ASTROSAT – SWG Meeting — IIA, Feb 6-7 2014

"Nearby Galaxies & Stellar Populations"

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Imaging across the Hubble Sequence : Galaxies in the nearby Universe

- a pictorial representation of the apparent shapes of galaxies as seen in visible wavelengths; broad types of Elliptical, Spiral & Irregular

- early surveys produced catalogs of galaxies which were classified on the basis of morphological appearance

- morphology relates to the mix of stellar populations in the galaxy, the amount of star formations activity, gas and dust.

- recent deep surveys (larger telescopes and HST) turned up larger fractions of 'peculiar' morphology since they sampled shorter wavelengths (redshifted) and were looking at younger galaxies

- an understanding of the UV properties of galaxies in the nearby universe is essential in order to interpret what we see in distant surveys (eg. 150 nm from an object at z ~ 2.7 is shifted to the 'V' band)

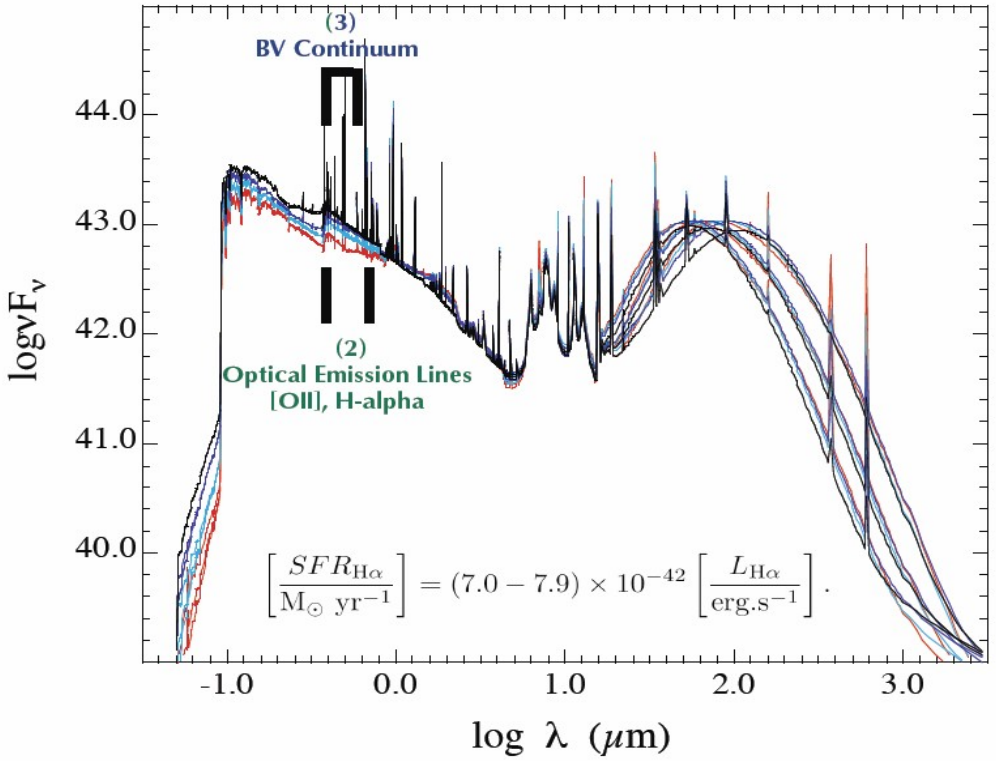
Morphology in the UV :

- appearance of galaxies in the UV is determined primarily by emission from hot stars and by the distribution of dust, with a contribution in the central regions from an active galactic nucleus (AGN) if one is present and unobscured.

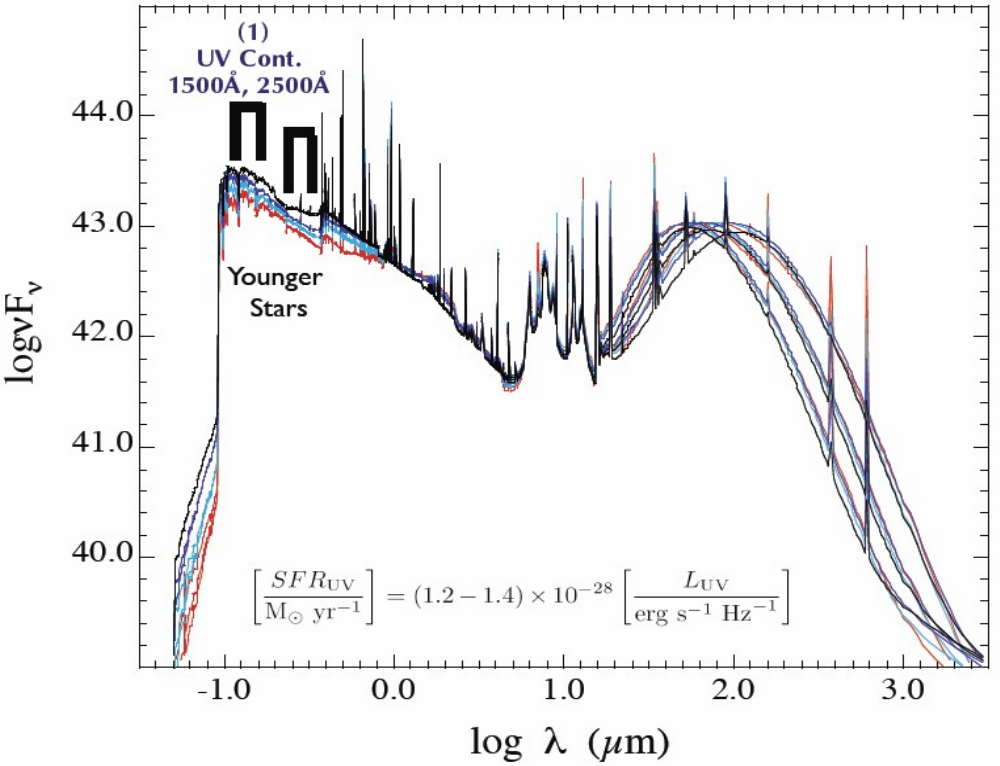
- Light in the 1500 Å far-ultraviolet (FUV) band originates in young objects of spectral types O and B and, if old populations are present, in certain types of low-mass stars in late stages of evolution

- UV can probe time scales of young stellar populations between that studied via H_a emission (only O stars, 5 Myr) and that evident in the optical colours (which trace the age of a stellar population on time scales of a few Gyr)

- opacity due to dust in FUV is far higher than in the optical V. Detectability in inclined disk galaxies is thus dependant strongly on the geometry. Scattering by dust is quite efficient in the FUV and may contribute significantly to the emission near H II regions and in spiral arms

