

The Rotating Universe

Simulating rotating Newtonian universes

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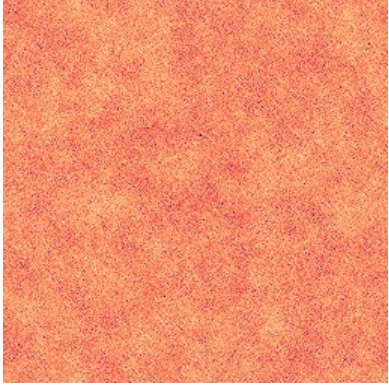
⁴*Jet Propulsion Laboratory, NASA*

Current state of cosmology

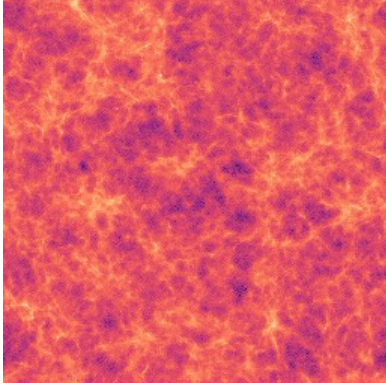
- Standard Model (of cosmology): Λ CDM
- It suffers from a **plethora of challenges**
 - E.g. H_0 tension (CMB vs SNe)
 - E.g. violations of homogeneity and isotropy
 - ...and lots of other problems...
- The **wounds** are constantly deepening...
- What can we do about it?

Cosmological simulations

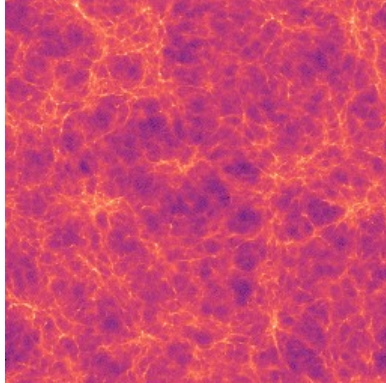
Init. conditions



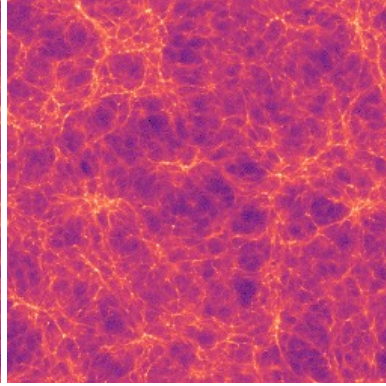
Snapshot #36



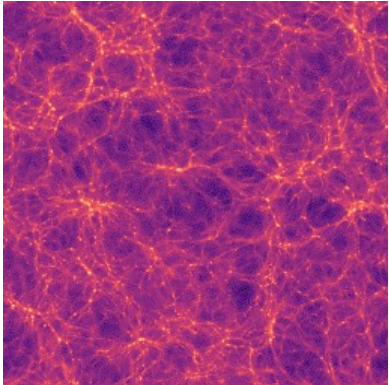
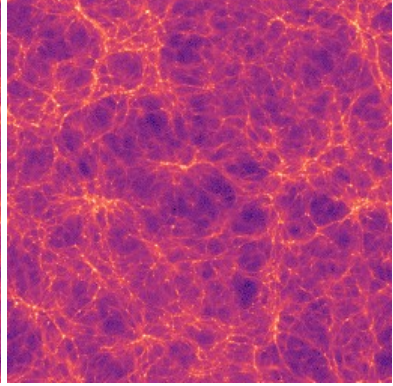
Snapshot #59



