Numerical Simulations and Gastrophysics

DISCUSSION

- Two major limits of our ignorance in simulations:
  - (1) Star Formation:

    - - Need ~ pc resolution to see star-forming cores
    - - Need self-consistent phase structure in simulation gas
    - - Need to understand how it depends on local density, temperature, ionization, magnetic fields, etc.

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DISCUSSION

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    - However....

      Kennicutt-Schmidt Law seems to very accurately describe global SF properties

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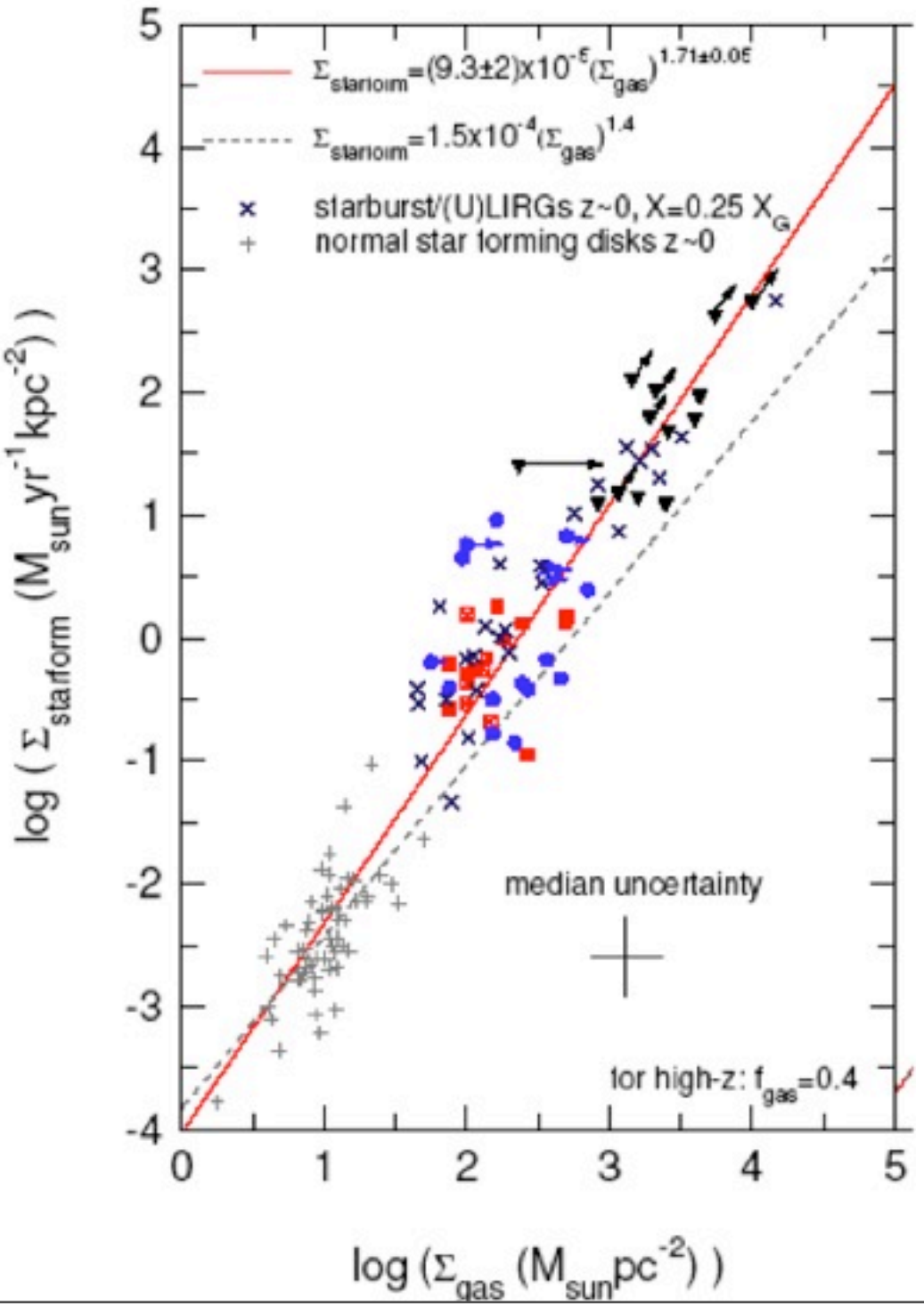
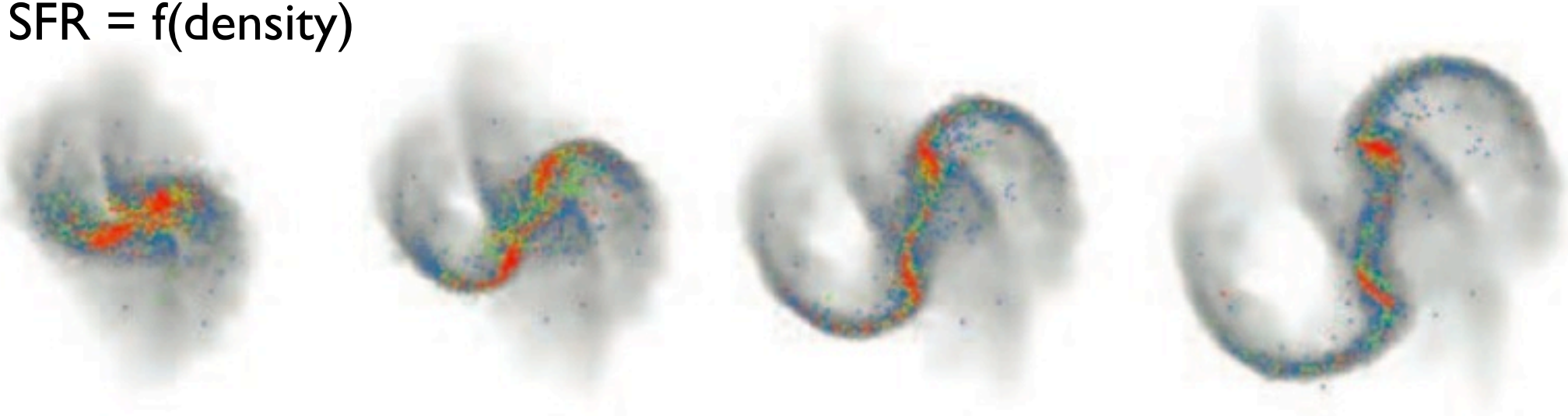
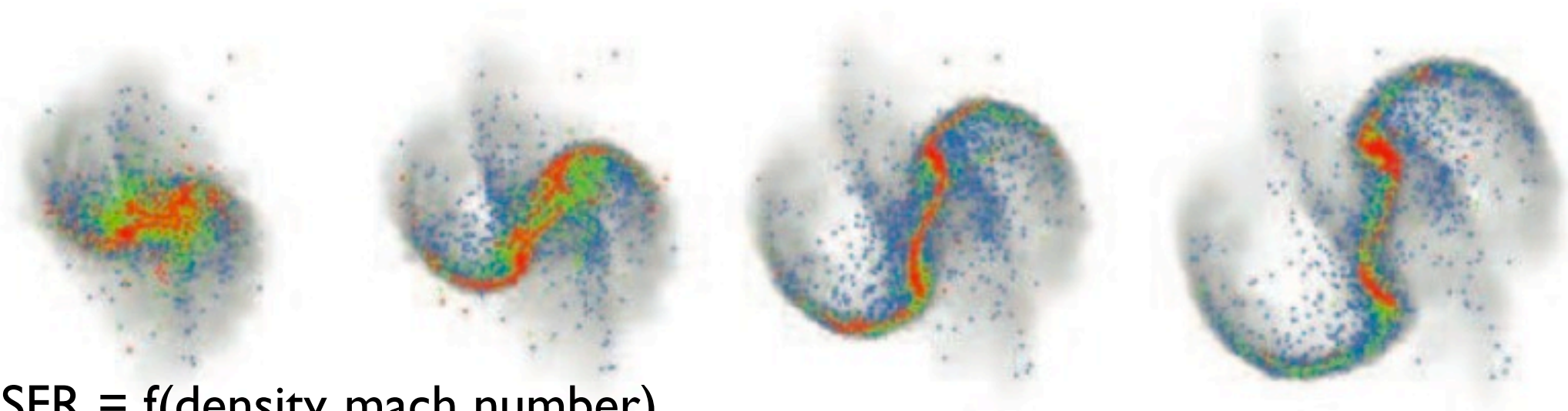
DISCUSSION



