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The stellar mass versus stellar metallicity relation of star-forming galaxies at $1.6 \le z \le 3.0$ and implications for the evolution of the α-enhancement

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・Metallicity
- gas-phase emission => many MZR study
- stellar absorption => MZR study limited (hi-zではCullen+19くらい)

・alpha-enhancement(CCSNe/SNeIaの指標) => SFHの情報

・zCOSMOSデータ
- 1336 SFG @ z=1.6-3
- rest-UV spectra

・Metallicity measurement
- stacking
- BPASS modelでフィット。
  - ISMの吸収は除外する
  - nebular continuumも追加
  - 実質的に[Fe/H]が求まる

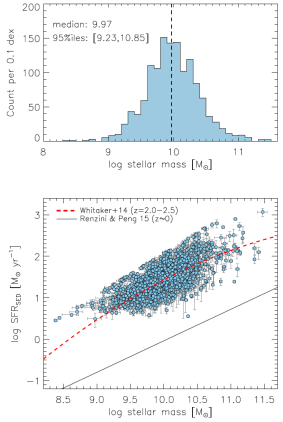

Figure 2. Results of the SED fitting. Upper panel: distri-

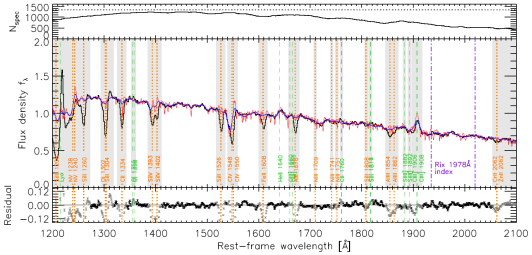

Figure 4. Composite VIMOS spectrum of the entire sample of 1336 galaxies at $1.6 \le z \le 3.0$. Top panel: the number of

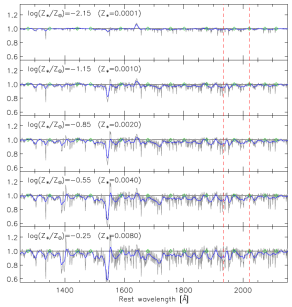

Figure 5. The BPASSv2.2.1 stellar population models.

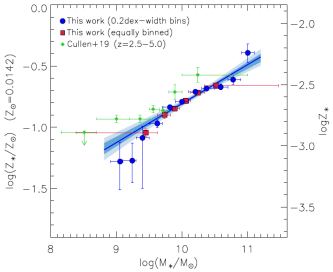

Figure 9. Stellar metallicity as a function of stellar mass,

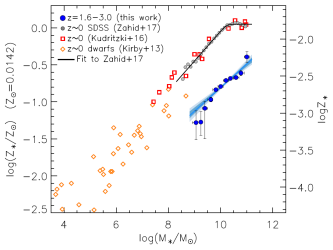

Figure 10. The stellar MZR for our sample (blue circles) at $\langle z \rangle = 2.22$ in comparison with those for $z \sim 0$ galaxies: SDSS

MZR

- 先行研究(<z>=3.5:Cullen+19)より少し低め。
  - Starburst99でフィットしているせい？BPASSにくらべ0.1dexほど高く出る
  - low-mass endでずれている
- z=0にくらべ0.8dex低い
- z=2.2の[O/H]にくらべて0.5dex小さい
  - [O/Fe]=0@z=0, 0.47@z=2.2
  - Strom+18([O/Fe]=0.42@z=2.2)と合致
  - 理論的上限は0.6なので、z=2ではSNIaによる鉄供給が全然進んでいない？
- モデル化:flow-through gas-regulated model (Lilly 2013)
  - MS進化を再現するようにパラメータ調整
  - Feのイールドを現実的な範囲内で調整したら再現できた(図16)
  - α元素超過はinstantaneous sSFRで決まる
- Galactic Starとの比較
  - High-zはThick disk starsと合致
  - 10Gyr前に形成、その時のMWの質量は1e10Msunなのでそれとも合致する

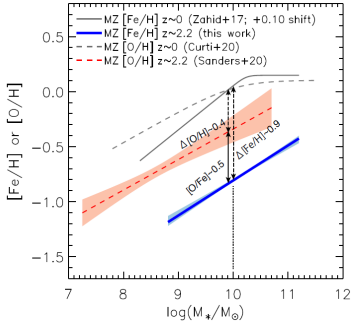

Figure 11. Comparison between the stellar ([Fe/H]) and gas-phase ([O/H]) MZRs at low and high redshifts: stellar

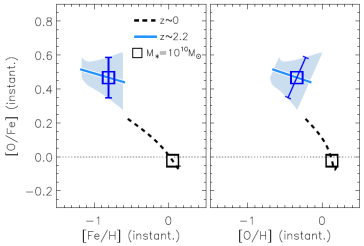

Figure 12. The implied [O/Fe] as a function of the iron abundance [Fe/H] (left panel) and the oxygen abundance [O/H] (right panel) obtained by eliminating M_* from the

銀河系のバルジに古いmetal-rich/low α 星がいるがそれの起源は？

1. 実は古い星ではない＋最近supersolar 星形成銀河がある？
2. 今回見えていない場所(ダストに覆われた星形成領域など：金属量が高い？)でできた
3. Z~2ですでに形成されていた？

2, 3だとSNIaのdelay timeはsupersolarでは短くなるひつようあり今回の観測された結果はless-dutyなものにバイアスされている可能性があることに要注意。

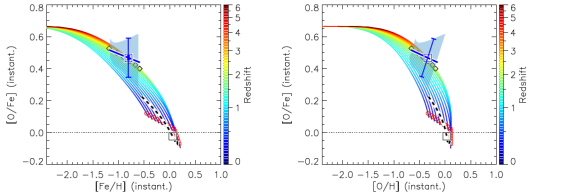

Figure 16. The calculated evolutionary tracks in the [Fe/H]–[O/Fe] (left) and [O/H]–[O/Fe] (right) diagrams in comparison with the observations (same as Figure 12). Visualization of the evolutionary tracks are the same as in Figure 15. The horizontal dotted line marks [O/Fe]= 0 (i.e., the solar value) in both panels.

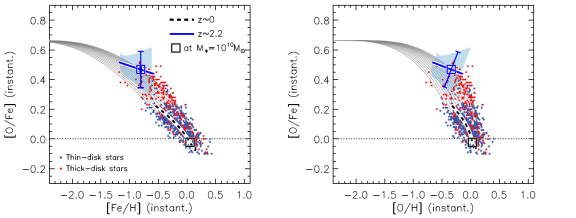

Figure 19. The observed data for $z \sim 2$ and $z \sim 0$ galaxies (same as in Figure 16) are compared to the data for the individual