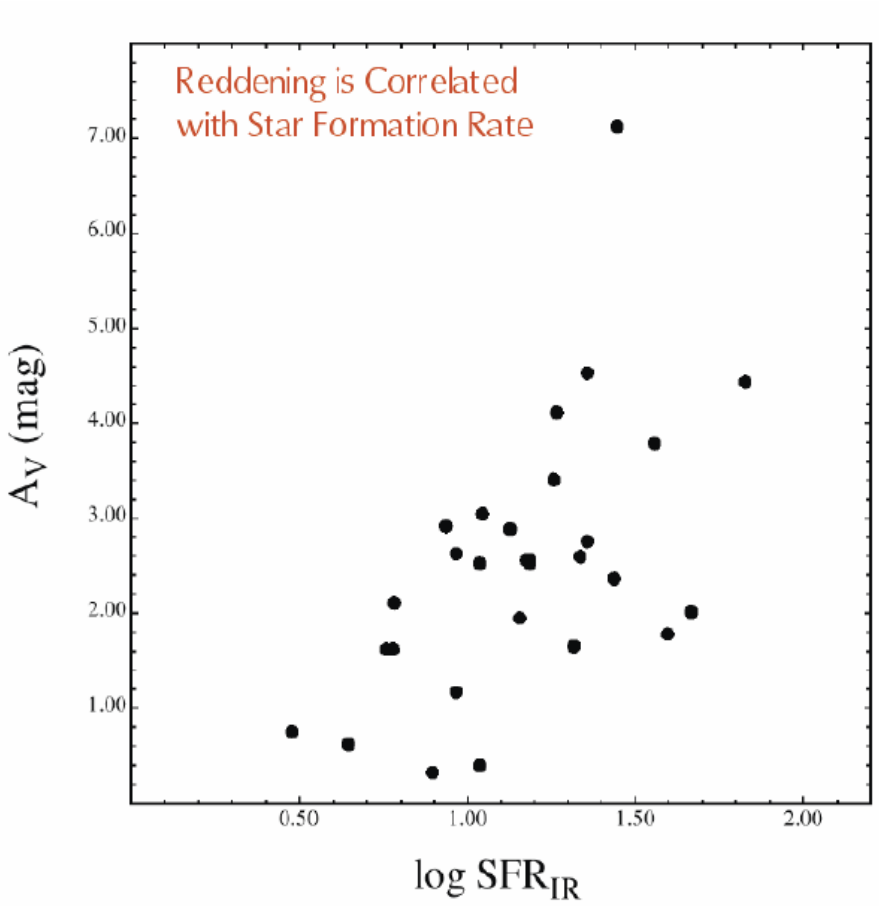


Star formation rate determined from optical emission

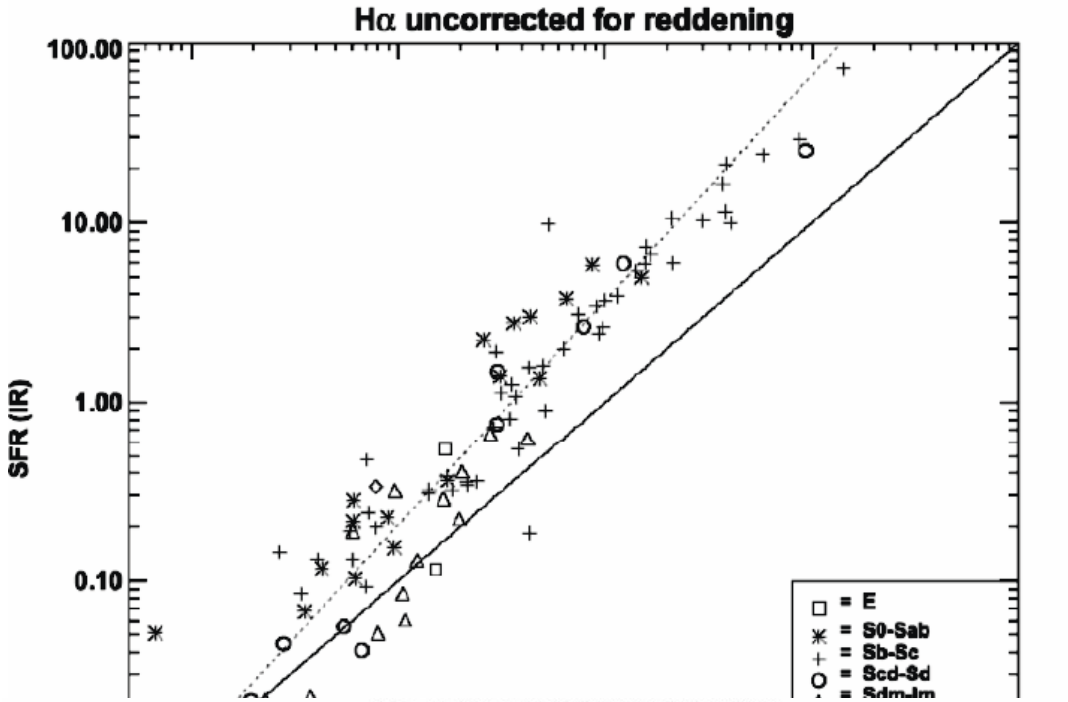


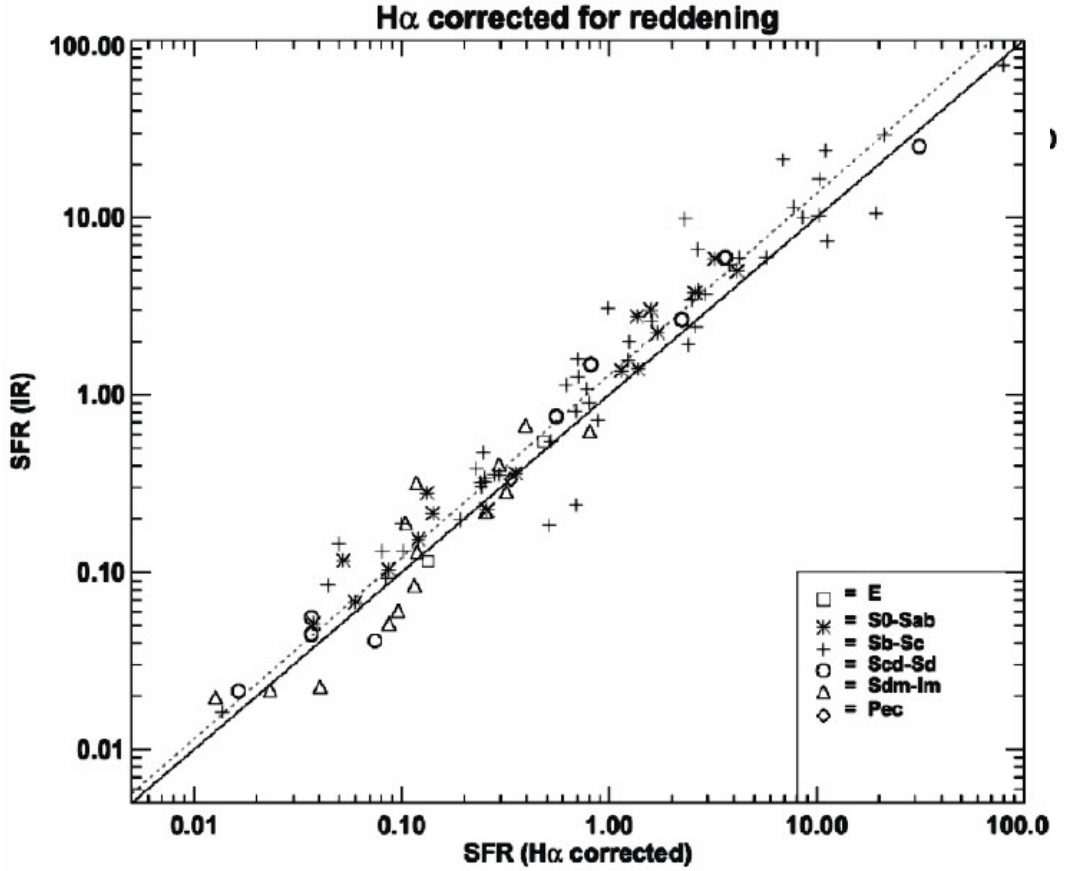
Star formation rate determined from the UV flux

Dust & Extinction



