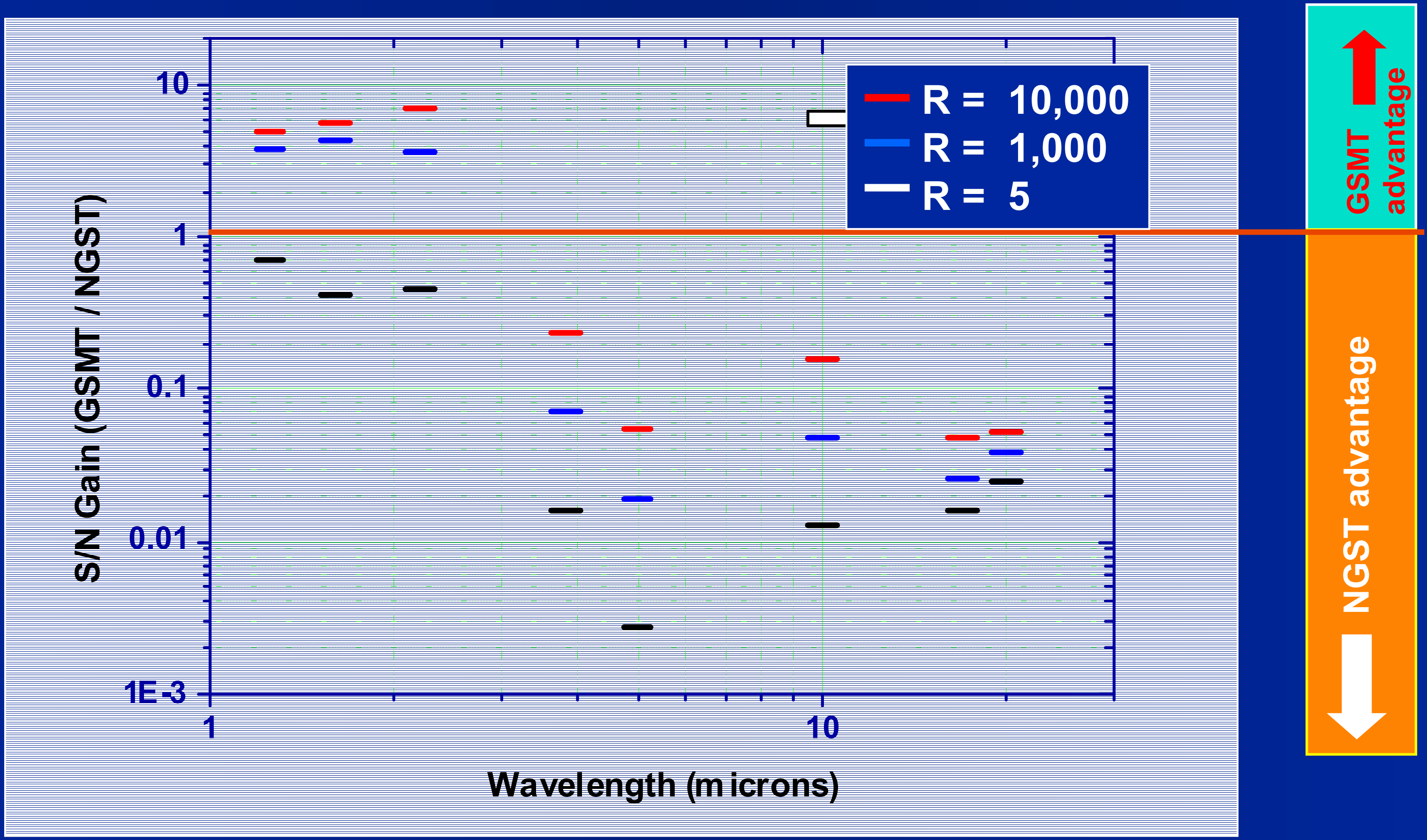
Developing Science Cases

- Two community workshops (1998-1999)
- Tucson task group meetings (SEP 2000)
  - Large-scale structure; galaxy assembly
  - Stellar populations
  - Star and planet formation
- NIO working groups (MAR 01 – SEP 01)
  - Develop quantitative cases; simulations
- NIO-funded community workshop (SEP 2002)
  - Understand space and ground context (ALMA; NGST; SKA…)
  - Refine performance goals and requirements

Comparing a 30m GSMT with a 6.5m NGST

Assuming a detected S/N of 10 for NGST on
a point source, with 4x1000s integration

