Understanding galactic scaling relations on resolved scales

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The interplay between local and global processes in galaxies
Cozumel, 12/04/2016

Outline

Understanding

Scaling relations

I'm not a number...

Scaling relations

I'm not a number...

... perhaps two, or even three!

A spherical-cow model

Diffuse gas: M_{HI}

Molecular clouds: M_c

Stars: M_*

A spherical-cow model

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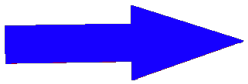
A spherical-cow model

Infall 

Diffuse gas: M_{HI}

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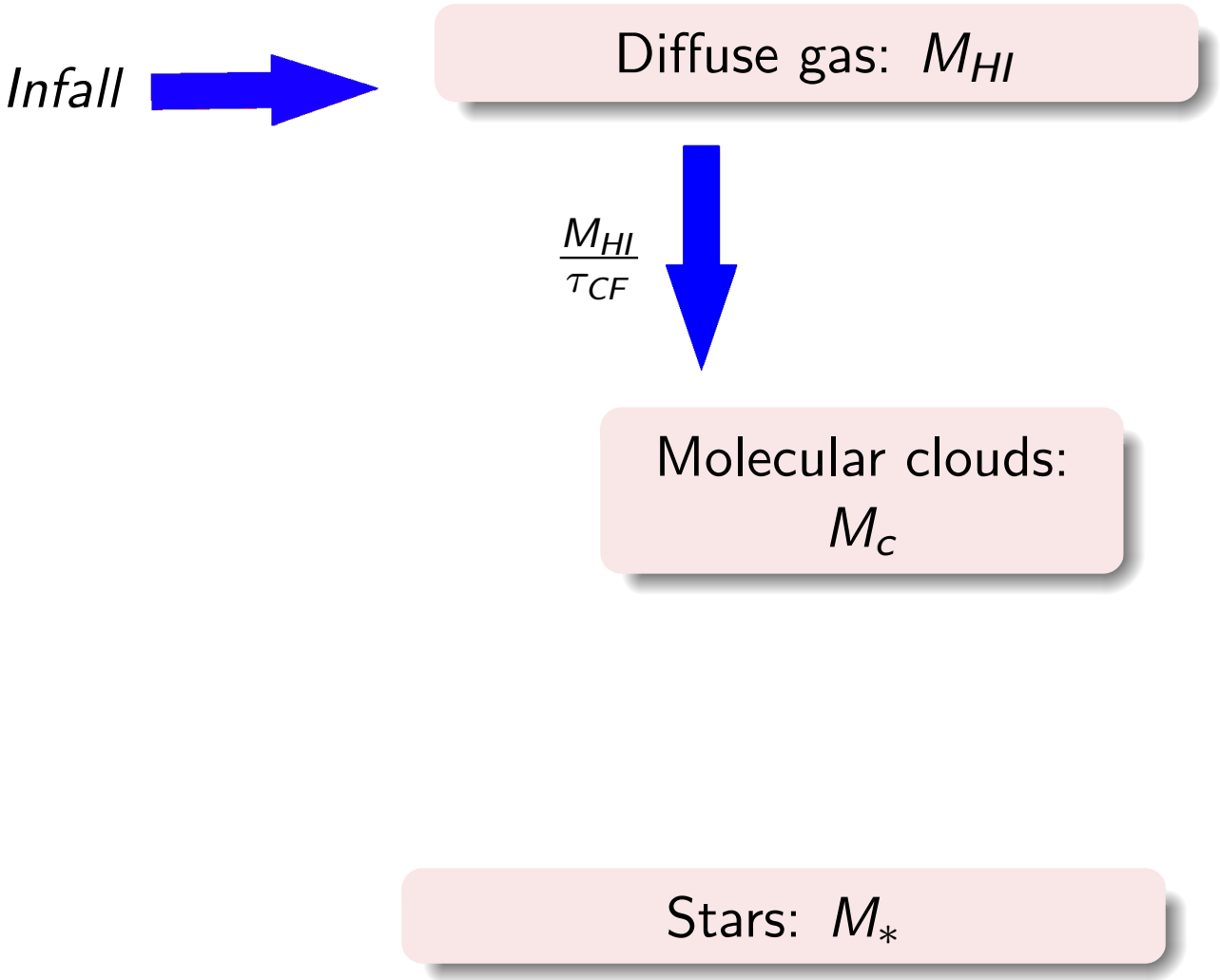
A spherical-cow model



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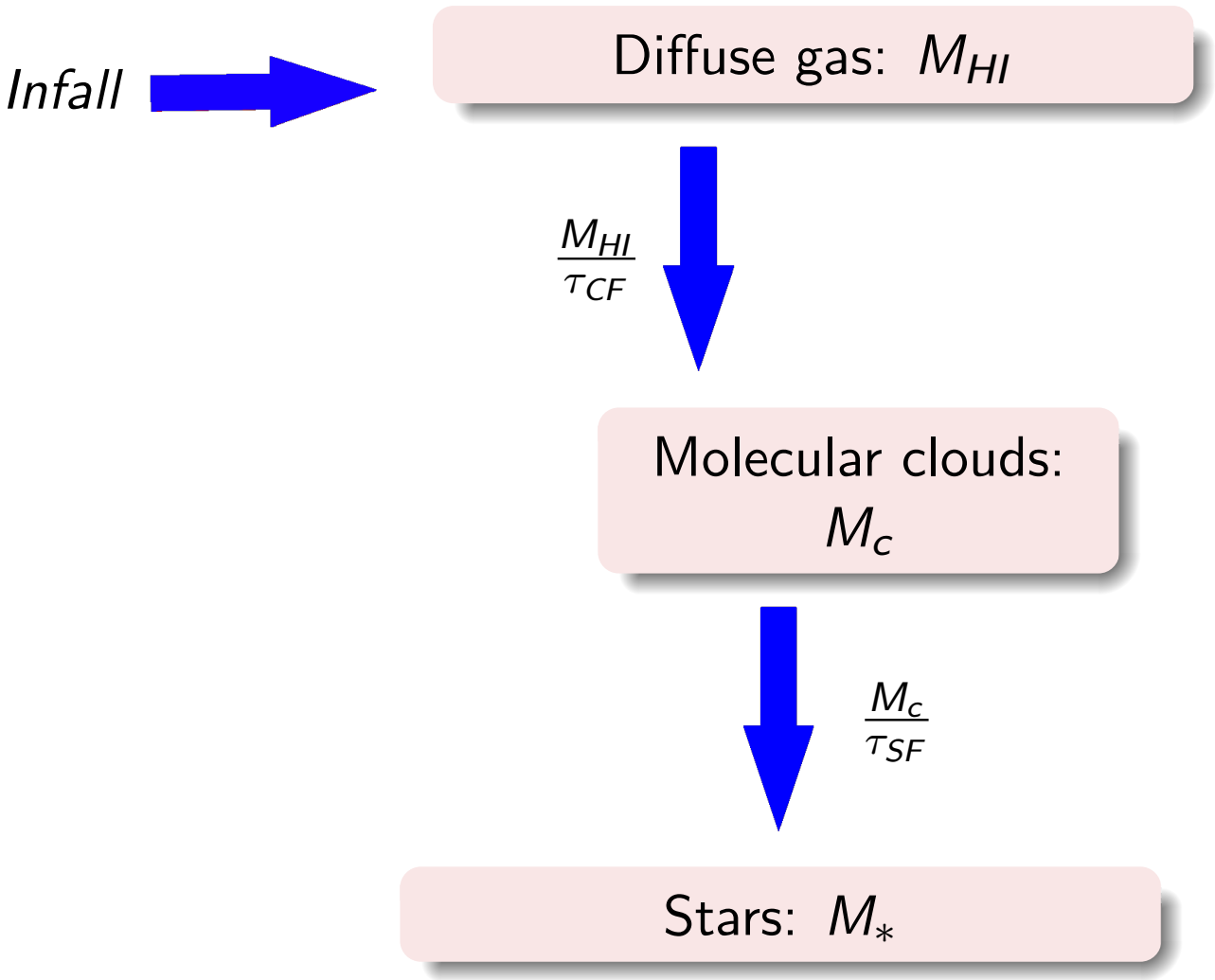

