

Galaxy Formation and Evolution



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I. Where are we now?

Crude understanding of gross properties of galaxies

(i.e., crude mass estimates, size, morphology)

Limited understanding of formation and evolutionary history

(i.e., some sample averaged properties: e.g., global star formation rate, global merger rate.

some knowledge that evolution and formation history is different for different galaxy types

indications that nuclear black hole formation is integral part of galaxy formation, but the connection or relevance is not clear

knowledge that galaxy environment is important

Well-developed evolutionary history

(little predictive power at present for observations of galaxy evolution since current effort is based on simple parametrizations of complex physics)

Keen sense that problem is complex!



II. What would we like to know?

When and how do galaxies form?

When do the first objects form?

At what epoch are galaxies first 'visible'?

At what wavelengths can the first objects be observed?

What *are* the first 'visible' objects?

Are these first 'visible' systems chemically mature?

Do galaxies form hierarchically?

(i.e., are the first objects small ones? large ones?
all sizes?)

Is galaxy formation biased?

Does BH formation always accompany galaxy
formation? Is it a prerequisite?

Is galaxy formation an ongoing process spanning many
epochs?

How do galaxies evolve as a function of mass and morphology?

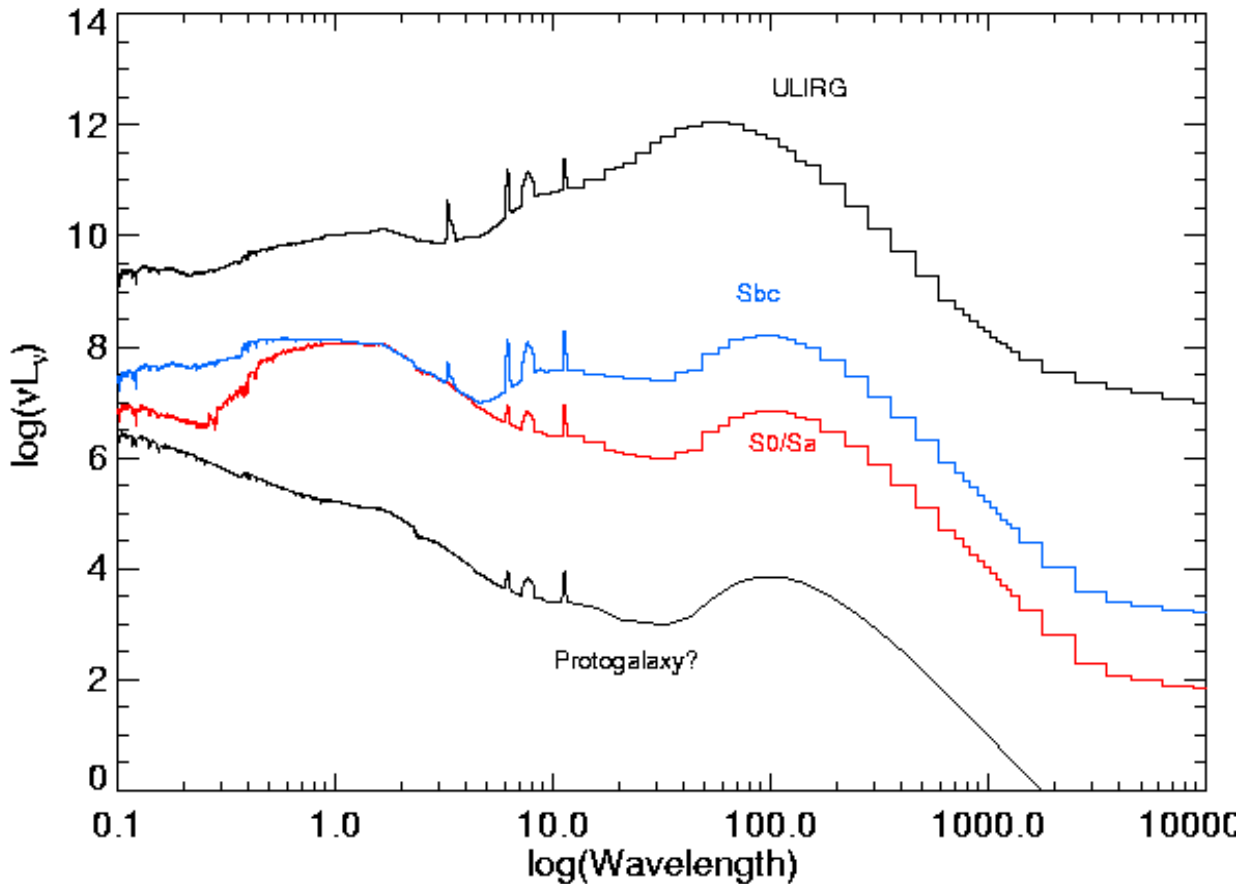
(the roles of galaxy environments, merging,
dark matter haloes, AGN)

