Unveil the [OIII]/[CII] luminosity ratio at 4<z<6 and the morphology of submillimeter galaxies with JWST

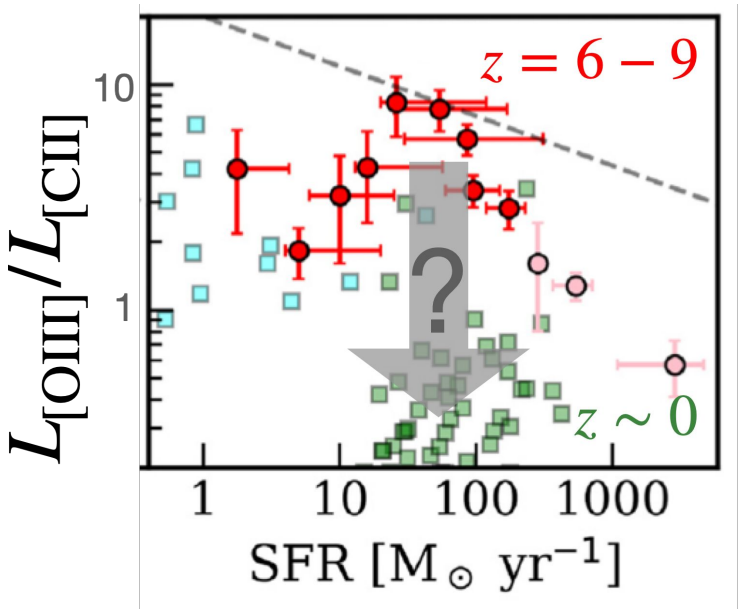
Supervisor: Eiichi Egami
Member: Makoto Ando, Takashi Yamamoto, Yuxing Zhong, Yi W. Ren, Hiroya Umeda, Moka Nishigaki

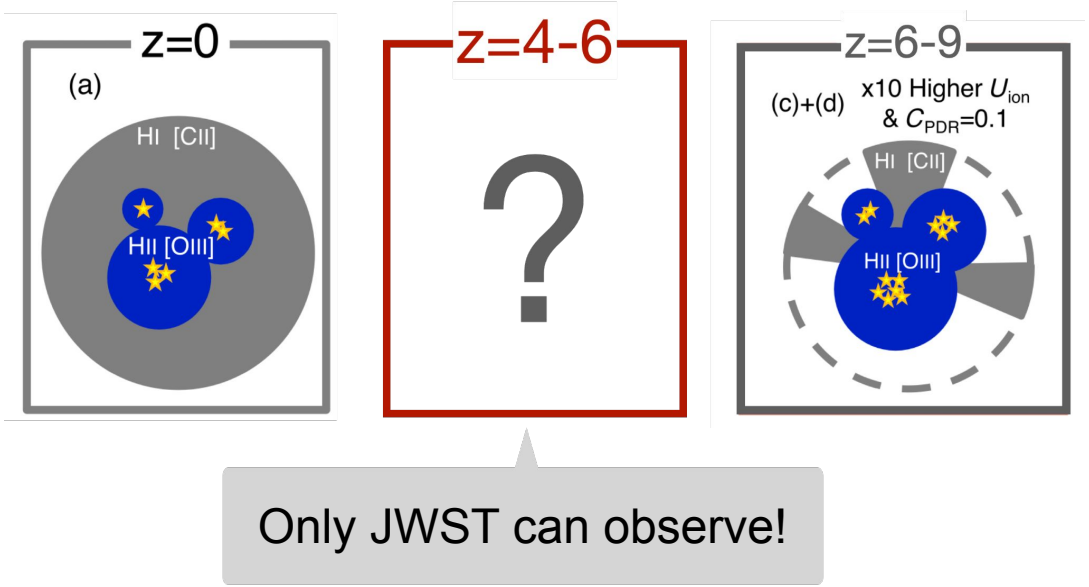
Galaxy-IGM workshop 2022
galaxy observation group

Topic: Make Your Proposals for JWST Cycle-2

- JWST Proposal 1
  - Moka Nishigaki
  - Makoto Ando
  - Yi W. Ren
- JWST Proposal 2
  - Takashi Yamamoto
  - Yuxing Zhong
  - Hiroya Umeda

