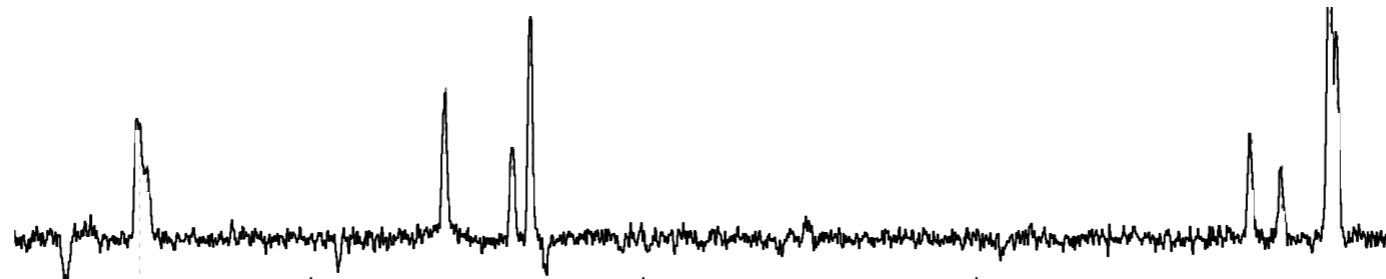


Danielle A. Berg

**EXTREME UV
EMISSION-LINE
GALAXIES:** Clues from
Reionization-Era
Analog

07.31.19



THE OHIO STATE UNIVERSITY



DAWN ERB
UWM



MAX PETTINI
CAMBRIDGE



GABE BRAMMER
STSci



RICK POGGE
OSU



KRISTEN MCQUINN
RUTGERS



JOHN CHISHOLM
UCSC



DICK HENRY
UOK



EVAN SKILLMAN
UMN

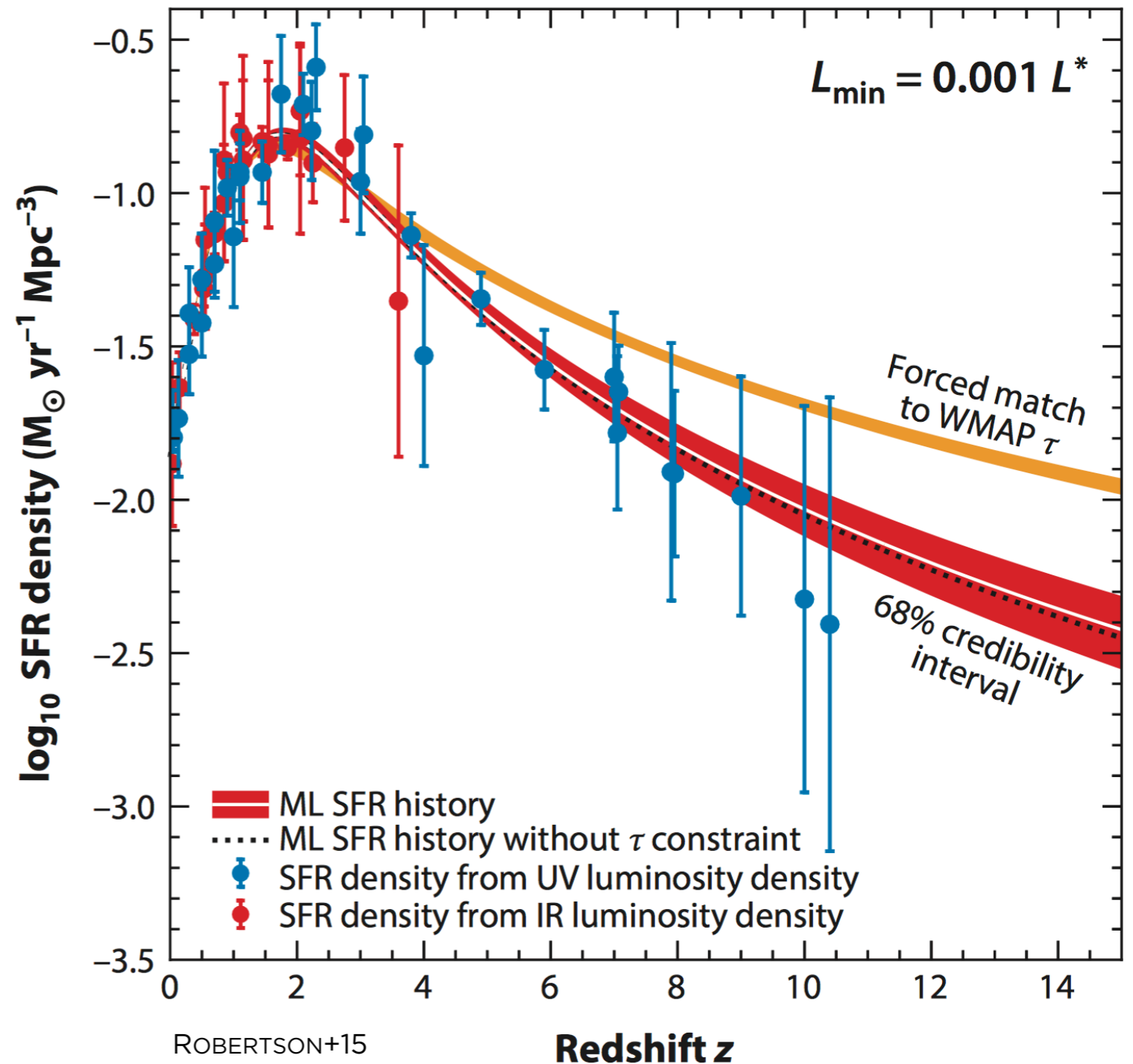


GRACE OLIVIER
OSU

NOT PICTURED:
MATT AUGER
CAMBRIDGE

HOW DO ANALOGS HELP US LEARN ABOUT THE EPOCH OF REIONIZATION (EoR)?

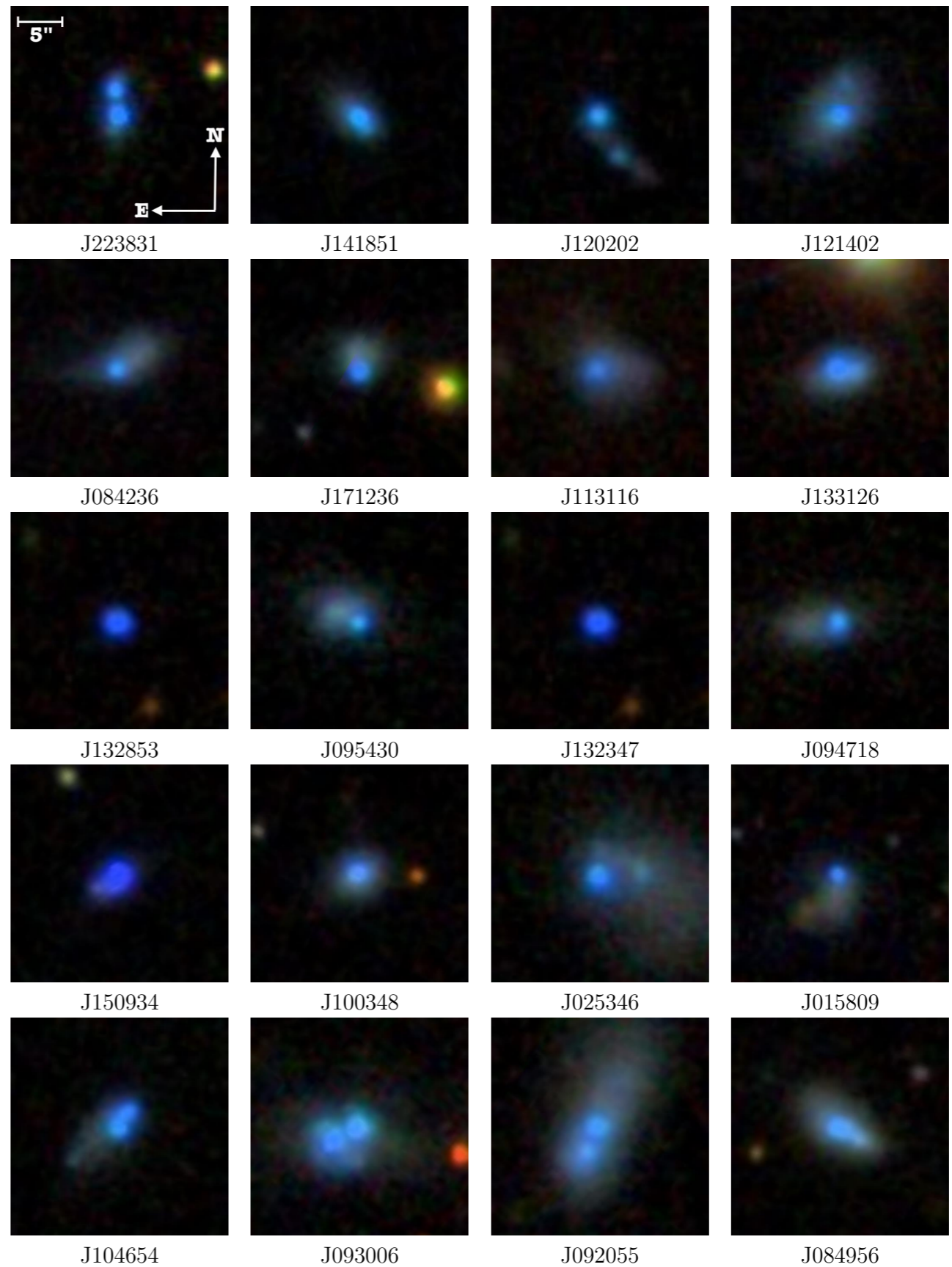
1. GALAXIES ARE THOUGHT TO BE THE MAIN DRIVERS OF REIONIZATION
2. THE EOR CANNOT BE OBSERVED DIRECTLY VIA LYC OR LY α
3. EOR GALAXIES HAVE STRONG REST-FRAME UV EMISSION LINES
4. UV LINE RATIOS CAN HELP US CONSTRAIN SOURCES OF IONIZATION AT HIGH-Z
5. EMISSION LINE STRENGTHS ARE DIRECTLY RELATED TO THE NUMBER OF IONIZING PHOTONS PRODUCED
- 6.... AND THE PROPERTIES OF THE STARS AND GAS THEY ARE PRODUCED FROM
7. WHILE THE PEAK OF THE SFR DENSITY AT $z \sim 2$ IS A GOOD PLACE TO LOOK FOR EOR ANALOGS, $z \sim 0$ PROVIDES THE MOST IN-DEPTH VIEW



