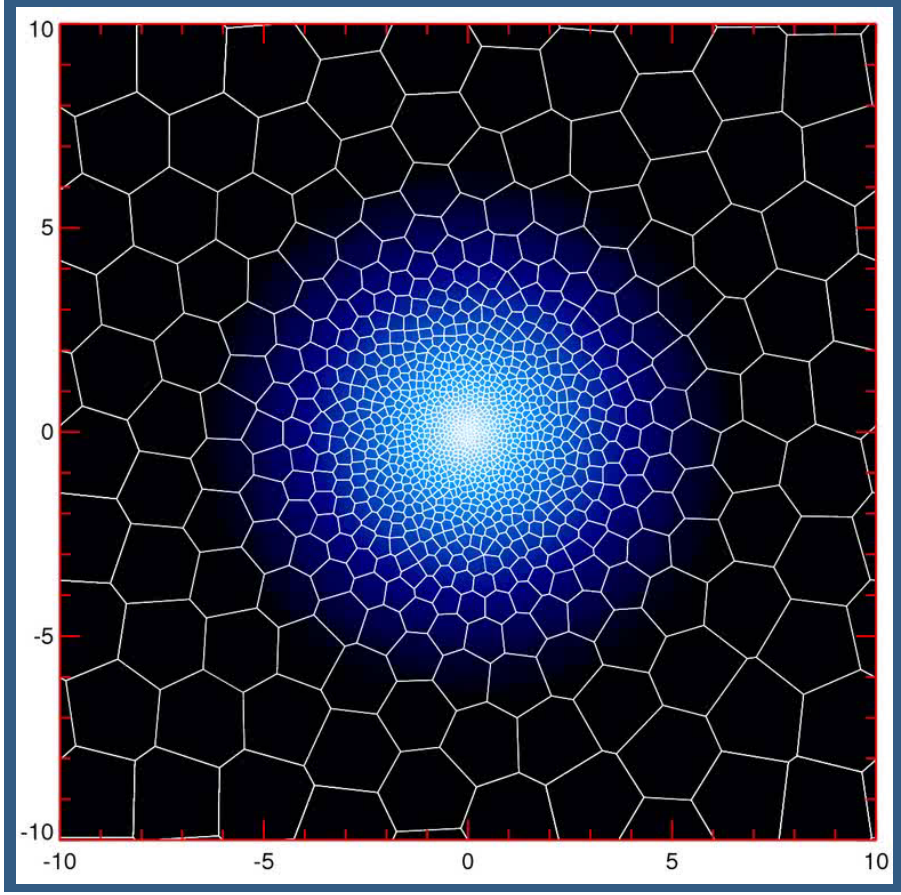
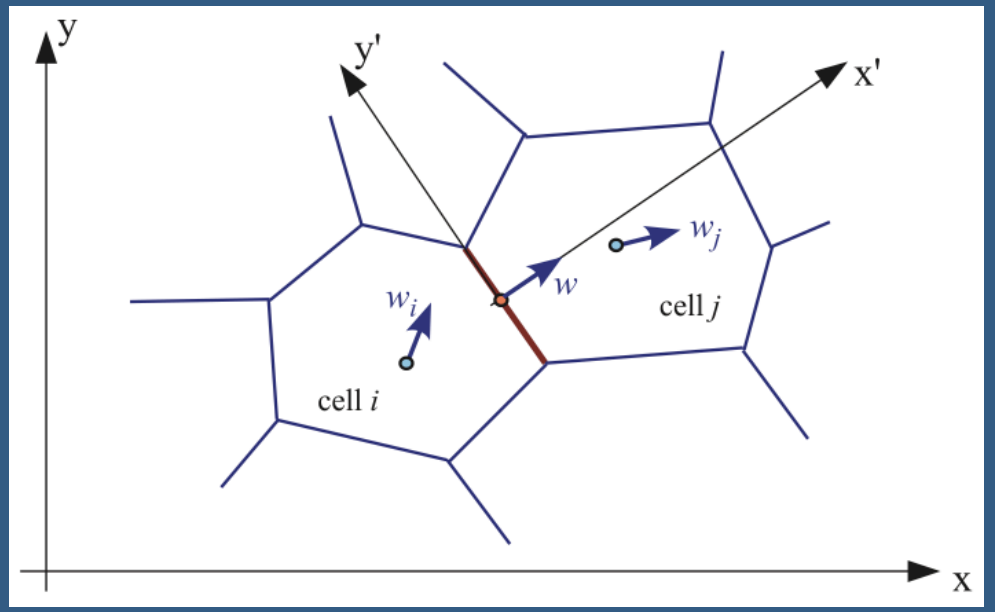
Quasi-Lagrangian hydro: a moving unstructured mesh with Arepo