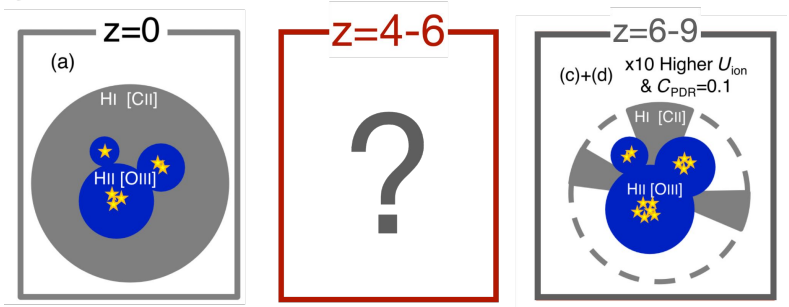
[OIII]/[CII] ratio in post-reionization galaxies





[OIII]/[CII] ratio in post-reionization galaxies

- At local universe, Herschel reveals [OIII]88/[CII]158 to be 1~11
- At 6 < z < 9, ALMA reveals [OIII]88/[CII]158 to be 2~9
- What about other redshift range?
- At 4 < z < 6, oxygen emission line can only be observed by JWST

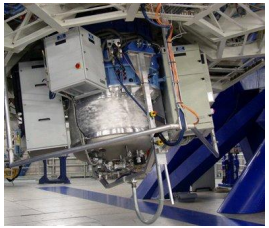


Harikane et al. 2020

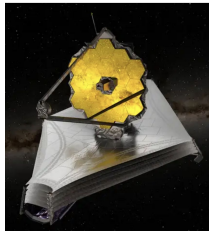
Herschel

…

VLT SINFONI



JWST



ALMA

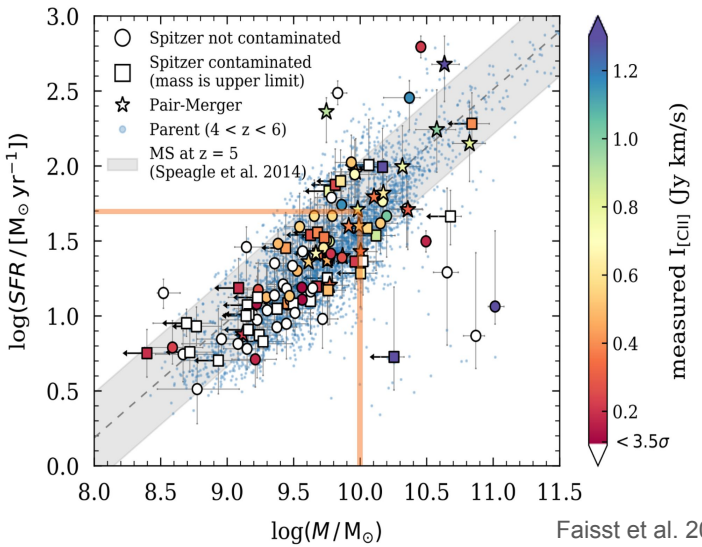
0 2 4 6 redshift

Sample & Method

- Selected from ALPINE sample with [CII]
  - ALMA Large Program to INvestigate CII at Early Times (e.g., Le Fèvre et al. 2020)
  - ALMA observation of [CII]158μm emission lines and dust continuum
  - 118 normal star forming galaxies at $z \sim 4-6$
- M*~10^10 Msun, SFR=10^1.7 Msun/yr

