大型光赤外線望遠鏡で探る
宇宙再電離と銀河形成

大内 正己
宇宙線研究所

共同利用研究課題

- 令和3年度

代表:大内正己

参加研究者：小野宜昭、播金優一、馬渡健、梅村雅之、他(東京大学、筑波大学、清華大学, UCLなど)。
計42名

予算:4万円(zoomライセンス等、オンライン対応)

論文（令和3年度中）

論文（査読論文、及び査読中/出版中の論文）: 23編

- Yajima,"FOREVER22: galaxy formation in protocluster regions",Monthly Notices of the Royal Astronomical Society,509,2022
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- Goto,"SILVERRUSH. XI. Constraints on the Ly{¥ensuremath{¥alpha}} Luminosity Function and Cosmic Reionization at z = 7.3 with Subaru/Hyper Suprime-Cam",The Astrophysical Journal,923,2021
- Gebhardt,"The Hobby-Eberly Telescope Dark Energy Experiment (HETDEX) Survey Design, Reductions, and Detections",The Astrophysical Journal,923,2021
- Zhang,"First HETDEX Spectroscopic Determinations of Ly{¥ensuremath{¥alpha}} and UV Luminosity Functions at z = 2-3: Bridging a Gap between Faint AGNs and Bright Galaxies",The Astrophysical Journal,922,2021
- Matsuoka,"Subaru High-z Exploration of Low-Luminosity Quasars (SHELLQs). XVI. 69 New Quasars at 5.8 $¥lt$ z $¥lt$ 7.0",arXiv e-prints,2021
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- Mawatari,"The SSA22 HI Tomography Survey (SSA22-HIT). I. Dataset and compiled redshift catalog",arXiv e-prints,2021