Z~0 EOR ANALOGS ALLOW
US TO STUDY CONDITIONS
WITH HIGH-IONIZATION UV
EMISSION LINES:

REST-FRAME UV
OBSERVATIONS OF LOCAL
DWARF GALAXIES W/
HST COS

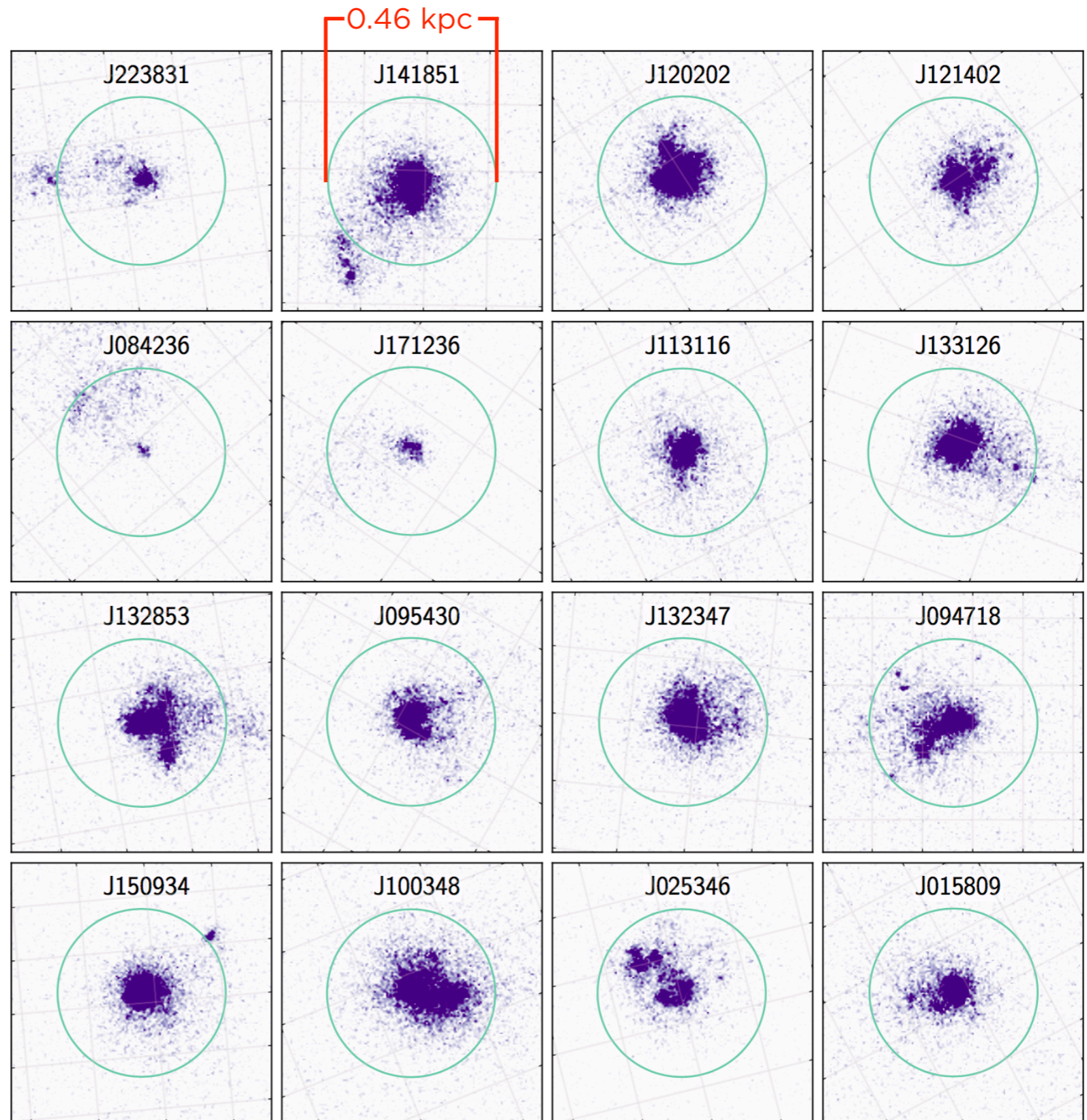
BERG+16
BERG+19A



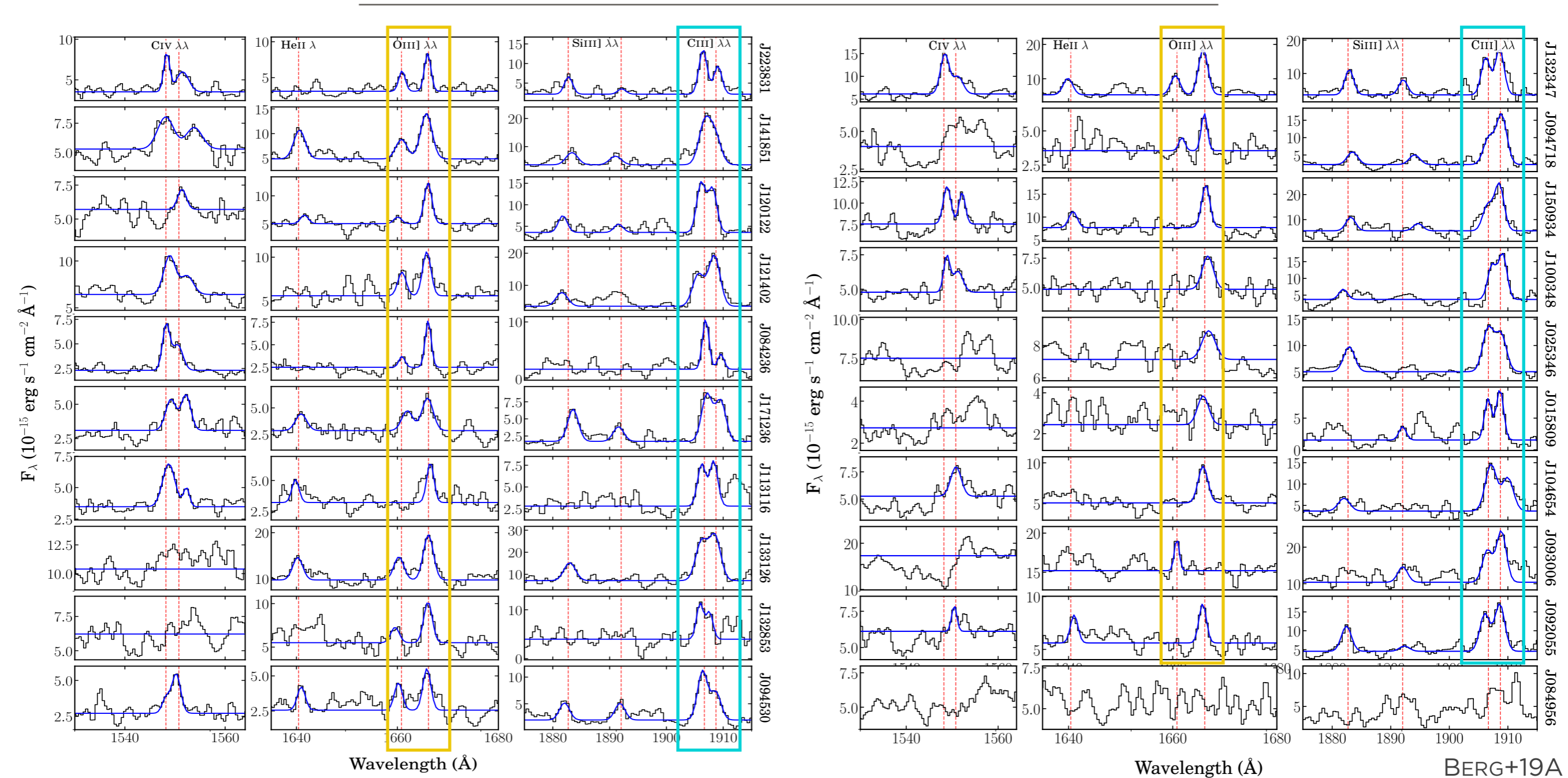
Z~0 EoR ANALOGS ALLOW
US TO STUDY CONDITIONS
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EMISSION LINES:

REST-FRAME UV
OBSERVATIONS OF LOCAL
DWARF GALAXIES W/
HST COS

BERG+16
BERG+19A

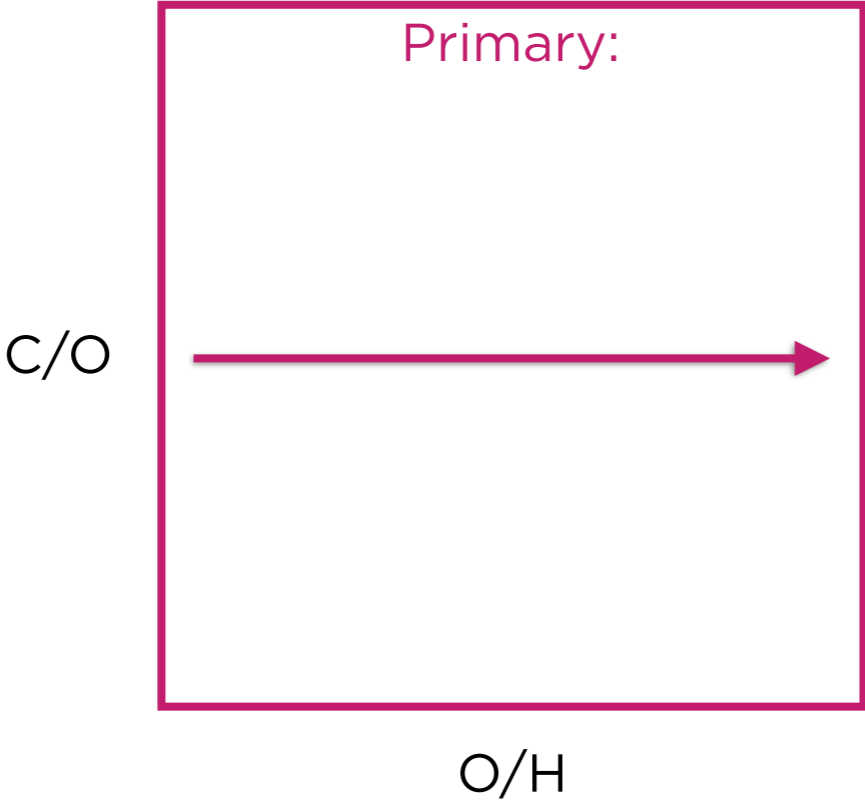


SIGNIFICANT O III] AND C III] DETECTIONS IN 19 GALAXIES

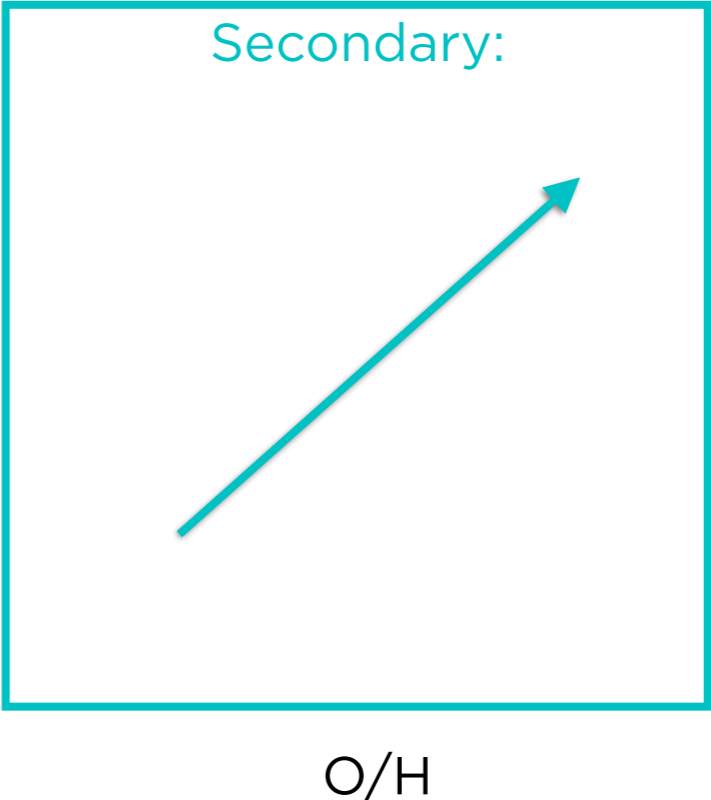


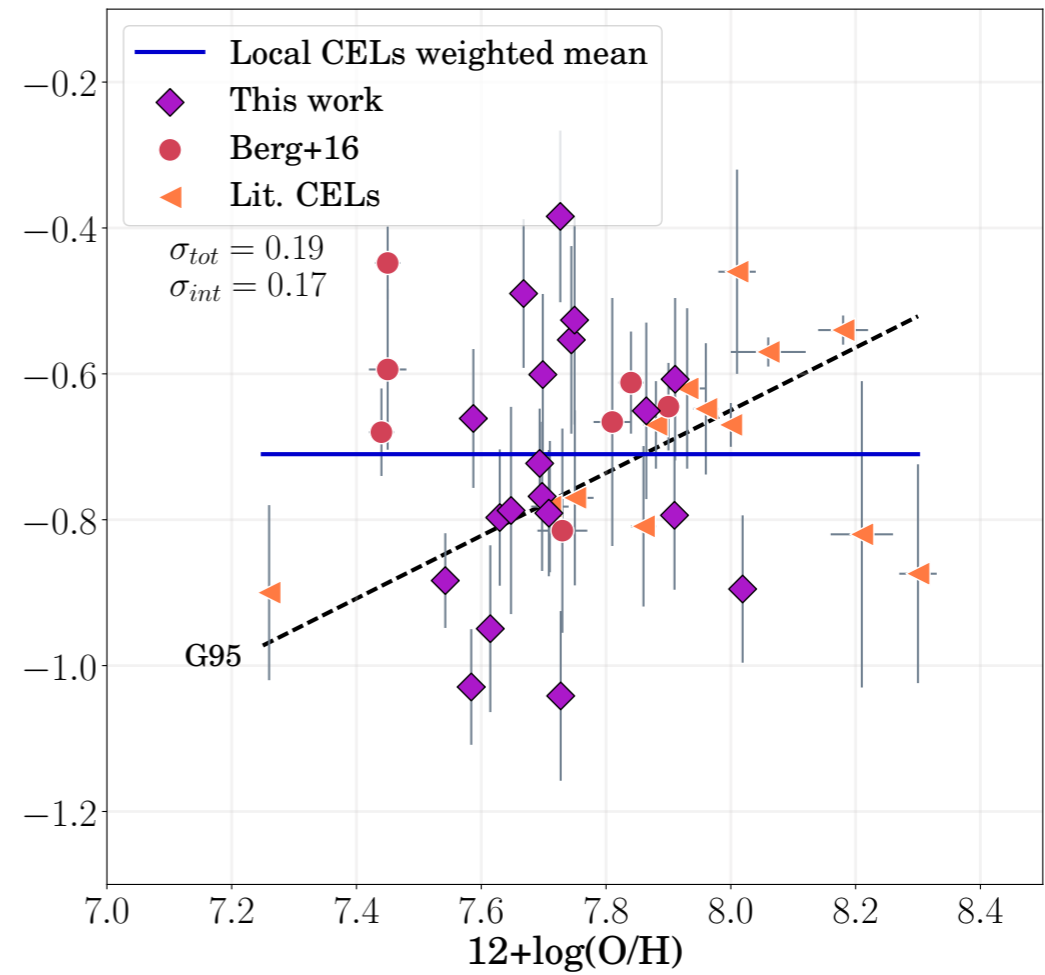
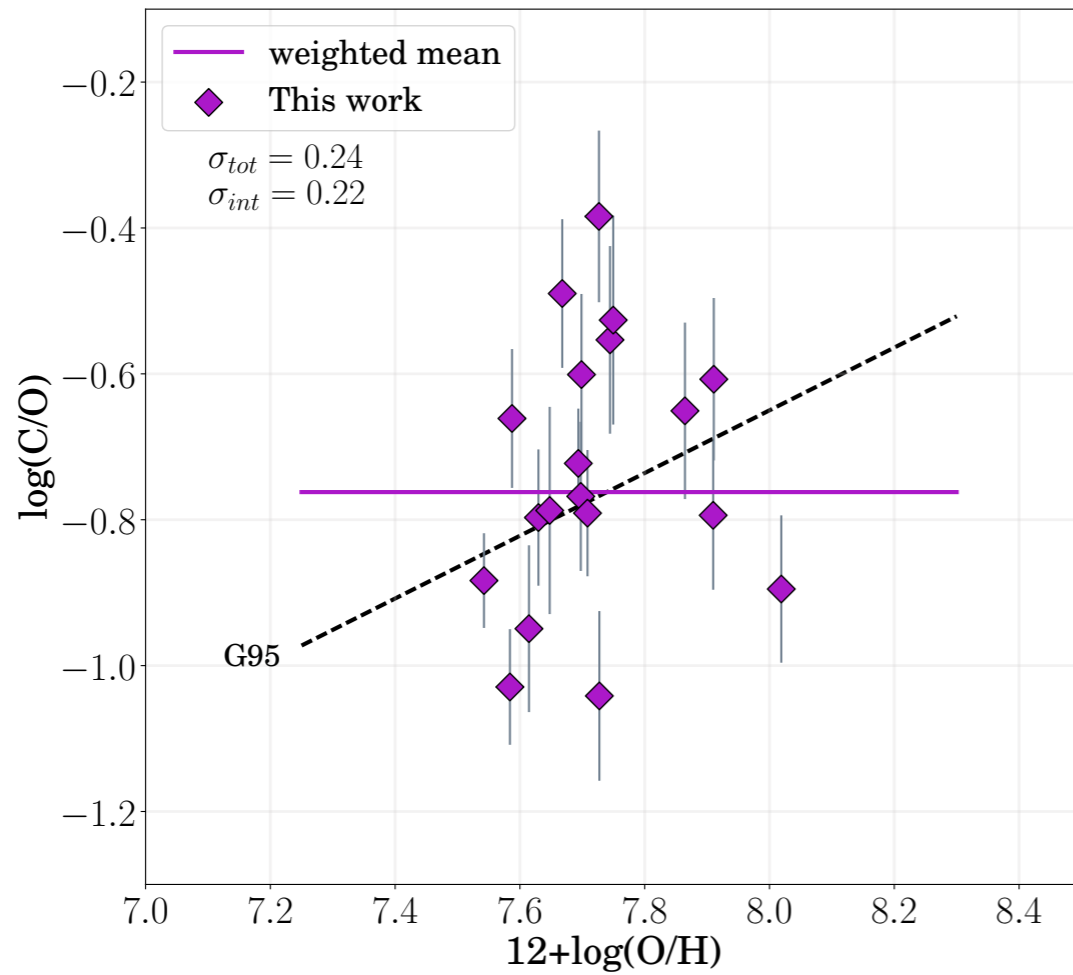
C/O vs O/H

