How to characterize WISH drop-out galaxies

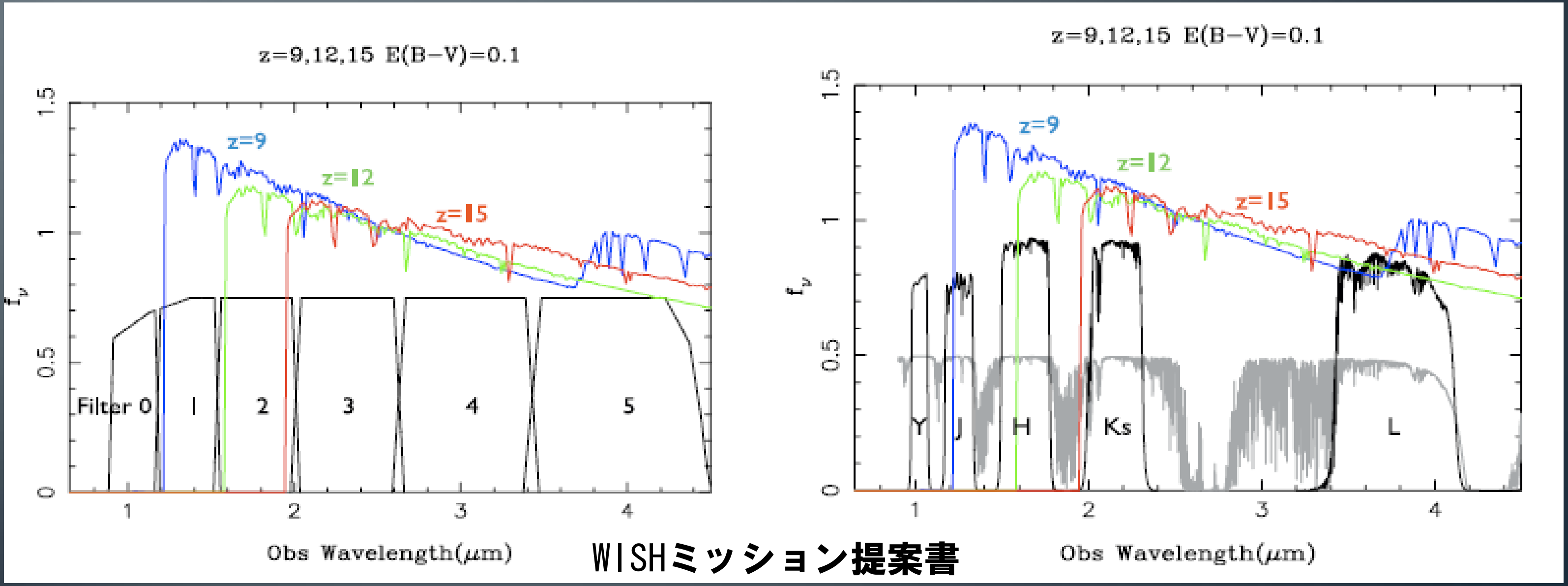
Akio K. INOUE

(Osaka Sangyo University)

大阪産業大学
OSAKA SANGYO UNIVERSITY

WISH Drop-out Galaxies

- Classical "drop-out" (or Lyman break) technique provides us with a large number of high-z galaxies from WISH deep survey.
  - F0-drop z>8 (i.e. y-drop) ~100,000 (UDS 100deg2)
  - F1-drop z>10 (i.e. J-drop) ~5,000 (UDS 100deg2)



WISHミッション提案書

Characterizing WISH Drop-out Galaxies

- Just discovering is not very physics…
- We should examine their physical properties and put constraints on the cosmological structure formation history.
  - When and how these galaxies (or stars) form?
  - When and how metal element pollution occur?

