CCDG (Clusters Clumps Dust and Gas) – Working notes

REFERENCES:

April 30 2020 - email – Arp 220 and N 1614 – first pass

May 6 email – N 3690 and N 2623 – first pass

DONE:

1. First pass catalog for 6 galaxies nearly completed , Arp 220, N1614, N2623, N 3690, --- ESO185, NGC 3256 (still. Finishing up these last two – should be on site in day or two)

TODO:

1. Haro 11 – first pass
2. Add Halpha to galaxies where available (Arp 220, NGC 2623, NGC 3690)
3. Add IR to all galaxies.
4. Add other galaxies when images available.
5. Add 3pix catalog for arp220 to website for Rupali to experiment with.

Known loose ends”

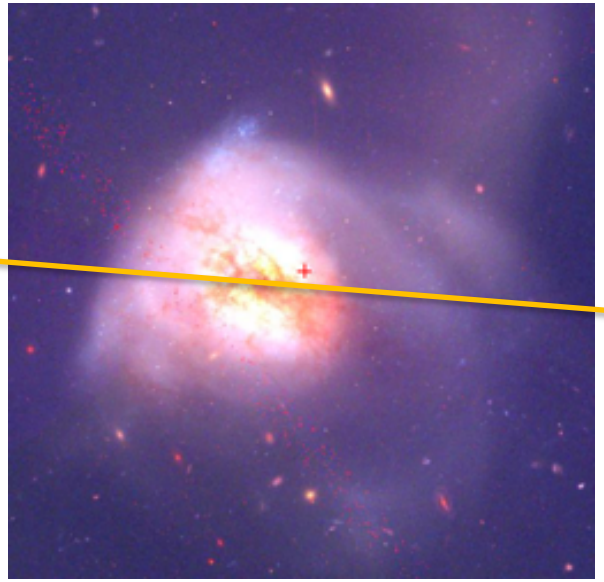
1. We need to realign the Haro 11 F435W image.
2. F110W observation for N 1614 missing
3. HRC F330W observation of NGC 2623
4. Halpha for few galaxies from archives (e.g., Arp 220, NGC 3690, NGC 2623, others?)

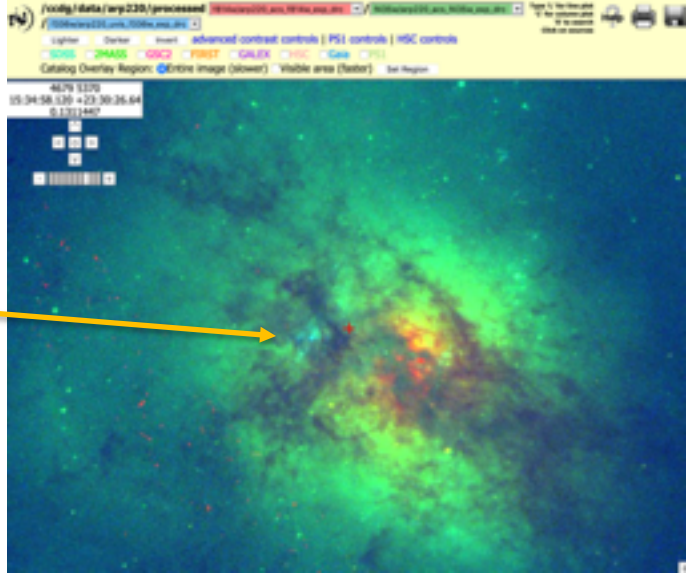
Arp 220 – Some science highlights

1. Most cluster likely between 100 and 500. Some old ones as well.

2. Almost no young star formation. One small blue region with Halpha here. Rest of SF must be in center ? This is opposite of Wilson paper.

3. Question of what drives the strong IR flux, SF or AGN?





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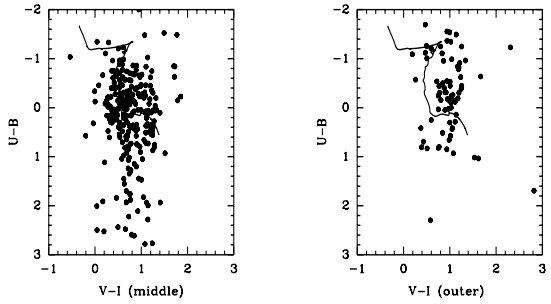
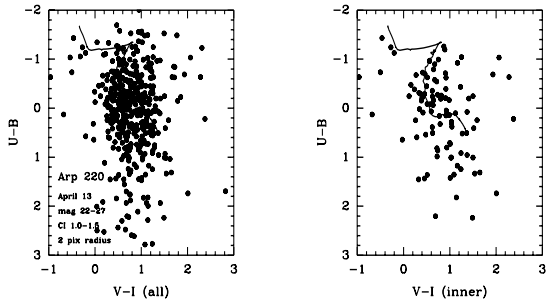
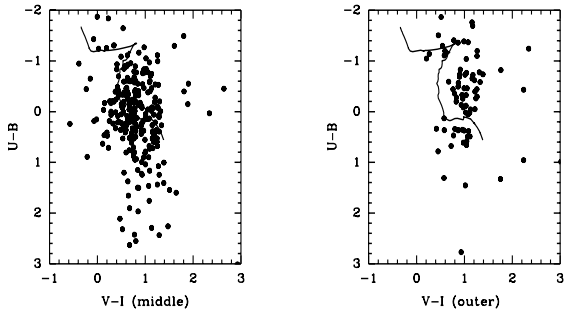
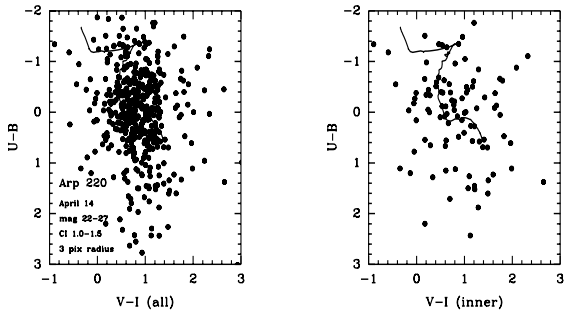


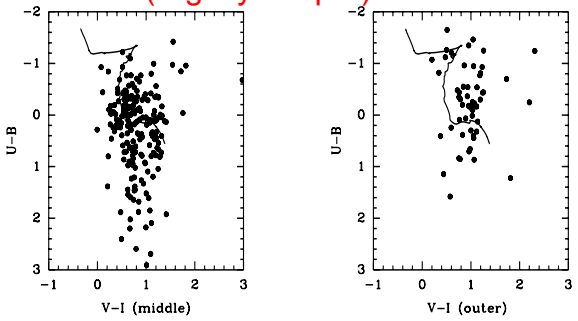


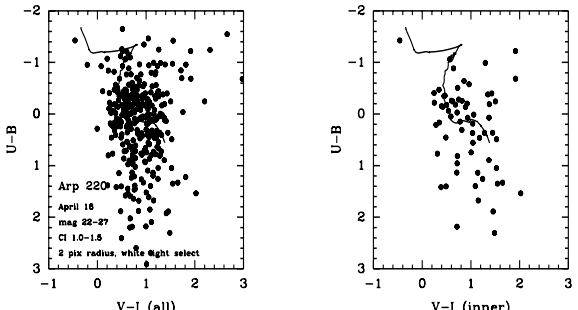
3 pix photometry





2 pix photometry – white light select (slightly deeper)



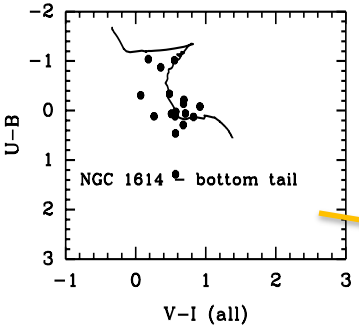


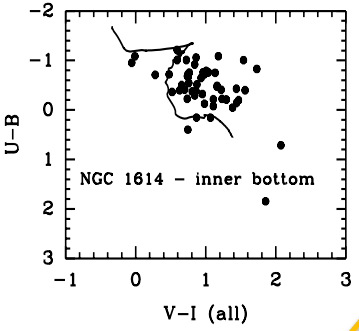
N1614 - Some science highlights

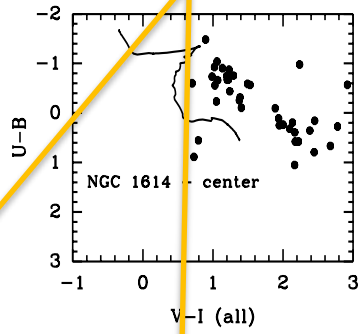
1. Large mix of ages from very young (strong Halpha and dust), to young/intermediate (right tail – very uniform age, to intermediate/old (bottom tail).

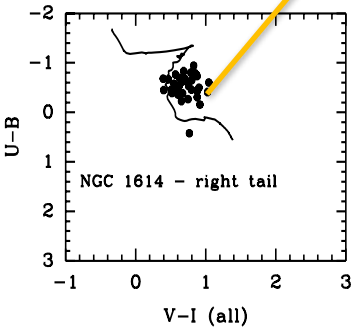
2. Fairly large galactic extinction and internal extinction so most points will move to the upper left.

