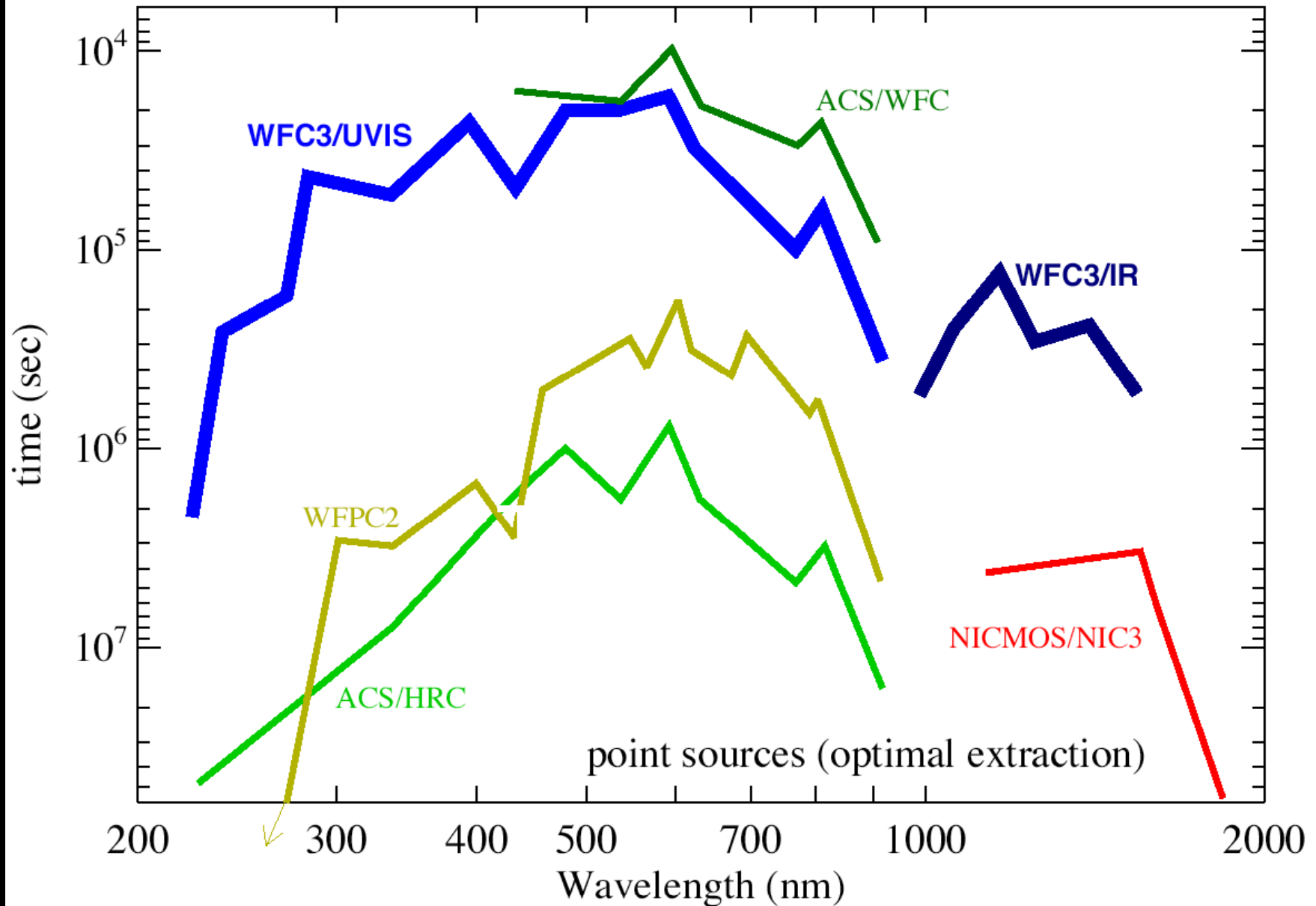




***Wide Field Camera 3:  
The SOC Science Program Proposal***

# HST - Time to survey 100 arcmin<sup>2</sup> to ABMAG=28



An extraordinary panchromatic survey efficiency covering a critical decade of frequency space combined with a large suite of narrow and broad band filters



***Theme I:  
Star Formation at Half the Hubble Time***

## *The Big Questions*

- *What determined the properties that galaxies have today?*
- *What set the balance between star formation and galaxy assembly?*
- *How did feedback shape the galaxy mass function?*

# ***Star Formation at Half the Hubble Time***

***Objective: To probe downsizing and merging in the critical  $1 < z < 2$  range by the:***

- Measurement of the star formation and stellar mass assembly rates from H-alpha grism spectroscopy and the rest-frame UV
- Determination of the evolution of the faint end slope of the luminosity and mass functions.

