

# ELT spectroscopy of resolved massive stars beyond the Local Group

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# Massive stars ( $M > \sim 8M_{\text{sun}}$ )

- Massive stars play a key role in galaxy evolution, in terms of:
  - feedback of kinetic energy
  - ionizing photons
  - chemical enrichment.

# Massive stars beyond the Local Group

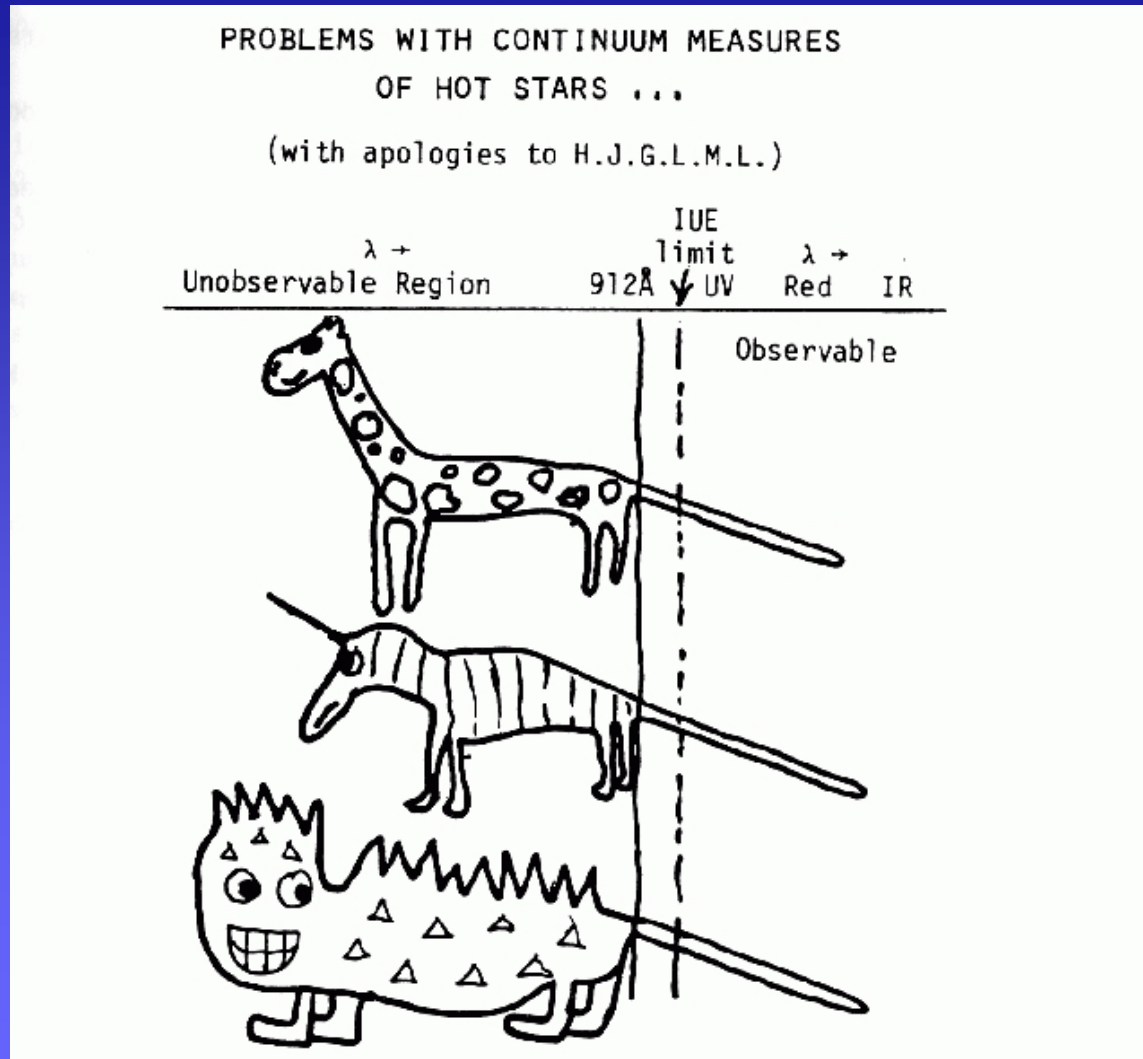
Two types of spectroscopic projects:

- Intermediate resolution surveys to determine the resolved stellar populations.
- Higher quality (S/N  $\sim 100$ ) observations to find physical parameters/abundances of individual stars.

