Modeling interacting galaxies seen in galaxy surveys

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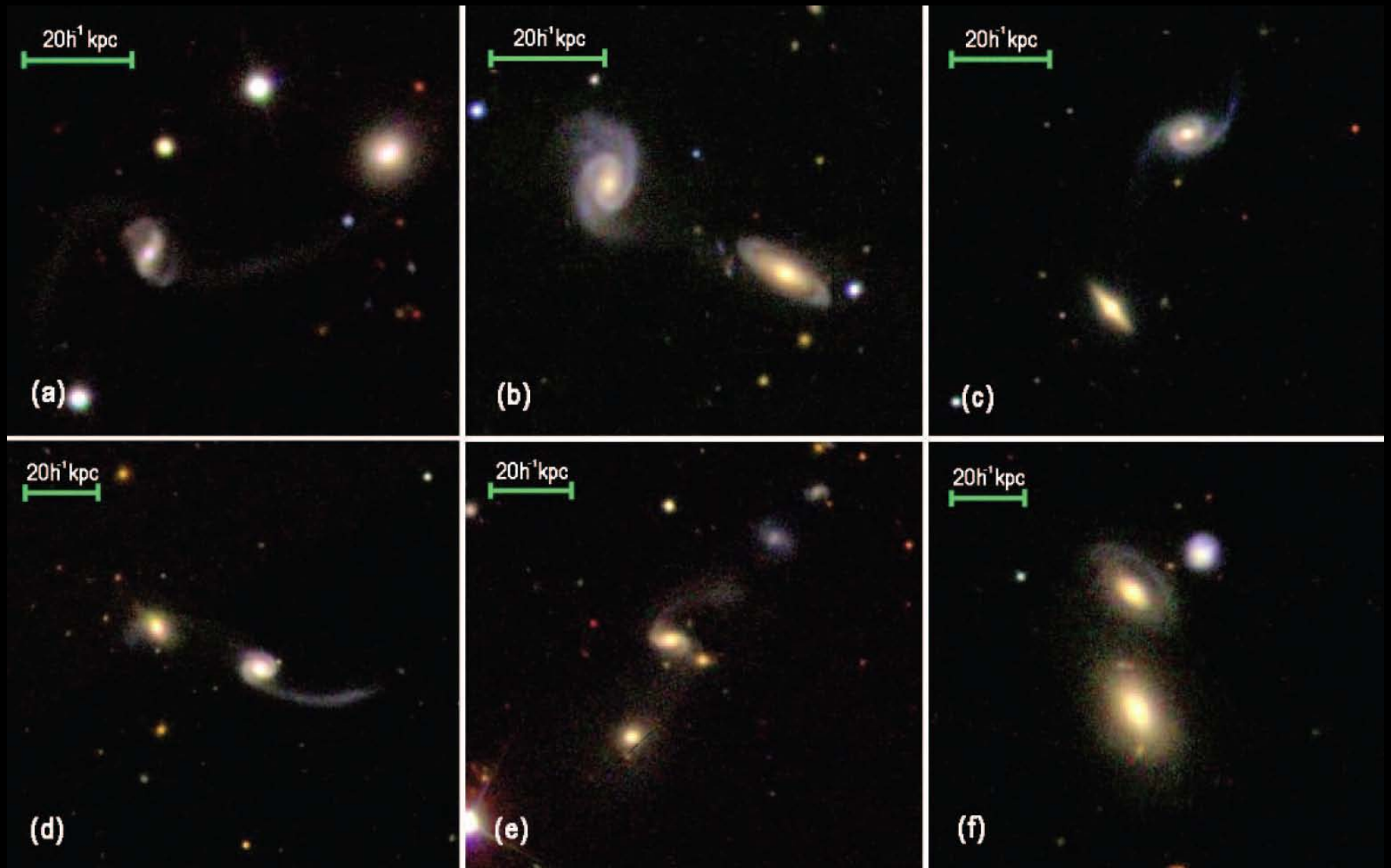
Interacting Galaxies Seen in SDSS

From Park, Choi, & Gott (2008)



Evolution of Galaxy Morphology

Park, Choi, & Gott (2008):

- analyzed volume limited samples from the SDSS data (DR4plus)

Name	Absolute Magnitude	Redshift	Distance[a]	Galaxies
D3.....	$M_r < -19.0$	$0.025 < z < 0.06869$	$74.6 < R < 203.0$	49,571
D4.....	$M_r < -19.5$	$0.025 < z < 0.08588$	$74.6 < R < 252.9$	74,688
D5.....	$M_r < -20.0$	$0.025 < z < 0.10713$	$74.6 < R < 314.0$	80,479

