Giant Molecular Cloud Evolution

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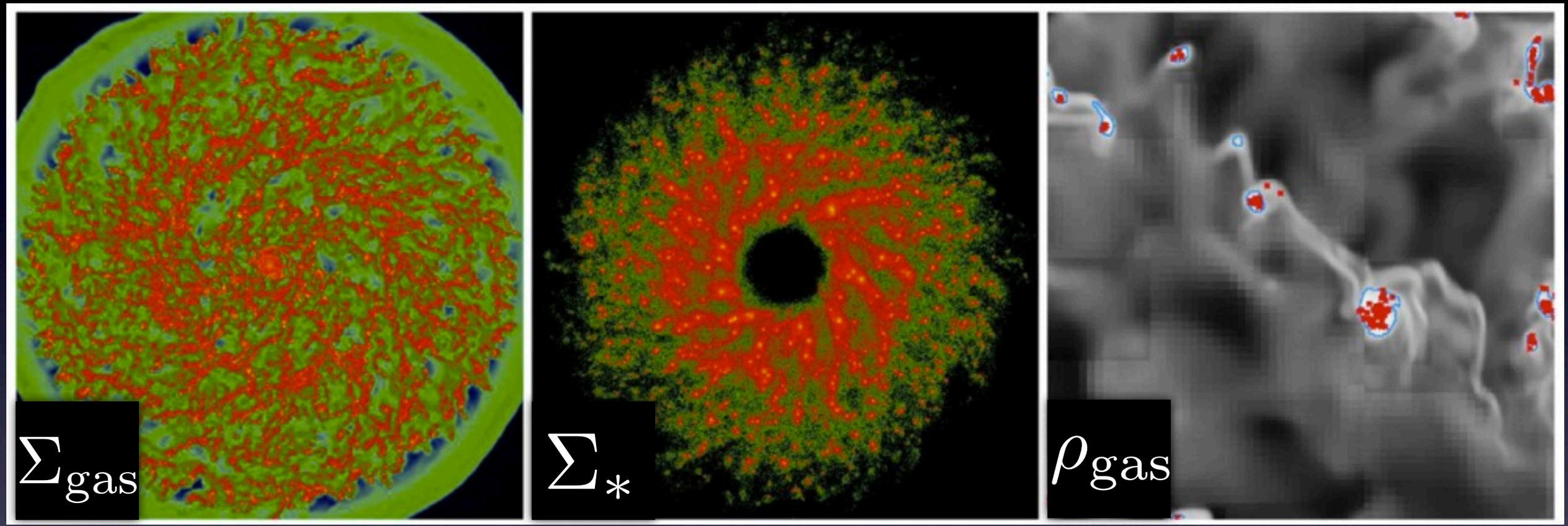
How is star formation modeled in galaxy evolution simulations?



$$\text{Cold, Dense Gas} \xrightarrow{\epsilon_{\rm ff}} \text{Stars}$$

Tasker 2011

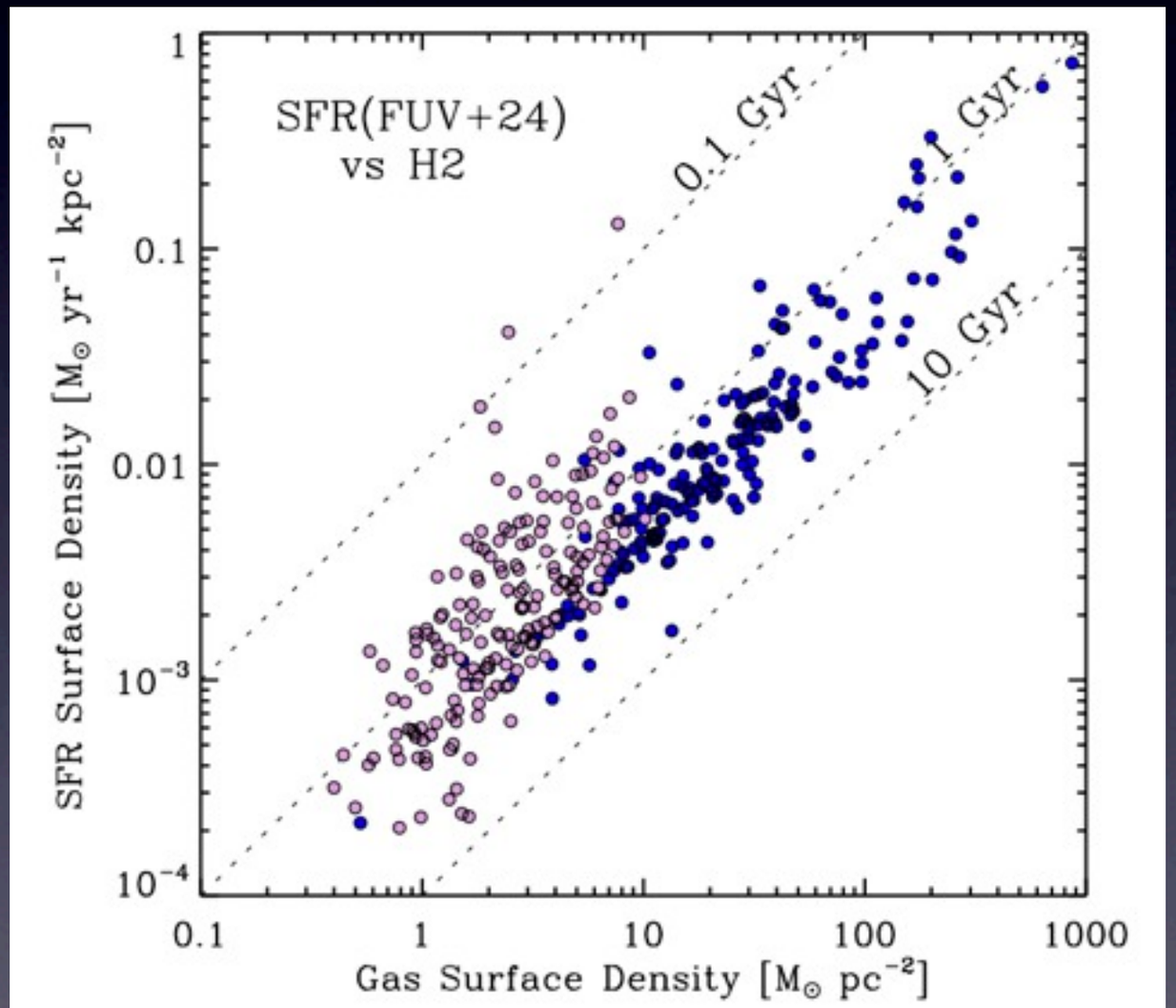
We can do better!

