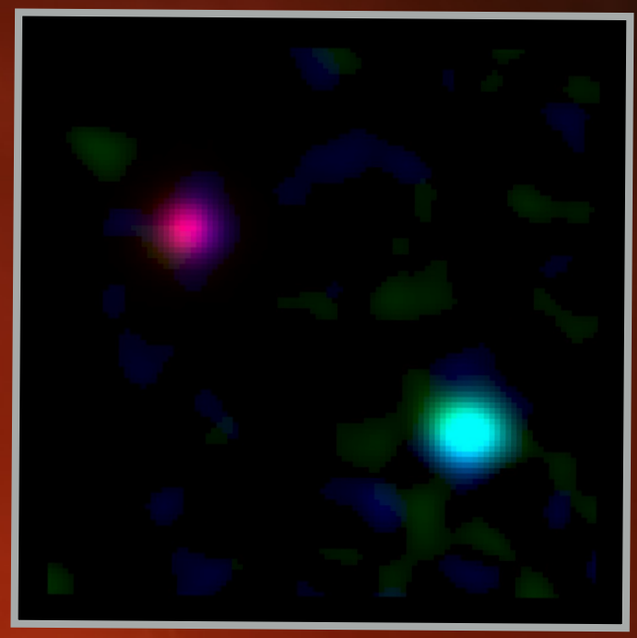
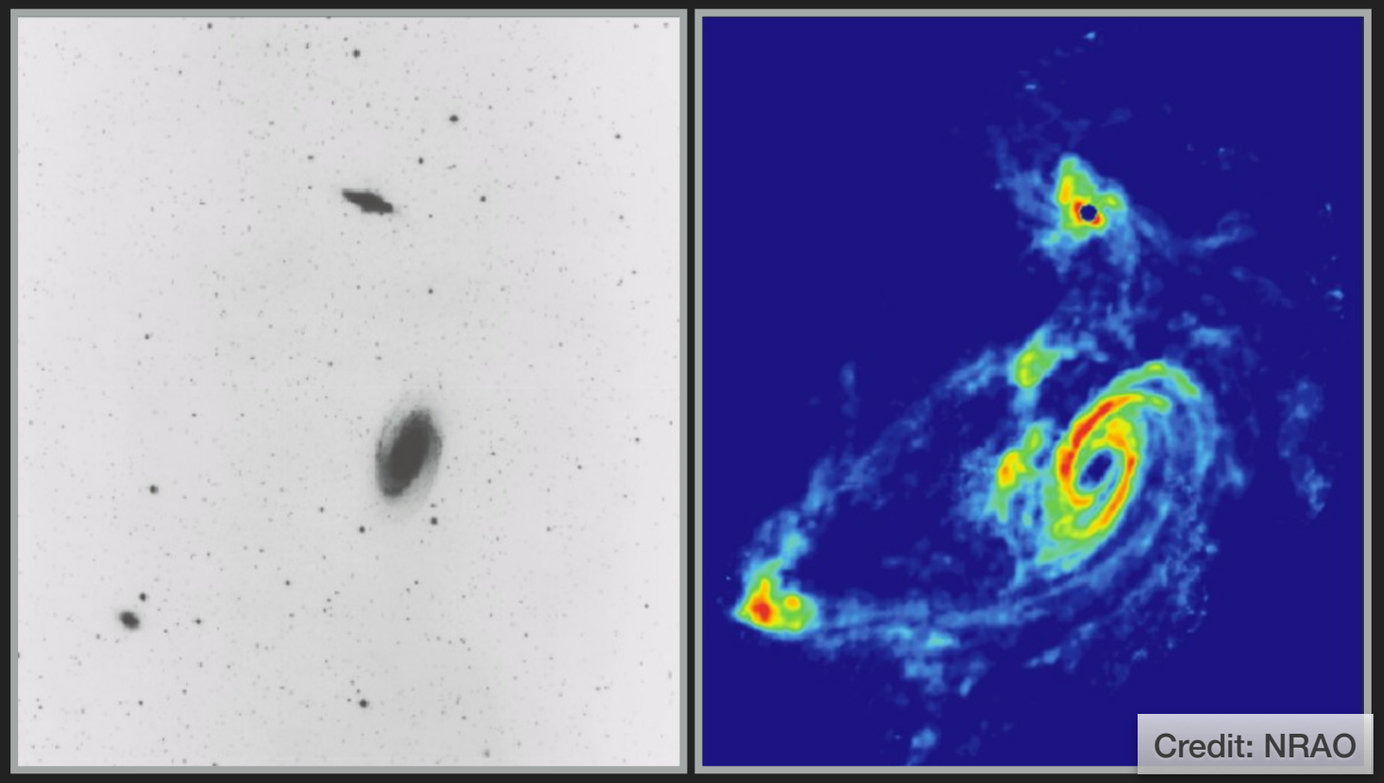
ALMA'S VIEW OF DLAS: USING SUB-MILLIMETER OBSERVATIONS TO DETECT THE HOSTS OF DLAS



MARCEL NEELEMAN (UC SANTA CRUZ)

DETECTING DLA GALAXY HOSTS

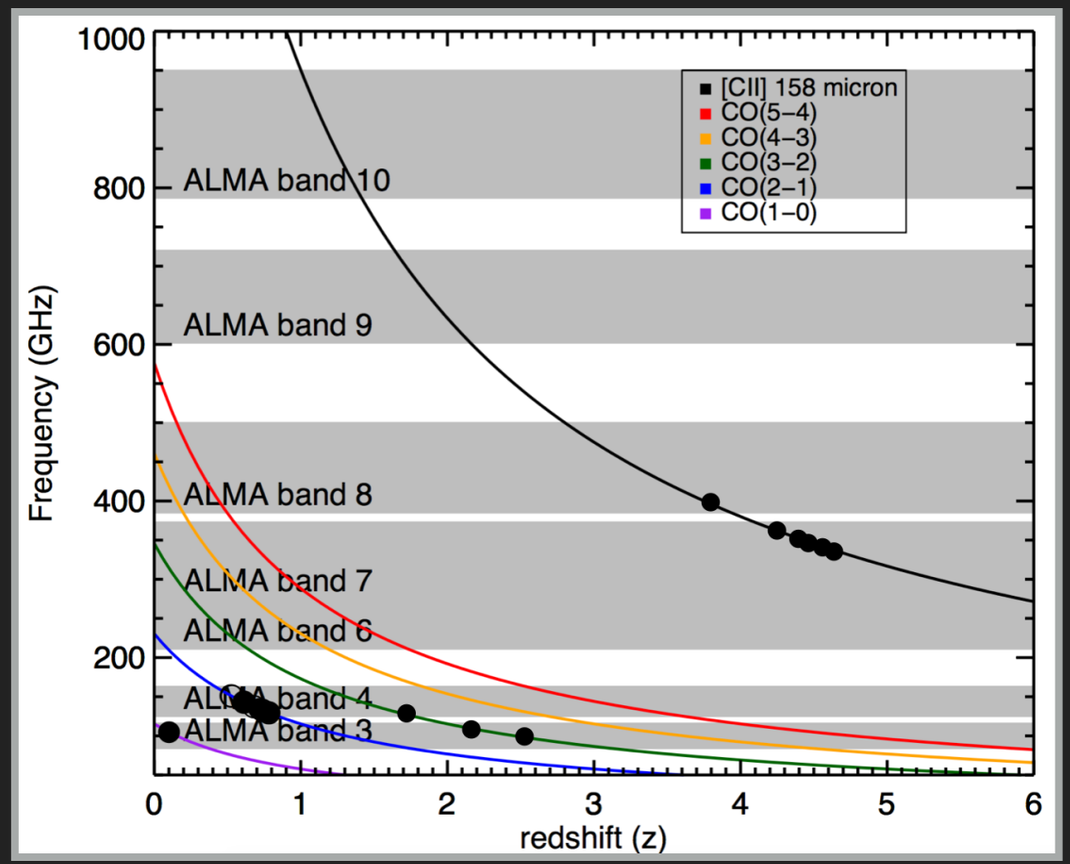


GOAL:

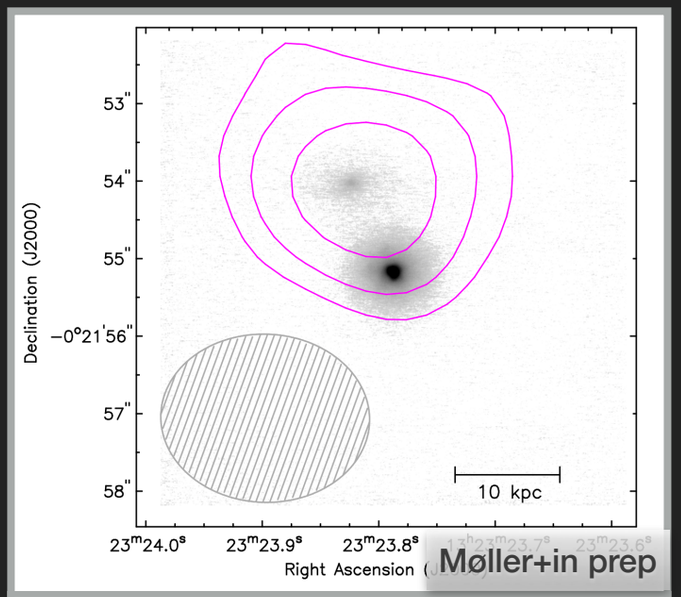
UNDERSTAND HOW THE HI GAS IS DISTRIBUTED OVER TIME, BOTH ON COSMOLOGICAL SCALES AND AROUND INDIVIDUAL GALAXIES.