The chemical processing and dispersal his- tory of galaxies

(i.e., enrichment and reprocessing history;
how did the IGM get enriched?)



III. What do / might galaxies look like?



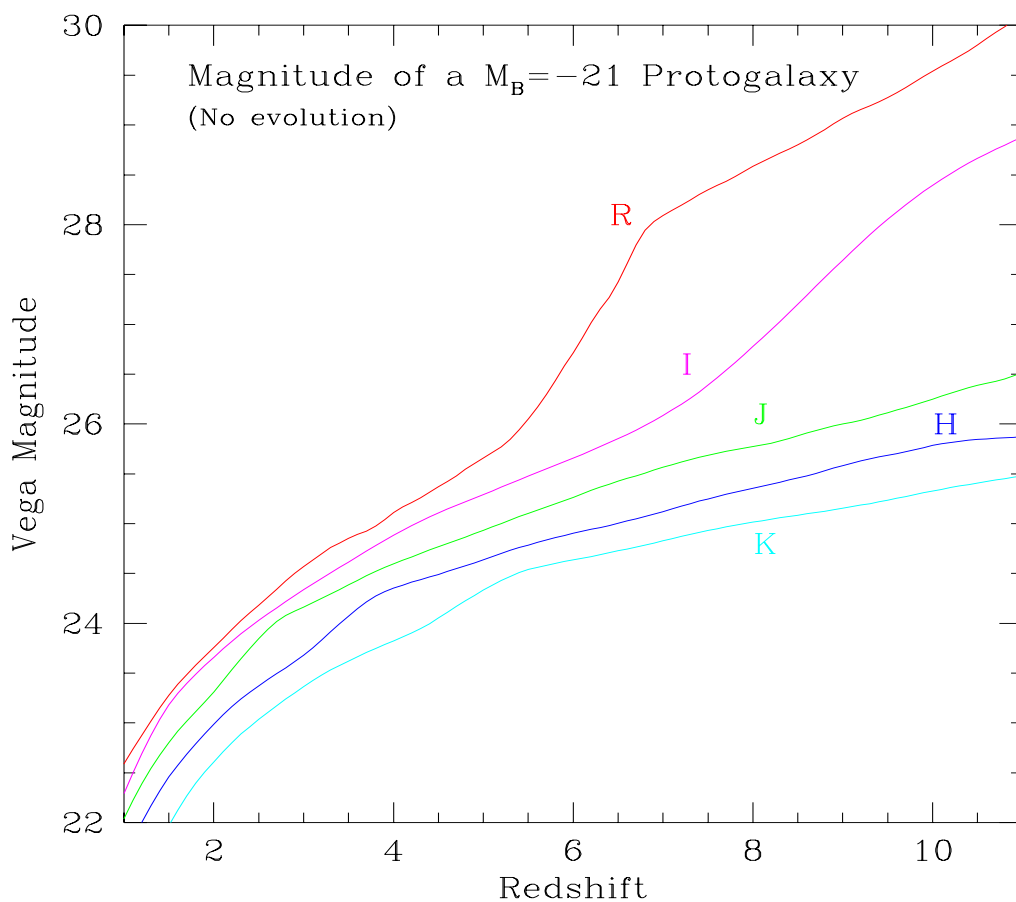
SEDs from Devriendt et al. (1999)