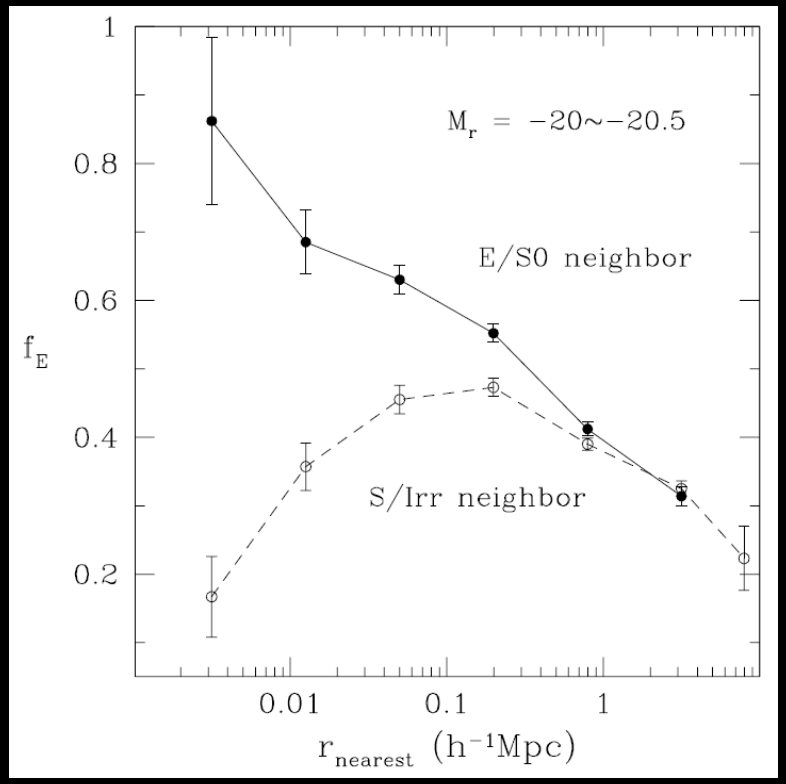
- found that galaxy morphology depends on the following environmental factors
  - * small-scale density due to the nearest neighbor ρ_n
  - * morphology of the nearest neighbor
  - * large-scale background density ρ_{20}

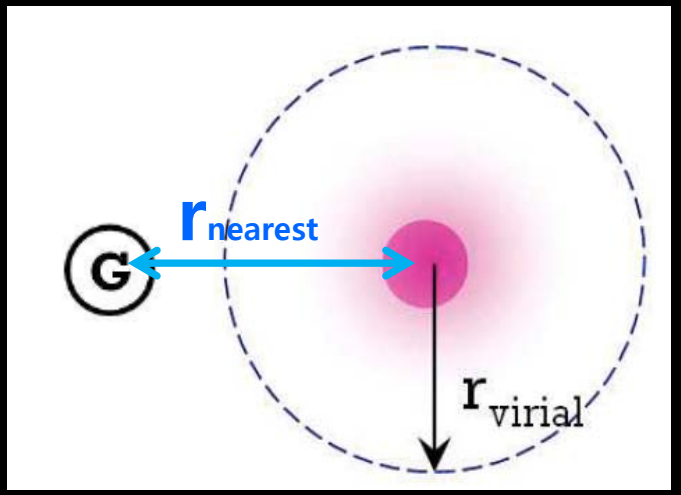
Evolution of Galaxy Morphology

from Park, Choi, & Gott (2008):