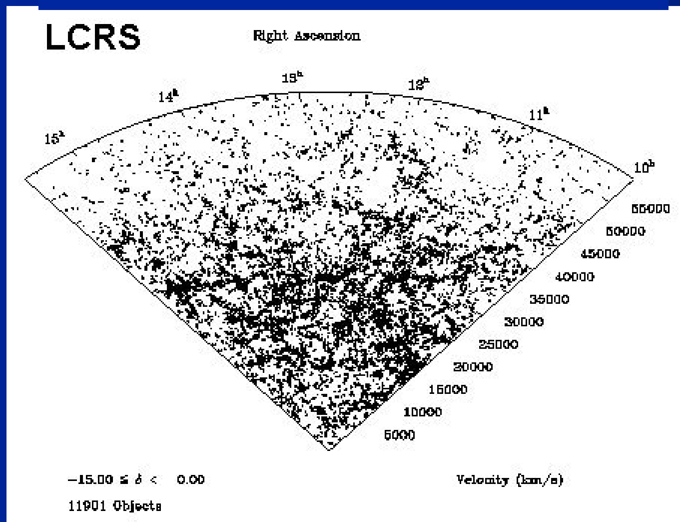


Tomography of the Universe

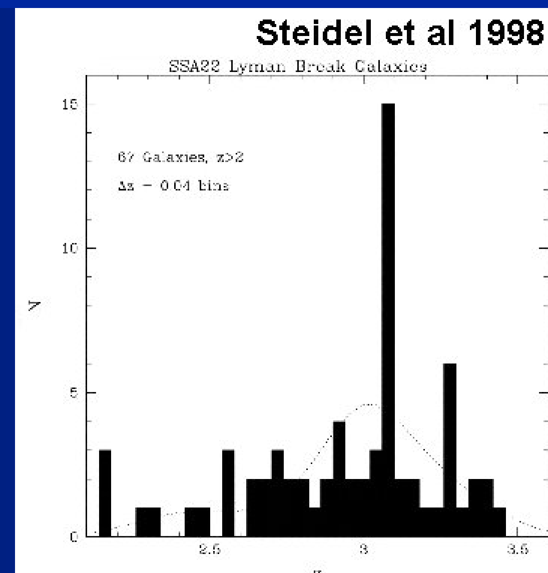
- Goals:
  - Map out large scale structure for z > 3
  - Link emerging distribution of gas; galaxies to CMB
- Measurements:
  - Spectra for 10^6 galaxies (R ~ 2000)
  - Spectra of 10^5 QSOs (R ~15000)
- Key requirements:
  - 20’ FOV; >1000 fibers
  - Explore prime focus spectrograph option
  - Exploit natural seeing
- Time to complete study with GSMT: 3 years
- Issues
  - Refine understanding of sample size requirements

Mass Tomography of the Universe

Existing Surveys + Sloan



Hints of Structure at z=3 (small area)



z~3

100Mpc (5^{O}x5^{O}), 27AB mag (L* z=9), dense sampling

GSMT	1.5 yr
Gemini	50 yr
NGST	140 yr

Tomography of Galaxies and Pre-Galactic Fragments

- Goals:
  - Determine gas and stellar kinematics
  - Quantify SFR and chemical composition
- Measurements:
  - Spectroscopy of H II complexes and underlying stars
- Key requirements:
  - Deployable IFUs feeding R ~ 10000 spectrograph
  - Wide FOV to efficiently sample multiple systems
  - Exploit diffraction limited performance
- Time to complete study with GSMT: ~1 year
- Issues
  - Modeling surface brightness distribution
  - Understanding optimal IFU ‘pixel’ size