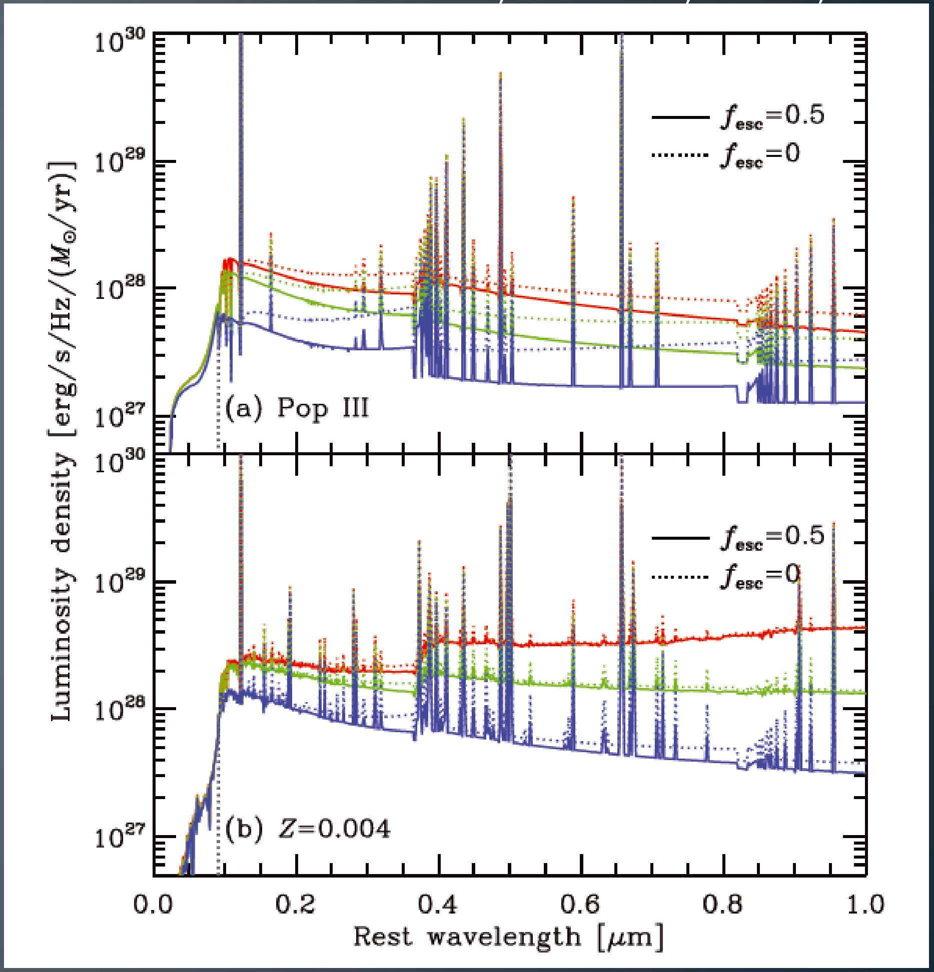
Characterizing WISH Drop-out Galaxies

- SED fitting is a nice tool to characterize WISH drop-out galaxies without additional observations.
  - Need template spectra with wide range of properties (e.g. nebular emission and extremely metal-poor or metal-free stellar populations).
- Follow-up spectroscopy always supplies much more information.
  - Exact redshift
  - Wind velocity
  - Metallicity
  - ISM density and temperature
- Which galaxies should we follow-up?
  - Those expected to have strong emission lines.

