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The Rotating Universe

Simulating rotating Newtonian universes

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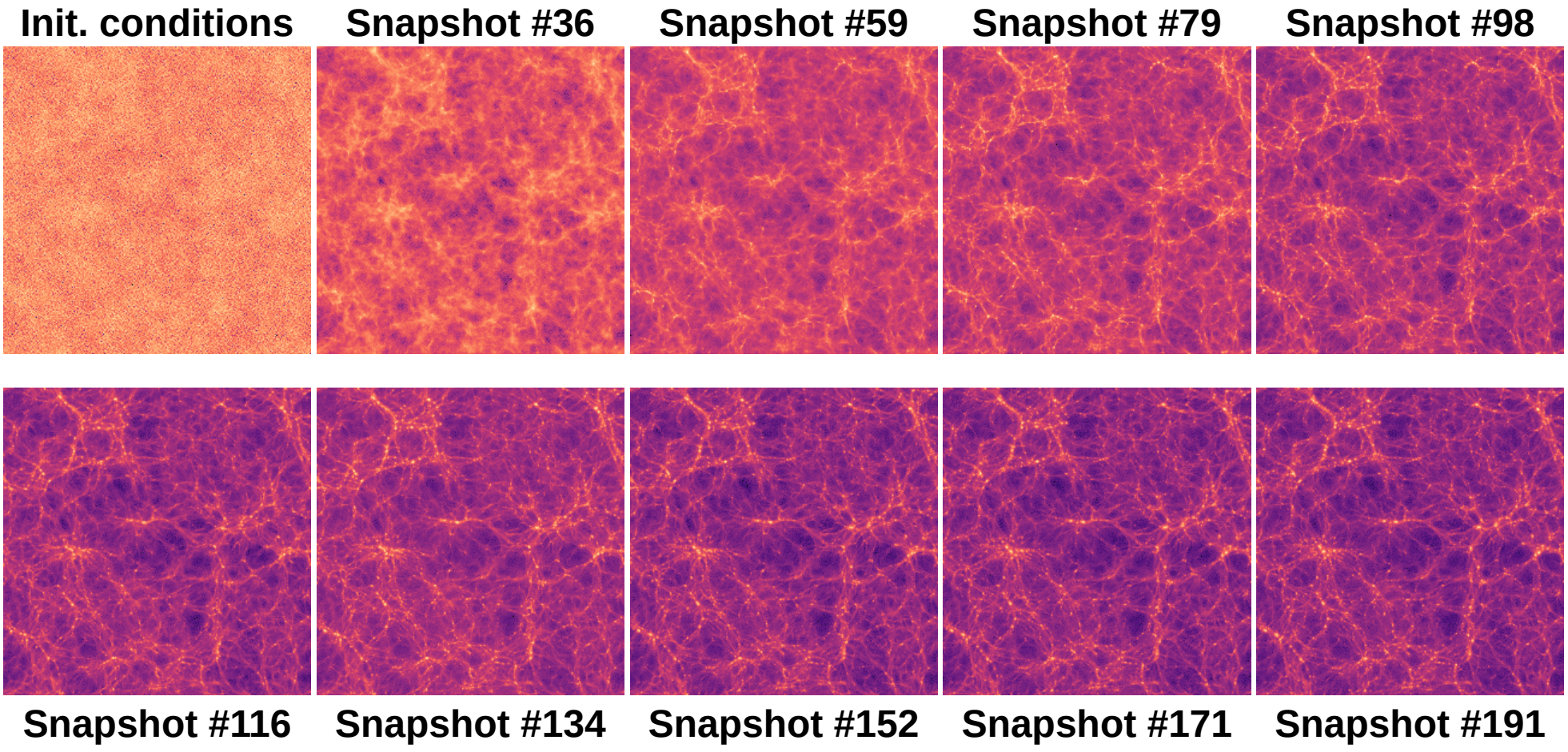
Wigner Scientific Computation Laboratory, Wigner RCP
XIV. GPU Day – 2024

Current state of cosmology

- Standard Model (of cosmology): **ΛCDM**
- 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?