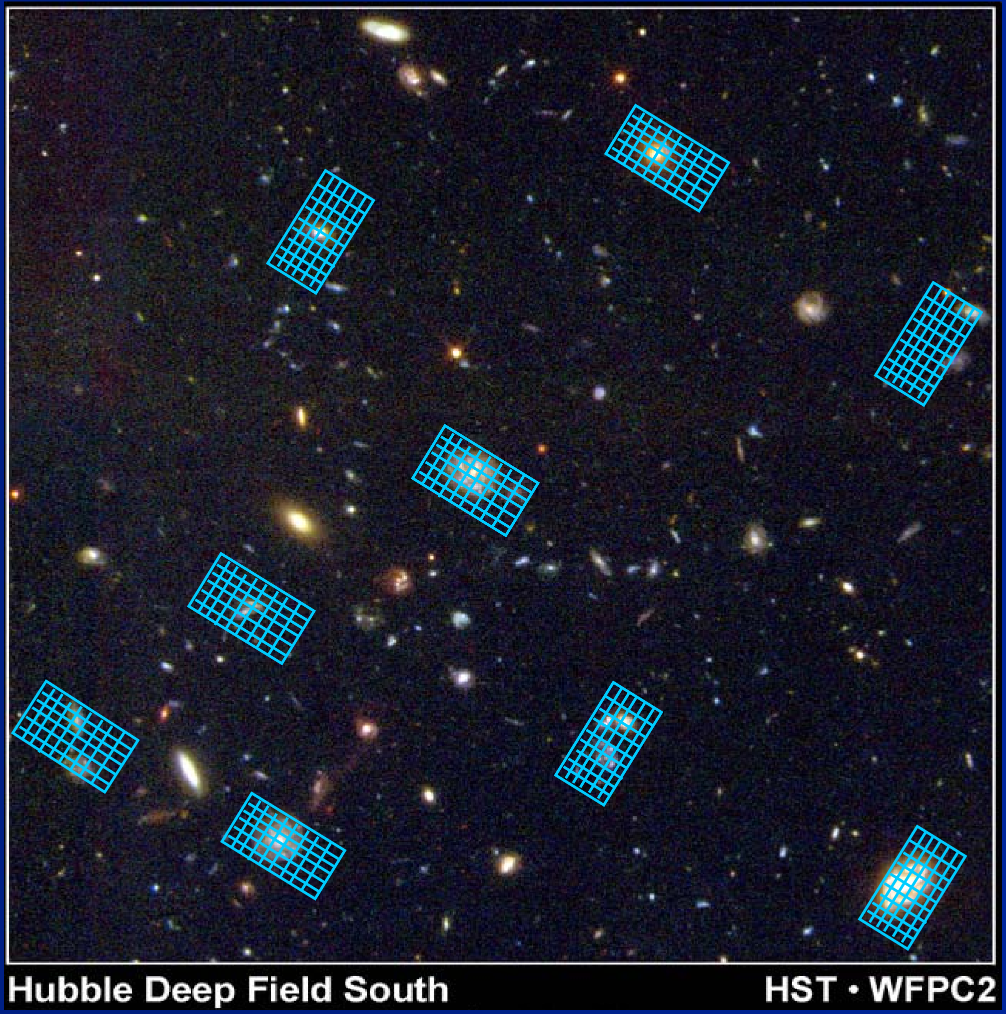
Tomography of Individual Galaxies out to z ~3

- Determine the gas and stellar dynamics within individual galaxies
- Quantify variations in star formation rate

– *Tool*: IFU spectra [R ~ 5,000 – 10,000]

GSMT 3 hour, 3σ limit
at R=5,000
0.1”x0.1” IFU pixel
(sub-kpc scale structures)

J	H	K
26.5	25.5	24.0



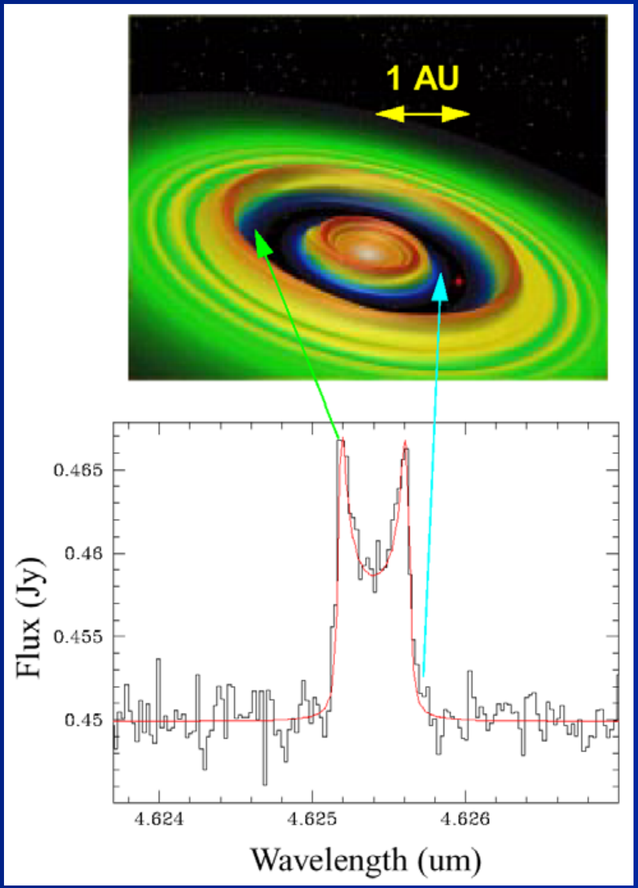
Origins of Planetary Systems

- Goals:
  - Understand where and when planets form
  - Infer planetary architectures via observation of ‘gaps’
- Measurements:
  - Spectra of 10^3 accreting PMS stars (R~10^5; $\lambda \sim 5\mu$)
- Key requirements:
  - On axis, high Strehl AO; low emissivity
  - Exploit near-diffraction-limited mid-IR performance
- Time to complete study with GSMT:
  - 2 years
- Issues
  - Understand efficacy of molecular ‘tracers’
  - Trades among emissivity; sites; telescope & AO design

Probing Planet Formation with High Resolution Infrared Spectroscopy

Planet formation studies in the infrared (5-30μm):

