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Simulating the Cold Molecular Hydrogen Gas in Dwarf Galaxies

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Observation of a molecular cloud from Hubble Space Telescope

Examining the connection between star formation and molecular hydrogen

- Plenty of observational evidence that stars form from molecular hydrogen, as opposed to warmer, neutral hydrogen
- This connection implies that to simulate where stars form, we must first find where the molecular hydrogen is
- However, until recently few simulations have included molecular hydrogen because of the high resolution necessary
- Here, we present the first cosmological simulations integrated to current day with molecular hydrogen

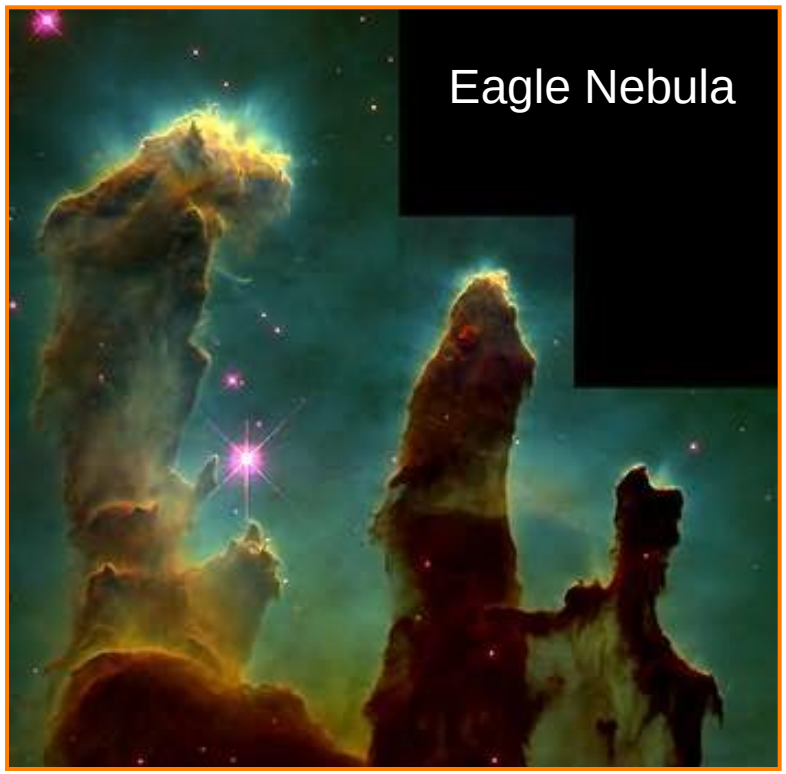

Image from Hubble Space Telescope:
Dark columns are molecular clouds, red points in clouds are embedded star formation