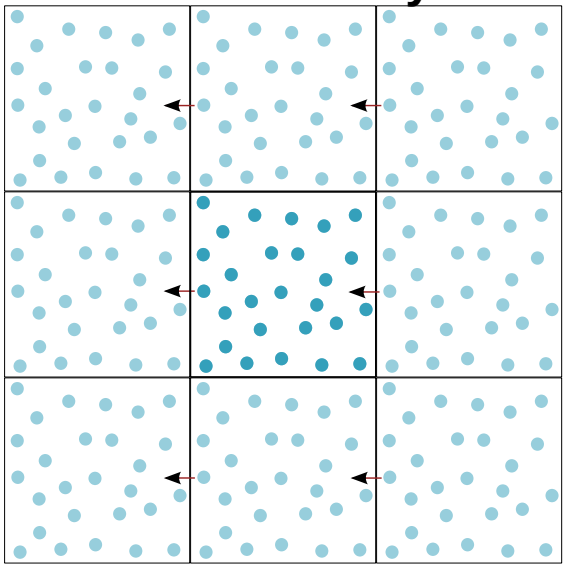
Cosmological simulations



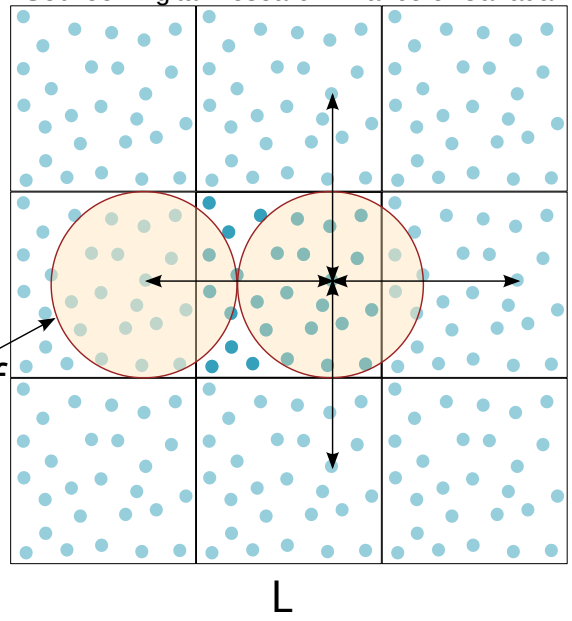
StePS vs. the world - Boundary conditions

StePS vs. the world - Boundary conditions

Periodic boundary conditions



Source: Digital Research Alliance of Canada



StePS vs. the world - Boundary conditions

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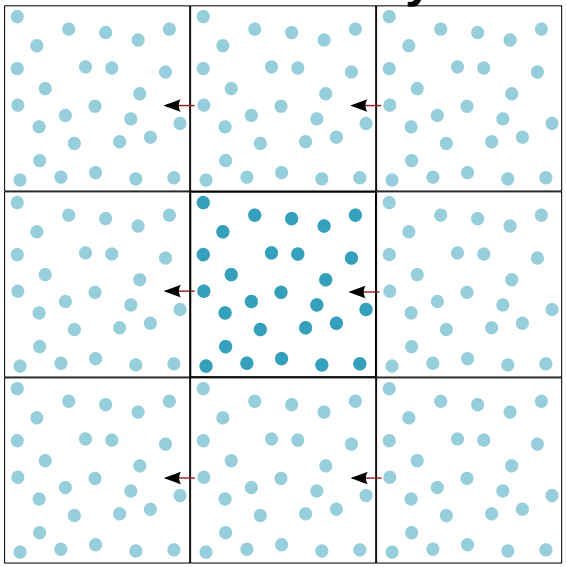

