Divergent evolution: **Comparing star formation in dwarf and spiral galaxies across redshift**

Charlotte Christensen

Tom Quinn, Fabio Governato, Alyson Brooks,
Sijing Shen, James Wadsley

8/2/12

Evolution

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- *Q: How does star formation and galaxy evolution progress in galaxies of different masses?*
- Simulated “similar” galaxies, a dwarf and a low-mass spiral
  - Same initial conditions
  - Scaled down spatially by a factor of **2**
  - Scaled down in mass by a factor of **8**
  - Resulting in the same density

Gasoline (Wadsley, et al., 2003)

- SPH code with
  - Cosmic UV background radiation
  - H & He ionization
  - **Metal line cooling** (Shen+ 2010)
  - Metal diffusion
  - **Star formation**
  - **Supernovae feedback (blastwave)** (Stinson+ 2006)
  - **Molecular Hydrogen** (Christensen+ *submitted*)

- Which reproduces
  - Damped Lyman-α systems (Pontzen et al., 2008, 2010)
  - Mass-metallicity relation (Brooks et al., 2007)
  - Broken exponential disks in spirals (Roskar et al., 2008)
  - Tully-Fisher relation (Governato et al., 2007)
  - Realistic rotation curves in dwarfs (Governato et al., 2010)
  - Reduced bulge mass in spiral galaxies (Guedes et al., 2011)
  - Change the angular momentum distribution (Brook et al., 2011, Pontzen et al., 2011)
  - ...

Implementing Molecular Hydrogen

- H2 abundances per particle
  - Integrated through simulation (Gnedin et al., 2009)
  - Based on local formation and destruction rates
  - Non-equilibrium
- Shielding of H2 and HI
- Other gas-phase physics: H2 cooling, collisional dissociation, formation via H-
- H2-based star formation

Implementing Molecular Hydrogen

Formation

- Forms on dust (metals) (Wolfire et al., 2008)
  - *Metallicity*
  - *Density*
  - Gas *clumpiness* (McKee & Ostriker et al., 2007)

Destruction

- Destroyed by LW radiation
  - *Flux* from local young stars
  - Self-shielding and shielding by dust (Draine & Bertoldi, 1996)
  - *Surface density* (column length x density)
  - *Metallicity*

Implementing Molecular Hydrogen

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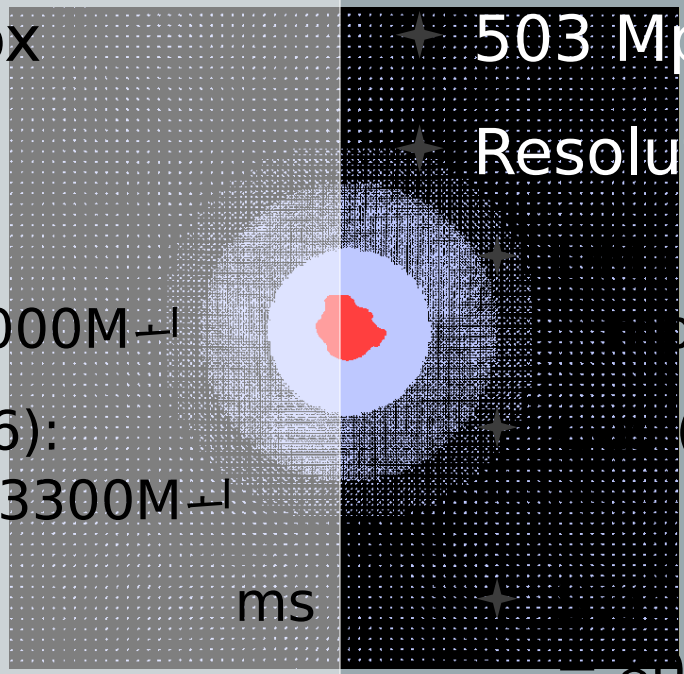
Initial Conditions

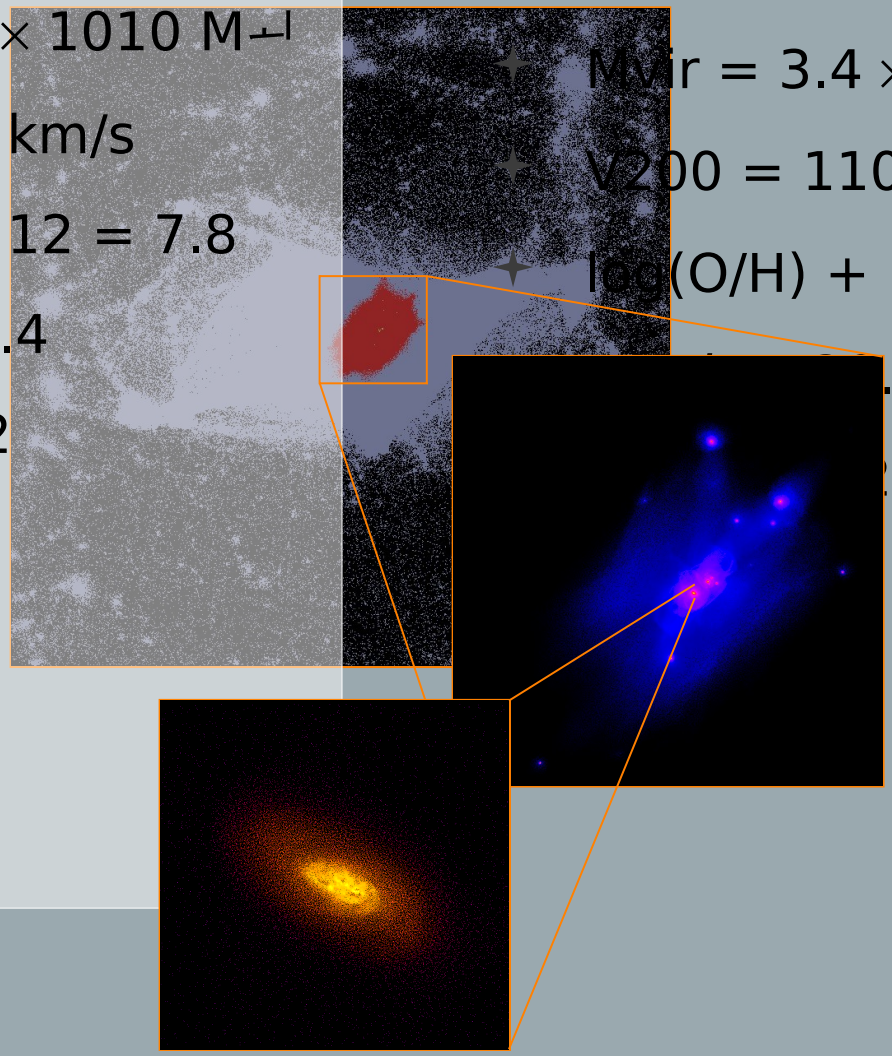
- Dwarf Galaxy
- 253 Mpc3 Box
- Resolution
  - DM (107):
    mp = 16,000M⊢
  - Gas (6 x 106):
    mg = 3300M⊢
  - Star: ms
    = 1000M⊢
  - Spatial Resolution: ~60 pc in disk