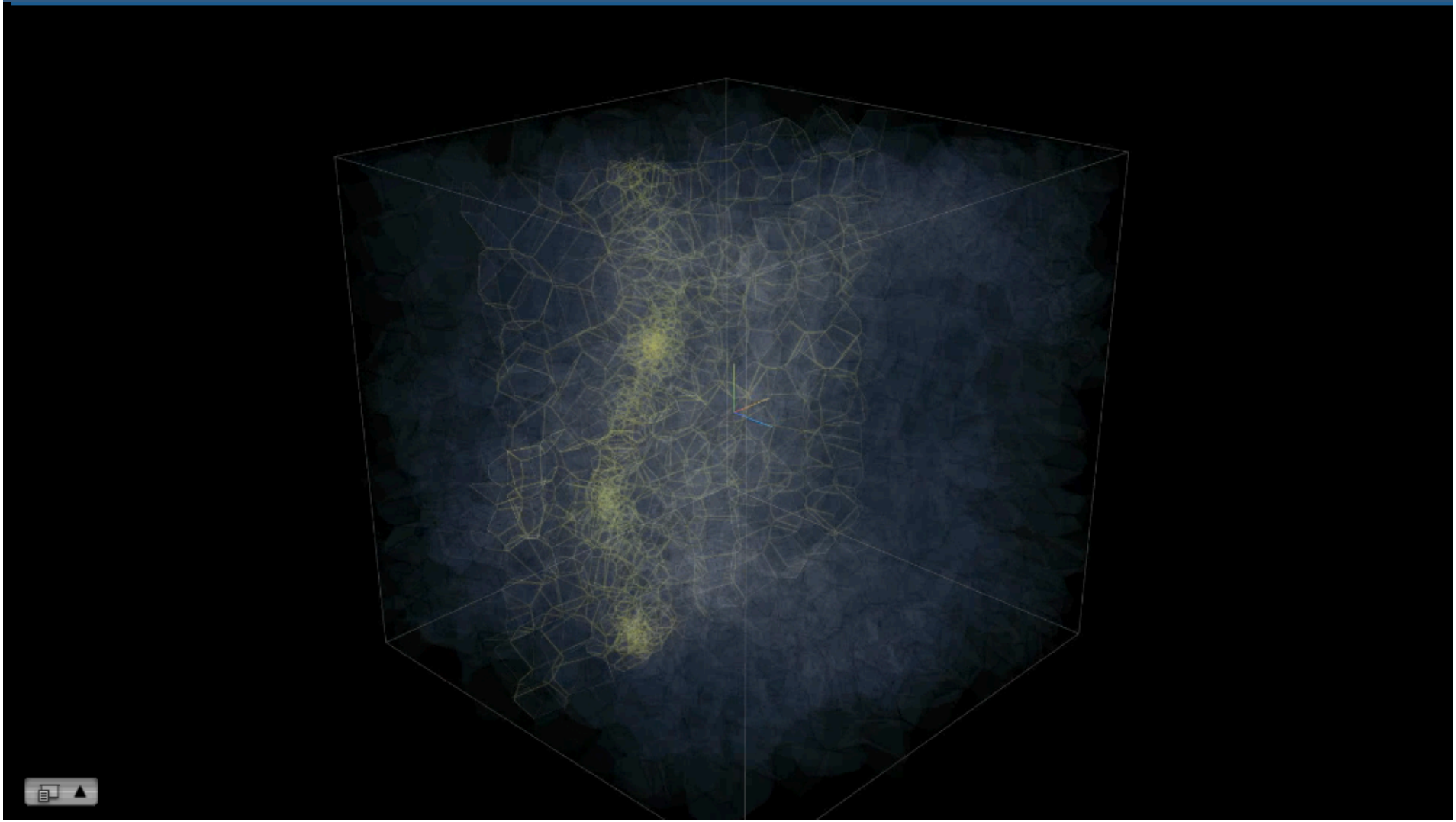




Springel 2010

Quasi-Lagrangian hydro: a moving unstructured mesh with Arepo

Courtesy of Dylan Nelson



Quasi-Lagrangian hydro: a moving unstructured mesh with Arepo

Community:

~50 people with code access, ~15 active users, ~10 active developers

Major activity hubs: HITS (Springel), ITC (Hernquist), MIT (Vogelsberger)

Existing capabilities:

- Gravity (Tree-PM)
- Hydrodynamics
- MHD
- Radiative cooling
- "Low-resolution" star-formation and feedback
- Stellar population evolution
- BHs and AGN feedback
- Tracer particles
- On-the-fly structure finder
- Shock finder

Physics under development:

- Constrained transport MHD
- Radiation-hydrodynamics
- "High-resolution" star-formation and feedback
- Cosmic rays
- Dust
- On-the-fly shock finder