And maybe learn something about molecular clouds along the way....

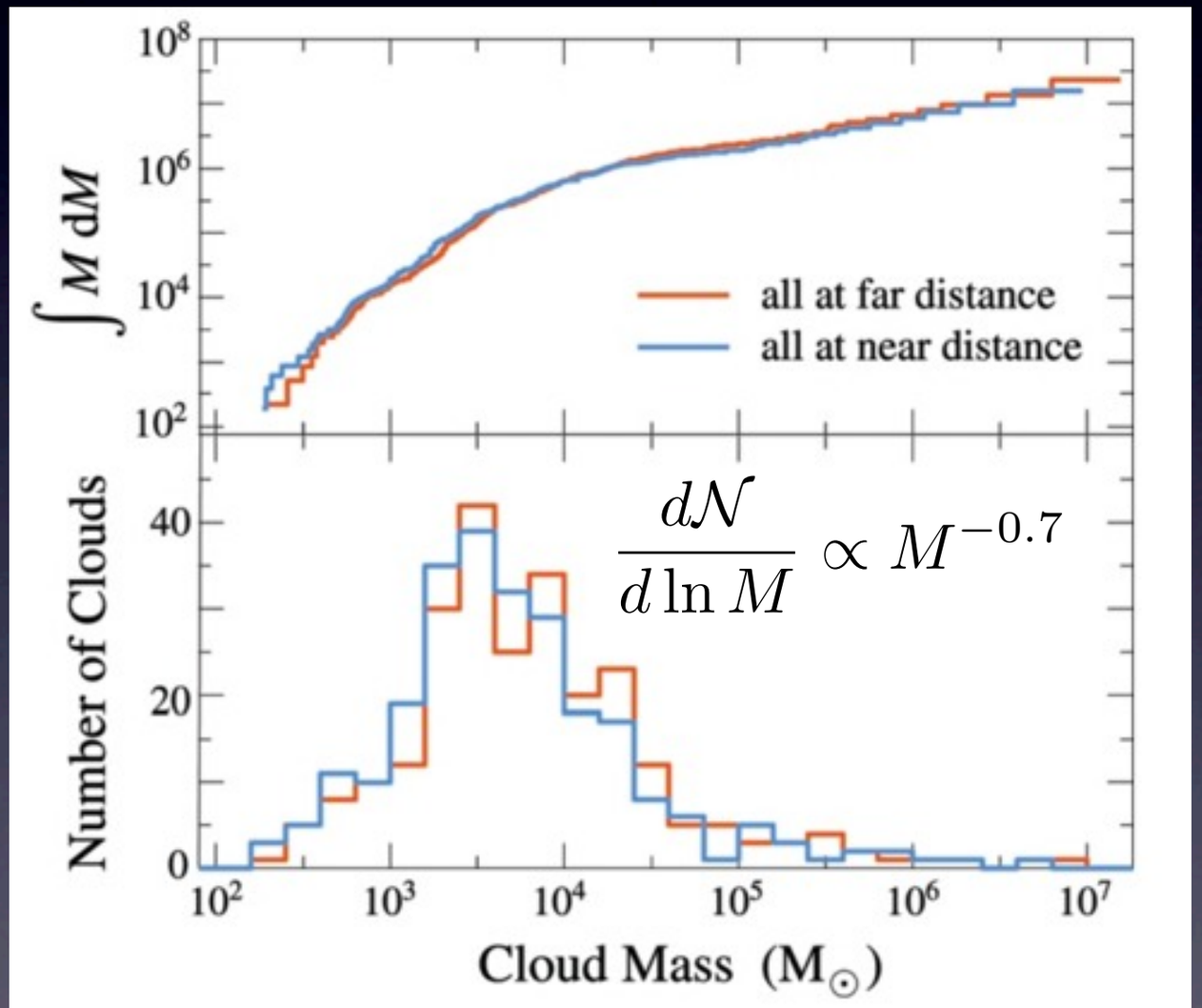
Outline

- Background on Giant Molecular Clouds
- `GMCevol`: A semianalytic model for molecular cloud evolution
- Comparison to Observations of GMCs
- A novel subgrid prescription for star formation in galaxy evolution simulations