SFR determined from UV flux needs to be corrected for extinction as it is for the case of H-alpha





Main new results from GALEX images

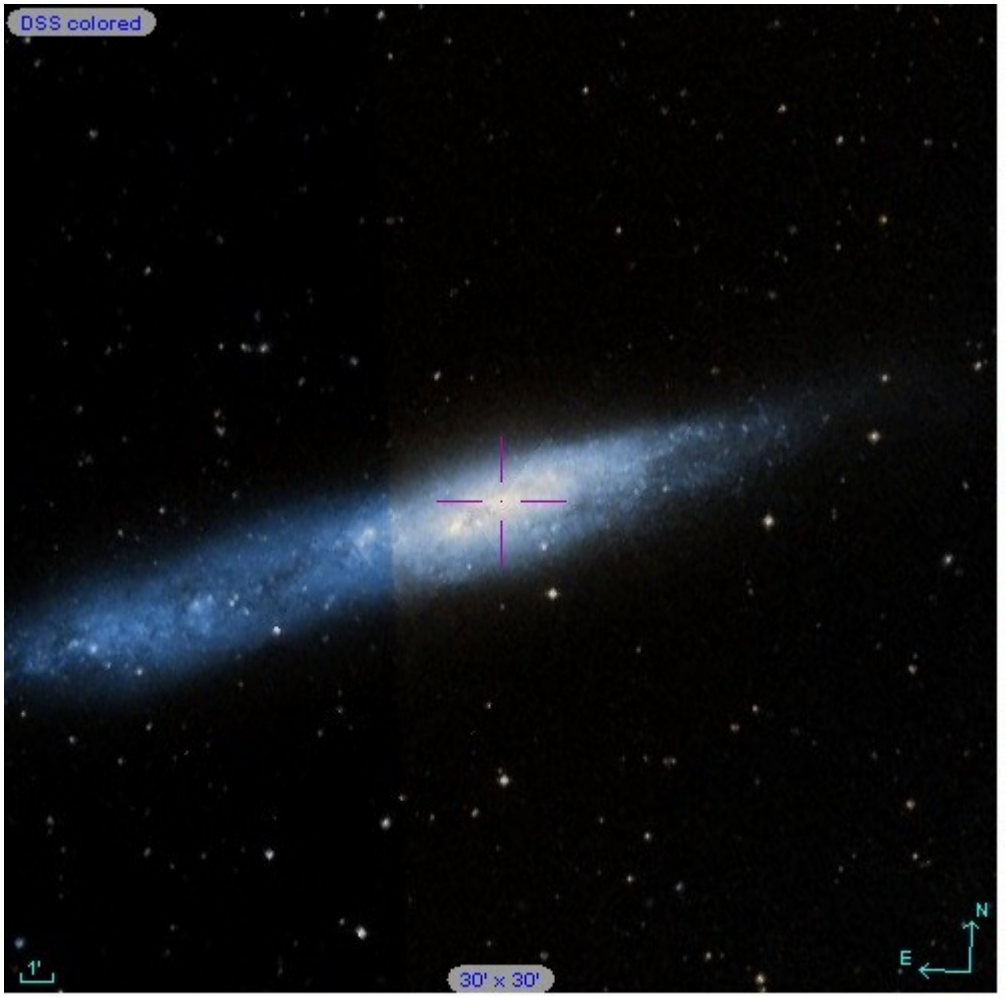
1. **Extended emission in the UV up to 3 or 4 times the optical radius in disk galaxies**