Application: the Illustris simulation

Vogelsberger et al. 2014
Genel et al. 2014
Sijacki et al. 2015

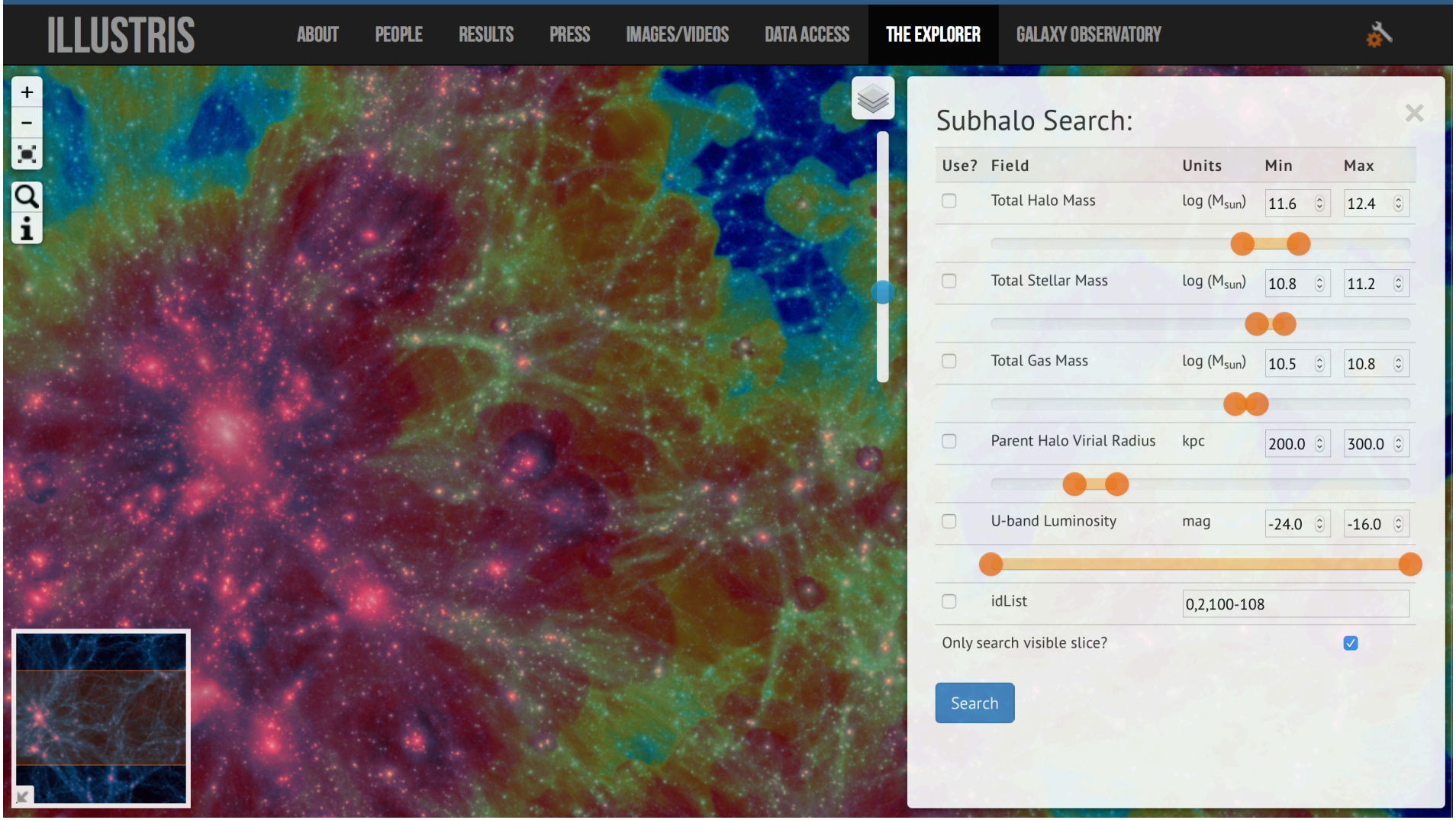
- A $(106.5\ \mathrm{Mpc})^3$ box run to $z=0$
- Baryonic resolution: $1.3\times10^6\ M_{sun}$
- Resolution elements: 2×1820^3
- Gravitational spatial resolution: 0.7-1.4 ckpc
- Galaxy formation physics (SF, winds, AGN…)

