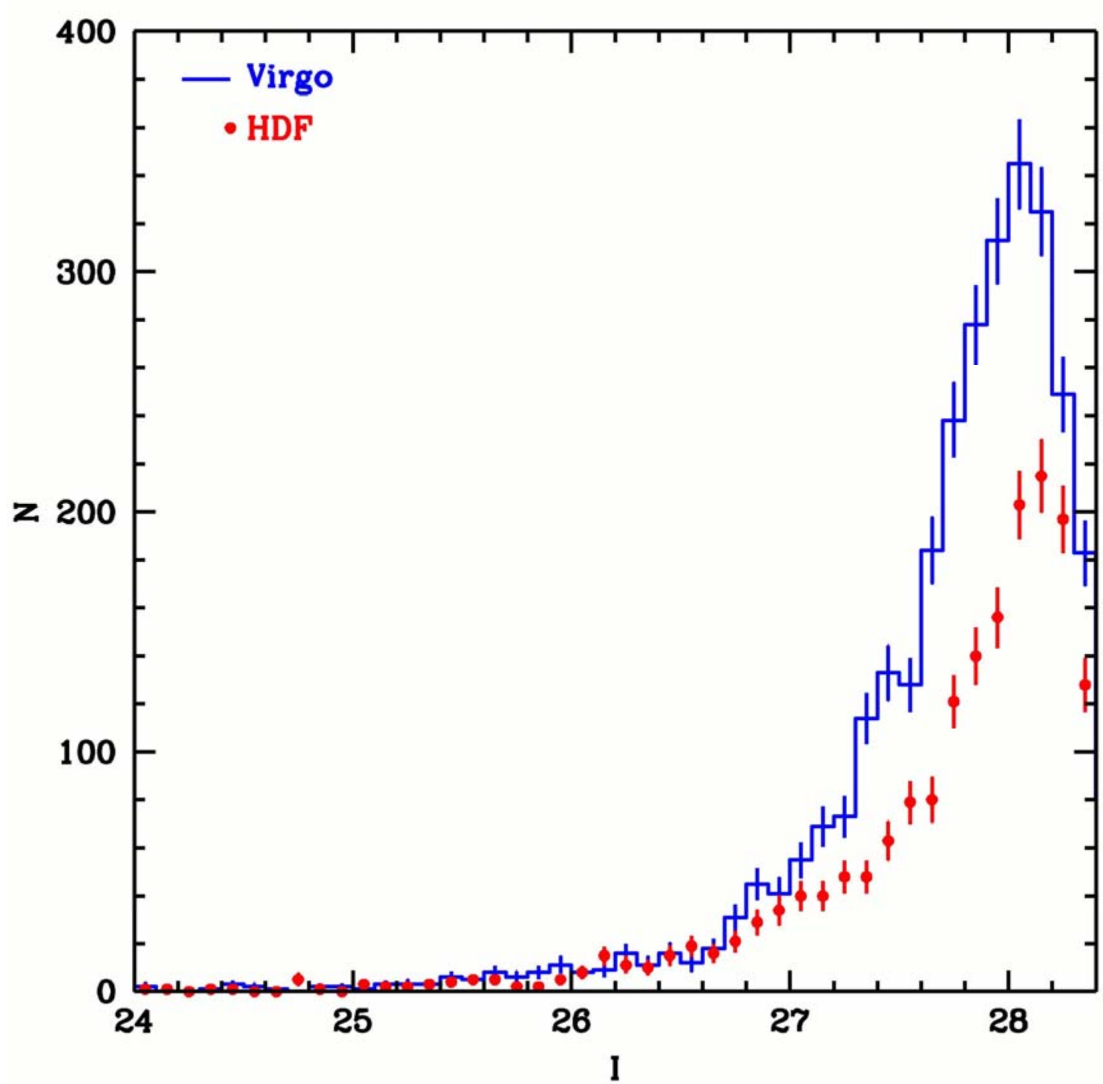
(Edvardsson *et al*. 1993; Binney & Merrifield 1998)

(Robert Gendler)