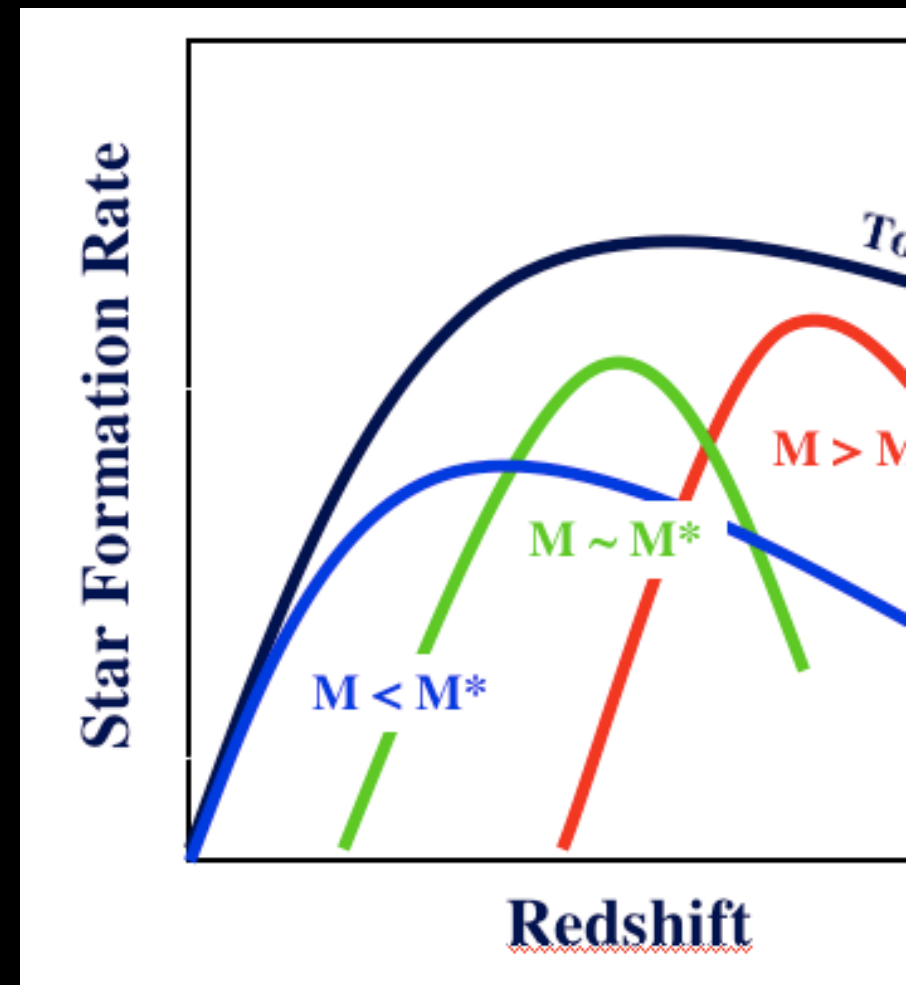
# Downsizing in Star Formation

- Measure star-formation rates from H and UV continuum as a function of total stellar mass and environment for  $0.7 < z < 2.5$

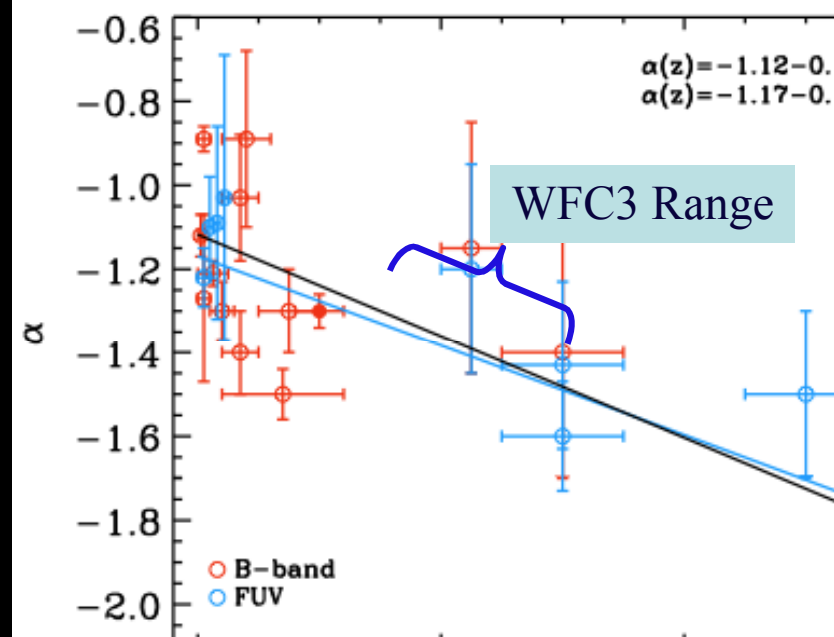
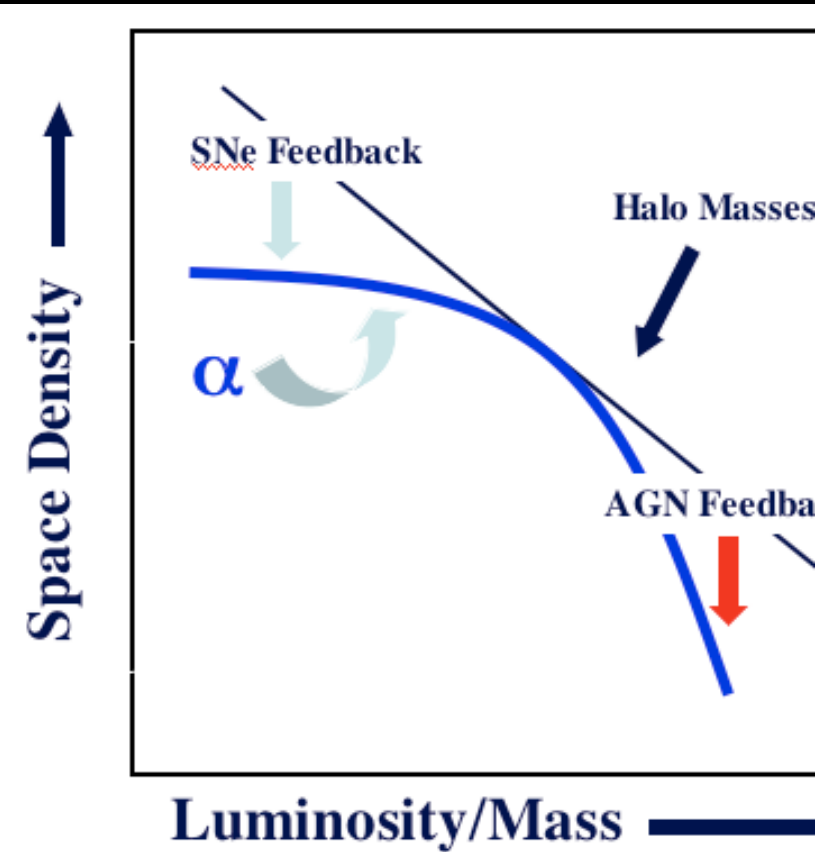
- Probe the LF down to  $M \sim 0.01M^*$

- Probe high, average and low density environments at  $z \sim 1.5$ .