- Spiral Galaxy
- 503 Mpc3 Box
- Resolution
  - 107):
    = 128,000M⊢
  - (6 x 106):
    mg = 25,000M⊢
  - ms
    = 8000M⊢
  - Spatial Resolution:
    ~100 pc in disk

Final State at z = 0

- Dwarf Galaxy
  - Mvir = 3.8 × 1010 M⊣
  - V200 = 60 km/s
  - log(O/H) + 12 = 7.8
  - Mag*i* = -16.4
  - *g* – *i* = 0.42
- Spiral Galaxy
  - Mvir = 3.4 × 1011 M⊣
  - V200 = 110 km/s
  - log(O/H) + 12 = 8.5
  - .3



Final State at z = 0

- Realistic Rotation Curves (Oh et al., 2011, Christensen et al., *in prep*)
- Lies on Moster et al, ’10 z=0 halo/stellar mass relation (Munshi et al., *in prep*)
- Reasonable magnitudes, colors, metallicities, and star formation rates

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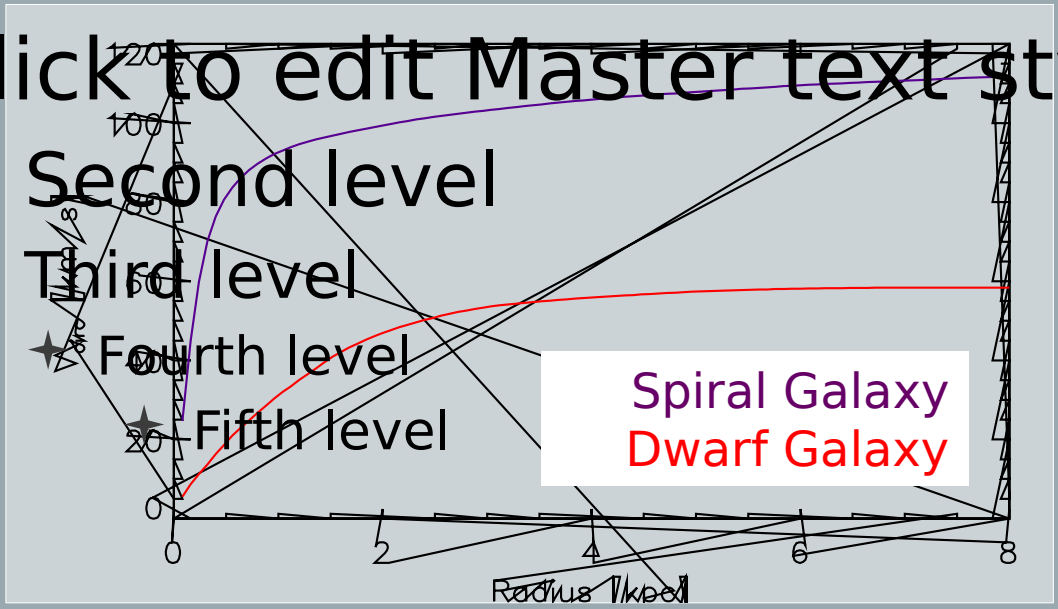
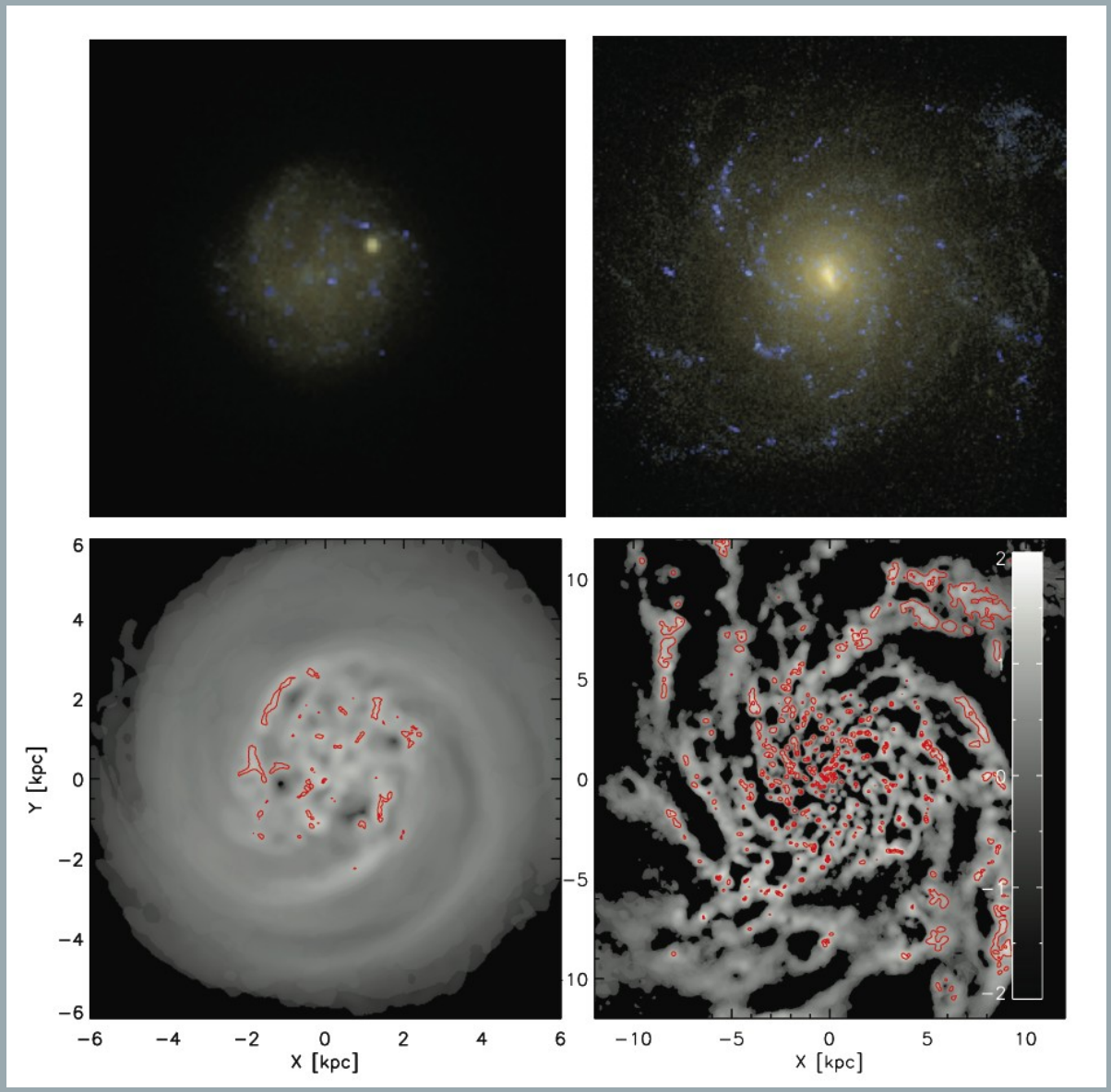
    - Fourth level
      - Fifth level