# Spectroscopic surveys

- With an ELT we can probe the upper IMF in a wide variety of systems beyond the Local Group.
  - Universality of the IMF?
  - Star-formation histories
  - Feed the results into codes such as STARBURST99
- Conceptually simple, but needs  $R \sim 3000$  spectroscopy – photometry alone is not sufficient!

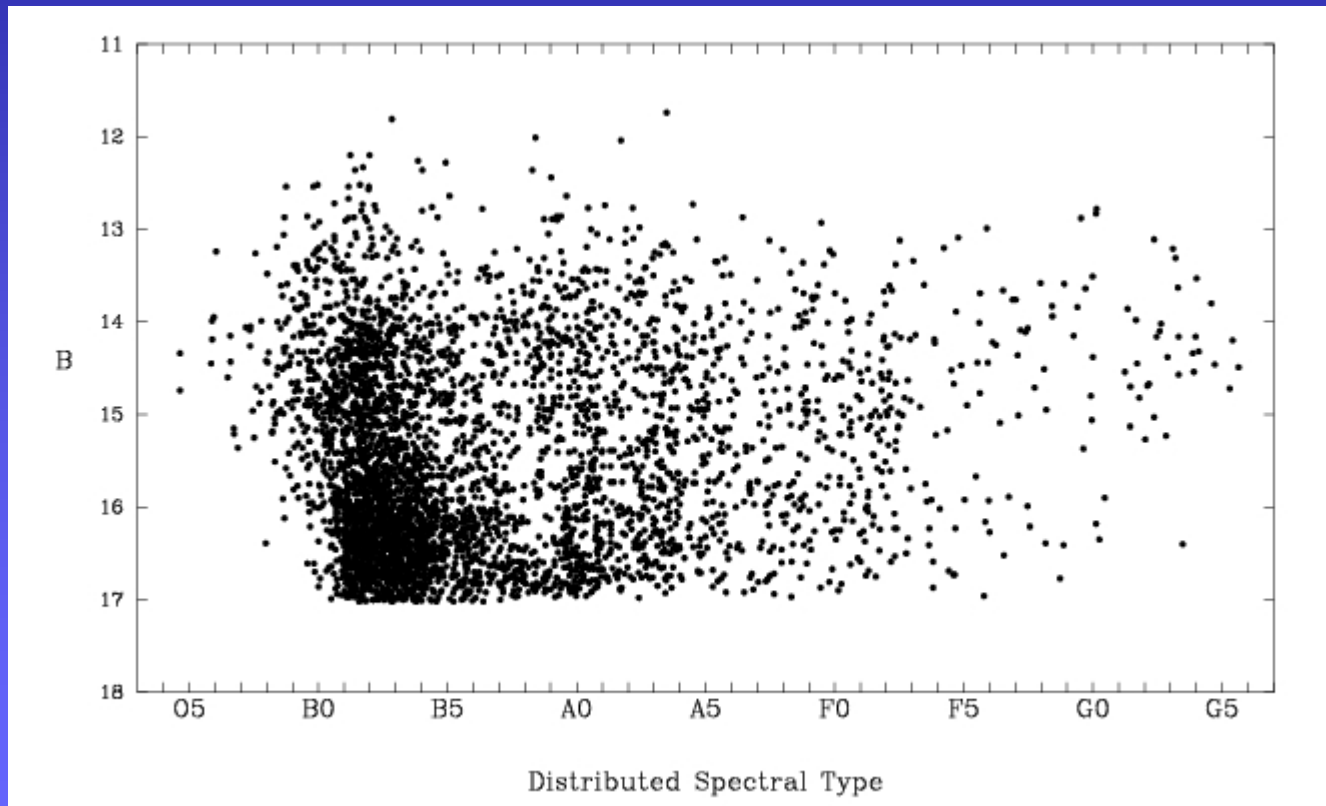
# Photometric colours are degenerate from O2-B2



Conti (1986)