- Isobe,"EMPRESS. III. Morphology, Stellar Population, and Dynamics of Extremely Metal-poor Galaxies (EMPGs): Are EMPGs Local Analogs of High-z Young Galaxies?",The Astrophysical Journal,918,2021
- Aihara,"Third Data Release of the Hyper Suprime-Cam Subaru Strategic Program",arXiv e-prints,2021
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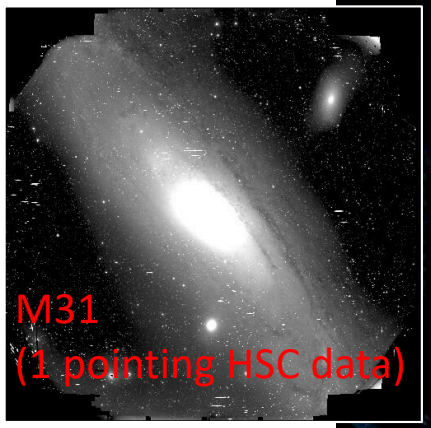
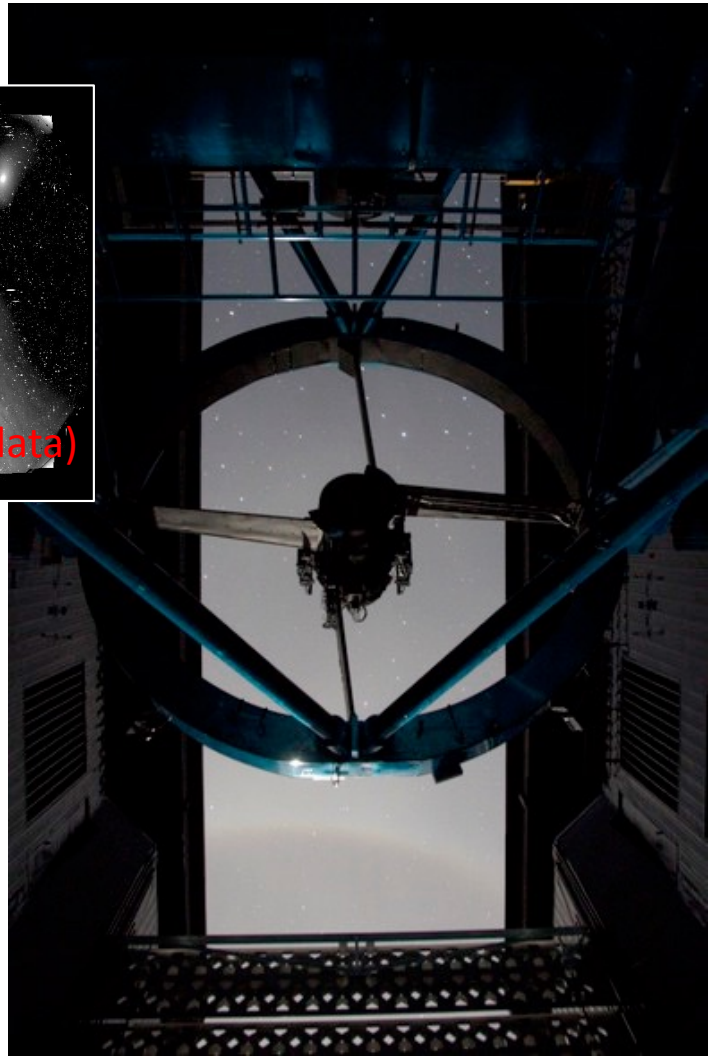
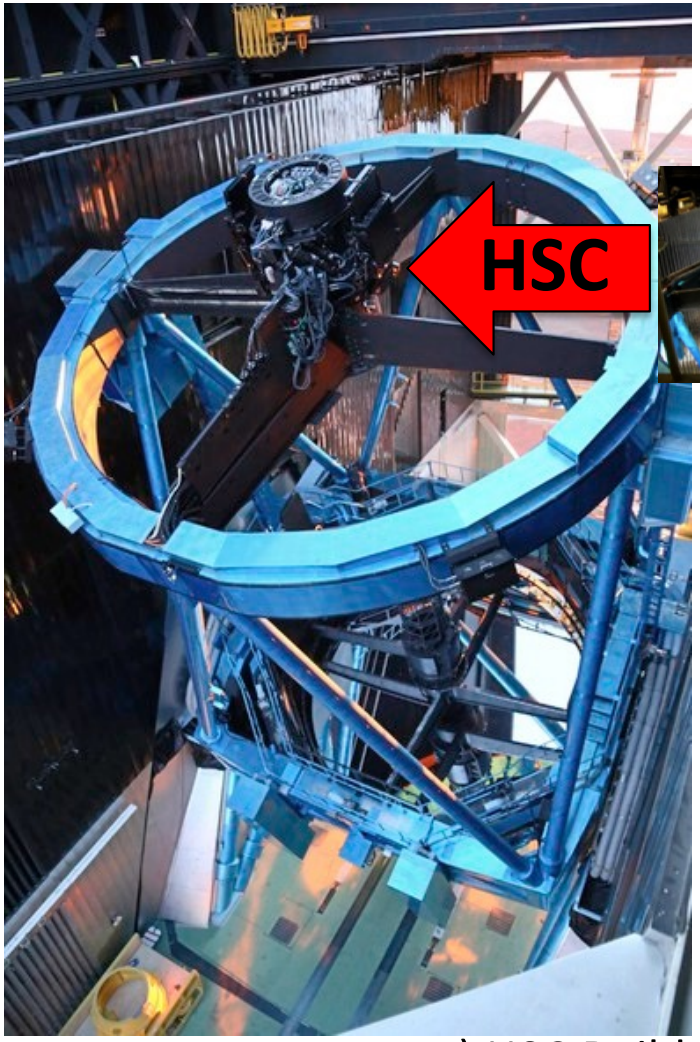
- Harikane,"GOLDRUSH. IV. Luminosity Functions and Clustering Revealed with ¥raisebox{-0.5ex}¥textasciitilde4,000,000 Galaxies at z¥raisebox{-0.5ex}¥textasciitilde2-7: Galaxy-AGN Transition, Star Formation Efficiency, and Implication for Evolution at z$¥gt$10",arXiv e-prints,2021
- Laporte,"ALMA Lensing Cluster Survey: a strongly lensed multiply imaged dusty system at z {¥ensuremath{¥geq}} 6",Monthly Notices of the Royal Astronomical Society,505,2021
- Kakuma,"SILVERRUSH. IX. Ly{¥ensuremath{¥alpha}} Intensity Mapping with Star-forming Galaxies at z = 5.7 and 6.6: A Possible Detection of Extended Ly{¥ensuremath{¥alpha}} Emission at {¥ensuremath{¥gtrsim}}100 Comoving Kiloparsecs around and beyond the Virial-radius Scale of Galaxy Dark Matter Halos",The Astrophysical Journal,916,2021
