Heating up galaxies in the cold of space

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Content of this talk

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- Simulations
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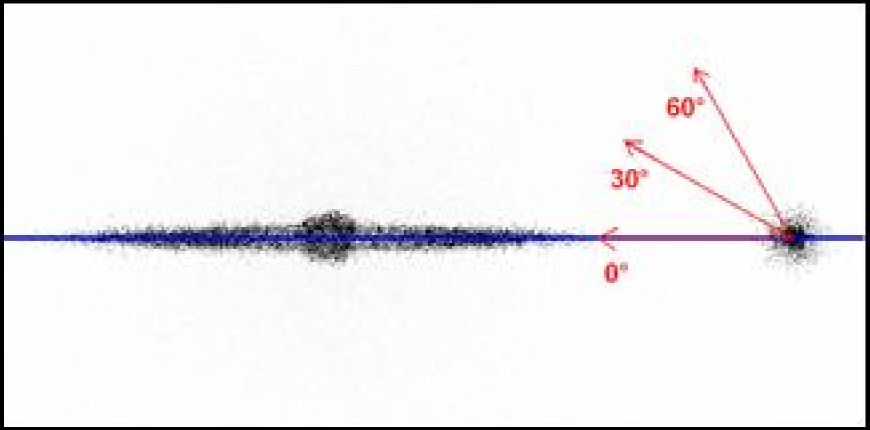
Initial Model

- Stellar dynamics only
- Disc galaxy: Kuijken-Dubinski A-model consisting of 180000 particles (80000 disc, 40000 bulge, 60000 halo) with a total mass of 1.9 10^{11} solar masses
- Dwarf galaxy: King-Model consisting of 10000 particles

Initial distance: 40 kpc

Initial velocity = circular velocity = 162 km/s

Different directions of relative velocity of the dwarf galaxy: inclination 0°, 30° and 60°