PG model from BC96 50My + VCC1003 ($\lambda > 4.27\mu\text{m}$) reddened by $E(B-V)=0.03$

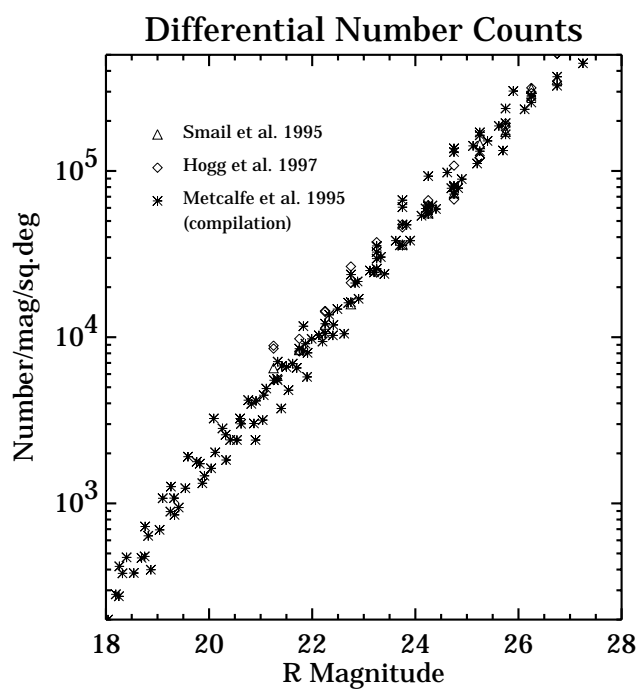
Will GSMT/ALMA detect these at high redshift with sufficient S/N to study them in detail?