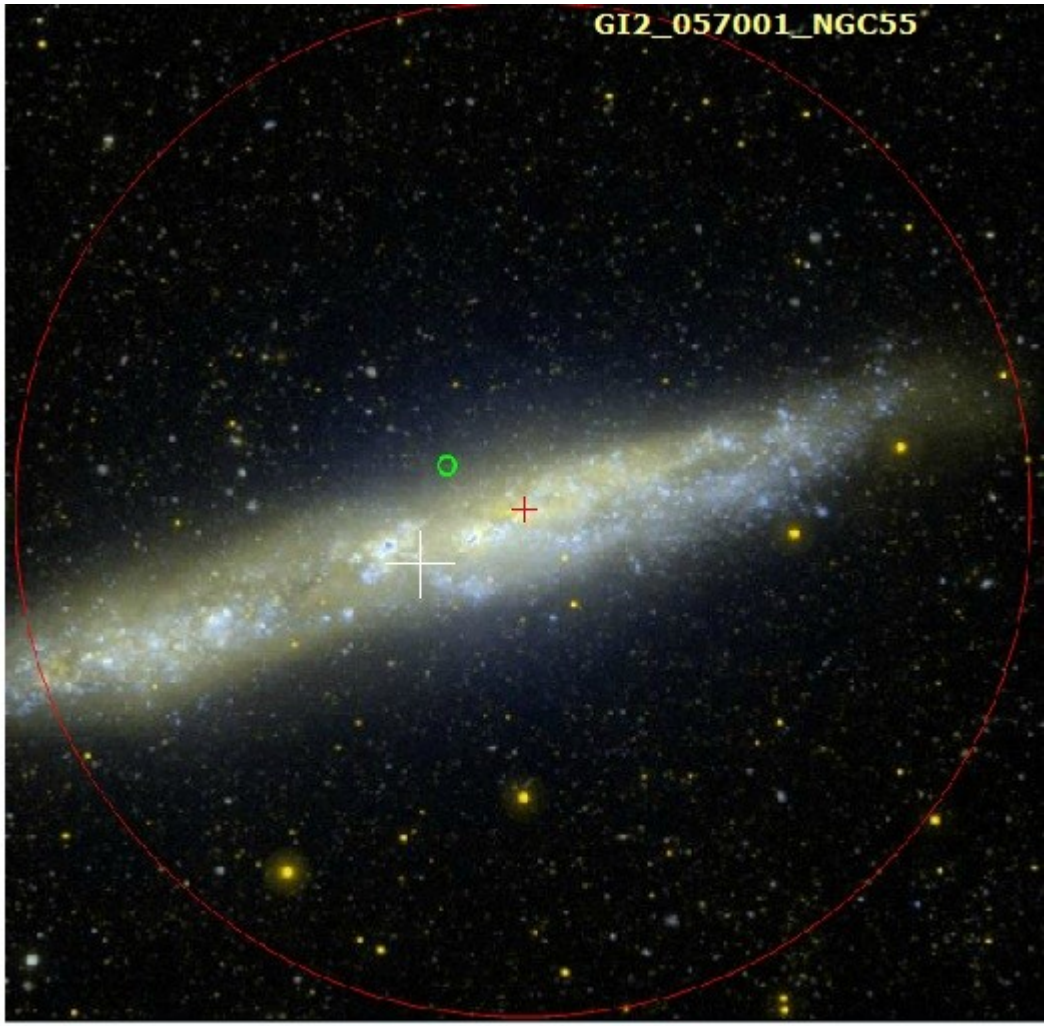
2. **UV - optical colours are well correlated with star formation and indicate star formation is an ongoing process in most disk galaxies.**

3. **Integrated FUV – K colour is a good discriminator between different morphological (ellipticals and spirals)**

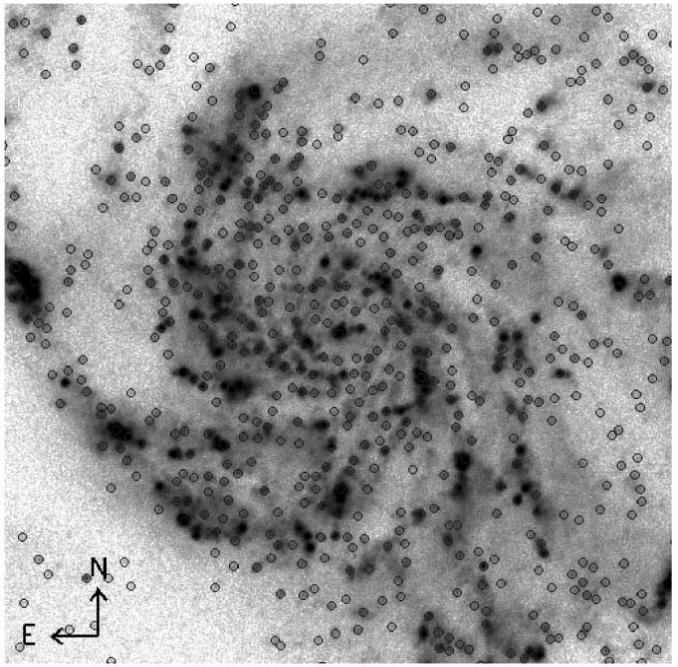
4. **The resolved UV and optical photometry allows determination of ages of stellar populations, reddening and masses in clumps of star formation.**

Typical well exposed galaxy in GALEX UV data – NGC 55 (right)