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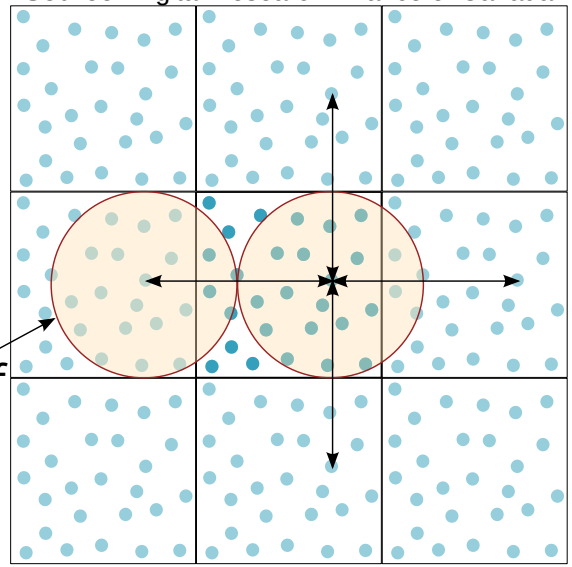
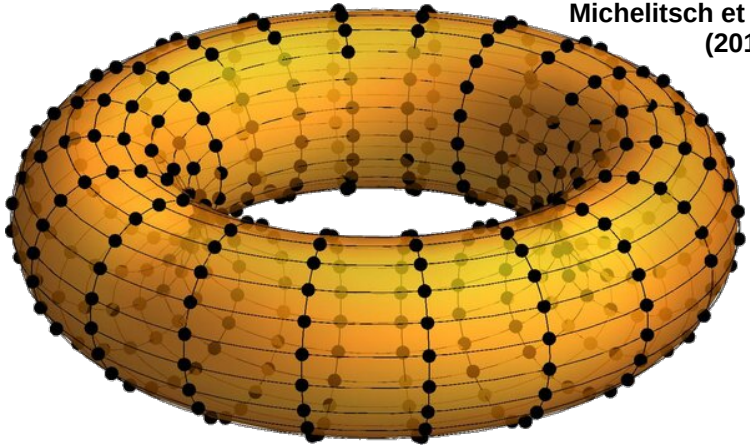


Michelitsch et al. (2017)



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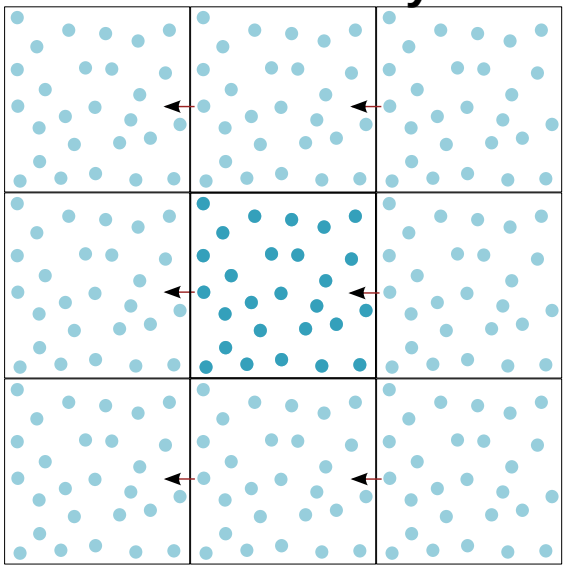

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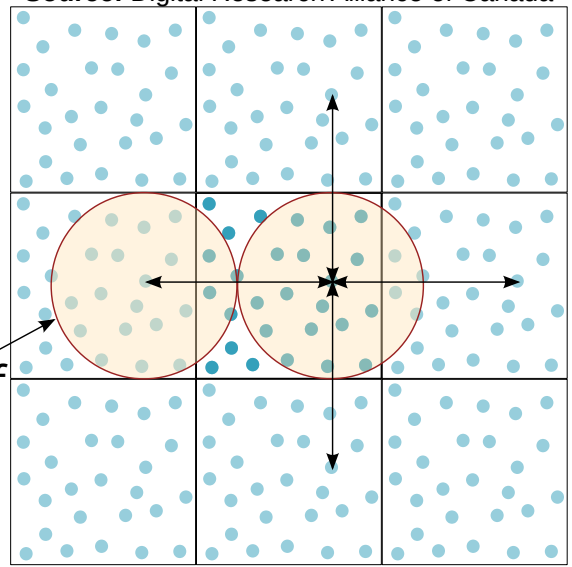
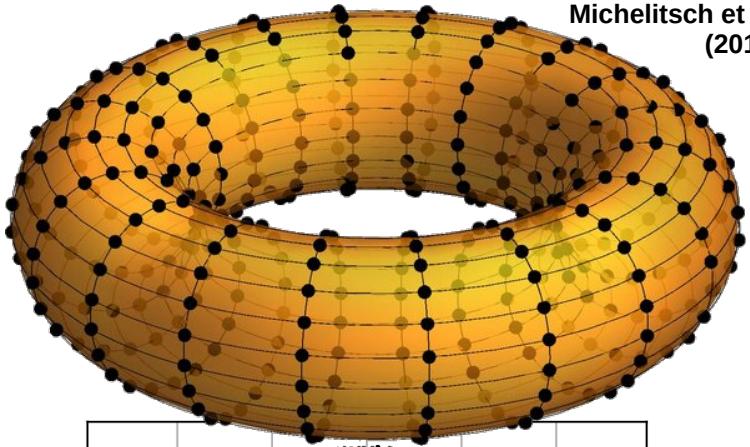
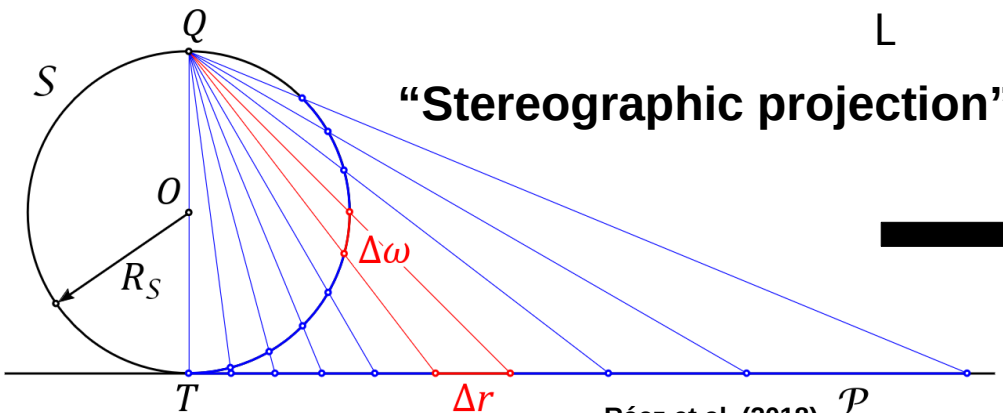