Spectral model of primordial galaxies

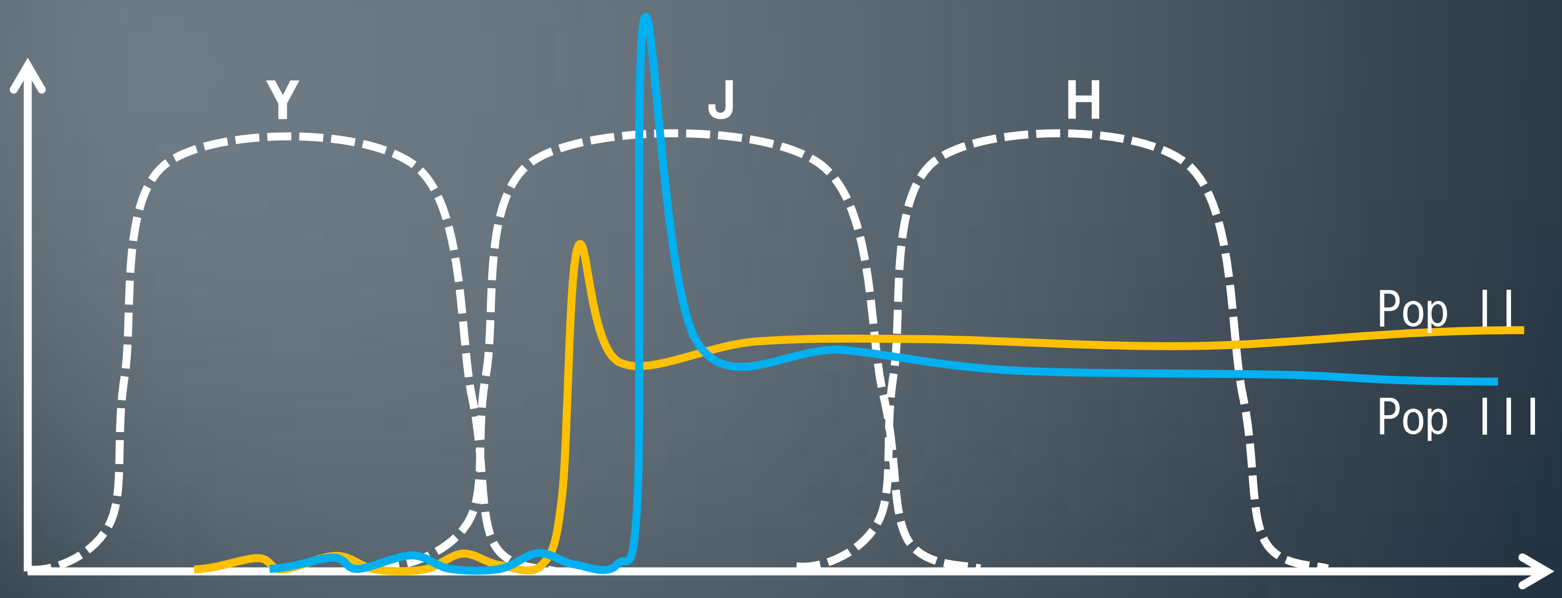
Inoue 2011, MNRAS, 415, 2920

- Wide range of metallicity
  - Z=0 to 0.02 (Solar)
- Metallicity dependent nebular emission lines
  - 119 emission lines from Lya to 1 micron (rest)
- Hydrogen nebular continuum
  - Two photon continuum
  - Bound-free continuum
  - Free-free continuum
- Escape of stellar and nebular Lyman continua
- See also
  - Zackrisson et al.
  - Schaerer?



Primordial signature imprinted in UV

- Very strong Lya of metal-free stellar population affects even broadband color.
  - Example of HST/WFC3 filter set: very blue J-H in Y-drop objects (Zackrisson, AKI, et al. 2011).