- Nagamine,"Probing Feedback via IGM tomography and the Ly{¥ensuremath{¥alpha}} Forest with Subaru PFS, TMT/ELT, and JWST",The Astrophysical Journal,914,2021
- Aoyama,"Gaia 400,894 QSO constraint on the energy density of low-frequency gravitational waves",arXiv e-prints,2021
- Kojima,"EMPRESS. II. Highly Fe-enriched Metal-poor Galaxies with {¥ensuremath{¥sim}}1.0 (Fe/O)$_{{¥ensuremath{¥odot}}}$ and 0.02 (O/H)$_{{¥ensuremath{¥odot}}}$: Possible Traces of Supermassive ($¥gt$300 M$_{{¥ensuremath{¥odot}}}$) Stars in Early Galaxies",The Astrophysical Journal,913,2021
- Fujimoto,"ALMA Lensing Cluster Survey: Bright [C II] 158 {¥ensuremath{¥mu}}m Lines from a Multiply Imaged Sub-L$^{{¥ensuremath{¥star}}}$ Galaxy at z = 6.0719",The Astrophysical Journal,911,2021
- Ono,"SILVERRUSH X: Machine Learning-aided Selection of 9318 LAEs at z = 2.2, 3.3, 4.9, 5.7, 6.6, and 7.0 from the HSC SSP and CHORUS Survey Data",The Astrophysical Journal,911,2021
- Strait,"RELICS: Properties of z {¥ensuremath{¥geq}} 5.5 Galaxies Inferred from Spitzer and Hubble Imaging, Including A Candidate z {¥ensuremath{¥sim}} 6.8 Strong [O III] emitter",The Astrophysical Journal,910,2021
- Miyatake,"First Identification of a CMB Lensing Signal Produced by 1.5 Million Galaxies at $z¥sim$4: Constraints on Matter Density Fluctuations at High Redshift",arXiv e-prints,2021