- Understand SFR  $f(\text{mass}, z, )$  and bridge from the present to  $z \sim 3$ .

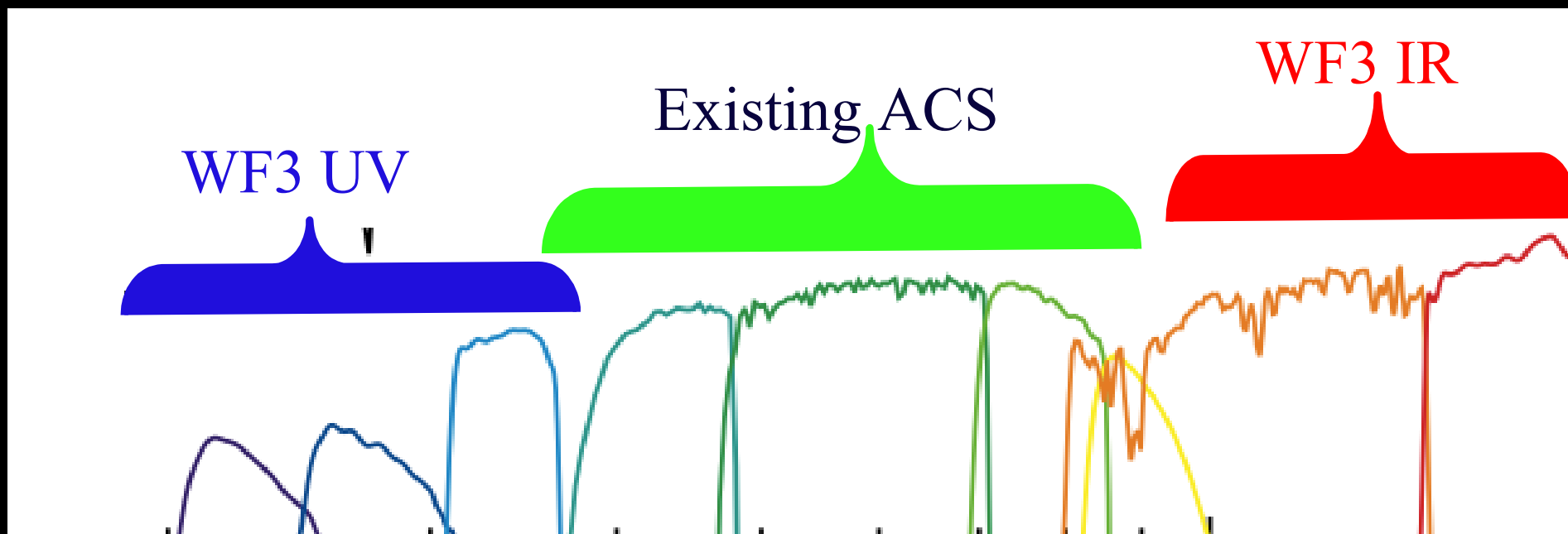


- Lambda-CDM predicts an LF much steeper than observed at the faint end
- AGN & SNe feedback and tidal stripping shape the bright & faint ends, respectively.
- The faint-end slope should evolve with redshift and environment.
- With WFC3 we can probe the faint-end slope at  $0.7 < z < 2$  with high precision



## Redshifts

- UVIS imaging in F225W, F275W & F336W
- UV G280 prism slitless spectra 2000-4000Å
- NIR imaging in F125W & F160W
- NIR G141 grism slitless spectra 1.1 - 1.7μm
- Build on existing ACS & spectroscopic survey fields



# *Preliminary Orbit Requirement*

Three Fields are to be selected from GOODS or COSMOS  
@ high, average and low densities.

Overlap with GRAPES/PEARS sought, if possible.

<i>Filter</i>	<i>Pattern</i>	<i>Area</i>	<i>Orbits</i>	<i>Depth</i>
<i>F225W</i>	1 x 1	21	2	26.0
<i>F275W</i>	1 x 1	21	2	26.5
<i>F336W</i>	1 x 1	21	1	27.0
<i>G280</i>	2 x 2	63	2	25.0
<i>UV Total</i>			<b>45</b>	
<i>F125W</i>	2 x 2	60	1.5	27.0
<i>F160W</i>	2 x 2	60	2	27.0
<i>G141</i>	3 x 3	137	2	25.0
<i>IR Total</i>			<b>60</b>	



***Theme II:  
Star Formation in Nearby Galaxies***

# *Star Formation in Nearby Galaxies*

## *The Big Questions*

- *How does star formation, and its history, vary among galaxies of different types?*
- *What triggers & regulates star formation?*
- *How universal is the Initial Mass Function?*