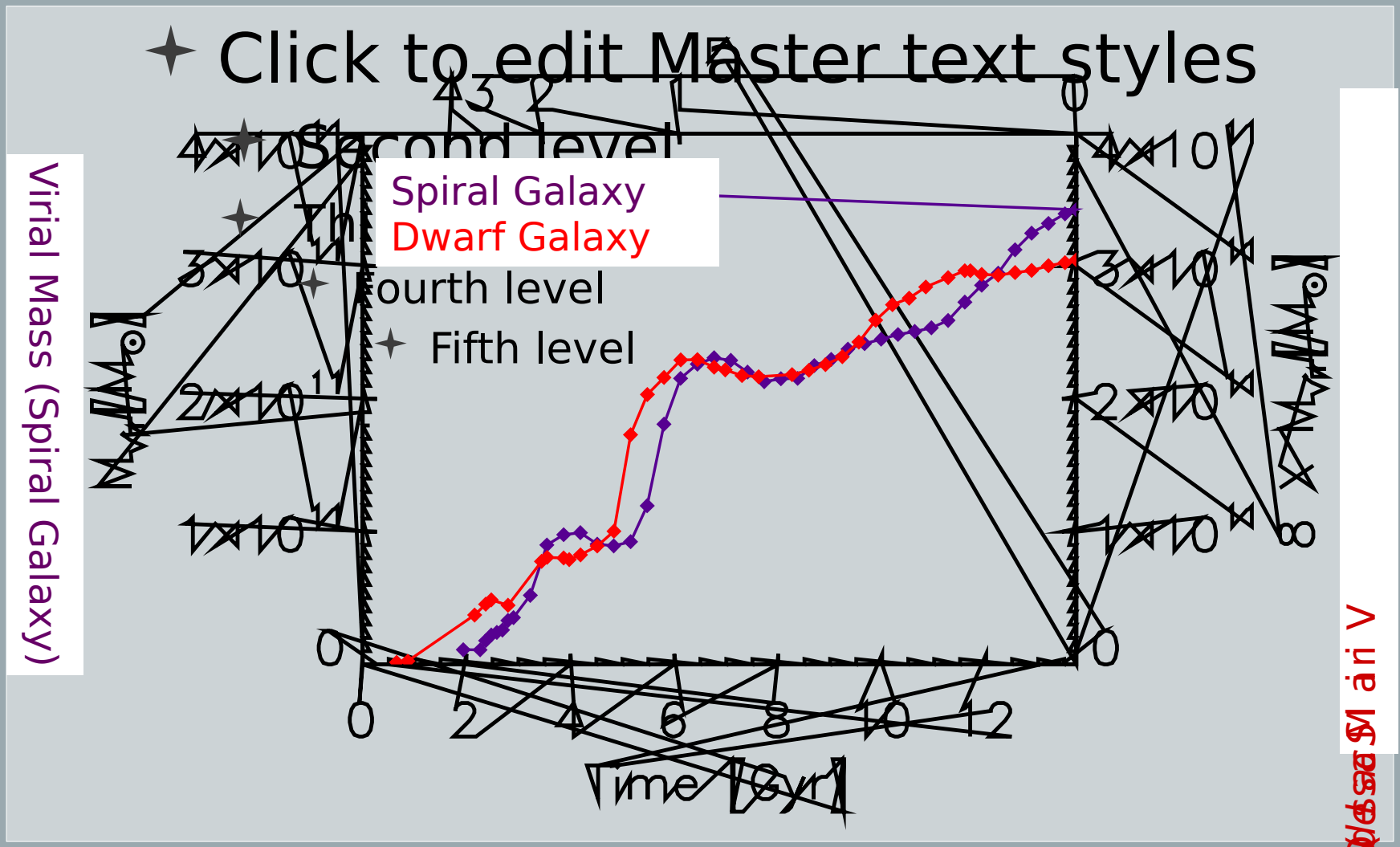


Mock-Observations at z=0

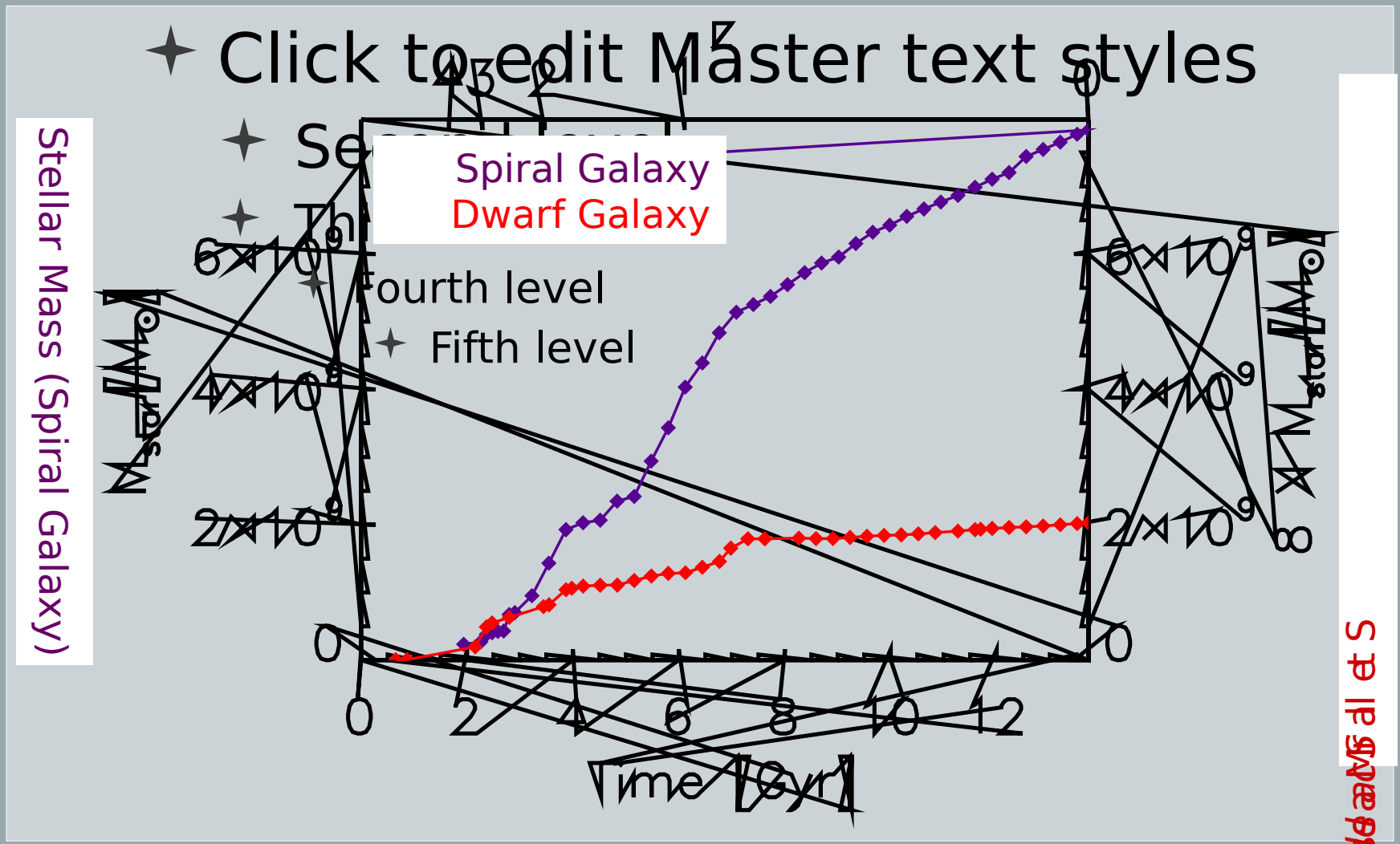


Images from SUNRISE (Jonsson ‘06)

Evolution of Total Mass