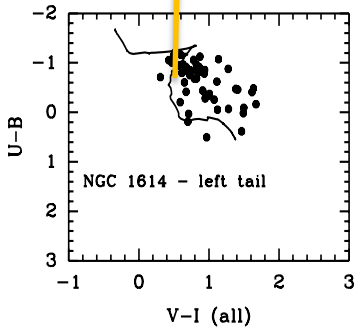
3. May be two nuclear regions with different amounts of dust.





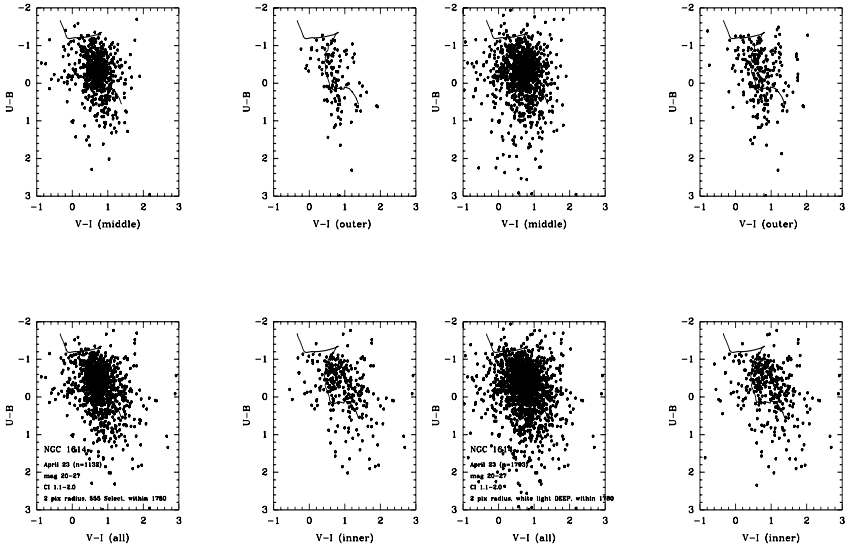






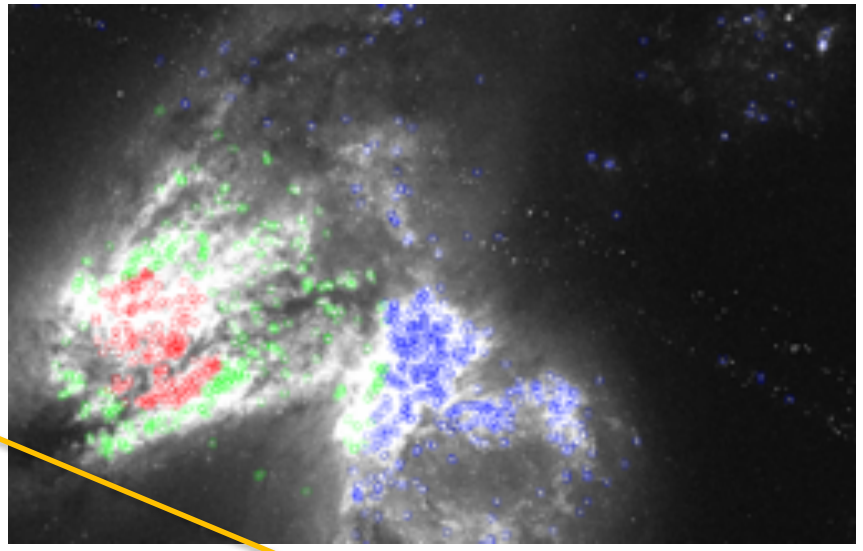
2 pix photometry – 555 select

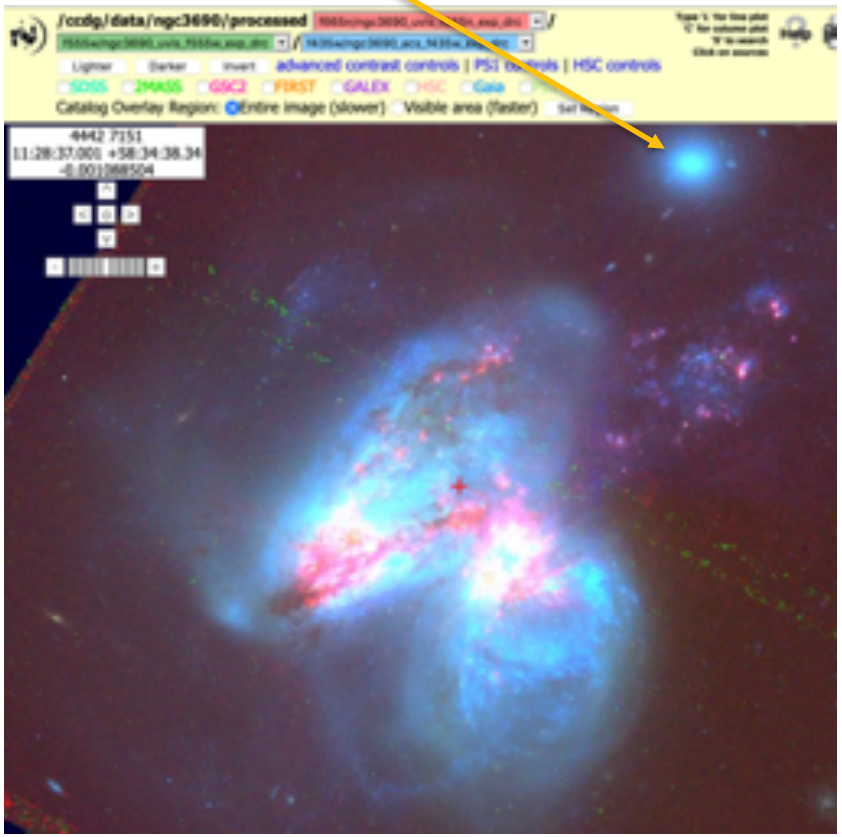
2 pix photometry – white light select

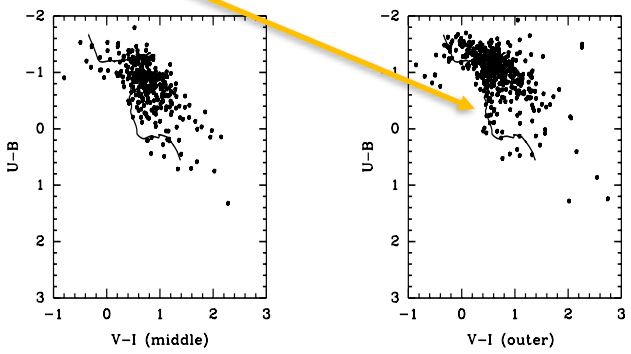


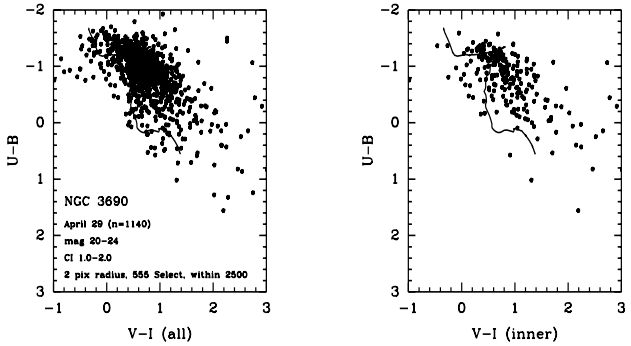
N 3690 - Some science highlights

1. Large mix of ages from very young (strong Halpha and dust), to intermediate (outer tail – note plume in CC down the isochrone around 100 Myr in “outer” panel).
2. Note more dust in the inner panel than outer
3. There is a fun elliptical galaxy above it with lots of old GC.







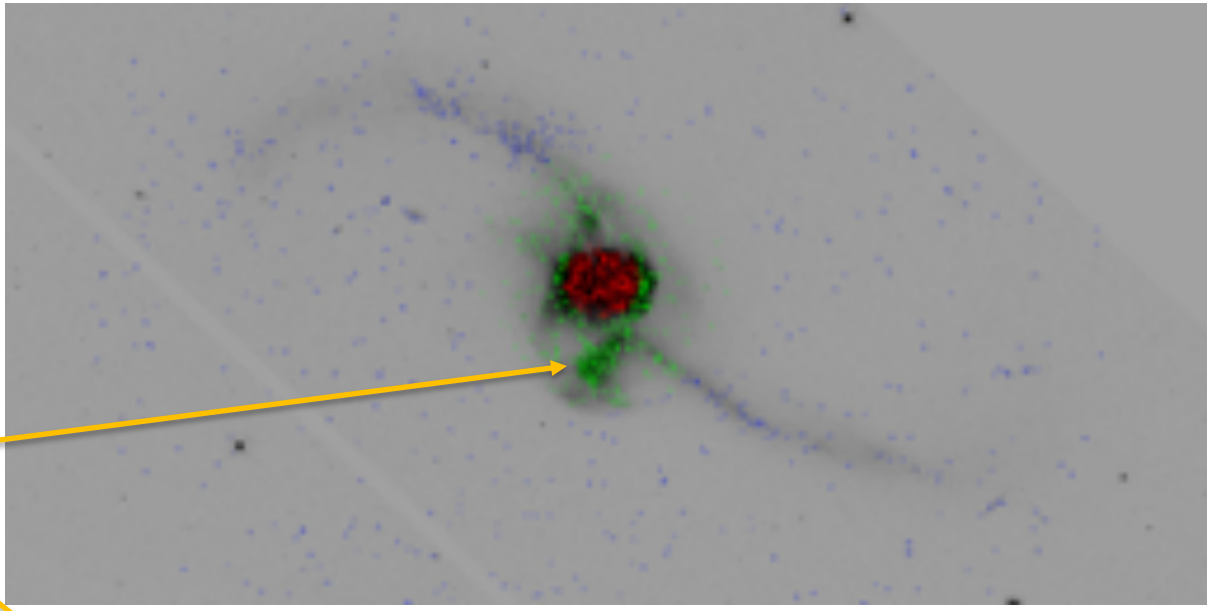


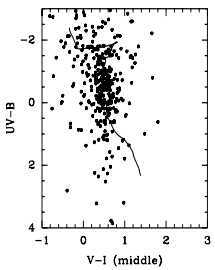
N 2623 - Some science highlights

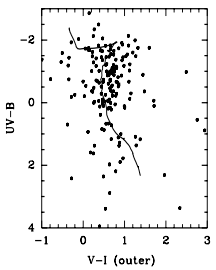
1.We do not have a wide field F336W image so using F275W (UV). This compromises our age estimates somewhat. However, the agreement with the isochrones is pretty good, and there is not much dust in the outer regions and tails.