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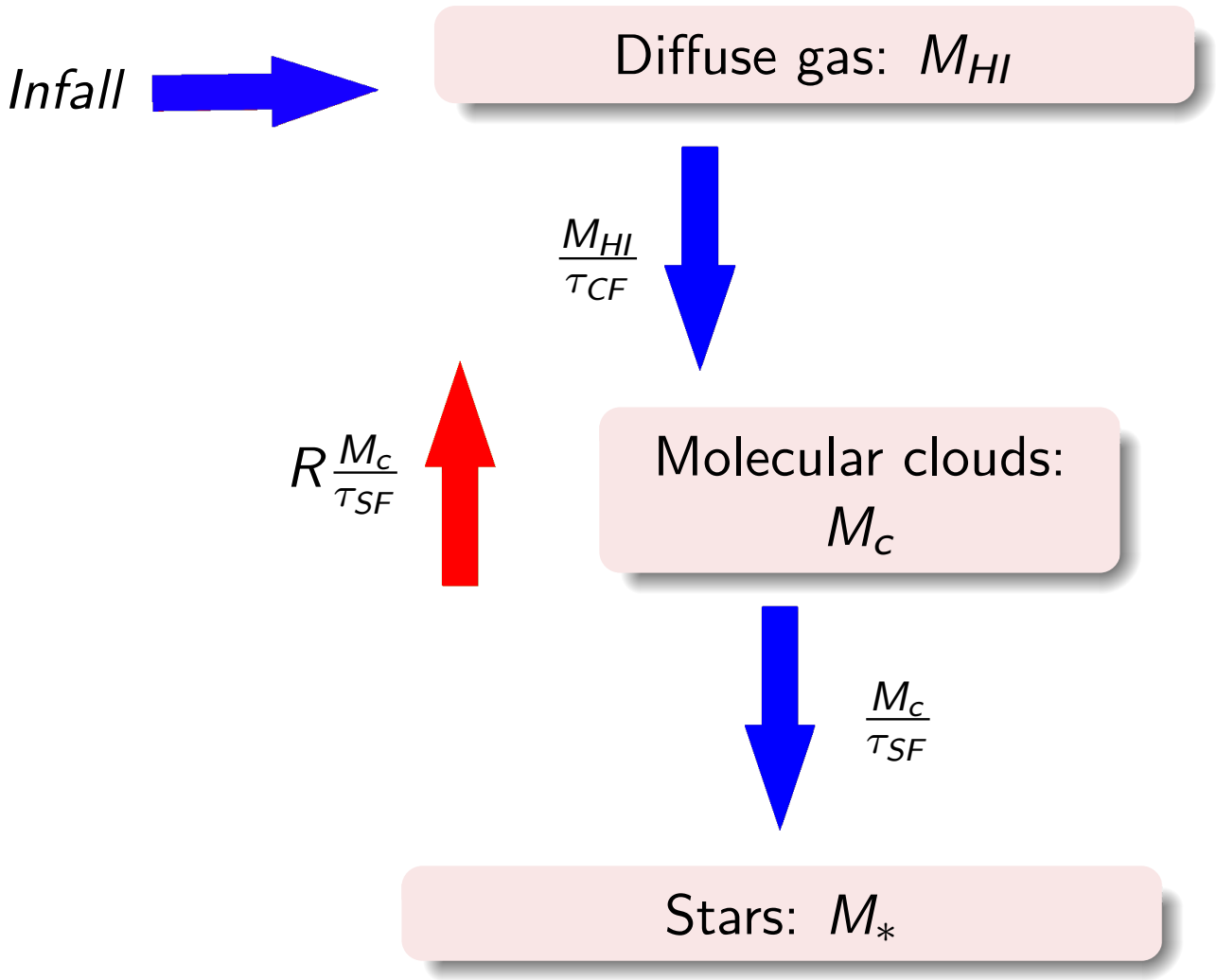

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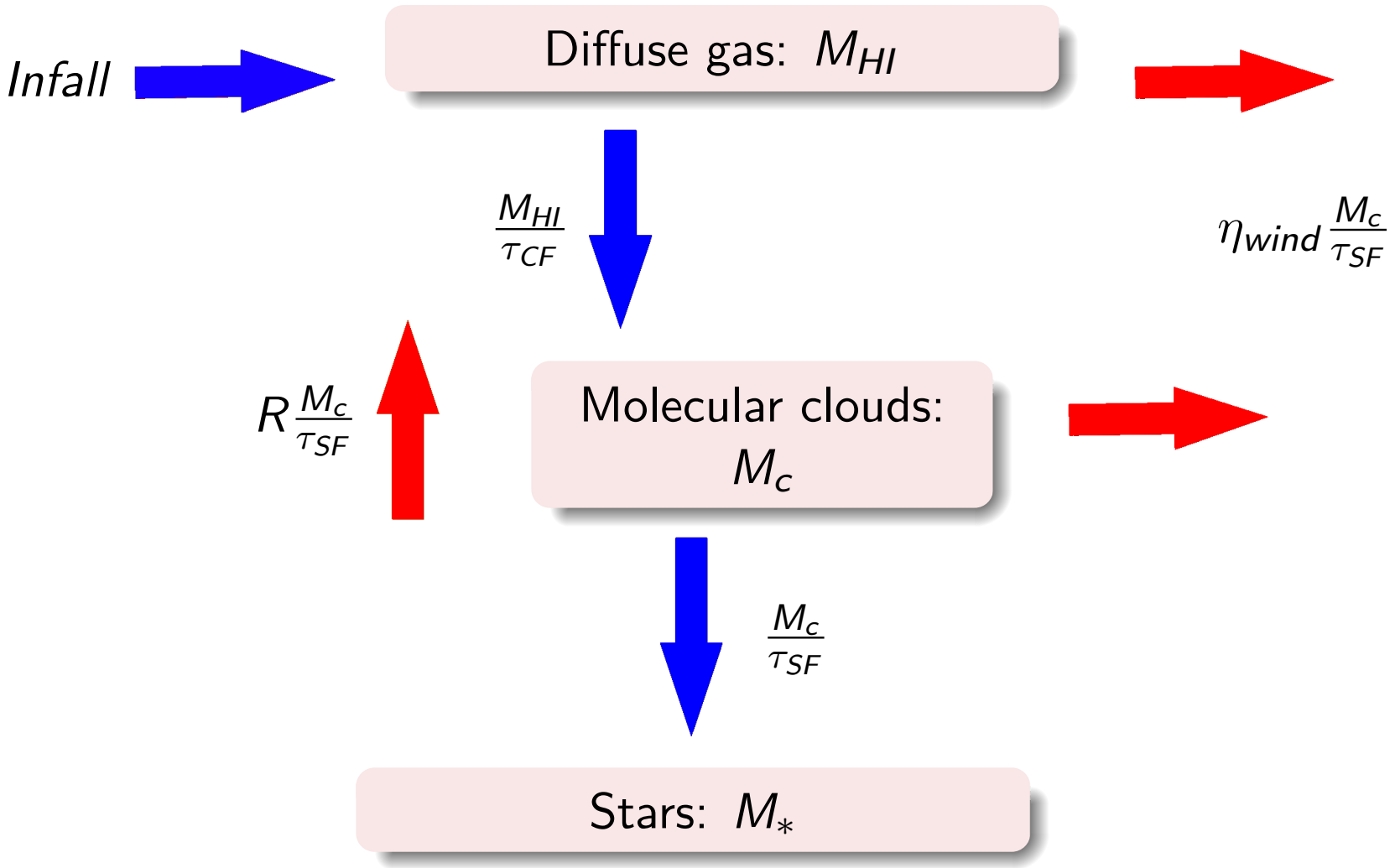

