Requirements from imaging surveys and spectroscopy for near-field cosmology

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using wide-field imaging and spectroscopy to probe the assembly history and properties of dark and visible matter in Local Group galaxies

Near-field cosmology - some key questions

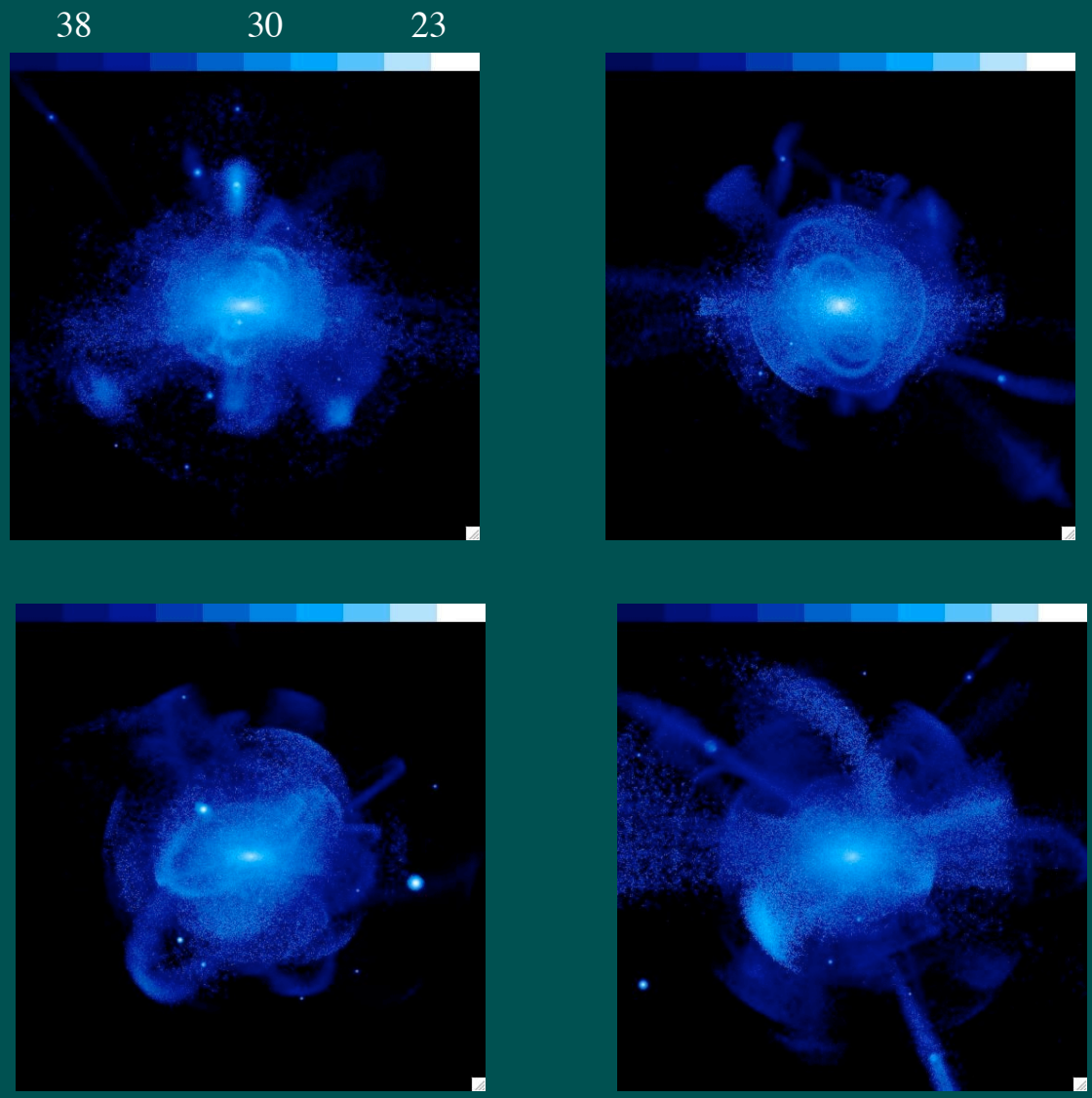
- where are the missing satellites predicted in ΛCDM ?
- are dark matter profiles universal ? NFW ?
- what is the extent, nature and spatial distribution of dark matter ?
- how were the Galaxy and M31 constructed ? are they typical disk galaxies ?
- what was the role of accretion in the formation of the Galactic halo, disk, bulge ?
- what was the detailed chemical enrichment history of the stellar components of each structure ?
- do the Galaxy and M31 look like the predictions ?

