ASTRO 461 Sp19 MDM OBSERVING PROPOSAL

Due: Friday, May 10, 6:00 PM

TITLE: Comparing star formation in merger galaxies with non-merger galaxies

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ABSTRACT: One of the main ways to understand galaxy evolution is by looking at the well defined Kennicutt-Schmidt law that describes the relationship between star formation rate and gas surface density which is a measure of the total gas mass. This law has been fit to spiral, (ultra)luminous IR, BzK and elliptical galaxies and shows a linear response for all of them. We want to see how galaxy mergers of different types fit into this relation based on their star formation rate and gas surface density. We will look at the Hɑ band to find their star formation rates and collect previously observed data giving us their gas surface density. With these two parameters, we can see how various merger galaxies stand in relation to non-mergers with respect to the Kennicutt-Schmidt law. This will give us insight into how the objects evolve over time and expand our knowledge on cosmology.

1.3-m + B4K CCD	Request	2.4-m + CCDS	Request
Filters	Hɑ, Hɑ+13nm	**Wavelength range**	N/A
Number of hours	3:30	**Number of hours**	N/A
Time range	21:00-23:00, 02:00-04:00	**Time range**	N/A

Notes about observing setup:

Time calculated with exposure times, standard stars and overhead.

We will need the H-alpha+13nm and the H-alpha filters for our observations.

SCIENTIFIC MOTIVATION.

When characterizing galaxies, star formation rate is a key component in understanding the evolution. From this we can derive information of the galaxy and understand how different types of galaxies evolve. This quantity is closely related to the gas surface density which is a measure of the total gas mass in a galaxy. The Kennicutt-Schmidt law gives us a relationship between the two values as

$$log \sum_{SFR}[M_{\odot}yr^{-1}kpc^{-2}] = 1.42 \times log \sum_{gas}[M_{\odot}pc^{-2}] - 3.83$$

(Daddi, E. et al. 2010)

The linear relationship between these quantities accurately describes the behavior of the different galaxy types. There have been surveys of galaxy categories that include spiral galaxies, BzK galaxies, Luminous IR galaxies, and quasi stellar objects. However, there has been no data taken on galaxy mergers. Galaxy mergers are interesting in that we don't have much data on how the dynamics of the interactions between the galaxies affect the behavior we are accustomed to with non-merging galaxies. When the collisions of objects are on this scale, it can be difficult to see how they change over time.

In order to understand more about the evolution and morphology of galaxies, we hope to see how well the galaxy mergers follow this law. We hope to measure the star formation rate through H-alpha imaging and gather gas surface density from cataloged gas mass data for mergers in early, mid, and late stages. We will also look at different types of mergers like Stephan's quintet which host 5 galaxies that are gravitationally interacting with a merger between two of them. We hope to expand the understanding of how galaxy mergers differ from non-merger galaxies and how they fit into our model for galaxy behavior.

TECHNICAL AND SCIENTIFIC FEASIBILITY.

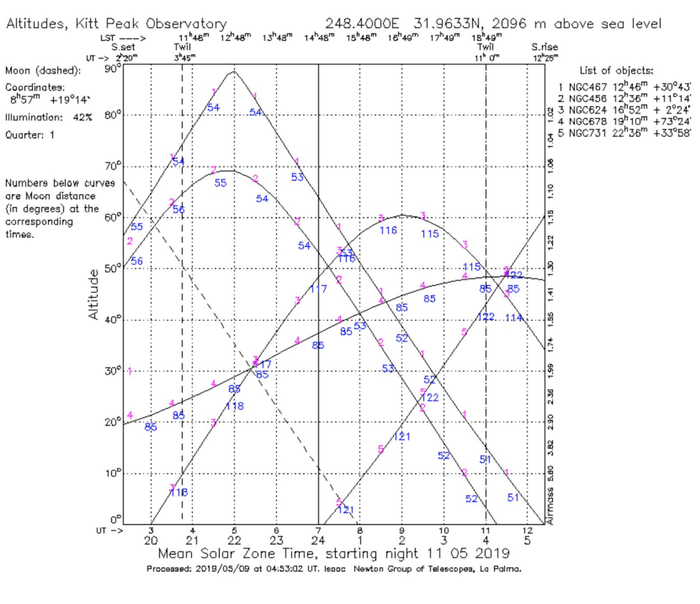
In order to compare star formation rates (SFRs) of our merger galaxies to the that of non-mergers we will plot SFR versus gas surface density (GSD) for both parties. Because we cannot directly measure SFR or GSD we need to introduce measurable quantities that relate to and can be used to calculate SFR and GSD. In the past, this has been done for SFR with a simple conversion from luminosity of Hα emission to SFR.