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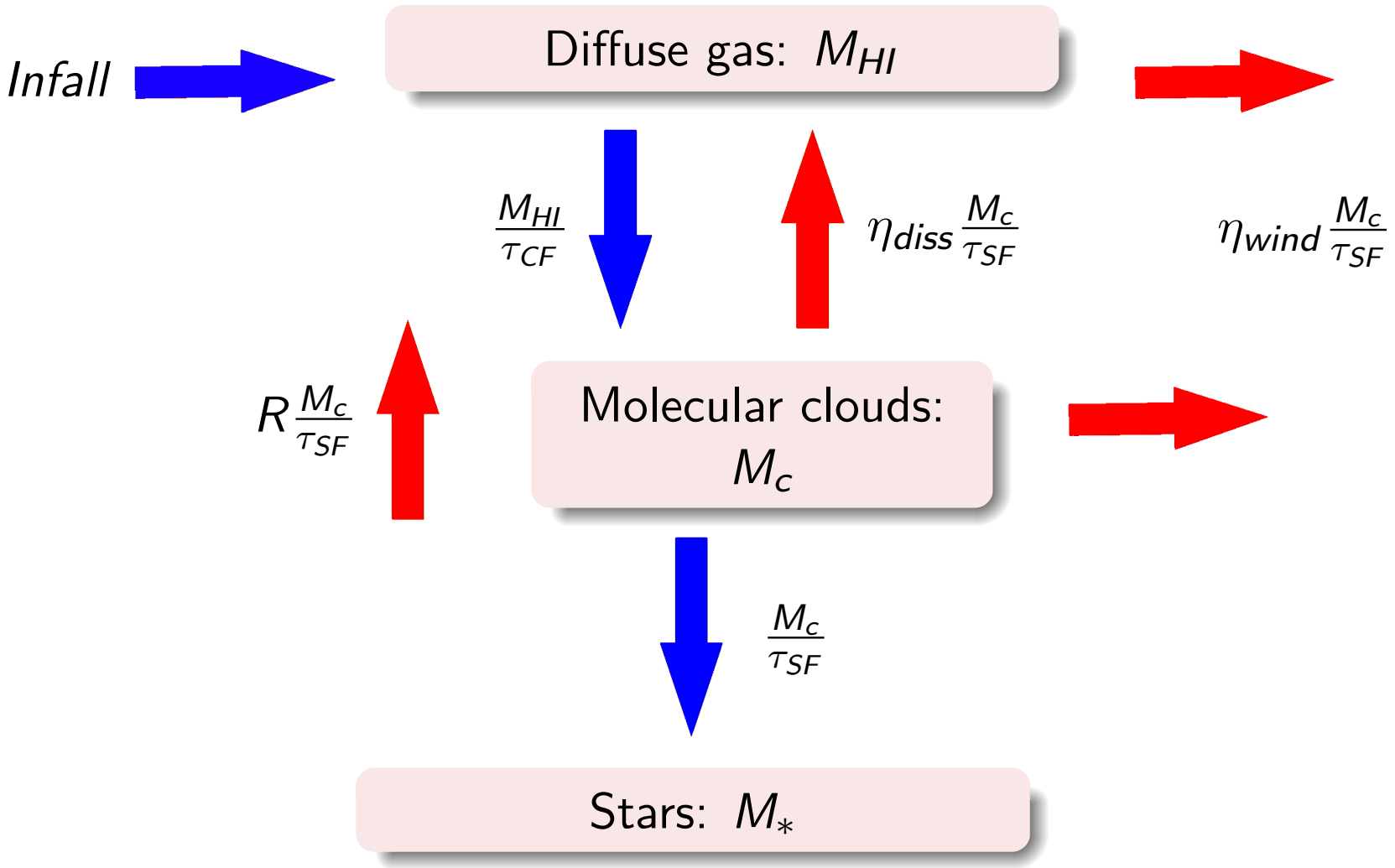

A spherical-cow model

Free parameters

- Infall
- τ_{CF}
- τ_{SF}
- η_{wind}

IMF-related

- R
- η_{diss}

A spherical-cow model

Free parameters

- Infall $\sim e^{-t/\tau_I}$
- τ_{CF}
- τ_{SF}
- η_{wind}

IMF-related

- R
- η_{diss}

A spherical-cow model

Free parameters

- Infall $\sim e^{-t/\tau_I}$
- $\tau_{CF} \propto \frac{1}{n_{dust}}$; (P_x)
- τ_{SF}
- η_{wind}

IMF-related

- R
- η_{diss}

A spherical-cow model

Free parameters

- Infall $\sim e^{-t/\tau_I}$
- $\tau_{CF} \propto \frac{1}{n_{dust}}; (P_x)$
- $\tau_{SF} \sim 3$ Gyr
- η_{wind}

IMF-related

- R
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A spherical-cow model

Free parameters

- Infall $\sim e^{-t/\tau_I}$
- $\tau_{CF} \propto \frac{1}{n_{dust}}$; (P_x)
- $\tau_{SF} \sim 3$ Gyr
- $\eta_{wind} \geq 0$; (w, ε_w)

IMF-related

- R
- η_{diss}

A spherical-cow model

Free parameters

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- $\tau_{CF} \propto \frac{1}{n_{dust}}$; (P_x)
- $\tau_{SF} \sim 3$ Gyr
- $\eta_{wind} \geq 0$; (w, ε_w)

IMF-related

- $R \sim 0.2$; (R_{SN}, R_{LIM})
- η_{diss}

A spherical-cow model

Free parameters

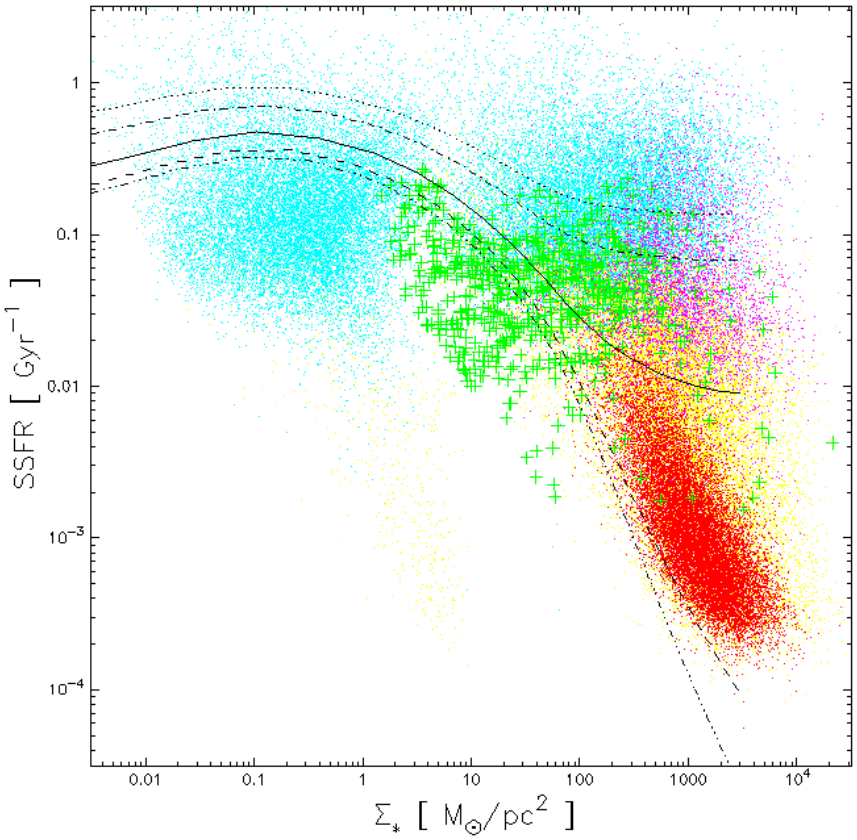
- Infall $\sim e^{-t/\tau_I}$
- $\tau_{CF} \propto \frac{1}{n_{dust}}$; (P_x)
- $\tau_{SF} \sim 3$ Gyr
- $\eta_{wind} \geq 0$; (w, ε_w)