# *Wide-Field Panchromatic Imaging*

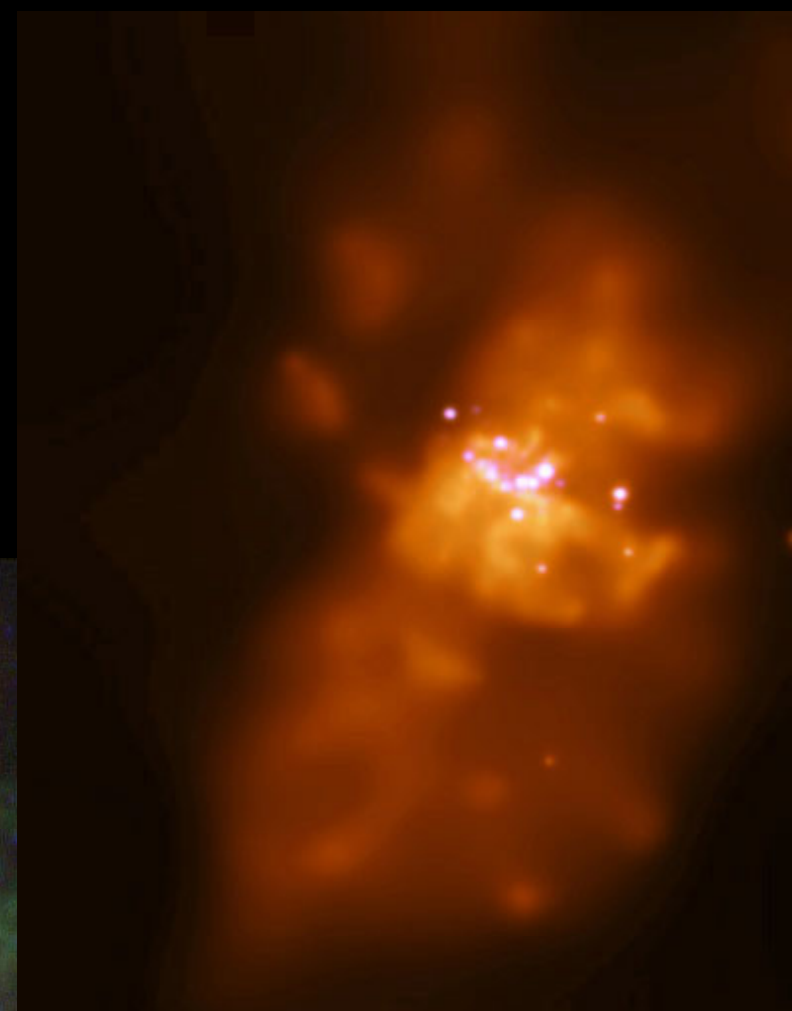
- **UV** (200 - 400 nm; critical for star cluster age dating)
- **IR** (to penetrate dust cocoons around the youngest regions of star formation)
- **Narrow band** (to determine physical parameters such as shock parameters, gas pressure, ionization parameters, star formation rates, etc.)

# Overall Approach

*To observe star formation in a wide range of environments in the local universe to determine how star formation is triggered, how it is regulated through feedback, and the degree to which it is universal.*



Subaru



Chandra



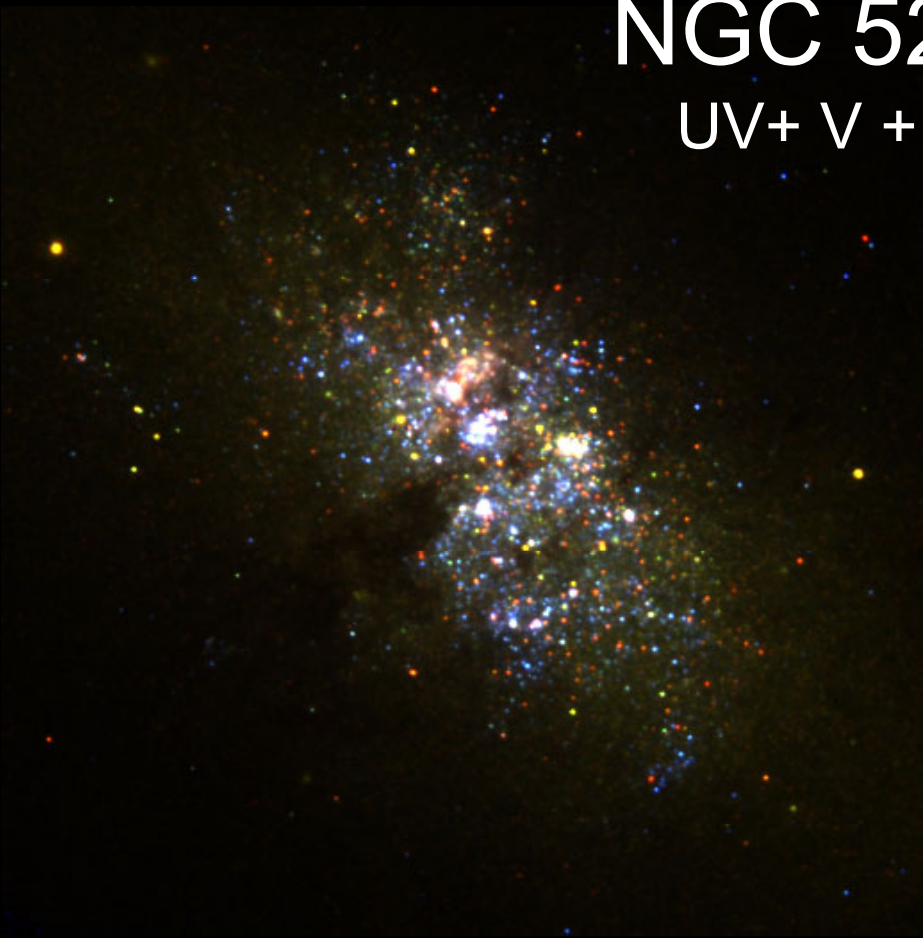
Spitzer

# Strategy.

- Broad band panchromatic filter set to distinguish age, metallicity, and extinction:  
*F225W, F330W, F435W, F550M, F814W, F110W, F160W*
- Narrow band filters for ISM shocks, pressure, abundance, extinction & excitation:  
*F373N [O II], F487N H-beta, F502N [O III], F656N H-alpha, F673N [S II], F128N P-beta, F164N [Fe II]*
- Build on existing data sets, both HST (primarily ACS, WFCP2, STIS) and others (SPITZER/SINGS, CHANDRA, ANGST, GALEX, radio, etc.)