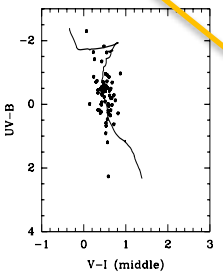
2. There is a nice ACS HRC F330W image we can use for about ½ the galaxy (included the “pie-wedge”) but that will take some additional time.

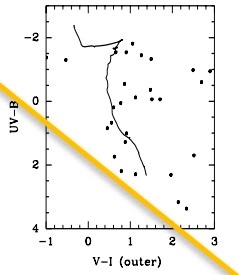
3. Mostly intermediate age clusters (50 – 300 Myr I would guess). Very little young SF (see Halpha image).

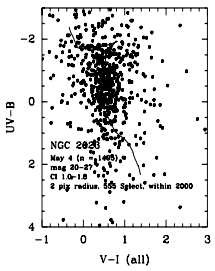


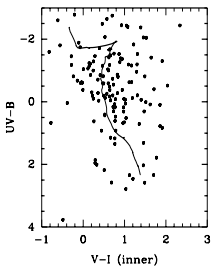


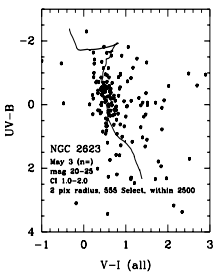


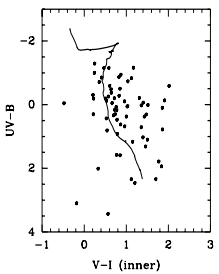


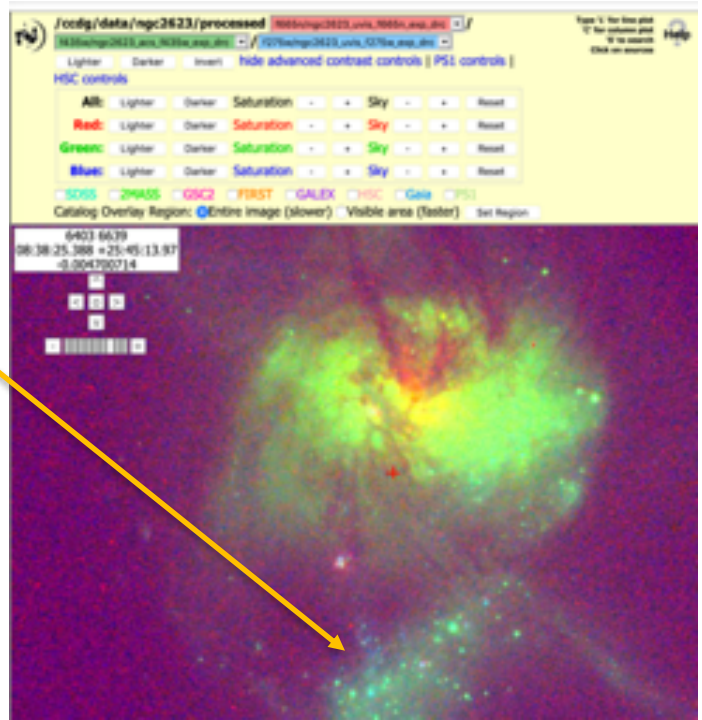












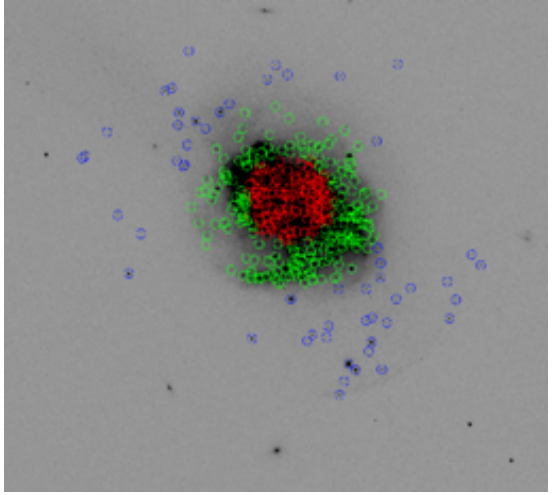
ESO185-013 -Some science highlights

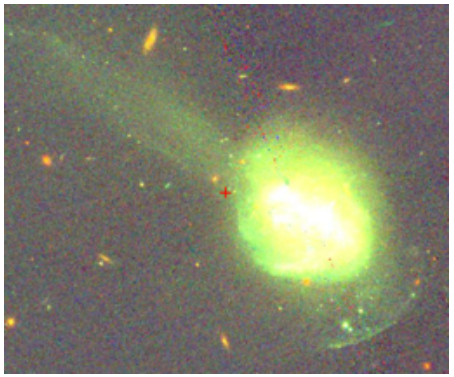
1. No F336W for this galaxy so using F275W (UV) for color-color. Agreement is excellent though !! Partly because very little dust.

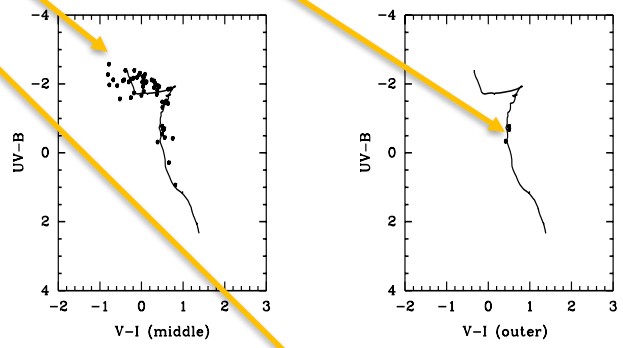
2. Most of the population is very young, with strong F275W, unlike most of the other galaxies.

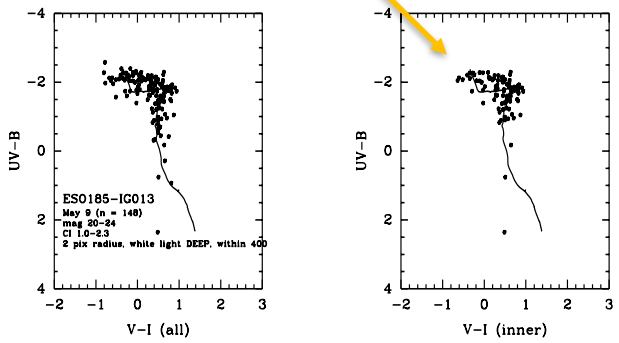
3. Also some intermediate age clusters in the outer regions (tails and shells).

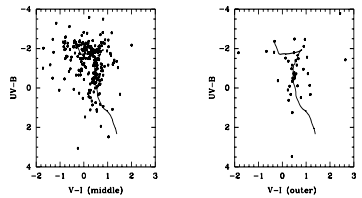
4. An interesting question for this galaxy might be whether there is enough very young, concentrated star formation to produce a galactic wind in this dwarfish galaxy.

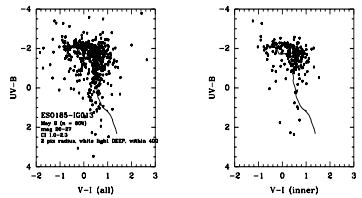








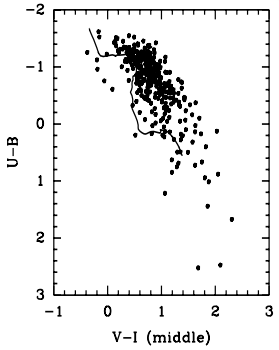


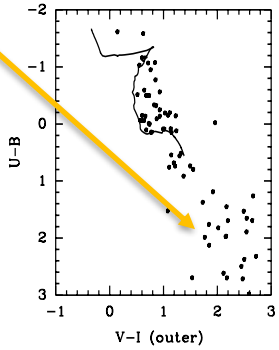


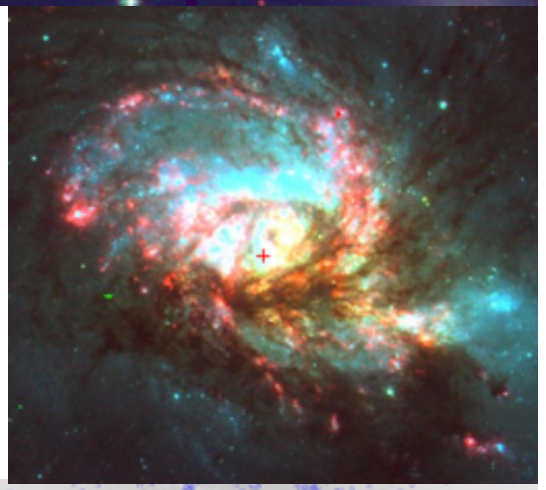
NGC 3256 – Just starting work on this galaxy.