Evolution of Stellar Mass



Star Formation Histories

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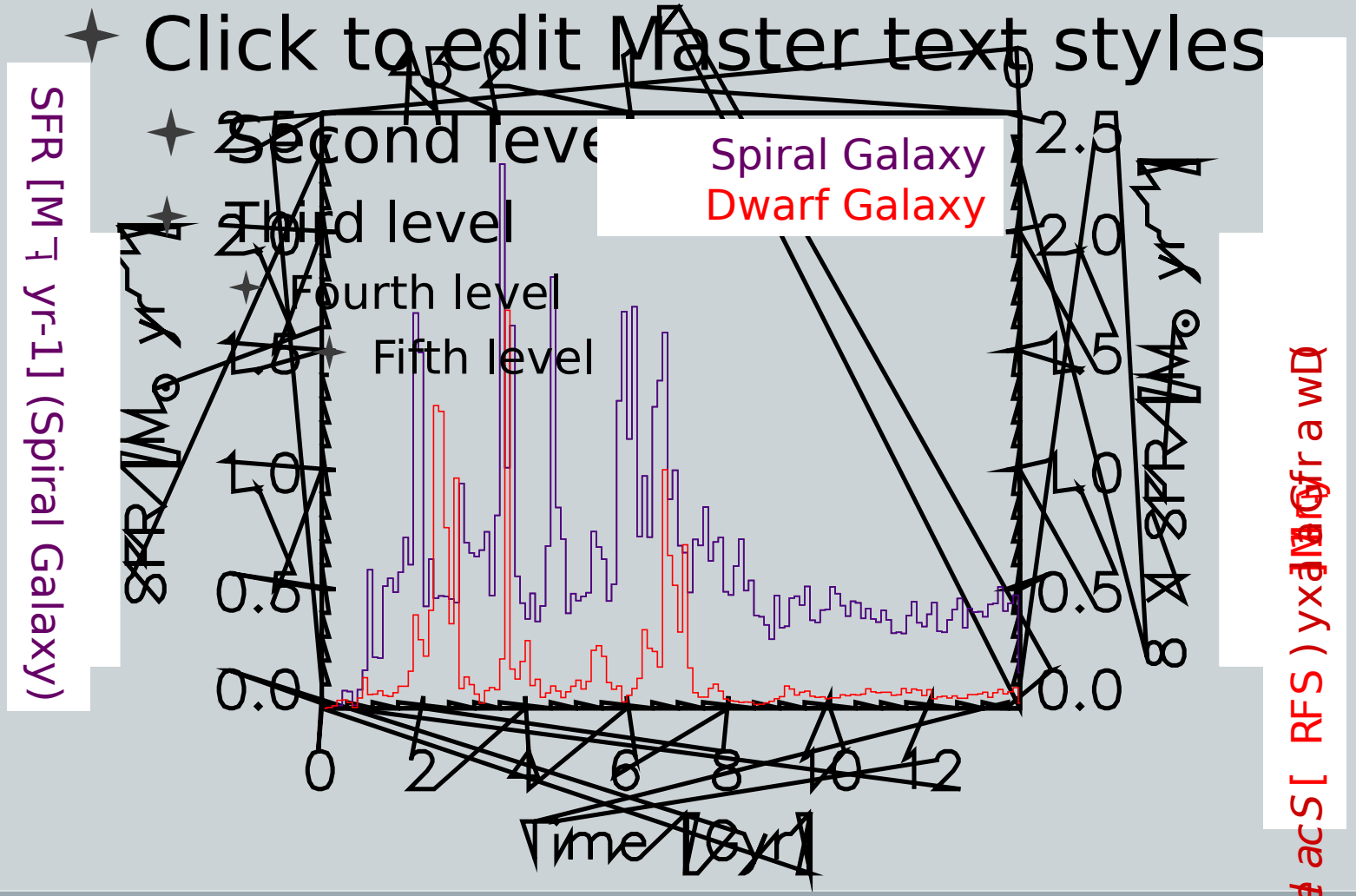