NGC 55 *NUV 30691 s* *FUV 29347 s*

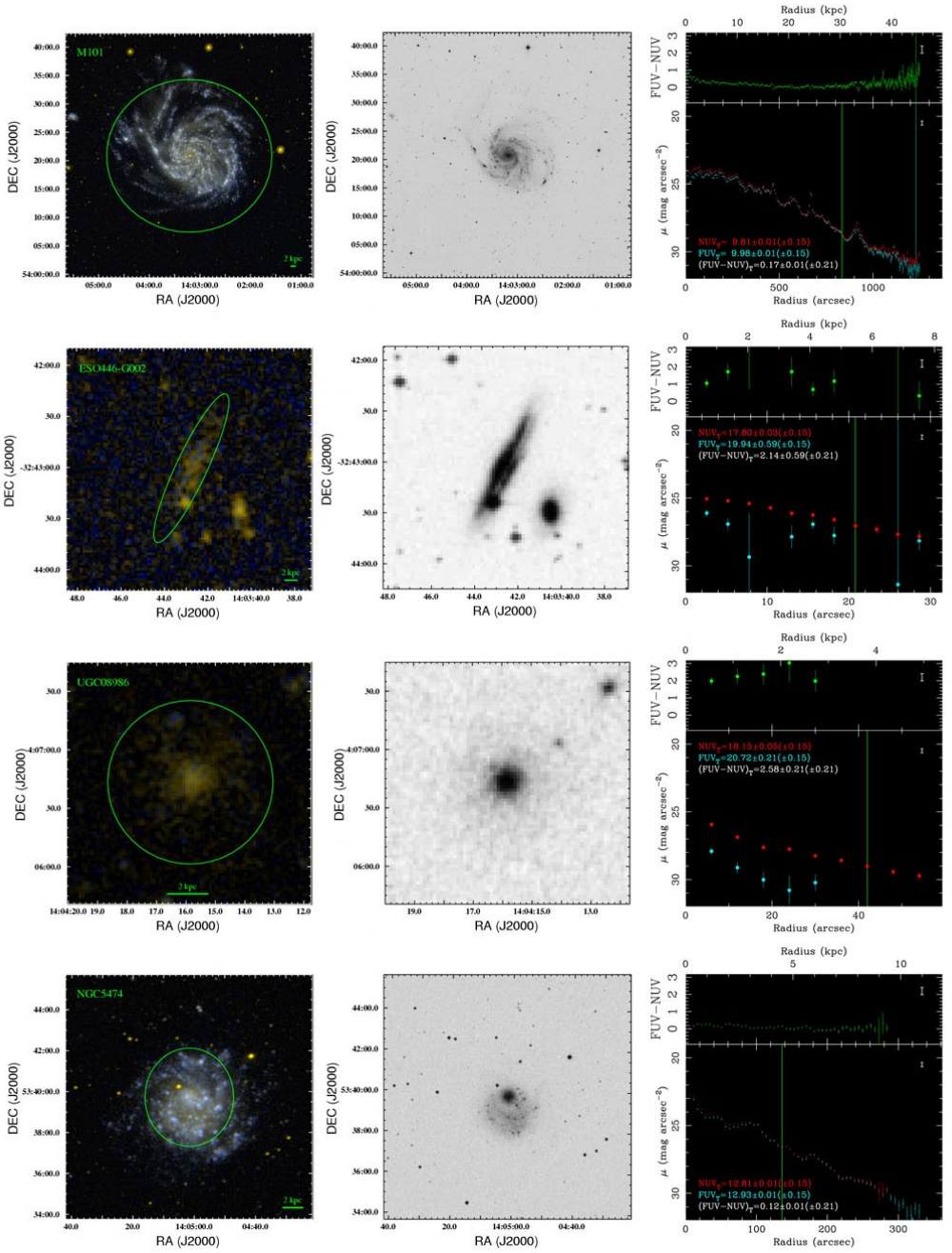


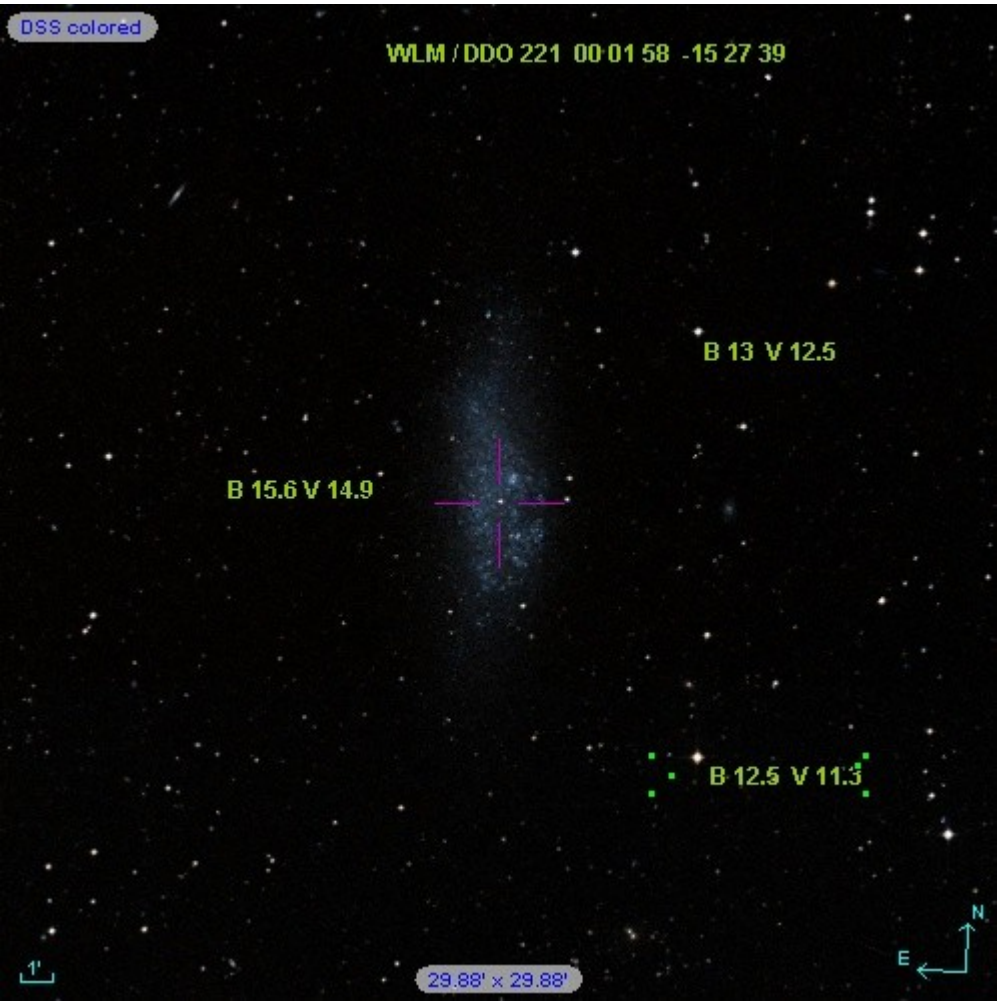
Portion (12.5 arcmin2) of a *GALEX*-NUV image of M101. The compact UV sources with photometric errors less than 0.2 mag are indicated with circles (Bianchi et al 2005 ApJL)