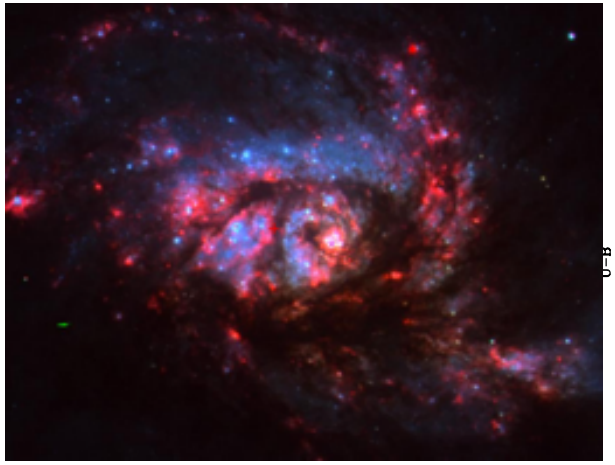
1. Primarily young clusters. Large amounts of dust and halpha, especially in the inner regions.

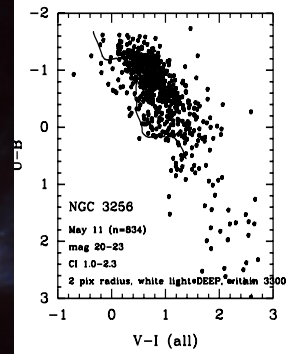
2. There are large numbers of red foreground stars in this galaxy. May need to filter these out in color space when making cluster catalogs.

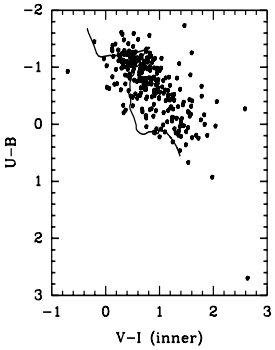


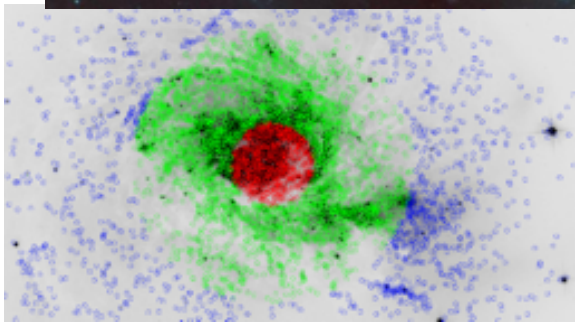












CCDG (Clusters Clumps Dust and Gas) – Working notes (from emails – slightly edited)

Arp 220 and NGC 1614 – April 30 email

Hi All – I now have preliminary catalogs for Arp 220 (updated from the initial version by normalizing the errors and adding a column for Mv – the rest of the numbers are the same) and NGC 1614. The main thing missing is the IR observations. Will probably do those in the next week or two. Details about the reductions are in the headers. Let me know if you see any issues or have questions.

As a reminder, there are 4 catalogs for each galaxy, 2 with 555-selected and 2 with white light image-selected; and 2 with the full "point-like source catalog" and 2 with an initial attempt at a cluster catalog (e.g., with CI in range 1 – 2, mag < 27, some artifacts (stars and background galaxies) removed. You may well want to make your own cluster catalog yourselves. I assume Rupali will decide on the official CCDG cluster catalog herself sometime in the future (i.e. will not go as deep since gets very noisy).

NGC 1614 – This galaxy has a fair amount of galactic extinction, so everything will go to the upper left a little. There is also a wide range in extinction in the galaxy itself, from almost none (bottom left panel – right tail ~ 50 Myr, with very small spread in colors – need to check whether the scatter we see is compatible with NO scatter in the intrinsic distribution – i.e., all the clusters formed in this region within 10 Myr range in age – what would simulations predict ?) to the nuclear region (middle right panel – most ages probably < 10 myr with 1 – 3 mag of extinction. The left tail (bottom right panel) and inner bottom (left middle panel – just below the nucleus) has ages from few Myr (i.e., there is Halpha in some but not all areas) to probably a few tens of Myr (i.e., has cleared dust and has no extinction). The bottom tail (upper right panel) has low extinction and ages around 300 Myr, but also a few very young regions (with Halpha – see color image), presumably from gas falling back into the galaxy along the tails, as we also see in the Antennae and in simulations.

Rupali – I pulled out m-M from NED. Let me know if you have other distances in mind.

A final thought – we originally planned to try to sidestep the cluster classification issue by saying we would just work with the objects brighter than -10 or -9, the limit for brightest stars. However, as you will see, we can easily go down to mags – 7 or -8 in these galaxies. We cannot really manually classify anything since they are not well resolved at these distances. In some cases (e.g., Arp 220) we can argue that all the point-like sources (except those with proper motion) are old, hence include everything, but for objects that have young stars (essentially everything but Arp 220) we cannot do this. My suggestion is that we do the various analysis using limits down to -10 (very safe), -9, -8, -7, and estimate the % pollution (and effect on results) from stars – a number we would try to estimate by fitting LF (slope = 2) for magnitudes dominated by stars (e.g., -7) and clusters (> -10). This is similar to what I did in my 2014 paper on clusters from HLA (I think I used – 8.5 as a limit since there was only a small effect on the final results at this range.)

CCDG (Clusters Clumps Dust and Gas) – Working notes (from email)

NGC 3690:

There is a gap in the F814W coverage which goes diagonally through the upper part of the right galaxy, not very obvious in the images I sent. Look at the interactive display. There are some very bright regions we will miss in CC and SEDs in this region probably somewhere between 10 and 20 % of the clusters.

There are also strips with cosmic rays slightly above this gap region which are visible. These are fairly easily removed using CI cuts and color criteria (since only show up in one color).

There is a nice Halpha image (see attachment), but I have not done the photometry yet. Same for IR images.

The CC diagram looks pretty normal, with the presence of a lot of dust in the inner and middle range obvious (i.e., does not go up to the 1 Myr point until the AV is allowed to float in the SED fitting). In the outer region it does go that far, since less dust.

Essentially all the clusters are young (i.e., no old GCs obvious, only small number in the range 100 My in the outer tails).

There is a fun elliptical galaxy above it with lots of old GC. Probably related (check velocity) Will be fun to look at that too. I might note that in the “full” catalog it is included with the flag = 13 set if you want to pull it out. It is also removed in the cluster catalog using this flag.

NGC 2623

Main issue here is no F336W, hence the CC is for F275W – B (i.e., UV – B). CC looks reasonable but loose about ½ the clusters and the scatter (vertical) is quite large.

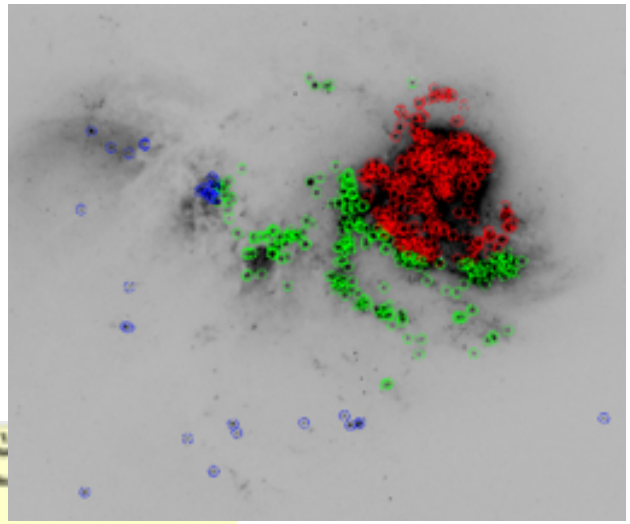
Mostly intermediate age clusters (50 – 300 Myr I would guess). There are papers by Rupali (Mulia) and Aaron Evans on this galaxy so can compare with those.

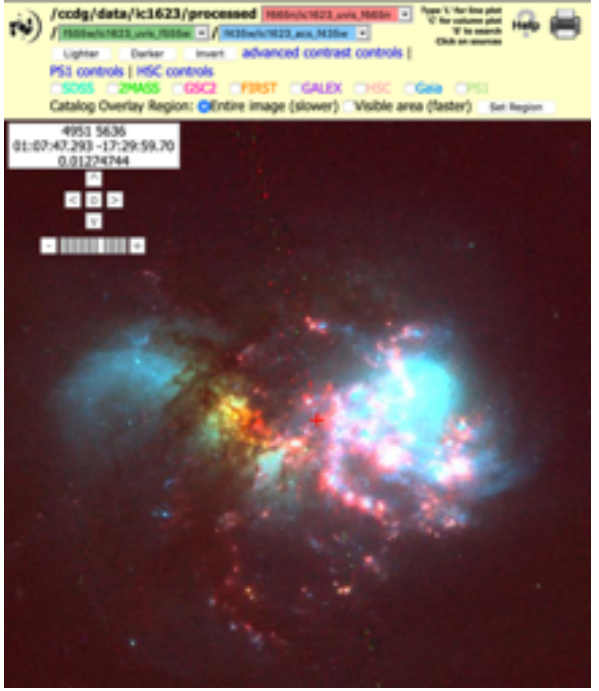
There is a nice ACS HRC F330W image we can use but that will take some additional time. It will cover the inner and medium spatial region (including the “pie wedge”) but not the outer tail. There is very little dust in the outer tails in any case so the BVI ages should be good in this outer region.