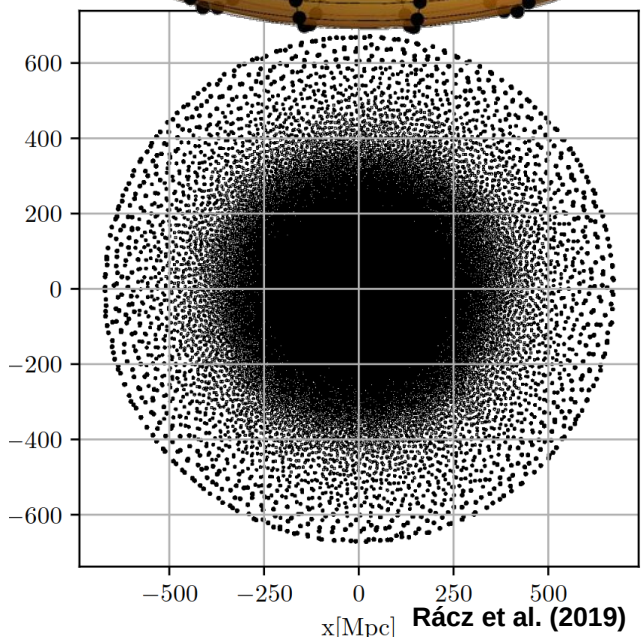
Michelitsch et al. (2017)





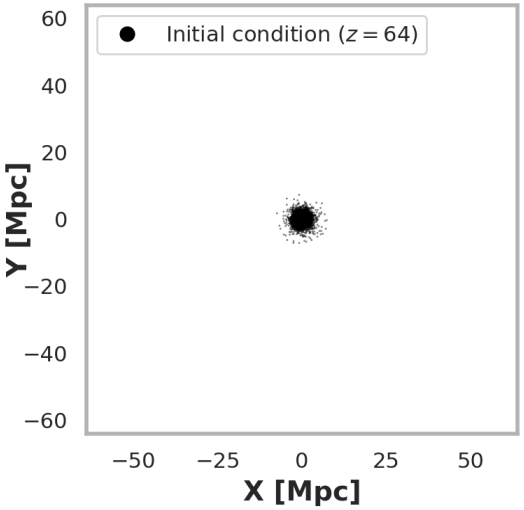
“Stereographic projection”