- **Probe forming planets in inner disk regions**
- **Residual gas in cleared region ➡ low τ emission**
- **Rotation separates disk radii in velocity**
- **High spectral resolution ➡ high spatial resolution**



S/N=100, R=100,000, λ> 4μm

Gemini	**out to 0.2kpc**	**sample**	**~ 10s**
GSMT	**1.5kpc**		**~100s**
NGST	**X**		

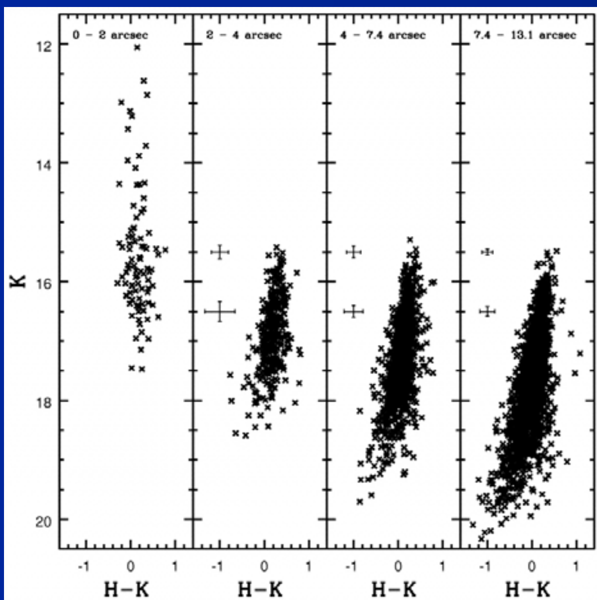
- 8-10m telescopes with high resolution (R~100,000) spectrographs can detect the formation of Jupiter-mass planets in disks around nearby stars (d~100pc).

Stellar Populations

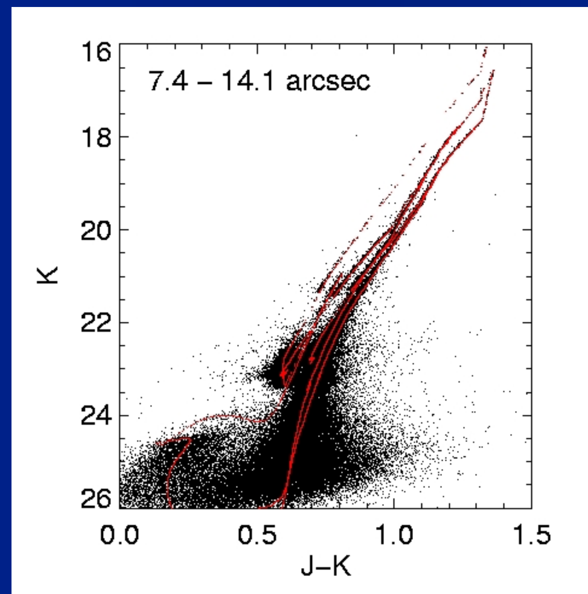
- Goals:
  - Quantify IMF in different environments
  - Quantify ages; [Fe/H]; for stars in nearby galaxies
  - Develop understanding of galaxy assembly process
- Measurements:
  - Spectra of ~ 10^5 stars in rich, forming clusters (R ~ 1000)
  - CMDs for selected areas in local group galaxies
- Key requirements:
  - MCAO delivering 2' FOV; MCAO-fed NIR spectrograph
- Time to complete study with GSMT: 3 years

Stellar Populations

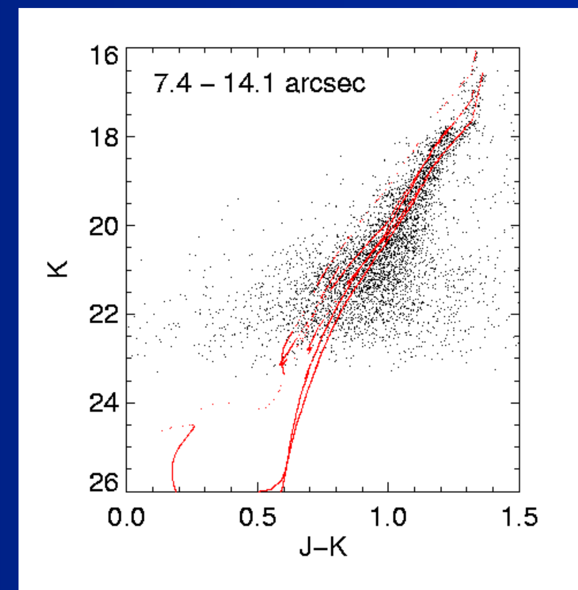
20”



M 32 (Gemini/Hokupaa)



GSMT with MCAO



NGST