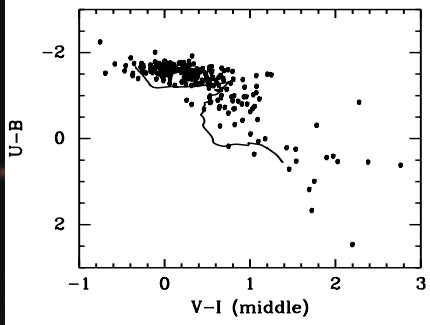
There is a Halpha image to include photometry from downstream, but there is not much emission in the galaxy since mainly older clusters. See attachment.

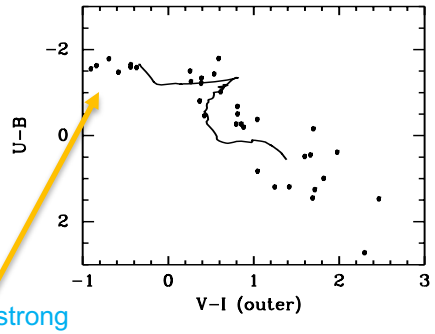
IC 1623 -Some science highlights

1. Spectacular galaxy in 4 parts: 1) old on far left, 2) dust lane center/left , 3) feathery starburst right, 4) intermediate-age far upper right.
2. Scatter toward bottom right in middle and right due to combination of dust and older clusters.

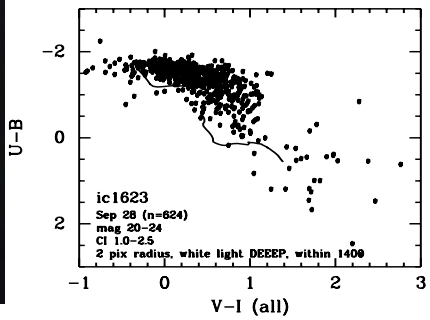


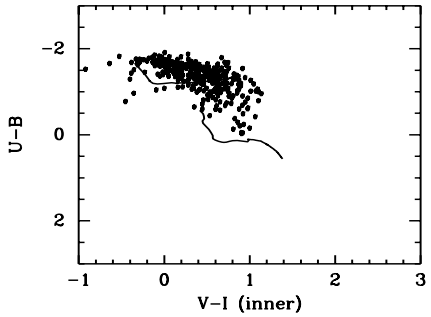






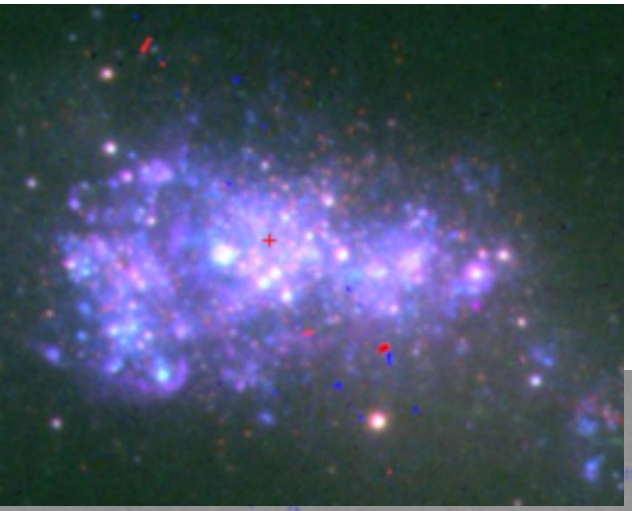
Probably strong emission and low metallicity galaxy

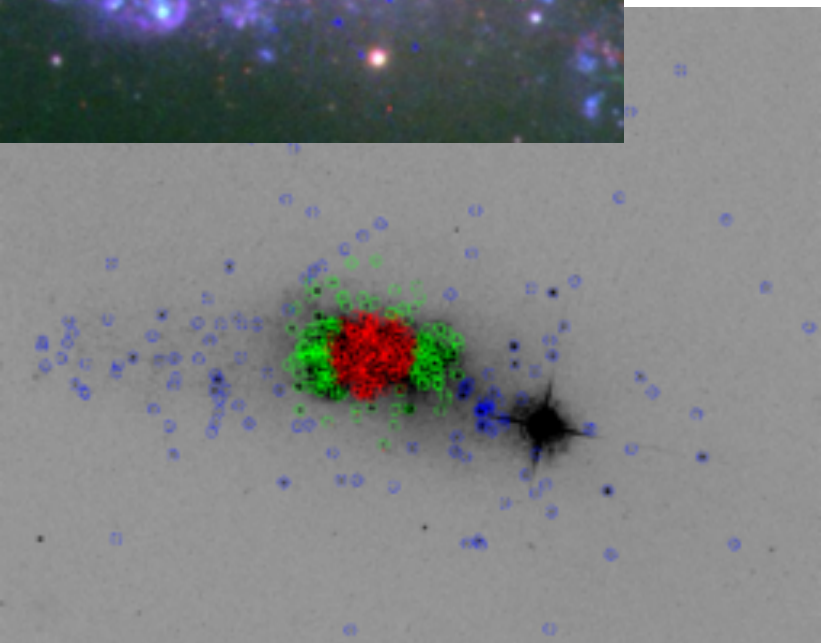


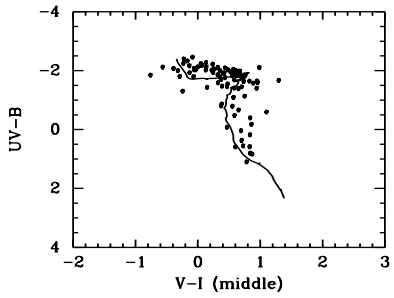


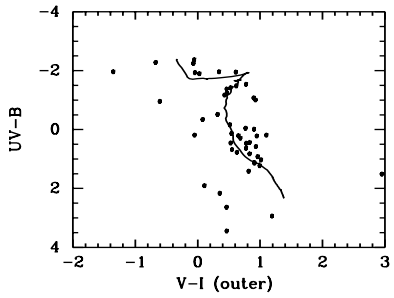
ESO 338 -Some science highlights

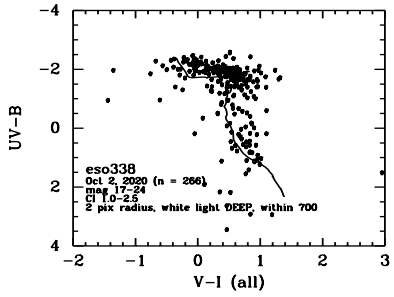
1. No F336W image available.
2. From color-color, there is very little dust present.
3. Nearly all all the object in the central region are young, some very bright
4. There are some intermediate age clusters in the middle region, and mainly intermediate-age clusters in outer region (can see this from image).