- Given that, our uncertainty is limited to details

SFR = f(density)





SFR = f(density, mach number)

Numerical Simulations and Gastrophysics

DISCUSSION

- Two major limits of our ignorance in simulations:
  - (1) Star Formation:
    - Probably ok at >~ 10pc scales
  - (2) Feedback:
    - ISM gas: pressurization/heating from winds & SNe
      (~10pc - 10kpc scale effects)
    - Starburst-driven winds:
      - Probably how *most* of the ISM gets metal-polluted
      - Involves large fraction of the mass in stars
      (~100pc - Mpc scale effects)
    - AGN:
      - Ionize & heat very large “bubbles”
      - Heat entire clusters
      (<< pc - 10s of Mpc scale effects)

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DISCUSSION

- Feedback energetics:

  - Binding energy of typical (~L*) galaxy:
    ~ (a few) * M_{stars} * V_c^2 ~ 5*(10^{11} M_{sun})*(200 km/s)^2 ~ $10^{59\text{-}60}$ erg

  - Supernovae: ~0.1 mass fraction goes SNe, each releases
    ~ 10^{51} erg (for mean mass ~ 8 M_{sun}), get:
    ~ (0.1*M_{stars})* (10^{51} erg / 8 M_{sun}) ~ 10^{60} erg