Giant molecular clouds are the primary sites of star formation in the Milky Way

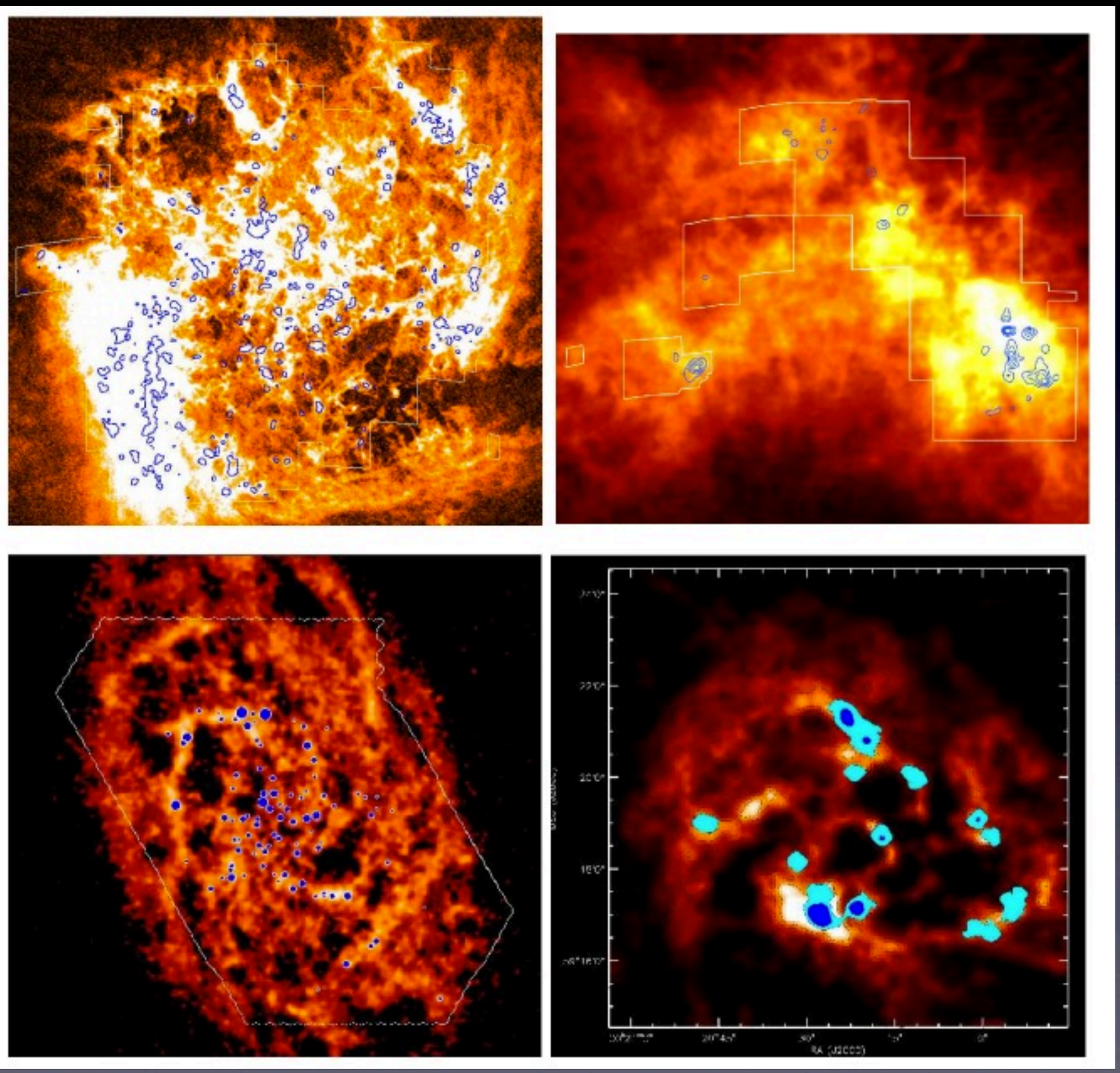


Schruba+ 2011



Stark & Lee 2006

GMCs are ubiquitously observed in quiescently star forming galaxies



Blitz+ 2007

Can measure global properties:

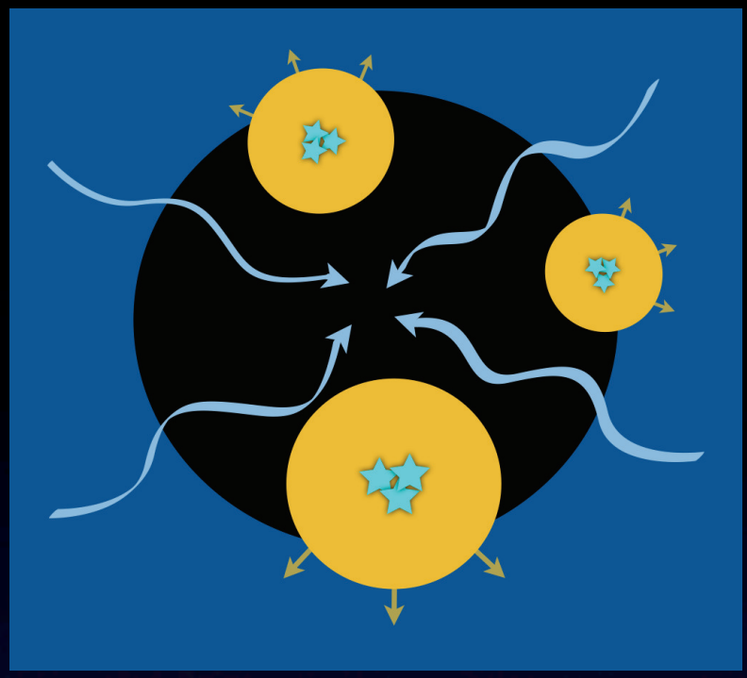
Mass: M_{cl}

Radius: R_{cl}

Velocity Dispersion: σ_v

GMCevol

A semianalytic model for
giant molecular cloud evolution



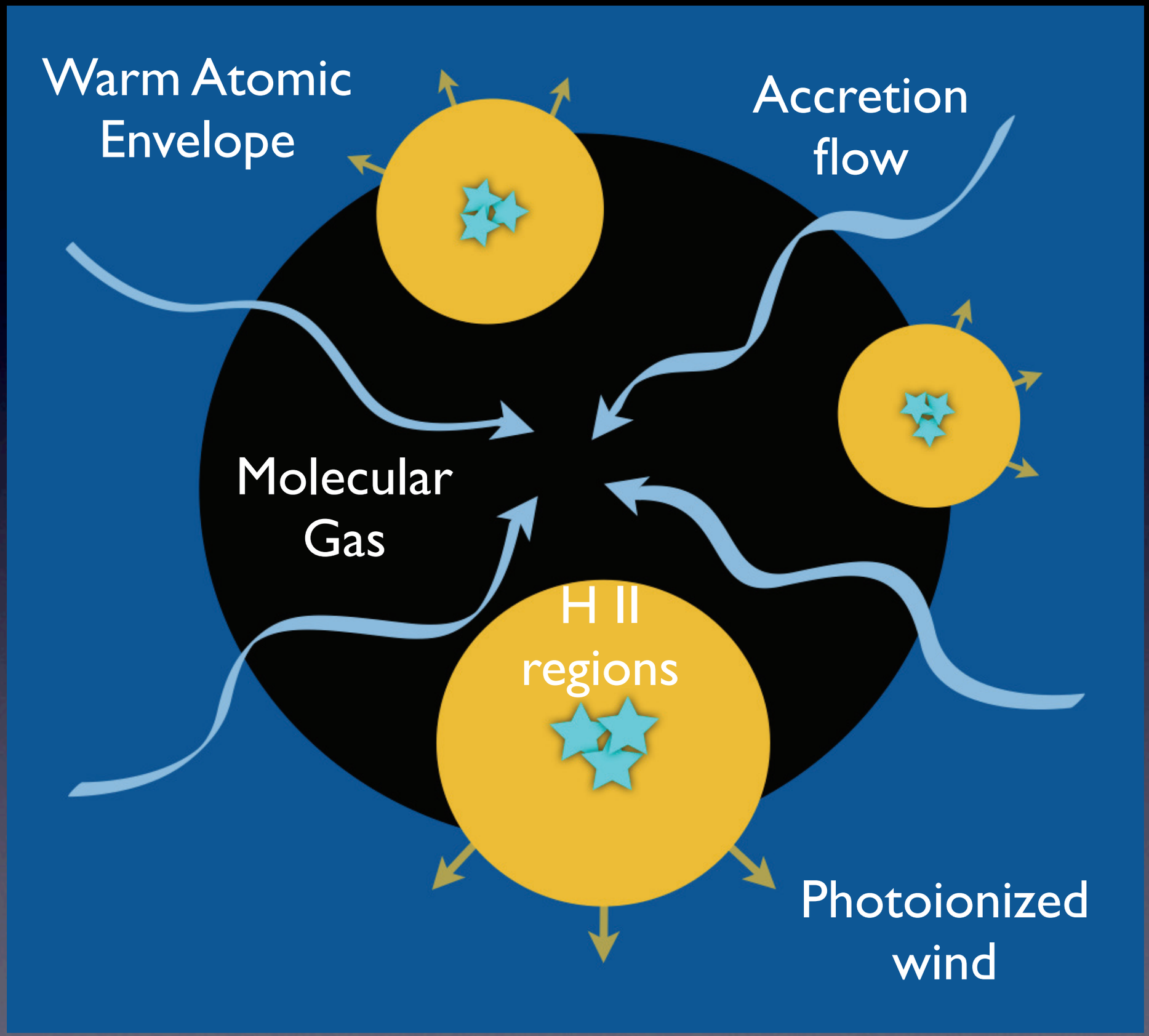
$$\frac{1}{2}\ddot{I}_{\rm cl} = 2(\mathcal{T}-\mathcal{T}_0)+\mathcal{B}+\mathcal{W}-\frac{1}{2}\frac{d}{dt}\int_{S_{\rm vir}}(\rho\mathbf{v}r^2)\cdot d\mathbf{S}+\int_{V_{\rm vir}}\mathbf{r}\cdot\mathbf{F}_{\rm b}dV$$