DETECTING DLA GALAXY HOSTS WITH ALMA

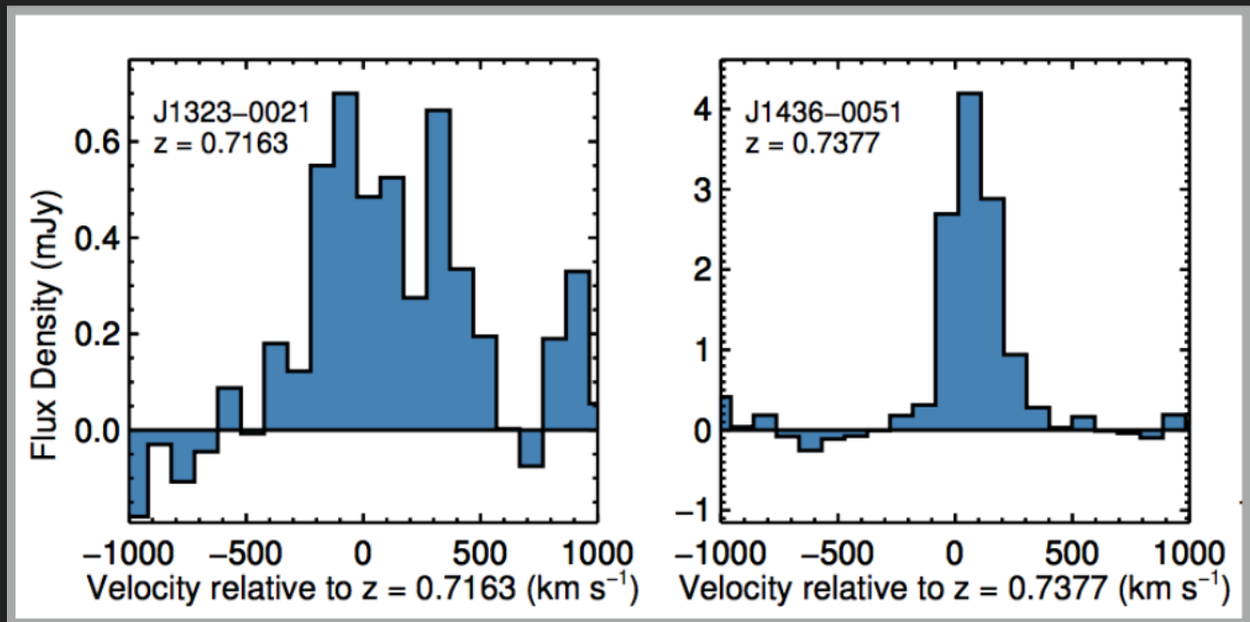
- CO emission at z~1
- CO emission at z~2
- C^+ emission at z~4