# NGC 5253

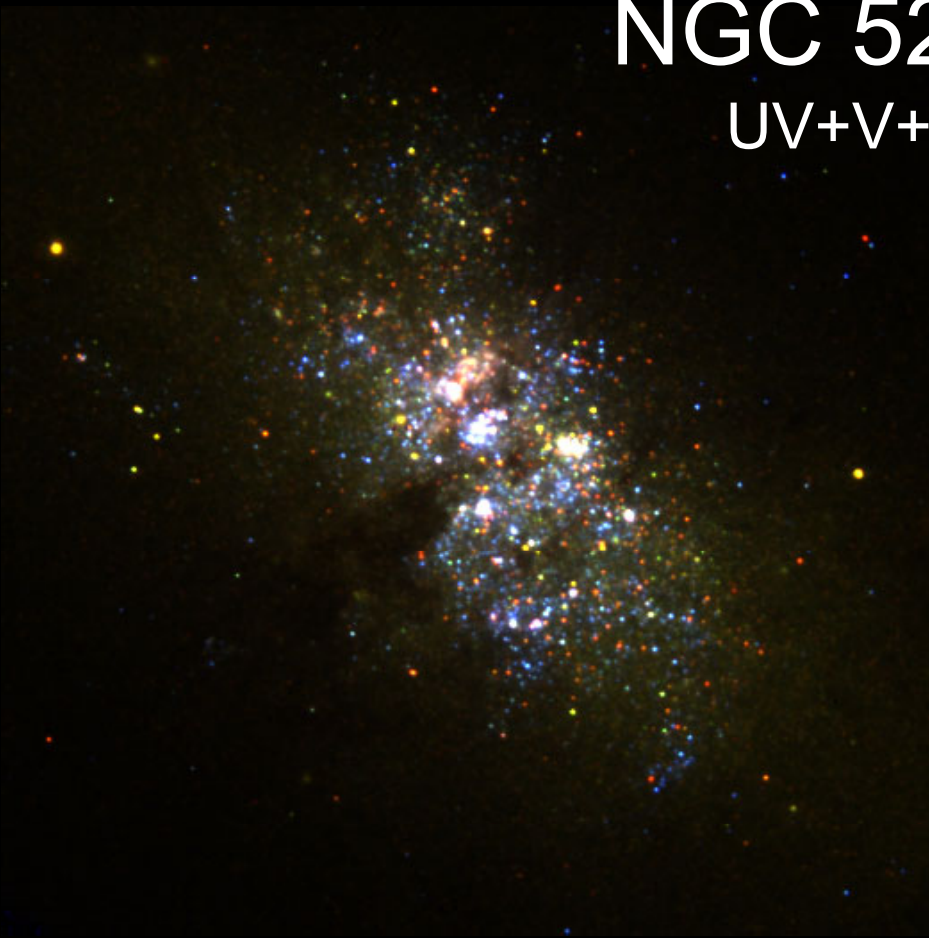
UV+ V + IR



Panchromatic continuum images, plus extinction from Balmer Line Imaging gives the detailed star formation rate, star formation history and extinction distribution

NGC 5253

UV+V+I



NGC 5253

H-alpha, H-beta  
[OIII] & [SII]