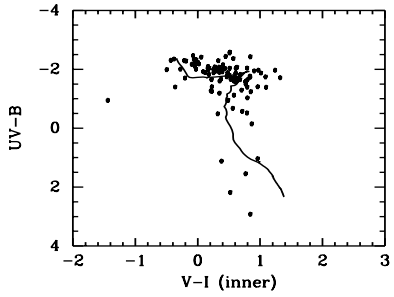






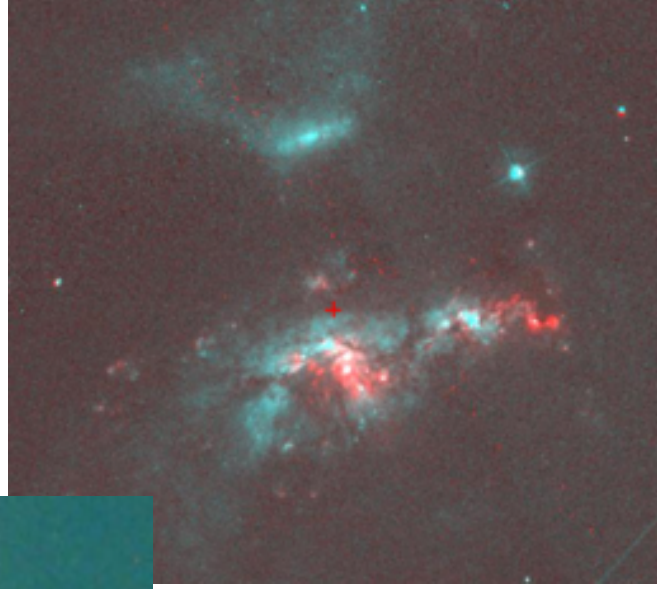


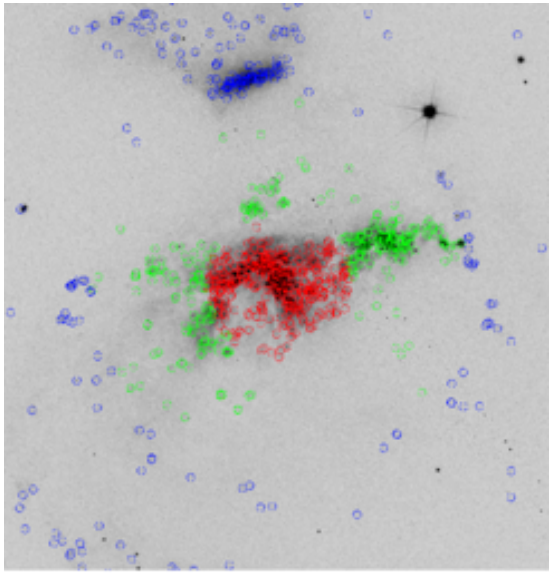


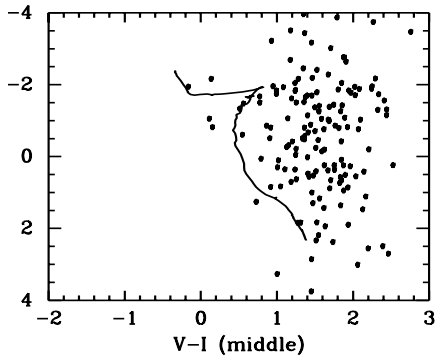


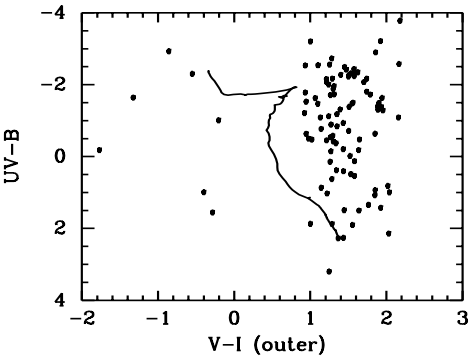
MCG 12 -Some science highlights

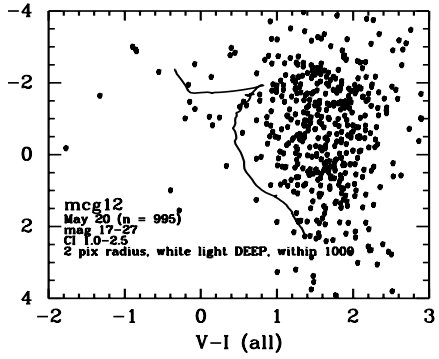
1. No F336W. F275W image is almost blank !
2. Galactic extinction Av = 2.66 ! Hence color-color plot has everything to the right.
3. Mainly intermediate age clusters, but there is some Halpha in the lower component.

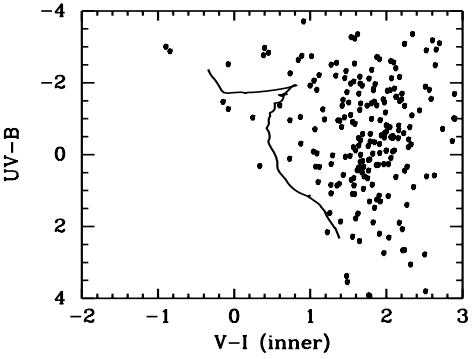










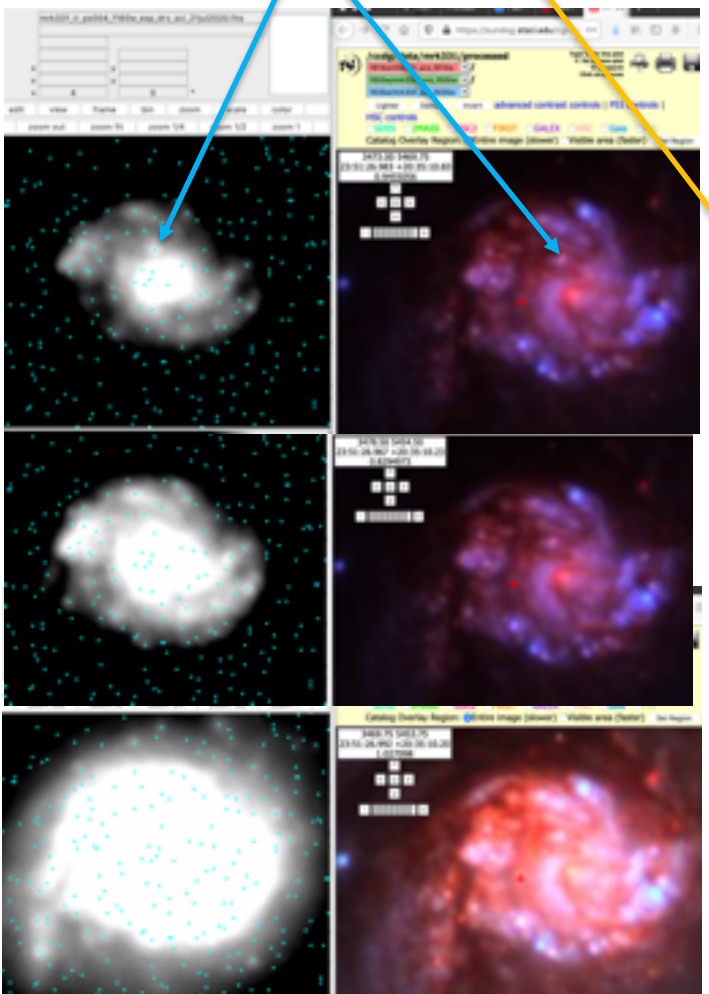


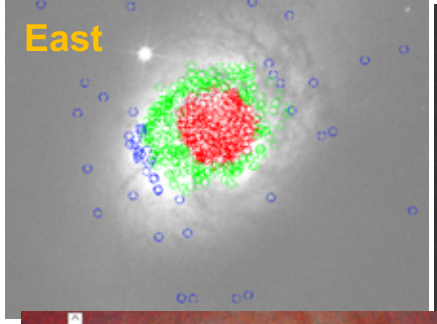
MRK 331 -Some science highlights

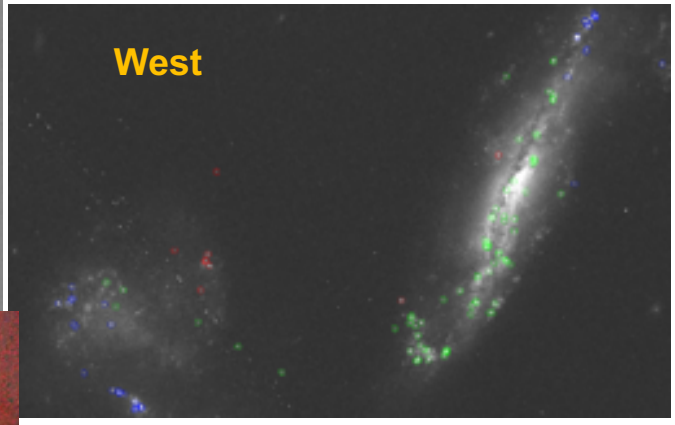
1. East component is very dusty in central regions (Av = 1 – 2 mag in color-color plots), with essentially all young clusters < 10 Myr (Halpha)

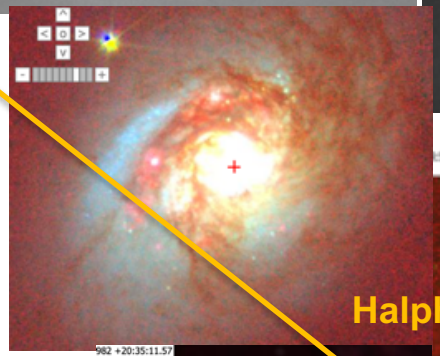
2. West components has very little dust, but most clusters are < 10 Myr again (Halpha and position in color-color plot). Why dust in one, not other ? Wind ?

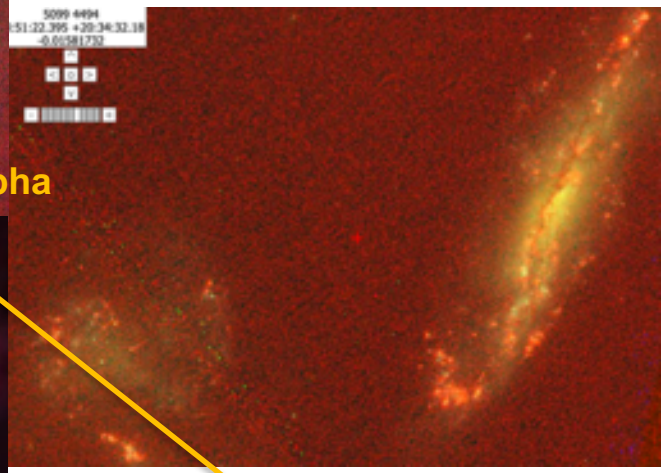
3. There are few if any F160W sources without optical counterparts (see below left)