IMF-related

- $R \sim 0.2$; (R_{SN}, R_{LIM})
- $\eta_{diss} \sim 300$

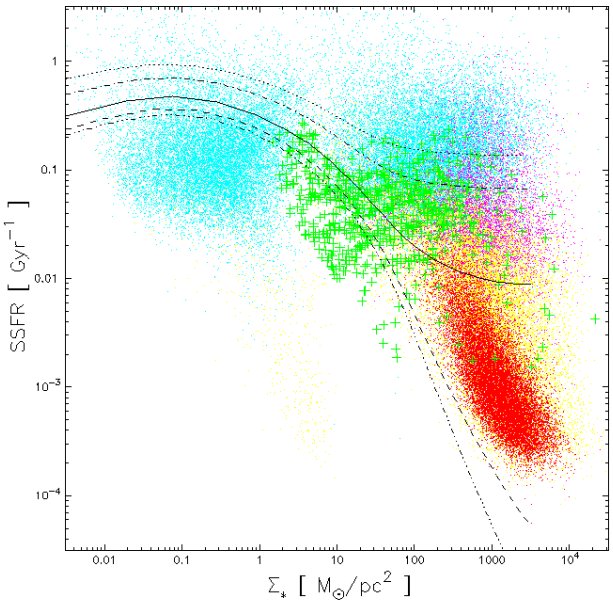
Star formation

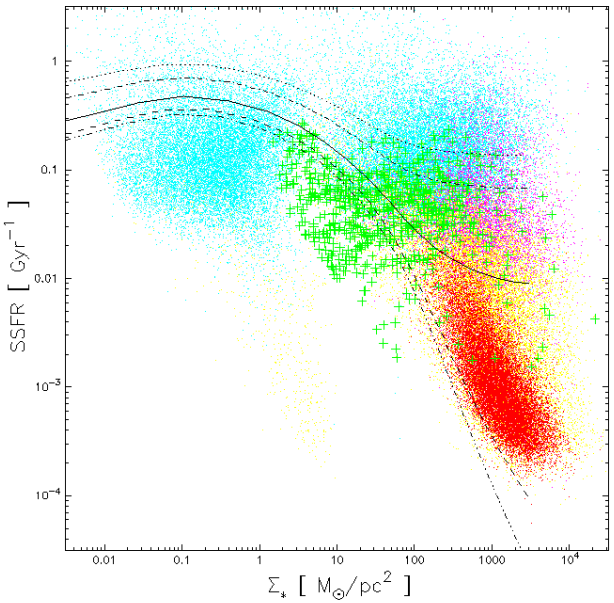
Gas infall: τ_I

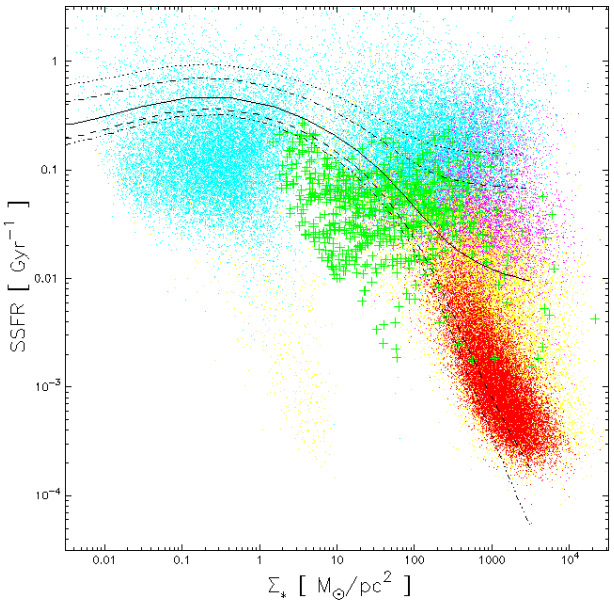


Star formation

Photodissociation: η_{diss}

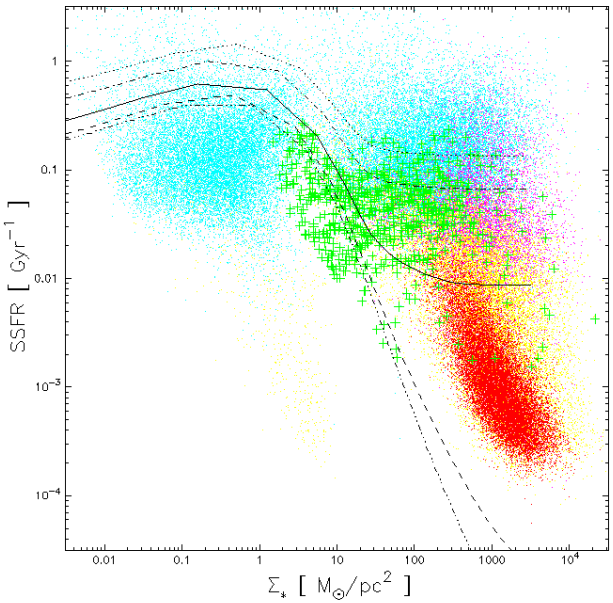


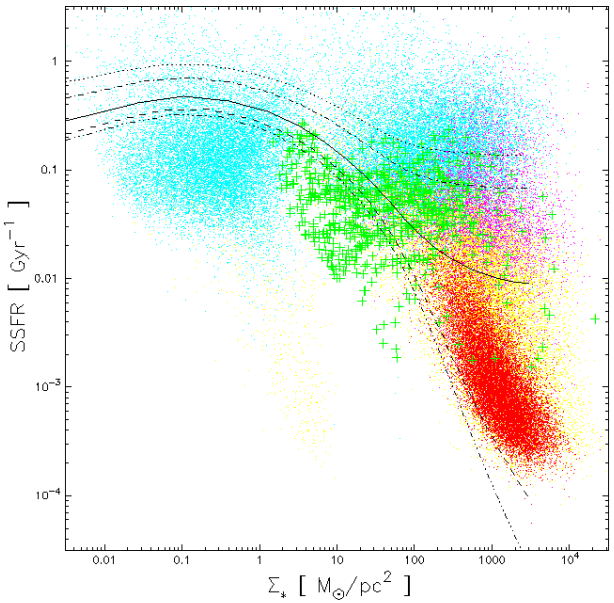