Galaxy substructure and satellite accretion

ΛCDM models predict large-scale subtructure in L_* galaxies like M31 and the MW

Bullock & Johnston 2005

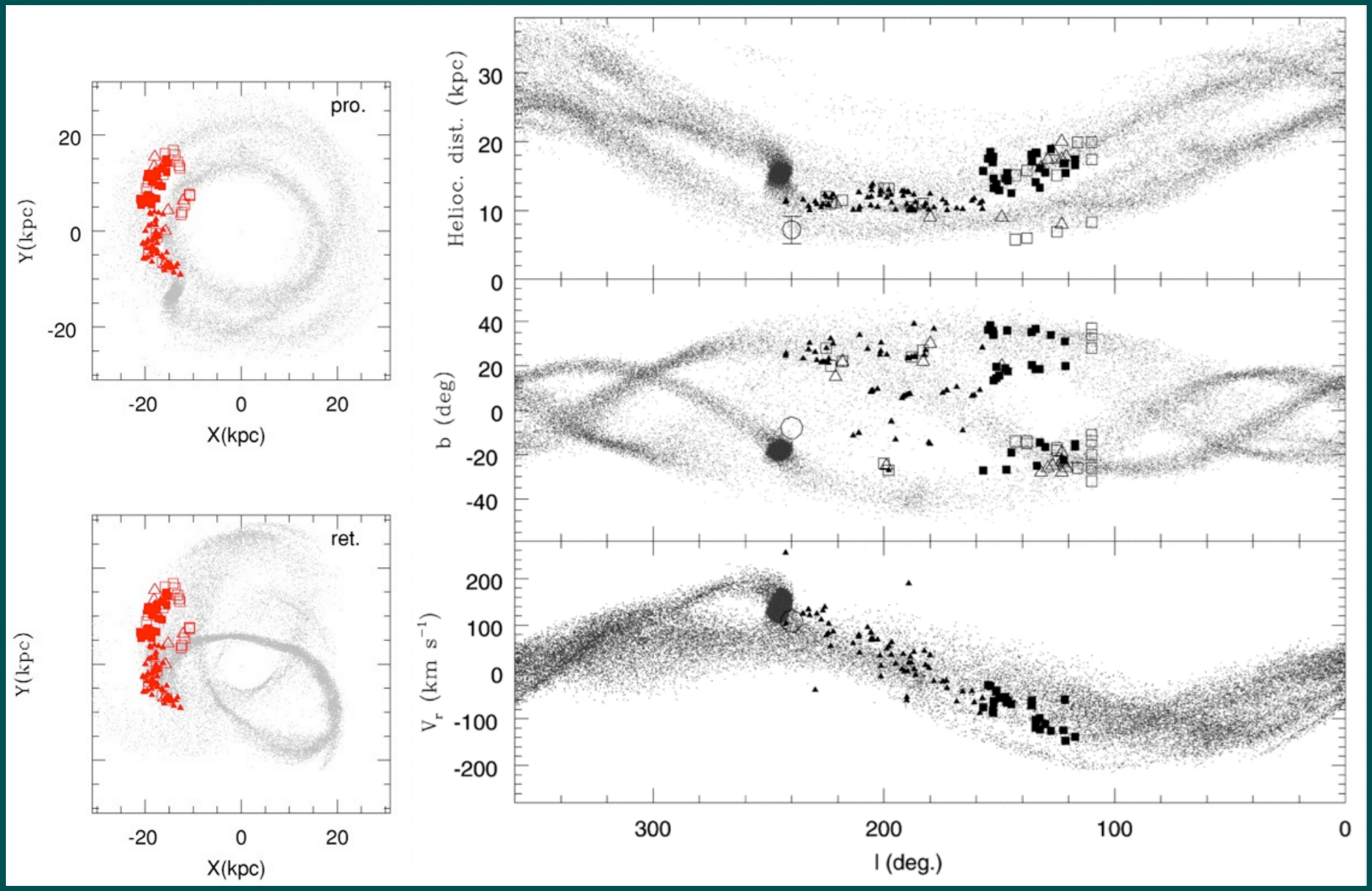
300 x 300 kpc



GA science requires detailed chemo-dynamic tagging

- chemo-dynamic structure of Galactic components
  - interface between disk, bulge/bar, halo
  - ancient dissolved and surviving substructures
- fossil record of chemical evolution of stellar pops
  - chemical signature of ancient accretions
  - discovery and properties of metal-poor popIII stars