- 20M cpu-hours = 8,192 cores X 3 months

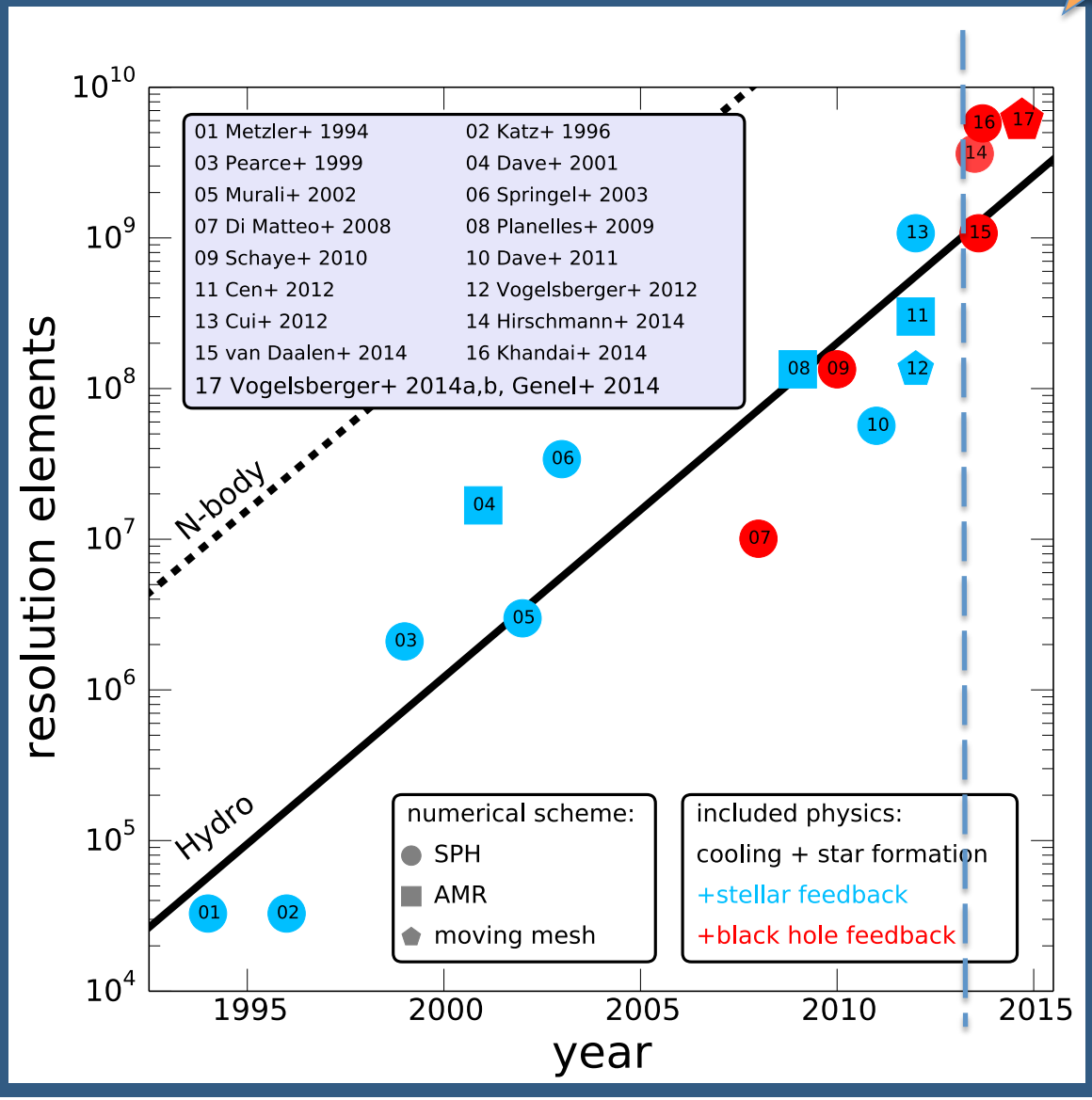
The Illustris simulation

Vogelsberger et al. 2014
Genel et al. 2014
Sijacki et al. 2015