Kennicutt-Schmidt Relation

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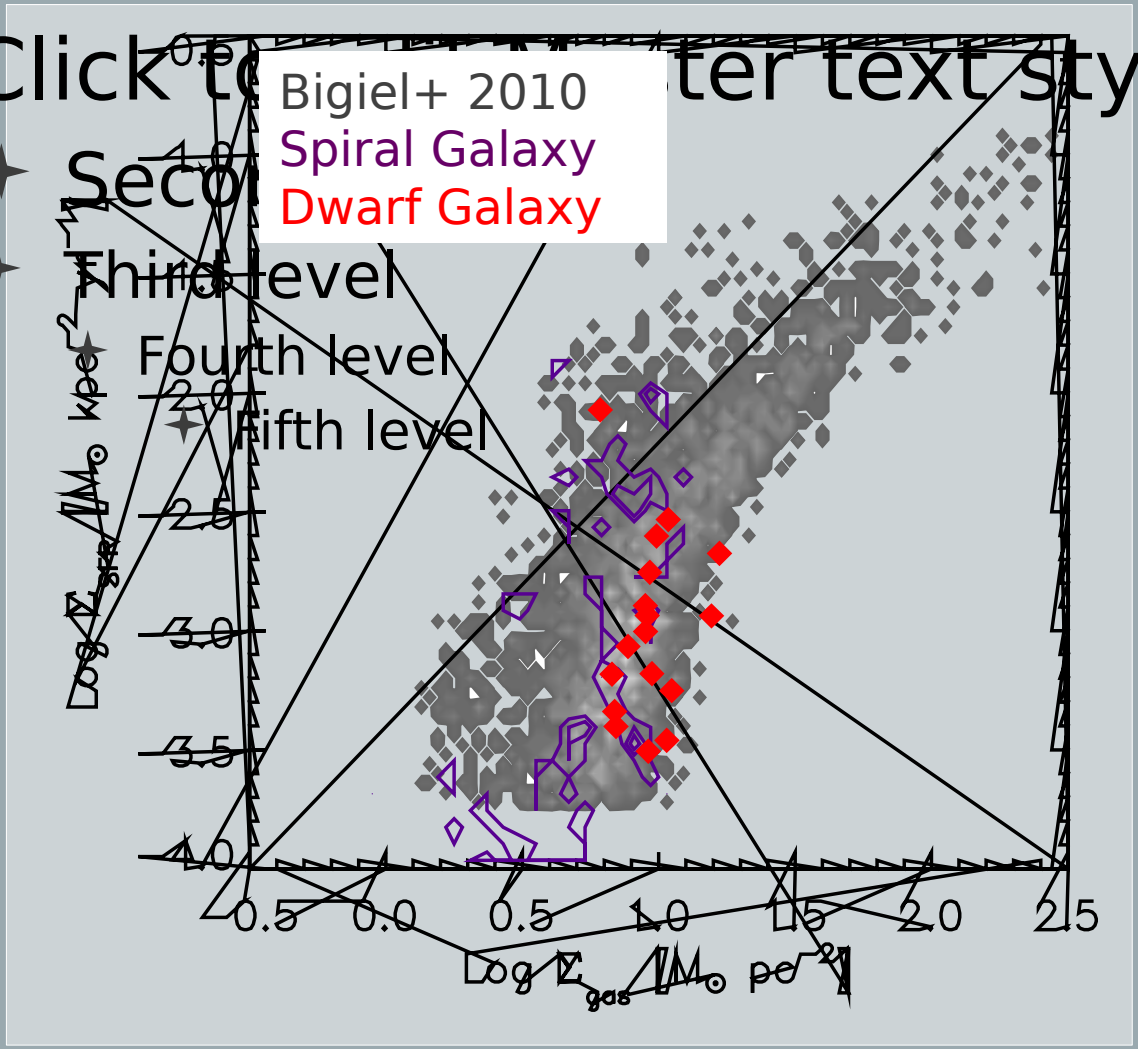