f_E = Probability for a (target) galaxy to be an early-type

$r_{nearest}$ = distance between a target galaxy & its nearest neighbor





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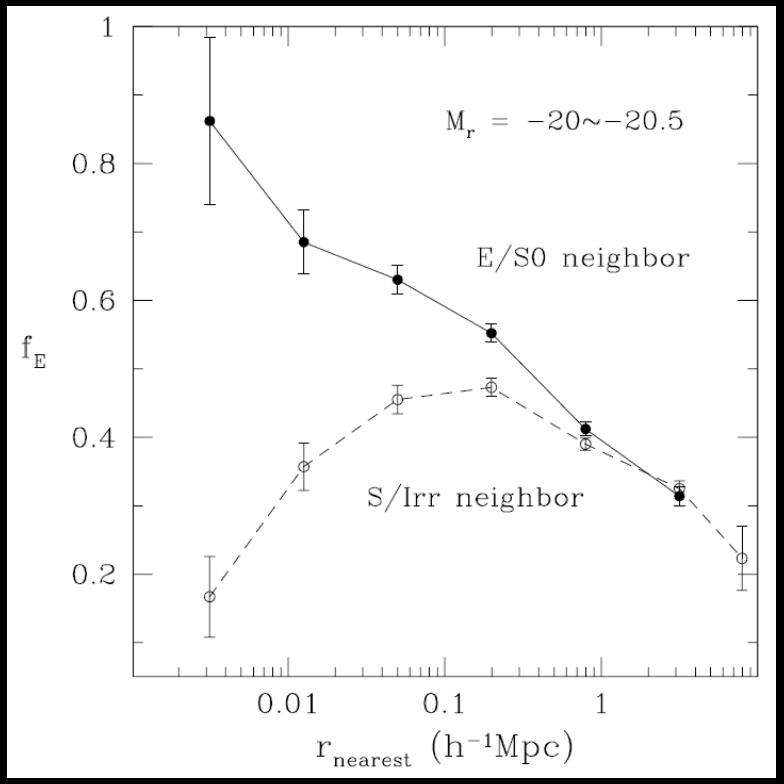
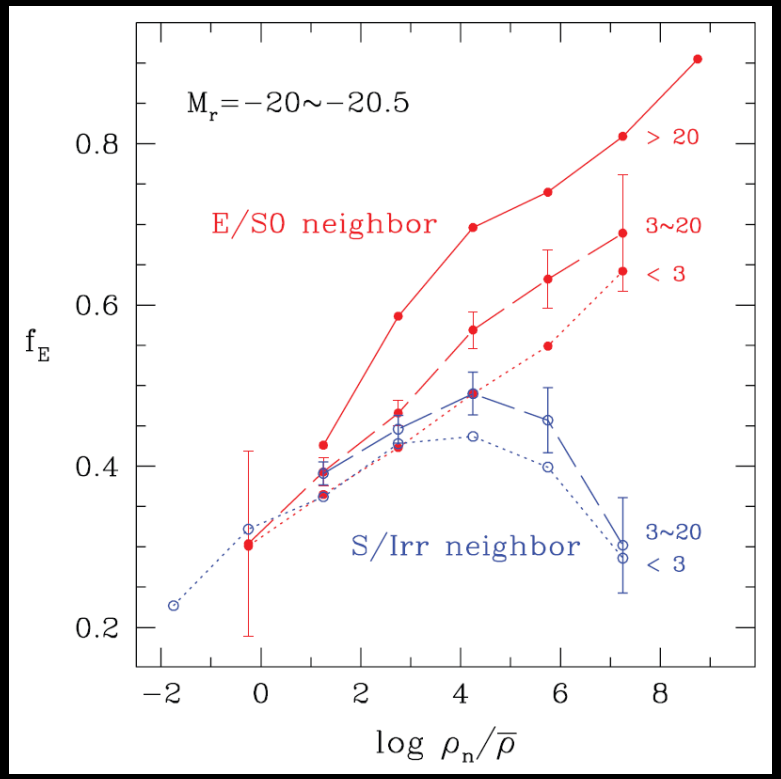




Initial Galaxy Models

Elliptical galaxy: E (bulge + DM halo)
EHi (bulge +DM halo+ gas halo)

Disk galaxy: D (DM halo + bulge + star disk + gas disk)
DHi (DM halo + bulge + star disk + gas disk + gas halo)

Mass in units of $10^{10}\ M_{\odot}$

E : $M_{tot} = M_{bulge} + M_{DM}$
$= 12 + 240 = 256$

EHi : $M_{tot} = M_{bulge} + M_{DM} + M_{ghalo}$
$= 12 + 237.6 + 2.4 = 256$

D : $M_{tot} = M_{bulge} + M_{sdisk} + M_{gdisk} + M_{DM}$
$= 1 + 4.4 + 0.6 + 120 = 126$

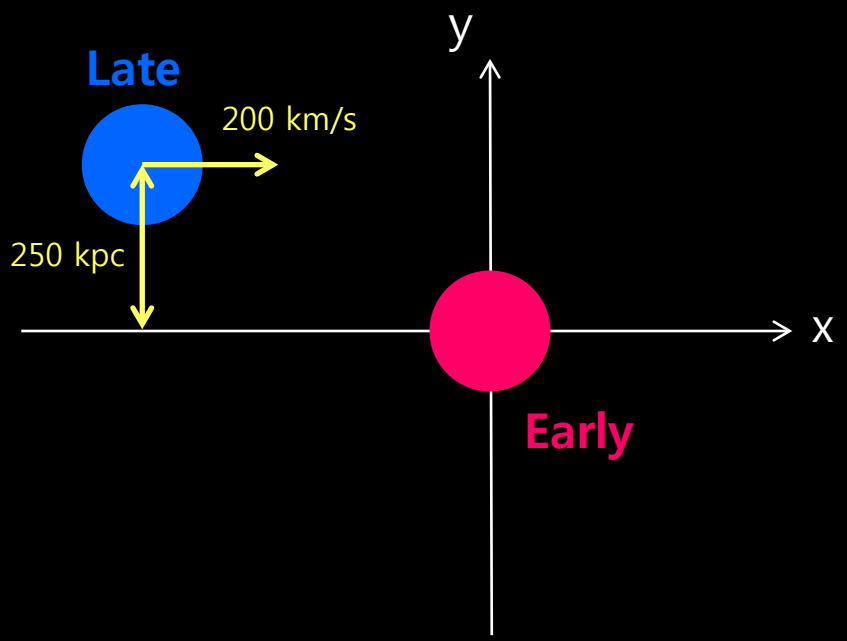
DHi : $M_{tot} = M_{bulge} + M_{sdisk} + M_{gdisk} + M_{DM} + M_{ghalo}$
$= 1 + 4.4 + 0.6 + 118.8 + 1.2 = 126$