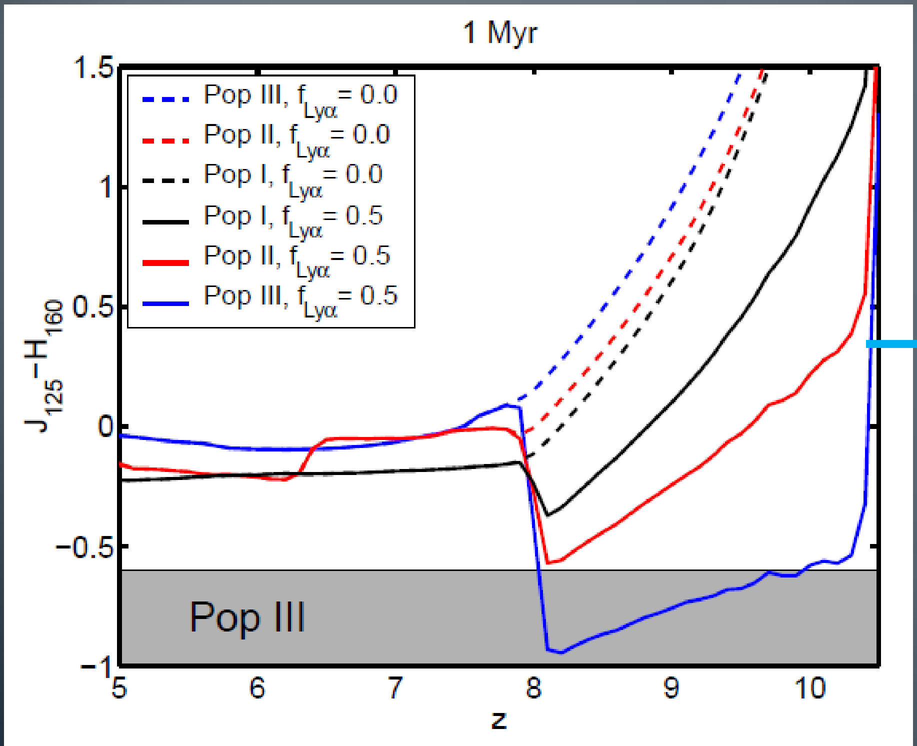
Pop-III candidates in HST/WFC3 survey

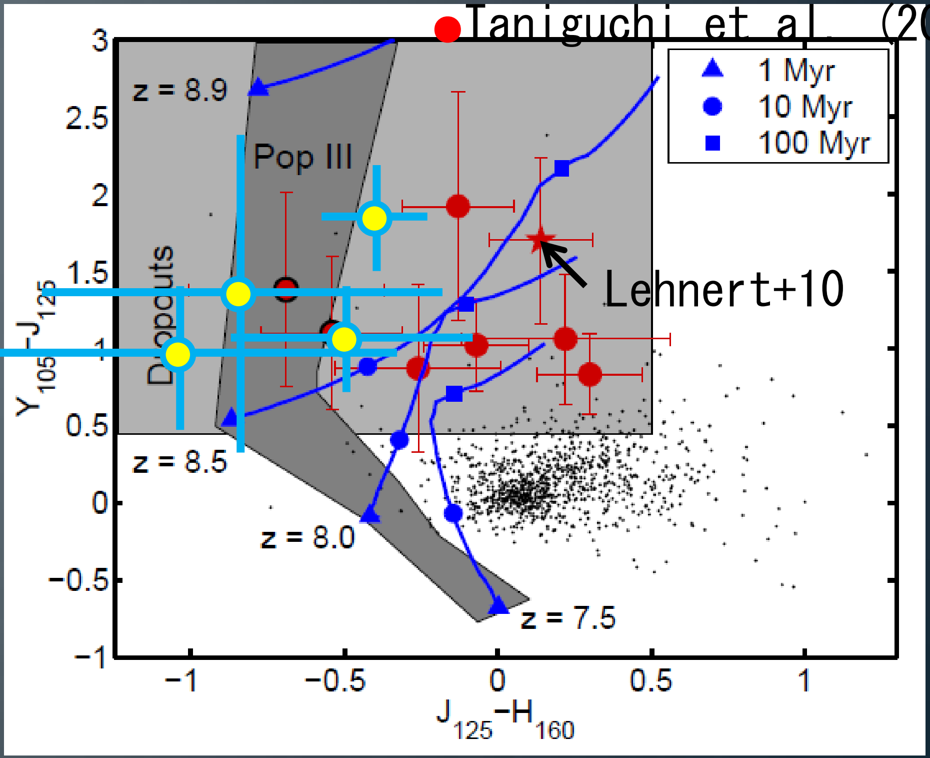
Zackrisson, AKI, et al. 2011, MNRAS

Solid: 50% Lya transmission through ISM and IGM