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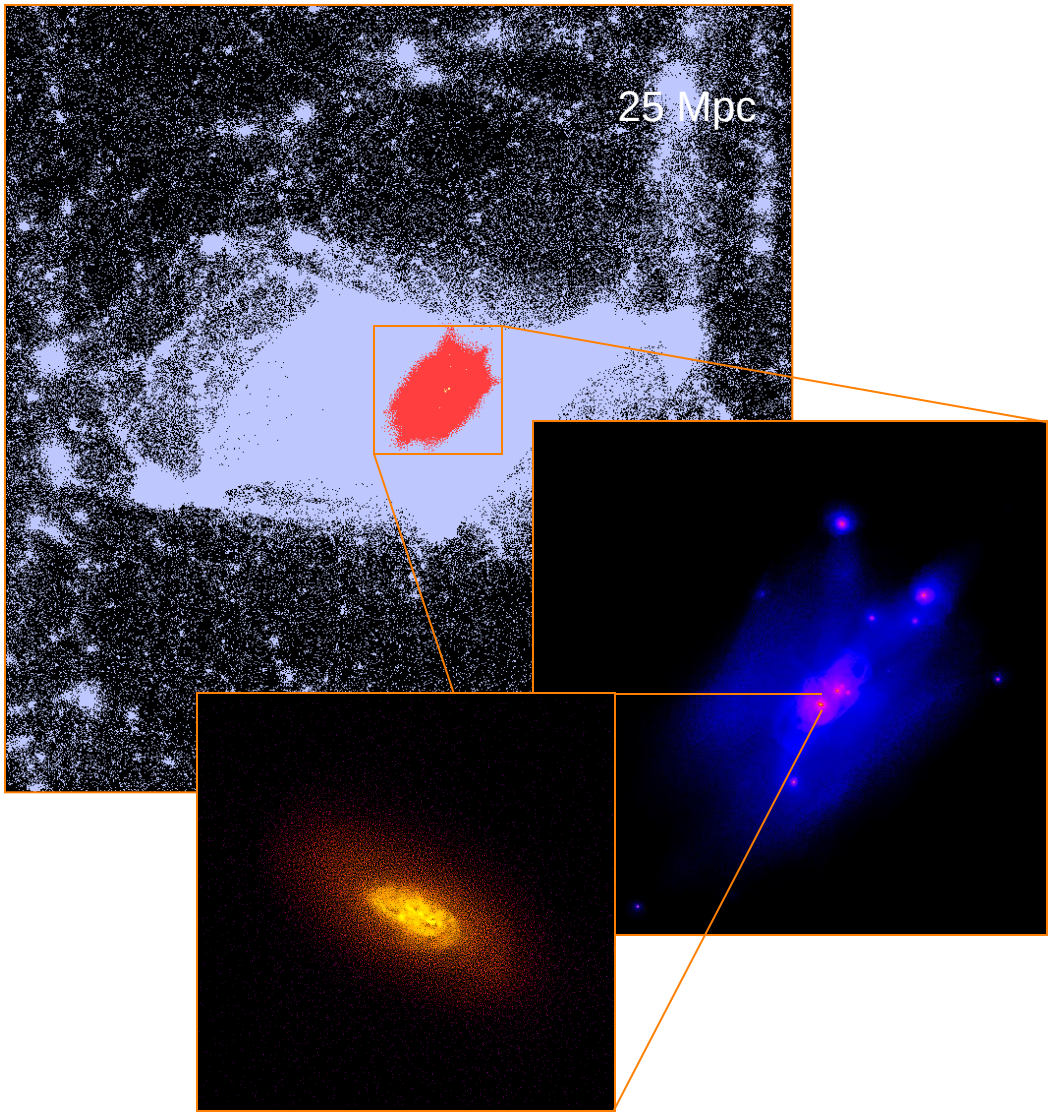
Computing the local abundances of molecular hydrogen

- We use the smoothed particle, hydrodynamic, parallel code GASOLINE (Wadsley et al. 2004)
- Includes physical processes such as
  - Star formation, supernova feedback, metal diffusion and cooling, background UV radiation, etc.
- Has been successful at reproducing such things as
  - Mass-metallicity relation, damped Lyman-α systems, broken exponential disks, HI holes, etc.
- We include the nonequllibrium abundance of molecular hydrogen in gas particles, based on local formation and destruction rates such as
  - Photo-dissociation by light from young stars, formation on dust grains, and shielding by itself and dust