OIR Magnitudes of Luminous Protogalaxies



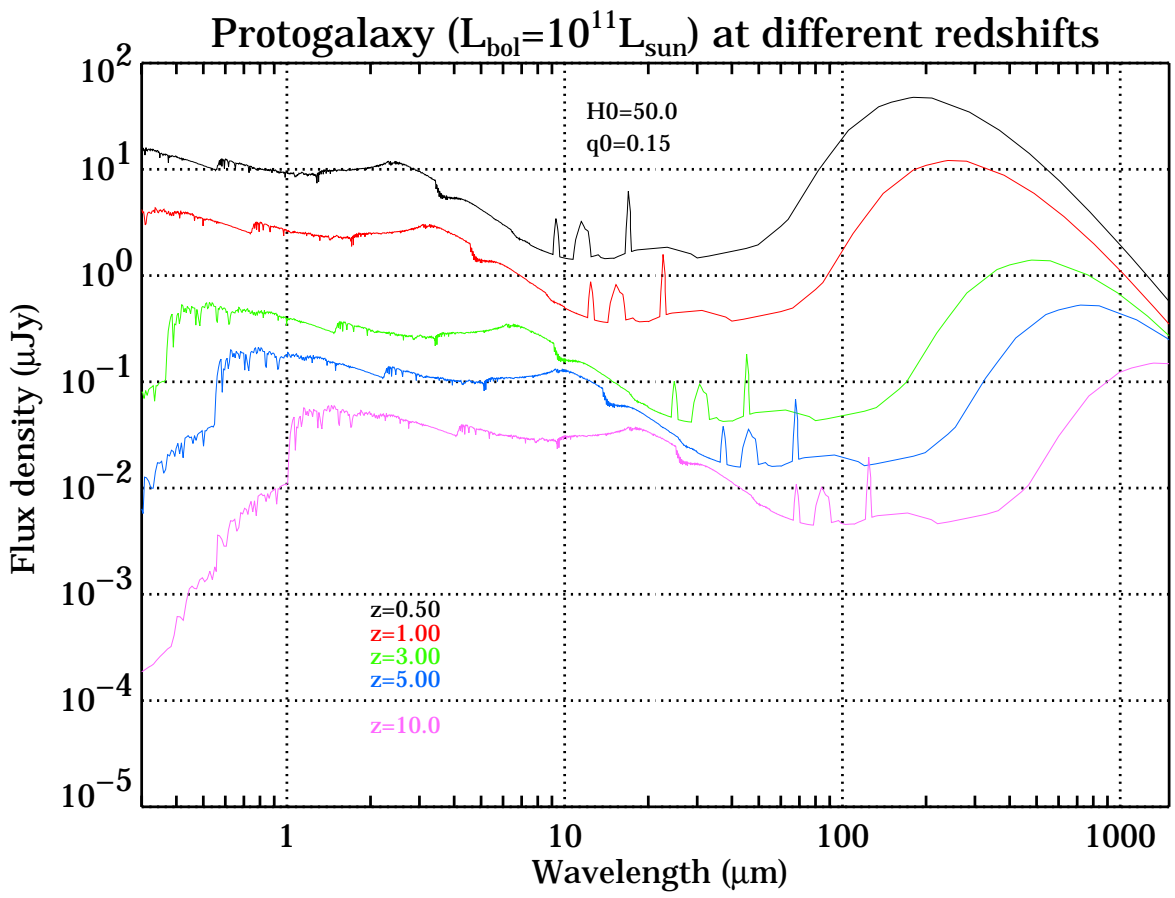