Stars Outside Galaxies

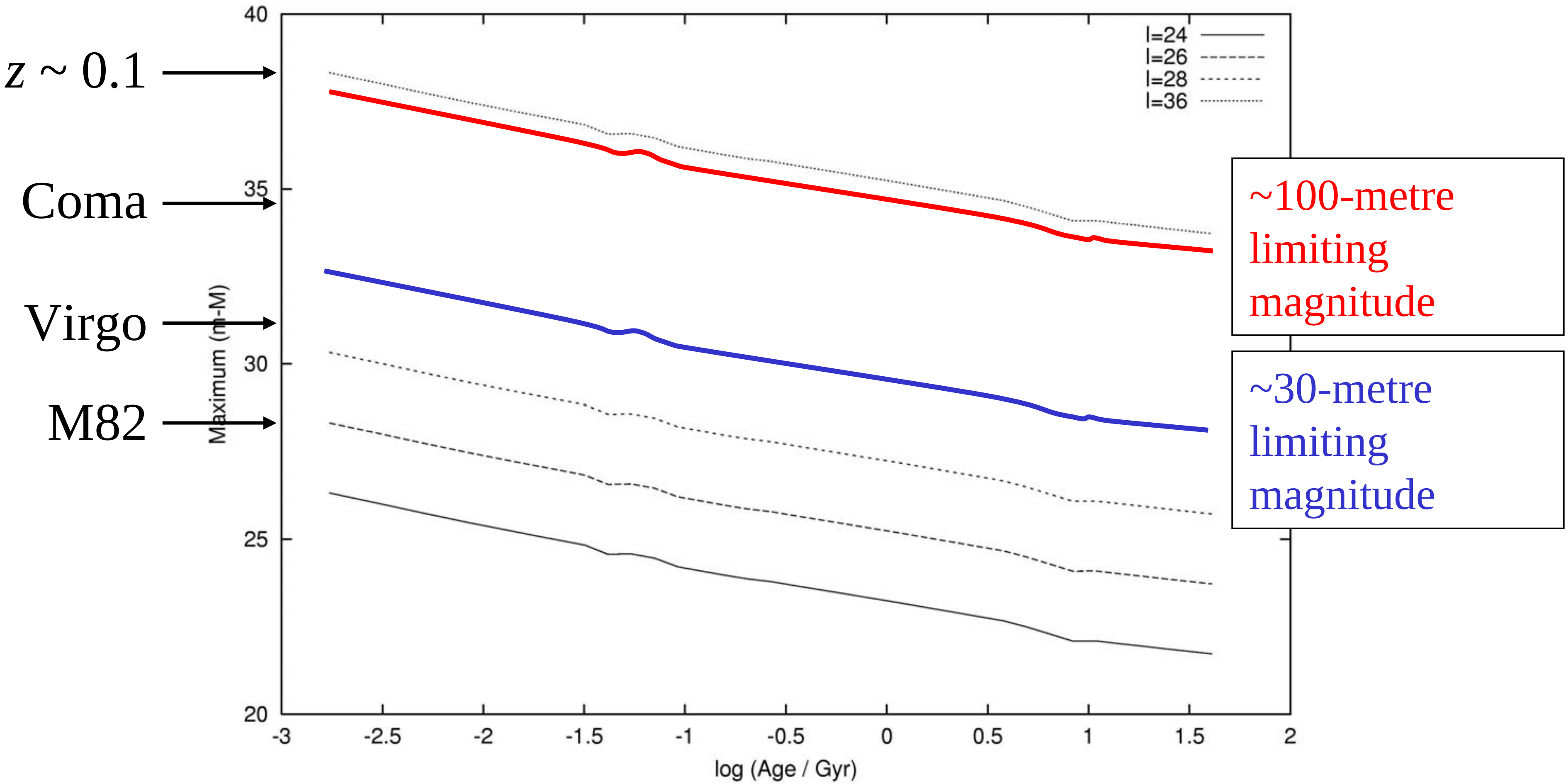


Hibbard & van Gorkom (1996)