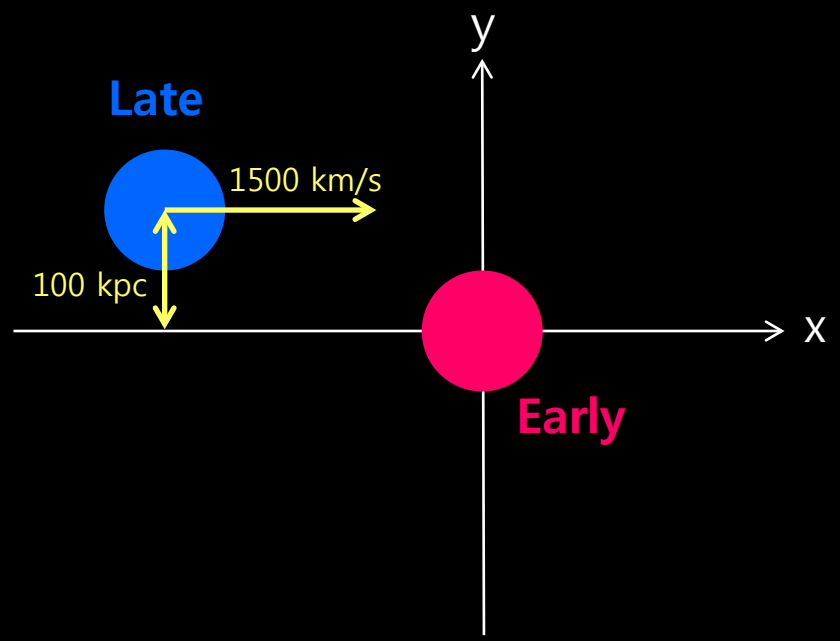
Codes used: ZENO for ICs & GADGET-3 (early version) for simulations
(refer to Hwang, Park, & Choi 2013)

Simulations

3 test runs:

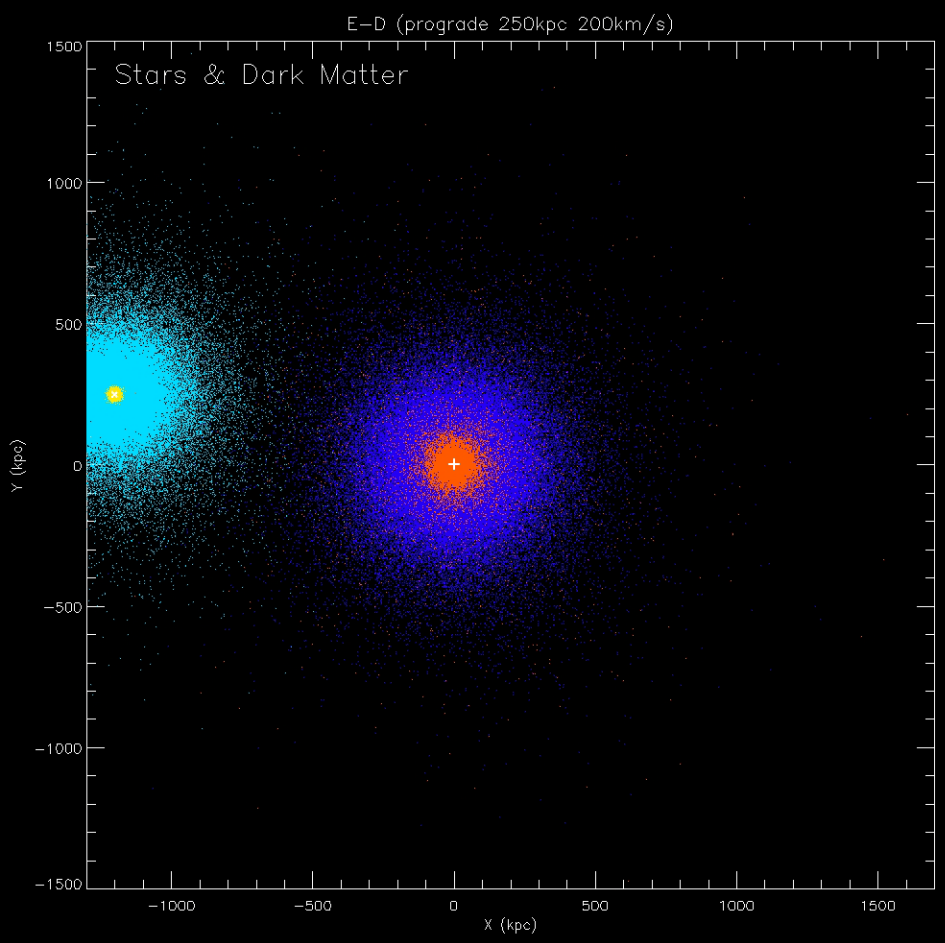
G1−G2	G1 r_0 (kpc)	G1 v_0 (km s^{-1})	G2 r_0 (kpc)	G2 v_0 (km s^{-1})	1st closest approach
E−D	0, 0, 0	0, 0, 0	-1200, 250, 0	200, 0, 0	95.65 kpc at 4.85 Gyr
EHi−DHi	0, 0, 0	0, 0, 0	-1200, 250, 0	200, 0, 0	95.93 kpc at 4.85 Gyr
EHi−DHi fast	0, 0, 0	0, 0, 0	-1200, 100, 0	1500, 0, 0	95.91 kpc at 4.85 Gyr

