Which star formation law in M31?

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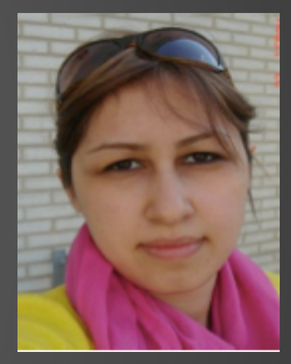


Introduction

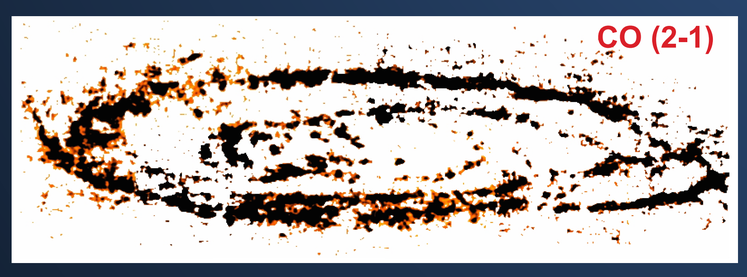
* The empirical Schmidt-Kennicutt Law: power-law relationship between the volume densities of the star formation rate (SFR) and gas mass ($\Sigma_{SFR} \propto \Sigma_{gas}^{1.4\pm0.15}$)
* Existing stars within a galaxy contribute to the SFR
* The Extended Schmidt Law: Power-law relationship between surface densities of SFR, gas mass and stellar mass ($\Sigma_{SFR} \propto \Sigma_{gas}^{N'} \Sigma_{star}^{\beta}$)

Image credit: (Jacob Bers) NASA/APOD/140730

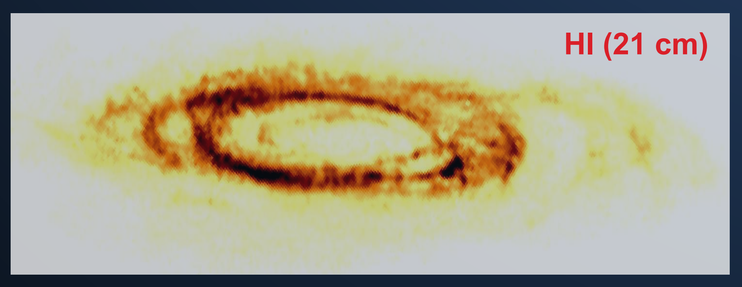
* The Andromeda galaxy serves as a unique testbed in which we seek to understand the extended Schmidt law, with the ultimate goal to understand the SFR in more distant galaxies

Gas Mass

* Surface density of total gas in the galaxy contains molecular plus neutral gas. CO (2-1) emission (from IRAM 30-m telescope) is used as a tracer of molecular gas in galaxy (Nieten et al., 2006). We choose the conversion factor as $X_{CO} = 2 \times 10^{20}$.



* HI moment-zero map presented in Chemin et al. (2009), using Synthesis Telescope and the 26-m antenna at DRAO.



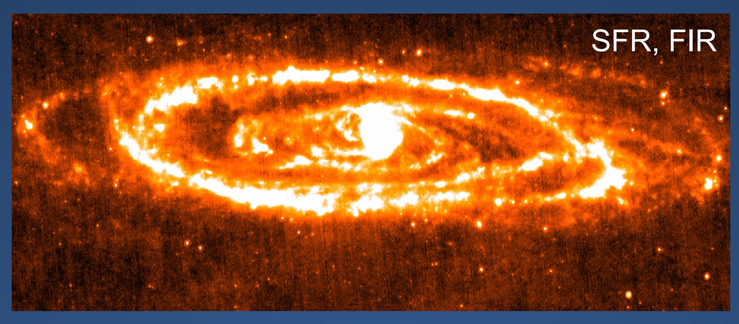
* The total gas mass was calculated from:

$$M_{total\ gas} = 1.36[MHI + MH_2]$$

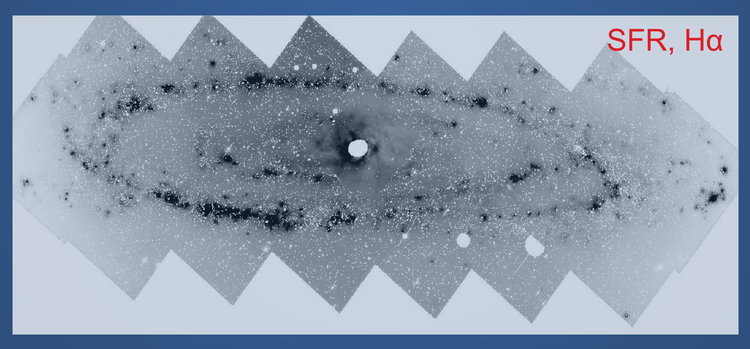
Factor 1.36 is a constant to consider He and the other heavier elements effect on gas mass.