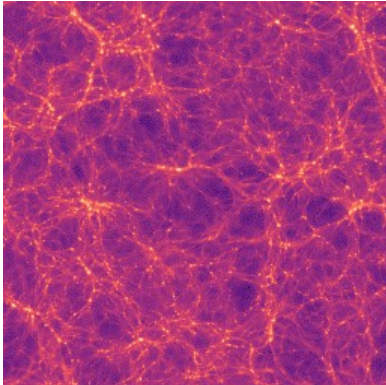
Snapshot #79



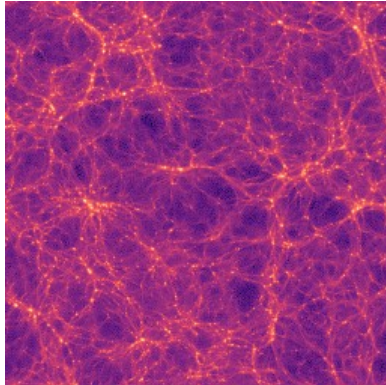
Snapshot #98



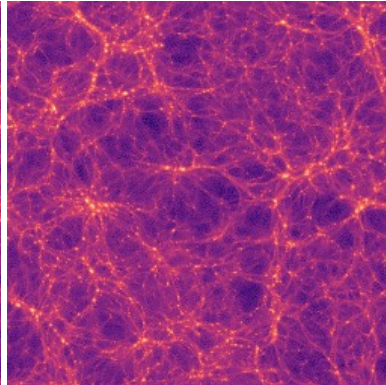
Snapshot #116



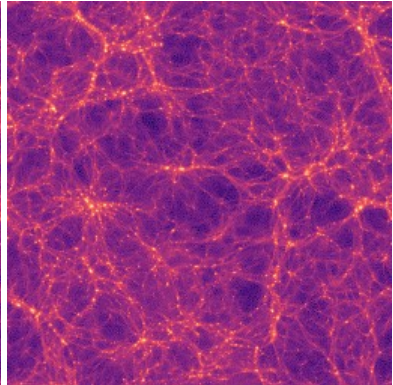
Snapshot #134



Snapshot #152



Snapshot #171

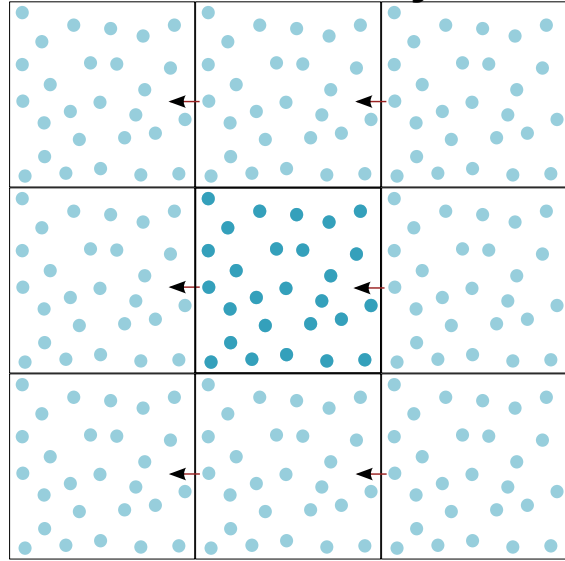


Snapshot #191

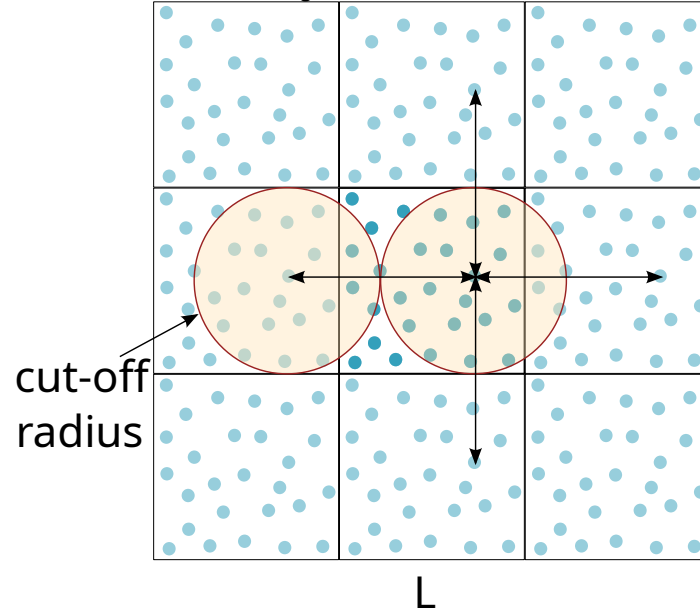
StePS vs. the world - Boundary conditions

StePS vs. the world - Boundary conditions

Periodic boundary conditions

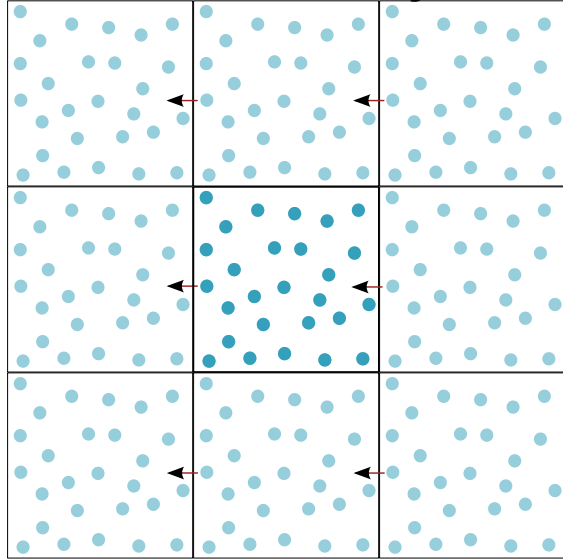


Source: Digital Research Alliance of Canada

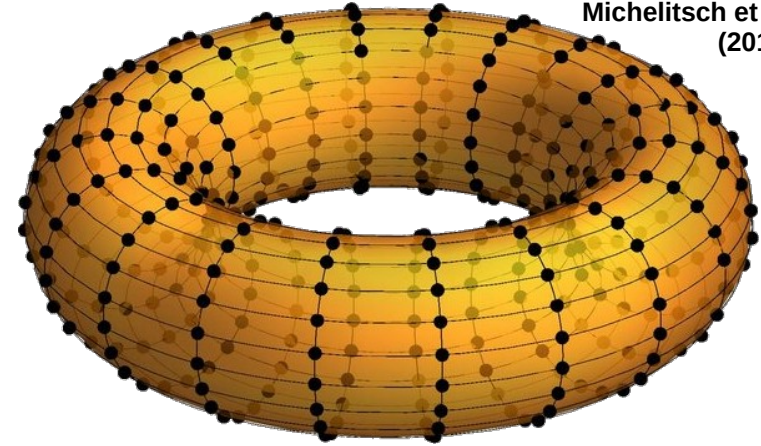
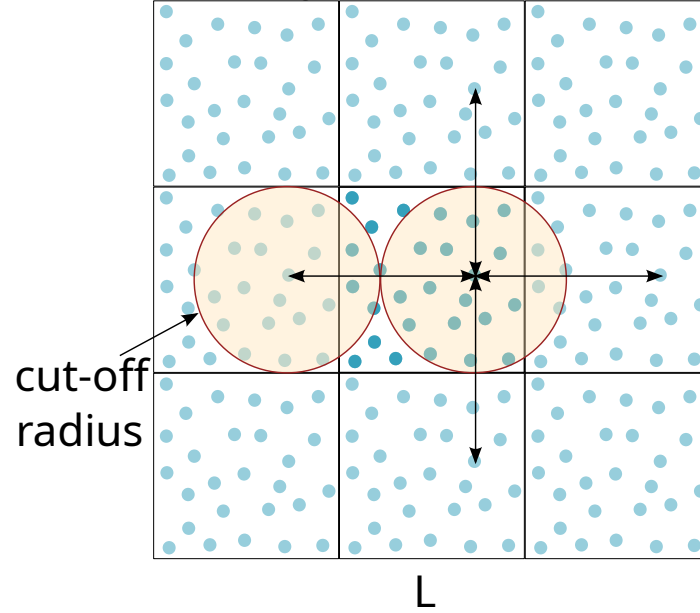