THEORETICAL
EXPECTATION:

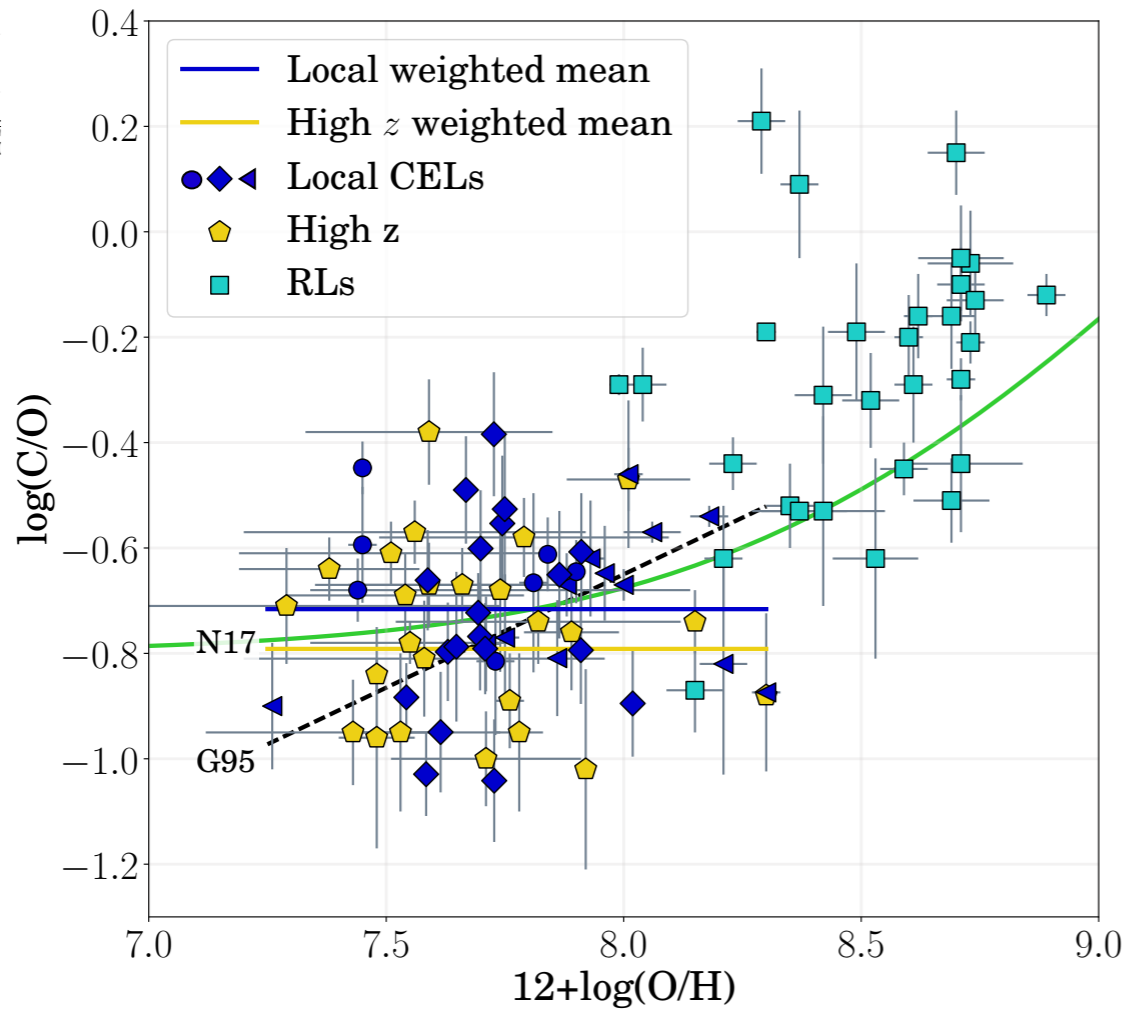
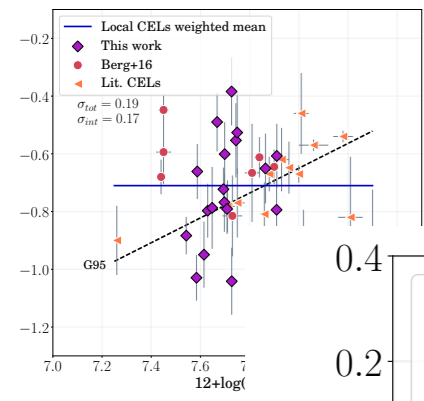


OBSERVED
(1990s-2000s):