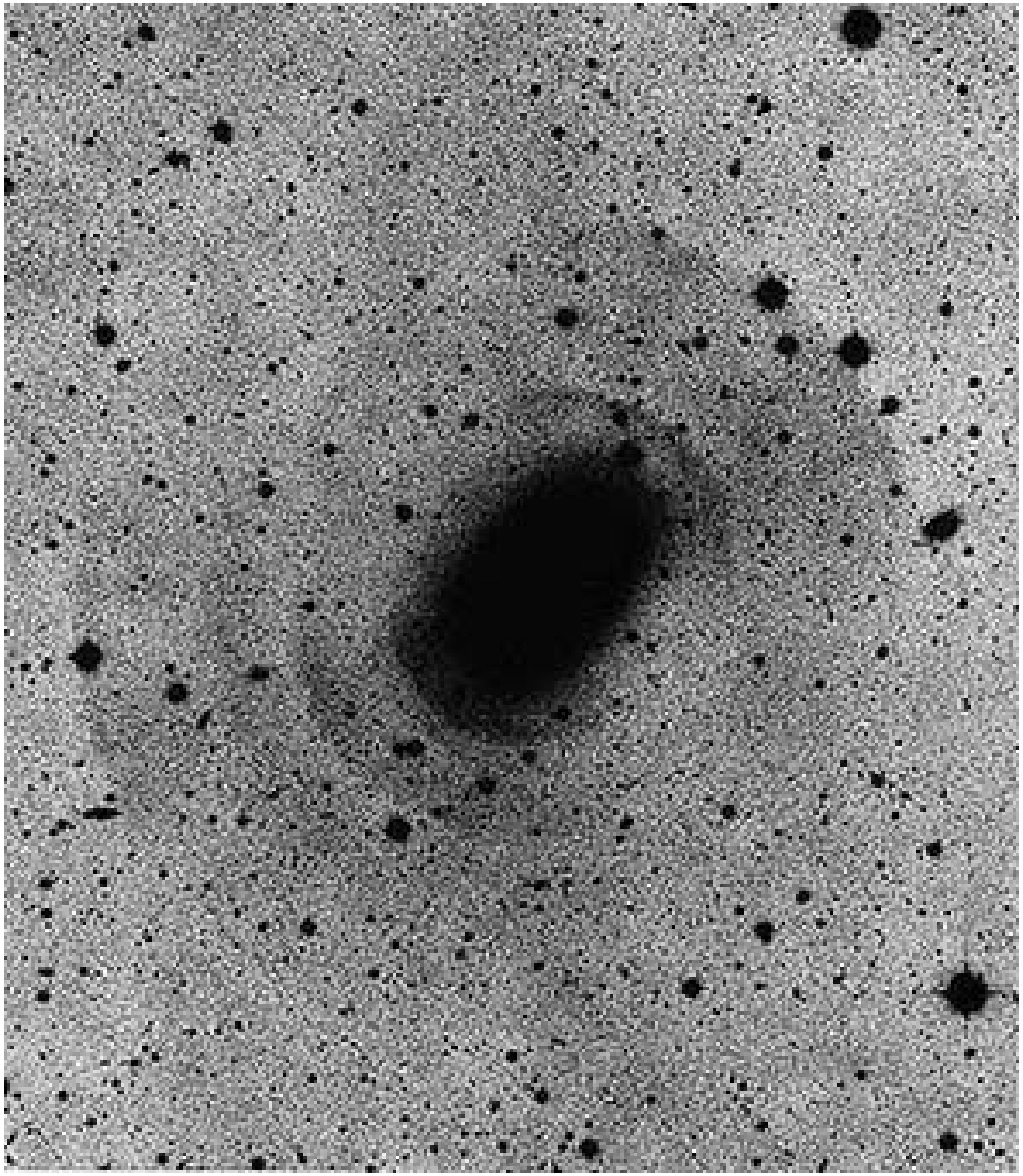
Ferguson, Tanvir & von Hippel (1998)

Can we reach the Main Sequence Turn-off?



(mutilated from Frayn 2003)

NGC3923



(Malin)