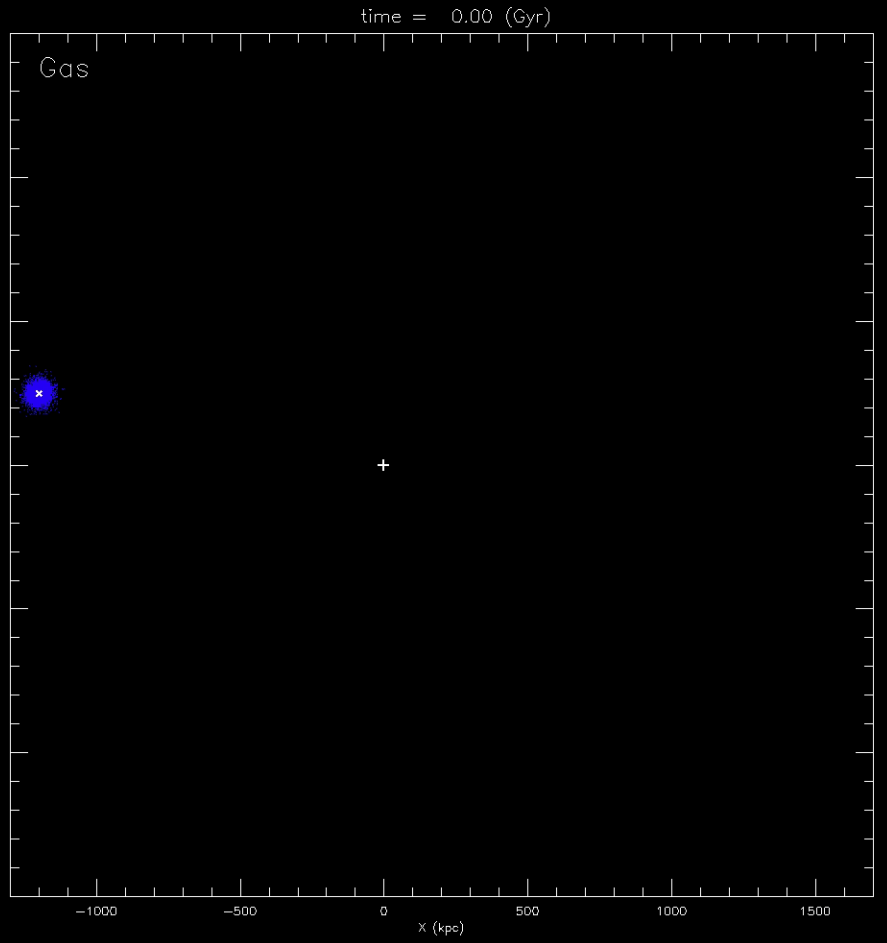




Run 1: E-D

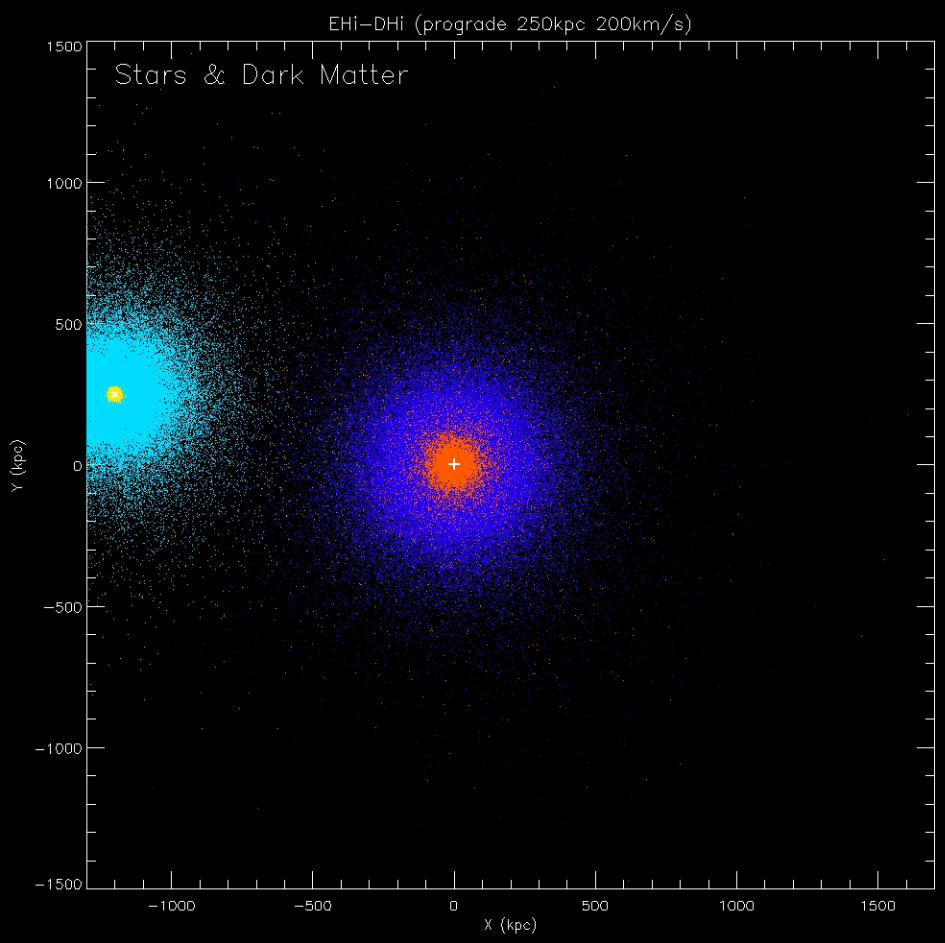
- w/o gas halo
- initial impact parameter & relative velocity: 250 kpc, 200 km/s
- 1st closest approach: 95.65 kpc at 4.85 Gyr