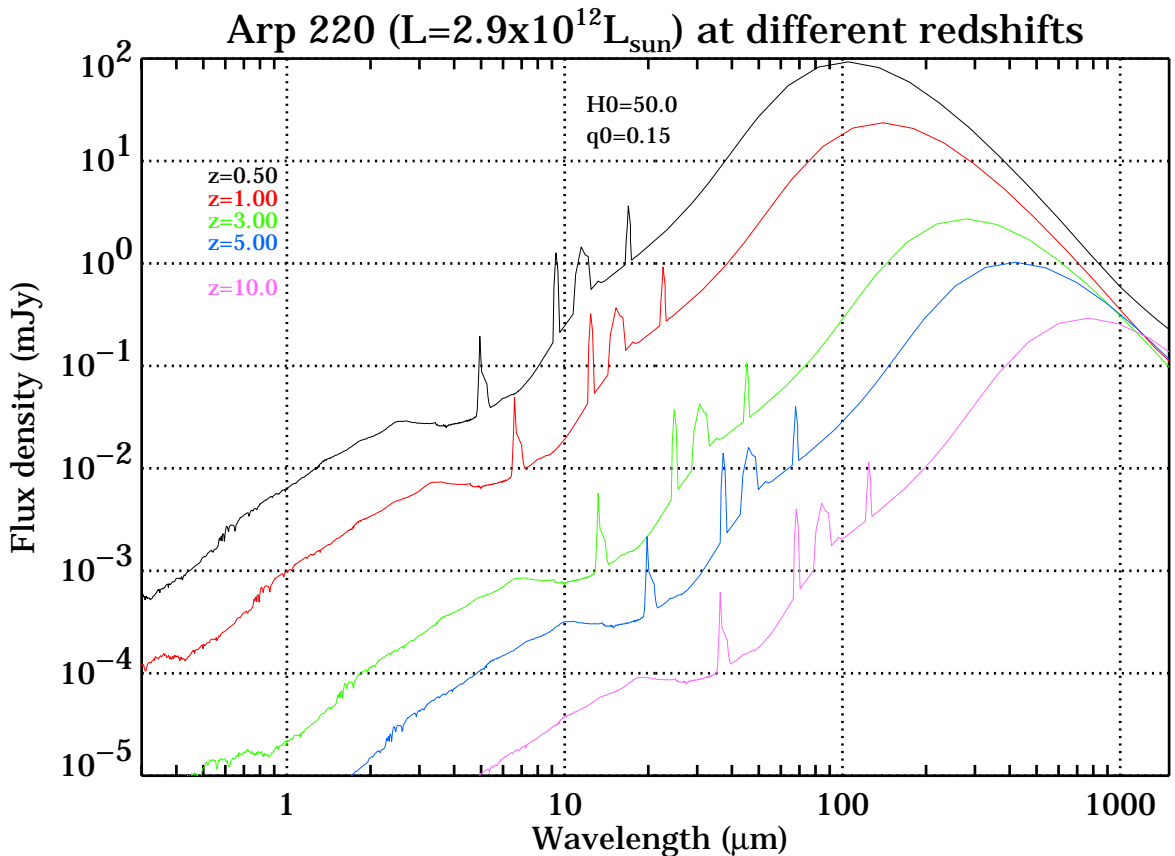
Optical Number Counts