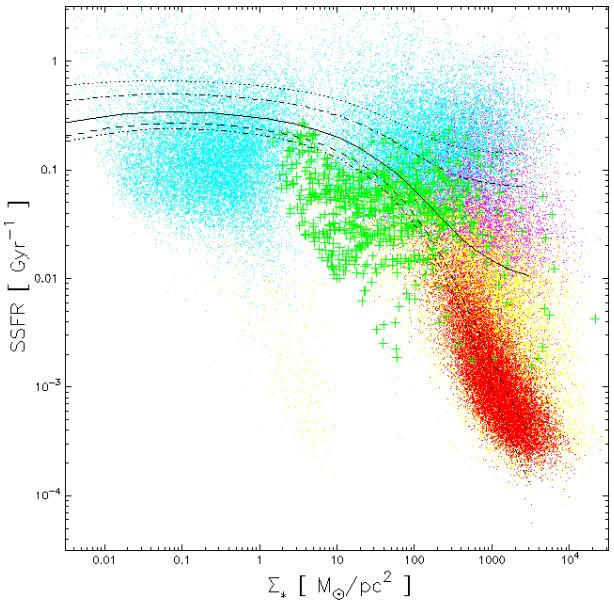


Star formation

Non-thermal pressure: P_x

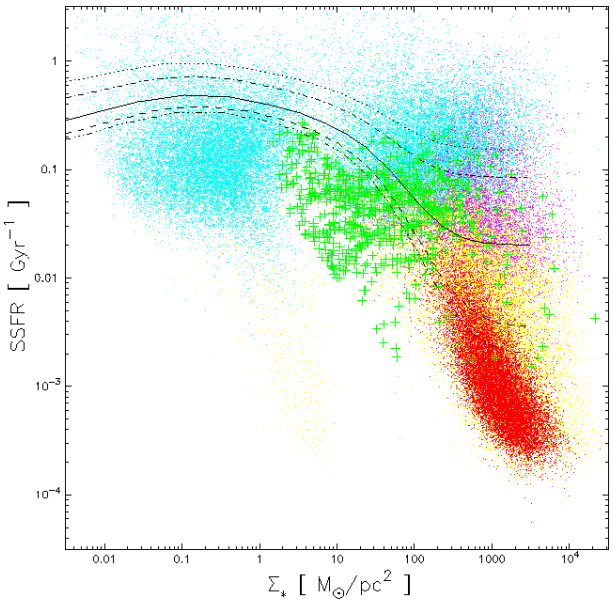


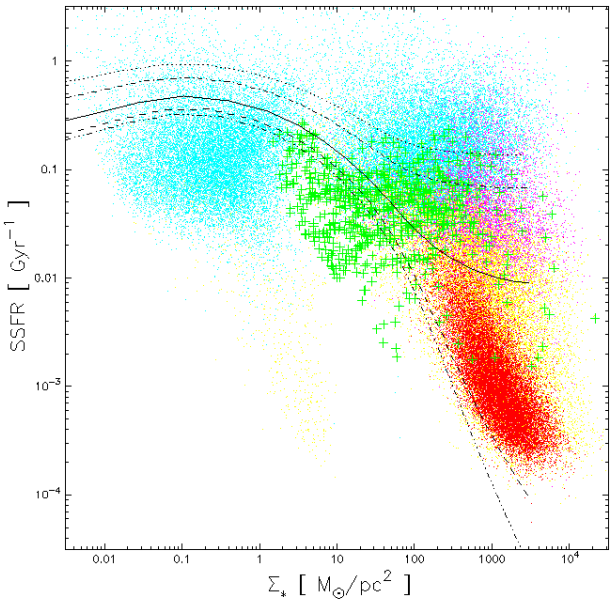


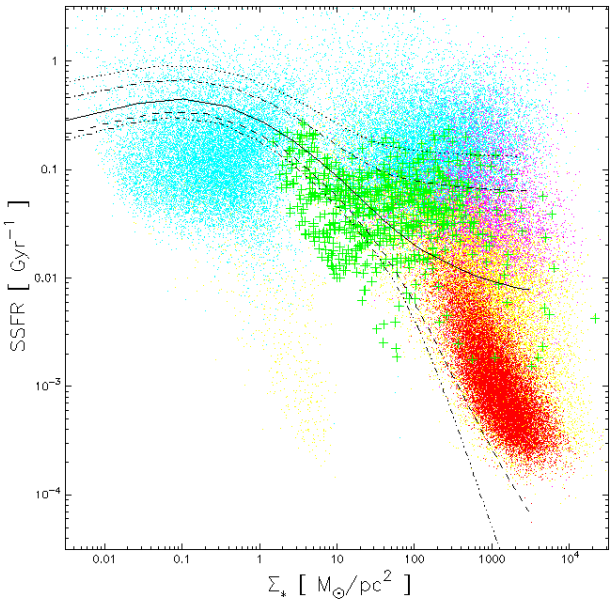


Star formation

Well-mixed wind: w

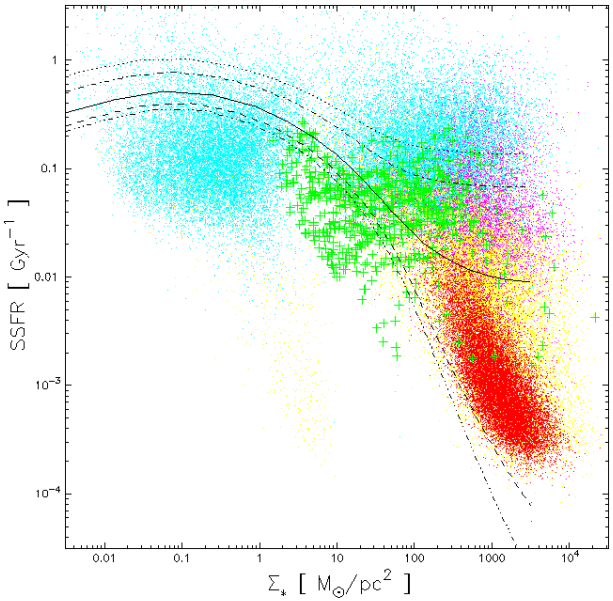


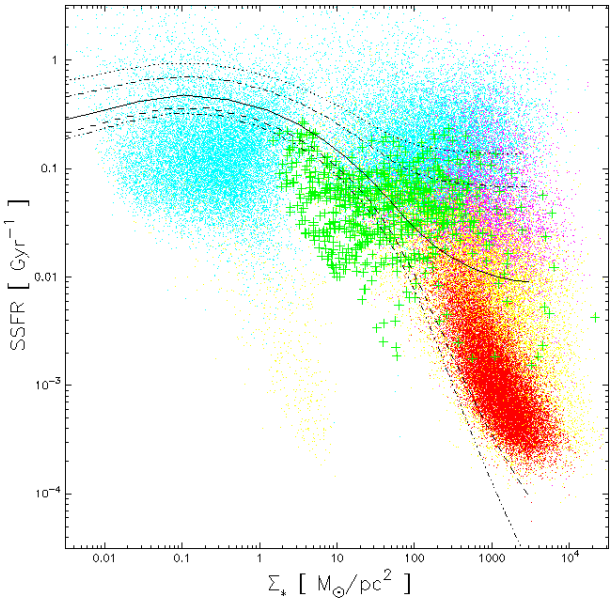


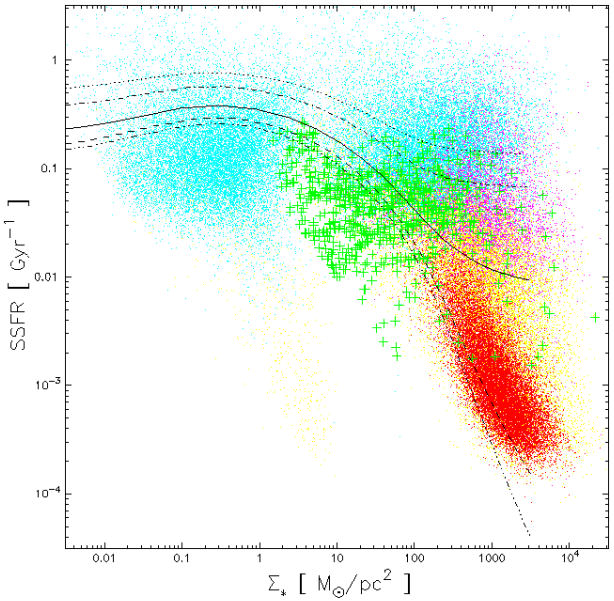