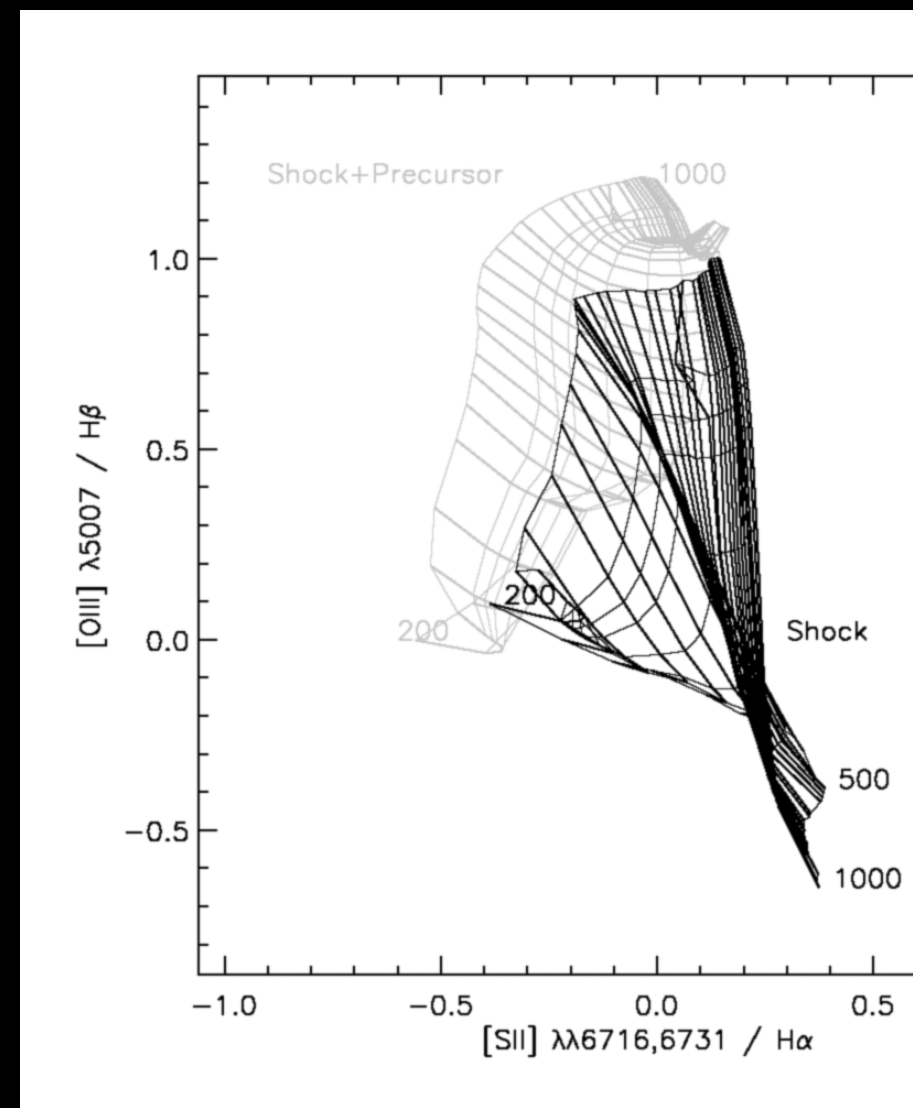
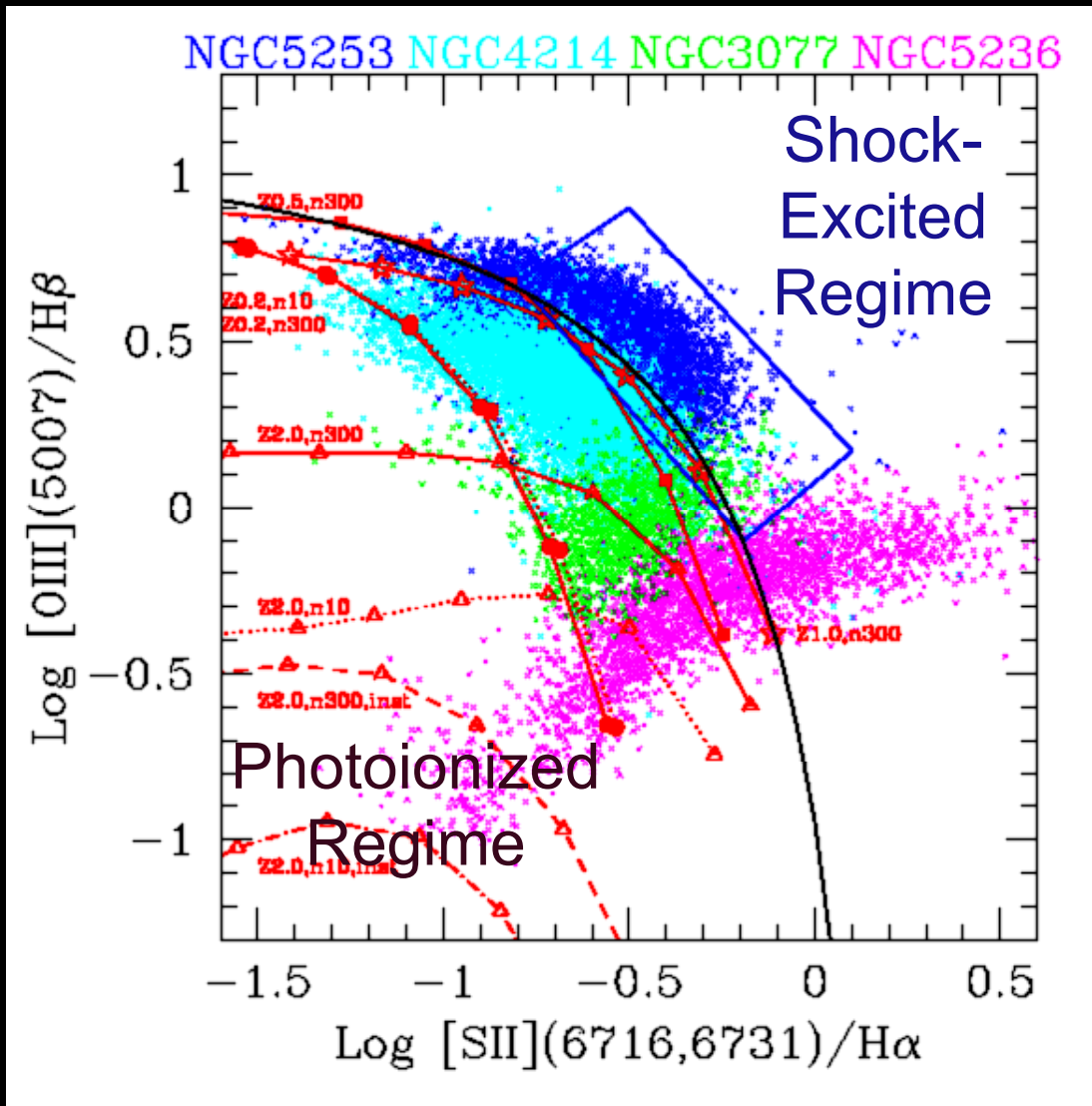
Balmer Line and Forbidden  
Line ratios form Diagnostic  
Plots which separate the  
shock-excited gas from the  
photoionized gas  
(Dopita, Calzetti).

Panchromatic continuum  
images, plus extinction from  
Balmer Line Imaging gives  
the detailed star formation  
rate, star formation history  
and extinction distribution  
(Calzetti, Whitmore)

# Examples of Diagnostic Plots

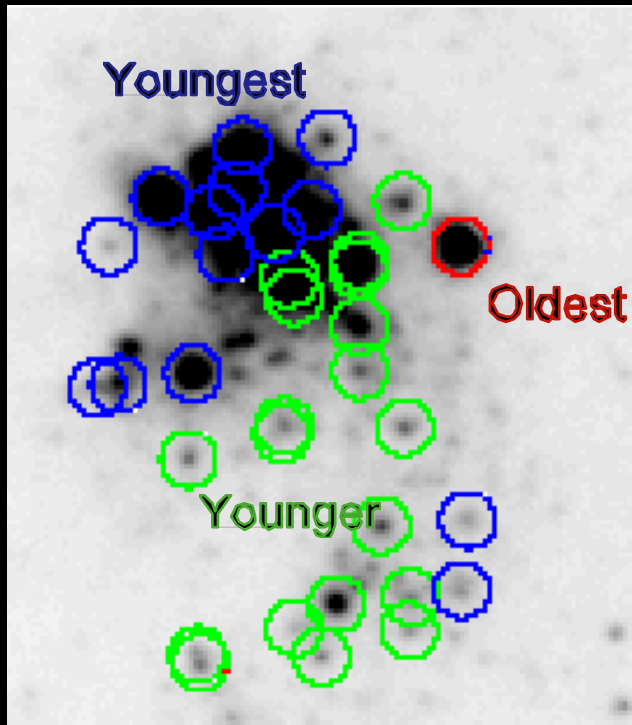
Observations: Calzetti et al. 2007  
Models: Kewley & Dopita