StePS vs. the world - Boundary conditions

Periodic boundary conditions



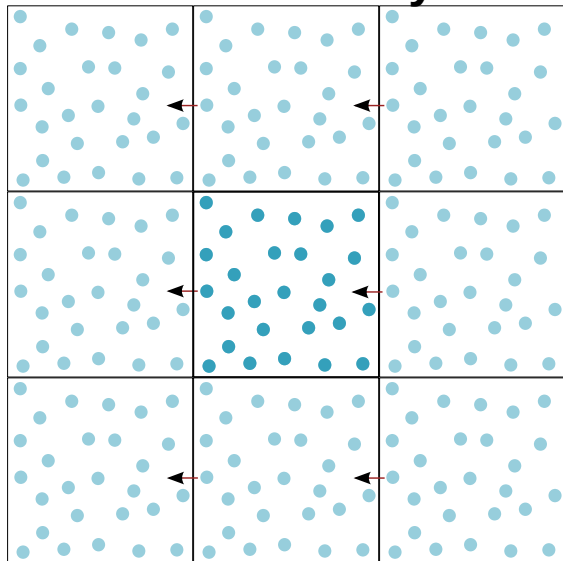
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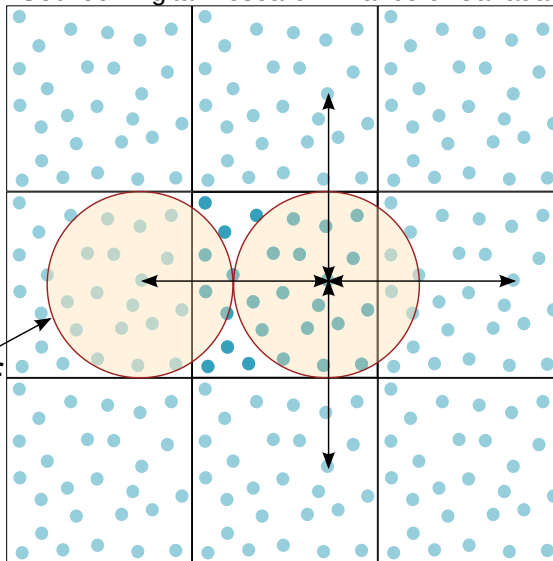
Michelitsch et al.
(2017)

StePS vs. the world - Boundary conditions

Periodic boundary conditions

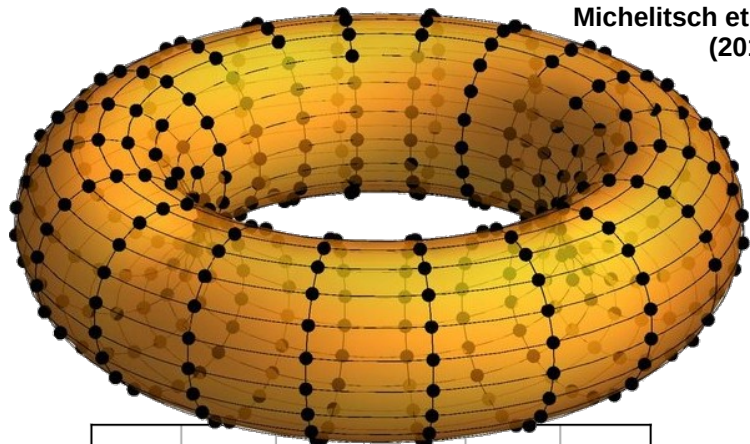


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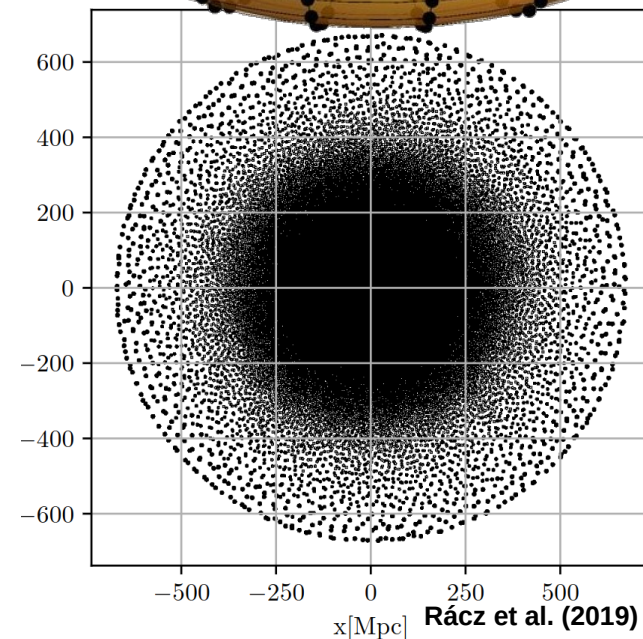