Star formation

Enriched wind: ε_w

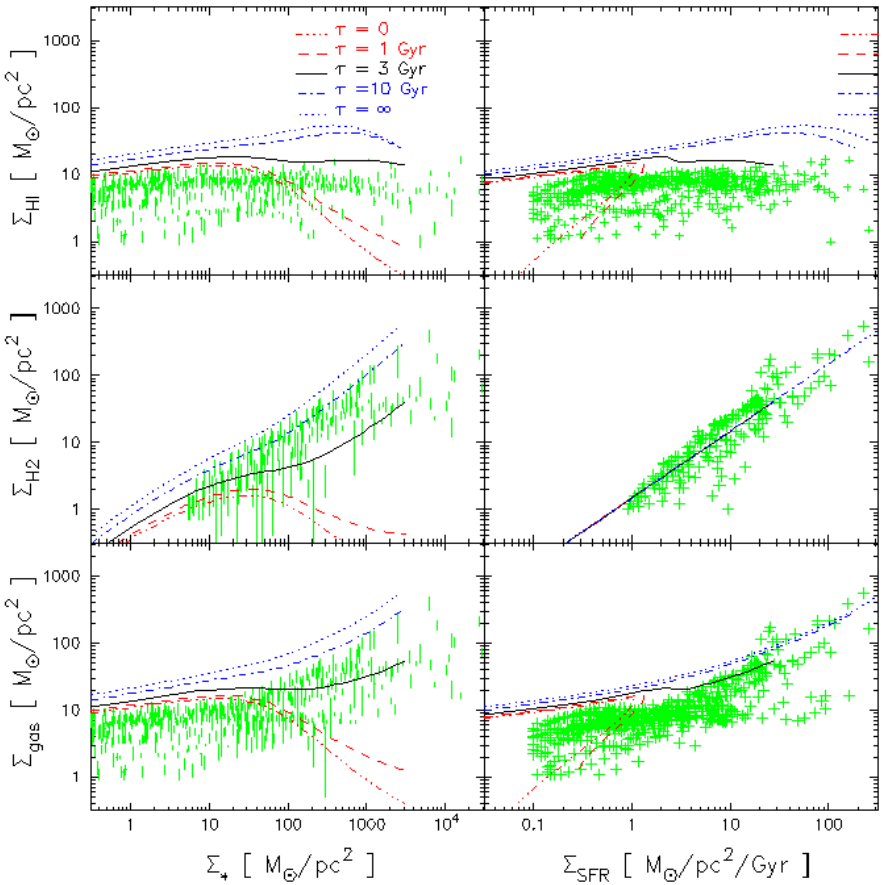






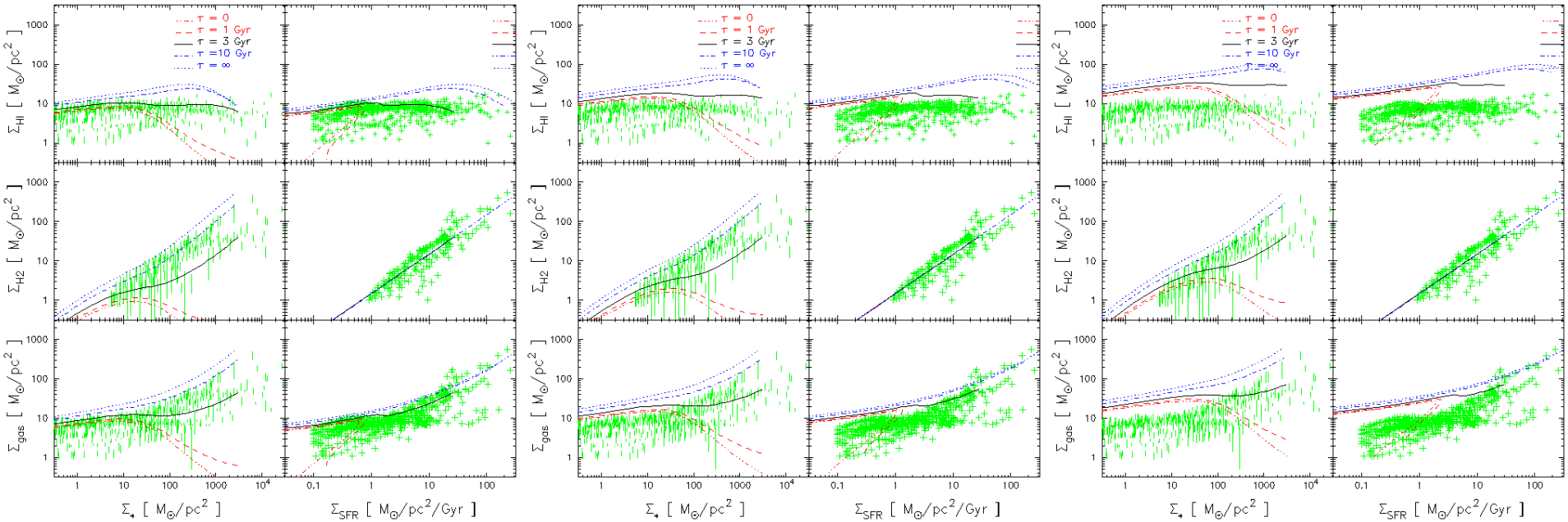
Neutral gas

Gas infall: τ_I



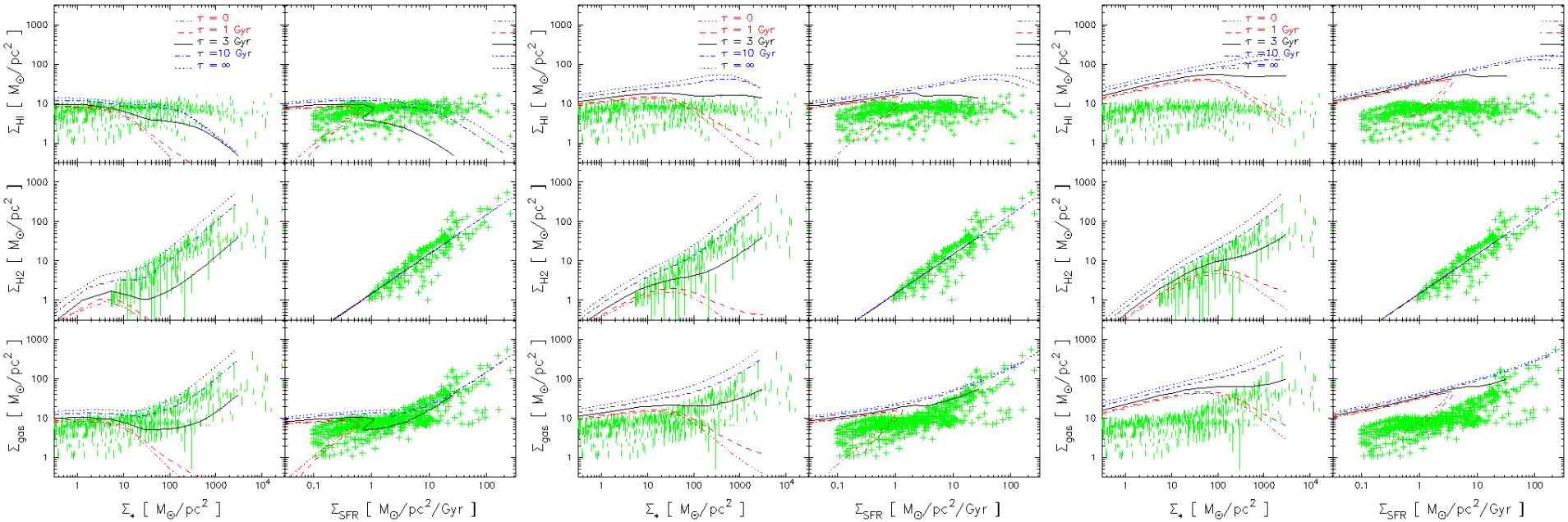
Neutral gas

Photodissociation: η_{diss}



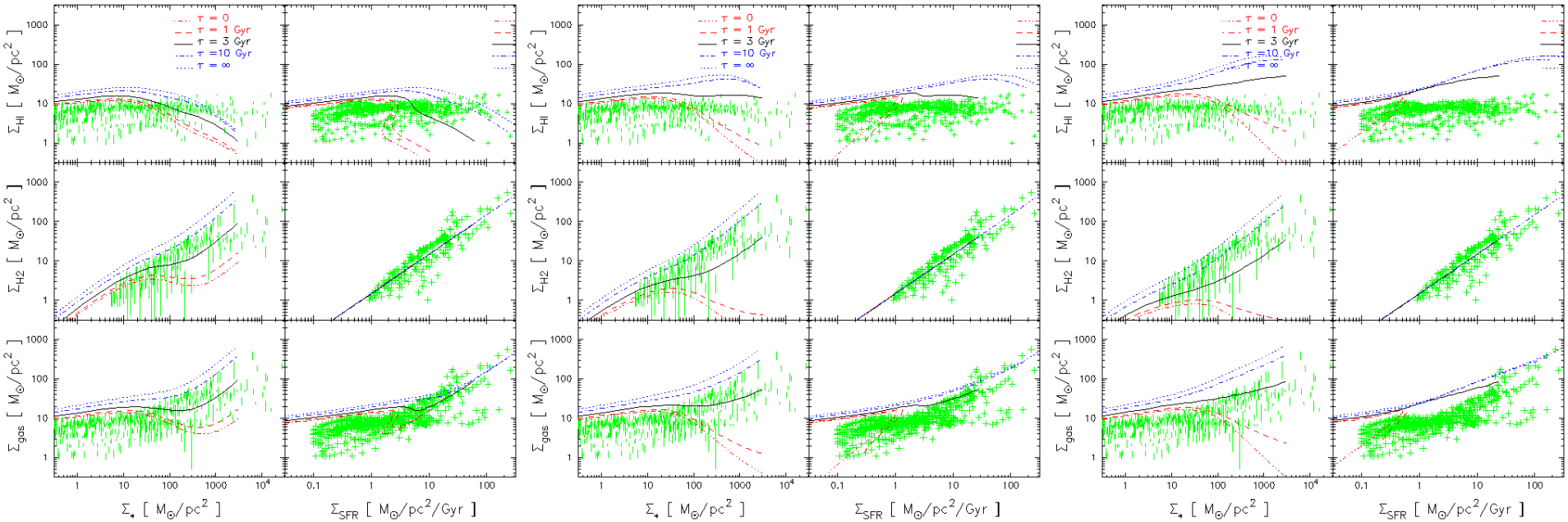
Neutral gas

Non-thermal pressure: P_x



Neutral gas

Well-mixed wind: *w*