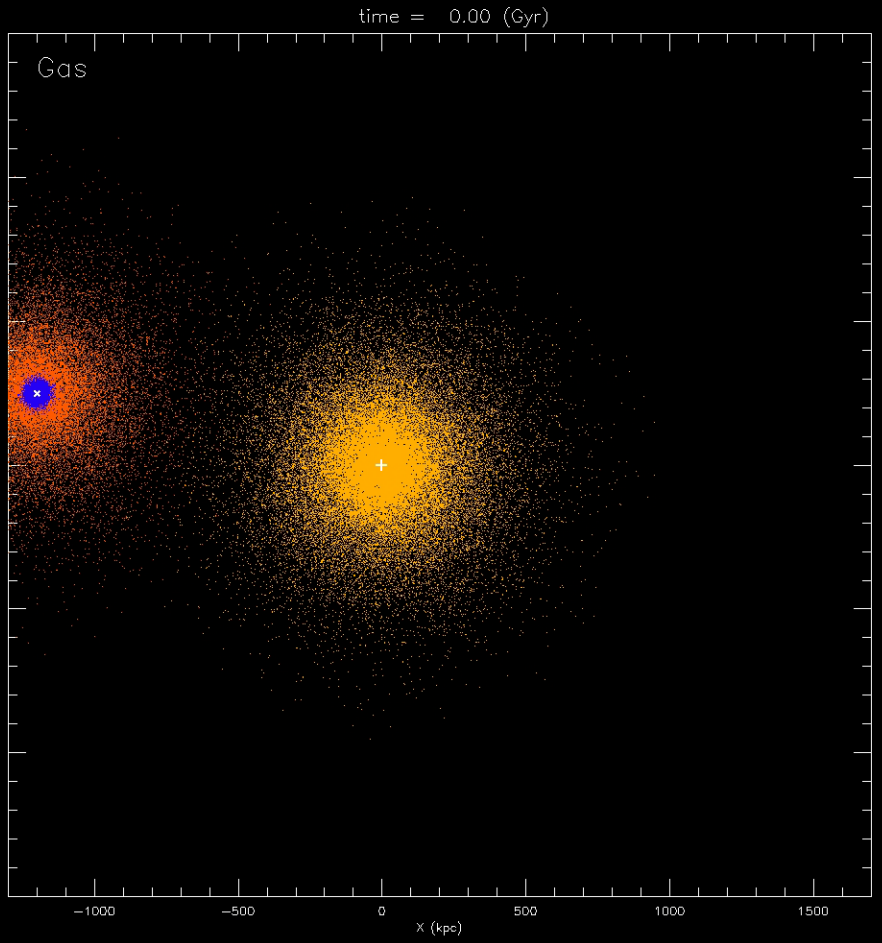




Run 2: EHi-DHi

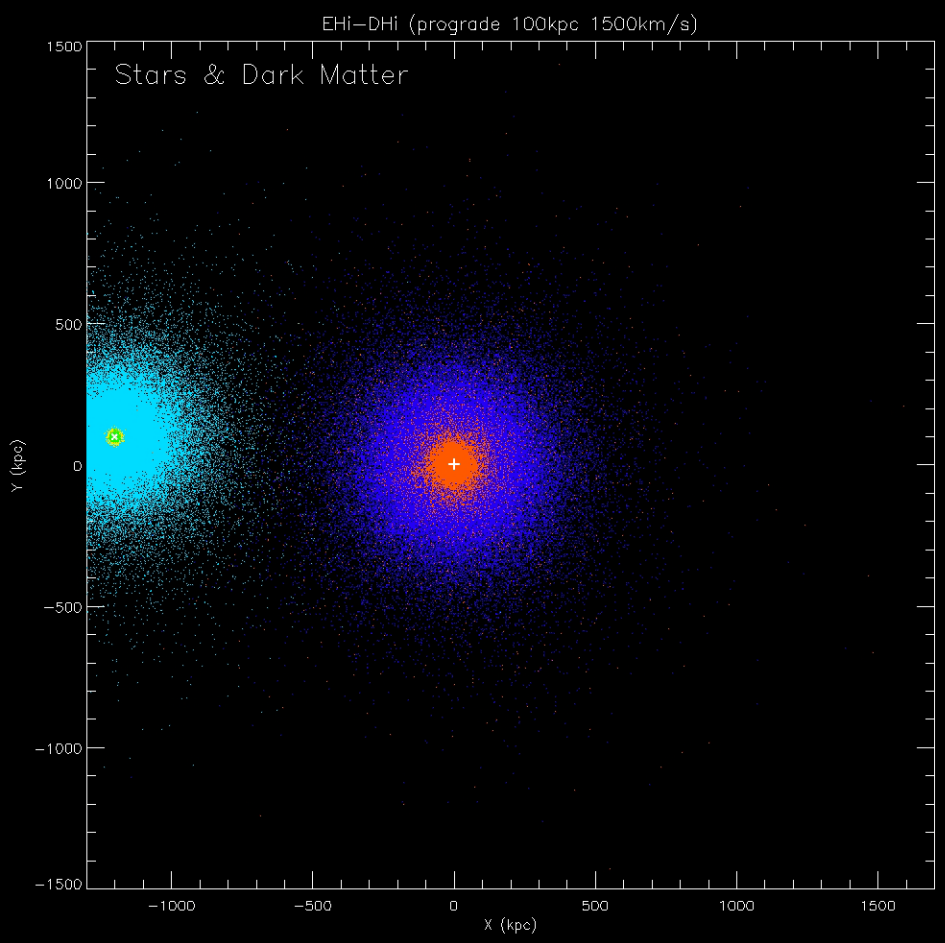
- with gas halo
- initial impact parameter & relative velocity: 250 kpc, 200 km/s
- 1st closest approach: 95.93 kpc at 4.85 Gyr