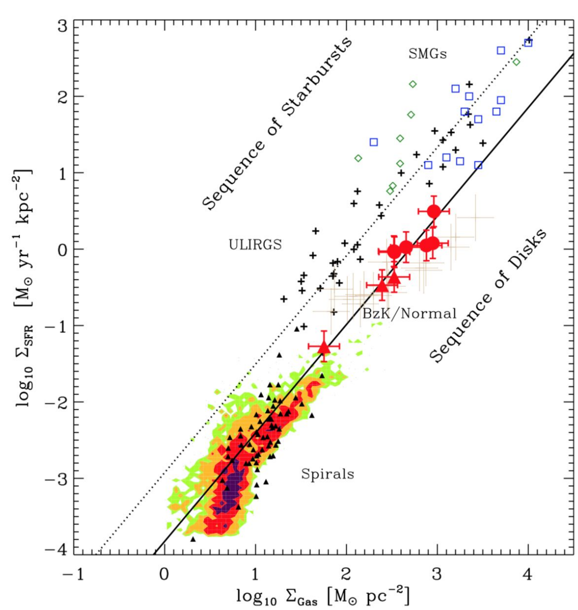
$$SFR(M_{\odot} yr^{-1}) = \frac{L(H\alpha)}{1.26\times10^{41} ergs\ s^{-1}}$$

(Kennicutt, R. et al. 1998)

The analogous solution to calculating GSD with a measurable quantity is observing CO luminosity. The underworkings of this conversion are more complicated, but it is essentially done by inferring the amount of molecular Hydrogen, which makes up almost all of the gas mass, based on typical mass percent compositions in galaxies and the amount of CO we know to be there from its measured luminosity. This gives us a good idea of the total gas mass in the galaxy. From this we can calculate the GSD using the visible surface area of the galaxy.

The 1.3m McGraw Hill telescope is capable of observing the Hα band we need in order to calculate SFR for our target galaxies, but neither of the telescopes here at MDM can observe the relevant CO lines. Thus, we have selected five target merger galaxies for which the necessary CO data exists and we will observe Hα to calculate SFR. With these two components we can connect back to the accepted relation between SFR and GSD to see how these merger galaxies compare to non-merger galaxies. Four of our five galaxies are at a redshift of $z \geq 0.02$, which causes the Hα line to be shifted enough such that it will not lie within the transmission range of the standard Hα filter. To remedy this, we are using the redshift Hα filter at a shift of +13nm which now captures the Hα lines of our more distant galaxies. We also have the problem that some of the flux received in the Hα exposures will not be related to star formation, so we will take exposures in the other Hα filter to do continuum subtraction, verifying the Hα we receive is in emission lines.





TARGET LIST

Object	RA (hh:mm:ss)	Dec (°:’:”)	V Mag	Other Parameters	Gas Mass Data (Molecular gas)
NGC 4676	12 46 10.1	+30 43 55	14.7	data z=0.02205 Filter:Hα+13 In process of merger	$5 * 10^{9} M_{\odot}$
NGC 4567, NGC 4568	12 36 34.3	+11 14 17	10.9	data z=0.00749 Filter:Hα Starting to merge	$1.28 \pm 0.2 * 10^{9} M_{\odot}$
NGC 6240	16 52 58.9	+02 24 03	12.3 (11.8-12.8)	data z=0.02448 Filter:Hα+13 Recently Coalesced	$1.2 * 10^{10} M_{\odot}$
NGC 6786	19 10 53.91	+73 24 36.6	13 (12.8-13.2)	data z= 0.02502 Filter:Hα+13 Large galaxy absorbing smaller galaxy	$5.4 * 10^{9} M_{\odot}$
NGC 7319	22 36 03.55	+33 58 32.59	12.16	data z=0.02251 Filter:Hα+13 In process of merger	$8.6 * 10^{8} M_{\odot}$

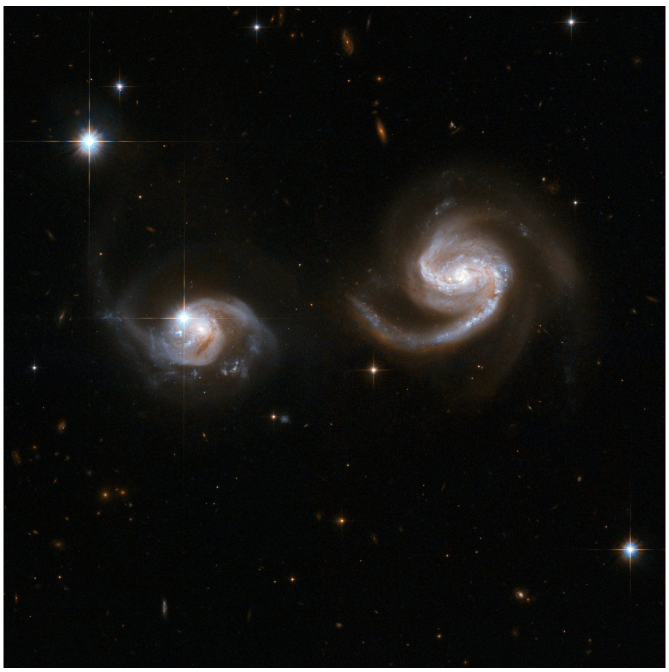
Z= $\frac{\Delta\lambda}{\lambda}$

REFERENCES

Kenney, Jeffrey D. et al. 1988
Kennicutt, Robert C. et al. 1989
Mirabel, I. F. et al. 1990
Yun, M. S. et al. 1997
Kennicutt, Robert C. et al. 1998
Yun, M. S. et al. 1999
Wilson, Christine D. et al. 2008
Daddi, E. et al. 2010

NGC 4676A/B 4.8’x2.8’

NGC 6240 2.1’x1.1’



NGC 6786 2.0’x1.7’

NGC 7319 and others in Stephen’s Quintet 3.4’x4.2’
NGC 7319 is the bottom right galaxy

NGC 4567/8 4.6’x2.1’

FOV of 4k imager 21.3’