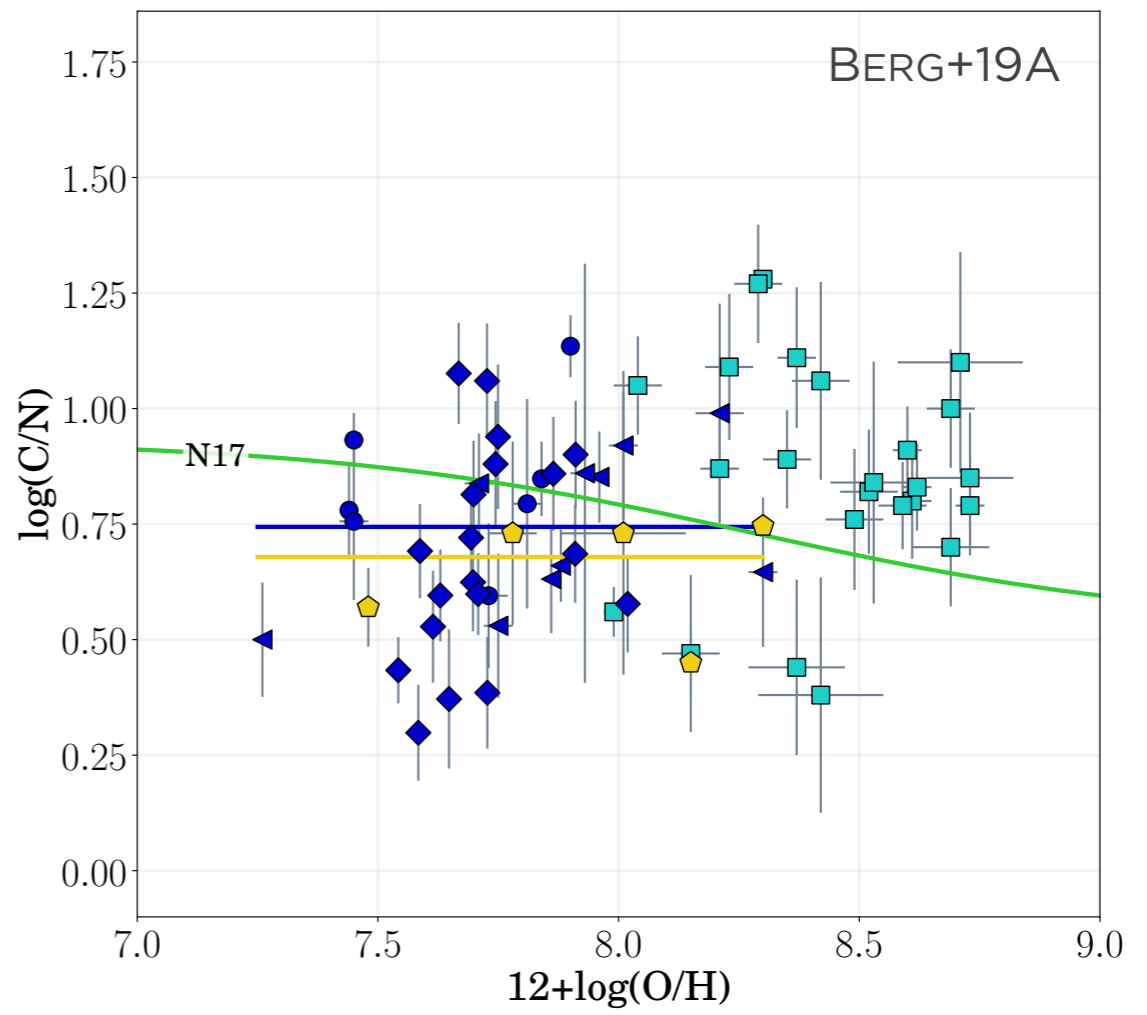


BERG+19A

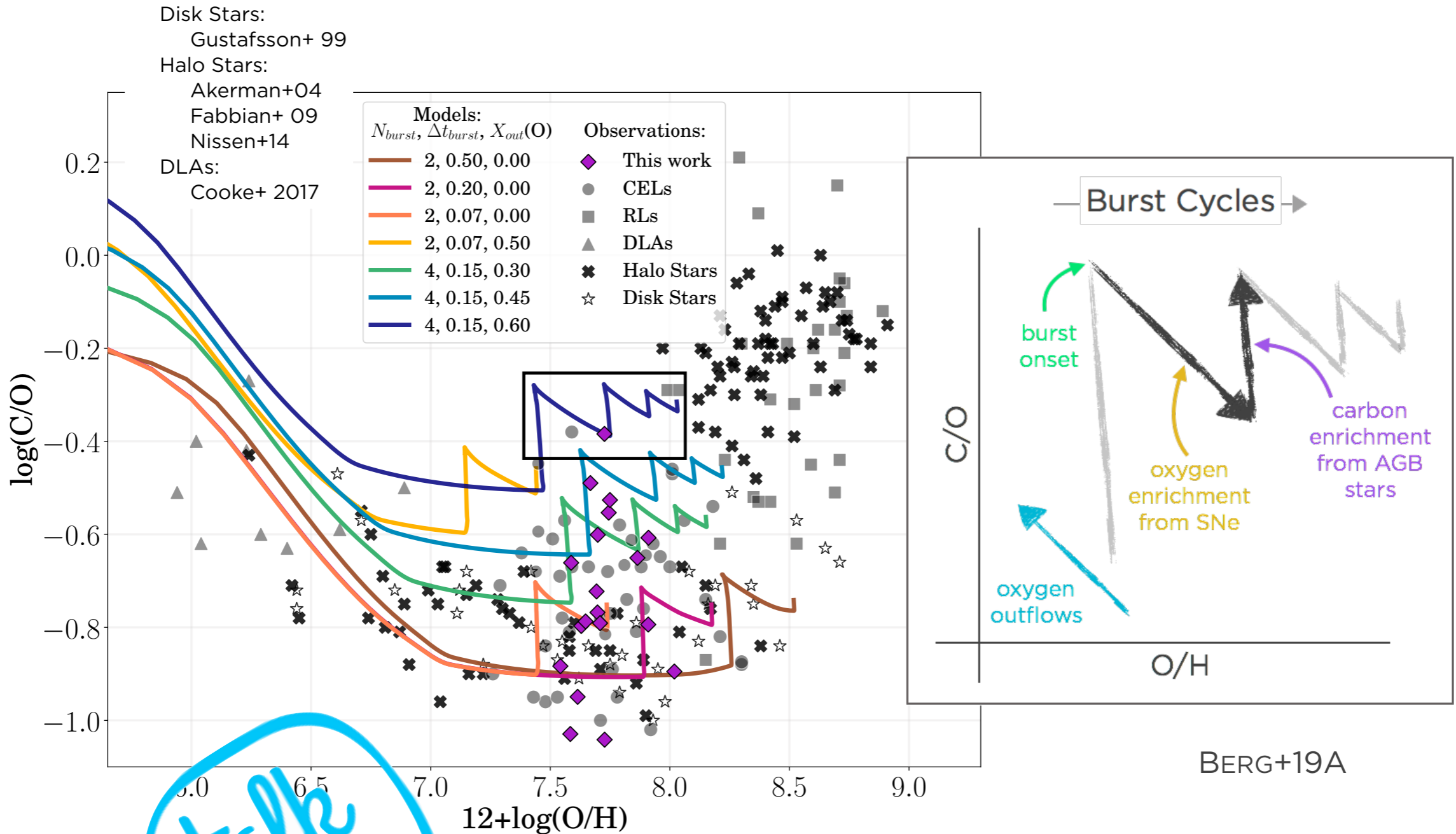


POSSIBLE PSEUDO-SECONDARY C PRODUCTION

- | | | |
|----------------|-------------|------------------|
| High z: | | RLs: |
| Pettini+02 | Stark+14 | Esteban+02 |
| Fosbury+03 | Steidel+16 | Peimbert+05 |
| Erb+10 | Vanzella+16 | García-Rojas+07 |
| Christensen+12 | Amorín+17 | López-Sánchez+07 |
| Bayliss+14 | Rigby+17 | Esteban+09 |
| James+14 | Berg+18 | Esteban+14 |



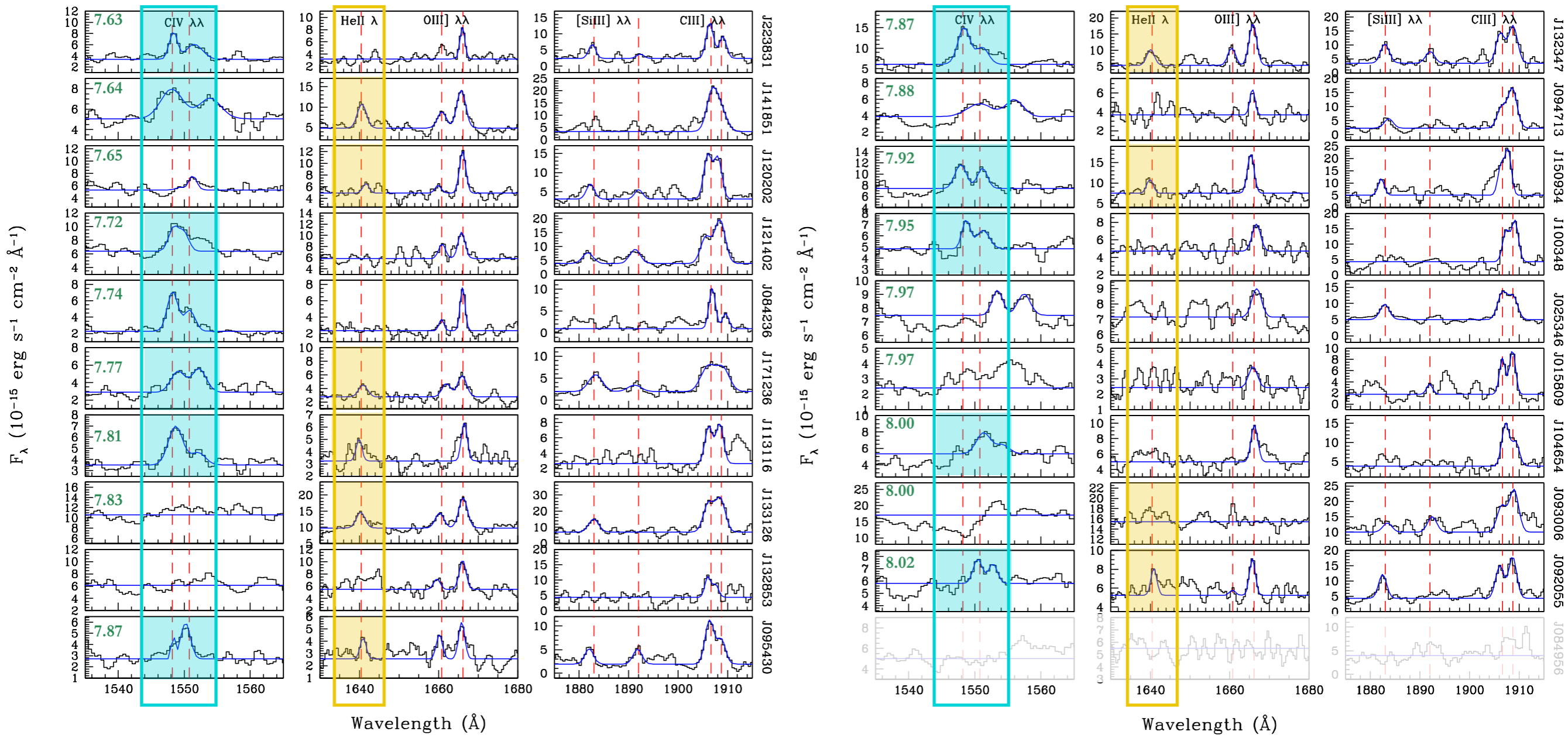
FLAT C/N RELATIONSHIP WITH LARGE SCATTER: C/O FOLLOWS BIMODAL PATTERN SIMILAR TO N/O?