- evolutionary history of stellar components
  - IMF, SFH, tagging the chemical development
  - tracking the role of star clusters
- linking the Bulge to the high Z universe
  - detailed comparative spectral synthesis
- detailed chemo-dynamics of surviving satellites
  - crucial for analysis of outer profiles & links to DM

Example: Canis-Major and the Monoceros Ring - a disk accretion ?



kinematics insufficient to discriminate between models -> need detailed abundances

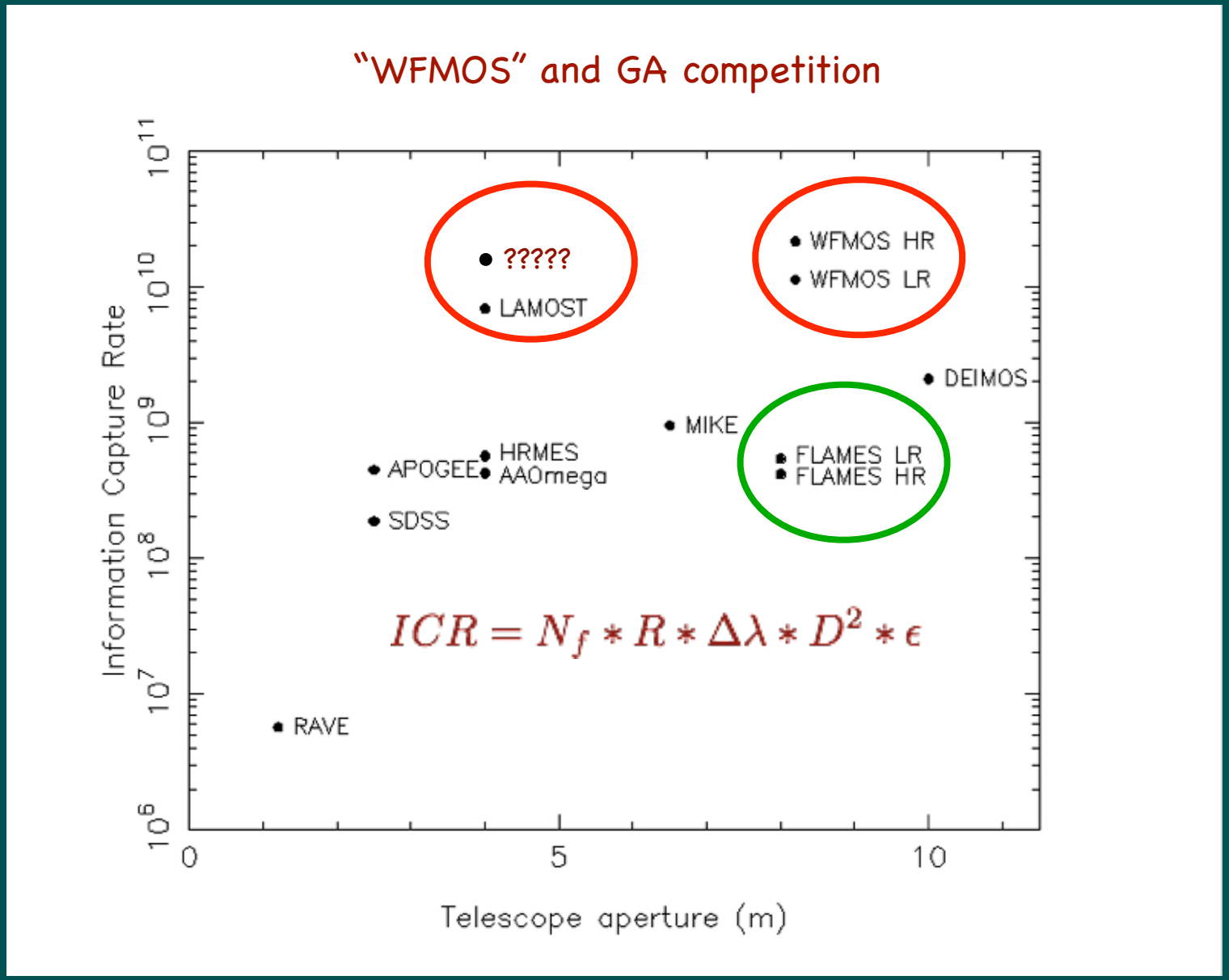
Near-field chemo-dynamics: What do you need - I ?