Molecular Hydrogen Over Time

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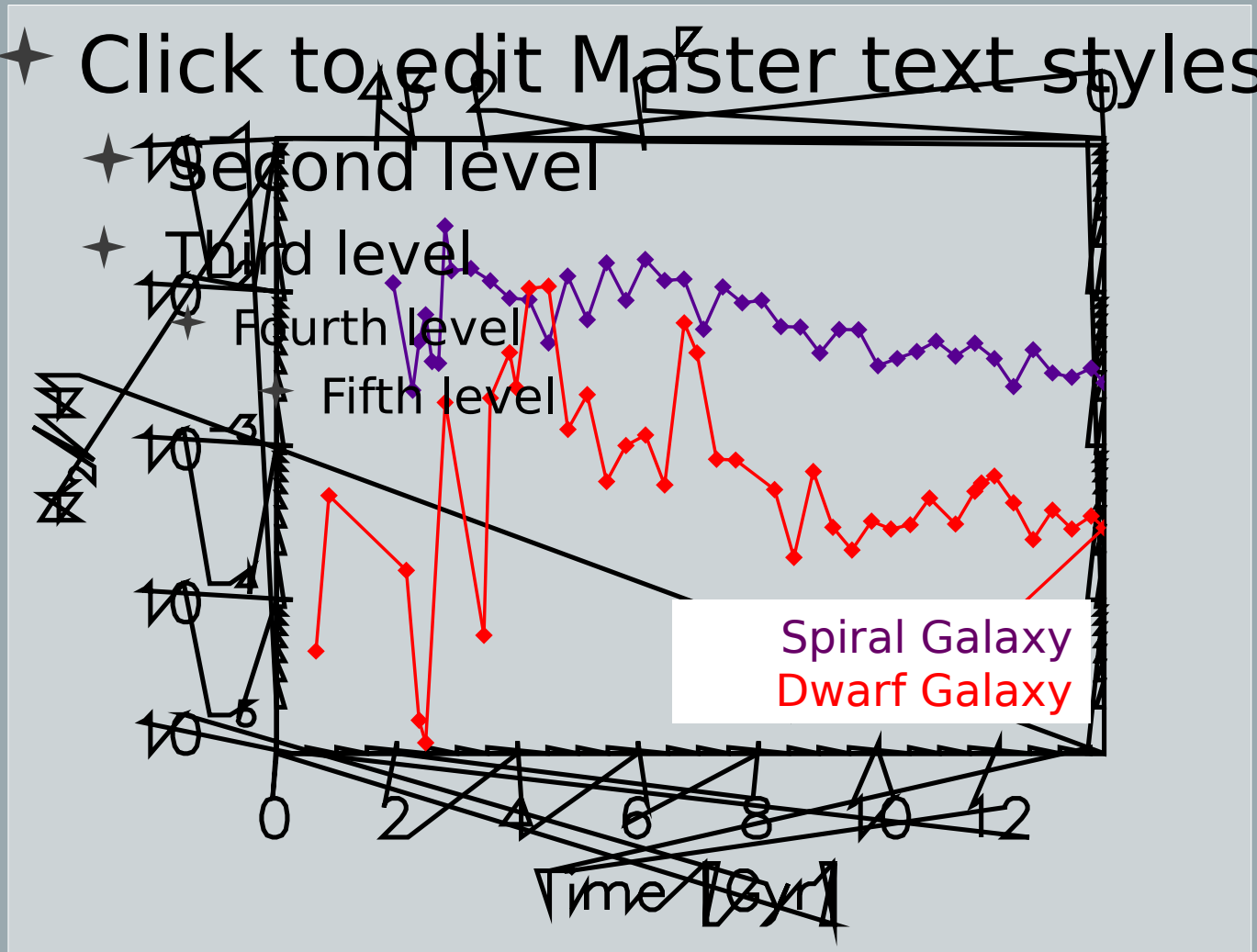

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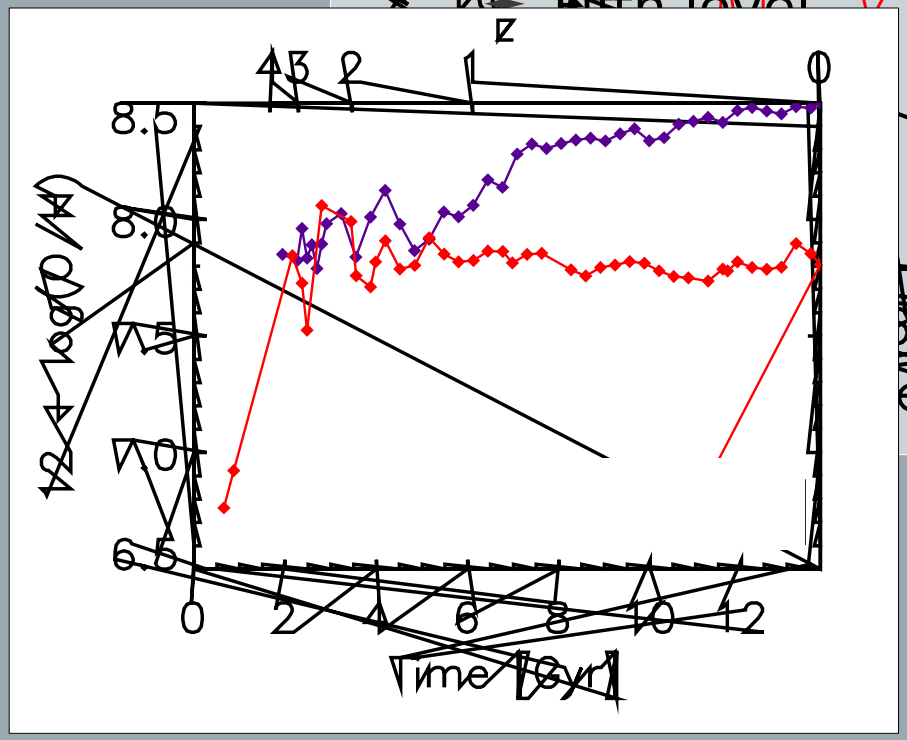