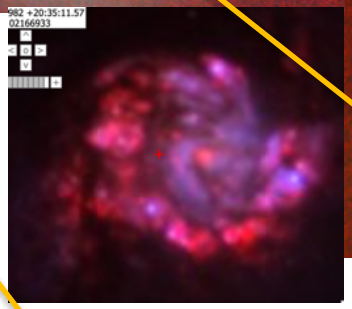


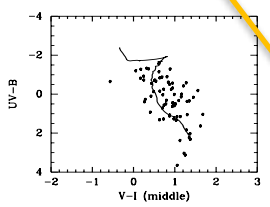


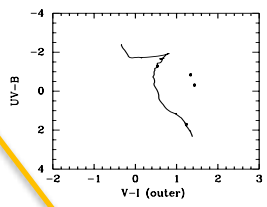




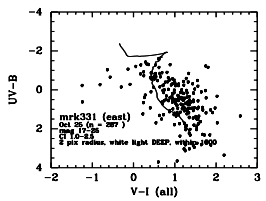


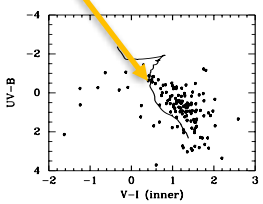






East

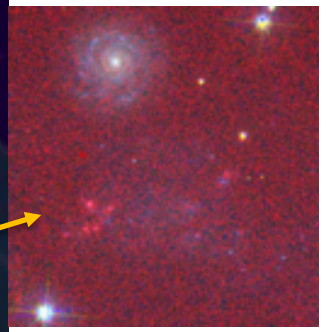


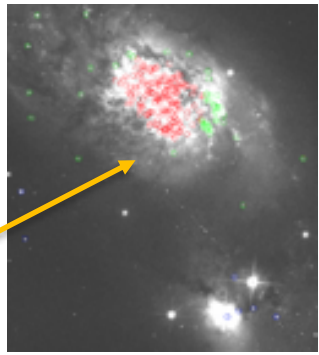


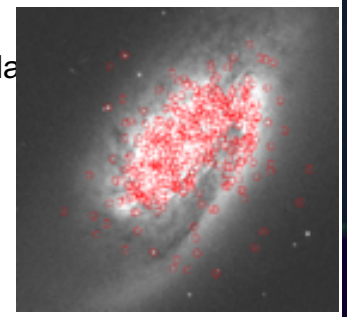
West

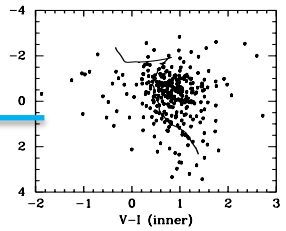
IC 4687

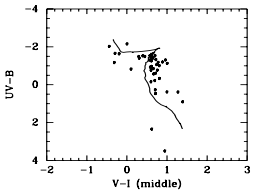
1. Central galaxy is fairly dusty, and also has fair amount of foreground dust (AV ~ 0.3), hence down the reddening vector a bit.
2. Also, no F336W so this CC use UV, which puts it farther down.
3. Note that some of the points are too the left, which might be from emission in low metallicity galaxy. Note the halpha in the far out tidal tail toward the north. Is the far north galaxy at same redshift? Probably not. Can someone check ?
4. Southern gala

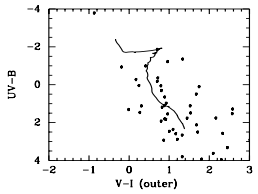


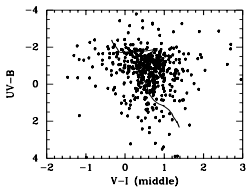


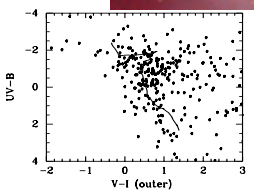


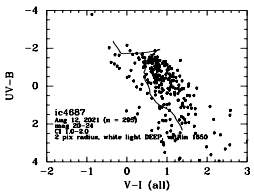


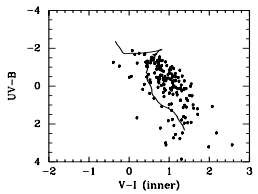


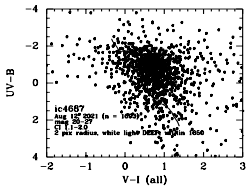


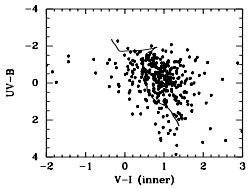












Arp 298

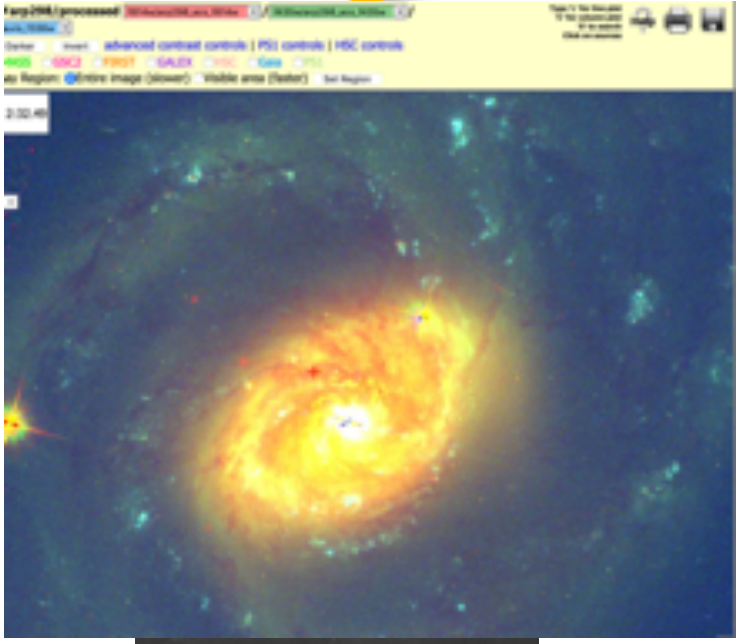
1. Central region quite dusty, data points down the reddening vector.

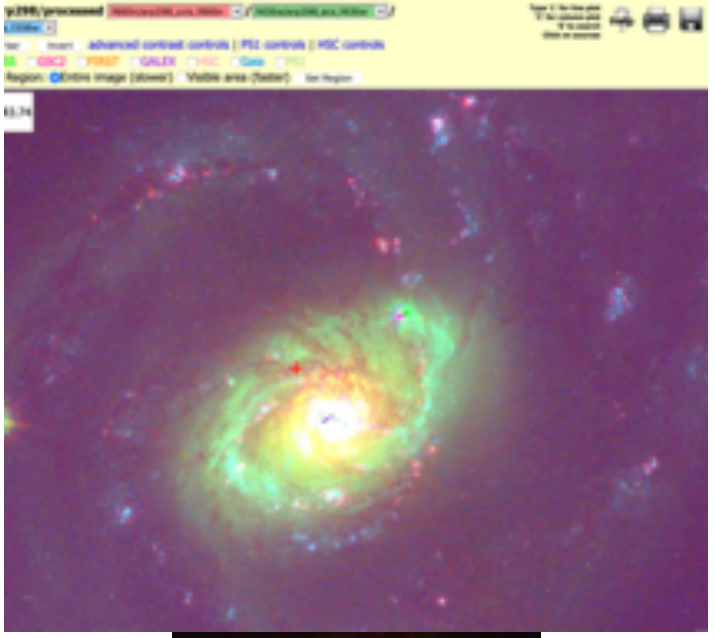
2. The middle region (green points) has less dust, hence ½ way up the reddening vector compared to inner.

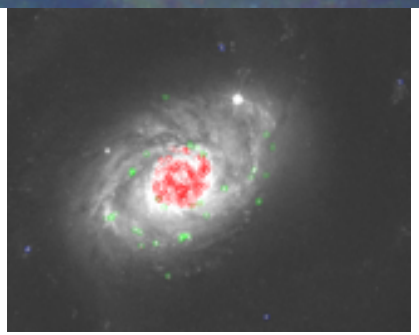
3. Central point like nucleus extremely bright >> saturated even in F275W and F656N !

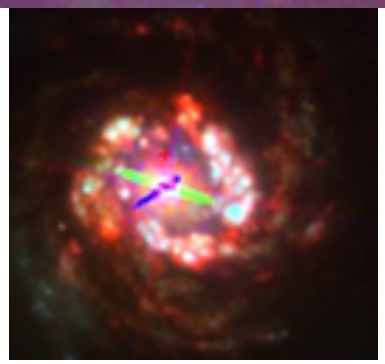
4. Has strong inner star formation ring.

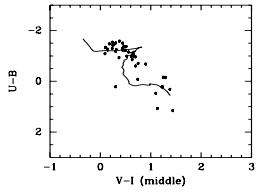
5. Has northern active galaxy which is 1/2 off the edge (next VG)