Dashed: 0% Lya transmission

UDF12

Schenker et al. 2013
McLure et al. 2013
Taniguchi et al. (201





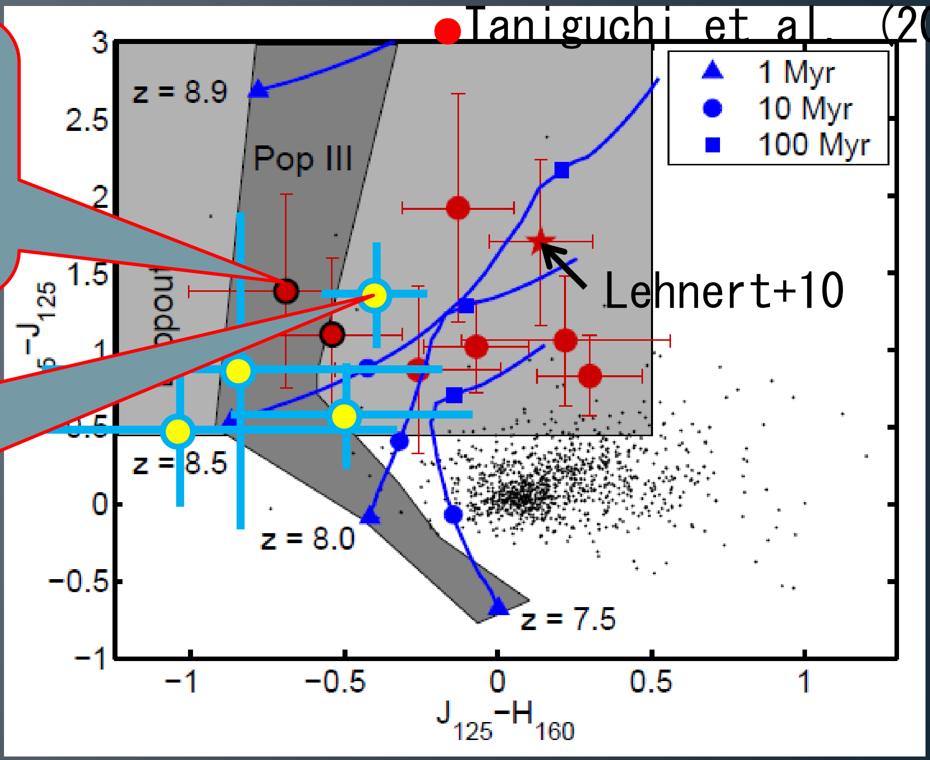
Expected Lya flux

～2×10⁻¹⁷erg／s／cm²
@ z=8–9