など。→ このうちKakuma, MO et al. (2021)とIsobe, MO et al. (2021)の結果を報告。

Subaru/Hyper Suprime-Cam (HSC)





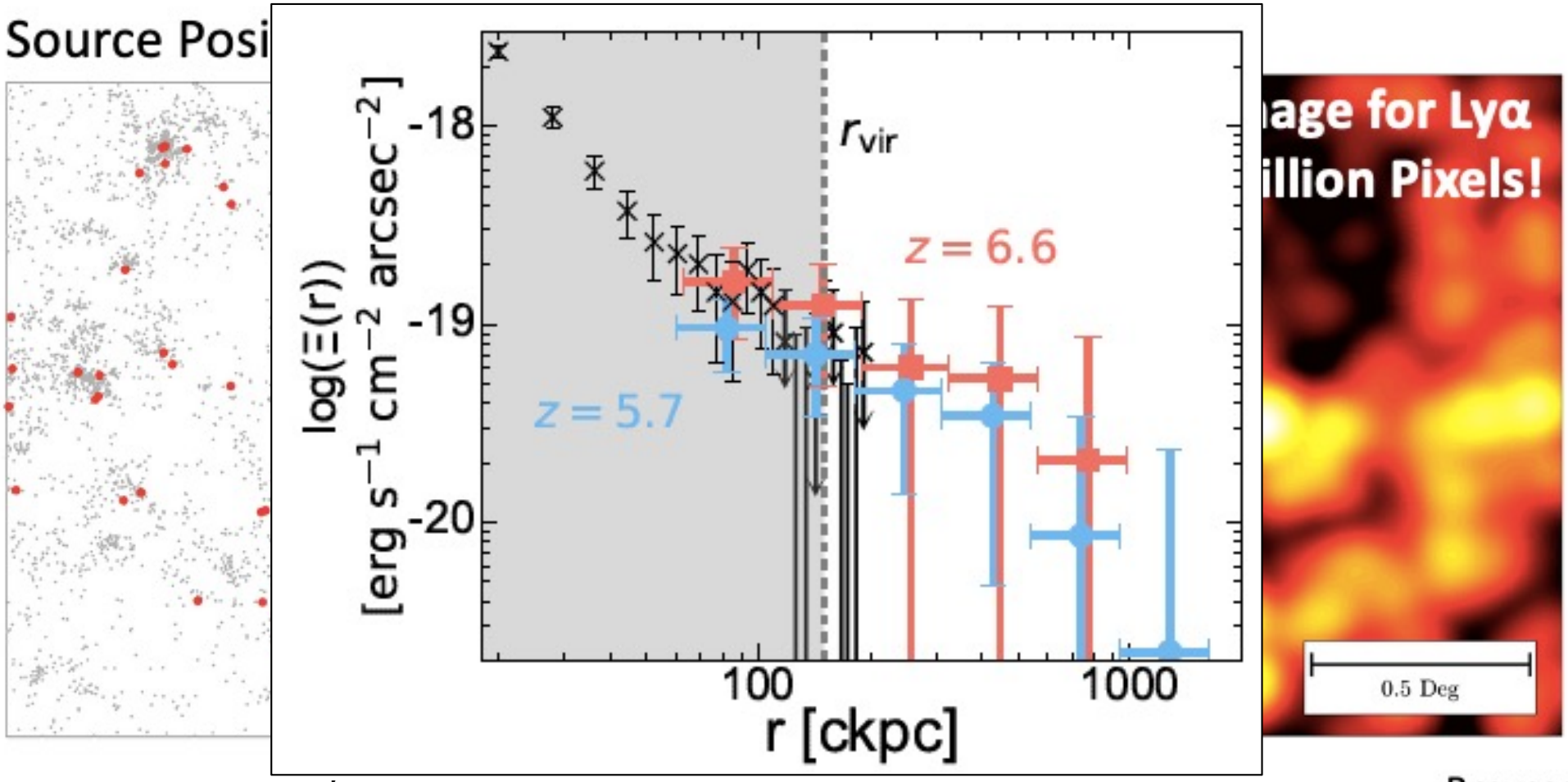


Suprime-Cam

c) HSC Builder's blog

- HSC: すばる可視光超広視野撮像装置（SCの7倍の探査速度）
- 2014年から観測スタート。観測完了（2021年）。
- 1000平方度のデータ。