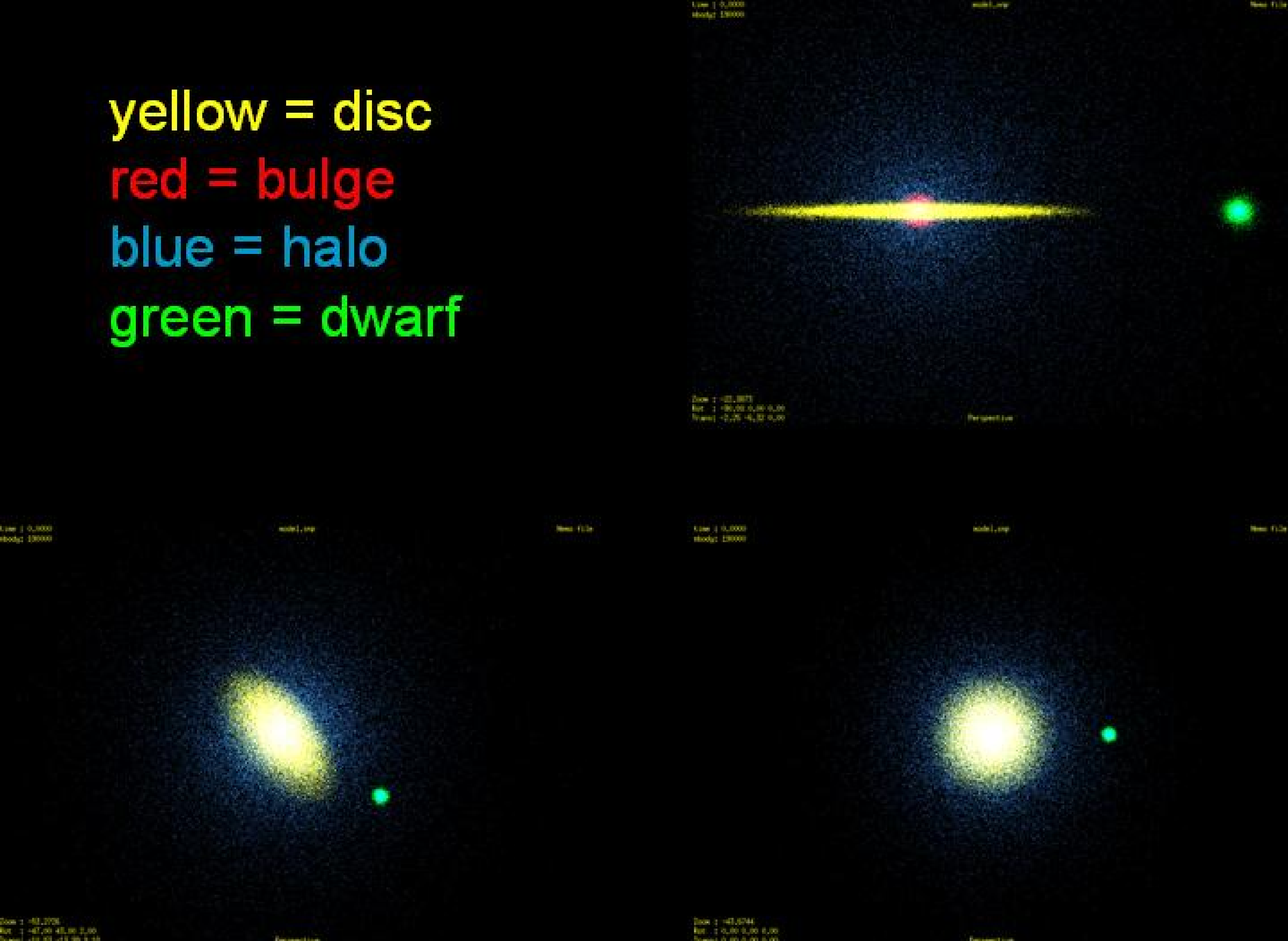


Different mass ratios of dwarf galaxy and disc galaxy: 1/10, 1/25, 1/50, 1/100 and 1/200 yellow = disc