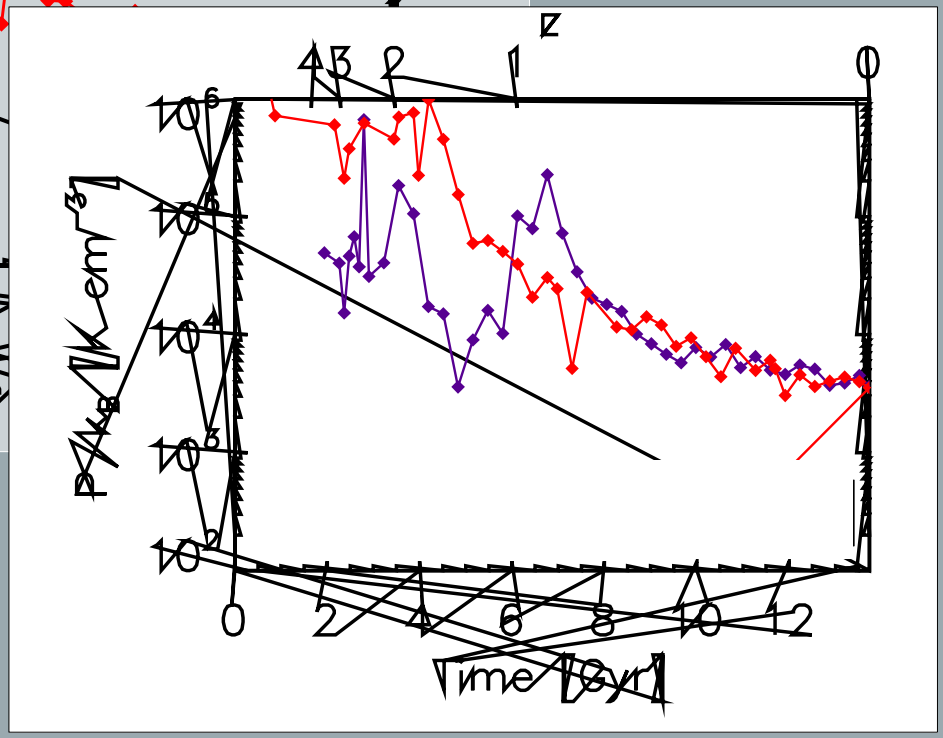

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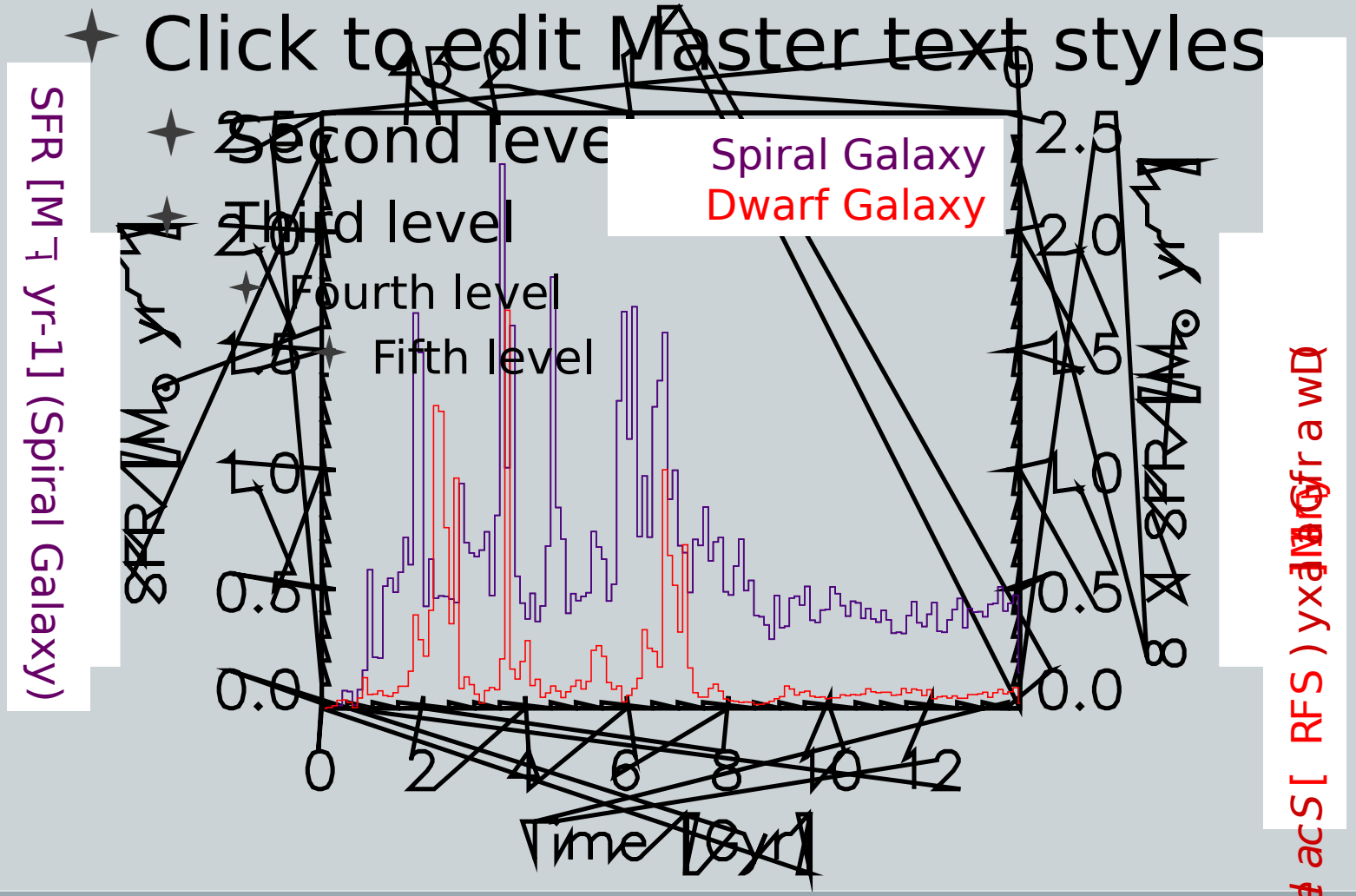
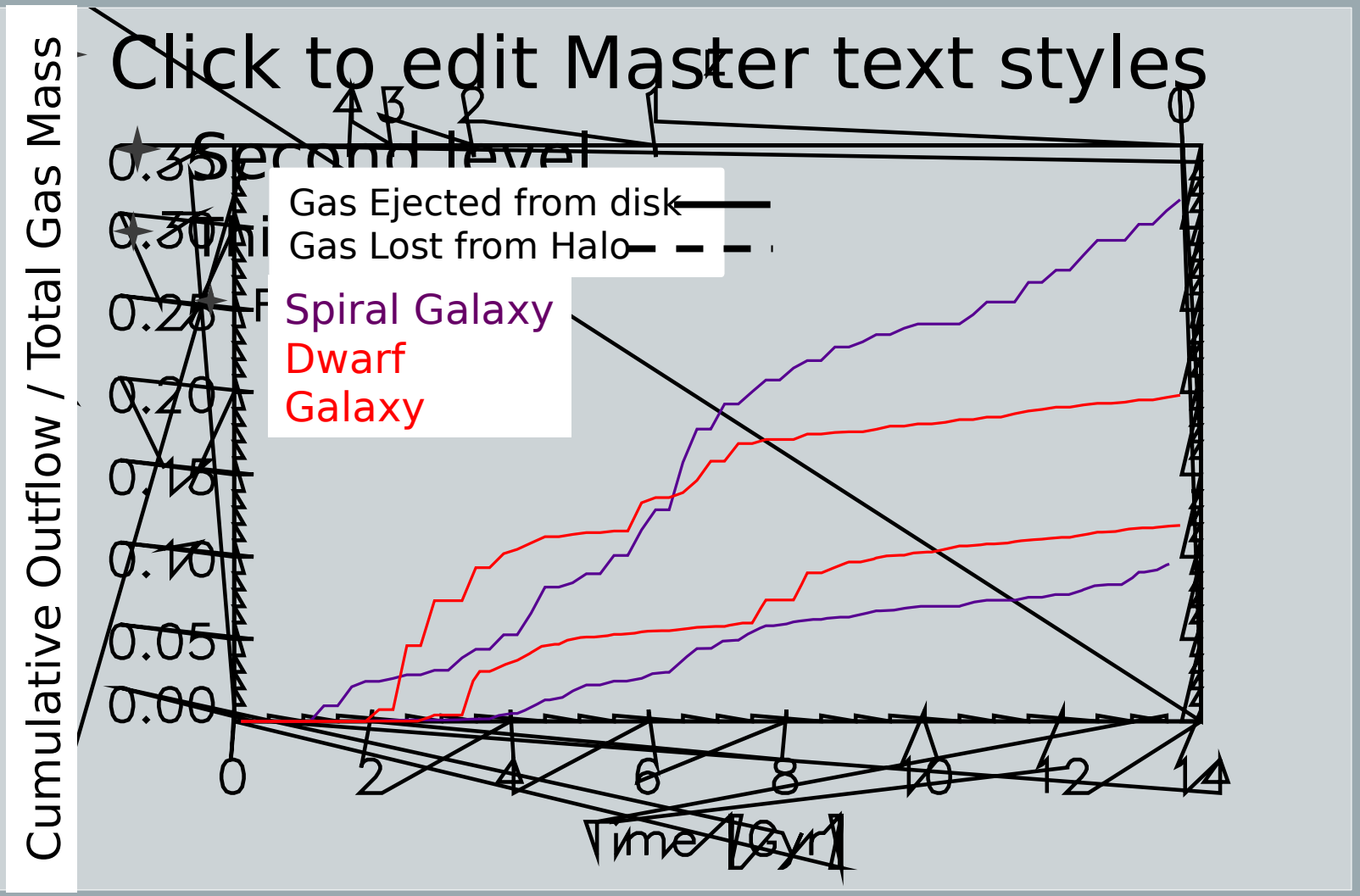