- wide field well calibrated imaging optical -> NIR
- north: SDSS ugriz, UKIDSS zyJHK, Pan-STARRS, MegaCam, (Hyper)SuprimeCam
- south: Skymapper, VST, CTIO 4m DE, VISTA
- all-sky: 2MASS, UCAC3 calibration and pathfinders
- Gaia mission: proper motions and parallaxes
- large area stellar spectroscopy (million stars)
- automate majority of processing and analysis

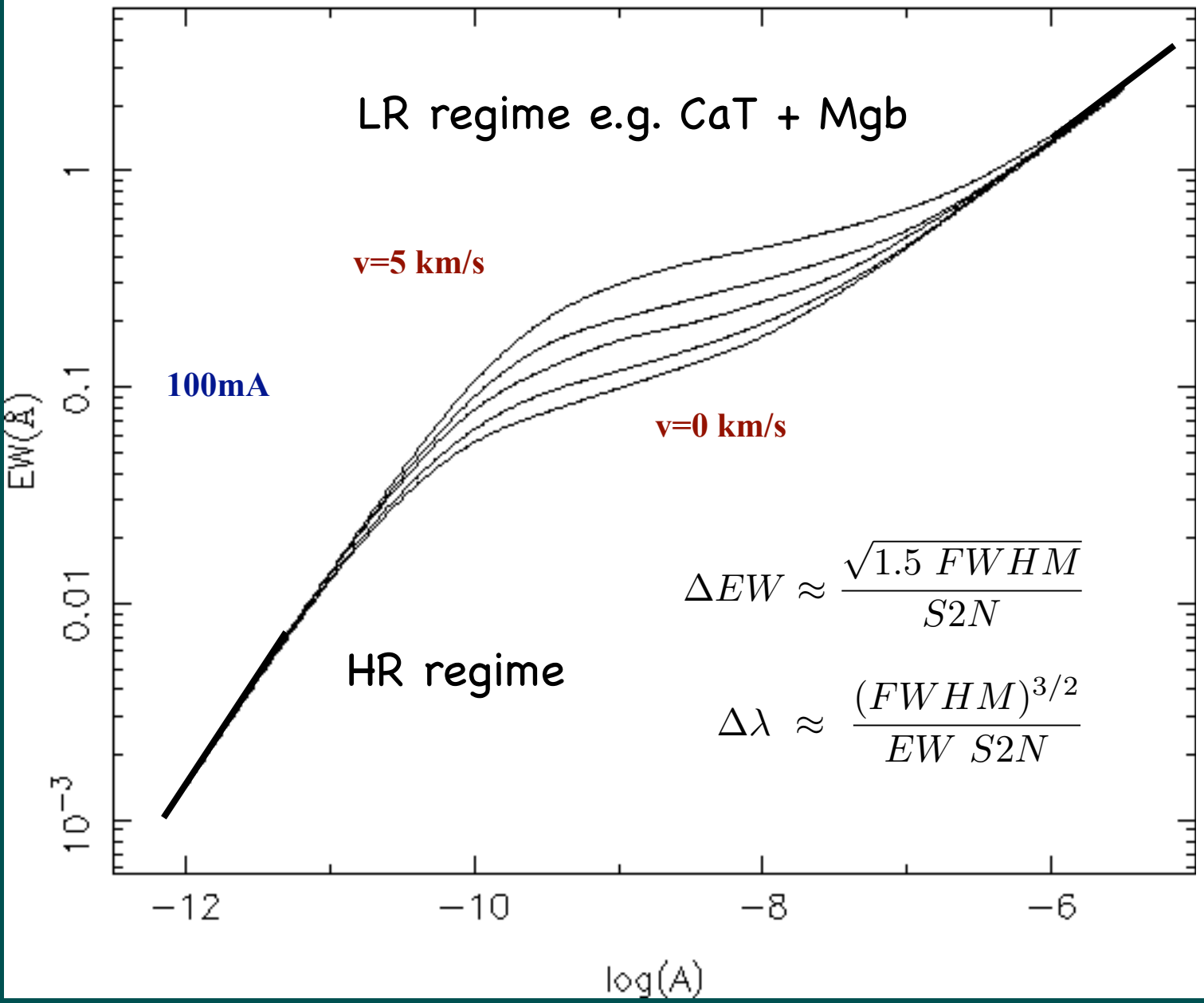
	$\|b\| =$	20°	30°	60°	90°	
V =	17	2290	1318	468	355	HR limit
	18	4074	2239	741	550	
	19	7079	3631	1122	832	
	20	11482	5623	1698	1230	LR limit
	21	17378	8128	2455	1778	
	22	23988	11220	3467	2399	

Estimated V-band stellar density per square degree

Why a "WFMOS" is needed for chemo-dynamic analysis of nearby galaxies



EWs and metal-line abundances



What do you need - II ?

- 4-8m class telescope with wide fov 1-2 deg diam
- 1000+ fibres to exploit target surface density
- survey selected regions totalling few 1000 sq deg
- LR survey vels to ~2 km/s; [Fe/H] to 0.1-0.2 dex .....
- sampled HR vels to 0.5 km/s; EWs to 5mA;
  good wavelength coverage e.g. few 1000A;
  abundances: light elements, alpha-elements, r- s-
  process and heavy elements => chemical tagging
- synergy with Gaia => LR to V~20 HR to V~17
  (Gaia will revolutionise GA but lacks spectroscopic depth)

Stellar atmosphere modelling

Params:

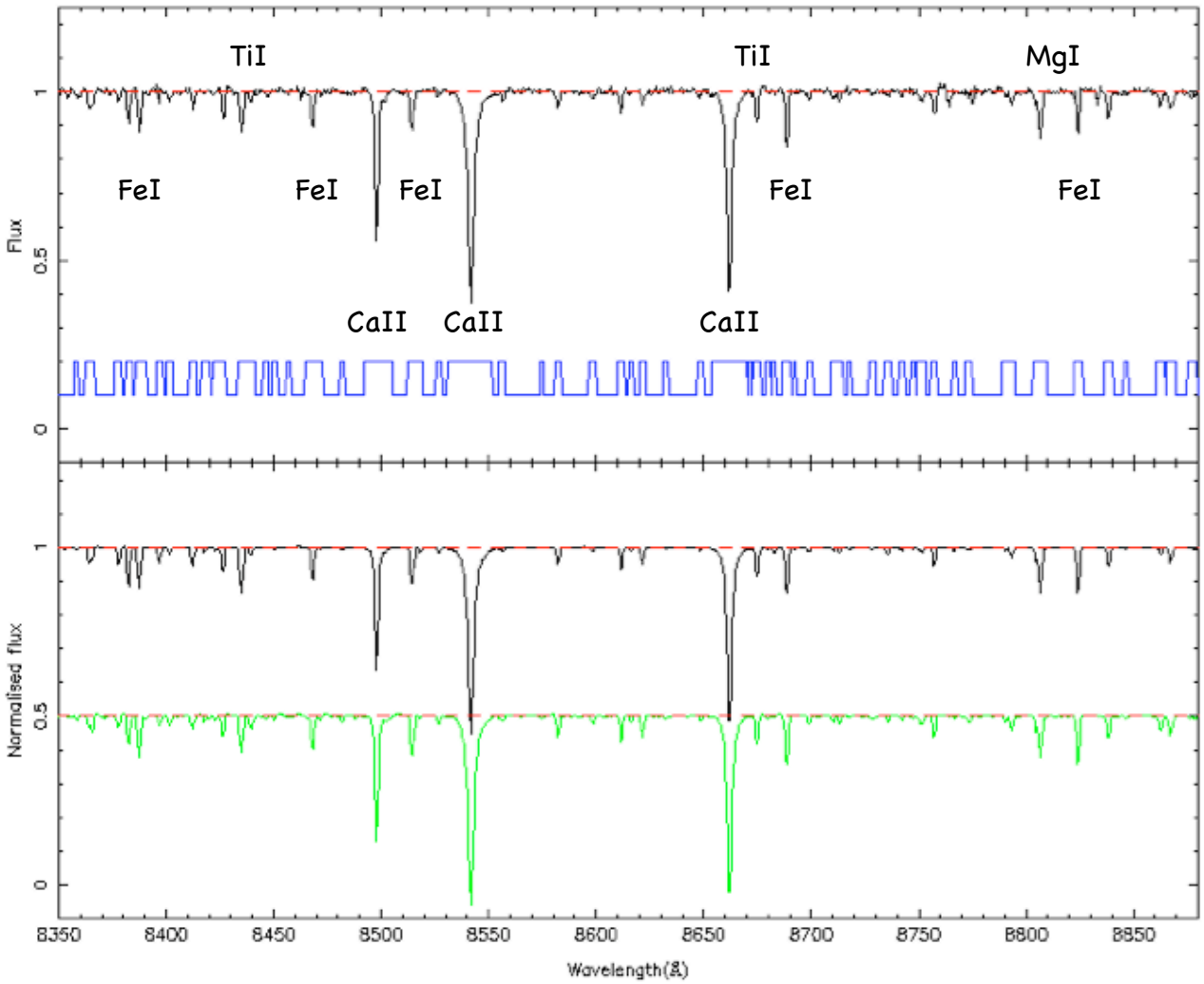
velocity
logg
[M/H]
[alpha/Fe]
Teff

Issues:

sky subtraction

continuum estimation

LS model fitting



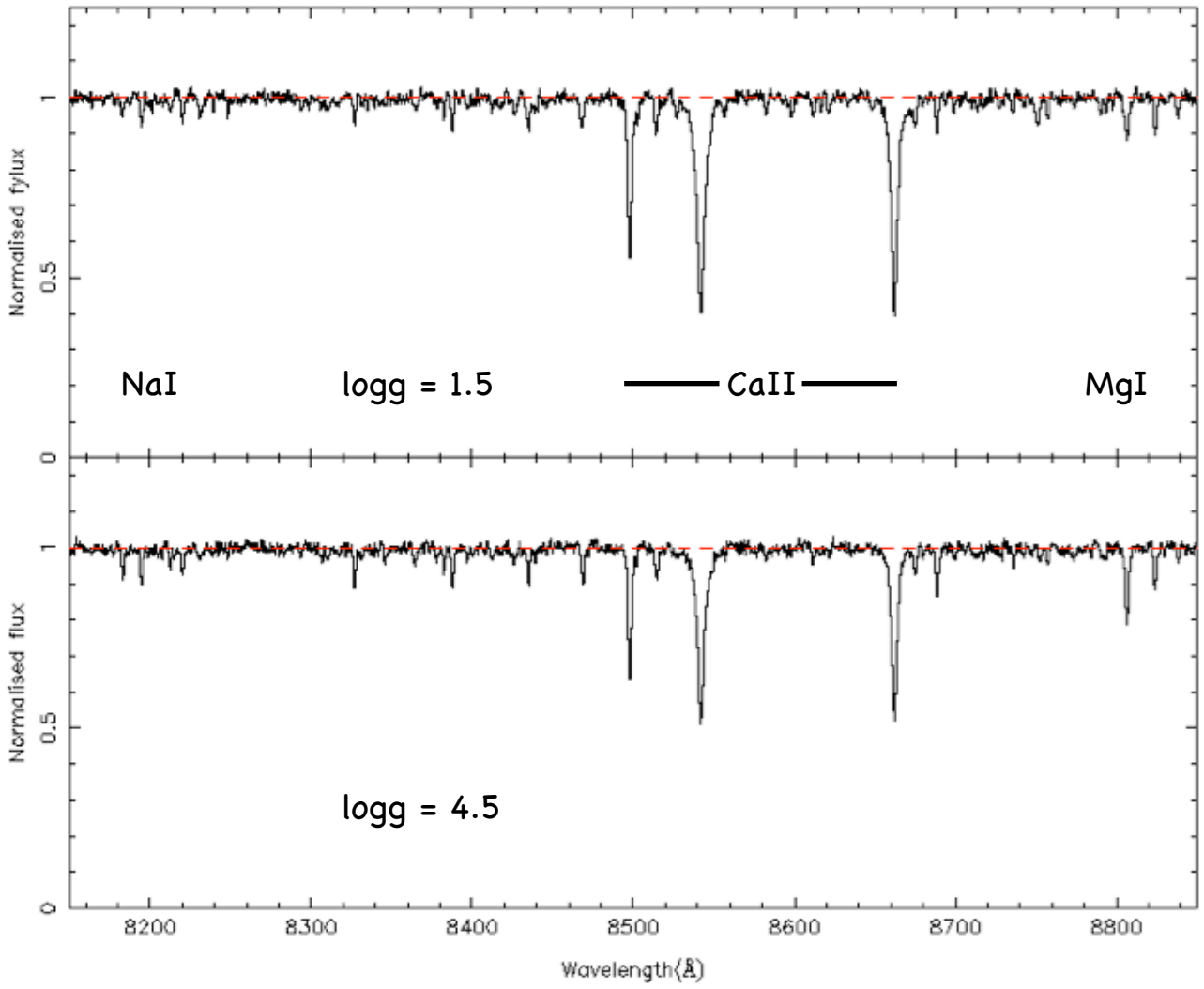
normalised averaged spectrum

line mask

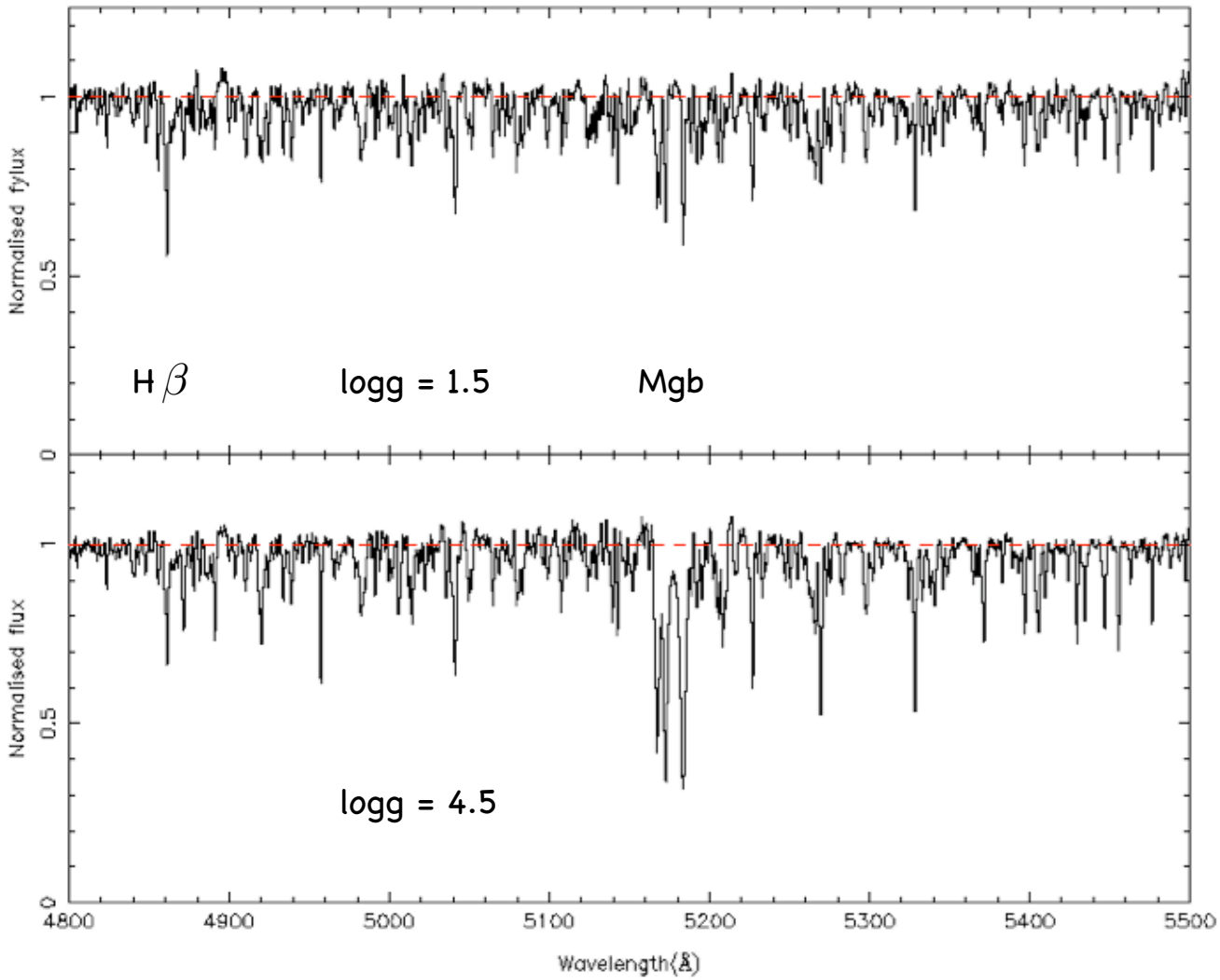
alpha enhanced

solar [alpha/Fe]

LR CaT dwarf -v- giant s:n=100



LR Mgb dwarf -v- giant s:n=100



Summary

- large area spectroscopic studies of the MW and nearby galaxies are needed to test cosmological predictions on low-mass scales
  - nature and distribution of dark matter
  - detailed formation history of galaxies
- Gaia will revolutionise this field, but will lack detailed chemical information, as well as accurate radial velocities -> European consortium Gaia Chemo-Dynamical Survey
- complex spatial variations in properties require wide-field kinematics and abundance measures to analyse structure and test near-field cosmological predictions