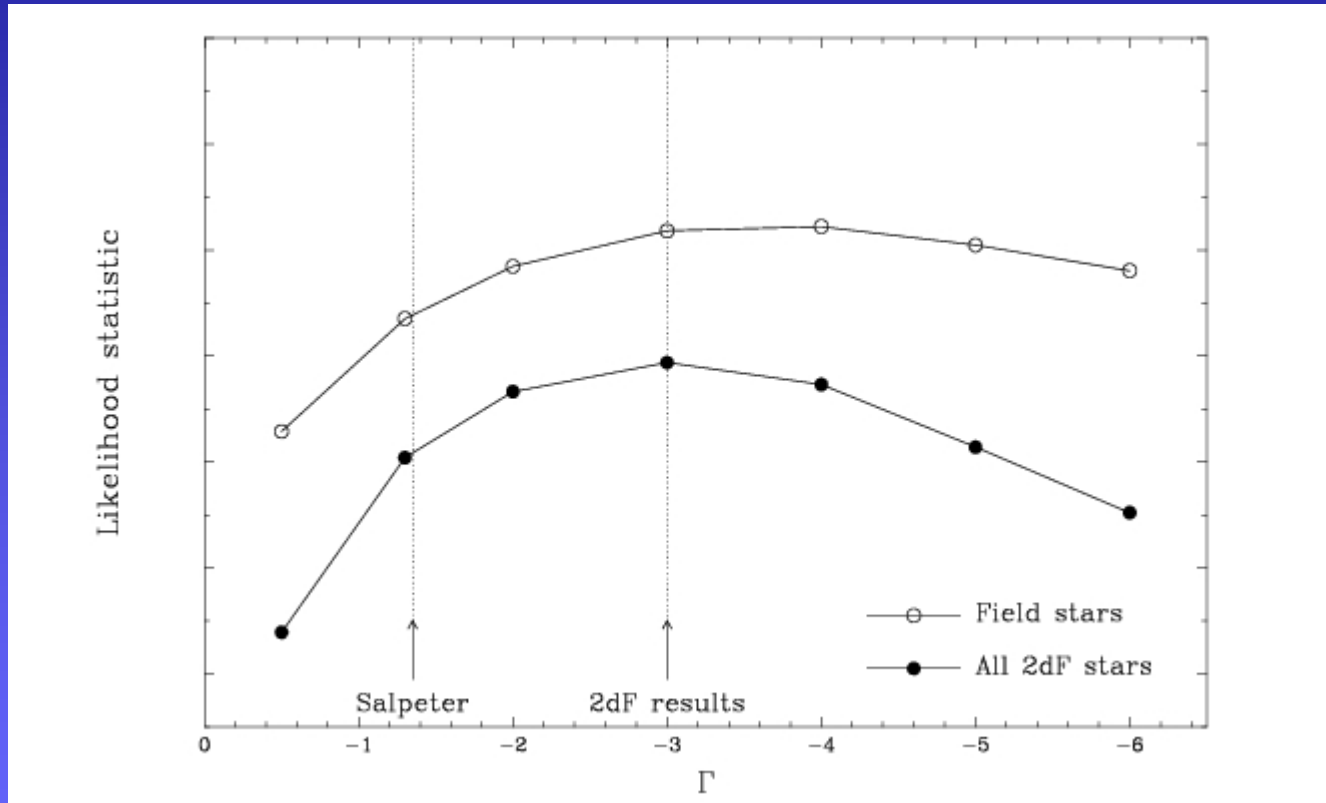
# 2dF spectroscopy in the SMC

Spectra of 4000 SMC stars to investigate the IMF.  
[New LMC 2dF survey ongoing in 2004B]



(Evans, Howarth et al. 2004)

# Field-star IMF in the SMC



# Spectroscopic surveys

- With an ELT we can probe the upper IMF of a wide variety of systems beyond the Local Group.
- Conceptually simple, needs  $R \sim 3000$  spectroscopy.
- Prime candidates: clusters & star-burst regions in M82.
- No need to talk in terms of “O7 equivalents” in local starbursts if we know the distribution of spectral types!