  → [OIII]5007Å with JWST spectroscopy

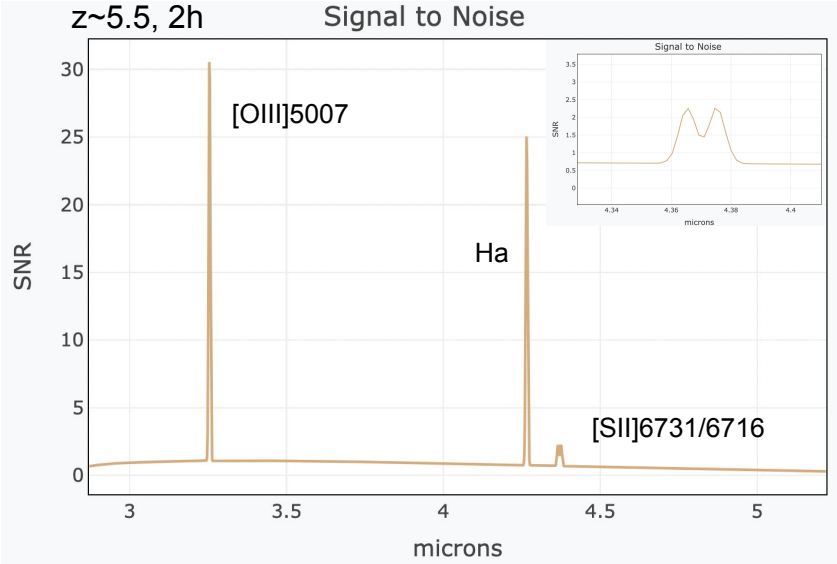
- [OIII]5007Å/ [OIII]88um from n_e
  - ne from [SII]6731/6716Å

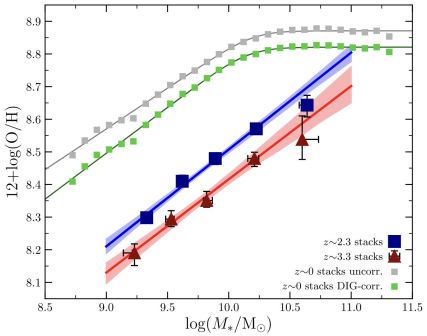


Faisst et al. 2022

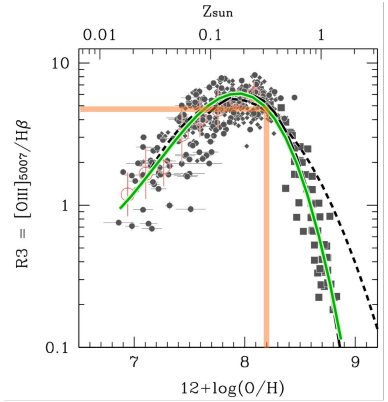
Feasibility

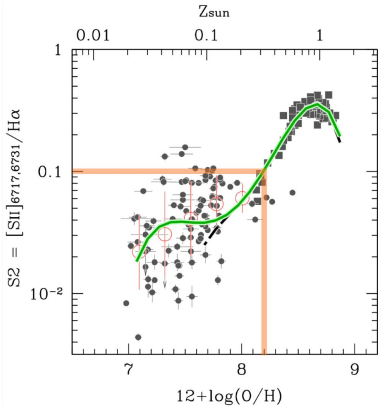
- **~2h obs.** for >2 sigma detection of [SII] doublet
- instrument
  - NirSpec (fixed slits)
  - Grating/Filter: G395M/290LP
  - slit: 0.4” * 3.8”
- assumption
  - M*=1e10 Msun, SFR=1e1.7 Msun/yr
  - SFR - Hα relation
  - Hα/Hβ = 2.86
  - E(B-V)=0.1
  - 12+log(O/H) ~= 8.2
  - [SII]6731/6716 /Hα = 0.1
  - [OIII]5007/Hβ = 5





Sanders et al. 2021





Nakajima et al. 2021

Other interesting things we can do...