Public data release – April 2015 (Nelson et al. 2015)



‘Uniform-box’ cosmological simulations



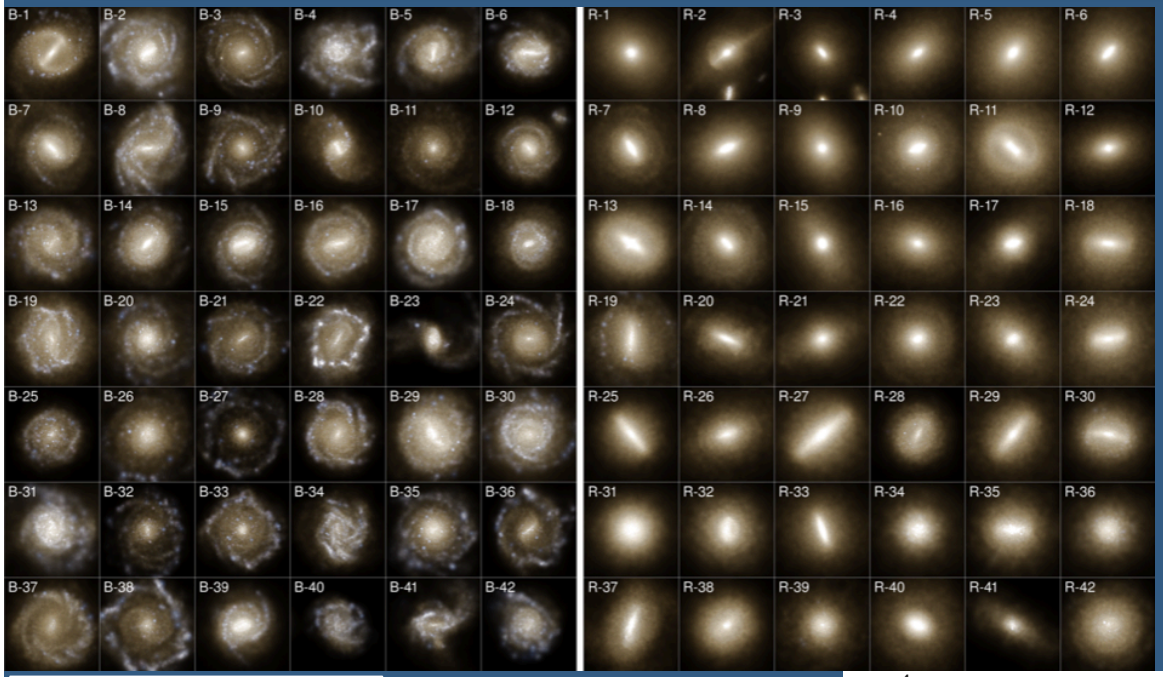
Illustris++
(in prep.)