cut-off radius

L

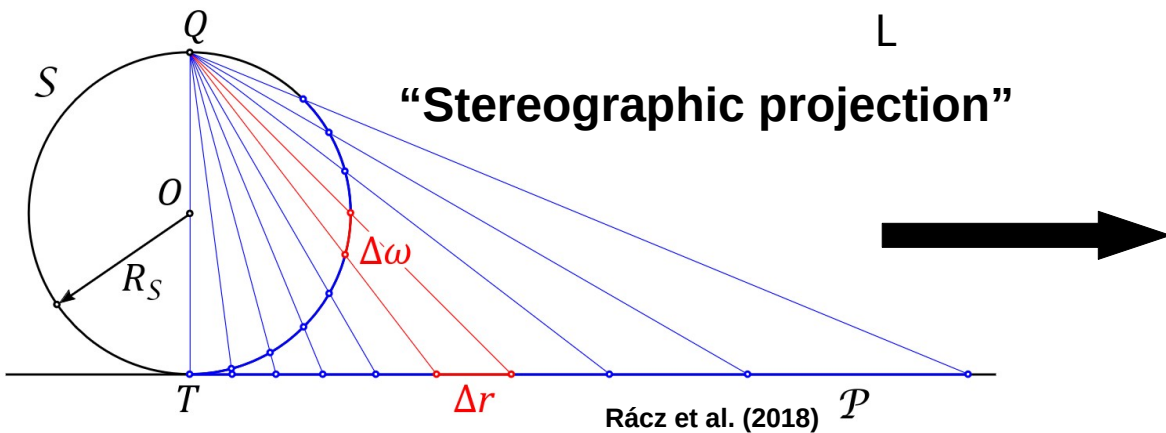


Michelitsch et al. (2017)



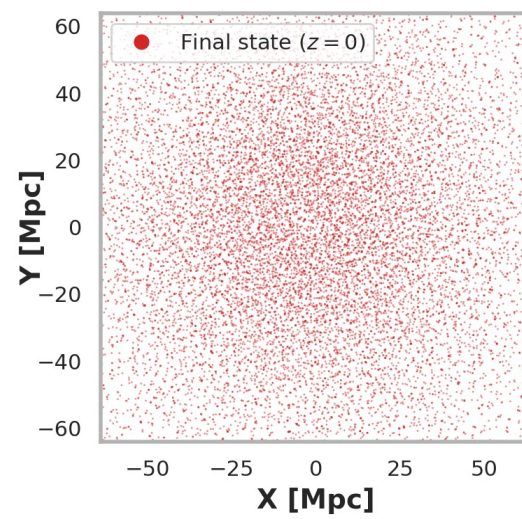
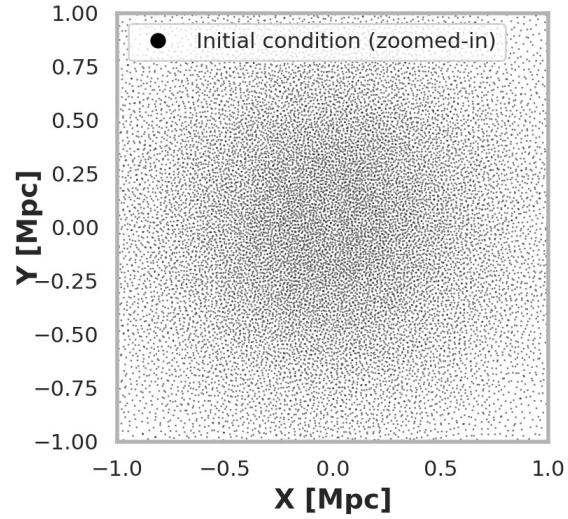
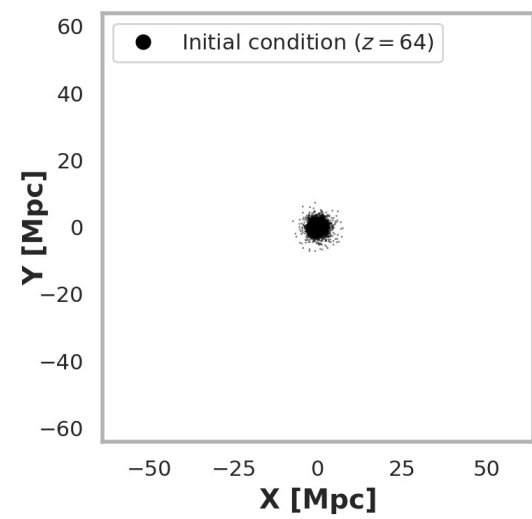
Rácz et al. (2019)

“Stereographic projection”



Rácz et al. (2018)