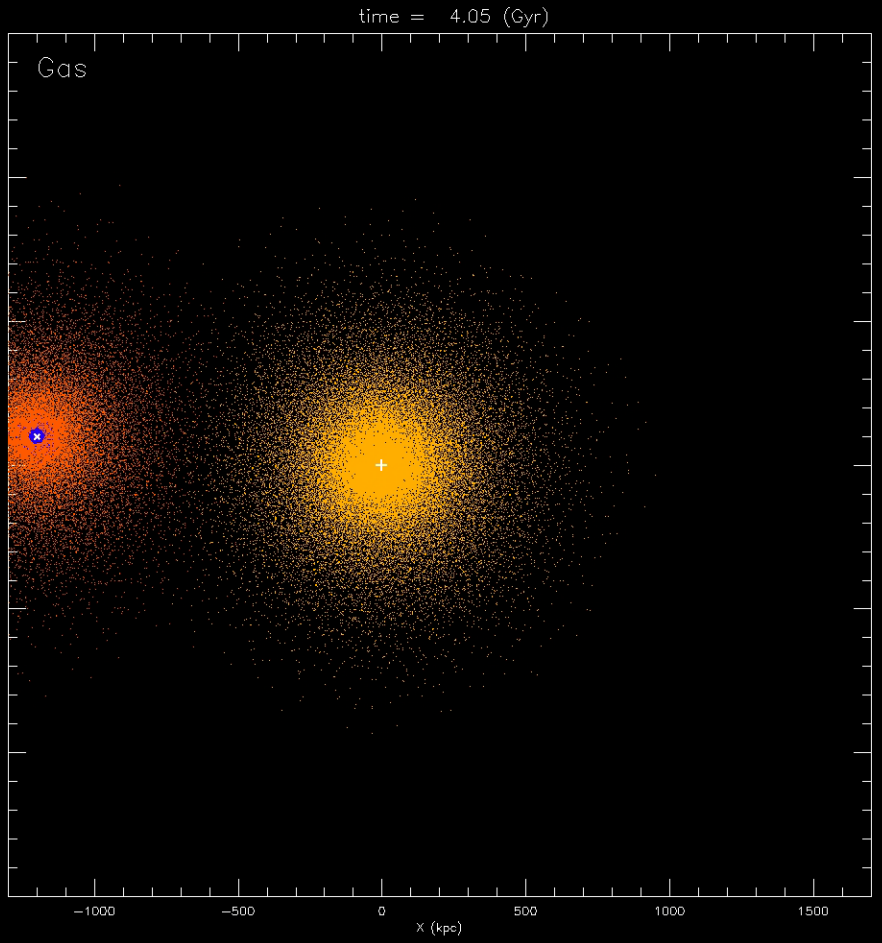




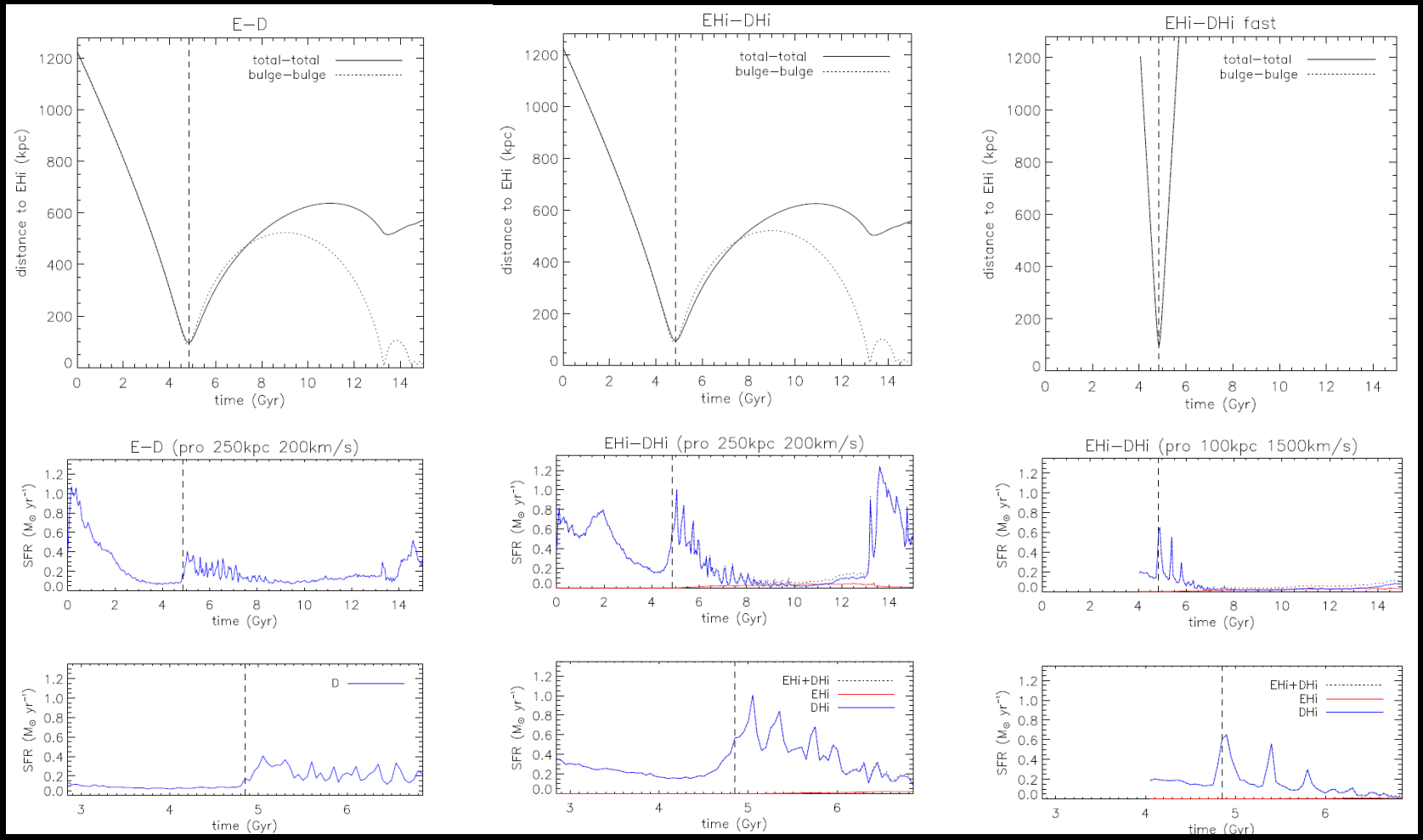
Run 3: EHi-DHi fast

- with gas halo
- initial impact parameter & relative velocity: 100 kpc, 1500 km/s
- 1st closest approach: 95.91 kpc at 4.85 Gyr





Star Formation Rates



More Work To Do

Changes of physical quantities:

- profile of each component, SFRs, mass transfer
- differences between E-D runs & EHi-DHi runs

More runs with varying

- initial impact parameter, relative velocity, tilt, etc
- mass, gas fraction in the disk & halo
- initial spins of the gas disk and gas halo

Thank you!