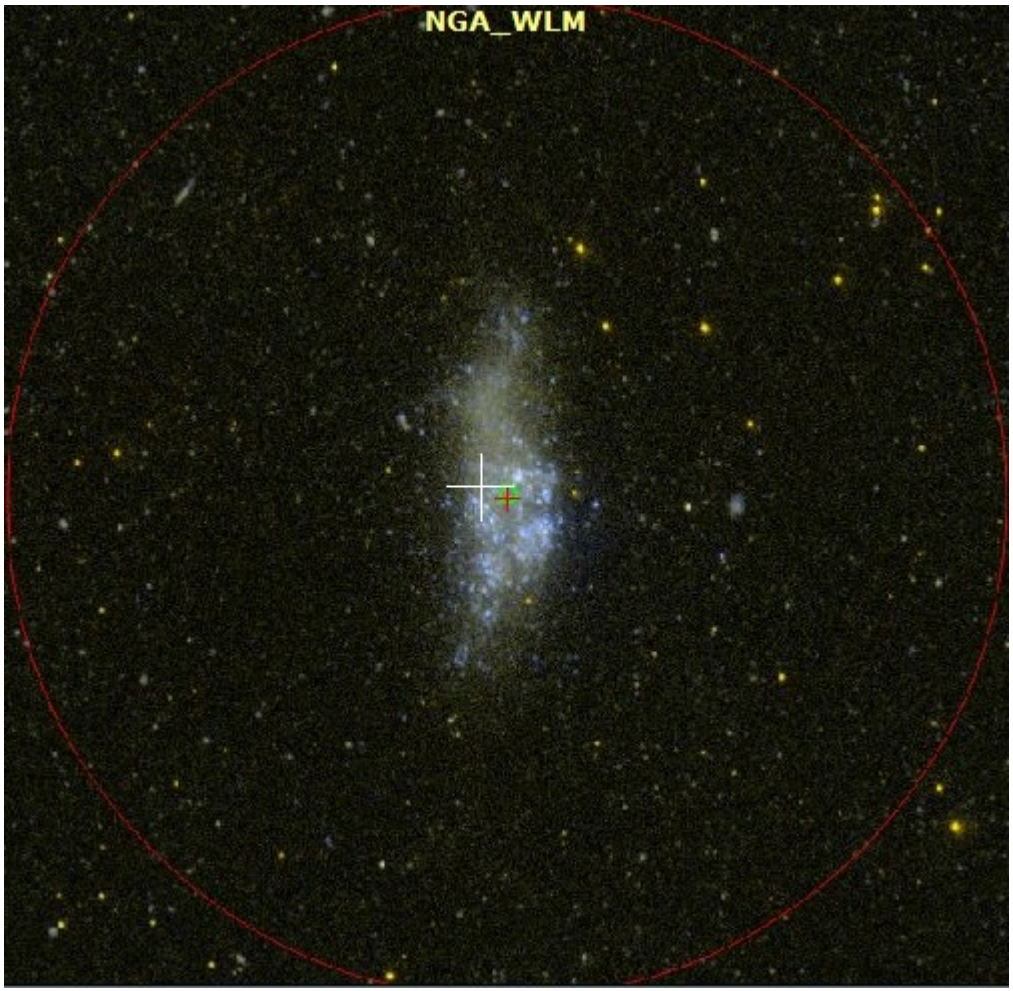
Resolution is 4.5 to 6 seconds of arc

Surface plots at right show need to go to brightness levels below UV mag 25 per squ arcsec

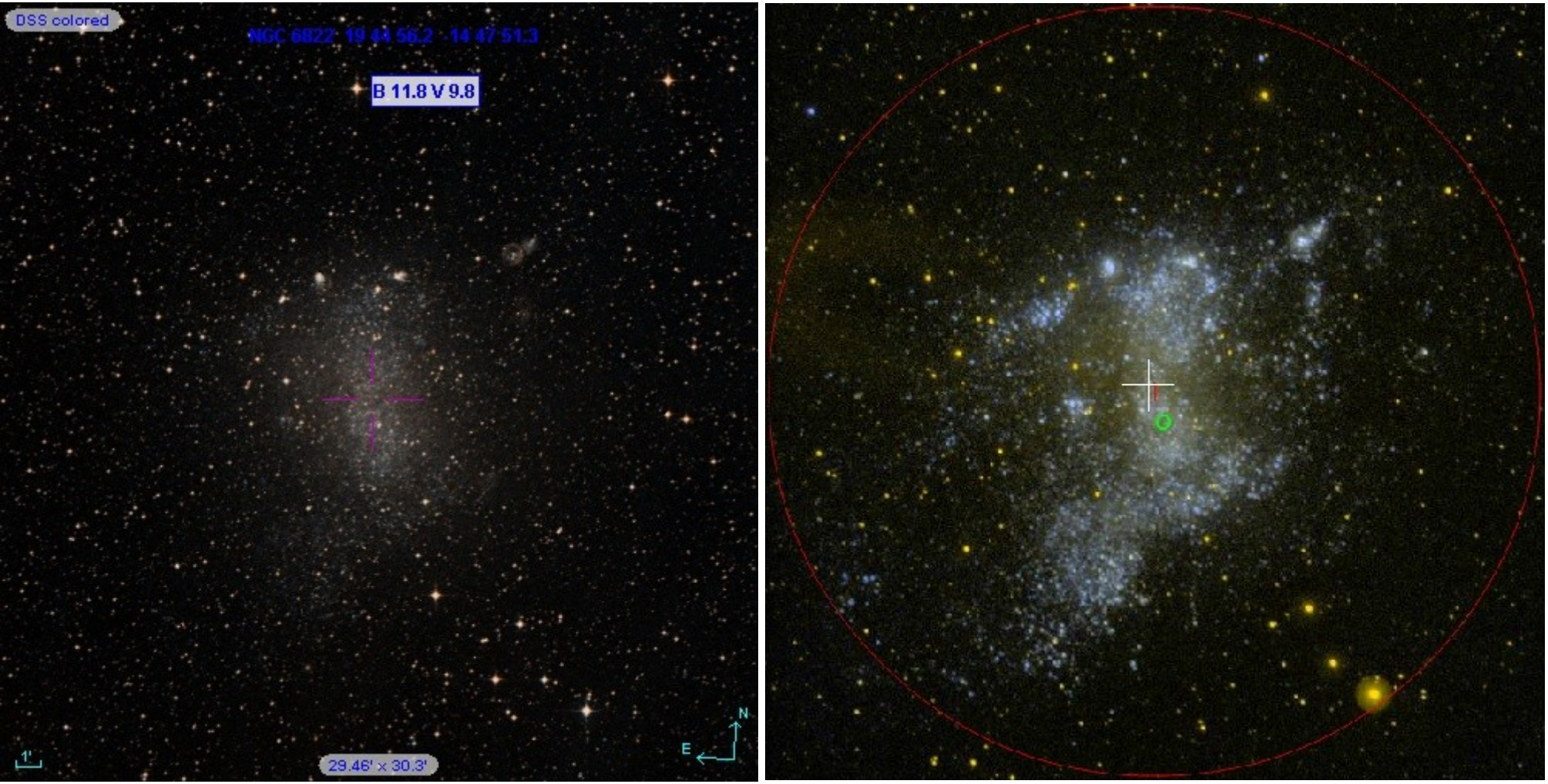
Gil de Paz et al 2007, ApJ Suppl 173







LSB galaxy in optical (left) and UV (right). Such objects seem to show widespread Star formation in the UV. GALEX surveys are not deep enough or completefor this class. Mapping of SFR should include detailed estimation of extinction.



Another LSB example showing up extending SF even with GALEX AIS data.