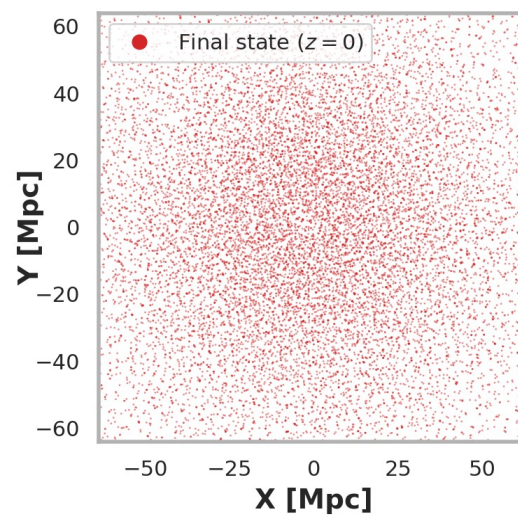
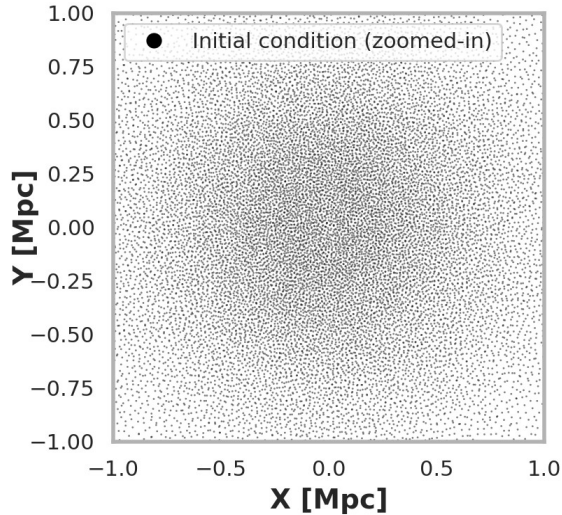
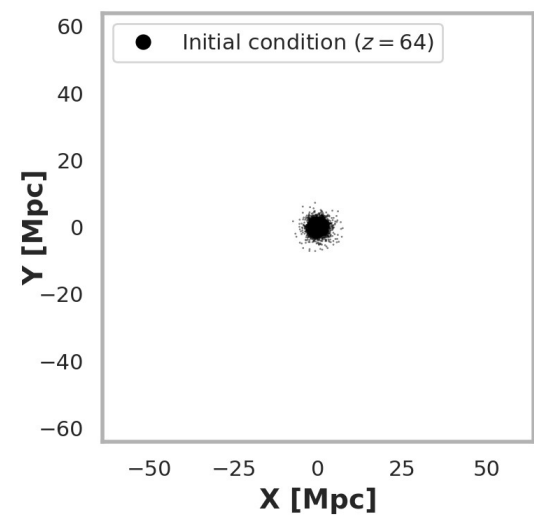
StePS rotating simulation



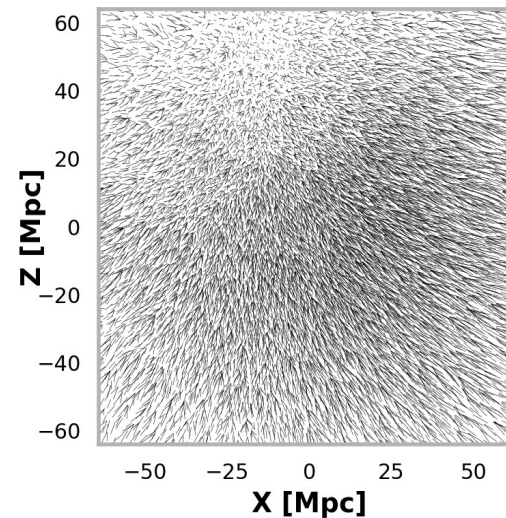
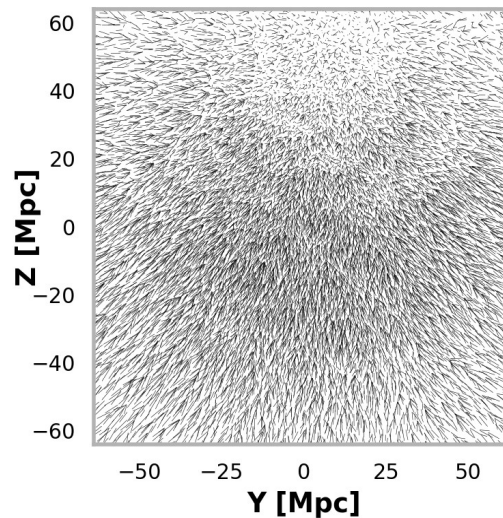
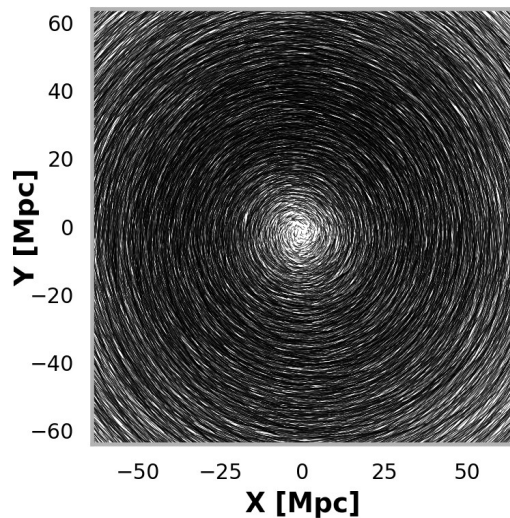
Evolution