High Velocity Shock Models  
Allen, Dopita & Kewley 2005

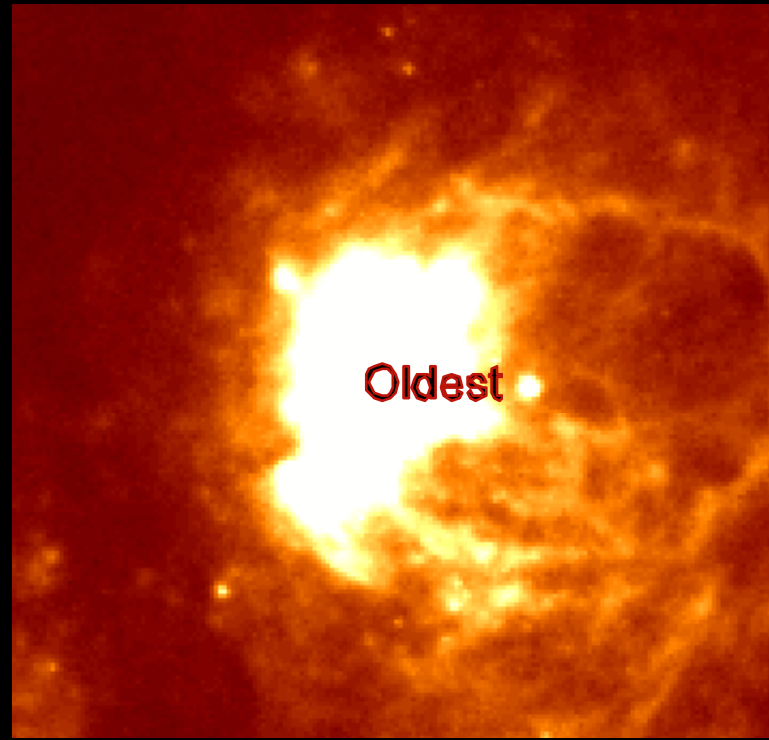


These tools quantify the energetics and the stellar energy feedback into the ISM of the galaxy observed. They identify outflows and

# Example: Cluster Age Dating & Triggering



Clusters  
in a  
HII super-bubble  
in the  
Antennae Galaxy



Cluster Ages

Ionized Hydrogen

- The Age gradient implies there has been triggered star formation.
- The HII super-bubble is centered on the old cluster, the younger clusters are located in the dusty shell of the super-bubble.
- The young clusters have a total mass of  $4 \times 10^6 M_{\text{sun}}$ , some five times more than the cluster which triggered their formation.

- Measurement of star cluster formation histories back to  $\sim 10$  Gyr to use fossil record of the assembly history of galaxies (e.g., to compare with results from the intermediate- $Z$  proposal).
- Exploration of the role of feedback. Obtain a full census of shock ionization in a variety of galactic physical and metallicity environments, and derive efficiency parameter for feedback.
- Determination of whether the star formation laws (e.g., Schmidt law, cluster mass and size functions, fractions of star formation in clusters/field, ...) are the same in different environments.
- Measurement of the IMF down to  $\sim 0.1$  Msolar in R136/30 Dor and NGC 3603 to determine if it is top-heavy in starbursts (will these clusters survive to become globular clusters?).

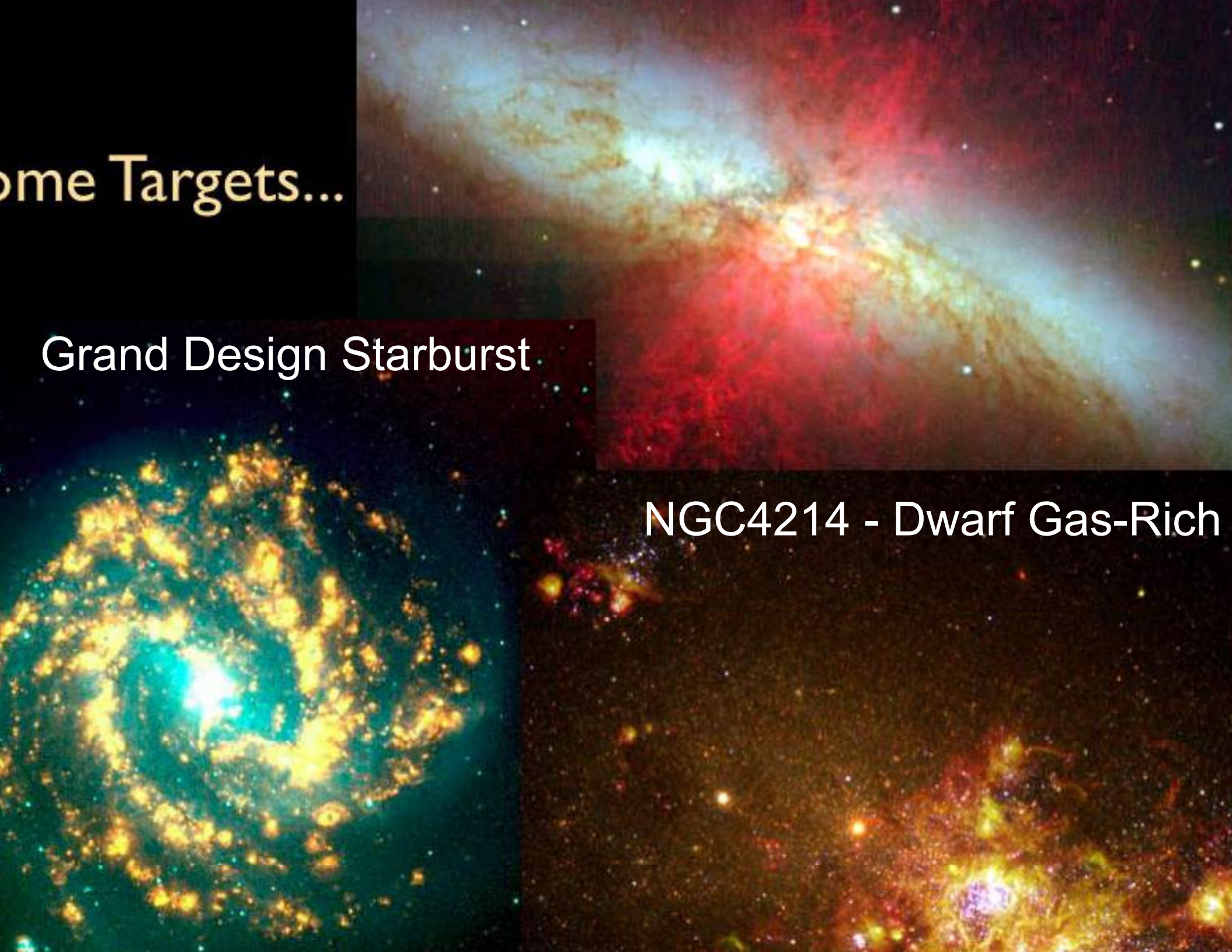
# Nearby Galaxies covering a wide range of types

