A panchromatic spatially-resolved analysis of nearby galaxies - Ⅱ.
The main sequence – gas relation at sub-kpc scale in grand-design spirals

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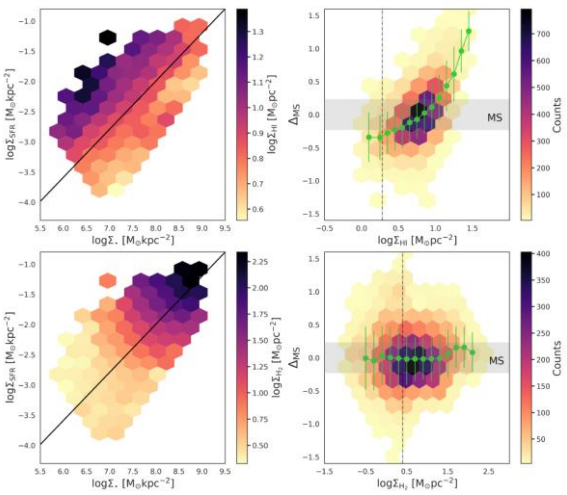
ABSTRACT

In the second work of this series, we analyse the connection between the availability of gas and the position of a region with respect to the spatially resolved main sequence (MS) relation. Following the procedure presented in Paper I we obtain 500pc scales estimates of stellar mass and star formation rate surface densities ($\Sigma_\star$ and Σ_{SFR}). Our sample consists of five face-on, grand design spiral galaxies located on the MS. Thanks to HI 21cm and ^{12}CO(2-1) maps, we connect the gas surface densities and gas fractions to the observed star formation properties of each region. We find that the spatially resolved MS (σ = 0.23 dex) is the combination of two relations: the Kennicutt-Schmidt law (σ = 0.19 dex) and the molecular gas MS (MGMS, σ = 0.22 dex); $\Sigma_\star$, Σ_{SFR} and the surface density of the molecular gas, Σ_{H_2}, define a 3D relation as proposed by Lin et al. (2019). We find that Σ_{H_2} steadily increases along the MS relation, varies little towards higher Σ_{SFR} at fixed stellar surface densities (not enough to sustain the change in SFR), and it is almost constant perpendicular to the relation. The surface density of neutral gas (Σ_{HI}) is constant along the MS, and increases in its upper envelop. Σ_{SFR} can be expressed as a function of $\Sigma_\star$ and Σ_{HI}, following the Equation: $\log\Sigma_{SFR} = 0.97\log\Sigma_\star + 1.99\log\Sigma_{HI} - 11.11$. Finally, we show that f_{gas} increases significantly towards the starburst region in the $\log\Sigma_\star$ - $\log\Sigma_{SFR}$ plane, accompanied by a slight increase in SFE.

論文のポイント

- 23個ものバンドのデータを用いてよりrobustなSED-fittingを行った
- KS law、 MGMS、 rSFMSの三者の関係を調べた

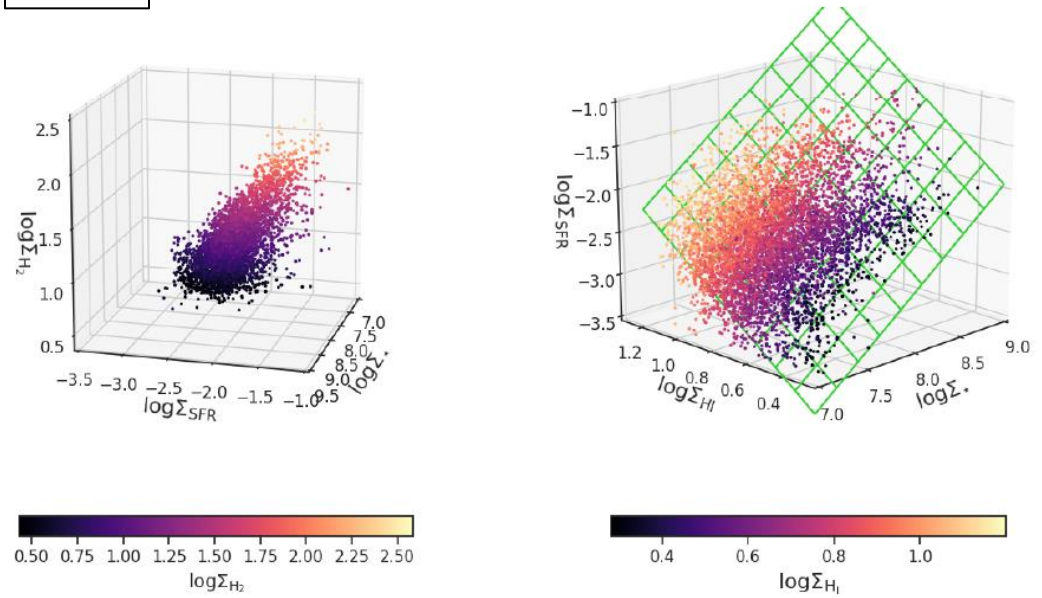
Fig. 4



サンプル

- DustPediaから大規模螺旋構造を持つSFGを抽出(Hubble stage index Tが2〜8、かつ $D_{25} > 6'$、かつ$i < 40°$、かつ22 Mpc以内)
- 5個の銀河

Fig. 6



結論

- $\log\Sigma_*$、 $\log\Sigma_{SFR}$、 $\log\Sigma_{H_2}$ の三者の3D plotにより、KS lawが最もtightな関係(0.19 dex)、次いでMGMS(0,22 dex)、rSFMS(0.23 dex)となった
  - ➢ Sub-kpcでのMGMSの存在から、SFRやstellar massのみからgasを推測できる可能性
- 分子ガスはMSに沿って増加、MSと垂直方向には一定
  中性ガスはMSに沿って一定
  - ➢ MSより上側は$\Sigma_{HI} \geq 10\ M_\odot pc^{-2}$であり、これはH Ⅰ からH2へ変化する典型値
- 高Σ_{SFR}になるほど分子ガスの割合もSFEも増加
  一方で中性ガスも含めたtotal gasで考えるとガス割合は増加するがSFEは弱い増加しか見せない
- 外側のdisc(星形成領域の多くが分布、高密度なH Ⅰ)では、小さな分子雲が星形成のfeedbackにより簡単に解離
- 銀河中心から中距離ではより強い輻射場によって高密度H Ⅰ がH2の解離を妨げている