  - AGN: couple ~0.05 of radiated energy (suggested by M-sigma), and radiate ~0.1 of accretion energy (Soltan argument), for M_{BH} ~ 0.001 M_{stars} (Magorrian relation):
    ~ 0.05 * (0.1* M_{BH}*c^2) ~ 5 10^{-6} (M_{stars}*c^2) ~ 10^{60} erg

10% gas

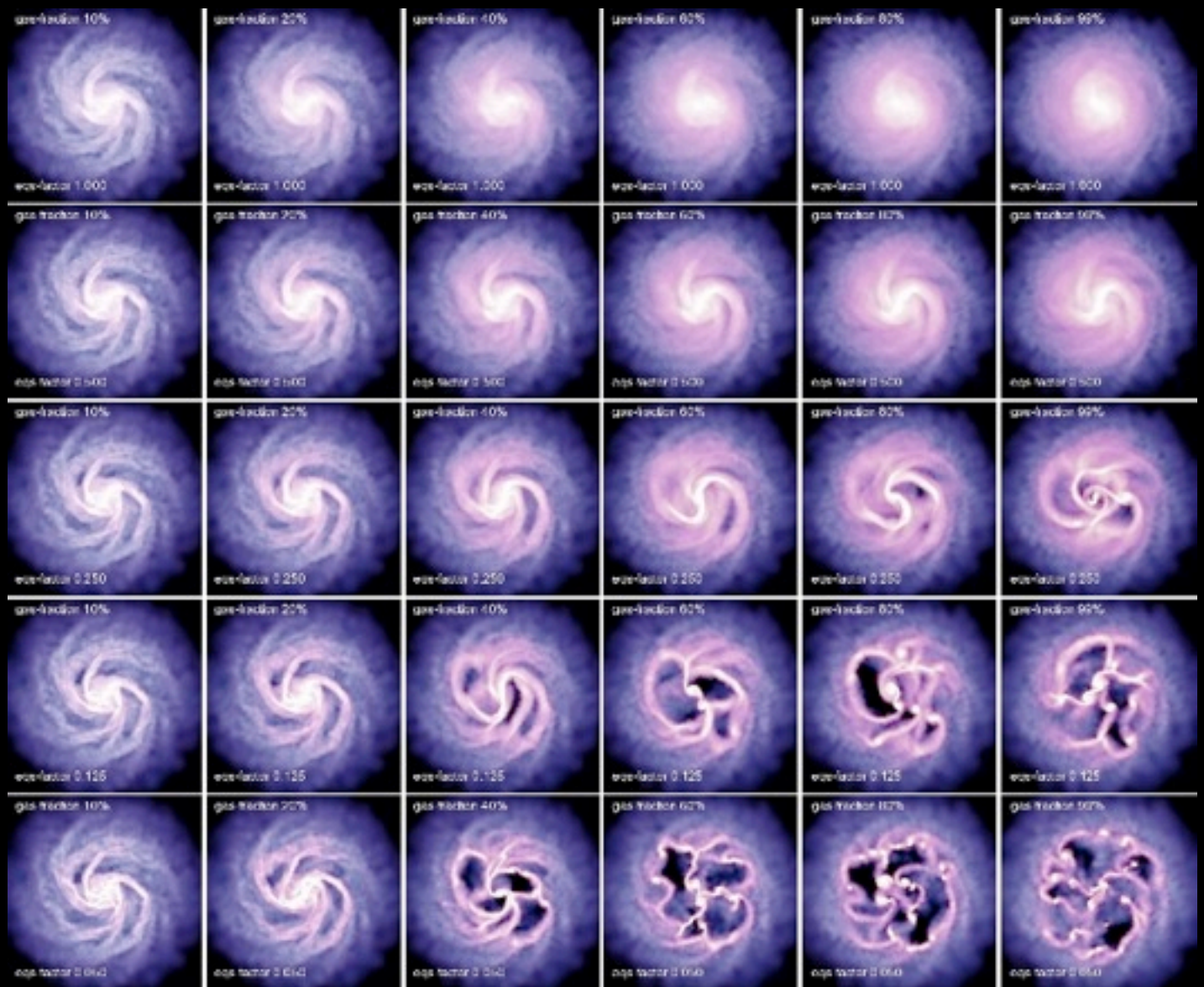
99% gas

more gas

softer EOS

~ 10^5 K

10^4 K



Numerical Simulations and Gastrophysics

DISCUSSION

- Two major limits of our ignorance in simulations:
  - (1) Star Formation:
    - Probably ok at >~ 10pc scales
  - (2) Feedback:
    - ISM gas: pressurization/heating from winds & SNe
    - Starburst-driven winds
    - AGN
      - Unlike star formation, we don't have a clear approximation on the scales we are interested in...