Some post-starburst E+A galaxies are not truly post starburst

Baron+2022, arXiv: 2204.11881

Post-starburst E+A galaxies are believed to be systems in a rapid transition between major merger starbursts and quiescent ellipticals. Their optical spectrum is dominated by A-type stars, suggesting a significant starburst that was quenched recently. While optical observations of post-starburst galaxies suggest little ongoing star formation, they have been shown to host significant molecular gas reservoirs. This led to the suggestion that gas consumption or expulsion are not required to end the starburst, and that star formation is suppressed by turbulent heating of the molecular gas. We present NOEMA continuum and CO(1-0) observations of 15 post-starburst galaxies, and collect CO measurements in post-starburst galaxies from the literature. Using archival far-infrared observations, we show that the majority of these systems host obscured star formation, with some showing far-infrared emission that is comparable to those of luminous and ultraluminous infrared galaxies. Once far-infrared star formation rates are used, these systems show similar SFR-M_{H_2} and Kennicutt-Schmidt relations to those observed in star-forming and starburst galaxies. In particular, there is no need to hypothesize star formation quenching by processes other than the consumption of molecular gas by star formation. The combination of optical, far-infrared, and CO observations indicates that some regions within these galaxies have been recently quenched, while others are still forming stars at a high rate. We find little connection between the post-burst age of the optically-thin quenched regions and the star formation rate in the obscured regions. All this calls into question the traditional classification of E+A galaxies.

Post-starburst galaxies : A型星の水素吸収が卓越 -> 星形成を終えて~1Gyr
- SF -> Quiescentの遷移銀河
- 多くがtidal feature -> Merger remnant
- Significant molecular gas & Significant obscured SF?

-> Gas consumption vs Turbulent heating
-> CO観測(NOEMA) & far-IR(IRAS)で星形成活動の実態を探る

Sample from Baron+2022
- Post-starburst (EW(Hδ)>5 Å) with AGN and ionized outflow
  -> 15天体をNOEMAでCO(1-0)観測
- 下記の先行研究からもCO観測のあるpost-starburst銀河を集め、far-IR (IRAS or Herschel) SFRを測定

Sample	Post-starburst selection	Emission line properties	N_{obj}	M_{H_2} detections	SFR(FIR) detections
French et al. (2015)	$H\delta_A - \sigma(H\delta_A) > 4$Å	EW(Hα) < 3Å	32	17 (53%)	32 (100%)
Rowlands et al. (2015)	PCA on 3175–4150Å: selection according to Hδ and Dn4000Å	SF/AGN/composites	11	10 (90%)	9 (81%)
Alatalo et al. (2016b)	$H\delta_A > 5$Å	SF/AGN/composites	52	47 (90%)	35 (67%)
Yesuf et al. (2017)	$H\delta_F \gtrsim 3$Å & cuts on (NUV-g) and Dn4000Å	Seyferts	24	6 (25%)	12 (50%)

M_* vs SFR図
- far-IR SFRは可視SFR(Dn4000)よりかなり大きい
- 可視だとMSかその下だが、far-IRだとMSよりSFRが高くULIRGs並み(可視輝線が強いとより高い位置にくる)
- 可視SFHから想定されるA型星によるfar-IR放射では説明できない

Fig. 2

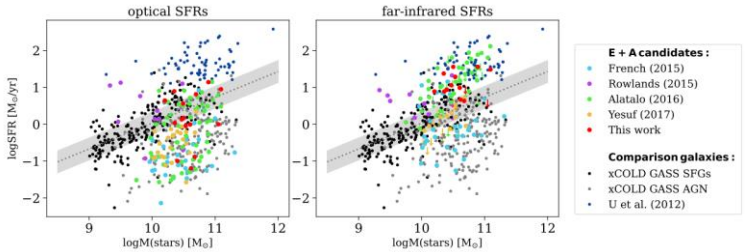
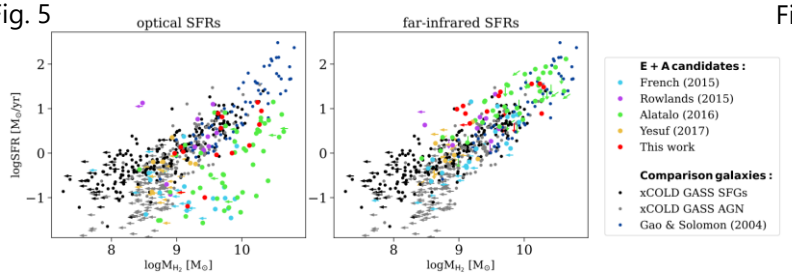
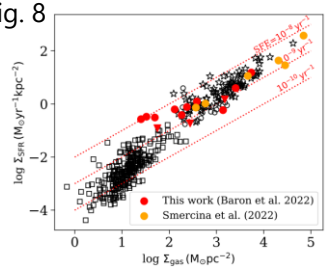


Fig. 5



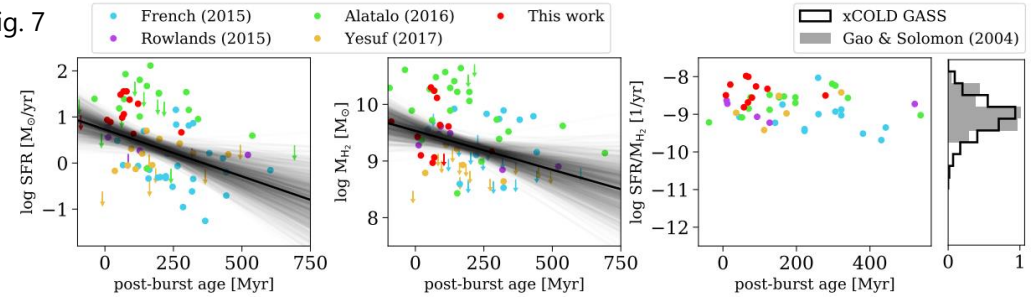
M_{H_2} vs SFR図
- far-IR SFRを用いるとSF- & SB-銀河を同じような系列に乗る
- 可視SFRに対して多くの分子ガスを持つものほど実際はobscured星形成領域を持っている

Fig. 8



KS-law (Σ_{gas} vs Σ_{SFR})
- far-IR SFRと適切なサイズ(可視光ではなく、COサイズ)を用いると、オフセットはない

Fig. 7



SFR, M_{H_2}, post-burst ageの相関
- French+2018でmolecular gas fractionがpost-burst ageとともに減少すること、Li+2019でSFEがpost-burst ageの関数として大きく減少することが示唆された。

-> 本論文ではfar-IR SFRを使うことでSFEが一定になる。SFR, M_{H_2}とpost-burst ageの相関(分散大)はSFE一定でSFRがpost-burst ageと弱く相関することによる。
-> SFRの減少はシンプルな分子ガス消費の描像で説明できる。

Fig. 9