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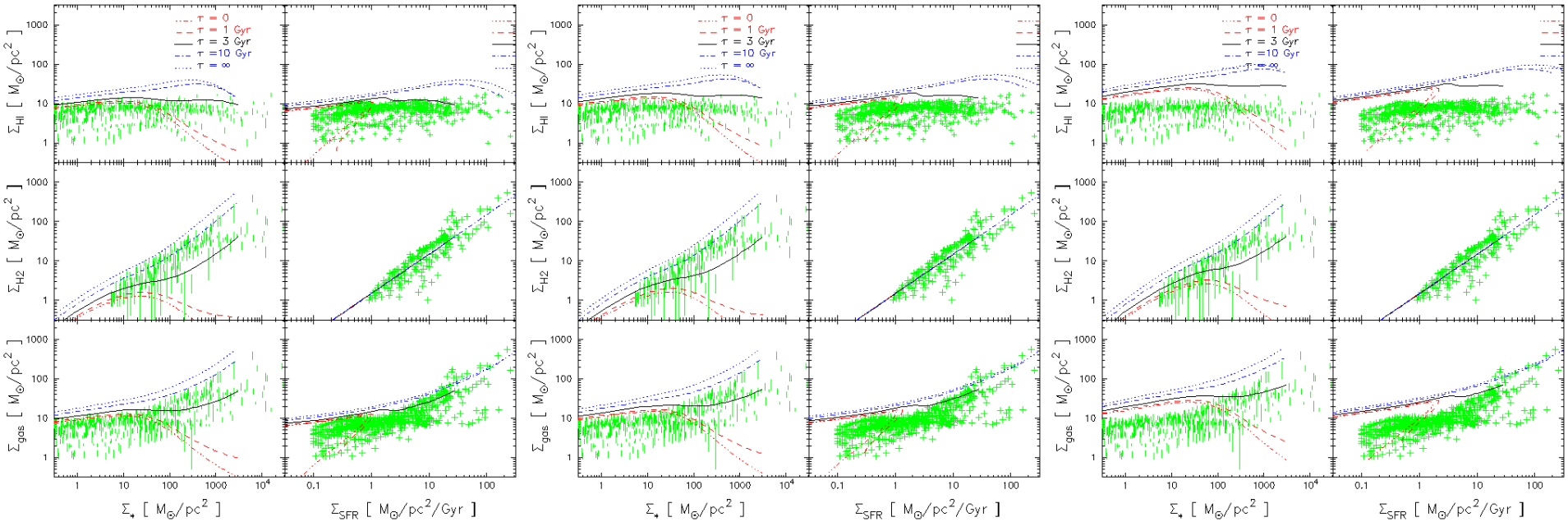
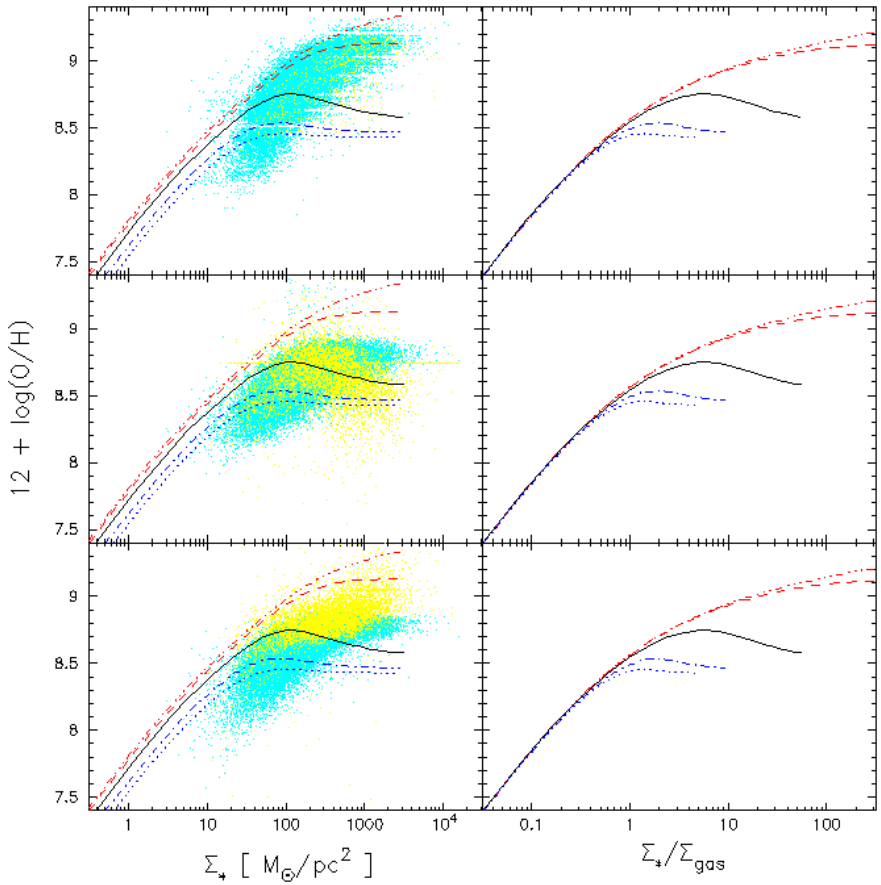


Metallicity

Gas infall: τ_I



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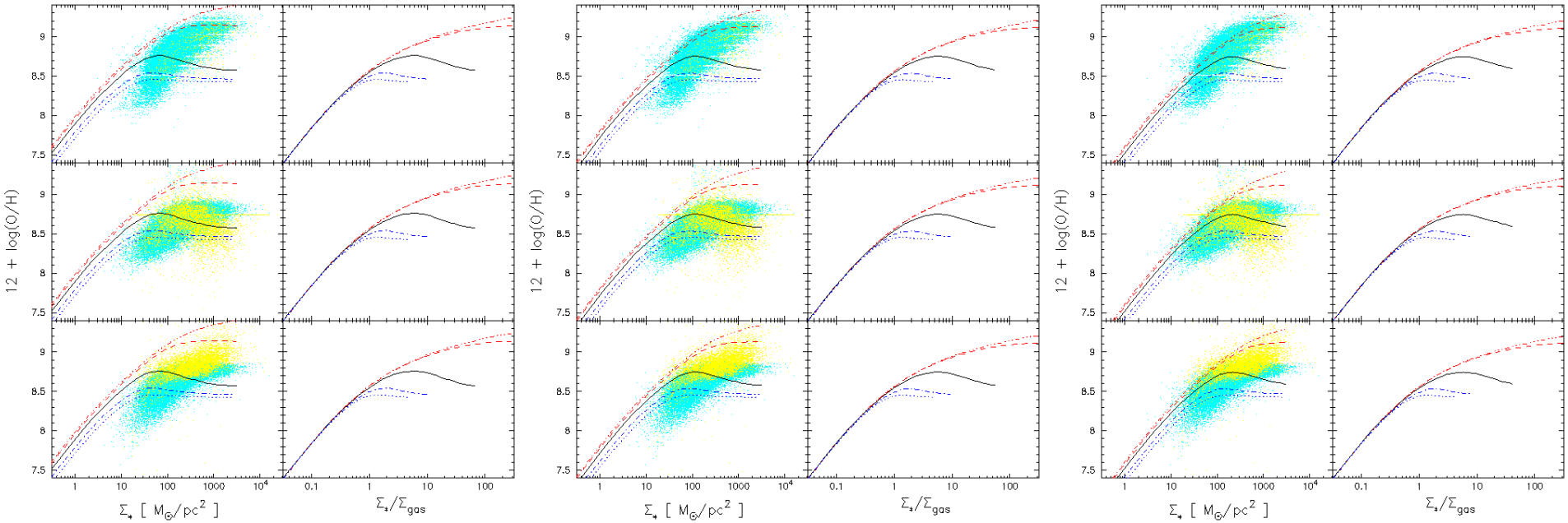

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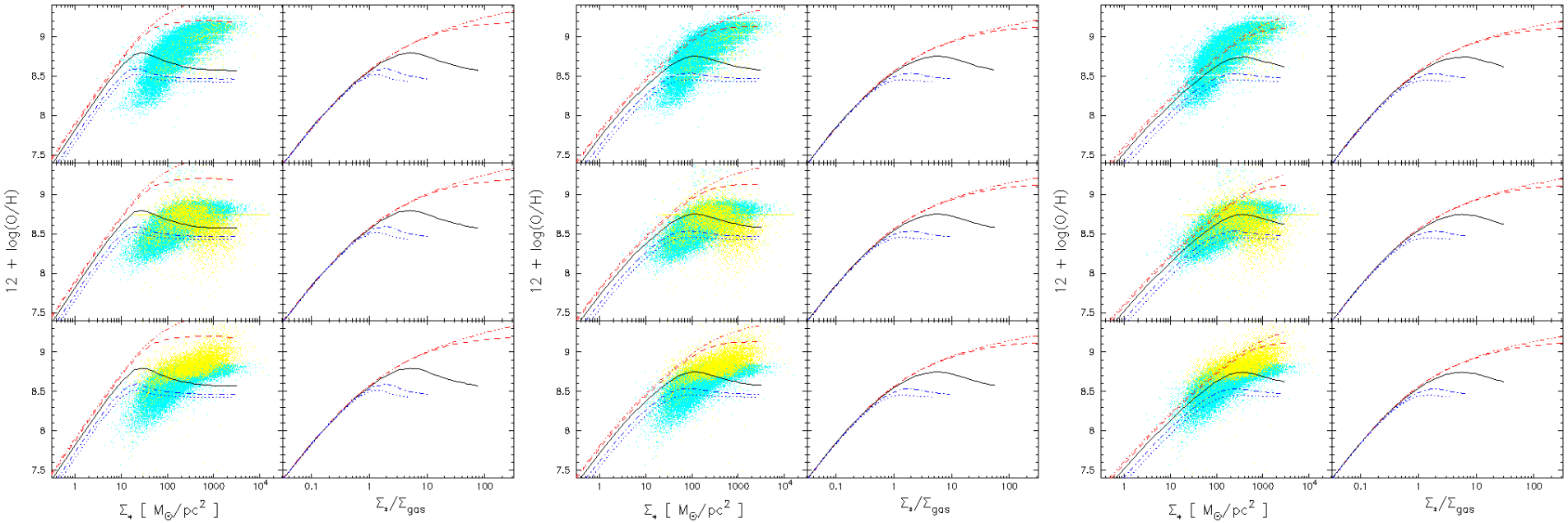