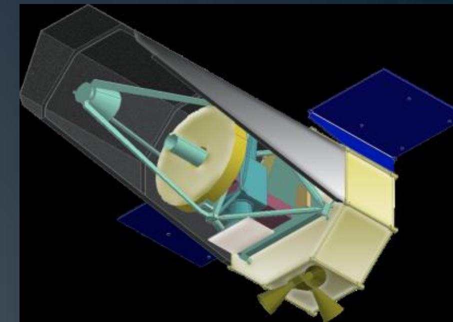
～4×10⁻¹⁸erg／s／cm²
@ z=8–9

UDF12

Schenker et al. 2013
McLure et al. 2013



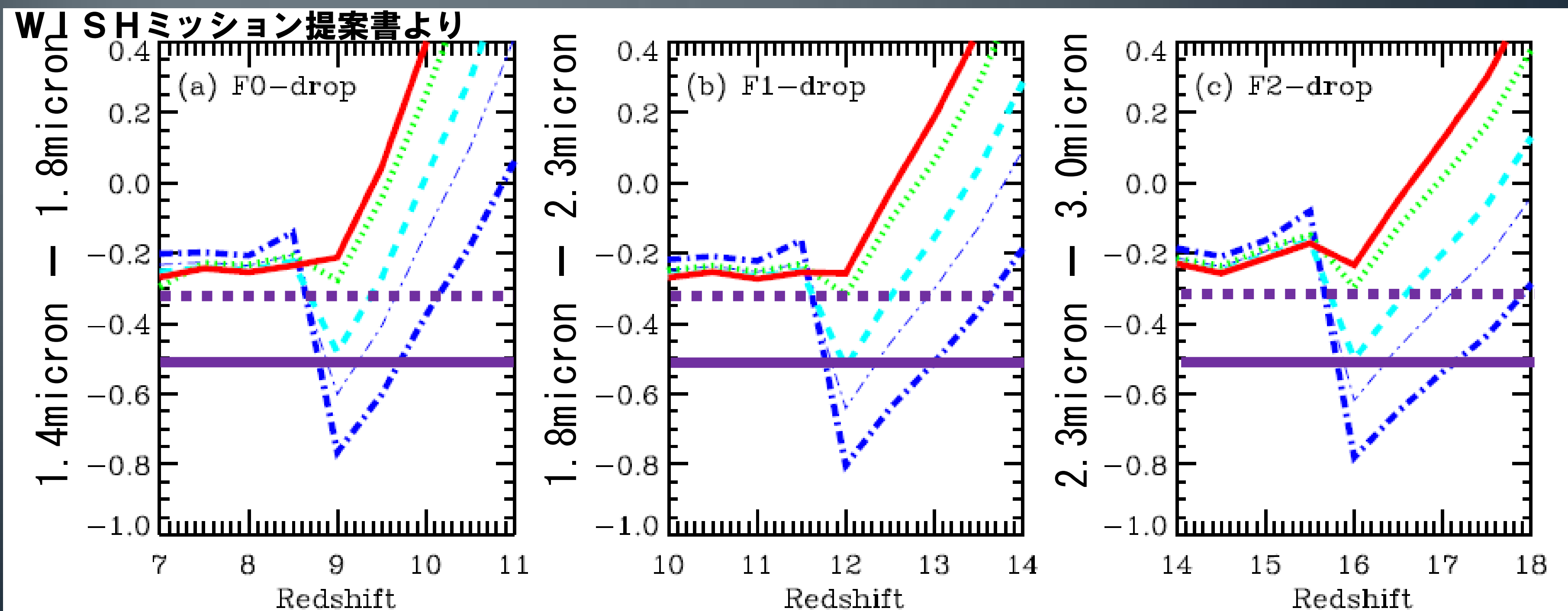
ESO VLT/X-shooter programs in P88 and P90 were not succeeded…