Also ongoing: zoom-in runs

- MW-like halos
- Galaxy clusters

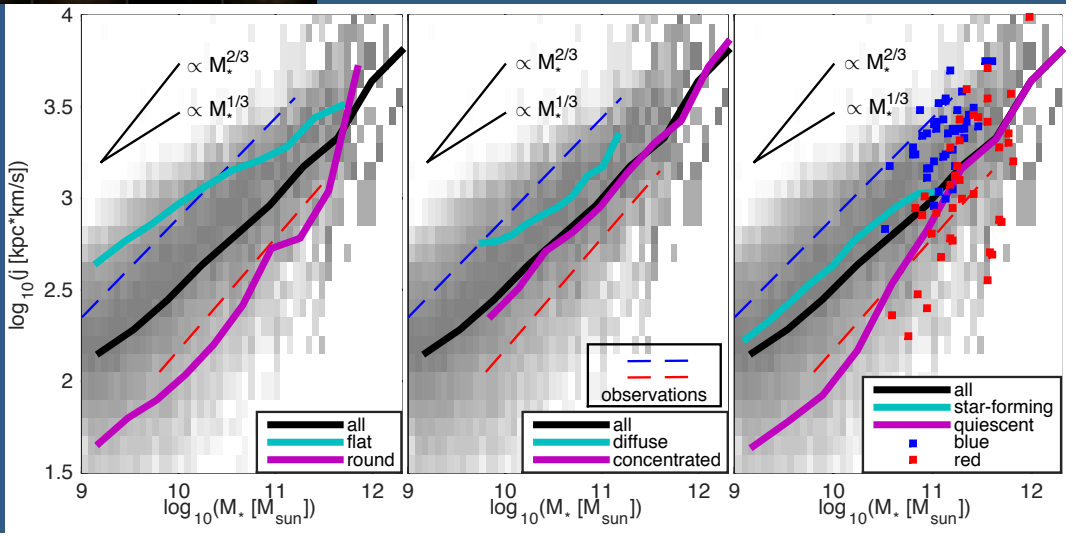
Genel et al. 2014

Galaxy bimodality & angular momentum



Genel et al. 2015

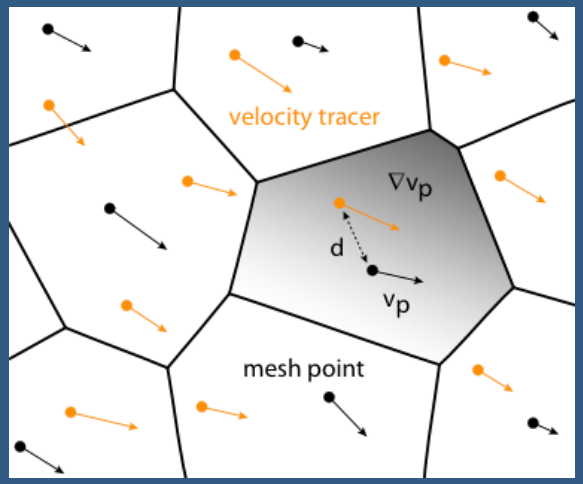
Vogelsberger, SG, et al. 2014