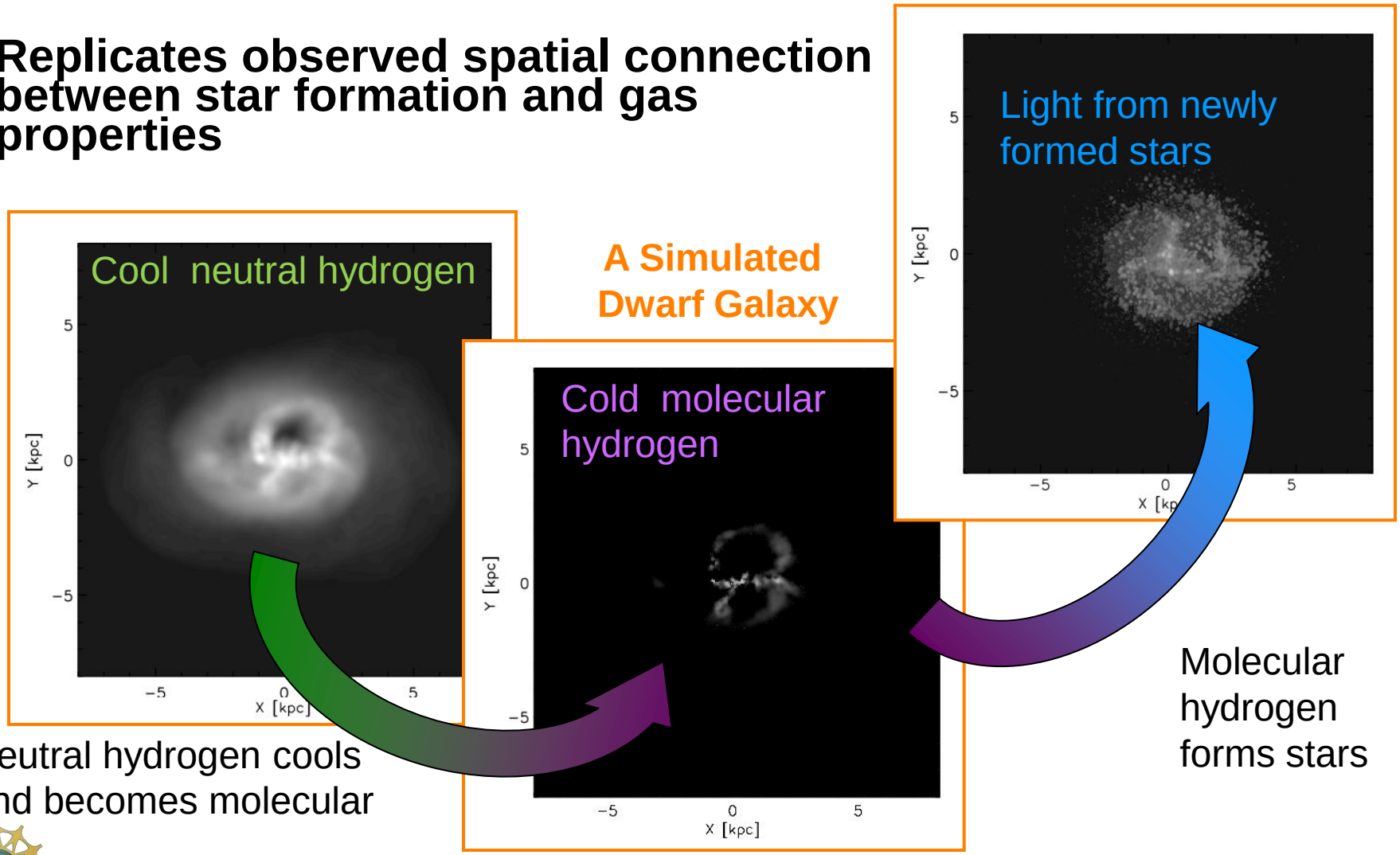
Simulated galaxies with molecular hydrogen

- Simulated both dwarf and classic spiral galaxies
- Used “Zoomed-in” initial conditions
  - Enable us to follow both the large scale gravitational structure and they small-scale environments where stars form
- Computed from a redshift of 10 to present day (over 13 billion years)
- High resolution
  - More than 16 million particles per simulation
  - Resolved giant molecular clouds



Distribution of molecular hydrogen, neutral hydrogen, and star formation

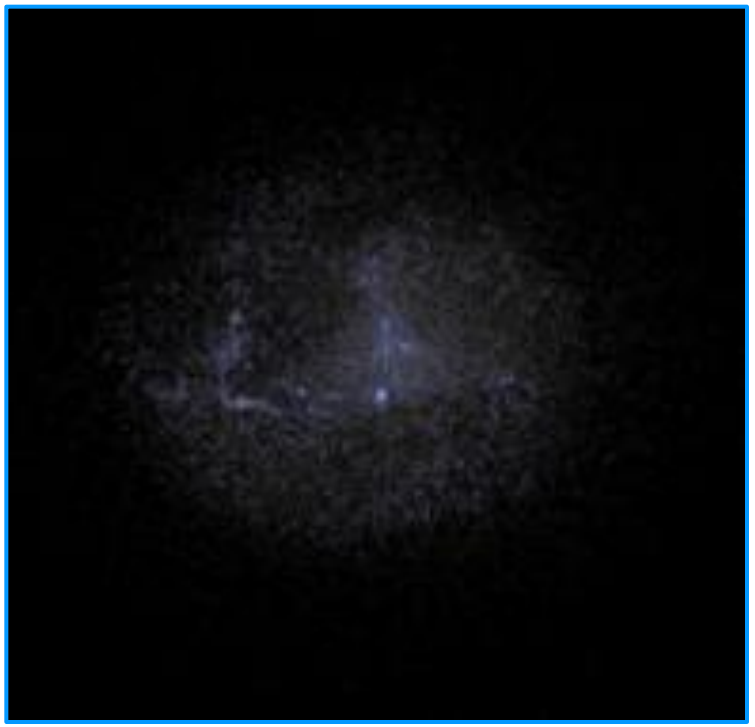
- **Replicates observed spatial connection between star formation and gas properties**