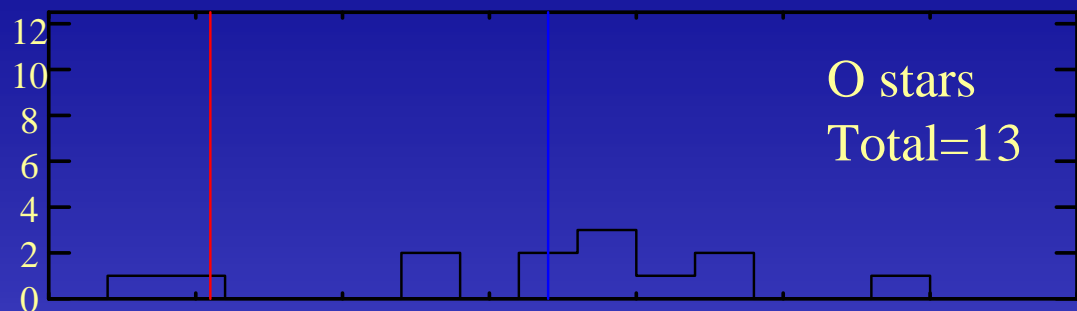


# Analysis of extragalactic stars

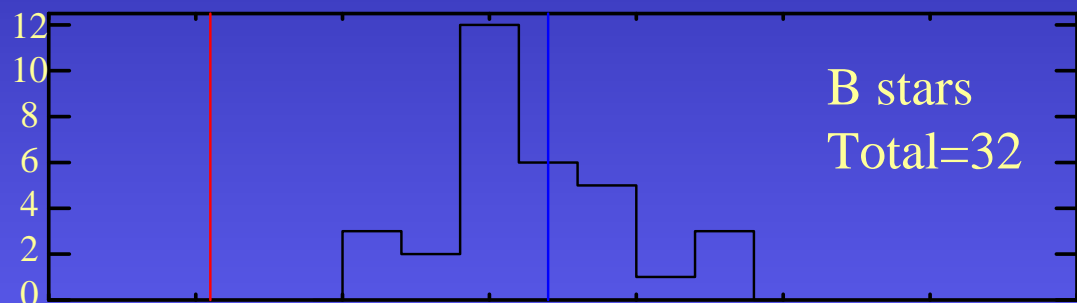
- VLT-UVES used for detailed studies of LMC/SMC stars
  - Physical parameters:  $T_{\text{eff}}$ , gravity, stellar mass-loss rates
  - Light-element abundances: C, N, O, Si, Mg

# SMC results

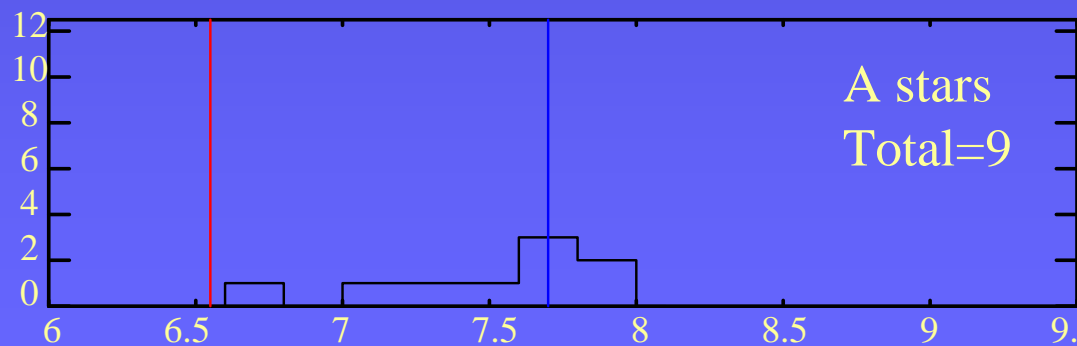
Number of Stellar Objects



Crowther et al. 2002  
Bouret et al. 2003  
Hillier et al. 2003  
Evans et al. 2004



Lennon et al. 2003  
Trundle et al. 2004  
Trundle & Lennon 2005  
Dufton et al. 2005



Venn et al. 1999

Figure from Trundle & Lennon, 2005

$12 + \log_{10}(N/H)$

# Analysis of extragalactic stars

- VLT-UVES used for detailed studies of LMC/SMC stars
- From VLT-FLAMES we have ~400 LMC/SMC stars.  
(Evans, Smartt et al., submitted)  
We can now undertake statistically significant studies of N-enrichment cf. stellar rotation.
- Want to now push studies to lower metallicity.

# Stars in very metal-poor systems

- Specific example: NGC 3109 at 1.2Mpc ( $z \sim 0.05$  solar).
- At  $V \sim 23$ ,  $S/N \sim 100$  ( $0.5\text{\AA}$  resolution) in 2hrs.
- This will be a key galaxy for testing our knowledge of stellar evolution in metal-poor systems, of interest in the context of, e.g.
  - the unresolved populations of Ly-break galaxies.
  - ionization in star-forming galaxies from IR/mm surveys.
  - Population III stars and their role in re-ionization of the Universe.
  - the physics of stellar winds in low metallicity systems.

# Finally, ELT vs 30m?

- Spectroscopic surveys in e.g. M82 and M83 – not impossible with a 30m, but can push further down the main-sequence with an ELT for IMF studies etc.
- Detailed analysis of stars in, e.g. NGC 3109 – *very* difficult to do with a 30m.

# Requirements of an ELT

- Spectral resolution: 2,000-10,000
- Instrumentation: some sort of multi-object, fibres, IFU
- Coverage: optical/near-IR
- Field-of-view: 1'?