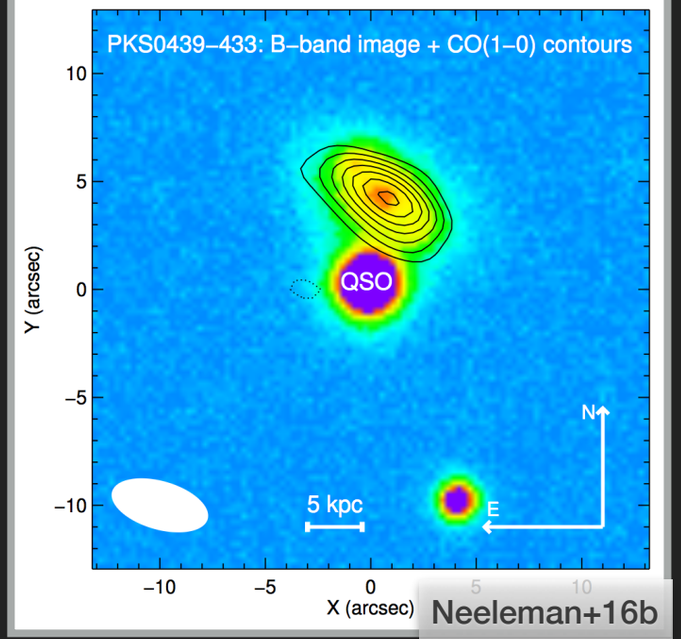


CO OBSERVATIONS AT Z~1

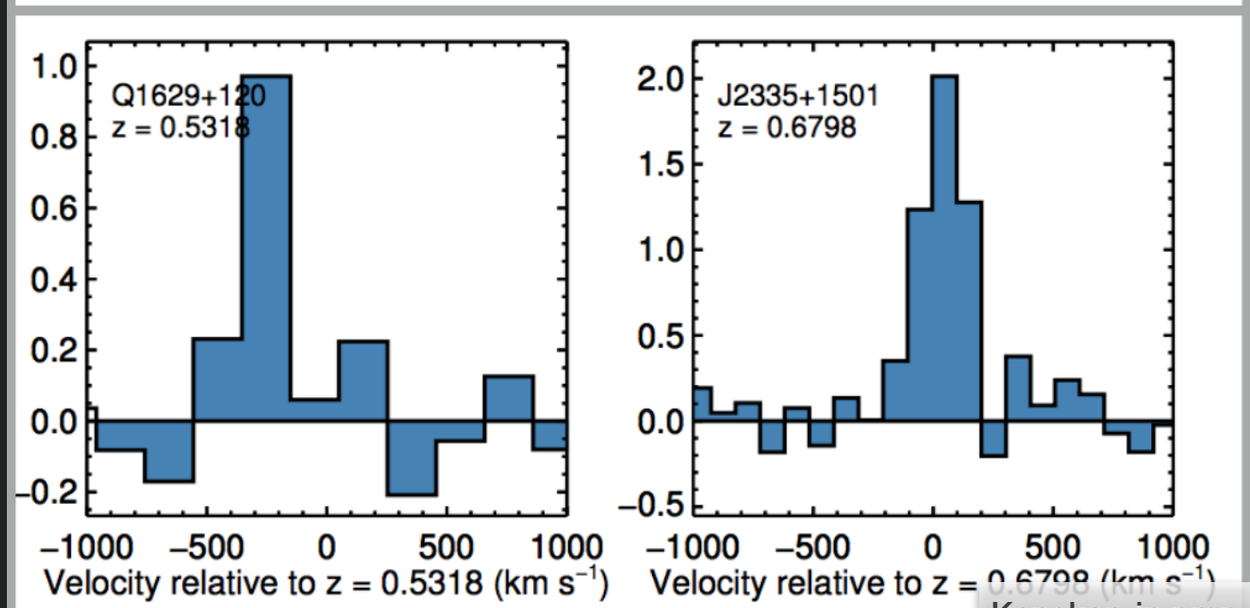


Møller+in prep





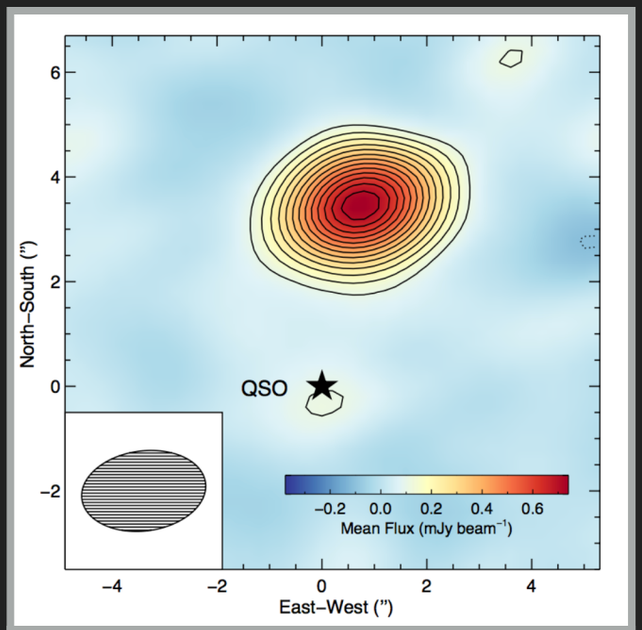
Neeleman+16b

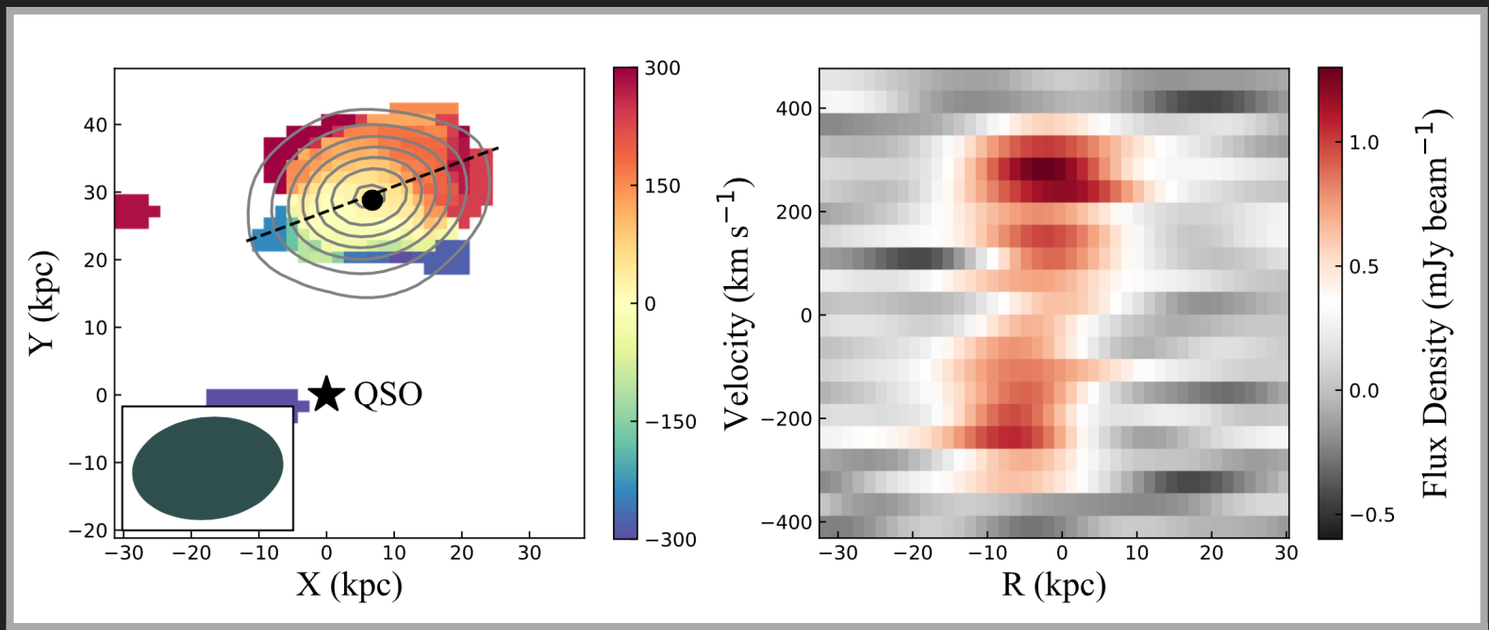


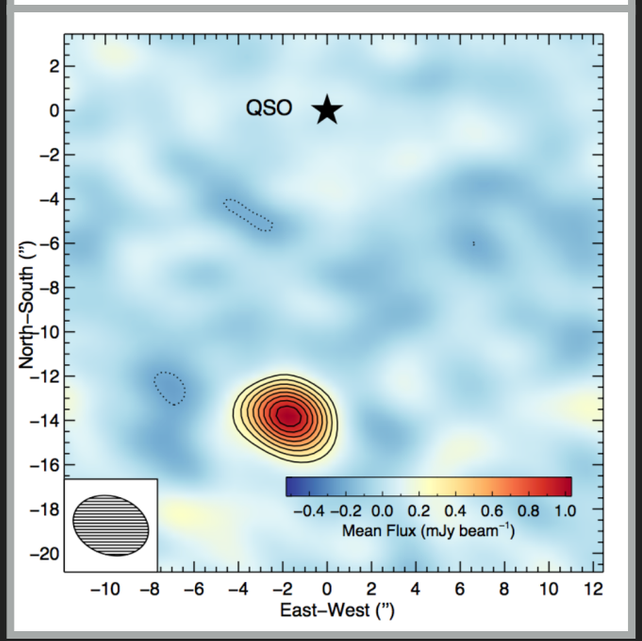
Kanekar+in prep

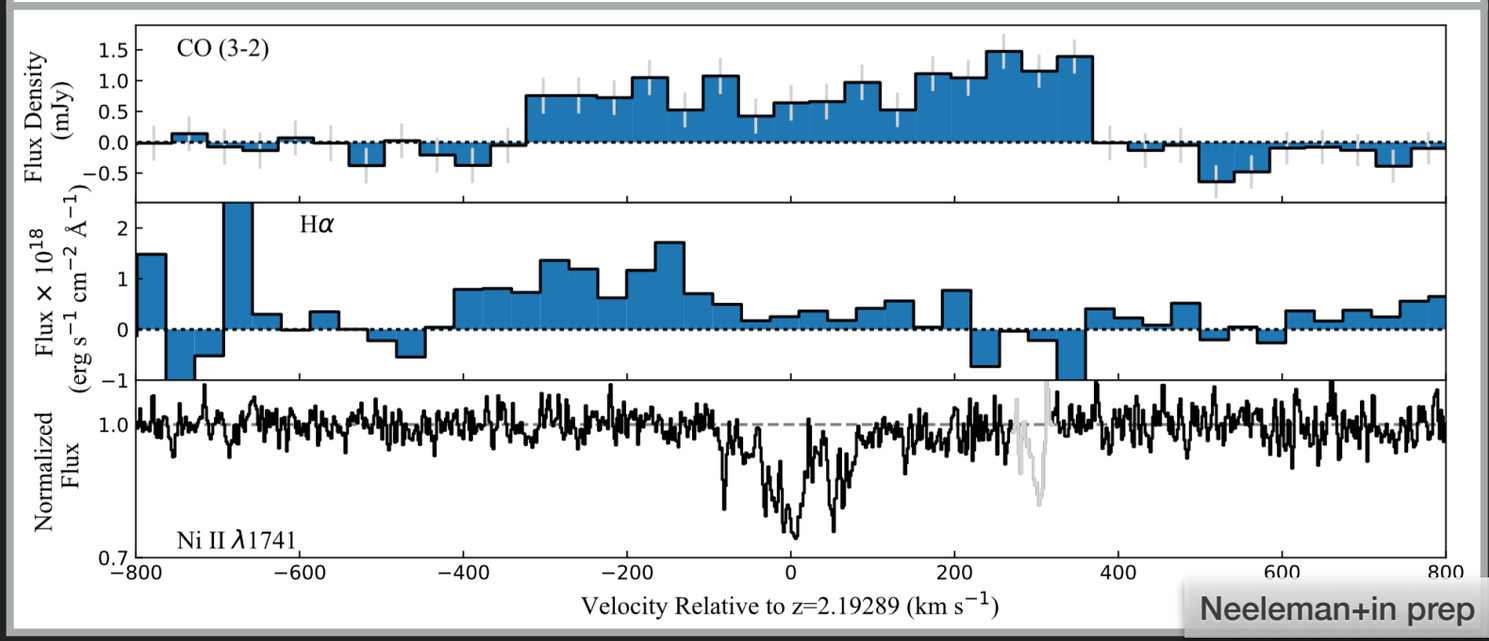
6 OUT OF 8 DLA HOST GALAXIES ARE DETECTED