For WISH survey

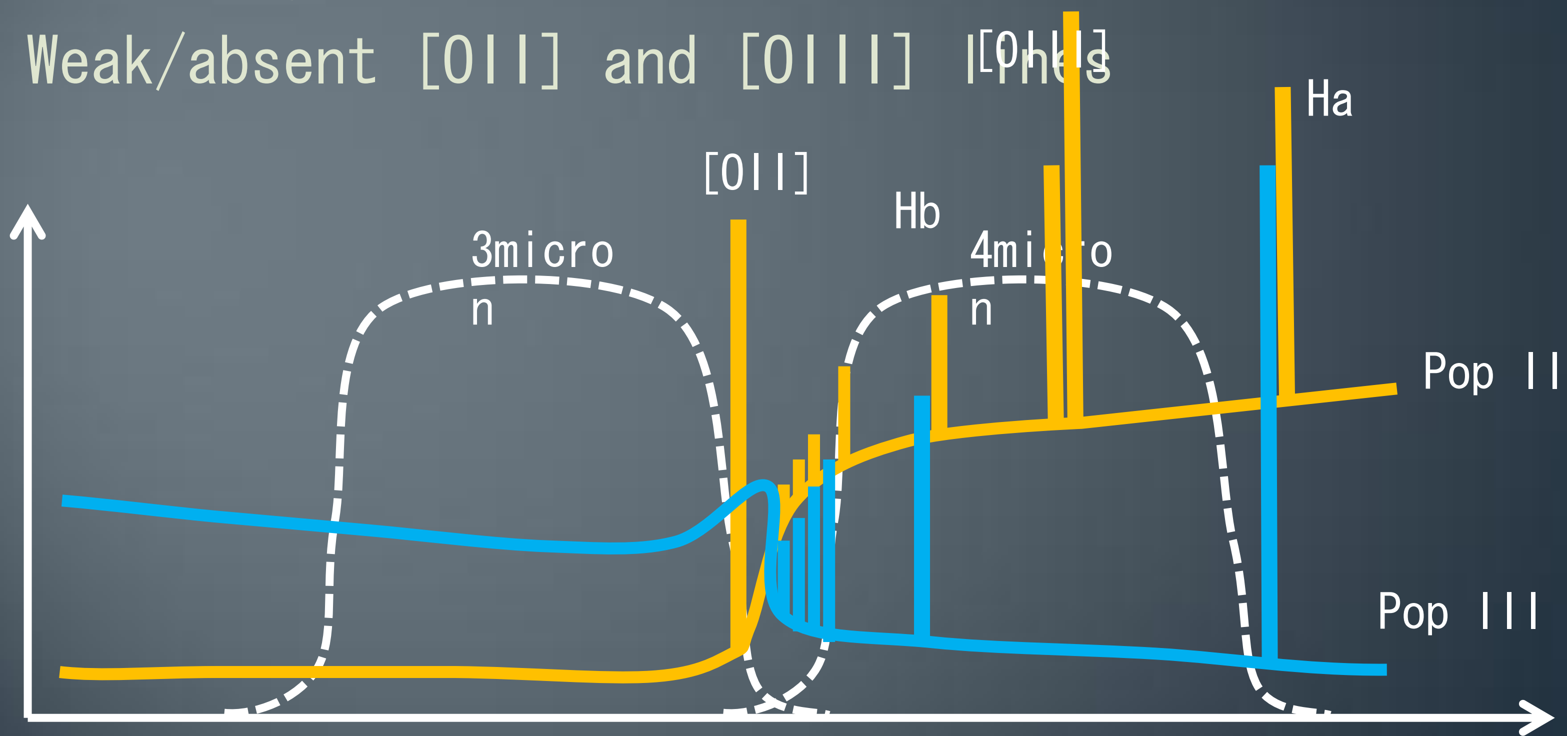
- WISH color < -0.5 (or -0.3) AB → Pop-III (or EMP) candidates

Constant SFR of 1 Myr, 50% Lya transmission through ISM and IGM, 50% escape
Red: Pop-I, Green: Pop-II, Cyan: EMP, Blue: Pop-III (thin line is the age of