(m-M)	Galaxy	Nature	Type
31.0	NGC 4382	- SO in Virgo (star formation)	S0
31.0	NGC 4150	- SO in Virgo (star formation)	S0
30.0	NGC 4592	- “retarded” galaxy	Spiral
29.9	NGC 2841	- flocculent spiral	Spiral
28.6	CenA	- nearest elliptical (accretion)	Elliptical
28.6	M 83	- grand-design spiral	Spiral
27.9	NGC 4214	- dwarf	Irregular
26.9	M 82	- dusty starburst	Irregular
18.5	30 Dor	- $10^5 M_{\odot}$ LMC star cluster	Star clus
13.9	NGC 3603	- $10^4 M_{\odot}$ Galactic star cluster	Star clus

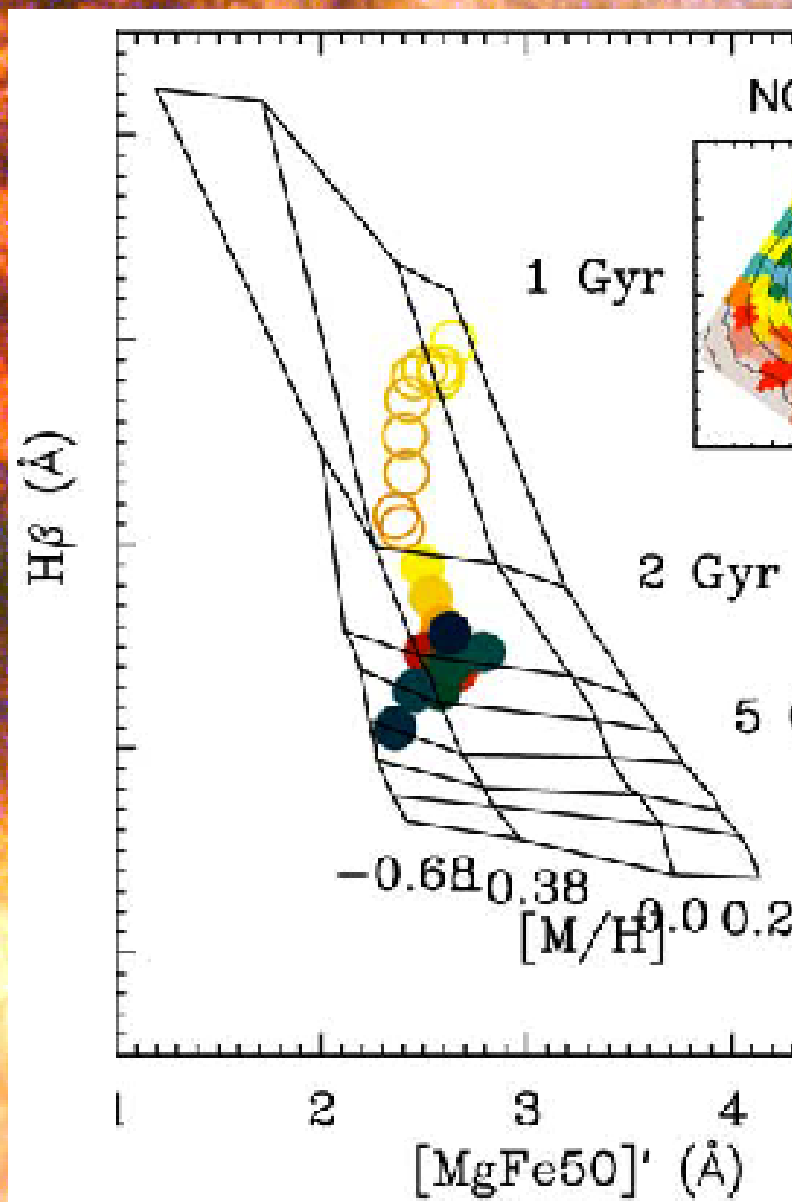
Some Targets...

Grand Design Starburst

NGC4214 - Dwarf Gas-Rich



# or - Massive LMC Star Cluster



# Preliminary Orbit Requirements

Galaxy Name	UV broad band	Optical broad band	IR broad band	Optical narrow band	IR narrow band	Totals
NGC 4382	2.1	4.0	5.2	3.9	2.6	17.8
NGC 4150	2.1	4.0	5.2	3.9	2.6	17.8
NGC 4592	1.4	2.1	5.2	3.4	1.7	13.8
NGC 2841	0.9	B-done, 1.0	5.2	2.3	1.2	10.6
CenA	0.9	DONE	3.3	1.3	0.9	6.4
M 83	0.9	DONE	3.3	1.3	0.9	6.4
NGC 4214	0.6	0.9	1.5	0.9	0.6	4.5
M 82	0.6	DONE	0.8	0.9	0.6	2.9
30 Dor	2.6	3.9	5.2	3.4	3.4	18.5
NGC 3603	1.3	2.6	0.5	2.6	3.4	10.4
Total						109.1