$R \sim 50$kpc

$v \sim 100$kms^{-1}

$\Downarrow$

$t_{dyn} \sim 0.5$ Gyr

Kinematically-Resolved Structure

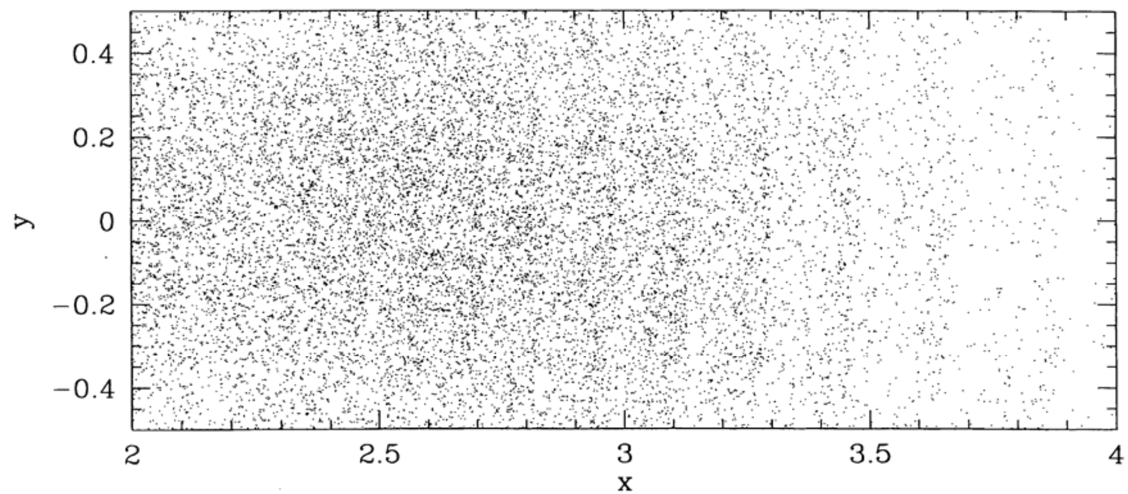


Figure 1. Projected density of part of the shell system generated by a small unbound satellite falling into a spherical isochrone potential.

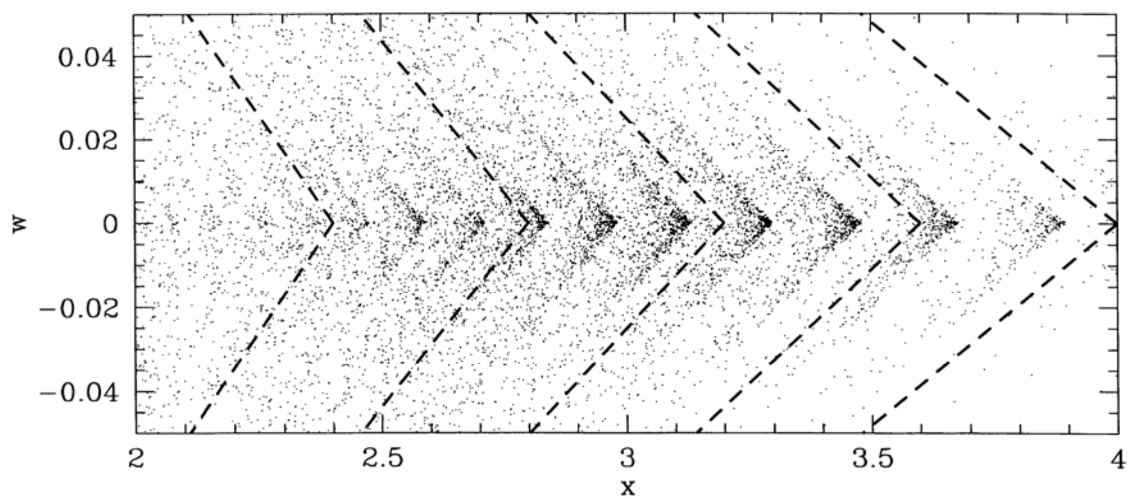
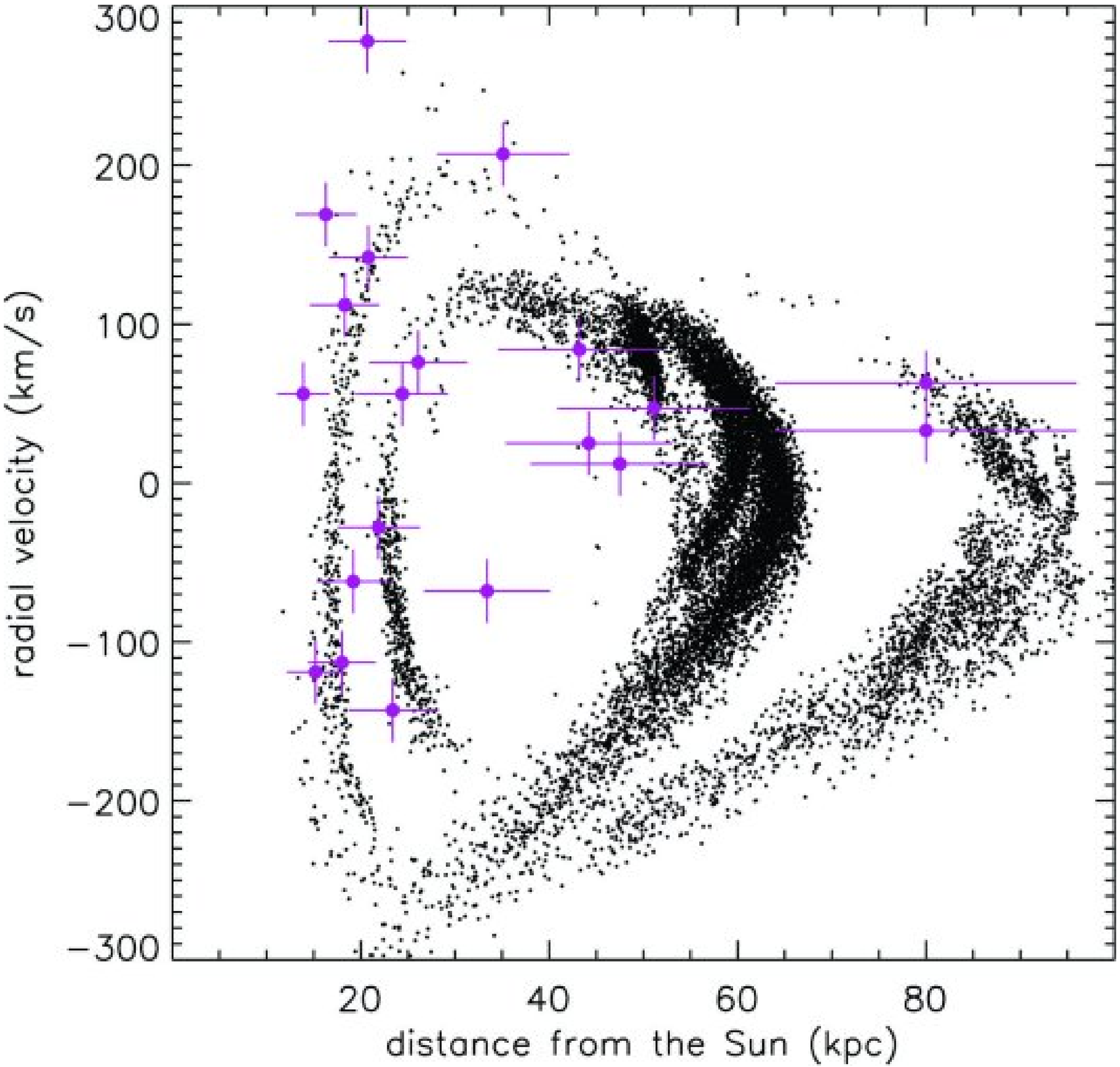