Outflowing Gas

- *Mass Loading Factor of ~ 2-4*



Angular Momentum

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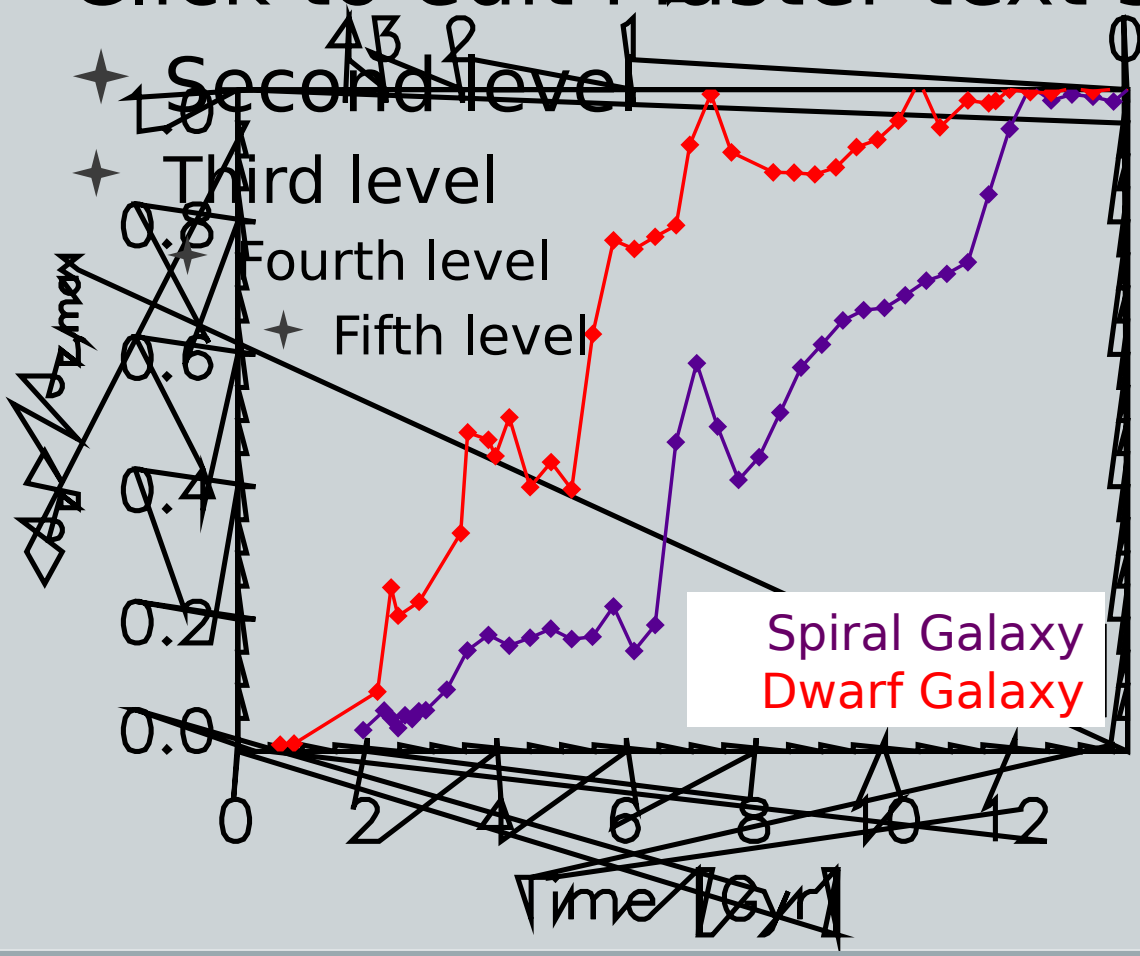

Evolution

- *Q: How does star formation and galaxy evolution progress in galaxies of different masses?*
- Simulated “similar” galaxies
- We demonstrate how lower pressure and metallicity result in smaller H2 abundances in the dwarf galaxy and lower stellar fractions
- In the future:
  - Higher resolution high-z runs
  - Quantify H2-pressure-Z-SF connection