In dwarf galaxies, linking star formation to molecular hydrogen extends and prolongs star formation

Simulation computed without molecular hydrogen

Simulation computed with molecular hydrogen



Mock observations of our simulated galaxies
(blue light denotes recent star formation)

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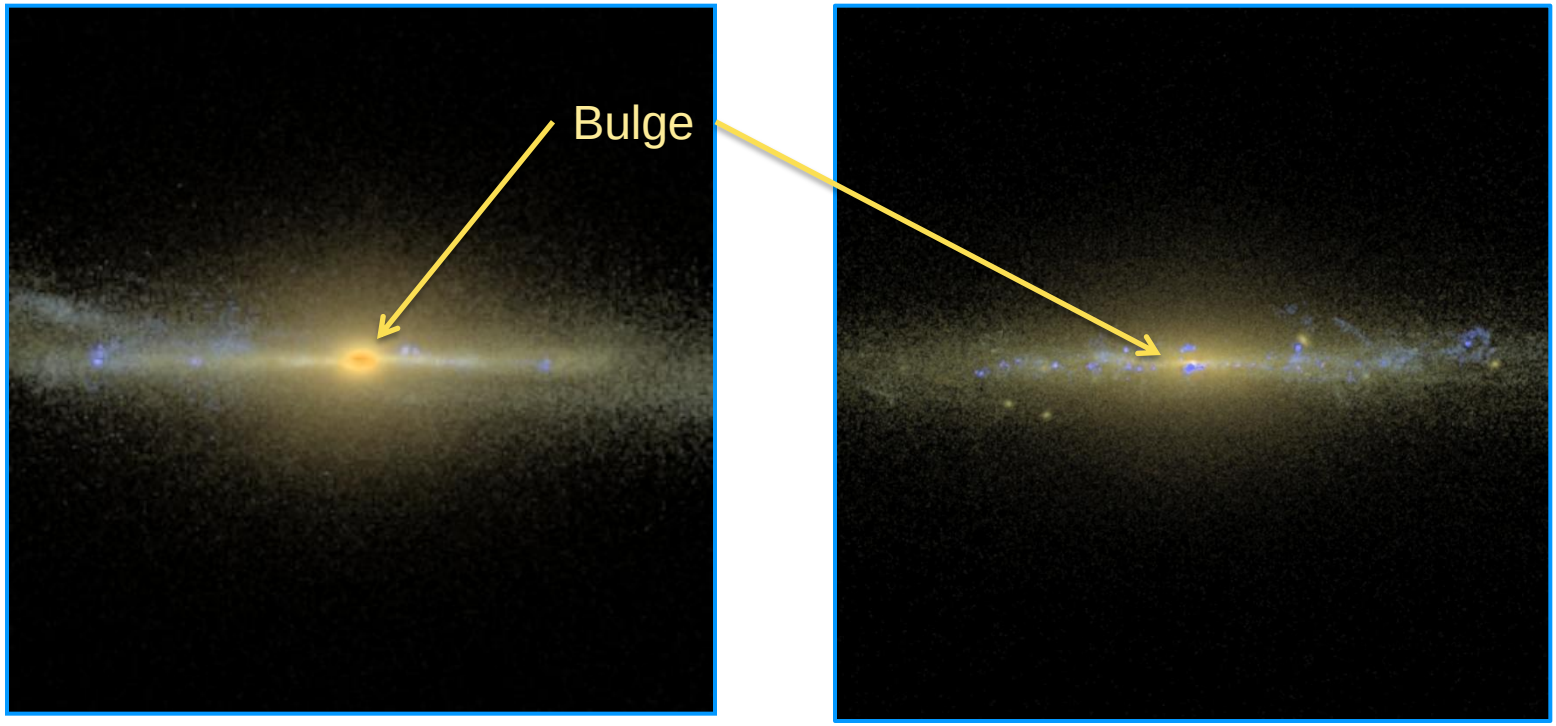
In spiral galaxies, linking star formation to molecular hydrogen results in dimmer bulges, *similar to observed galaxies*

Simulation computed without molecular hydrogen

Simulation computed with molecular hydrogen



Mock observations of our simulated galaxies

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