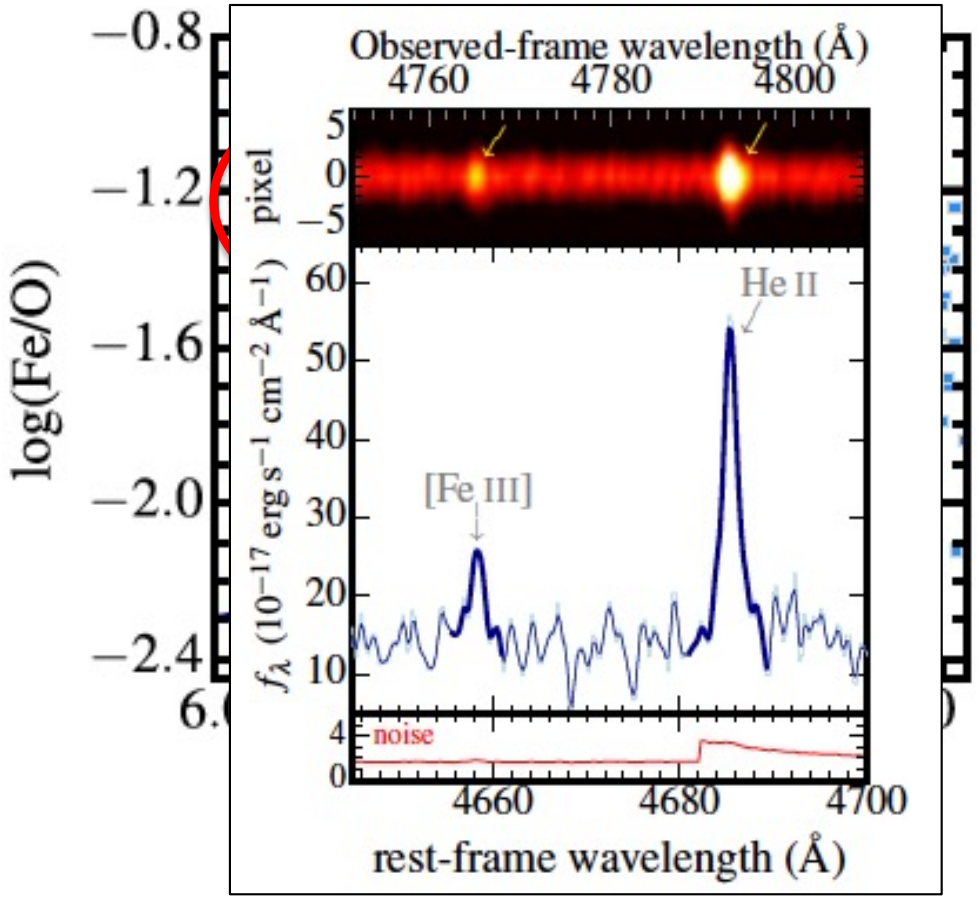
宇宙再電離期の Lyαハローの検出



Breysse+16

- Intensity Mapping法
  →z=6-7 (宇宙再電離期)でのLyα輝線ハローを検出（200-1000 comoving kpc）
  → 暗黒物質ハローの半径の約5倍
  → 何故、巨大なガスハロー？銀河周囲の水素のLyα散乱で説明難しい。周囲の矮小銀河？(Bacon+21)
- z=5.7とz=6.6を比較：進化無し（エラーを超えるレベルで）→宇宙再電離の影響は非検出