Figure 2. The velocity structure of the shells shown in Fig. 1. The slopes of the V-shaped line profiles agree well with the predictions of the approximate formula of equation (7) (shown as dashed lines).

(Merrifield & Kuijken 1998)

Galactic Halo Kinematics



(Spaghetti Survey; Helmi 2002)

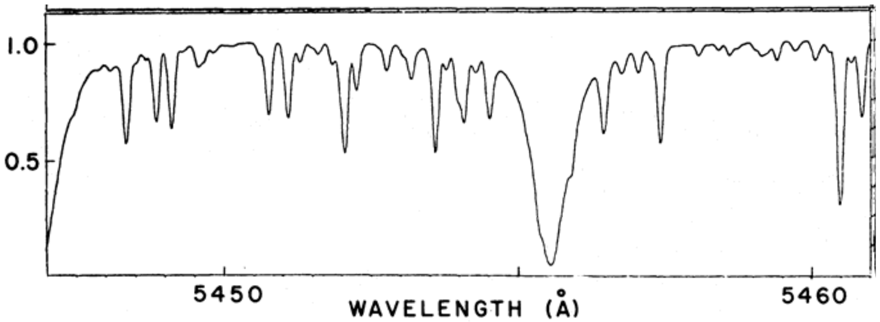
$R \sim 50\text{kpc}$

$v \sim 100\text{kms}^{-1}$

$\Downarrow$

$t_{\text{dyn}} \sim 0.5 \text{ Gyr}$

Beyond Confusion



Typical K giants have iron lines with widths of only ~ 3 km/s

(Bonnell & Branch 1979)