CO OBSERVATIONS AT Z~2





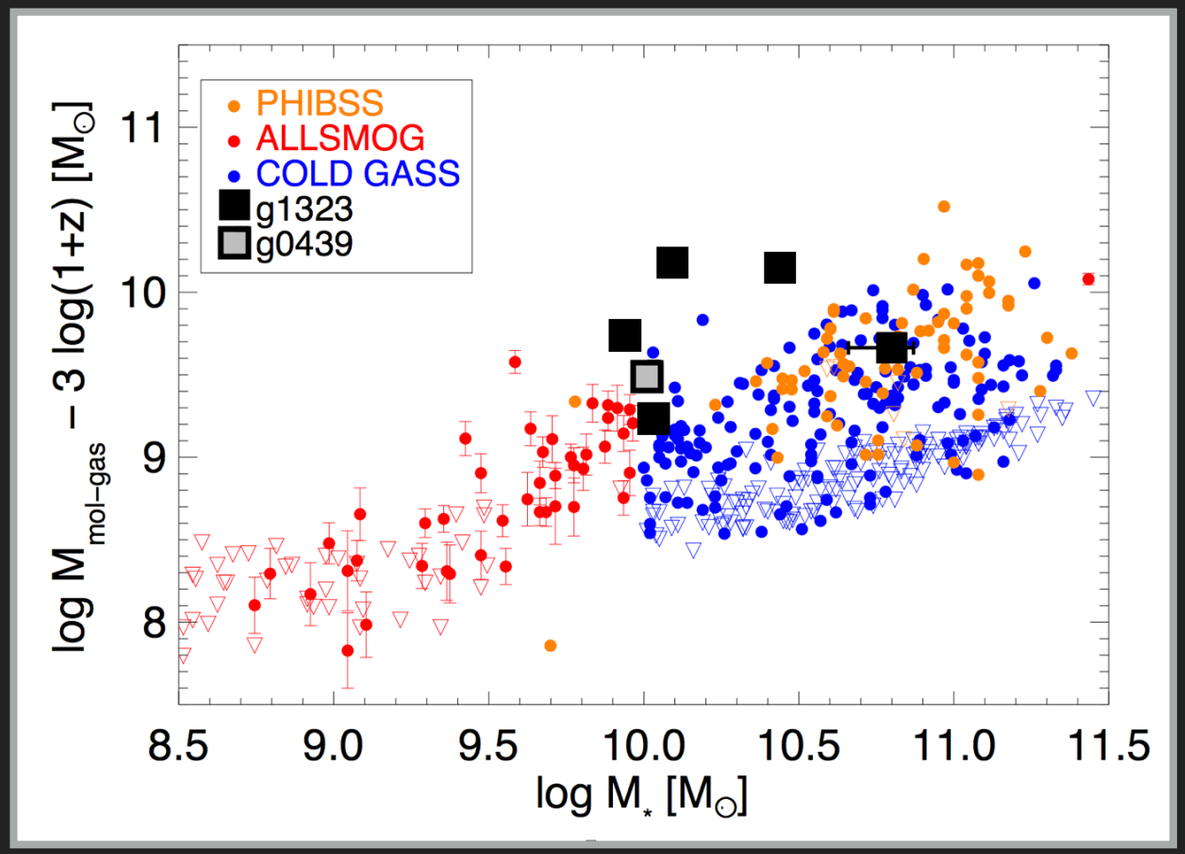


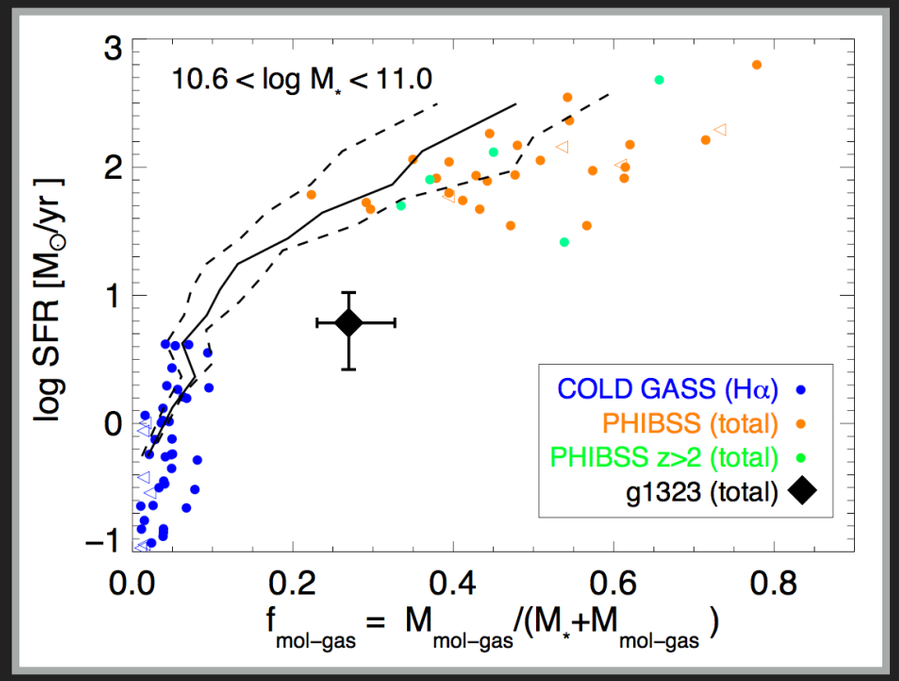


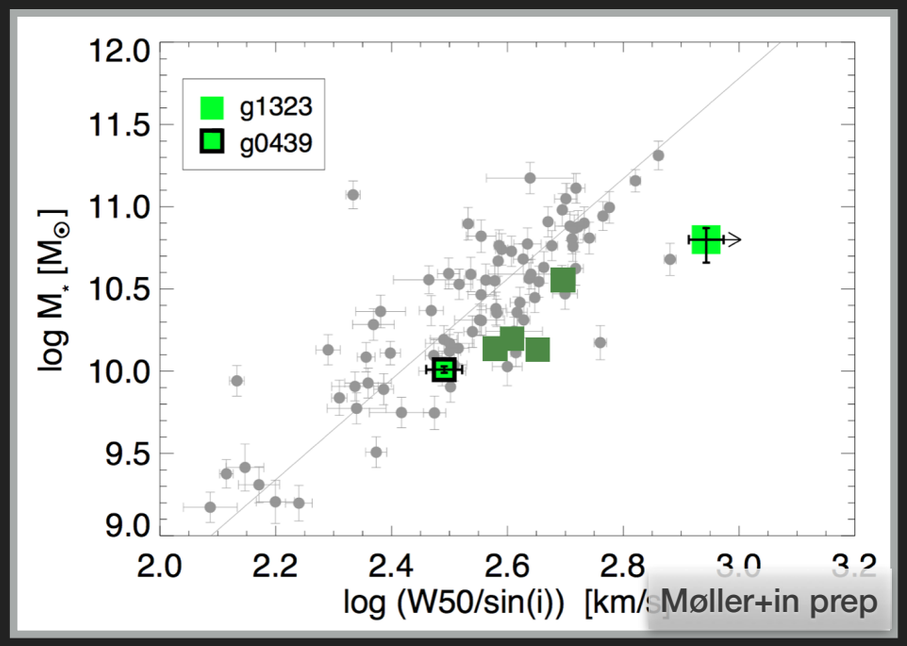
Neeleman+in prep

2 OUT OF 3 DLA 'HOST' GALAXIES ARE DETECTED

CO OBSERVATIONS: RESULTS

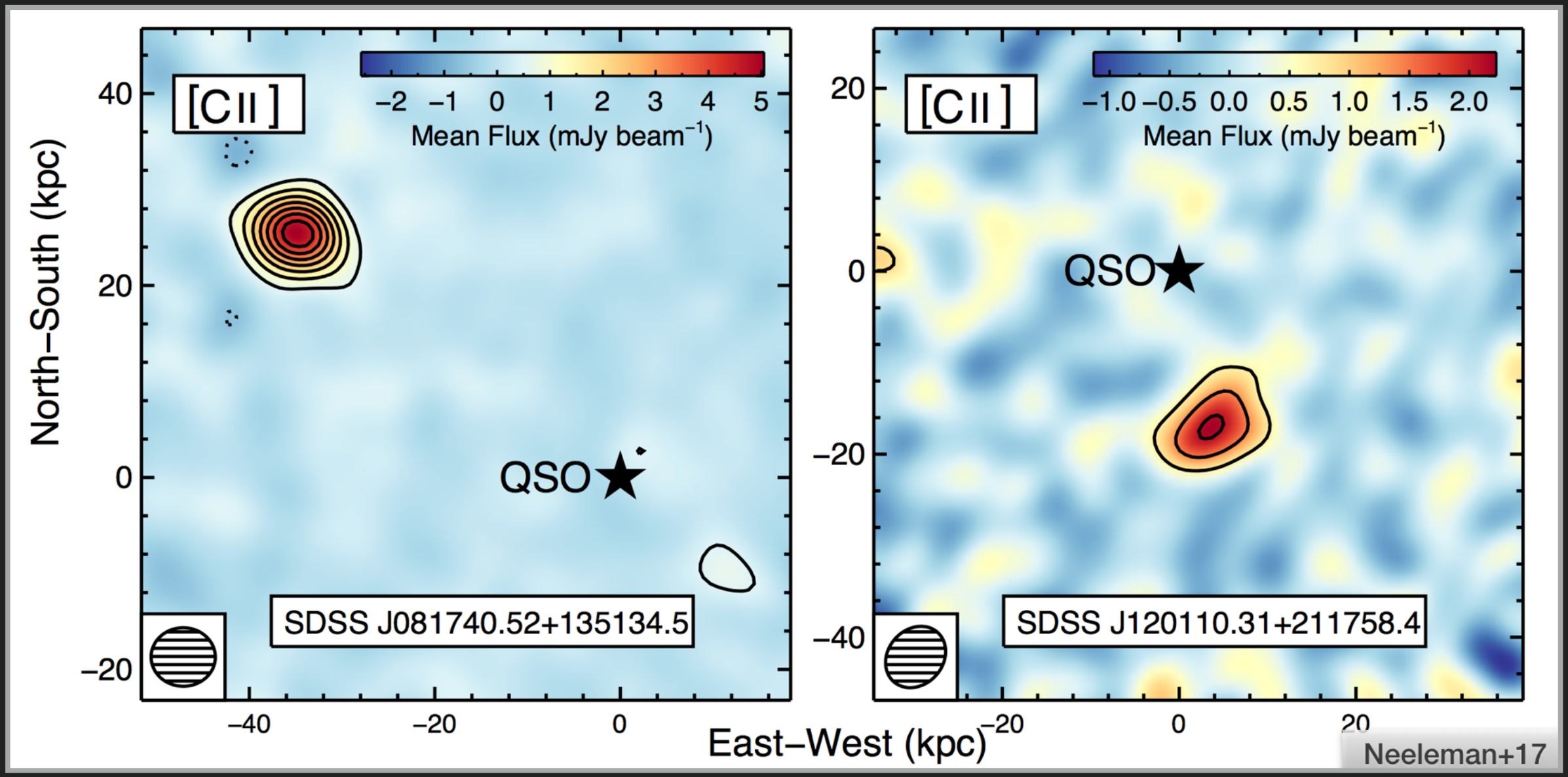






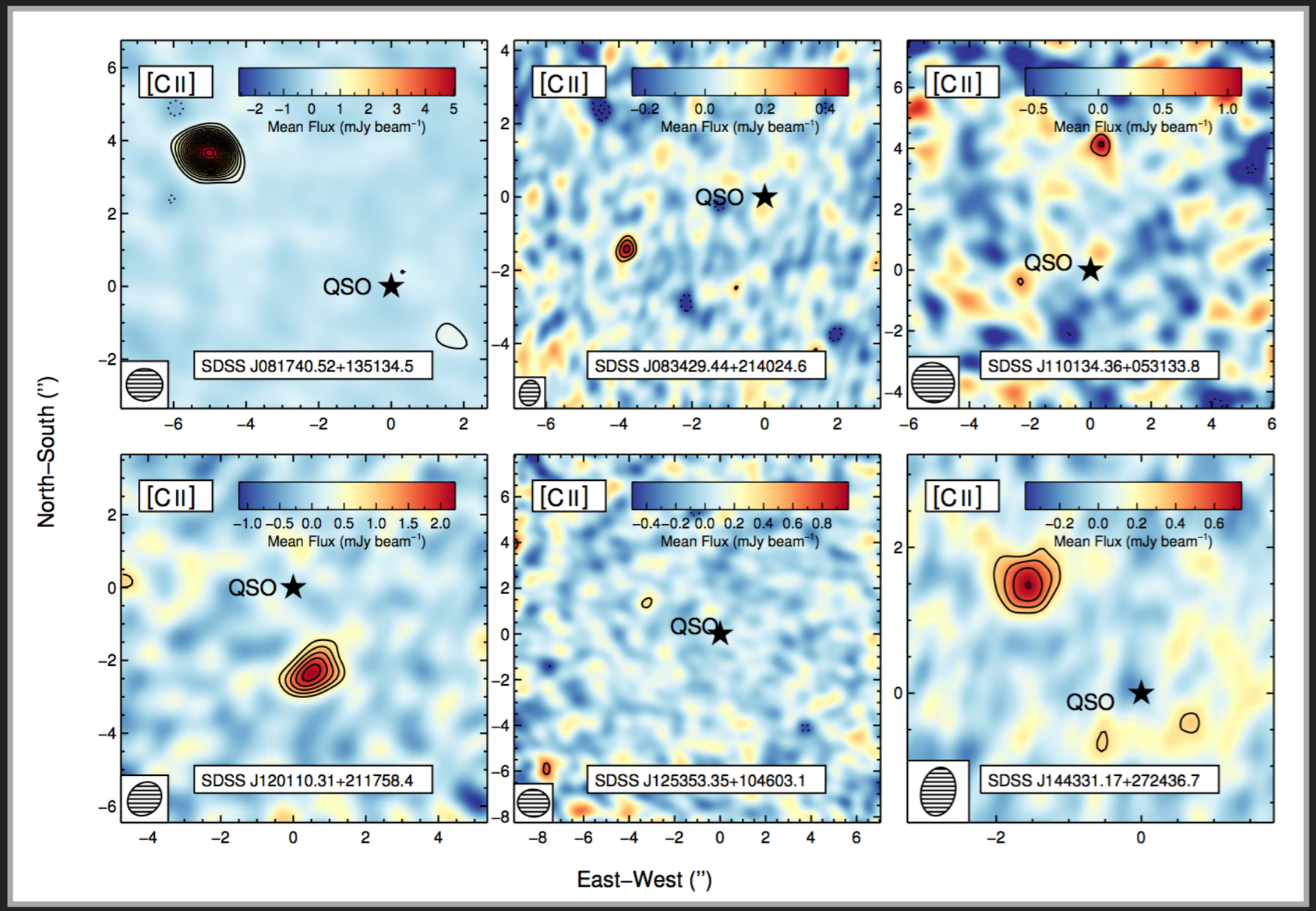
- Molecular masses are higher than other star forming galaxies.
- Star formation rate efficiency is low.
- Line widths are larger than typical.