StePS rotating simulation

Evolution

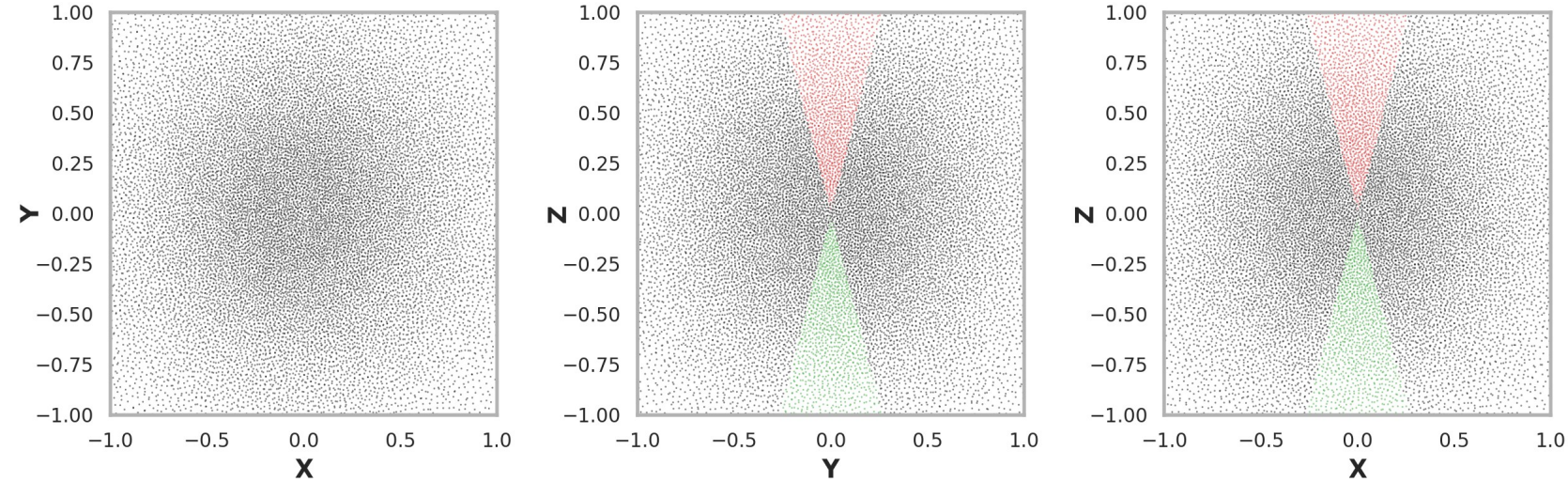


Displacement field

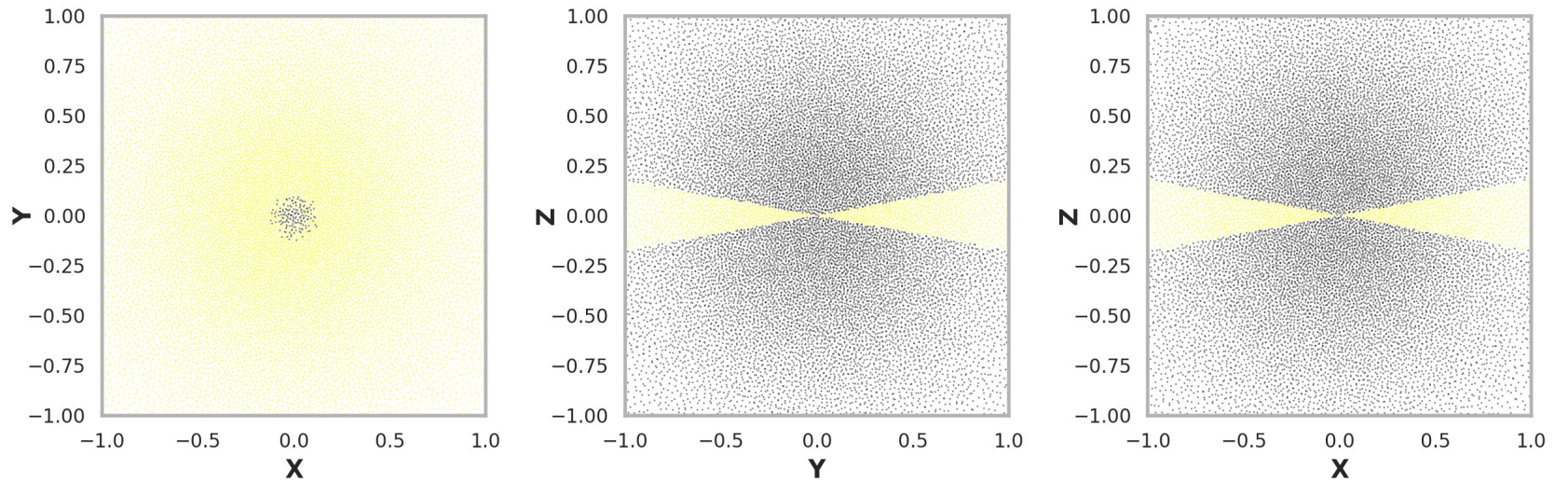


Measuring scale factor in orthogonal directions

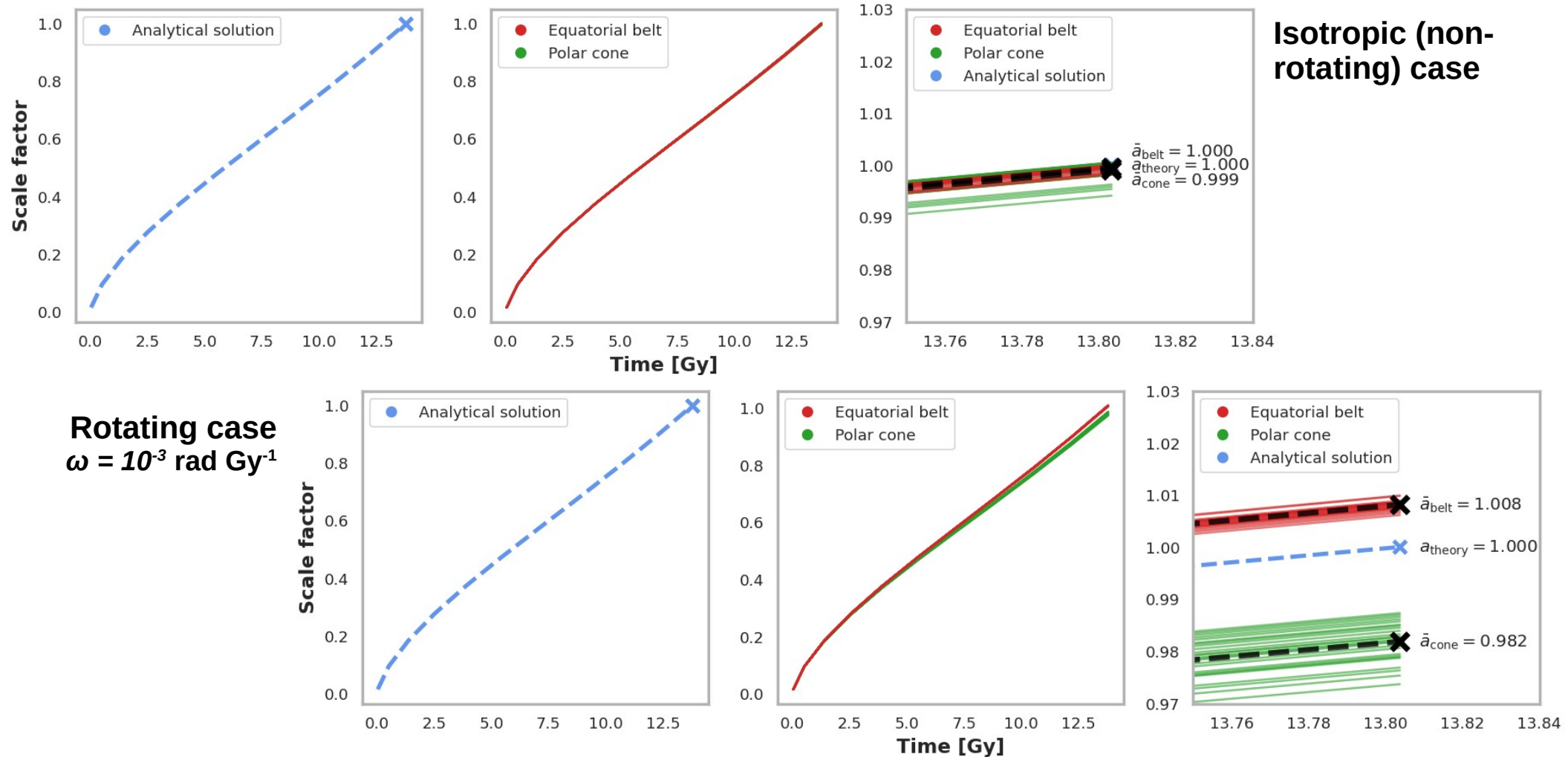
Spherical sectors