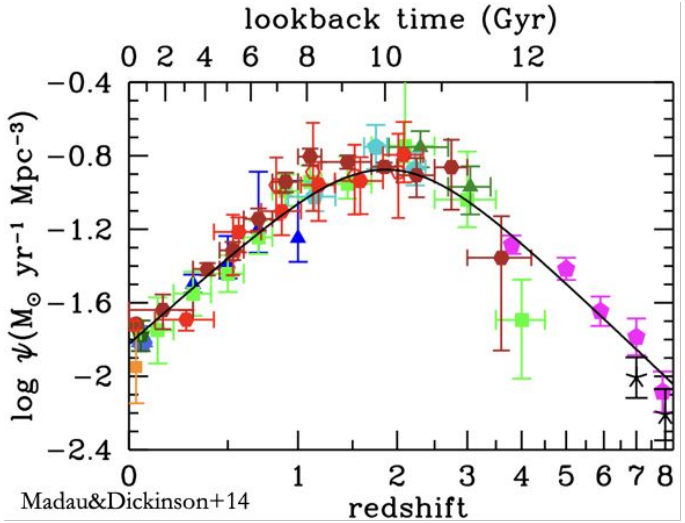
- SFR from Hα
- Metallicity from ([OII] 3727 + [OIII]5007/4959) / Hβ
- Ionization parameter from [OIII]5007 / [OII] 3727
- [OIII]5007 / [CII]158 diagnostic
- ...and any ideas?

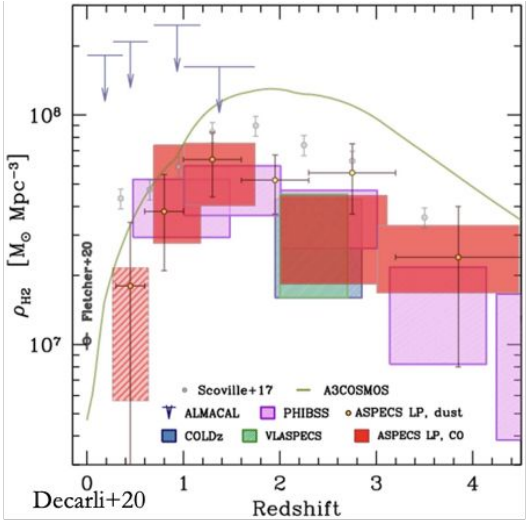
JWST proposal 2:
Submillimeter Galaxies

Background: Galaxy Evolution and Submillimeter Galaxies

Submillimeter Bright Galaxies(SMGs)

- Infrared luminous, gas rich, and starburst
- Progenitor of Dust Obscured Galaxies, red Quasars, or Massive Ellipticals(?)



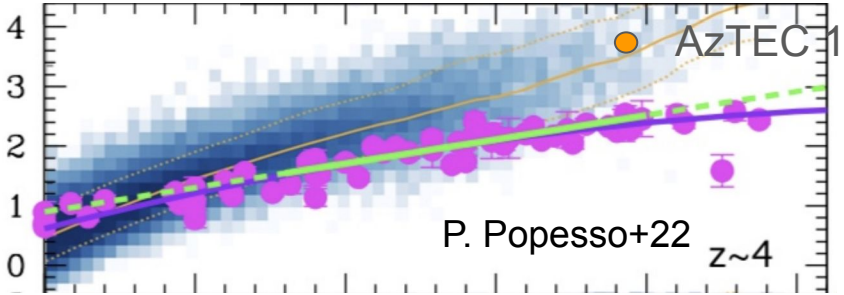


Key for Understanding Galaxy Evolution!

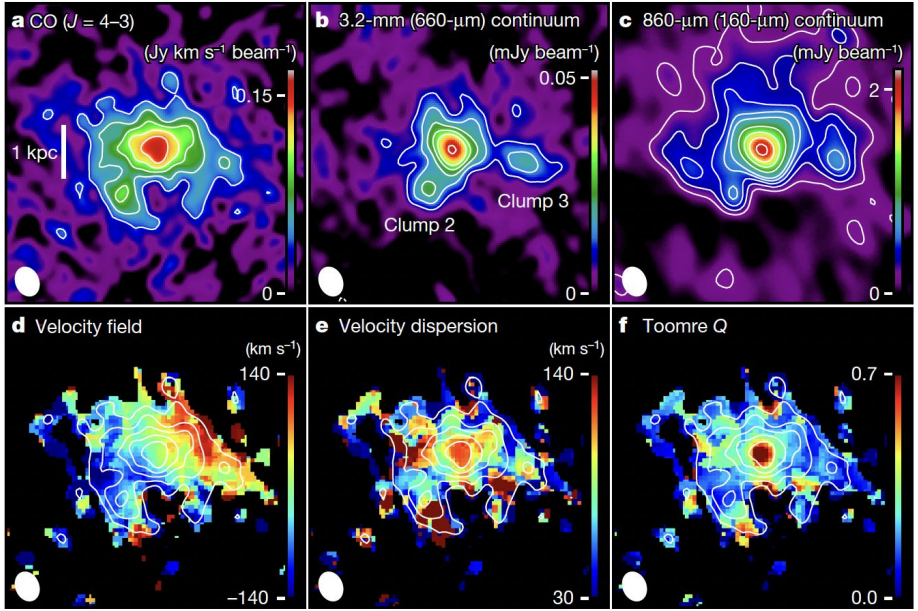
Objective: Uncover starburst mechanism in SMGs(?)