talk to me

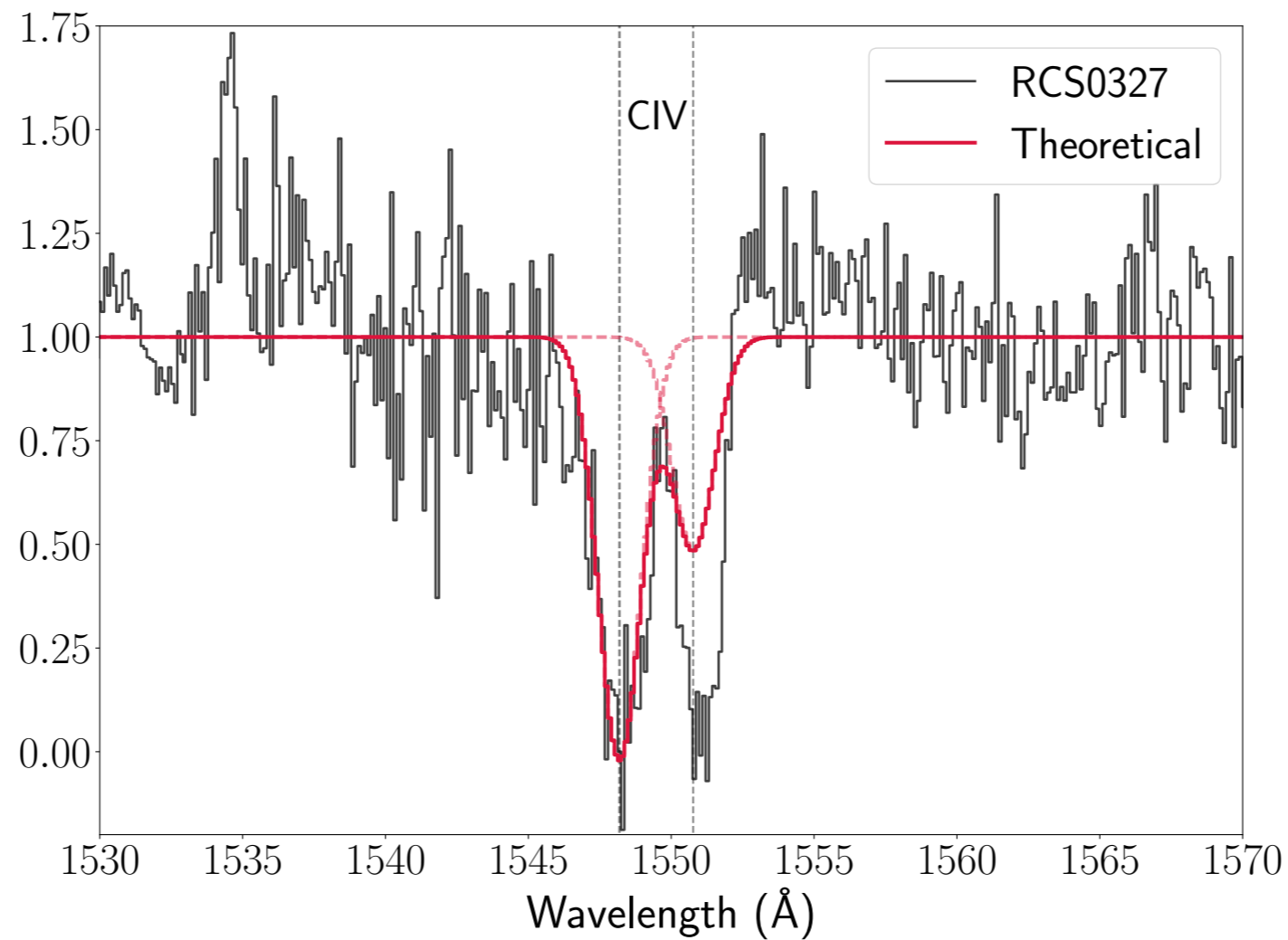
SIMPLE BURST MODELS WITH OUTFLOWS CAN REPRODUCE OBSERVED SCATTER

MANY SERENDIPITOUS C IV AND HE II DETECTIONS!

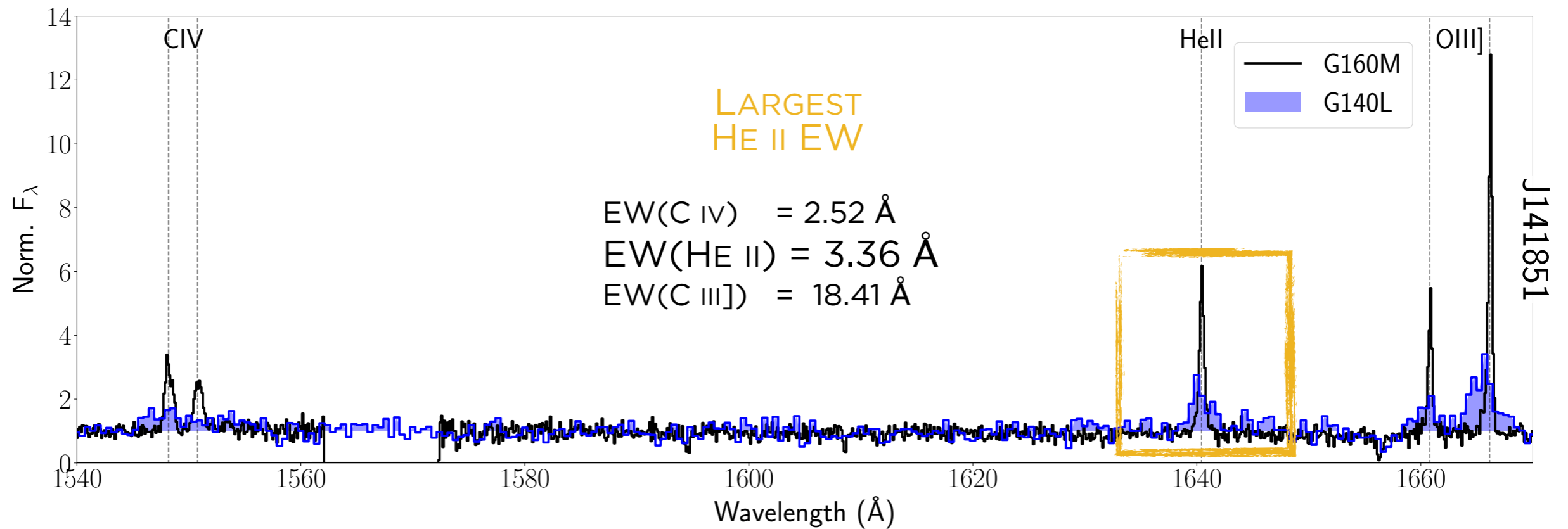
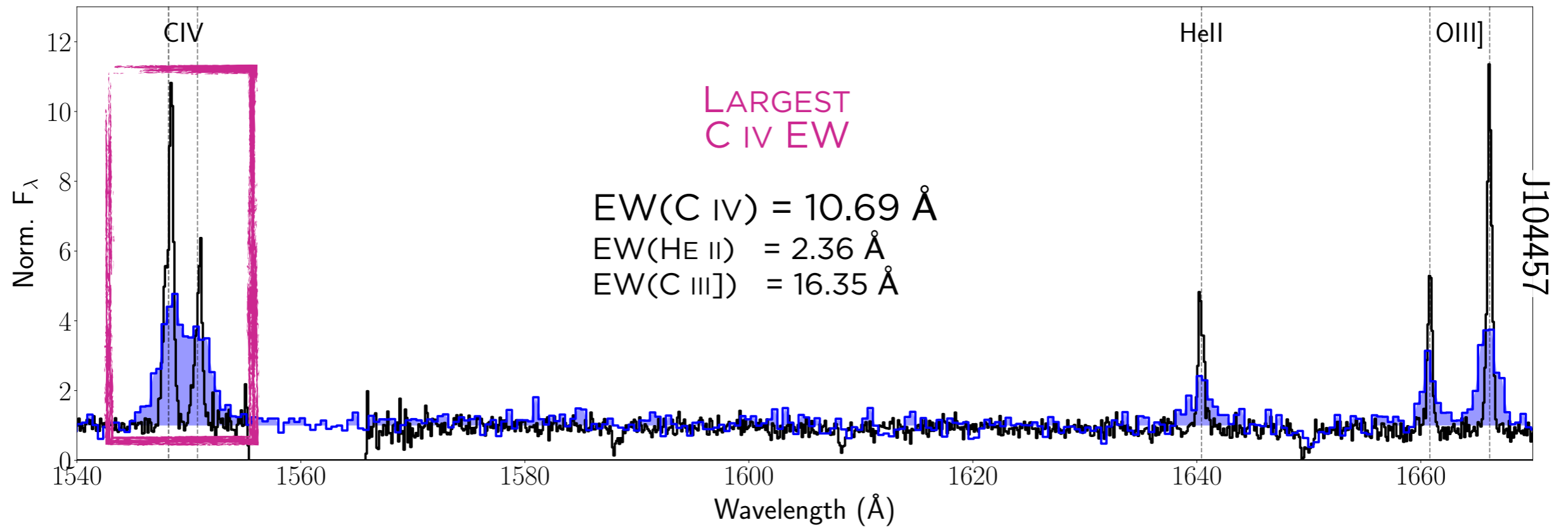


BERG+19A

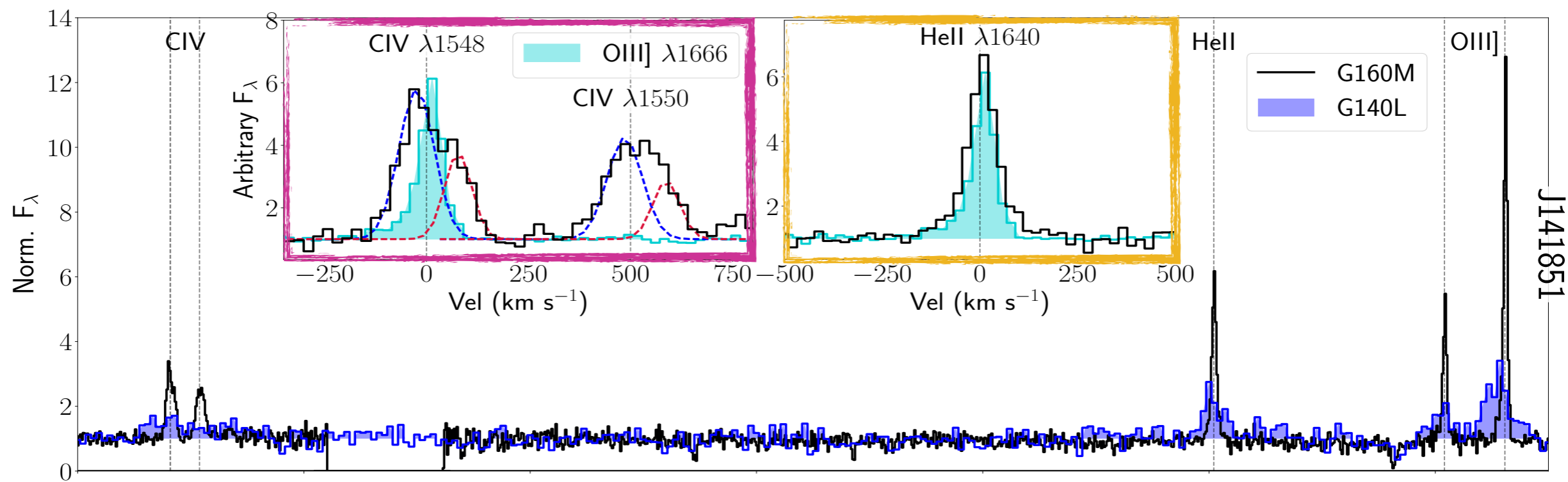
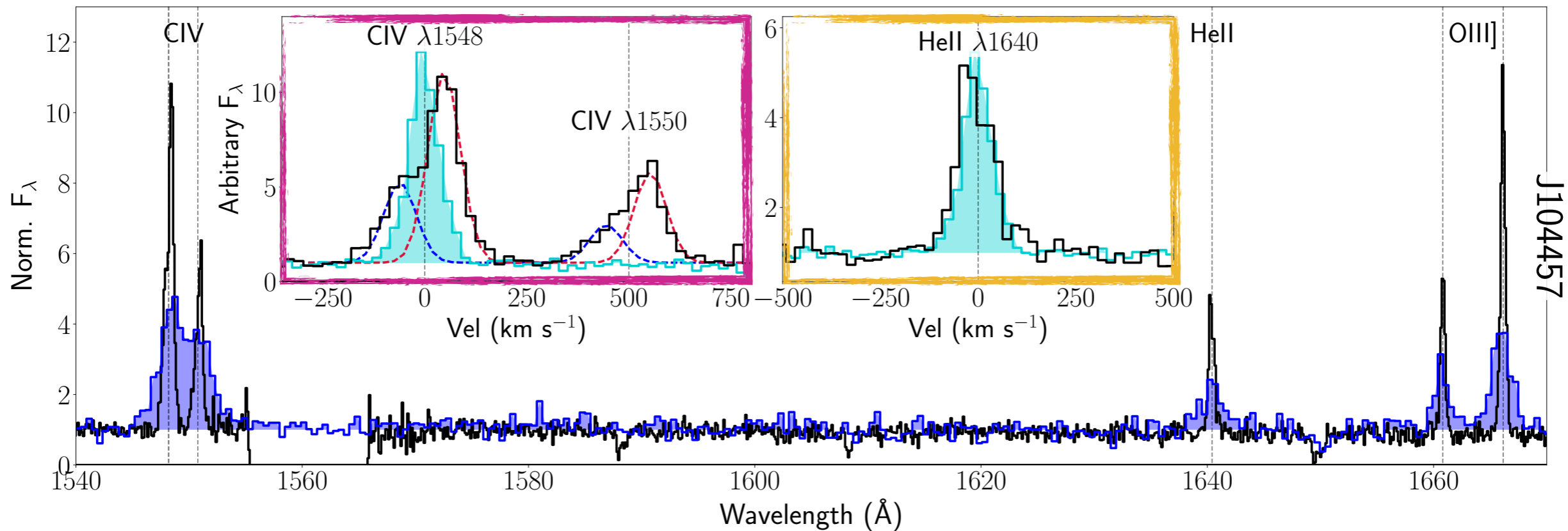
“TYPICAL” C IV PROFILES ARE NOT PURE EMISSION