red = bulge

blue = halo

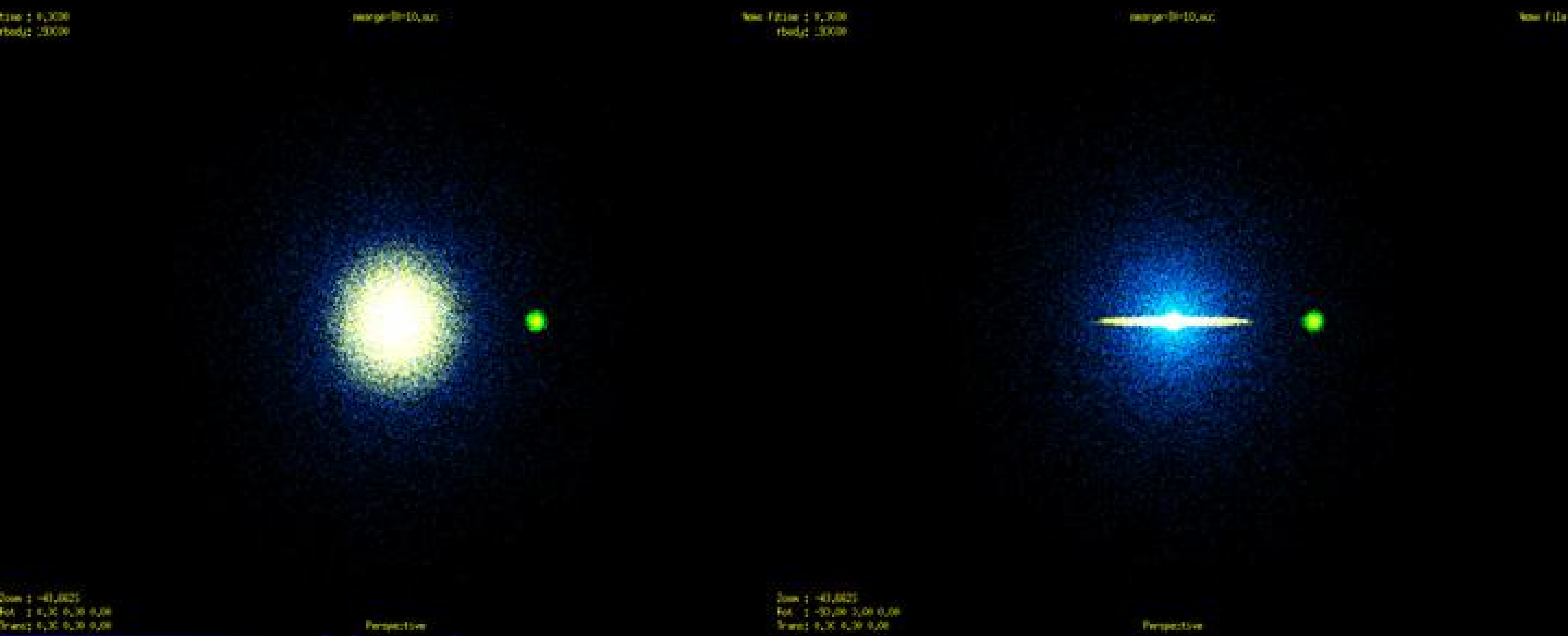
green = dwarf



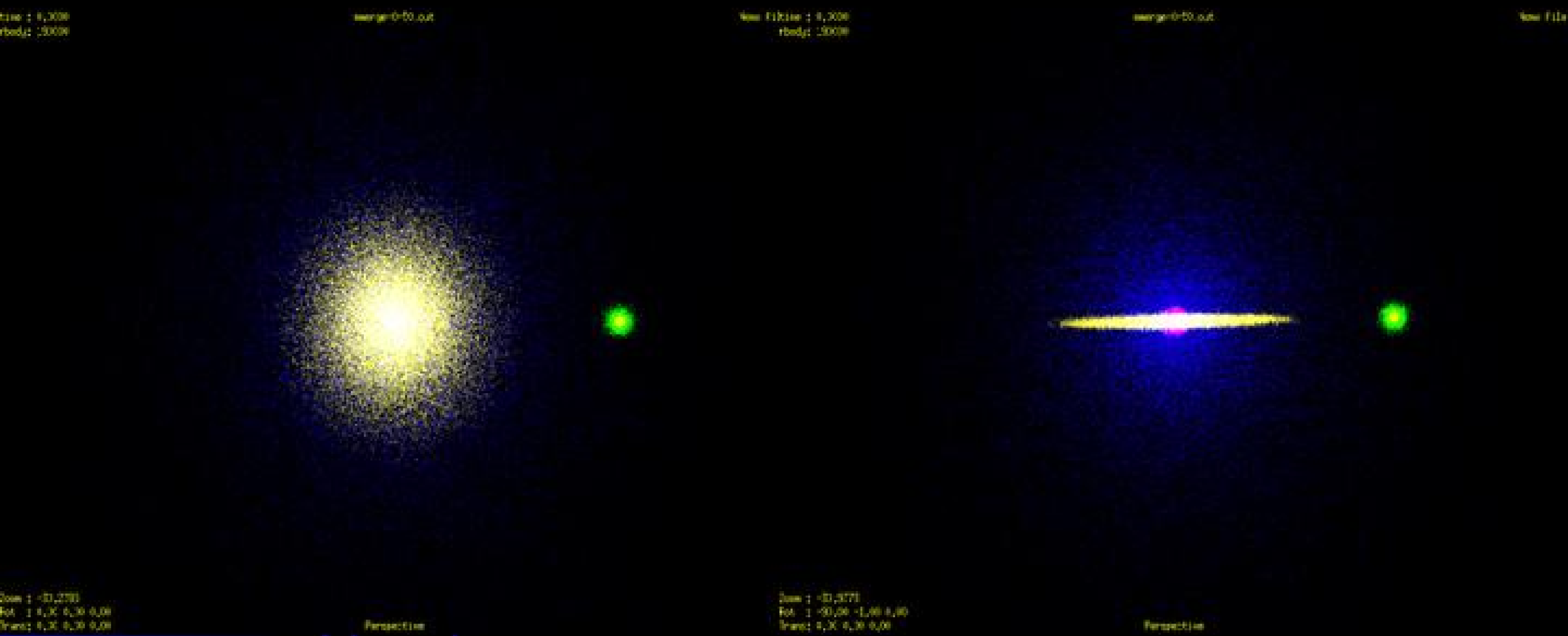
Simulations

- using NEMO-package by P.J. Teuben
- Stellar dynamical N-body simulation
- gyrfalcON tree-code for numerical integration
- ran 15 simulations with different initial conditions
- Integration time 2 Gyr (in case merger was not finished extended up to 8 Gyr)