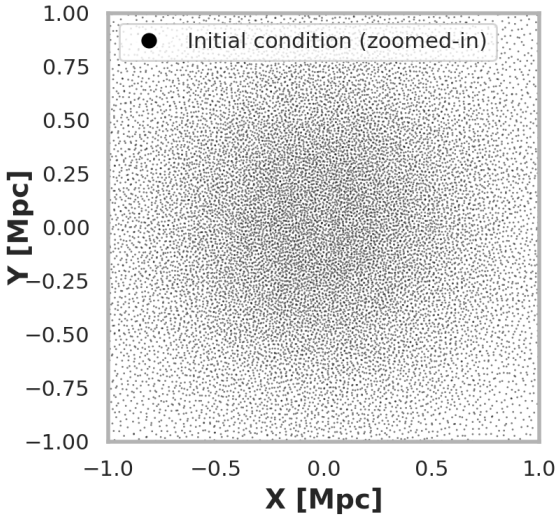
Rácz et al. (2018)

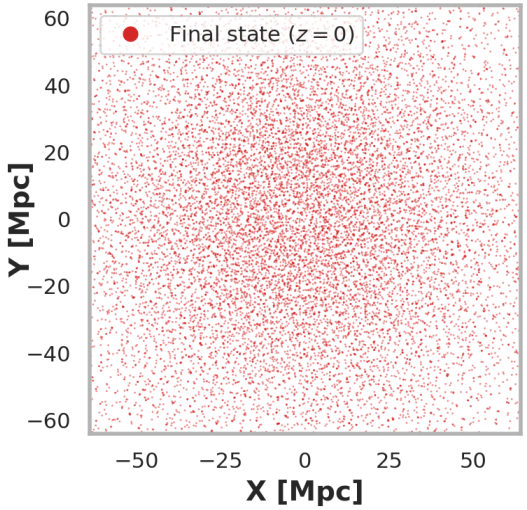


Rácz et al. (2019)

