Central star formation in double-peak gas rich radio galaxies

Maschmann et al. 2021, arXiv:211212796

The respective contributions of gas accretion, galaxy interactions, and mergers to the mass assembly of galaxies, their morphological transformations, and the changes in their molecular gas content and star formation activity are still not fully understood. Galaxies with two kinematic components which are manifested as a double-peak (DP) in their emission lines, have been identified in a recent work to play a major role in the morphological transformation towards larger bulges. Notably, star-forming DP galaxies display a central star formation enhancement and are thought to be associated to a sequence of recent minor mergers. In order to probe merger induced star formation mechanisms, we conducted observations of the molecular gas content of star-forming DP galaxies in the upper part of the main sequence (MS) of star formation with the IRAM 30m telescope. In combination with existing molecular gas observations from the literature, we gathered a sample of 41 such galaxies. We succeed to fit the same kinematic parameters to the optical ionised and molecular gas emission lines for 24 (59 %) galaxies. We find a central star formation enhancement which is most likely the result of a galaxy merger or galaxy interactions which is indicated by an excess of gas extinction found in the centre. This star formation is traced by radio continuum emissions of 150 MHz, 1.4 GHz and 3 GHz, which are all three linearly correlated with the CO luminosity described by the same slope. By comparing the measured star formation efficiency and the molecular gas mass fraction with the expected values of the MS, we find a significantly larger amount of molecular gas in the present DP galaxies and larger depletion times. We discard a scenario of large scale instabilities driving gas into the centre and find no direct link between the measured kinematic signatures and inclination. This leads us to conclude that the observed DP galaxies are mostly the result of a recent merger that funnelled molecular gas towards the centre, triggering efficient star formation there.

Double-peak emission line galaxies (DP galaxies)

= Post-coalescence mergers？質量獲得、形態変化に重要な段階

Maschmann+20(M20): 5663 DP galaxiesでlenticular galaxies(S0)が多い

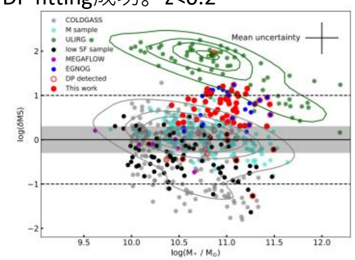
星形成は中心集中, DPは回転ディスクではなく、minor merger

→ 分子ガスの観測を追加して、DP galaxiesの性質を探る

Sample: 新たなCO観測と過去データのかき集め

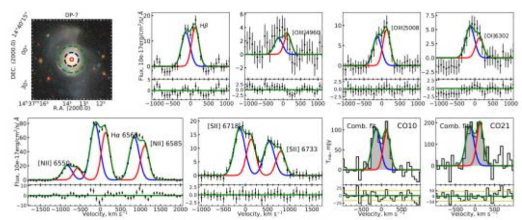
- M20&IRAM: δMS>0.3dex & Sf or COMP & radio continuum観測あり→34
- DP galaxiesのCO観測をCARMA, FCRAO, IRAM(COLDGASS)などから → 7

→ 24天体(59%)についてionized gasとCOを同じ速度、速度分散でDP fitting成功。z<0.2



比較用サンプル

- COLDGASS = represent local galaxy population (Saintonge+11, 17)
- M sample = Around MS at higher-z(0.5-3.2) (Tacconi+18)
- EGNOG = Above MS (Bauermeister+13)
- ULIRG = 複数文献から計94天体 (LFIRによるSFRはAGNの影響やcompanionの混入でoverestimate)
- Low SF sample = 複数文献から計45天体
- MEGAFLOW = in- and outflows in CGM (Freundlich+21)

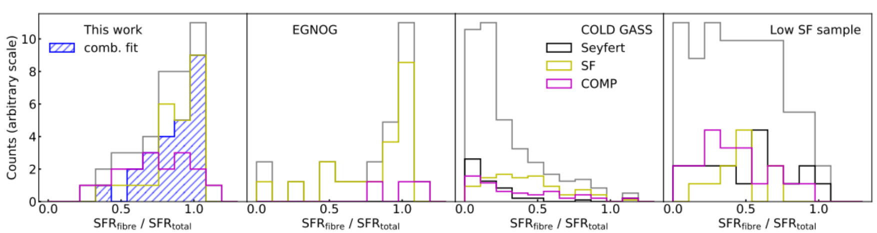


星形成の中心集中度

- SFR_{fibre}/SFR_{total}をBrinchmann+04の値で計算

→ DP, EGNOG sampleで中心集中した星形成

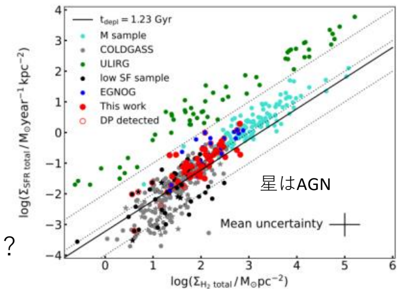
(ULIRG, M sampleについてはSDSSの観測がない or high-z過ぎてSFR_{fibre}/SFR_{total}が意味を持たないため、図示なし)



KS-relation

- DP, EGNOG sampleはtdepl~1Gyrの線上で、密度は近傍のCOLDGASSと高赤方偏移のM sampleの間
- 二成分分離フィットに成功した24天体について、それぞれの成分でプロットする(下図)
  - 二成分が同じtdepl → 相互作用で生じうるinner rotating gaseous disk?
  - 二成分が異なるtdepl → mergerによる異なる二成分？

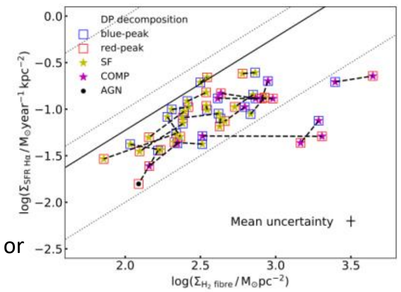
→ 検証には空間分解した可視や電波の観測が必要



Molecular gas-to-stellar mass ratioとdepletion timescale

- DP, EGNOG sampleはMSで予想される値と比べて…
  - μgasが高い
  - tdeplはMSと同程度
- MEGAFLOW(in-, outflow in CGM)はMSとどちらも同程度

→ DPではmergerで大量のガスが流れ込んだか



CO luminosityとradio continuumの相関

- DP sampleはいずれの周波数でもlow SFやM sampleのSF or COMPのものと同じ相関に乗る
- AGNが効くとULIRGのように外れる

→ DP sampleはAGNの影響を受けていないmergerによる中心starburst?