Equatorial belt



Scale factor in orthogonal directions (Λ CDM)



Thank you for the attention!



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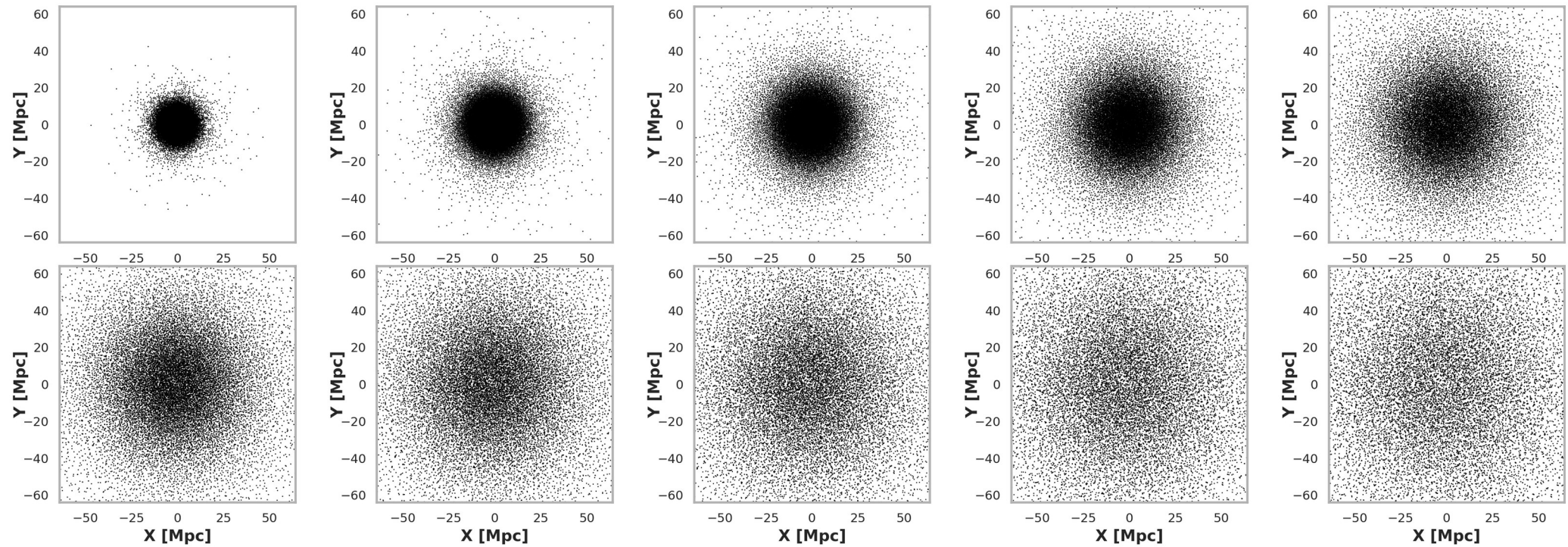
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REN