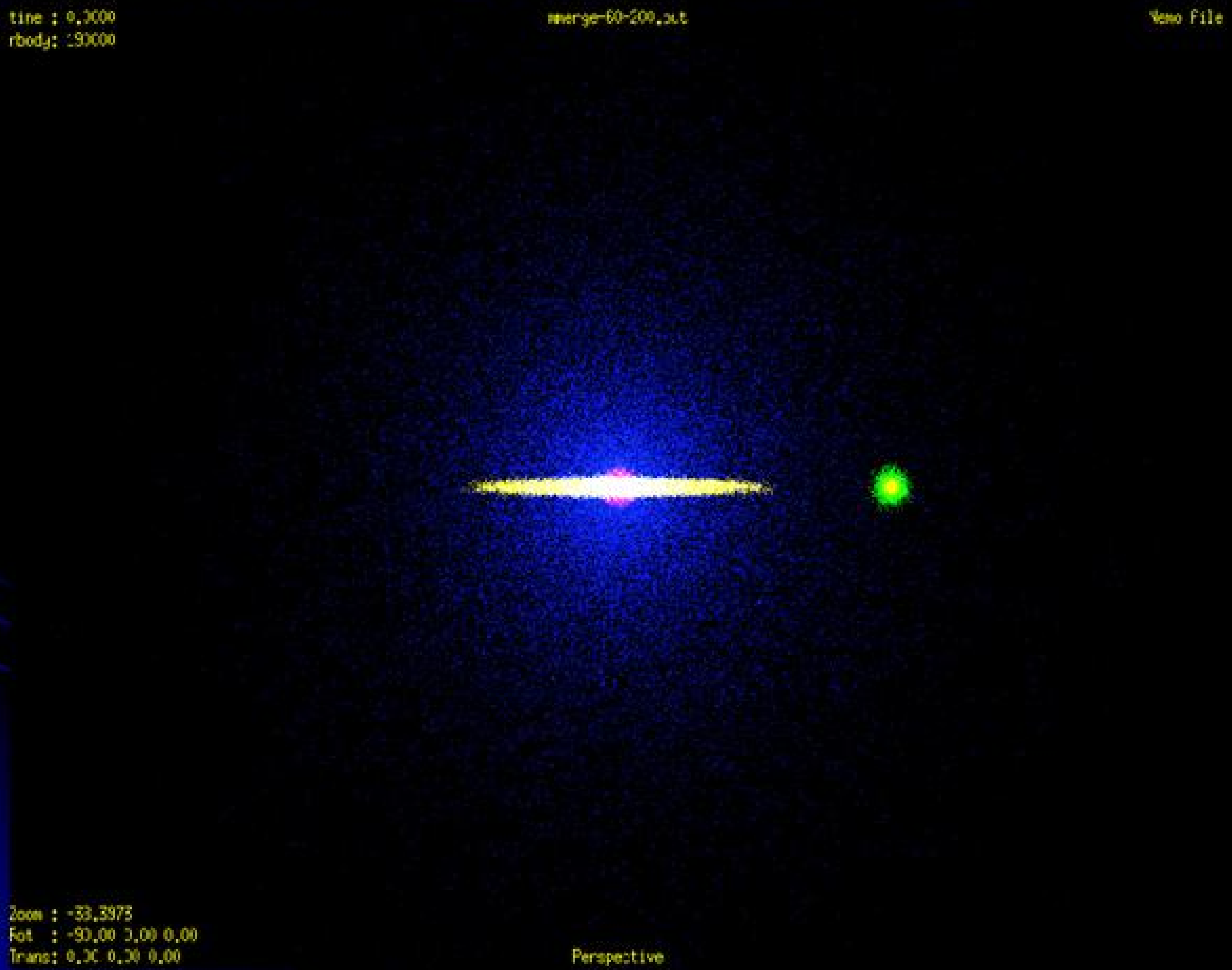
- mass fraction = 1:10; inclination = 30°



- mass fraction = 1:50; inclination = 0°



- mass fraction = 1:200; inclination = 60°



Merging Times

- Measured 'visually'
- Increases with inclination of the dwarf's orbit
- Decreases with the mass of dwarf