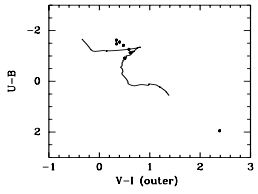


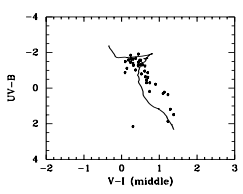


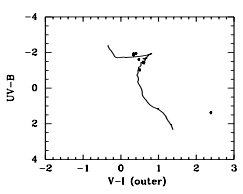


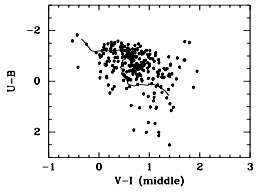


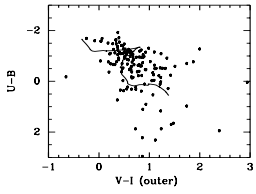


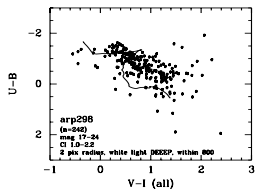


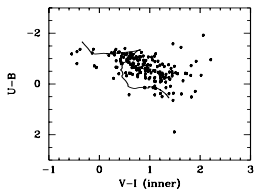


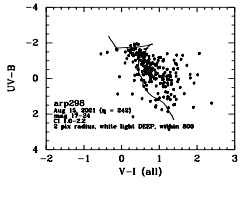


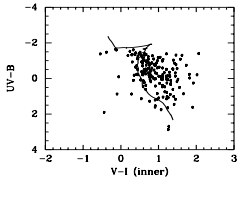


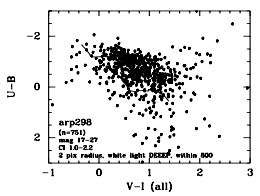


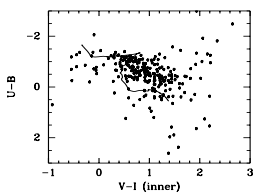








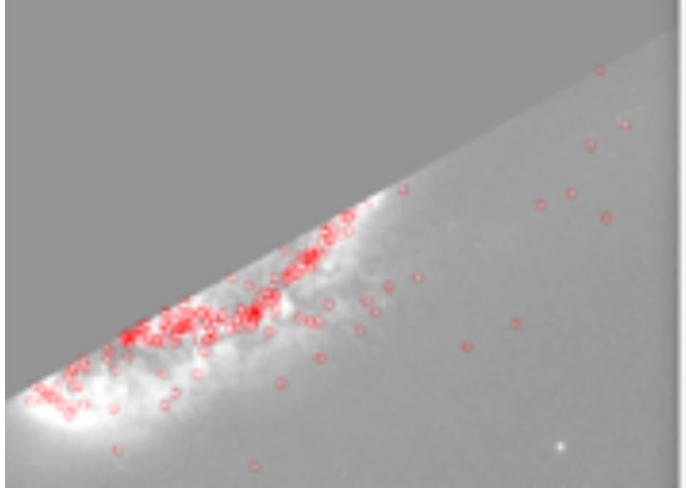


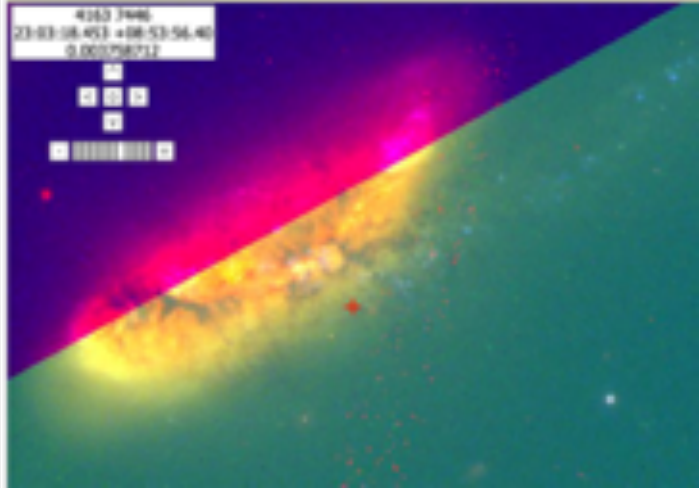


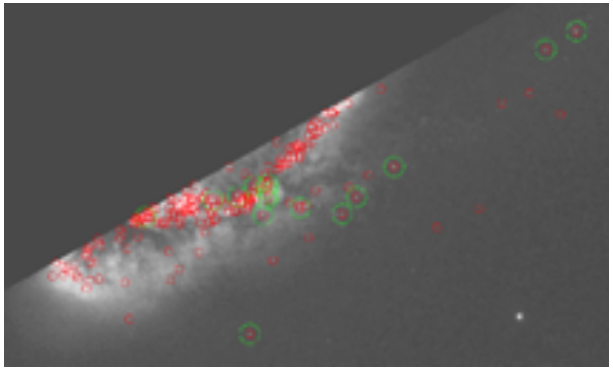
Arp 298 – North

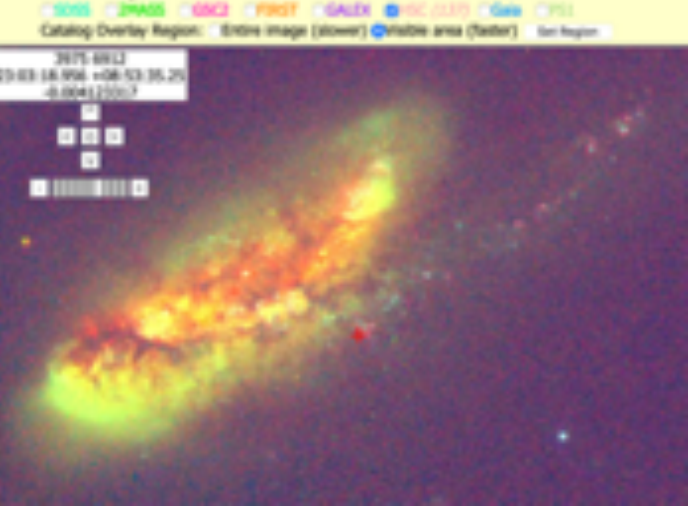
1. Very dusty inner part, so points are down the reddening vector.

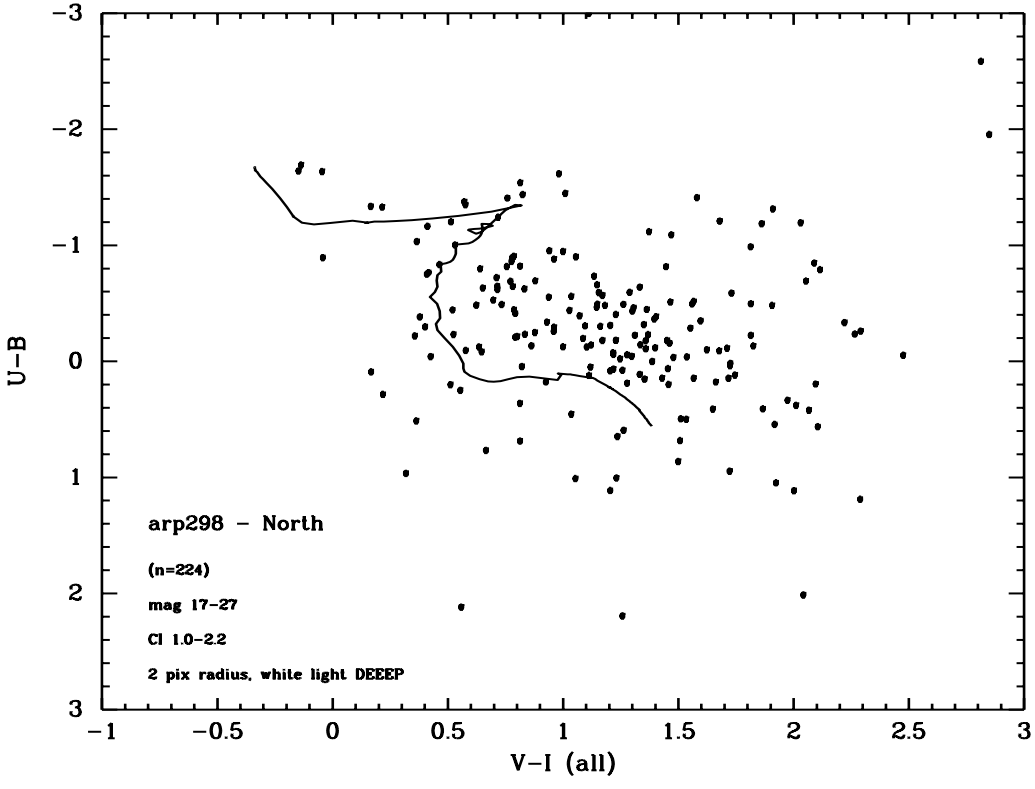
2. Halpha emission both in the outer tail and the inner loop. Most of the Halpha sources are above the 10 My line in CC as expected.











Some questions on my mind (mainly about dust) – Aug 22, 2021

1. It seems obvious that mergers can produce large amounts of dust. However when talking to people (e.g., Karl Gordon) who are dust experts they say the dust is already there and just lit up. That you don't make much dust in mergers (e.g., in SN). Is this true?
2. Note that several of the galaxies have ALL of the points in the inner regions obscured by high AV in the CC, Hence none have been able to blow bubble to clear dust ? Farther out you see similar things, but ~ ½ up the reddening vector. Does this mean that much of the dust is in a roughly spherical halo so affects all the clusters, rather than a flat disk where many clusters should be dust free?
3. The north galaxy in Arp 298 might be good galaxy to help sort out, since has outer points in tail free of dust, and all the inner region with dust. MRK 331 also, with one very dusty galaxy and the other two very blue.

4. When feedback blows a bubble does it move the dust out or destroy it or both. How determine this ?

5. What if anything do we know about global (or local) outflows in these galaxies? Can we look at the cluster star formation history and strength and predict whether they have outflows or not?

6. Can someone do a literature search on these galaxies and make of list of the 5 most important papers for each galaxy? Perhaps we can put these on a file on the box site

7. Do any of the galaxies have ALMA data, so that someone could start looking into this with the outflow questions. Rupali

Progress notes:

1. Have done first pass catalogs for all 13 galaxies.

2. I need to make the mastercat (i.e., measure halpha and IR) for four galaxies, Haro 11, N 2623, N 3256, N 3690. Was kind of waiting for Rupali to play with the IR colors to see if they were making any sense before finishing up.

3. Will ask Leonardo to make a place on website to put this file and others like it (e.g., table of distances).