Testbed: z~4 SMGs

- compact molecular core
- rotation dominated
- mysterious clump (bar, spiral)?
- Above the observed MS



→Stellar (optical) components



Tadaki+2018

Science Goal

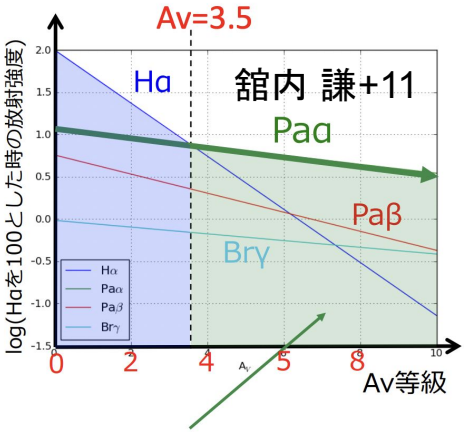
Uncover kinematics of stars in SMGs

UV/Optical lines←Attenuation by dust

→<u>IFU</u> observation of <u>Pβ</u> (less attenuated by dust)

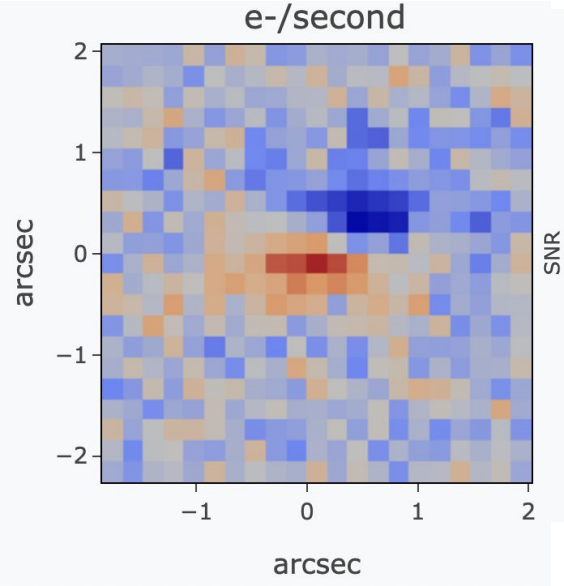
Feasibility: Kinematics

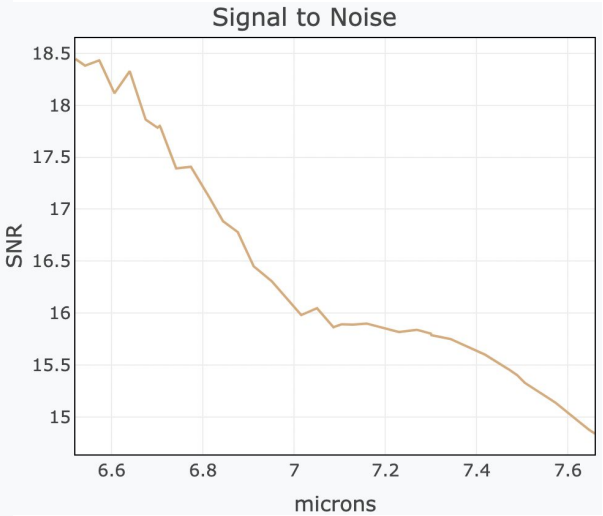
- MIRI IFU; CH1 Long (6-7 um)
- Total Exposure Time: ~1.5 hr

