EPOCHS VIII. An Insight into MIRI-selected Galaxies in SMACS-0723 and the Benefits of Deep MIRI Photometry in Revealing AGN and the Dusty Universe (arXiv:2309.06932v1)

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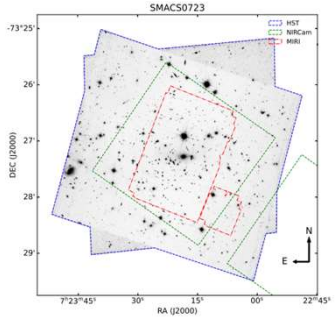
ABSTRACT

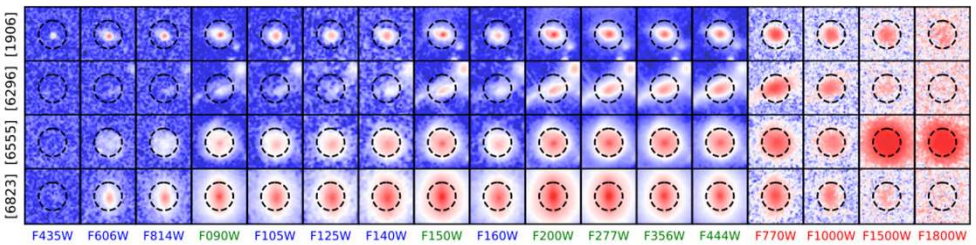
We present the analysis of the stellar population and star formation history of 181 MIRI selected galaxies at redshift 0 – 3.5 in the massive galaxy cluster field SMACS J0723.3–7327, commonly referred to as SMACS0723, using the James Webb Space Telescope (JWST) Mid-Infrared Instrument (MIRI). We combine the data with the JWST Near Infrared Camera (NIRCam) catalogue, in conjunction with the Hubble Space Telescope (HST) WFC3/IR and ACS imaging. We find that the MIRI bands capture PAH features and dust emission, significantly enhancing the accuracy of photometric redshift and measurements of the physical properties of these galaxies. The median photo-z's of galaxies with MIRI data are found to have a small 0.1% difference from spectroscopic redshifts and reducing the error by 20%. With MIRI data included in SED fits, we find that the measured stellar masses are unchanged, while the star formation rate is systematically lower by 0.1 dex. We also fit the median SED of active galactic nuclei (AGN) and star forming galaxies (SFG) separately. MIRI data provides tighter constraints on the AGN contribution, reducing the typical AGN contributions by ~14%. In addition, we also compare the median SED obtained with and without MIRI, and we find that including MIRI data yields steeper optical and UV slopes, indicating bluer colours, lower dust attenuation, and younger stellar populations. In the future, MIRI/MRS will enhance our understanding by providing more detailed spectral information and allowing for the study of specific emission features and diagnostics associated with AGN.

JWST/MIRI:中間赤外線の新たな観測装置
Spitzerと比べ感度・解像度が大幅に改善
→PAH輝線分析の進展・AGN検出への利用
本論文:SMACS0723のMIRI観測データ+HST, NIRCam
→**・遠方銀河の赤方偏移決定**
・dustyかつAGNをもつ銀河の物理情報決定
銀河の観測におけるMIRIの有用性は？

サンプリング
観測データ(HST, NIRCam, MIRI)
①SExtractorで光源を検出
②TOPCATで各検出器の光源の対応を決定
③ 以下の条件に合う光源を抽出
A) MIRIとNIRCamの双方で検出
B) 銀河団中心に近すぎない
C) 銀河である
D) (SEDフィッティング後)$\chi^2_{red} < 6$である
E) 分光赤方偏移のP値が測光赤方偏移の半分未満(2nd peakが存在する場合)
→181銀河をサンプリング
その後、HSTカタログとの照合を行う(0.3"以内に対応天体がないものはforcedアパーチャー内でHSTのフラックスを計算)



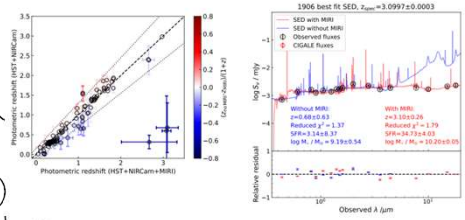
MIRI, NIRCam, HSTの各観測領域。画像はHSTのもの。

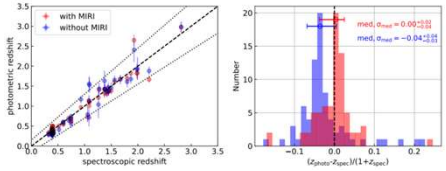


SEDフィッティング
photo-zを様々な方法で導くためcigale, EASYでSEDフィット

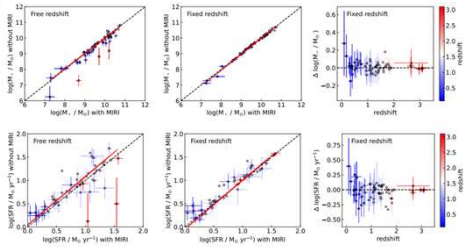
①MIRI, NIRCam, HSTデータを用いてSEDフィットを行い、銀河サンプルの物理量(赤方偏移、星質量、SFR、fracAGN)をχ^2検定とベイズ統計学的手法で決定
② ①と同じSEDフィットをMIRIデータを使わずに行い同様に物理量を決定

物理量の比較
①赤方偏移(測光赤方偏移)
・ほとんどは一致、MIRIにより誤差が半分
・一部の銀河はMIRIなしでlow-zと誤認
(ライマン/バルマーブレイクの誤認が原因)
・分光赤方偏移との比較:MIRIの使用により誤差が3%→0.1%

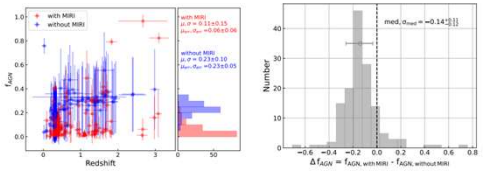


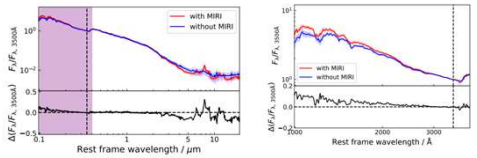


②SFR・星質量
zをfreeにしたfitとMIRI観測値でfixしたfit
・星質量は変化ほぼ無し、誤差0.1dex低下
・SFRは0.1dex低くなり誤差も0.1dex低下
・一部天体(zの誤差が大きかったもの)は誤差が劇的に小さくなった



③fracAGN
・MIRIの使用により全体的に値が下がる
・各データ点の誤差が平均0.17低下、
①や②と同様改善がみられる
・SEDフィッティングよりfracAGN＞0.1でAGN、それ以外がSFG?



Median SED比較

MIRIデータ使用の有無によるmedian SEDの変化:
・4μm以上でwith MIRIが顕著なPAH輝線を示す
・可視光とUV slopeがsteepに
→ダスト減光が弱く、若い星が多いと判断される