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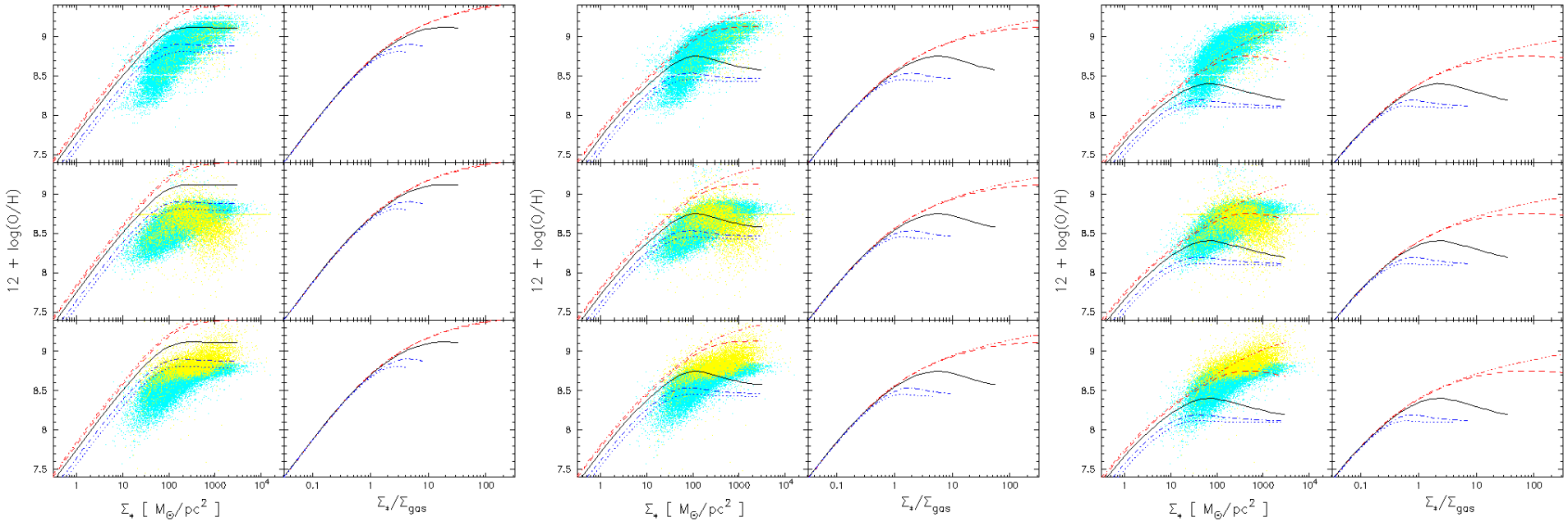

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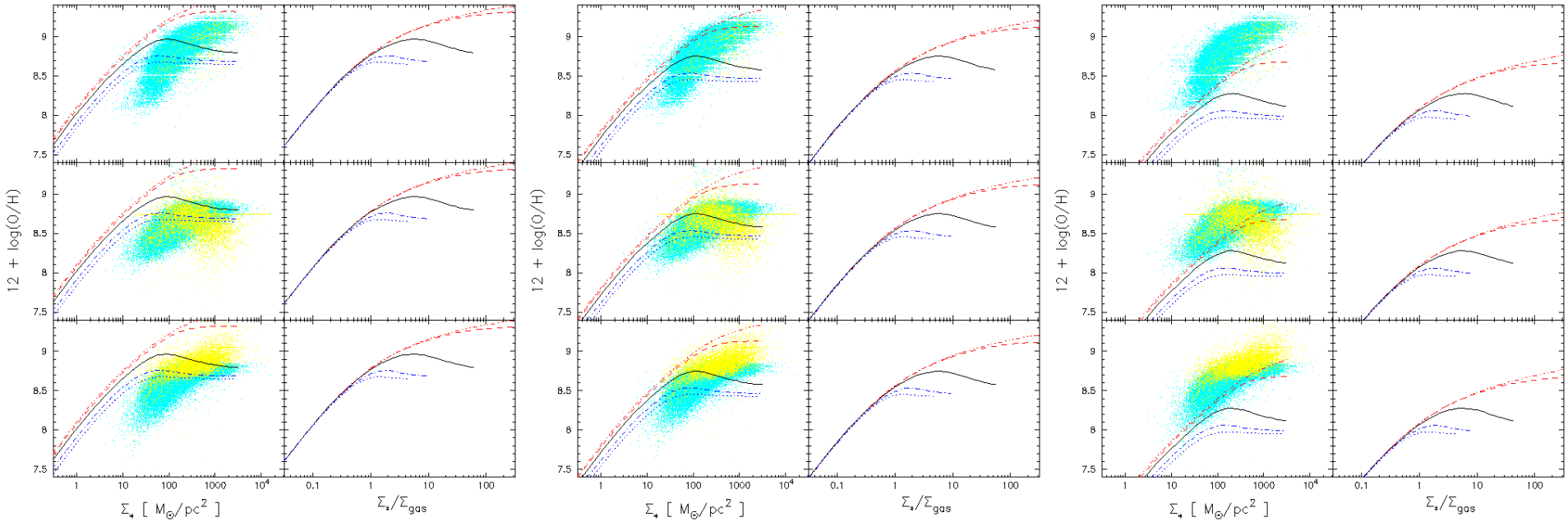

Summary

Scaling relations

- $\Sigma_{SFR}(\Sigma_*)$
- $\Sigma_{HI,H2}(\Sigma_*)$
- $(O/H) - \Sigma_*$
- $(O/H) - \Sigma_*/\Sigma_{gas}$
- ...

Why?

- SFE $\propto n_{gas} Z$
- $\eta_{diss} \gg \eta_{wind}$

Conclusions

- SF is regulated by the formation and destruction of H_2
- The devil is in the details
- We need free parameters, but we have clues!

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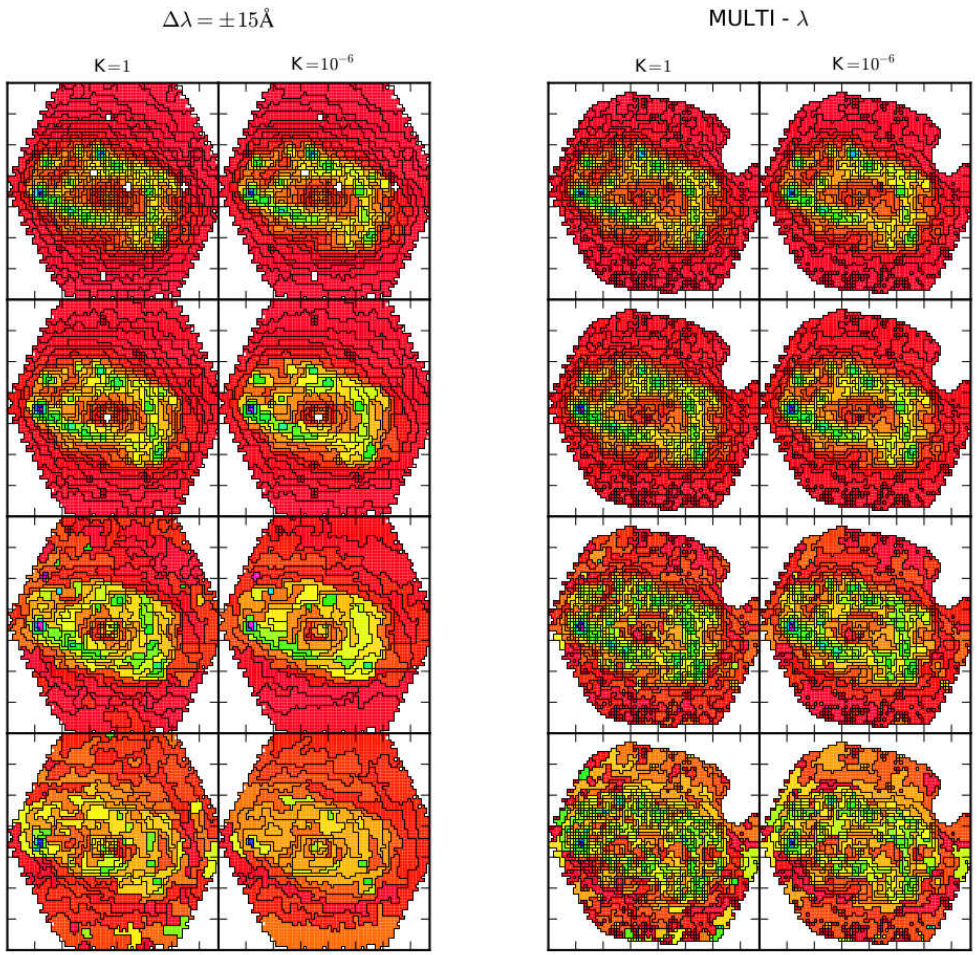
Ask me about BaTMAn ;-D



Thank you!