C+ OBSERVATIONS AT Z~4



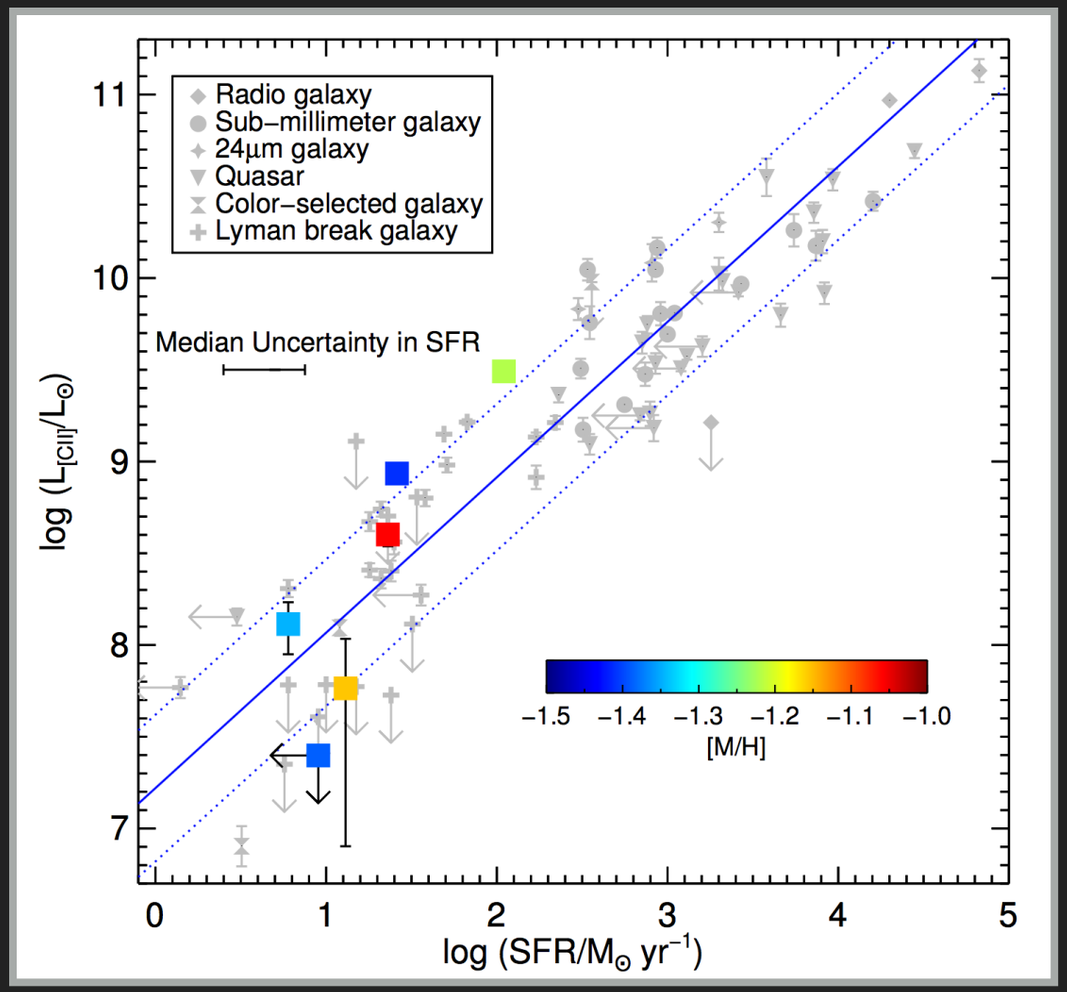
2 OUT OF 2 DLA HOST GALAXIES ARE DETECTED