UV imaging of groups and clusters of Galaxies

Galaxy morphology & evolution

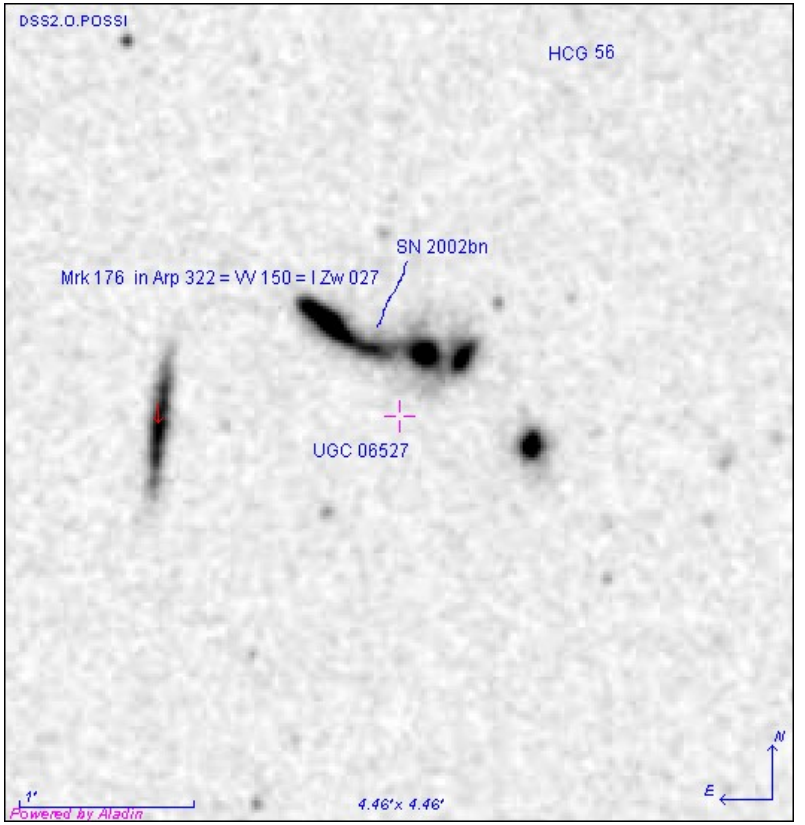
- local & related to formation and passive evolution
- affected by environment

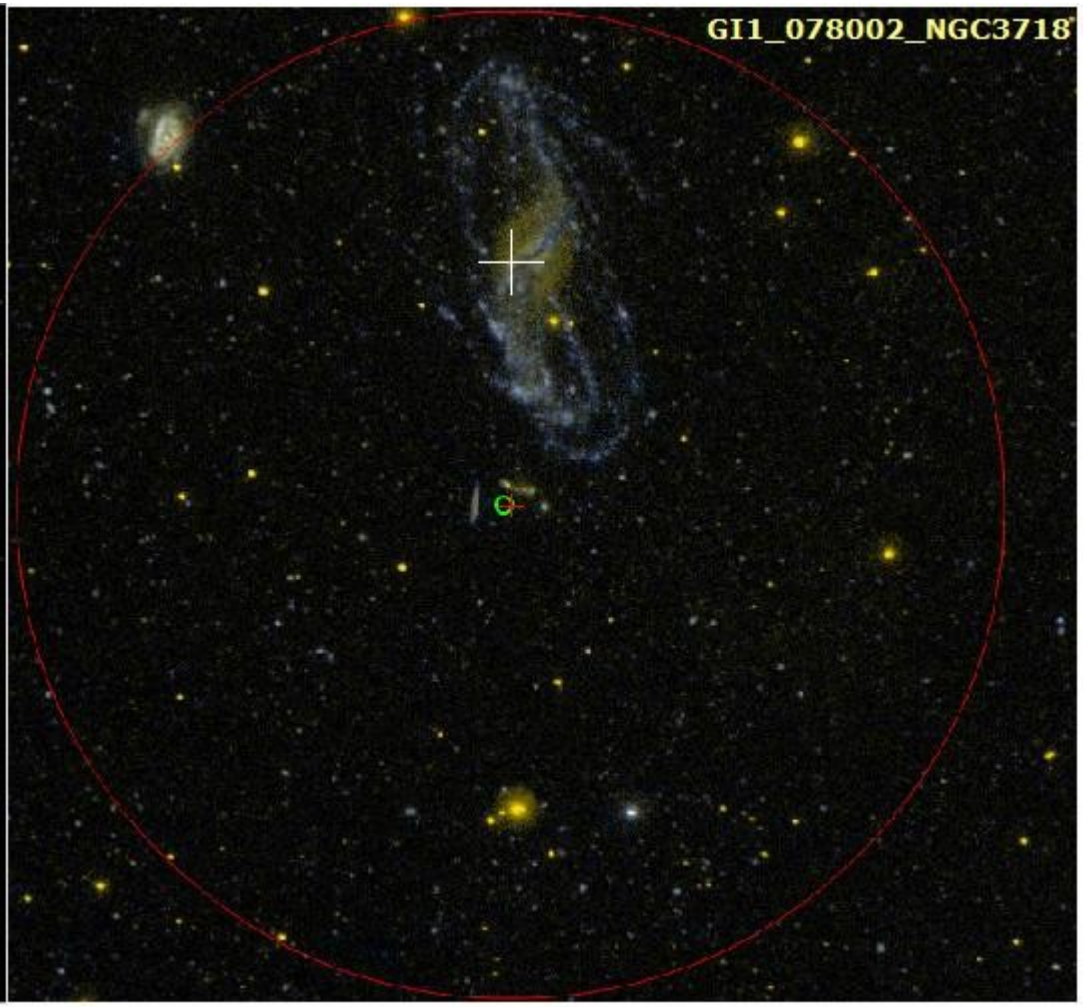
Groups & clusters of galaxies

- important for study of evolution, particularly effect of environment

- distribution of morphology and its relation to colour give clues to formation and evolution