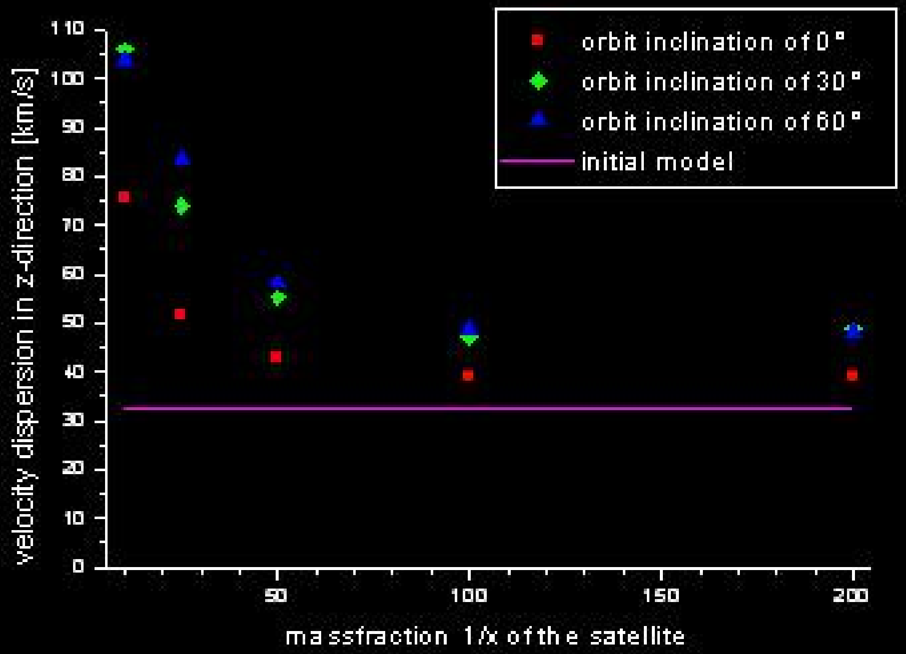
mass ratio:	1:10	1:25	1:50	1:100	1:200
inclination of 0°					
inclination of 30°					
inclination of 60°					