MEGASAURA SURVEY
RIGBY+18



BERG+19B



BERG+19B

J104457:

BOTH CIV LINES ARE WELL FIT BY A DOUBLE GAUSSIAN

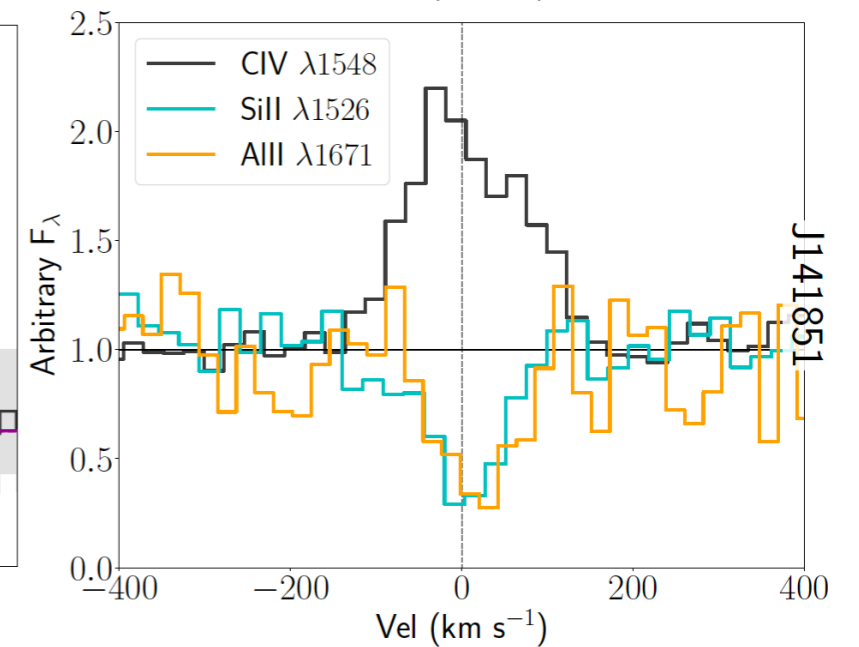
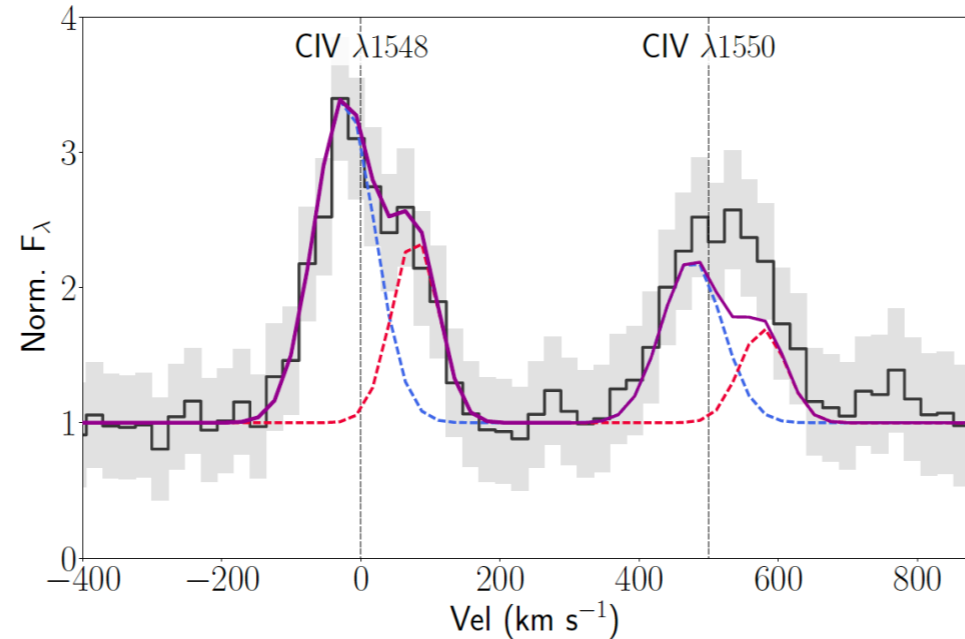
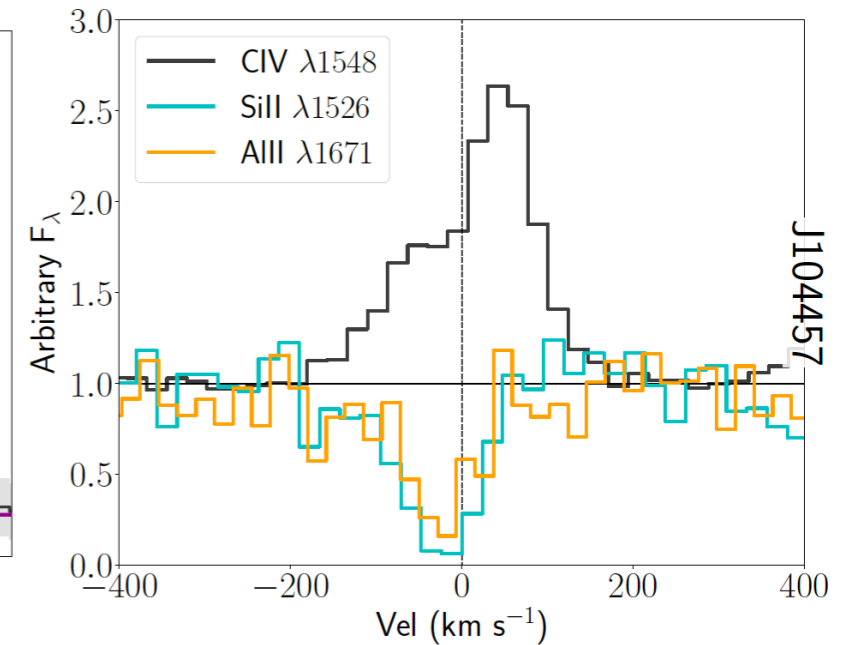
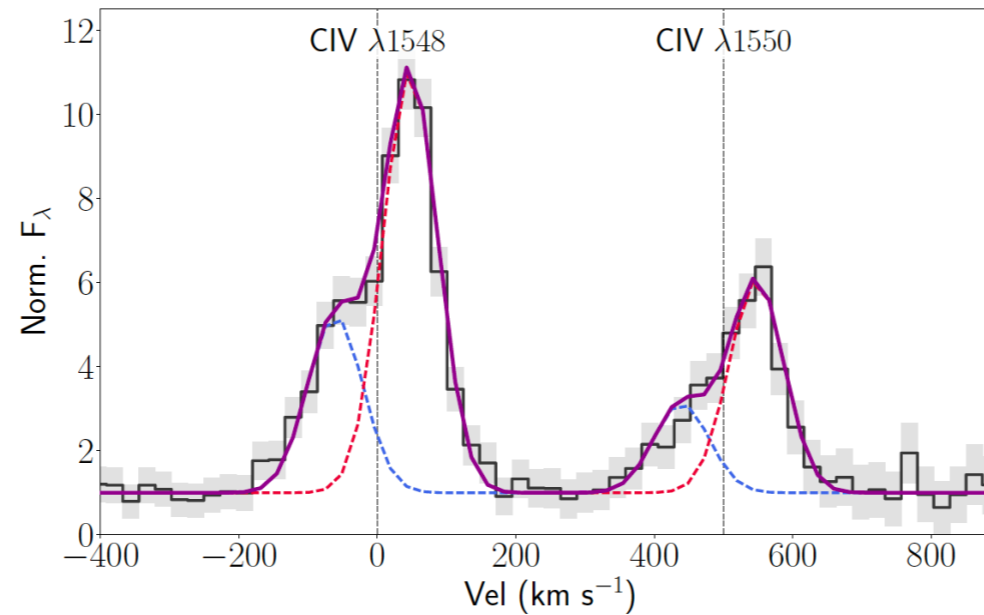
NARROW PEAK SEPARATION INDICATES POSSIBLE ESCAPE OF HIGH-ENERGY PHOTONS?