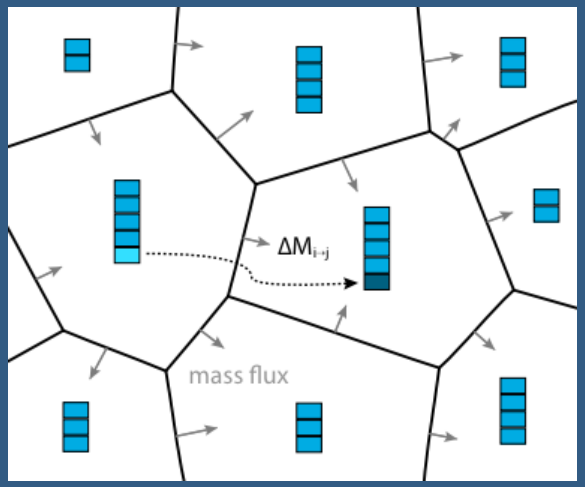


Genel et al. 2013

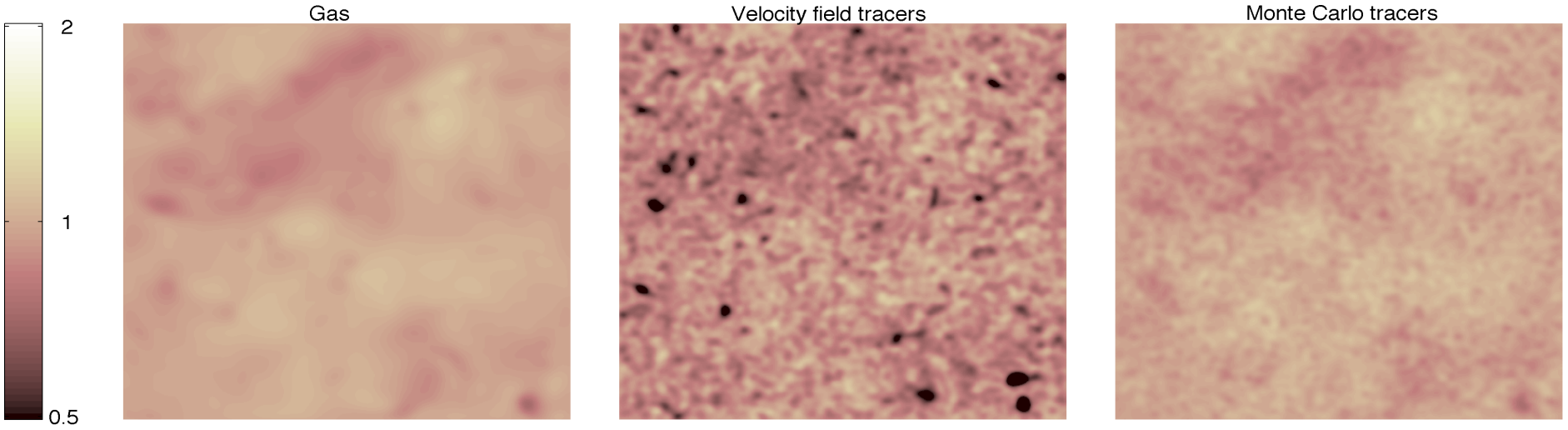
Tracer particles in Arepo

Velocity Field tracers





Monte Carlo tracers

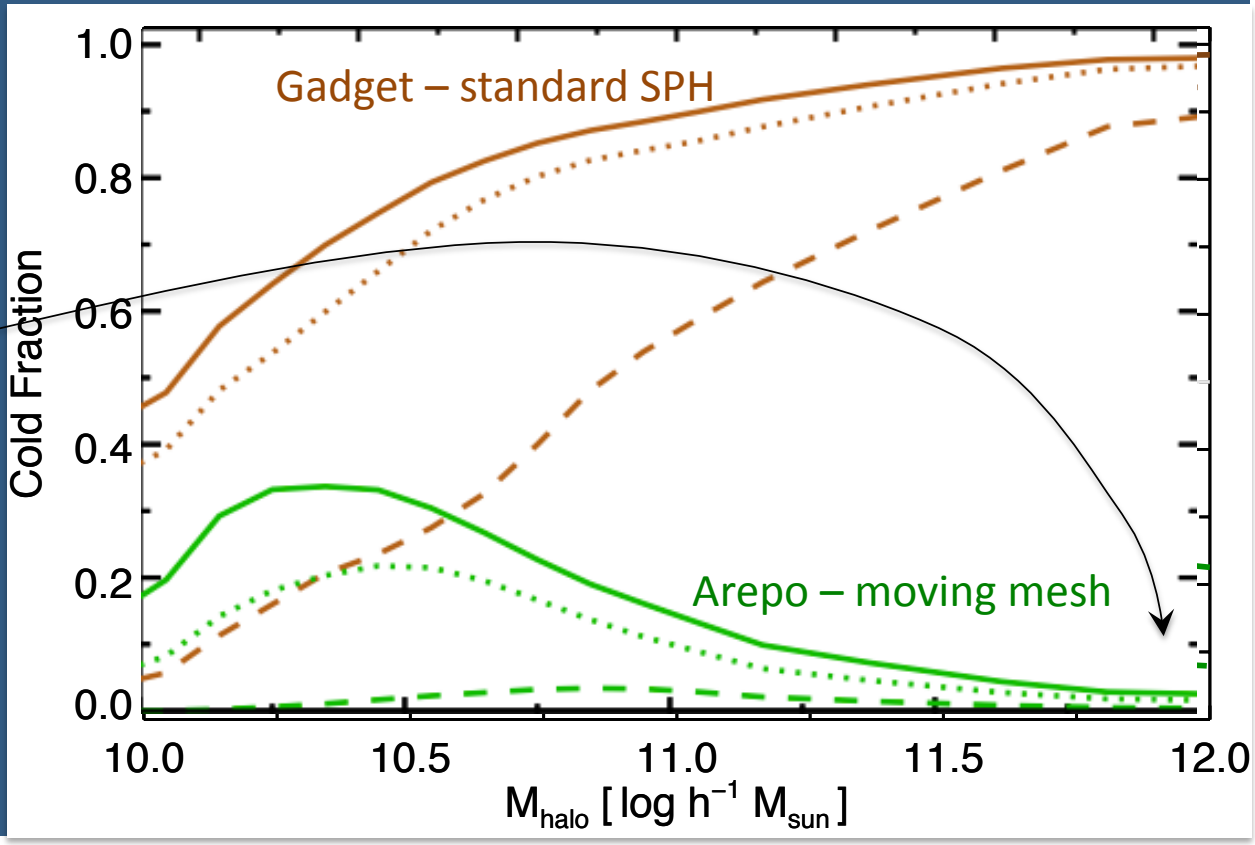


Nelson, Vogelsberger, SG, et al. 2013

Cold mode fraction of galaxy gas

'Smooth' gas accretion is hot-dominated everywhere at $10^{10} < M[M_\odot] < 10^{12}$

Cold fraction dropping to ≈0 at $M \approx 10^{12} M_\odot$



Halo gas structure @ z=2 – zoom-in simulations

Nelson, SG, et al. 2015