merging time	<1 Gyr	1-2 Gyr	2-4 Gyr	4-6 Gyr	6-8 Gyr	>8 Gyr

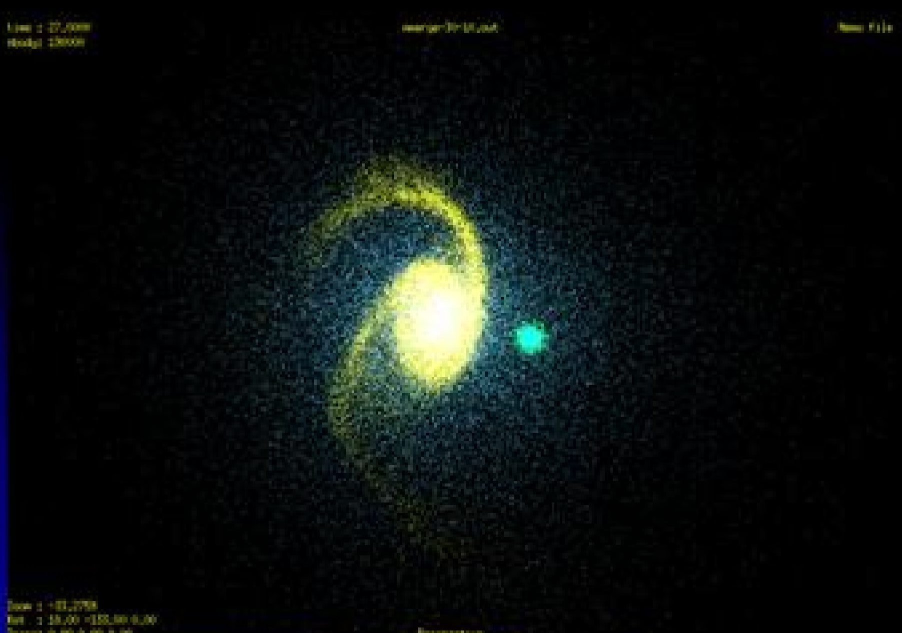
Heating of the disc

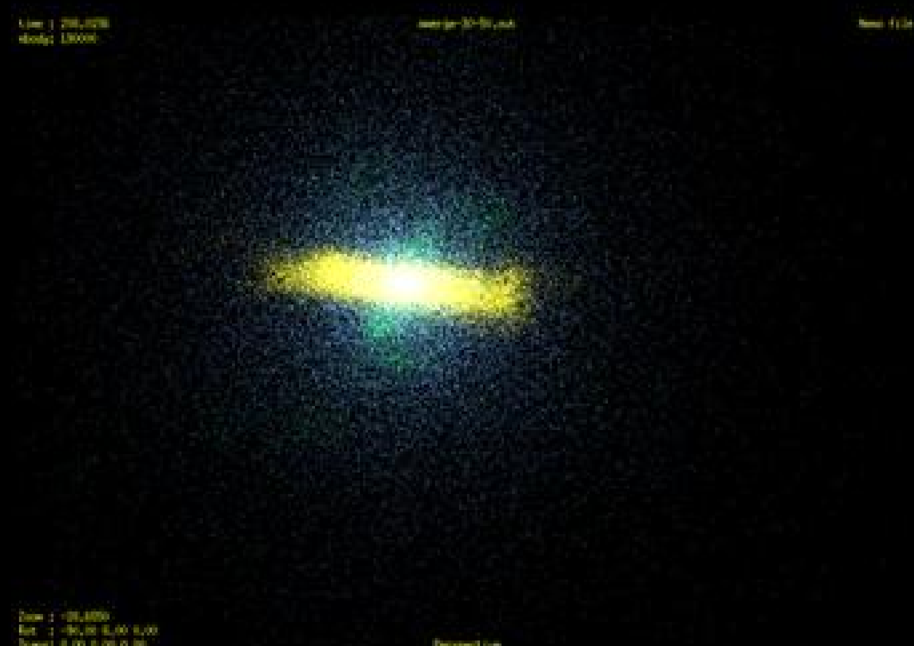
- Dwarf galaxy on polar orbit
- force normal to the galactic plane
- distortion of star in disc
- Increases vertical velocity distribution
- Galactic disc gets thicker/hotter

- Heating measured by the z-component of the velocity distribution of the disc particles
- Heating strongly depends on mass of the dwarf
- Little dependence on inclination of inclined orbit
- Only small effect if central collision because no additional force normal to disc



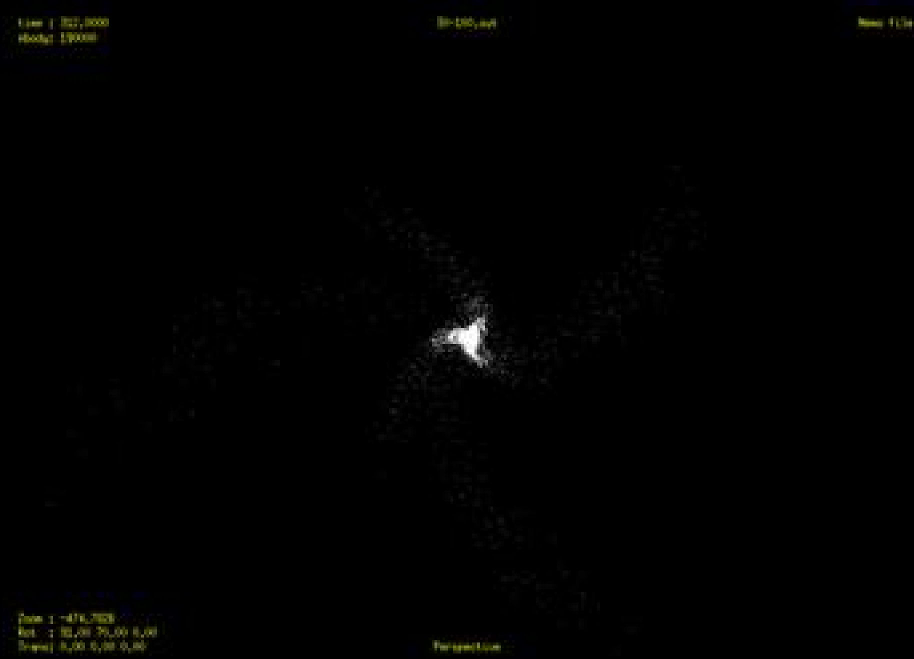
- Visible features of interaction stronger with higher mass of dwarf galaxy
- For high mass dwarfs: significant transition of the disc galaxy's morphology





Remnants of the dwarf galaxy

- The core of the dwarf settles in the bulge
- Tidal arms remain some time after merging process is finished
- Each orbit of the dwarf is visible but contrast will be to small



Conclusions

- Merging time of minor mergers decreases with the mass of the dwarf but increases with the inclination of the dwarf's orbit
- Heating of the galactic disc depends on the dwarf's mass but hardly on its orbit
- The visible effect on the structure of the host galaxy is stronger with a higher mass of satellite galaxy
- Core of dwarfs settles in bulge of disc galaxy