Star Formation Rate

* Far Infrared Luminosity (FIR) is calculated from calibration provided by Boquien et al. (2010) using luminosity of galaxy in 8, 24, 70, and 160 μm.
* Spitzer (MIPS and IRAC) data is used.
* Star formation rate is calculated using formula introduced in Calzetti et al. (2007)



* Star formation rate map is made by using Hα emission (Massey et al., 2007) plus 24μm (Gordon et al., 2004) as a tracer of star formation. Star formation rate is calculated by the relation from Calzetti et al. (2007)



* Table 1 shows the comparison of total SFR in $M_{\odot}yr^{-1}$ calculated by different groups.

ref.	*Method*	*Total SFR*
Current work	Hα and 24μm	*0.25*
Current Work	*TIR luminosity*	*0.4*
Ford et al. (2013)	FUV and 24μm	*0.25*
Ford et al. (2013)	*TIR luminosity*	*0.48-0.52*
Azimlu et al. (2011)	Hα and 24μm	*0.34*
Azimlu et al. (2011)	Corrected Hα	*0.44*

Stellar Mass

* The Andromeda galaxy image from Spitzer/IRAC in 3.6 μm emission (Barmby et al., 2006) is used as a tracer of existing stars. Conversion from 3.6 μm flux to stellar mass is performed using the calibration of Eskew et al. (2012).

* Using this method total stellar mass is calculated $M = 6.94 \times 10^{10} M_{\odot}$.

References:
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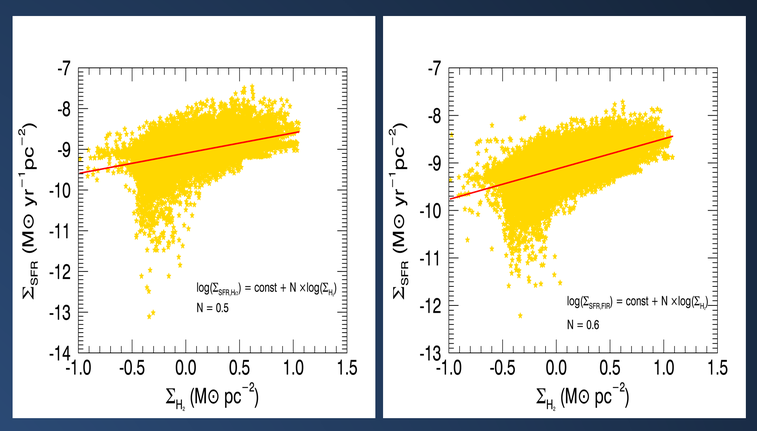
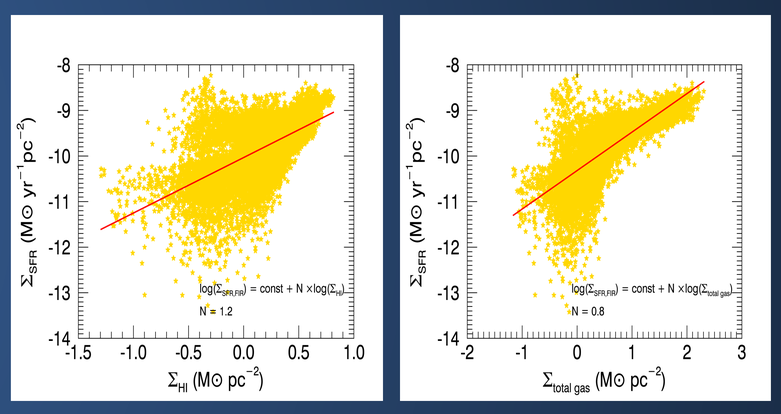
Fitting SFR Laws

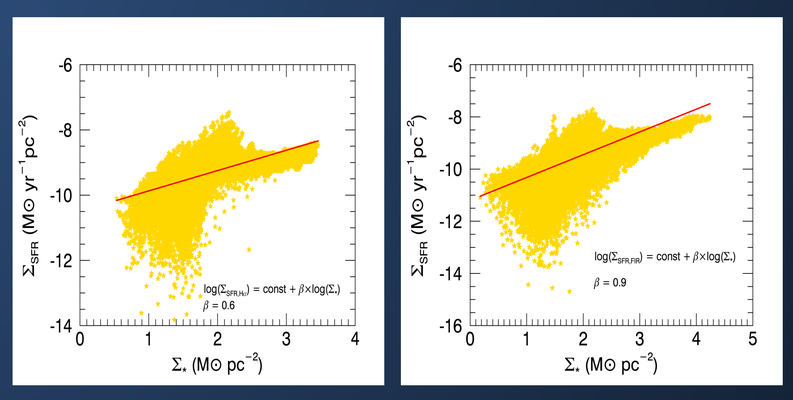
K-S law fitting:
Surface density of SFR (Hα + 24μm/FIR) VS. surface density of Molecular Hydrogen



K-S law fitting:
Right: surface density of SFR(FIR) VS. surface density of Atomic Hydrogen
Left: surface density of SFR(FIR) VS. surface density of total gas



Extended Schmidt law fitting:
Surface density of SFR (Hα + 24μm/FIR) VS. surface density of star



Which SFR Law?

* Preliminary results: K-S law index in M31 sits in low end of the relation determined by Kennicutt (1998b)
* Preliminary results: Surface density of star formation rate correlates with old stellar population mass surface density (in some cases has better correlation than surface densities of SFR and Gas mass)
* Future work: In different region of the M31 which SFR law works better and why?

Support for this work is provided by an NSERC Discovery Grant

Presented at the From Galactic to Extragalactic Star Formation – GESF2014

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