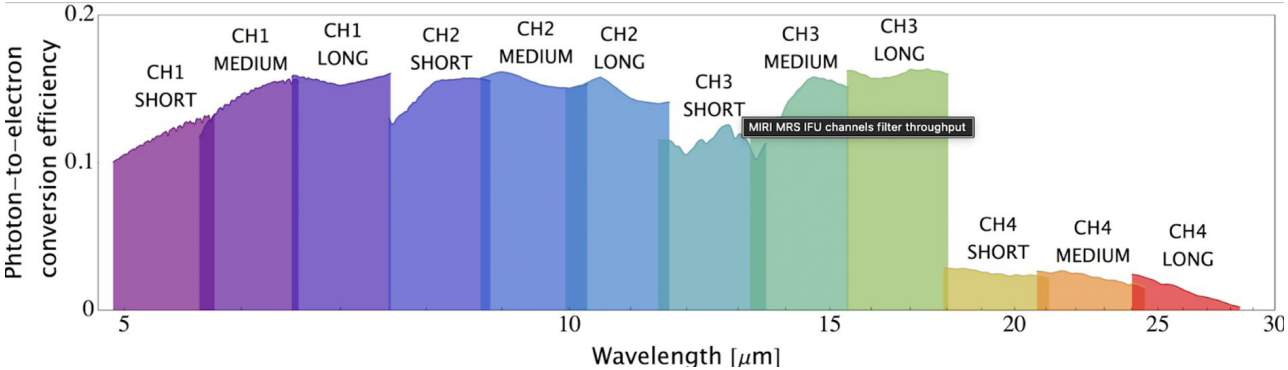


A_V=3.5等以降では
Paα輝線の見かけの強度が一番強い

※CaseB T=10000Kを仮定





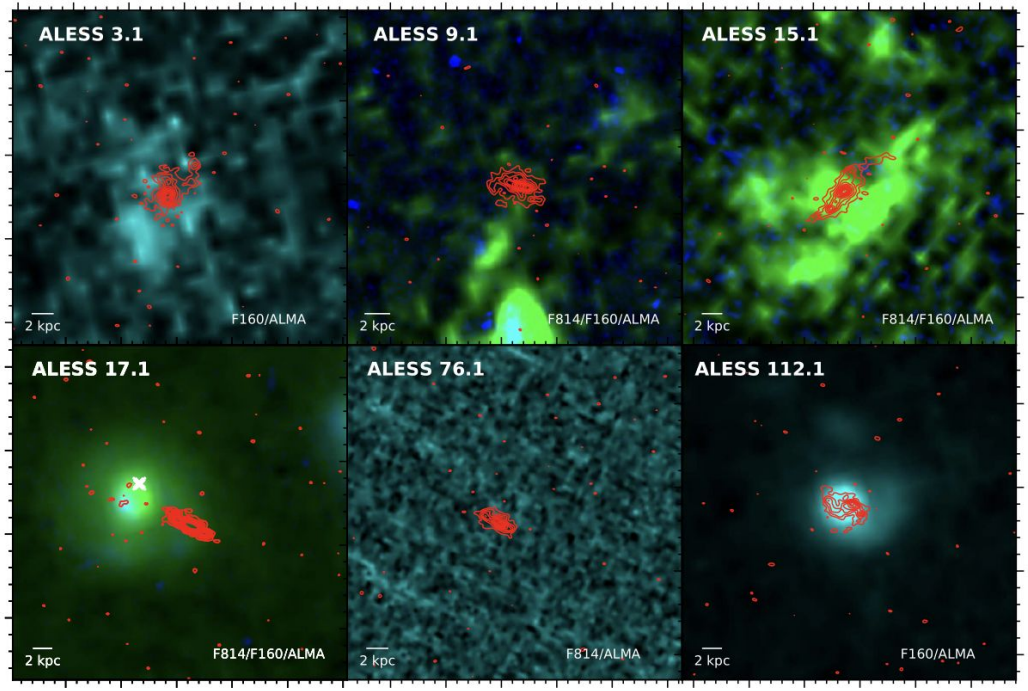


Prospects (still thinking)

Next Targets(?)

Extended, Faint Components?

Dwarf nearby?



We are welcome your comments & suggestions☆