$$\frac{d\mathcal{E}_{\rm cl}}{dt}+\int_{S_{\rm vir}}\left[\rho\mathbf{v}\left(\frac{1}{2}v^2+e+\phi+\frac{P}{\rho}\right)+\mathbf{S}_P\right]\cdot d\mathbf{S}=\int_{V_{\rm vir}}\mathbf{v}\cdot\mathbf{F}_{\rm b}dV-\Lambda$$

$$\dot{M}_{\rm cl}=\dot{M}_{\rm ej}+\dot{M}_{\rm acc} \qquad \mathbf{F}_{\rm b}=\mathbf{F}_*+\mathbf{F}_{\rm w}+\mathbf{F}_{\rm acc}$$

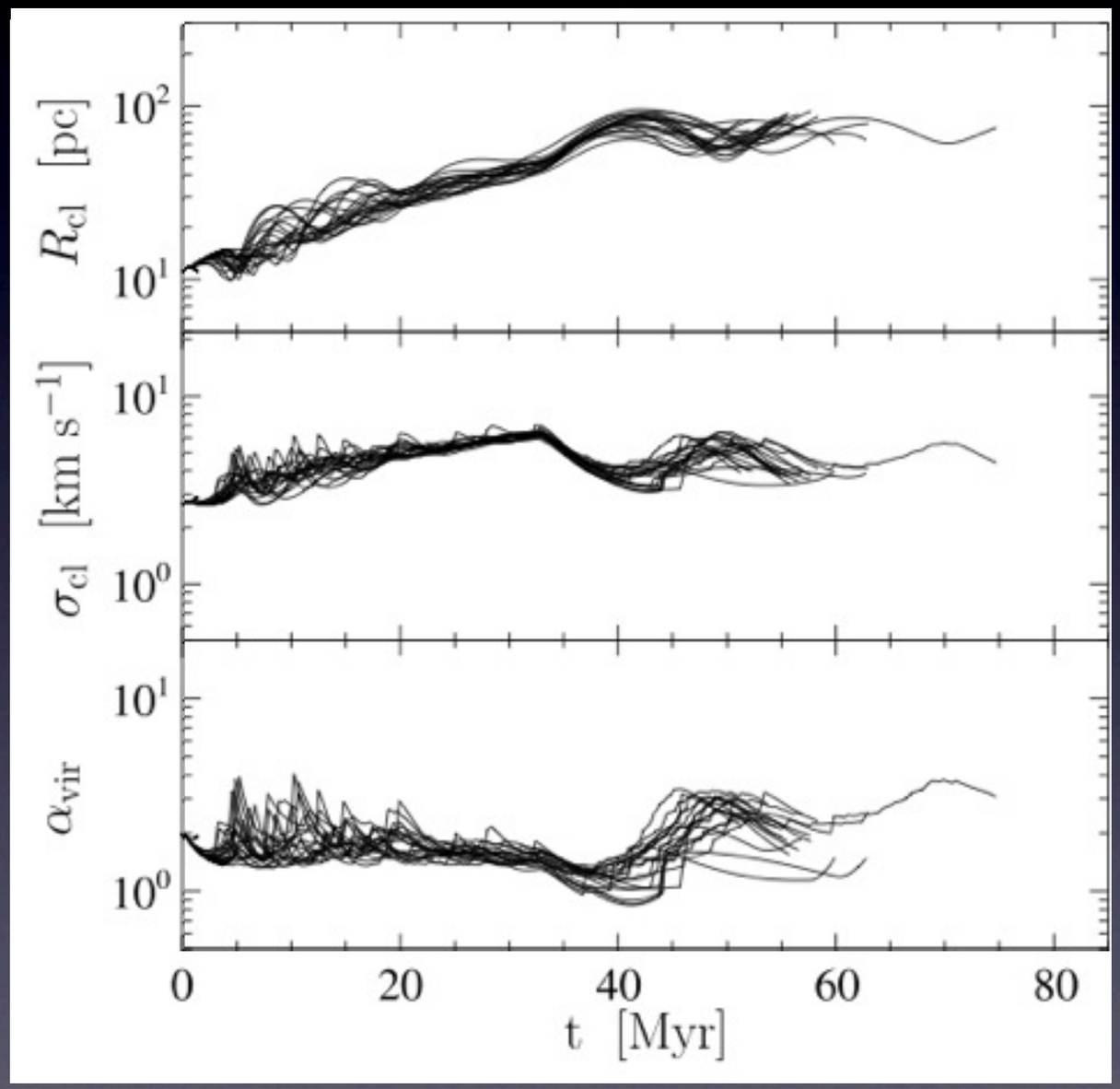
Follow evolution of: M_{gas}, M_{star}, R_{cl}, dR_{cl}/dt, σ_{cl}