Flux Densities for ULIRGs and PGs

Note different scales!



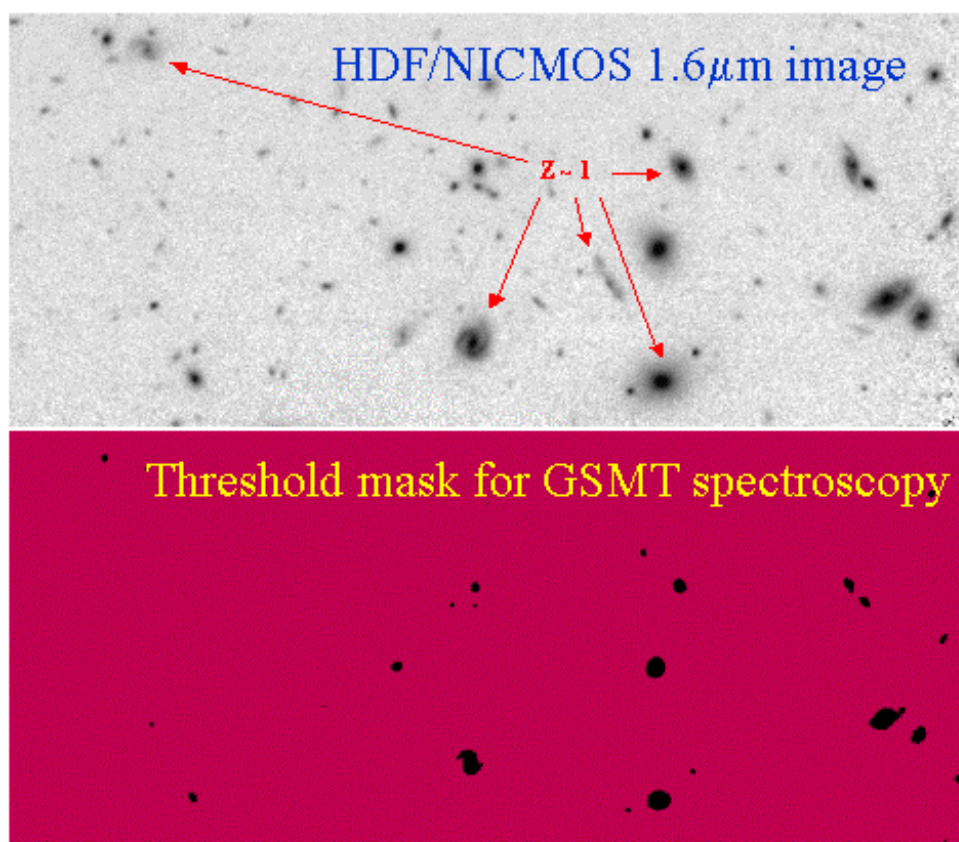
Lbol -> 912A - 1mm



IV. What Can GSMT see?

Surface brightness limits for GSMT

GSMT 2-D spectroscopy: HDF/NICMOS $1.6\mu\text{m}$ galaxies



Assumptions:

30 m GSMT primary

Solid angle element for 2D spectroscopy = $0''.1 \times 0''.1$

$R = 2000$

Exposure time = 6 hours

S/N per solid angle and spectral resolution element = 10

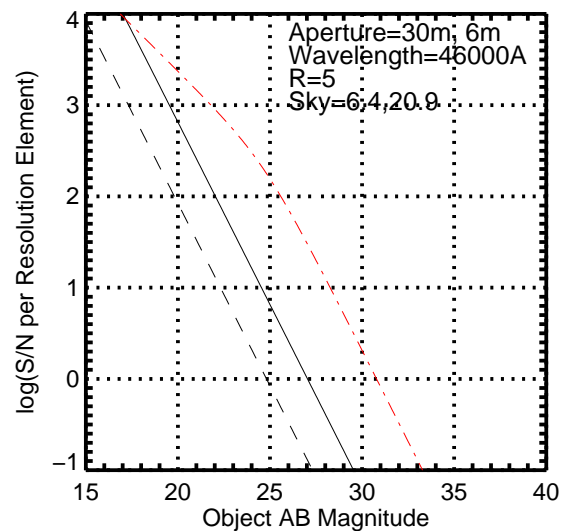
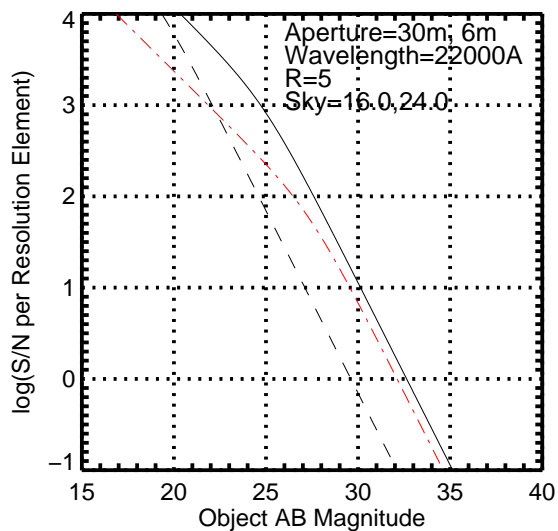
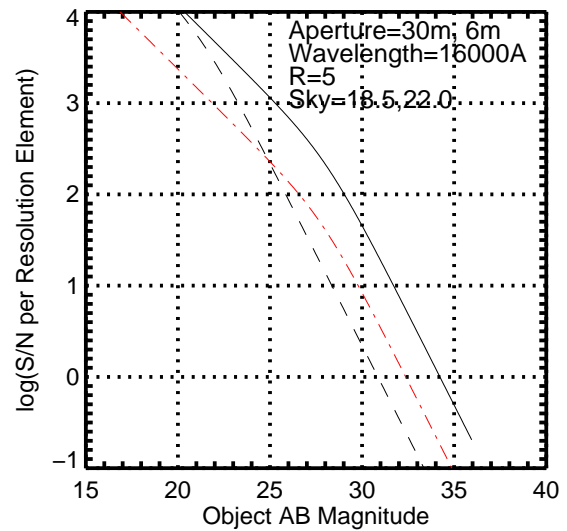
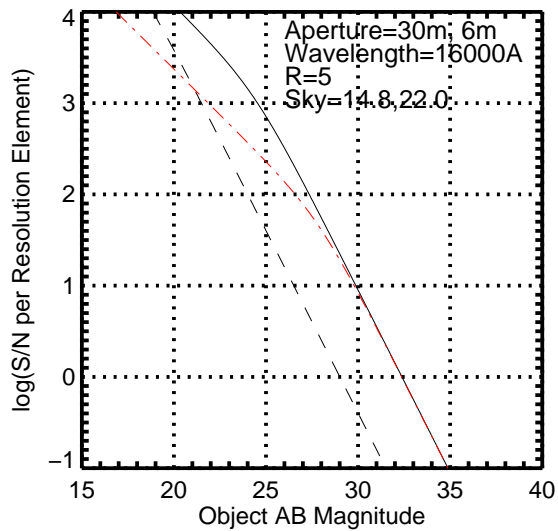
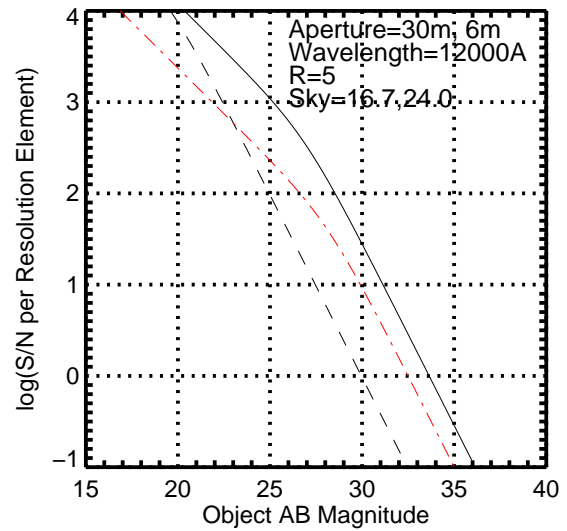
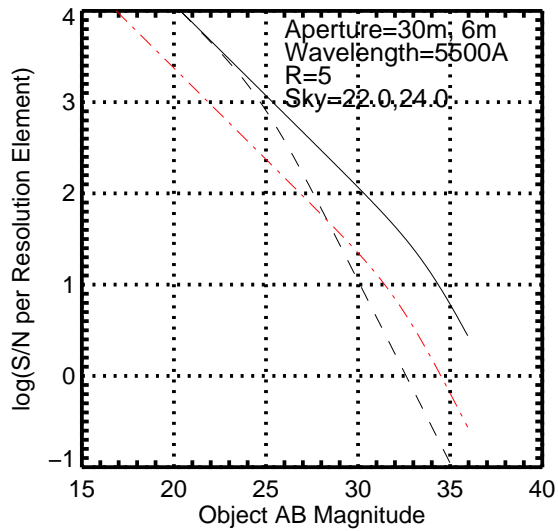
$1.6\mu\text{m}$ continuum sky bkgd = $18.5 \text{ AB mag/arcsec}^2$