StePS rotating simulation

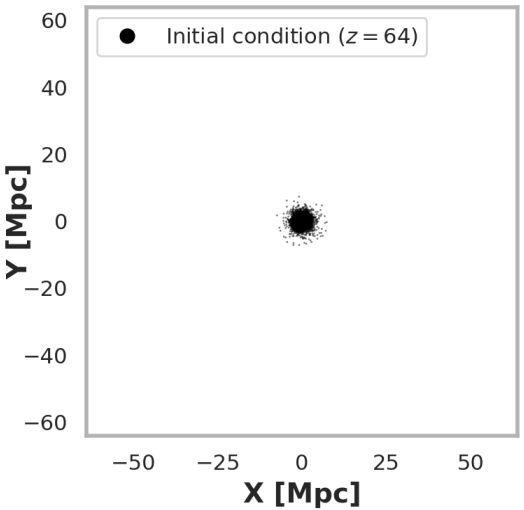


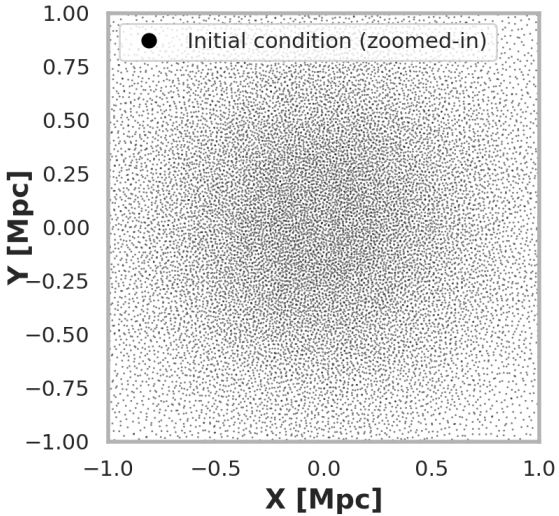


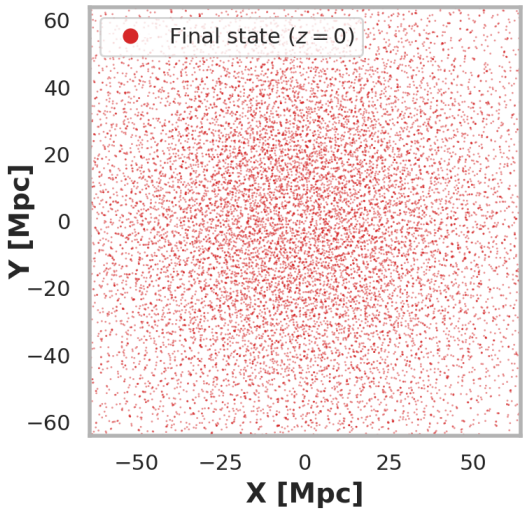


Evolution

StePS rotating simulation

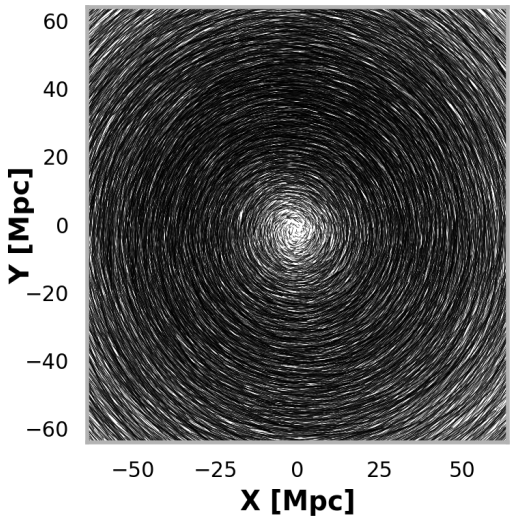


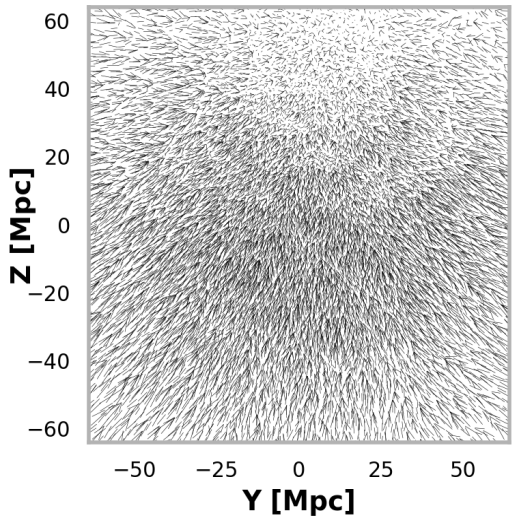


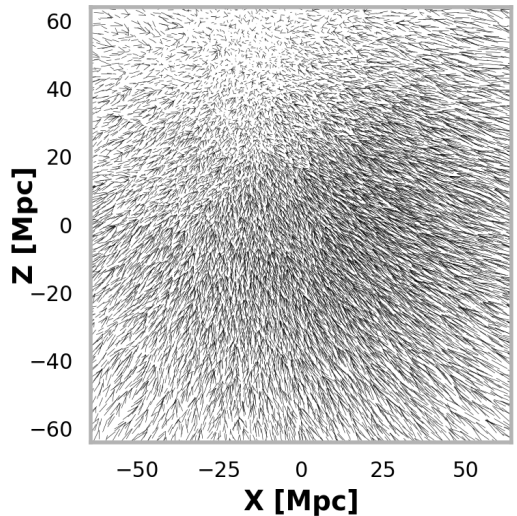


Evolution