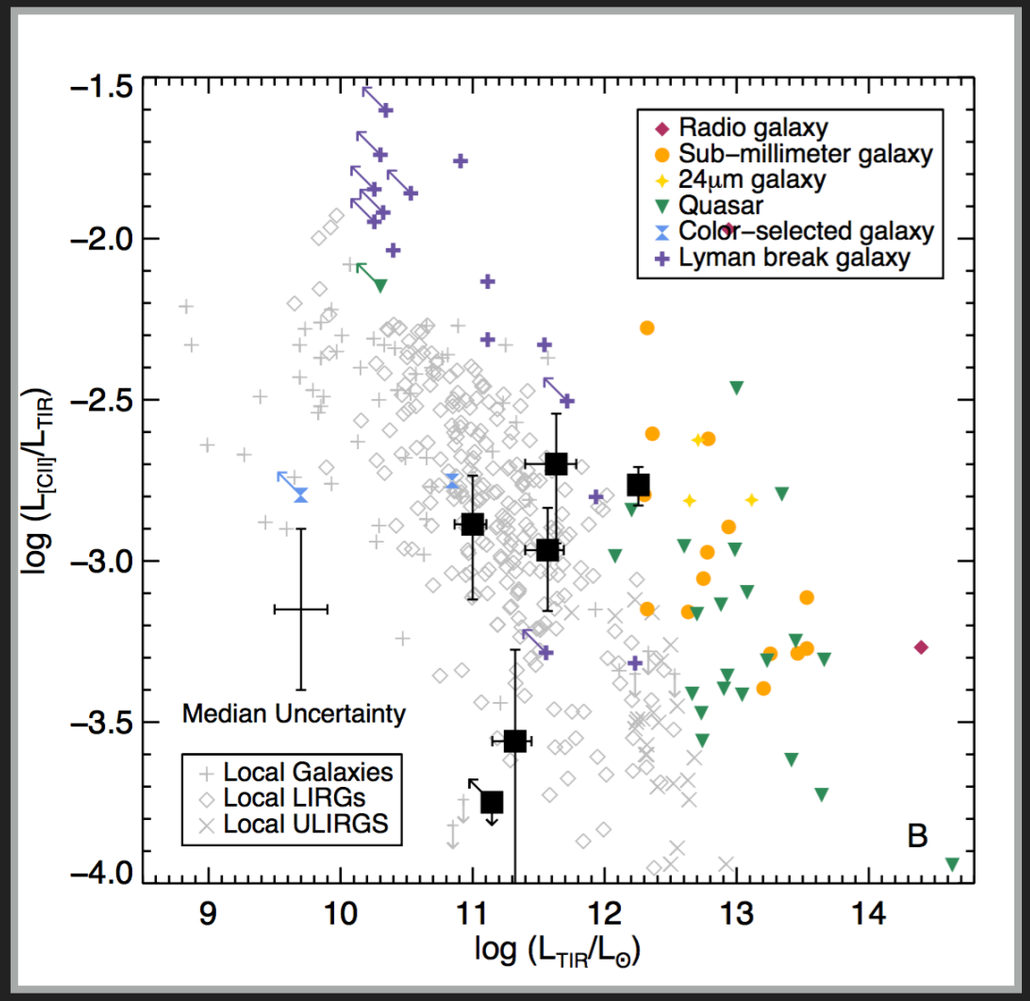
C+ OBSERVATIONS AT Z~4



5 OUT OF 6 DLA HOST GALAXIES ARE DETECTED

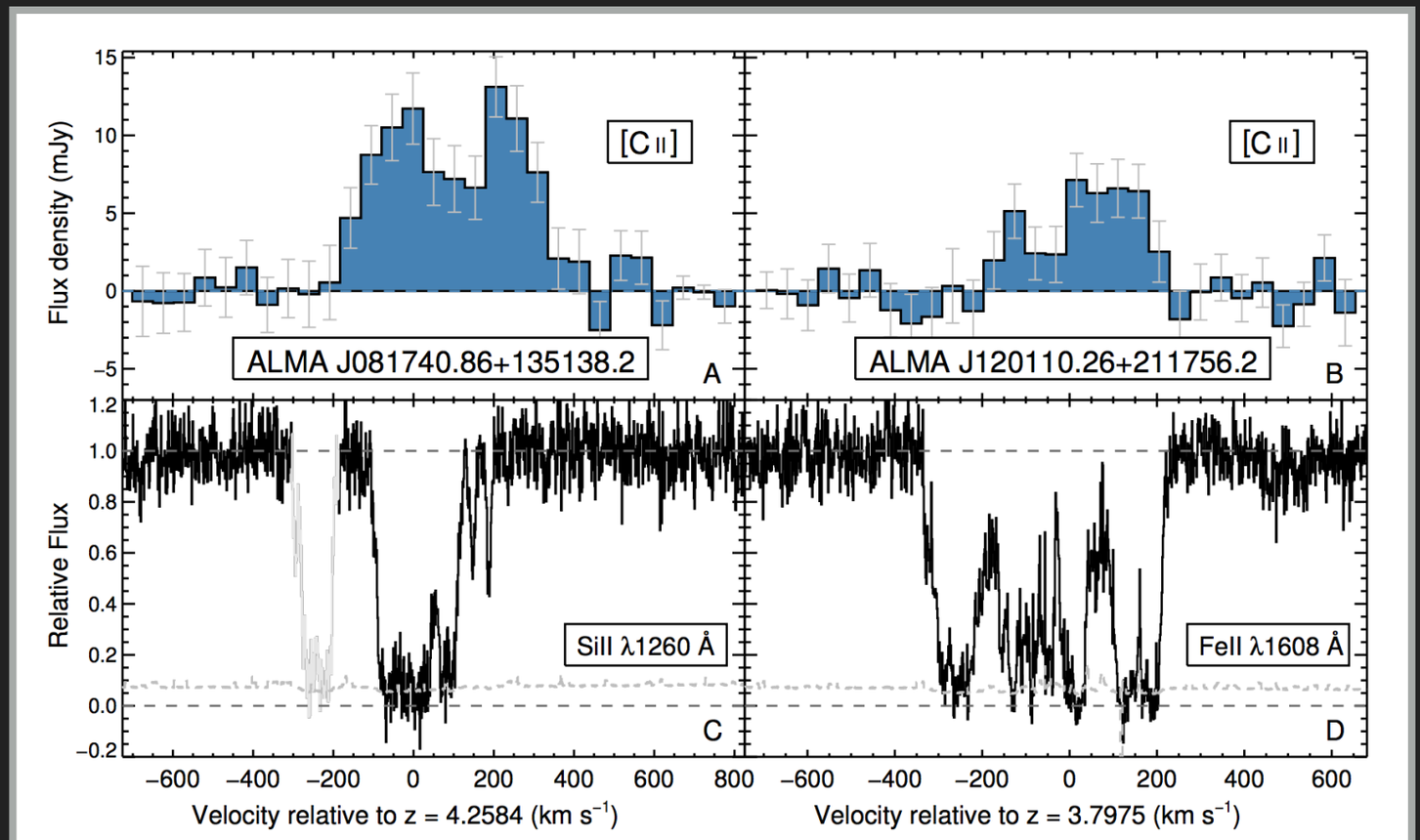
C+ OBSERVATIONS: RESULTS

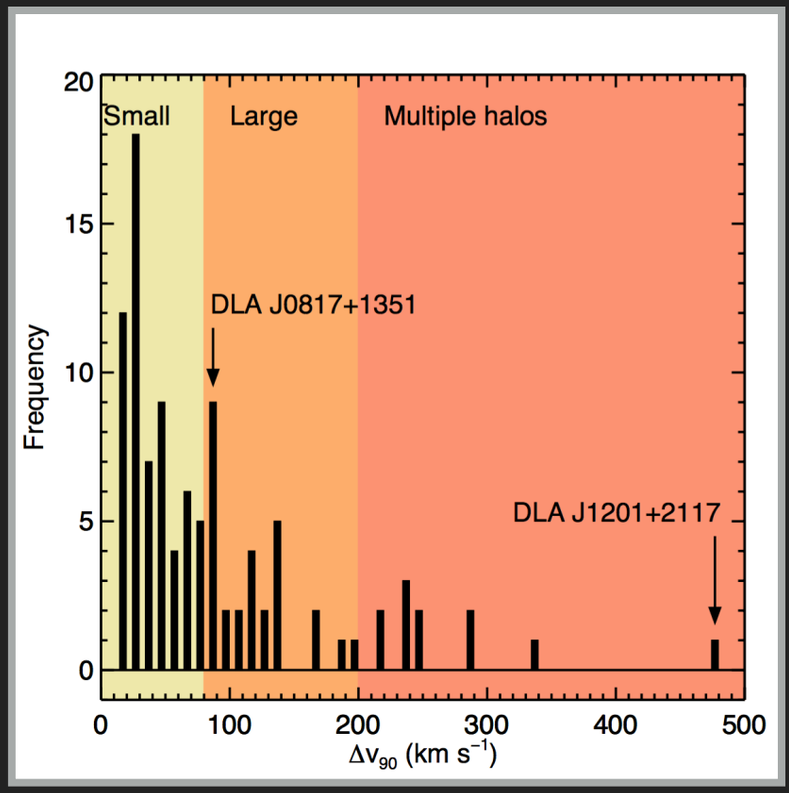


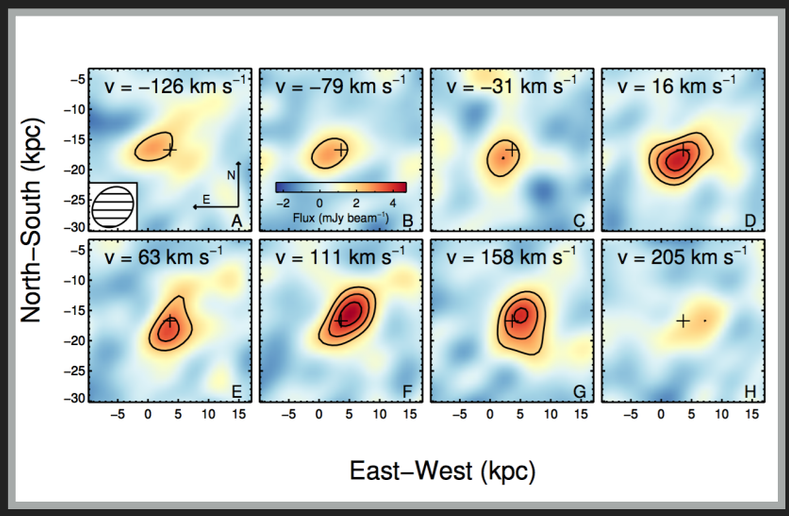


THESE ARE 'TYPICAL' Z~4 'STAR-FORMING GALAXIES

C+ OBSERVATIONS: RESULTS



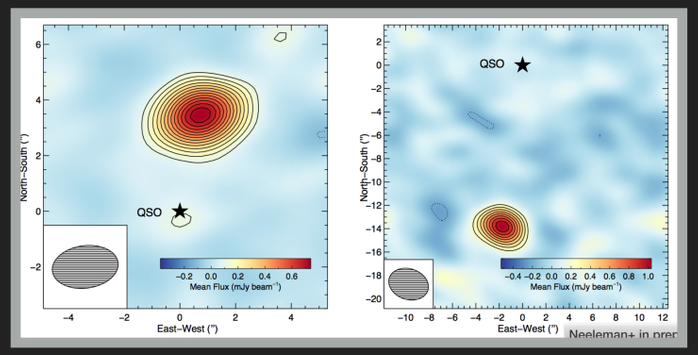


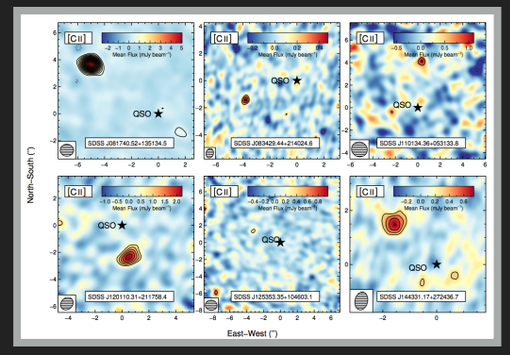


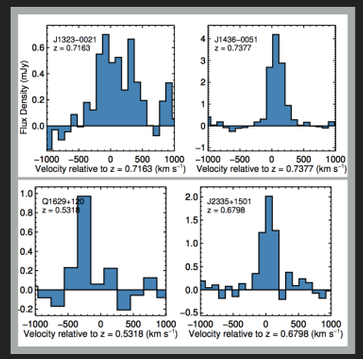
DIFFERENT VELOCITY STRUCTURES POINT TO DIFFERENT ORIGINS: CO-ROTATING HI GAS, MERGER/OUTFLOW.

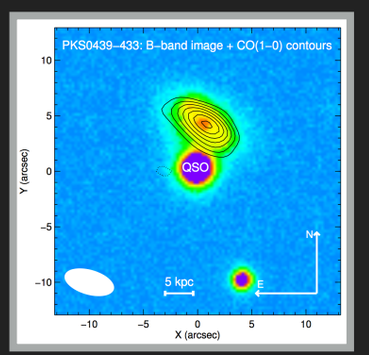
ARE THESE GALAXIES REALLY THE HOSTS OF THE DLA?

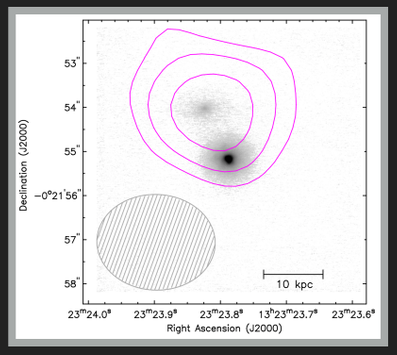
THE DLA COULD BE PROBING A SATELLITE GALAXY AROUND THE MORE MASSIVE GALAXY SEEN IN THE ALMA IMAGES.





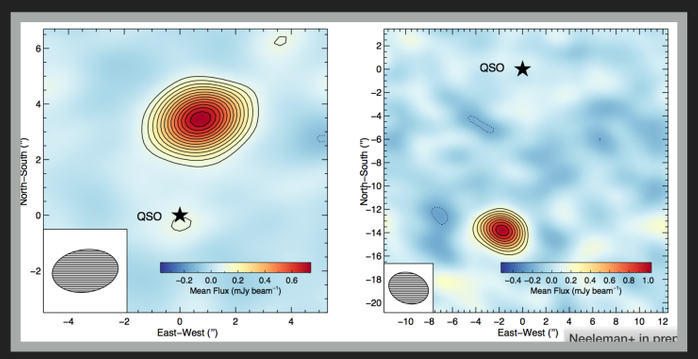


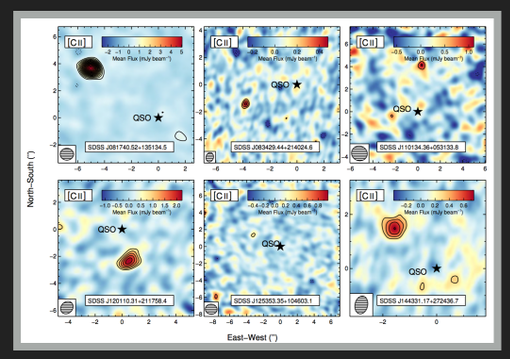


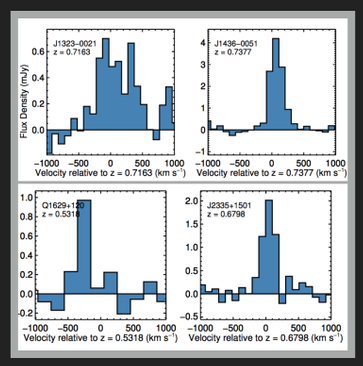


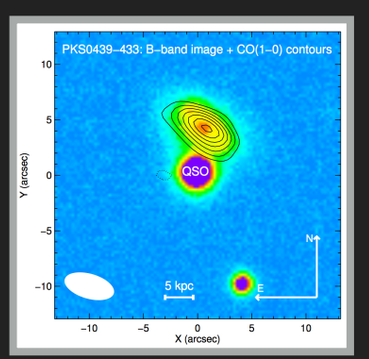
ARE THESE GALAXIES REALLY THE HOSTS OF THE DLA?