DOMINANT RED PEAK INDICATES SOME OUTFLOWS, SIMILAR TO ABSORPTION PROFILES

J141851:

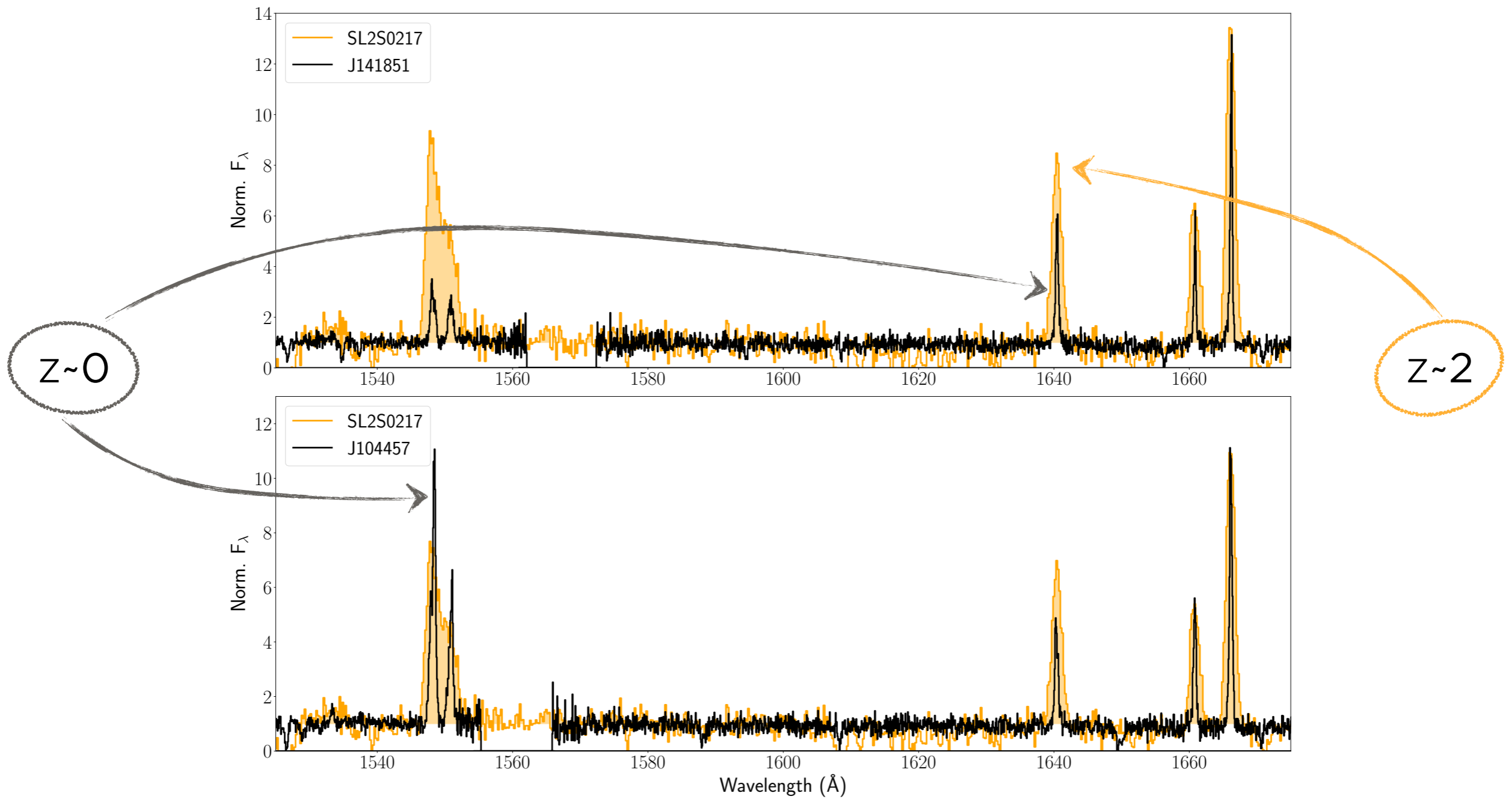
ALSO DOUBLE-PEAKED, WITH NARROW PEAK SEPARATIONS

DOMINANT BLUE PEAK INDICATES SOME INFLOWS



BERG+19B

EXTREME UV EMISSION-LINE GALAXIES AT LOW AND INTERMEDIATE REDSHIFTS MAY SERVE AS GOOD EOR ERA ANALOGUES



SUMMARY:

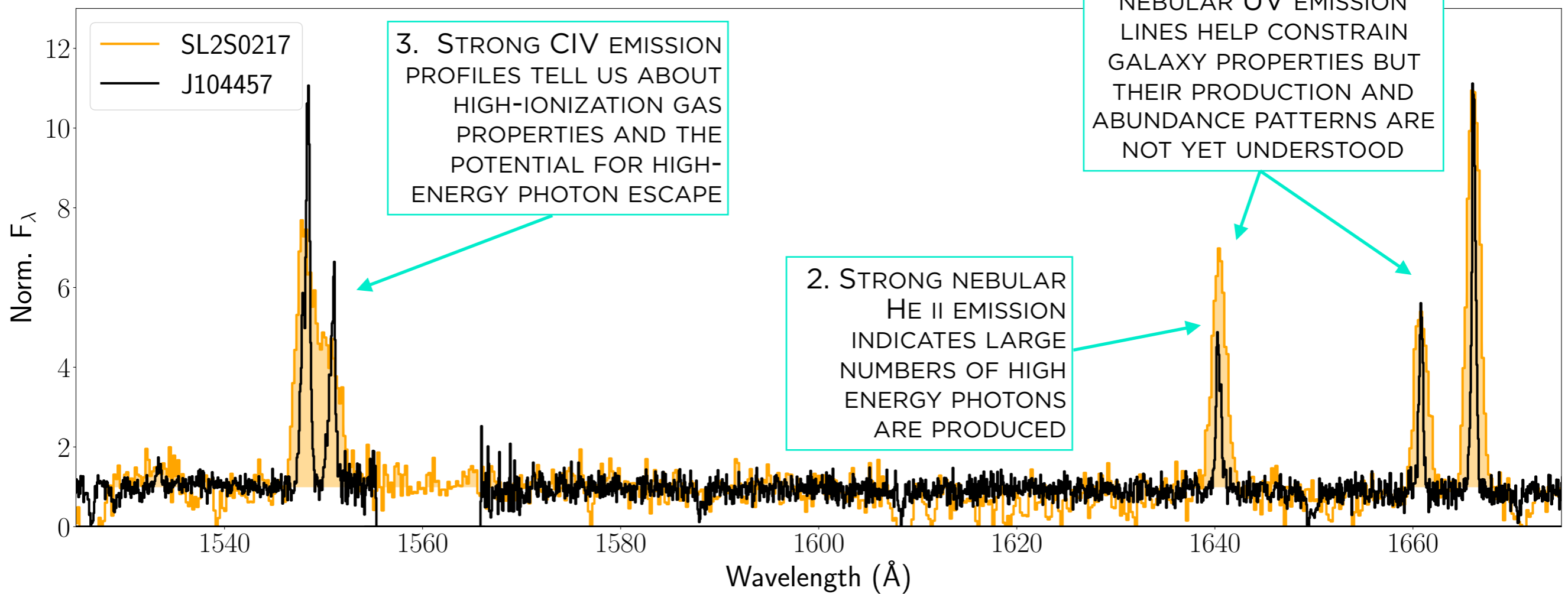
EXTREME UV EMISSION-LINE GALAXIES AT LOW AND INTERMEDIATE REDSHIFTS INFORM EOR

1. EXTREME UV EMISSION-LINE GALAXIES AT LOW AND INTERMEDIATE REDSHIFTS MAY SERVE AS GOOD EOR ERA ANALOGUES

4. HIGH-IONIZATION NEBULAR UV EMISSION LINES HELP CONSTRAIN GALAXY PROPERTIES BUT THEIR PRODUCTION AND ABUNDANCE PATTERNS ARE NOT YET UNDERSTOOD

3. STRONG CIV EMISSION PROFILES TELL US ABOUT HIGH-IONIZATION GAS PROPERTIES AND THE POTENTIAL FOR HIGH-ENERGY PHOTON ESCAPE

2. STRONG NEBULAR HE II EMISSION INDICATES LARGE NUMBERS OF HIGH ENERGY PHOTONS ARE PRODUCED





COS LEGACY ARCHIVE SPECTROSCOPIC SURVEY: A TREASURY OF STAR-FORMING GALAXIES

PIs: DANIELLE BERG, JOHN CHISHOLM, TIM HECKMAN,
BETHAN JAMES, CRYSTAL MARTIN, DAN STARK
CO-IS: DAWN ERB, EVAN SKILLMAN, AND 26 OTHERS

44 NEARBY STAR-FORMING GALAXIES WITH FULL REST-FRAME FAR-UV SPECTRAL
COVERAGE OF STELLAR, NEBULAR, AND ISM FEATURES