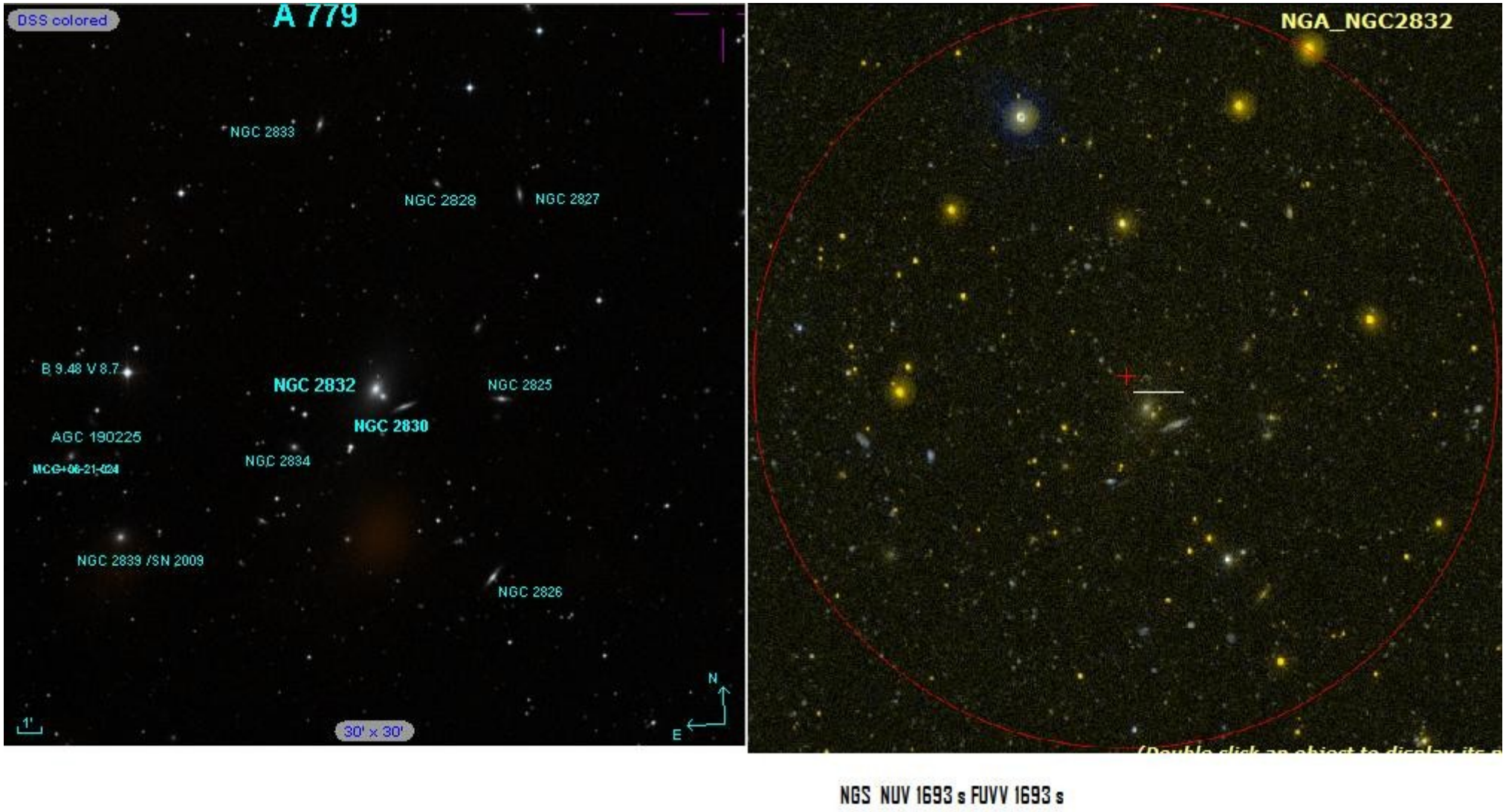
Morphological segregation ie. " Shaping of the Hubble sequence " in different environments is perhaps the clearest signature of the environmental dependence of the processes that govern the formation and evolution of galaxies.





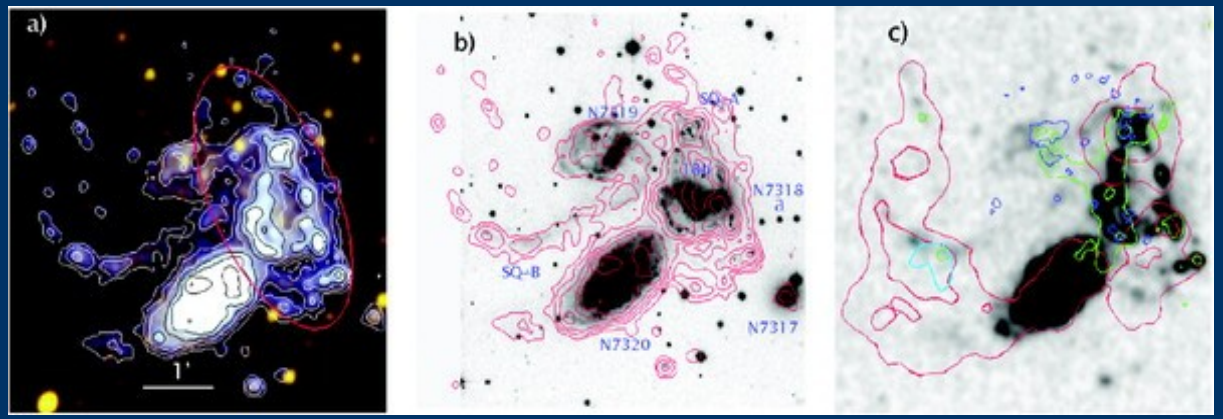
NUV 1620 s FUV 1620 s

Illustrating that fields can be chosen to include both compact groups and larger galaxies.



Example of cluster of galaxies with subgroups involving evident interactions.

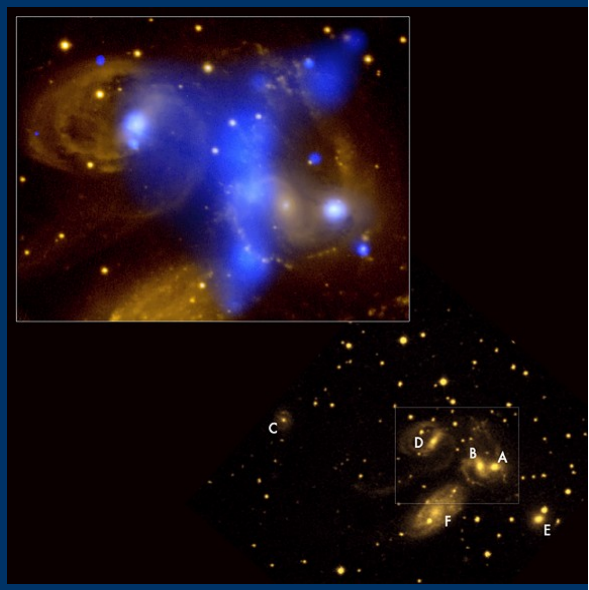
Stephen's Quintet



FUV + NUV (blue)

FUV on B band

FUV + H_a (grn) + HI (red) + CO



Chandra - Xray

Famous example showing signatures at different wavelengths of the extended emission enveloping interacting members in a group and the star forming knots resulting from such interactions.

Observations for Baseline Science:

Imaging through CaF2-1, Sapphire, NUV Silica,NUVB4, NUVB13, NUVB13, NUVN2

(The chosen bands will sample the slope of the UV flux both shortward and longward of ~2175 A. This dip in the UV spectrum due to extinction is seen in the Galaxy. It is not seen in the Magellanic clouds. In other galaxies ? We can sample the spectrum using combinations of these filters till v ~ 20,000 km/sec)

Each field requiring 24 orbits (2000 sec observations per orbit)

Selection of thirty fields => 720 orbits

- possible to optimize positions to include other interests