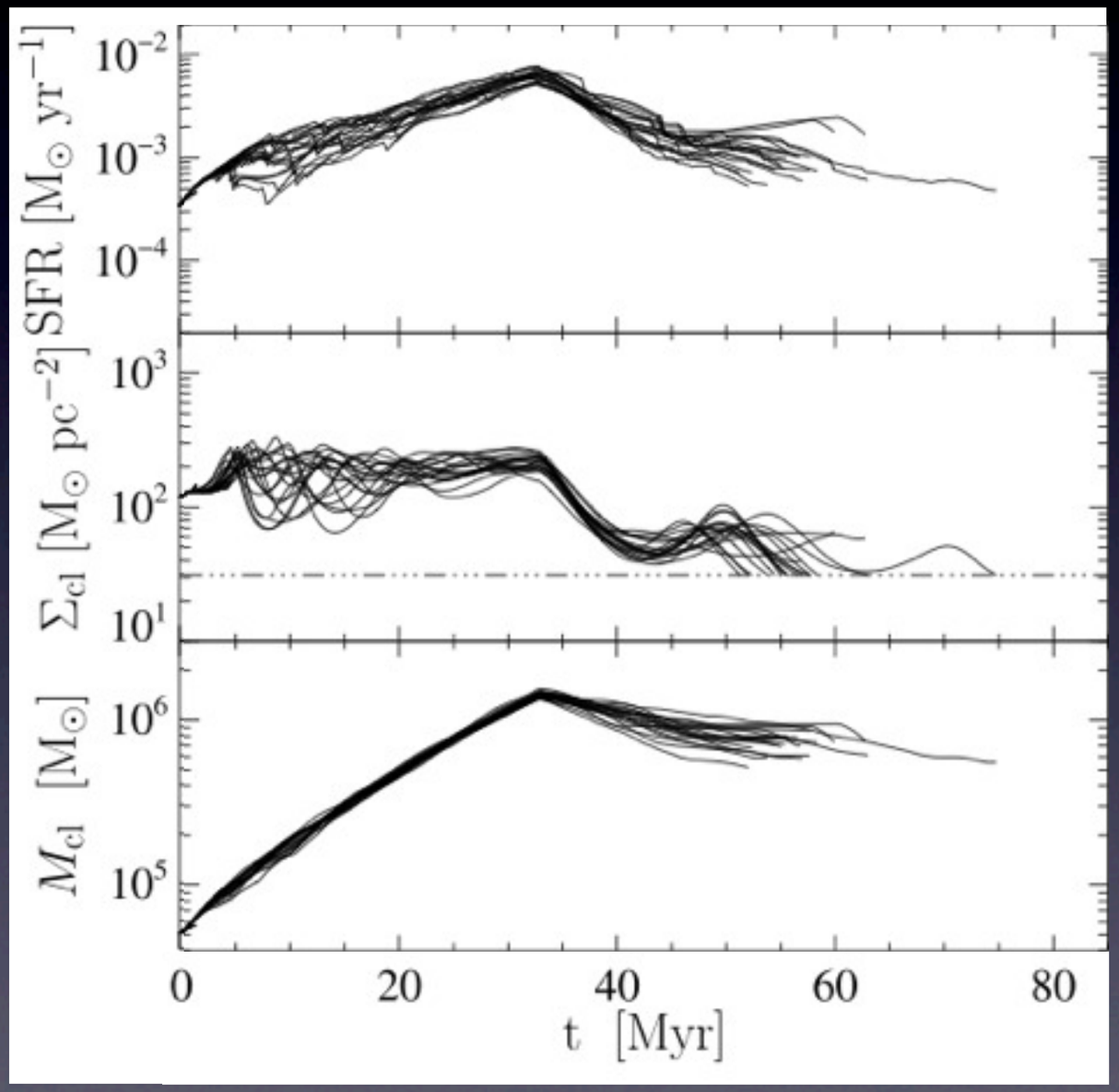
Components of the GMC model



Cloud growth, evolution, and death

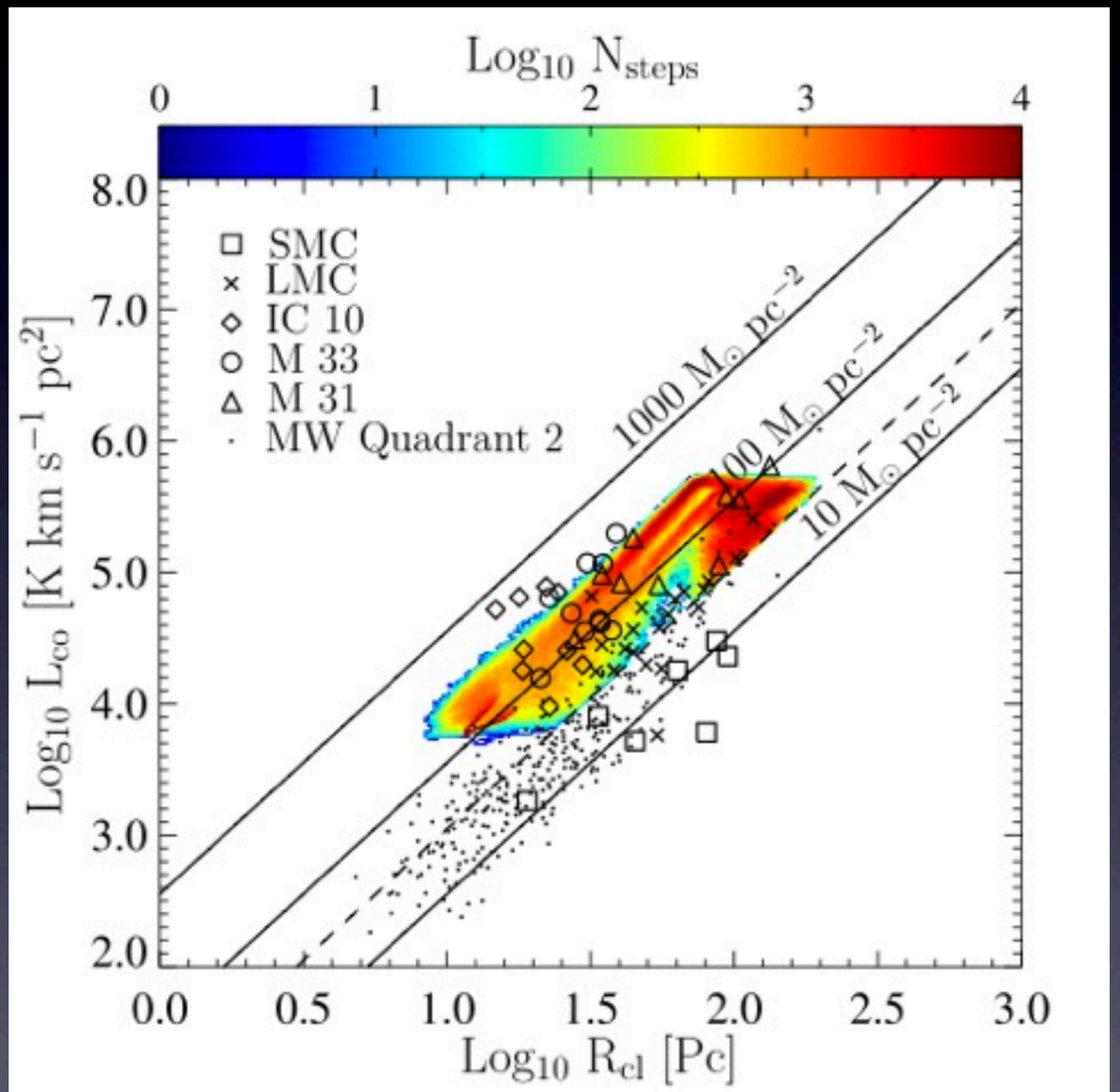
$$\Sigma_{\rm res} = 16\ M_\odot\ {\rm pc}^{-2}$$