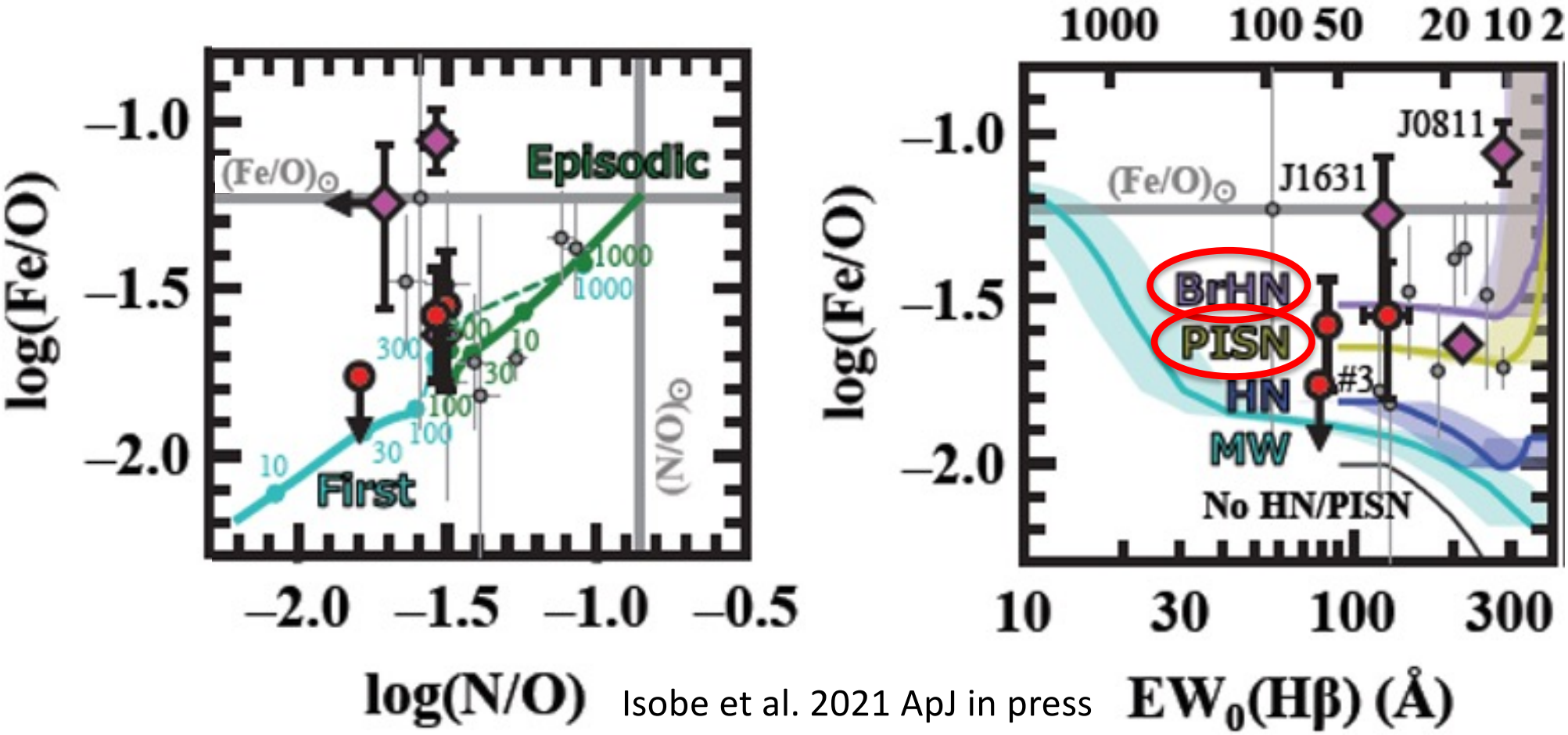
形成初期銀河の鉄元素



Kojima et al. (2021)

- HSCで検出された形成初期銀河
- 鉄の元素量が卓越 (Fe/O) ~ 1.0 (Fe/O)sun (Kojima+20/21)
  - 形成初期でなぜ？

理論モデルによる検証



Isobe et al. 2021 ApJ in press

- 高い (Fe/O) ~ (Fe/O)sun → 理論モデルによる説明
  - Ia型超新星爆発 (SNeIa) による鉄生成？→ No (delay timeより小さい星年齢)
  - 間欠的な星形成（古い星種族の存在）？→ No (N/Oが小さすぎるため）
  - ダストへの降着→No (IGMのFe/Oが小さいため）

  何か？→対不安定型超新星(PISNe)又は明るい極超新星 (HNe)の効率的鉄生成

まとめ

すばるHSCによる宇宙再電離と銀河形成の観測研究

１）宇宙再電離期のLyαハローの検出に成功
- 暗黒物質ハローの半径の約5倍に相当
- Lyα散乱で説明難しい。宇宙再電離の影響は非検出

２）Feが豊富な形成初期銀河の存在

→対不安定型超新星(PISNe)又は明るい極超新星(HNe)の効率的鉄生成で説明