Primordial signature imprinted in optical

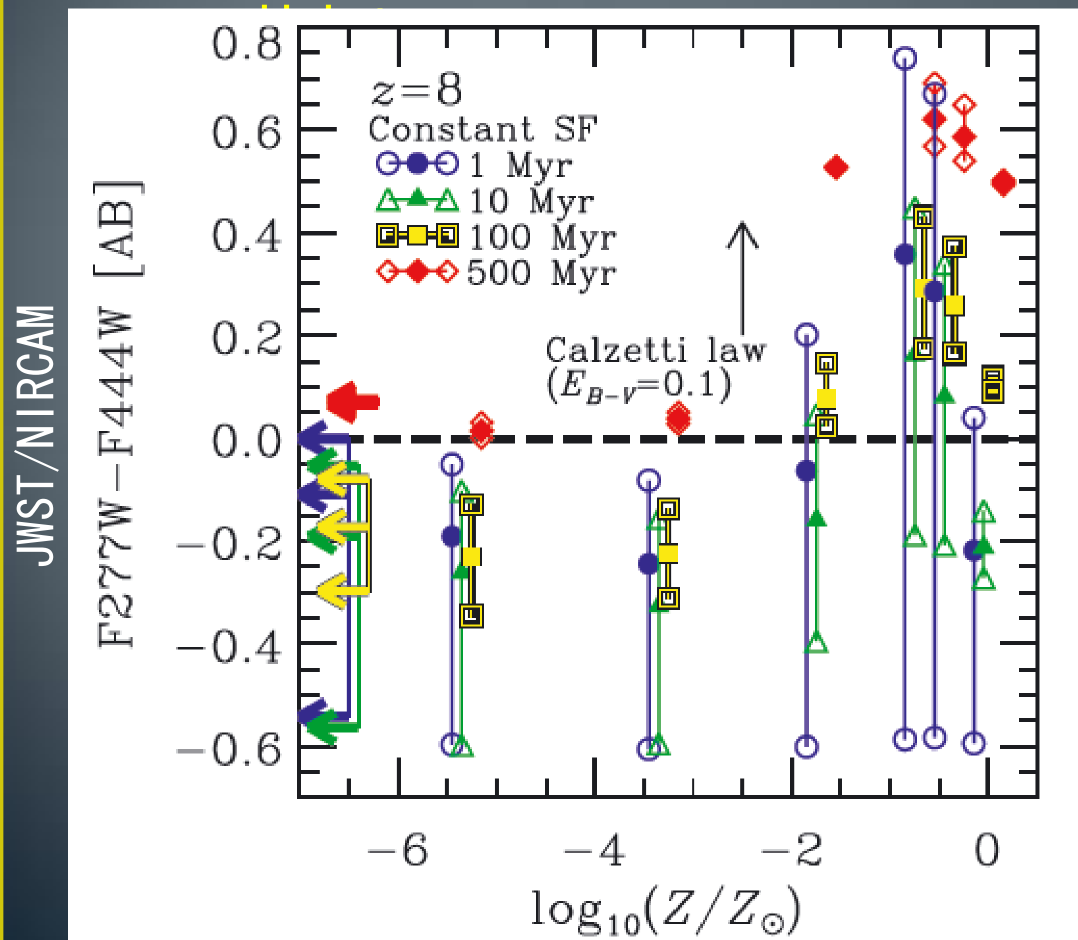
- Balmer jump/break
- Strong hydrogen Balmer lines
- Weak/absent [OII] and [OIII] lines



Rest optical diagnostics

Inoue 2011, MNRAS, 415, 2920

- 3micron−4micron < 0 AB → Pop-III or EMP



Balmer break
In old stellar conti

[OIII]5007 line

Balmer series lines

Balmer jump in nebular contin

Young stellar continuum

LyC escape fraction: 0% (upper), 50% (middle), 100% (lower)

Follow-up strategy

- Follow-up with TMT and JWST
  - Strong Lya line in very blue objects is the suitable target.
  - Rest optical lines (Ha, Hb for blue objects and [OII], [OIII] for red objects) could be also good targets.
- Follow-up with ALMA
  - FIR metal emission lines from red objects are interesting.
  - [CII] 158micron is good, but a bit long wavelength, then, only for lower redshift.
  - [OIII] 52/88 micron is very interesting for z>8.
    - Expected [OIII]88 line flux: 7e-19 cgs when Z~0.2Zsun for 28AB objects

      → 0.6 mJy (100 km/s/Δv) (1+z/10) @ 340 GHz