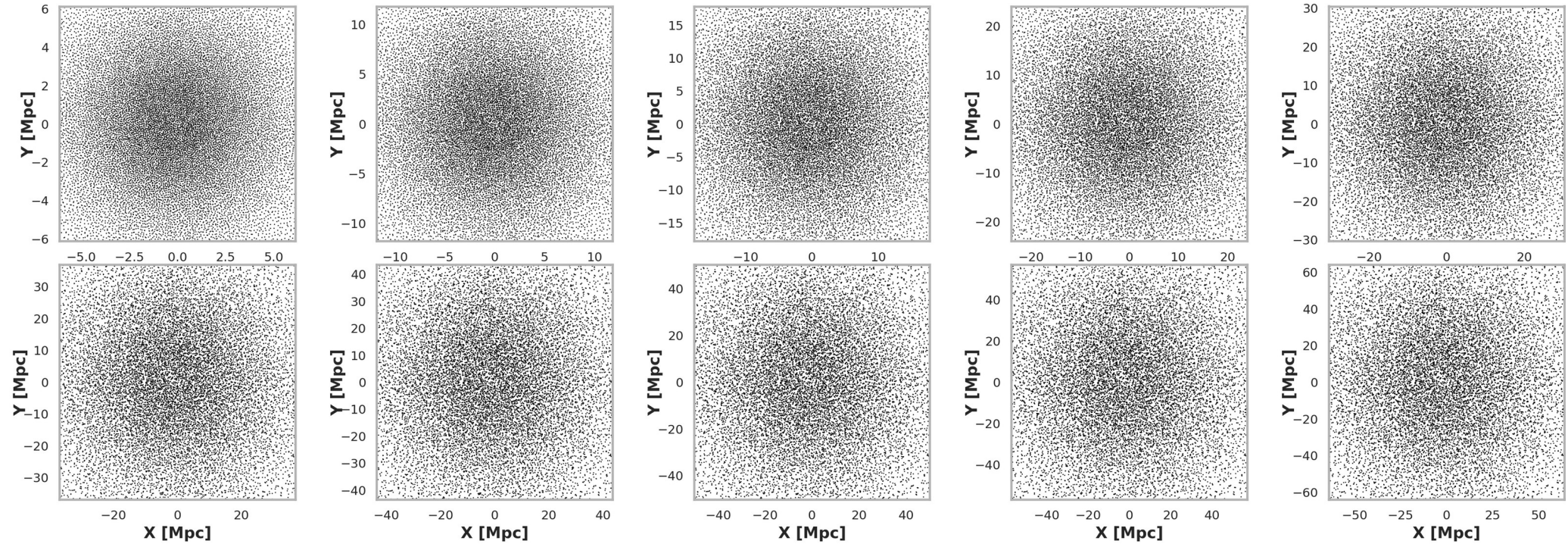
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Bonus slides

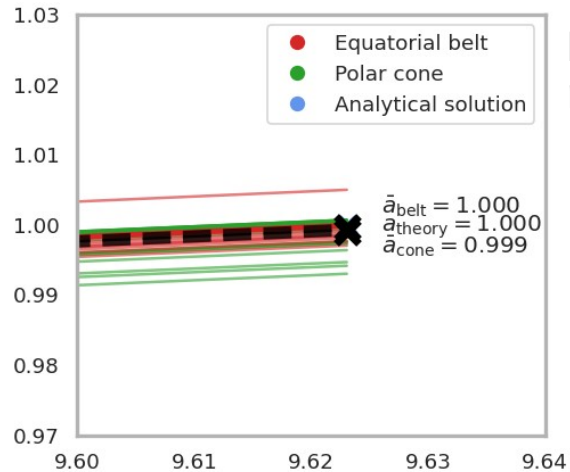
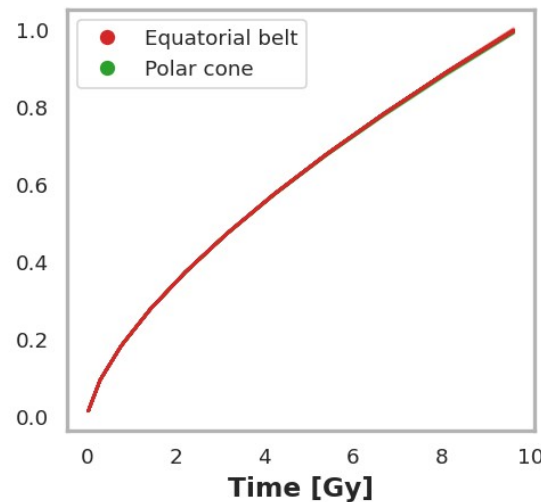
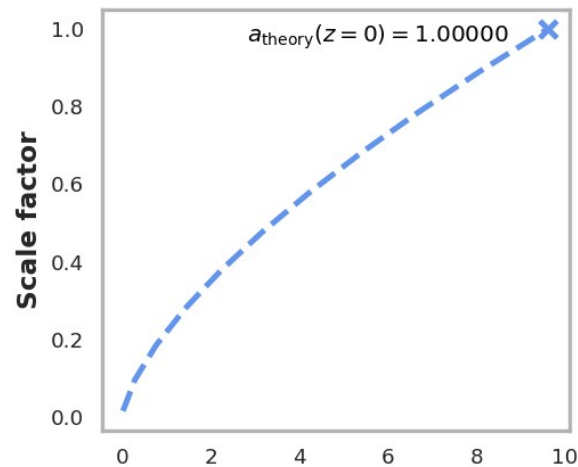
Evolution in physical/proper coordinates



Evolution in comoving coordinates



Scale factor in orthogonal directions (EdS)



Isotropic (non-rotating) case

Rotating case
 $\omega = 10^{-3} \text{ rad Gy}^{-1}$