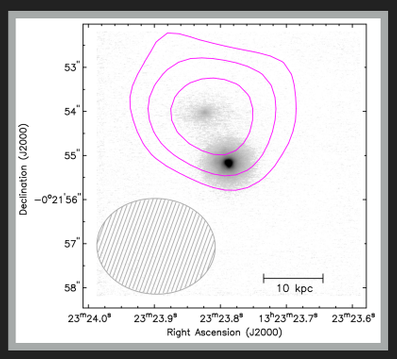
	central galaxy	non-'enriched' satellite	enriched satellite
large impact parameter			
large abs. velocity width			
high metallicity			
nearby 'massive' galaxy			





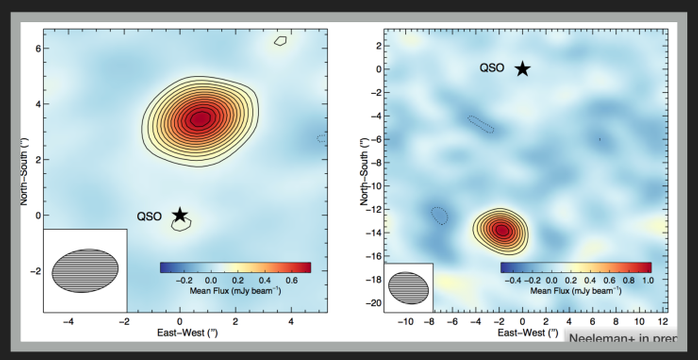


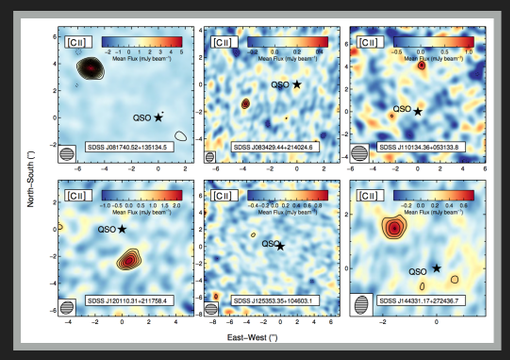


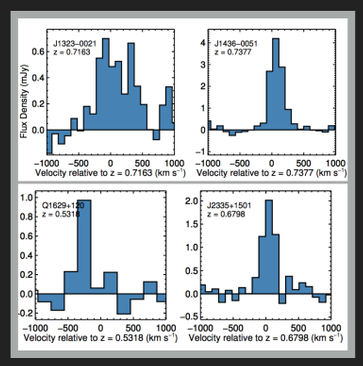


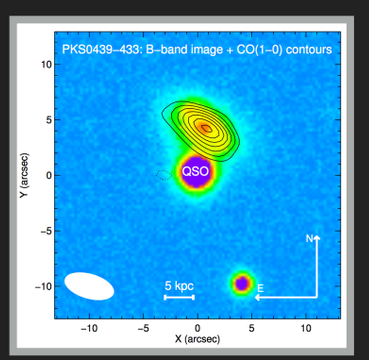
ARE THESE GALAXIES REALLY THE HOSTS OF THE DLA?

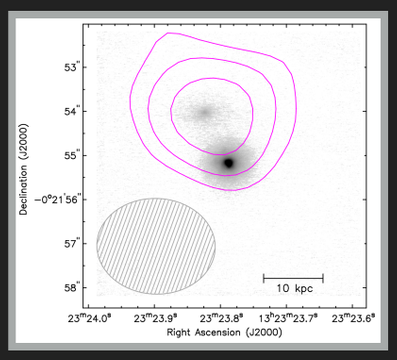
	central galaxy	non-'enriched' satellite	enriched satellite
large impact parameter	?		
large abs. velocity width	✓		
high metallicity	✓		
nearby 'massive' galaxy	✓		





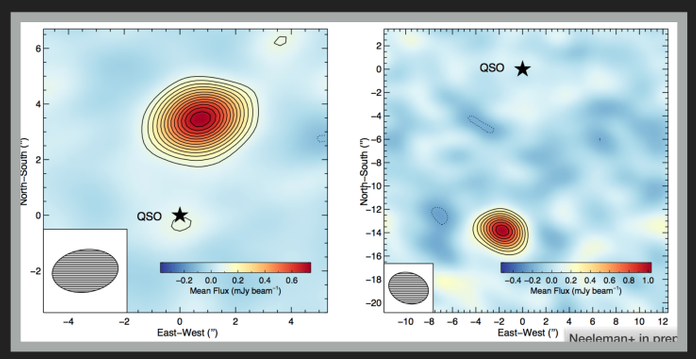


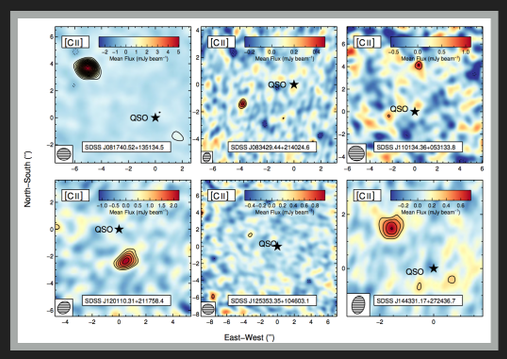


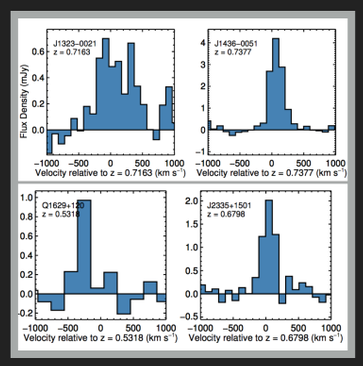


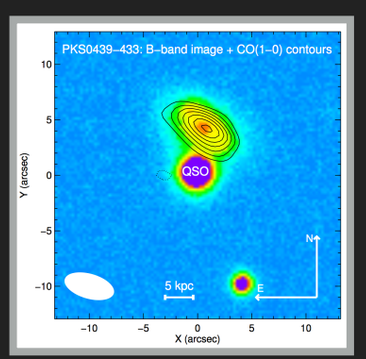
ARE THESE GALAXIES REALLY THE HOSTS OF THE DLA?

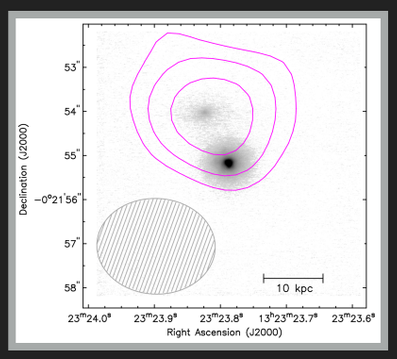
	central galaxy	non-'enriched' satellite	enriched satellite
large impact parameter	?	✓	
large abs. velocity width	✓	✗ ?	
high metallicity	✓	✗	
nearby 'massive' galaxy	✓	✗	





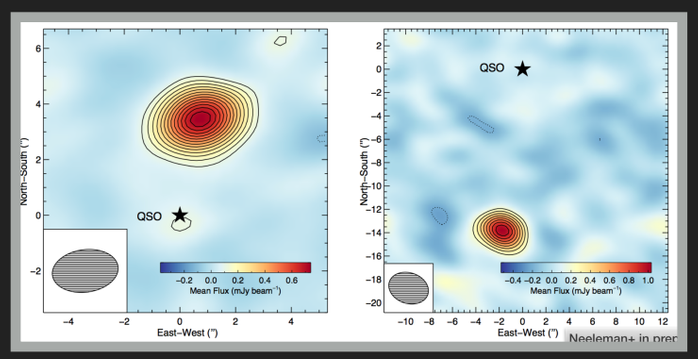


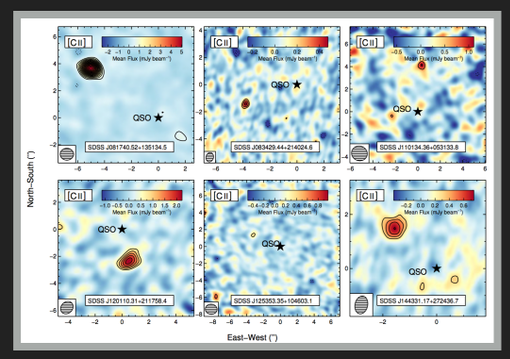


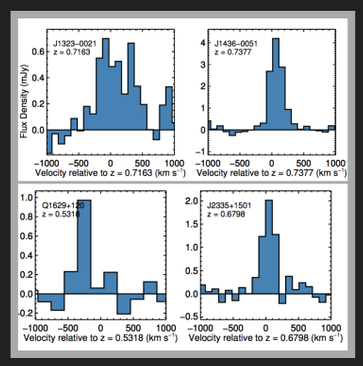


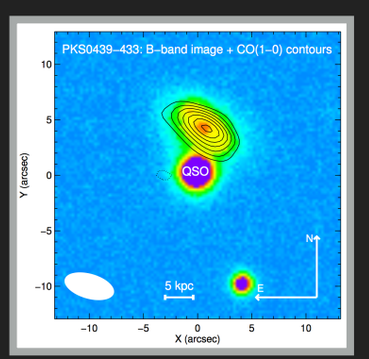
ARE THESE GALAXIES REALLY THE HOSTS OF THE DLA?

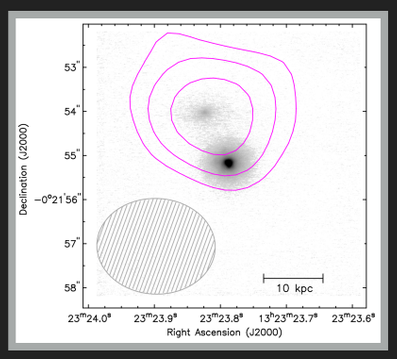
	central galaxy	non-'enriched' satellite	enriched satellite
large impact parameter	?	✓	✓
large abs. velocity width	✓	✗ ?	?
high metallicity	✓	✗	✓
nearby 'massive' galaxy	✓	✗	✓