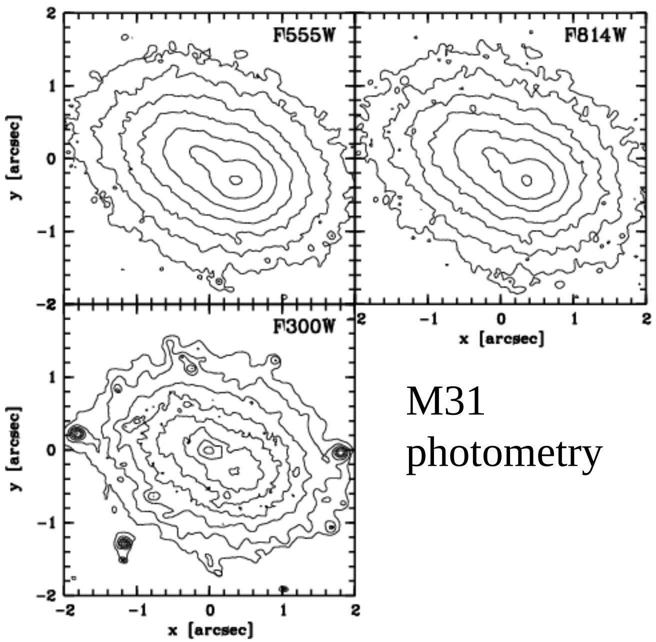
If there are not too many stars in a single spectrum, then we will still be able to measure their individual kinematics by resolving these lines.

- For example, with a 100-m telescope, the centre of an elliptical in the Virgo Cluster will contain ~10 RGB stars per resolution element

- These will be resolved out by a spectral resolution of ~20 km/s (*c.f.* ~300km/s velocity dispersion of galaxy).

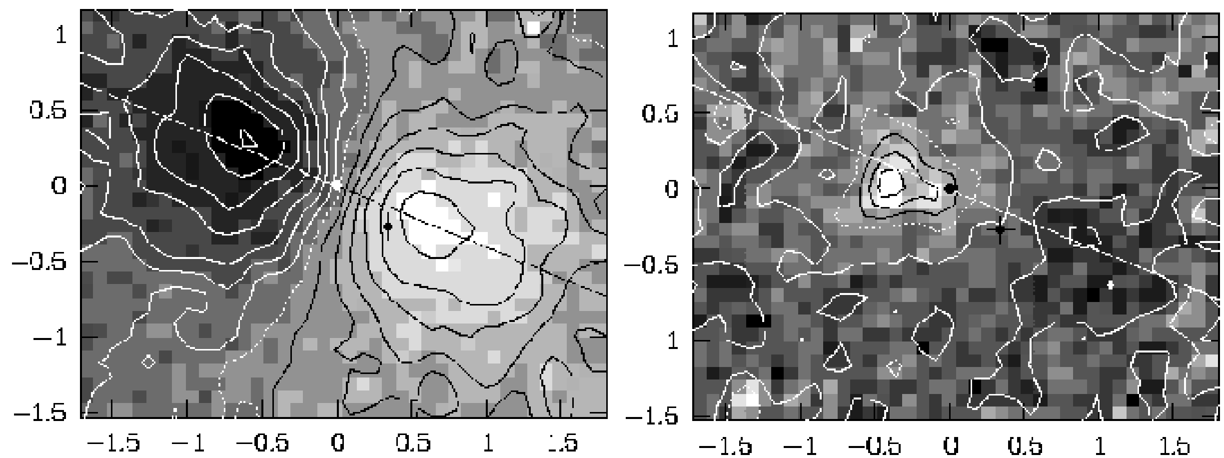
- The requisite signal-to-noise ratio can be obtained in ~1 night with a 100-m telescope

Galactic Nuclei



M31 photometry

M31 Stellar Kinematics



Bacon *et al.* (2001)

With a 100m telescope, we can:

— Study peculiar structures like M31's nucleus to Virgo Cluster distances

— Resolve "region of influence" of supermassive black holes in stellar kinematics to ~ 0.5Gpc

— Obtain mid-IR images and resolved spectra of tori in nearby AGN

The Bottom Line

With a suitably-designed ELT, we will be able to provide definitive answers to *the most fundamental questions* about the relationship between stars and galaxies:

How do stars form in galaxies?

How are galaxies formed from stars?

These answers will dovetail neatly with ELT work on galaxy formation in its cosmological context (see “Galaxies and Cosmology”), and the localized physics of star formation (see “Planets and Stars”).

However, these science drivers impose some strong design constraints:

— Aperture must be ~100m to reach a representative slice of the Universe

— Telescope must work at optical wavelengths to address many of the scientific issues (discrimination of CM diagram, source confusion, etc)