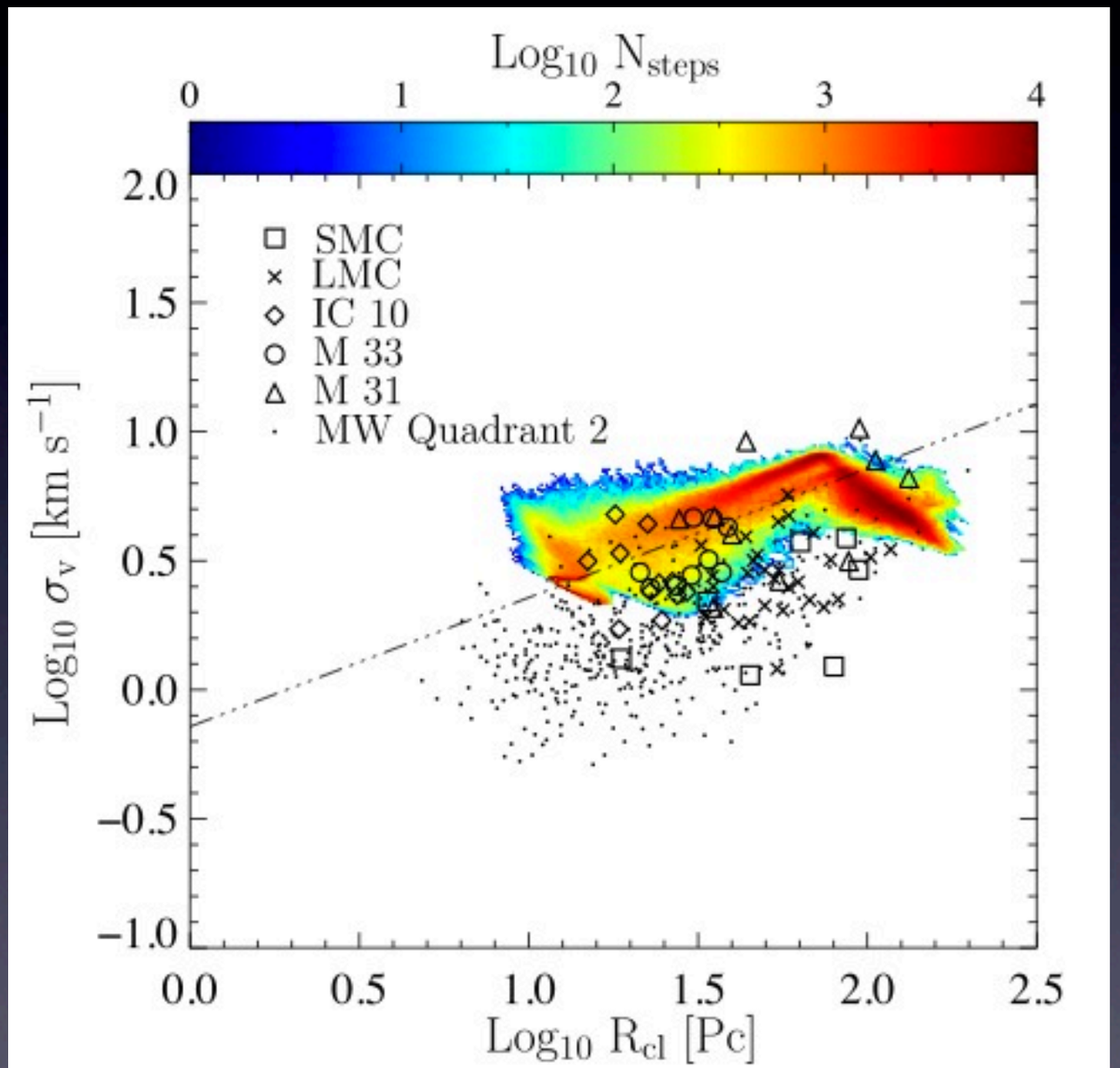




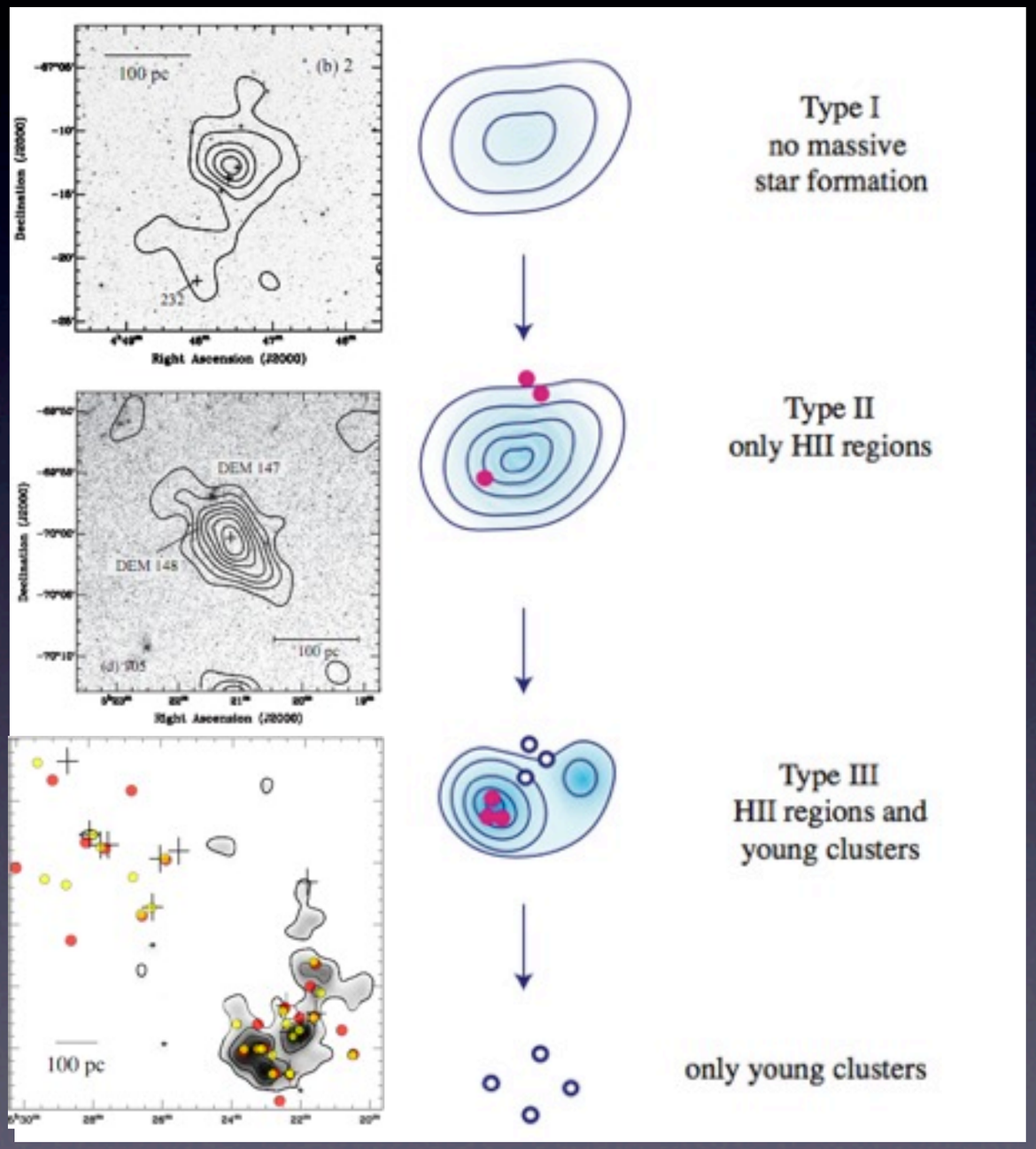
Models run in a fraction of a second

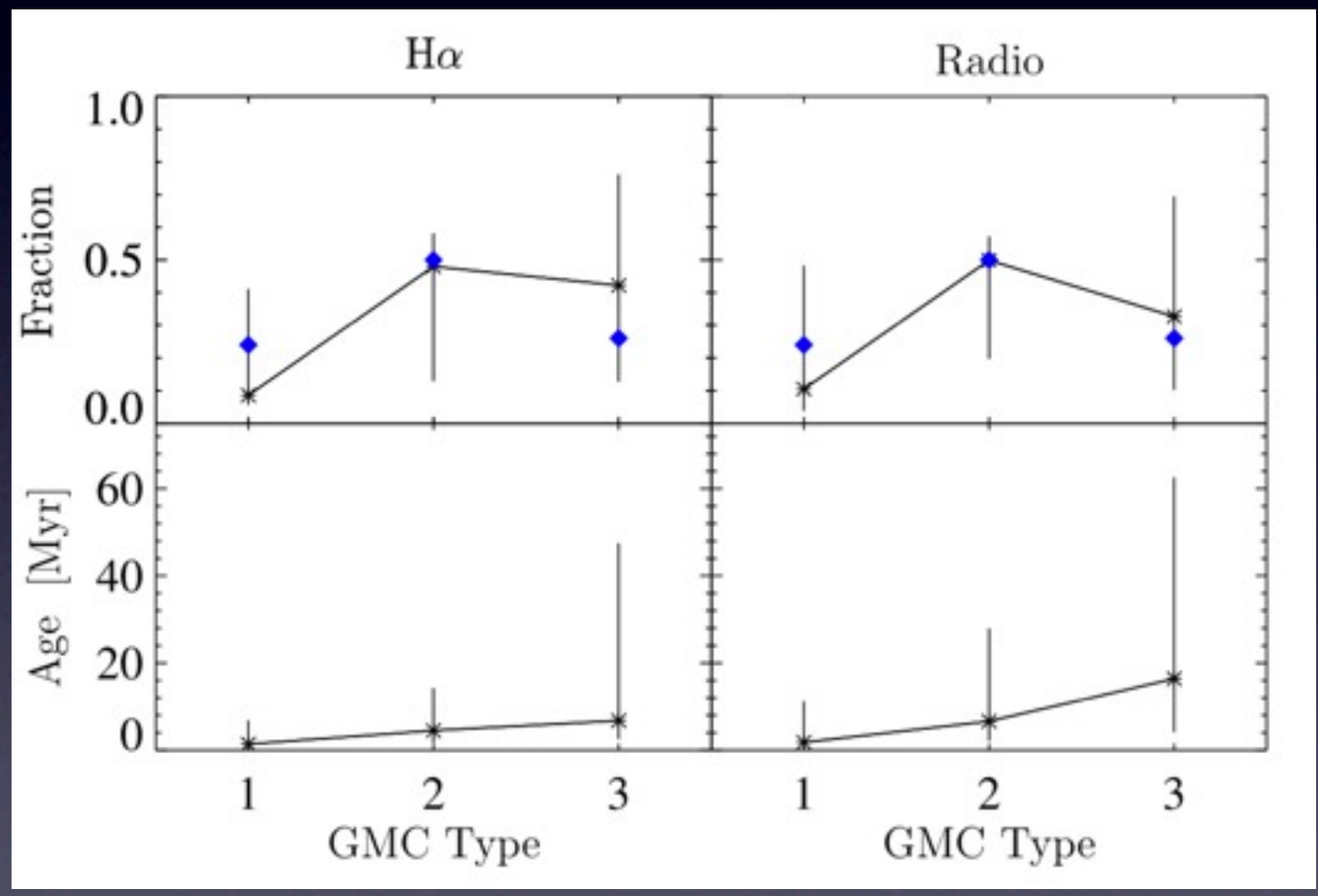
Comparison to Observations: Larson Scaling Laws





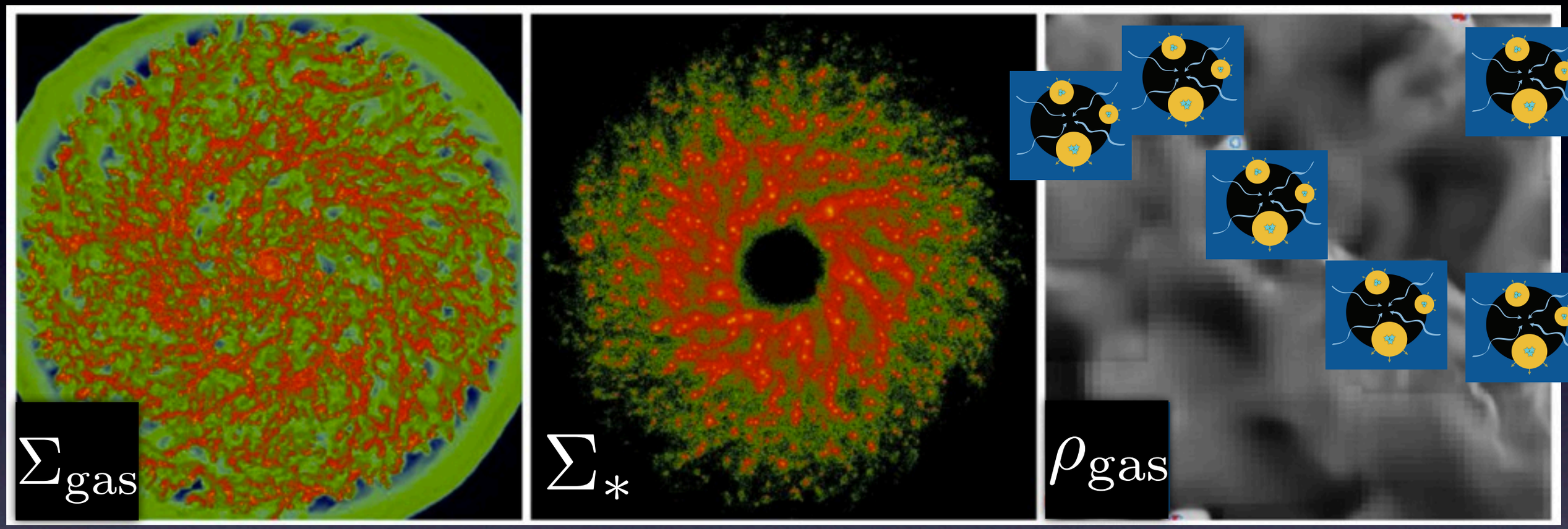
Comparison to Observations: GMC Classification





Kawamura+ 2009

What next?



Self-consistently model the co-evolution of a population of GMCs and a quiescently star-forming galaxy

For more details, see our paper:

THE GLOBAL EVOLUTION OF GIANT MOLECULAR CLOUDS II:
THE ROLE OF ACCRETION

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ApJ in press

http://arxiv.org/abs/1105.6097