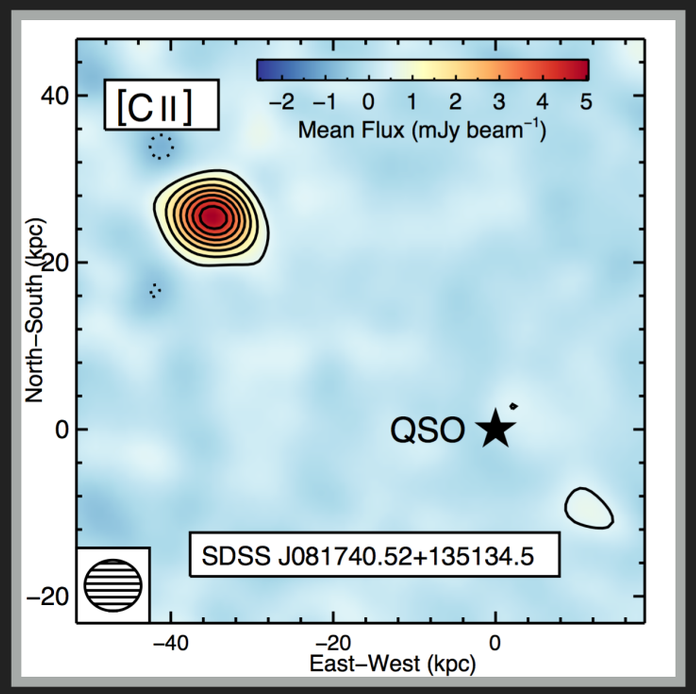


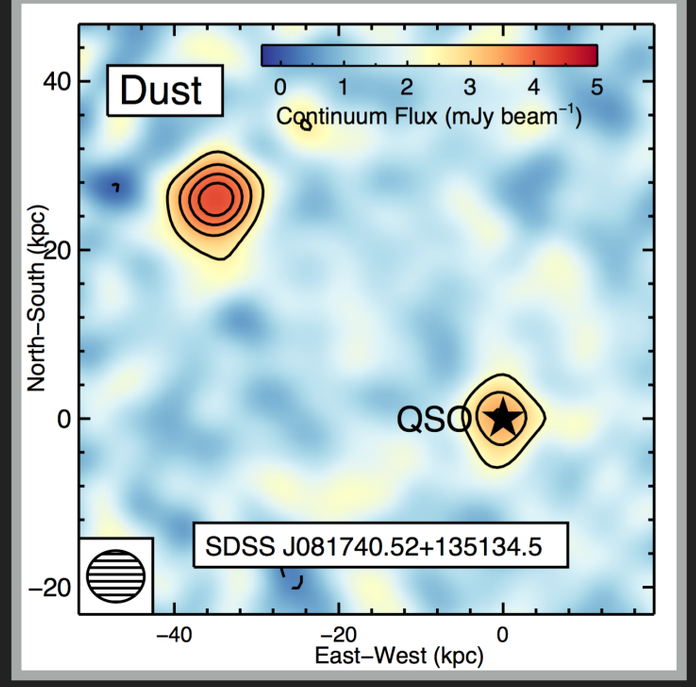


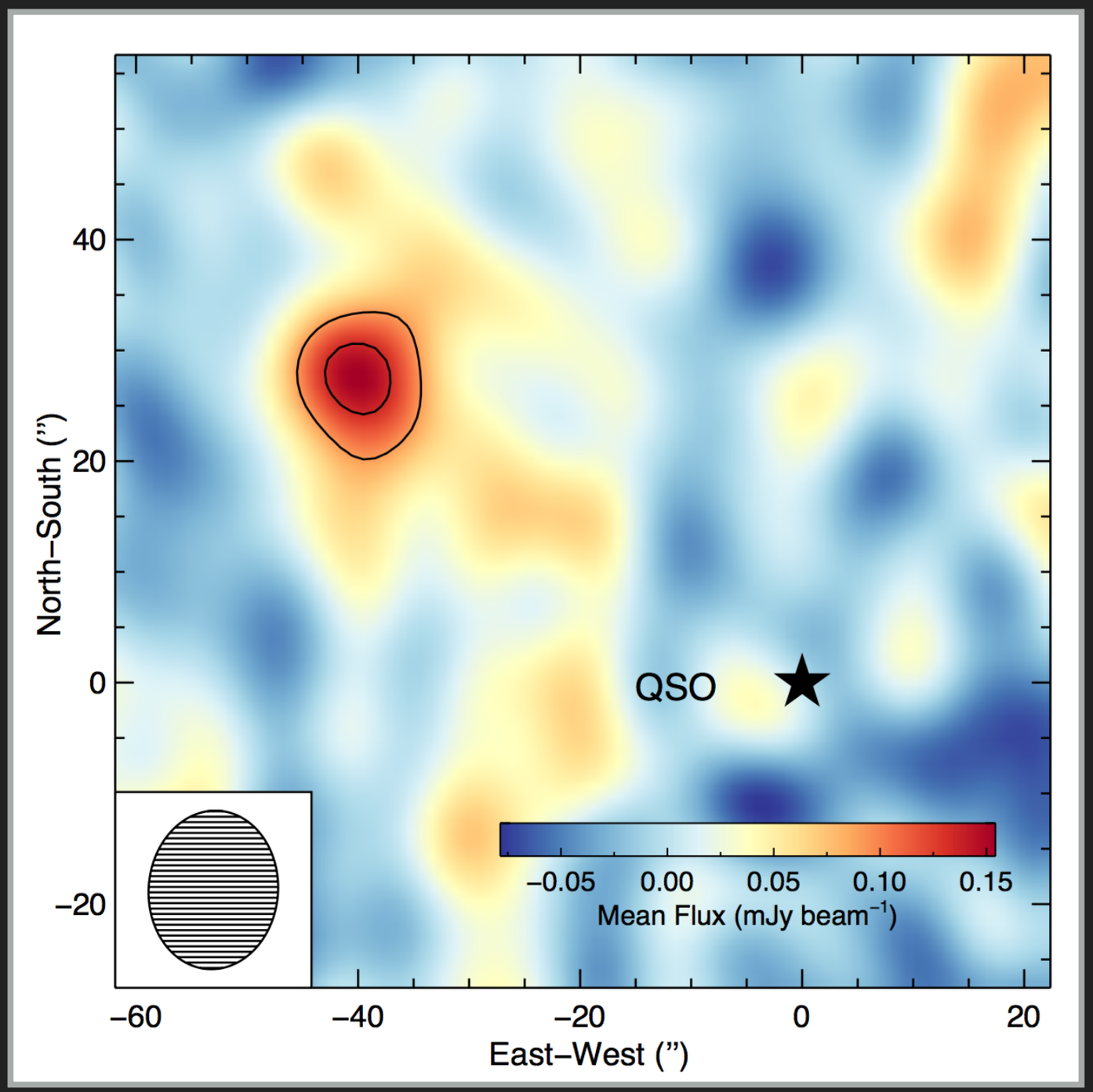
SUMMARY:

- Sub-mm observations are proving to be an effective way to observe the galaxies associated with DLAs.
- These studies suggests that the most metal-rich high-z DLAs are associated with galaxies that are similar to typical LBGs, with a-typically large molecular masses.
- The large impact parameter tied with the large metallicity suggests we are looking at HI gas not in the ISM of the galaxy but further out, either in inflows/outflows or satellite galaxies, but which has been significantly enriched by the galaxy we see in the sub-mm.

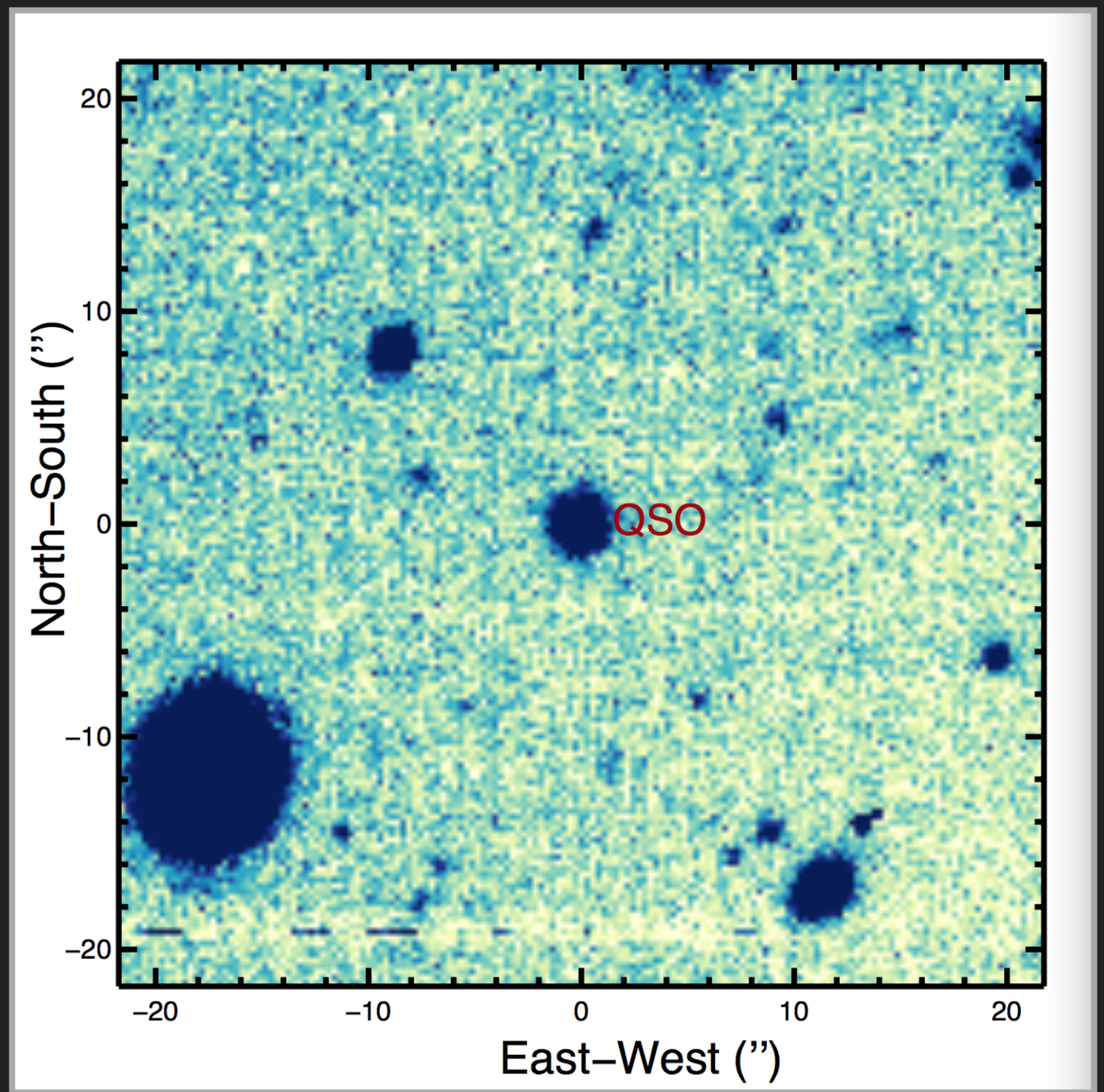
DETECTING DLA GALAXY HOSTS WITH THE VLA







DUST IN DLAS AND GALAXIES



DUST IN DLAS AND GALAXIES