Total throughput = 50%

Only the highest surface brightness objects are available for IFU spectroscopy!

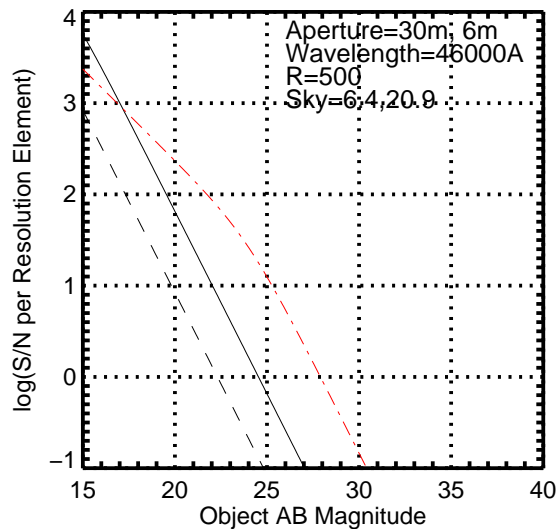
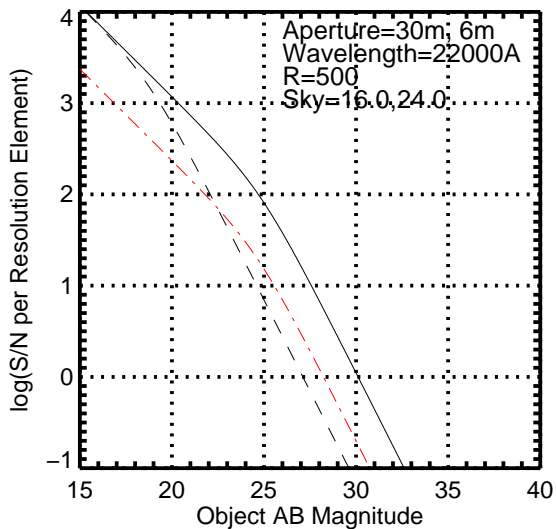
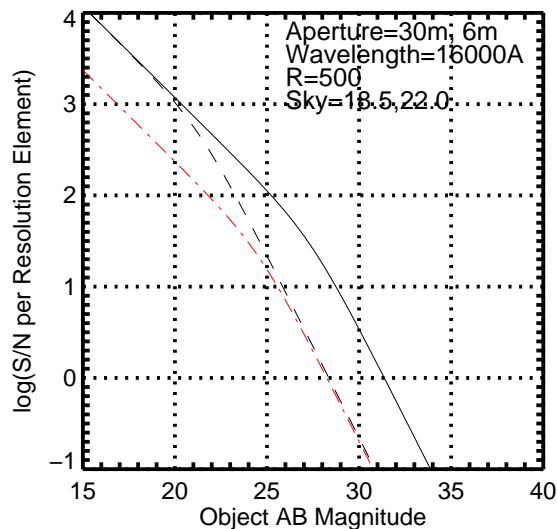
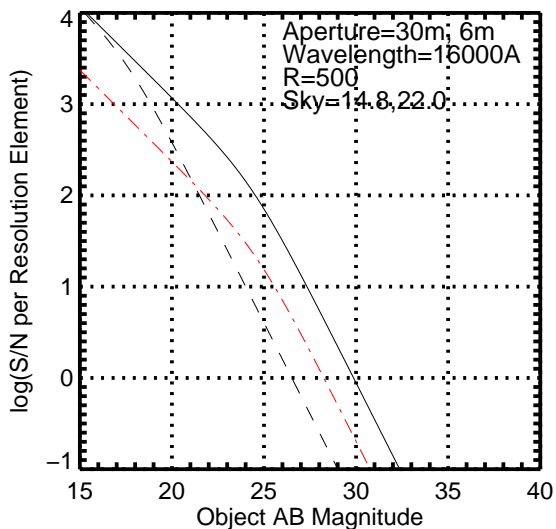
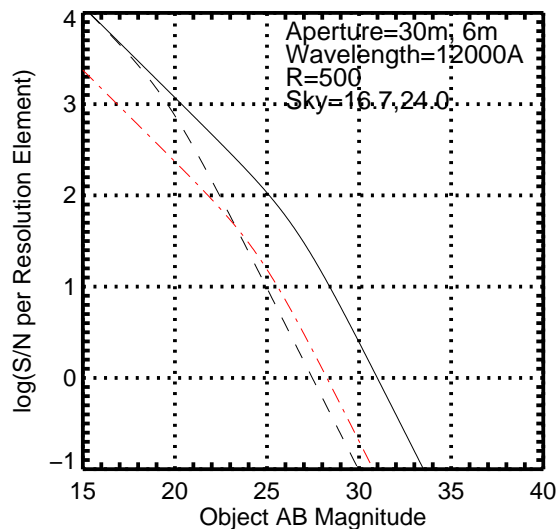
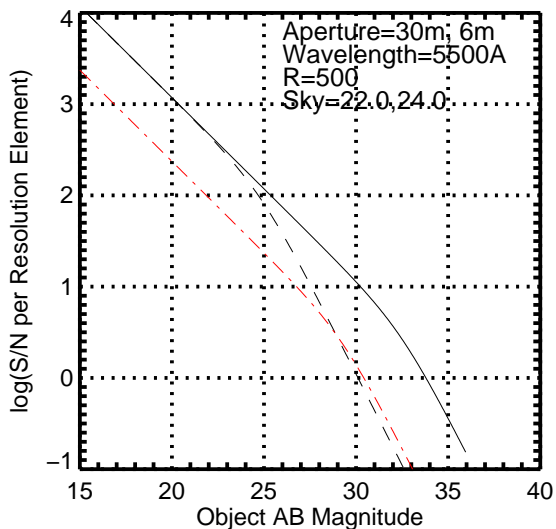


Imaging Sensitivity





Low Resolution (R=500) Spectroscopic Sensitivity





Moderate Resolution ($R=5000$) Spectroscopic Sensitivity