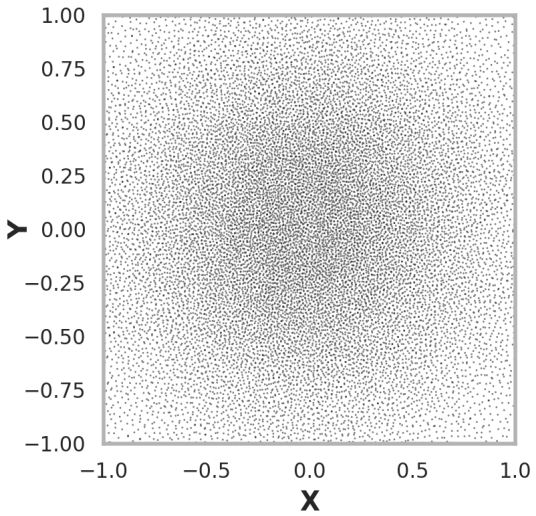
Displacement field

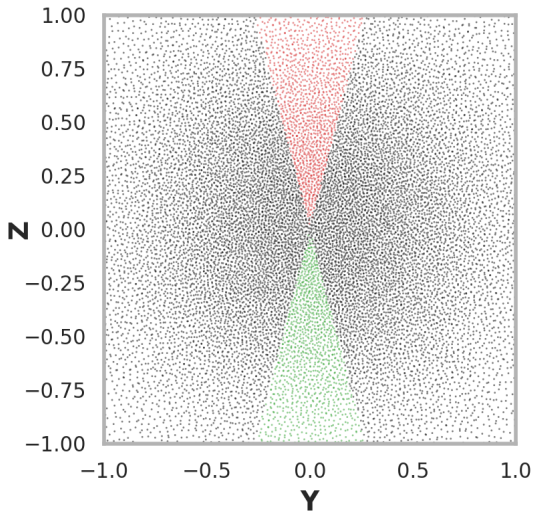


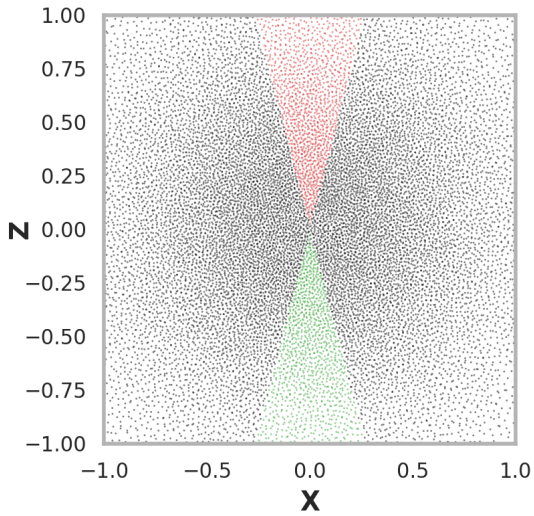




Measuring scale factor in orthogonal directions

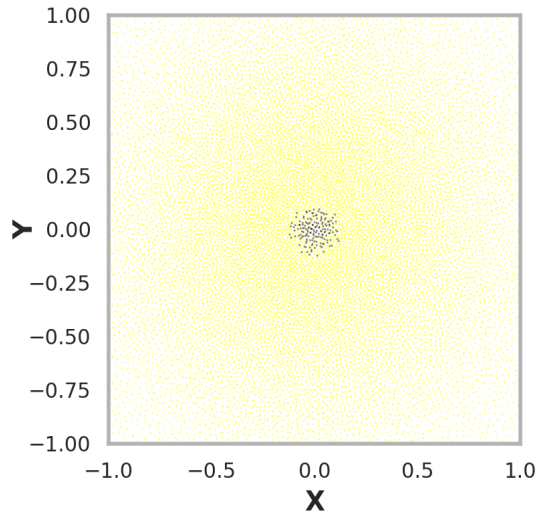


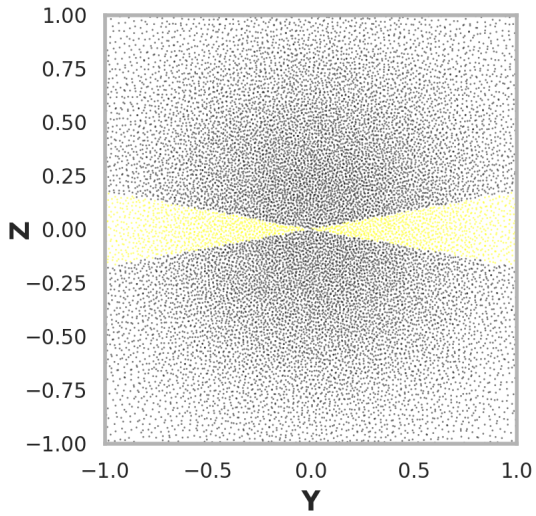


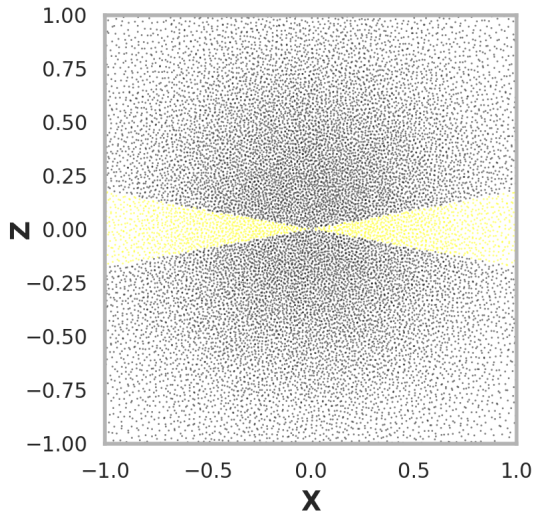


Spherical sectors

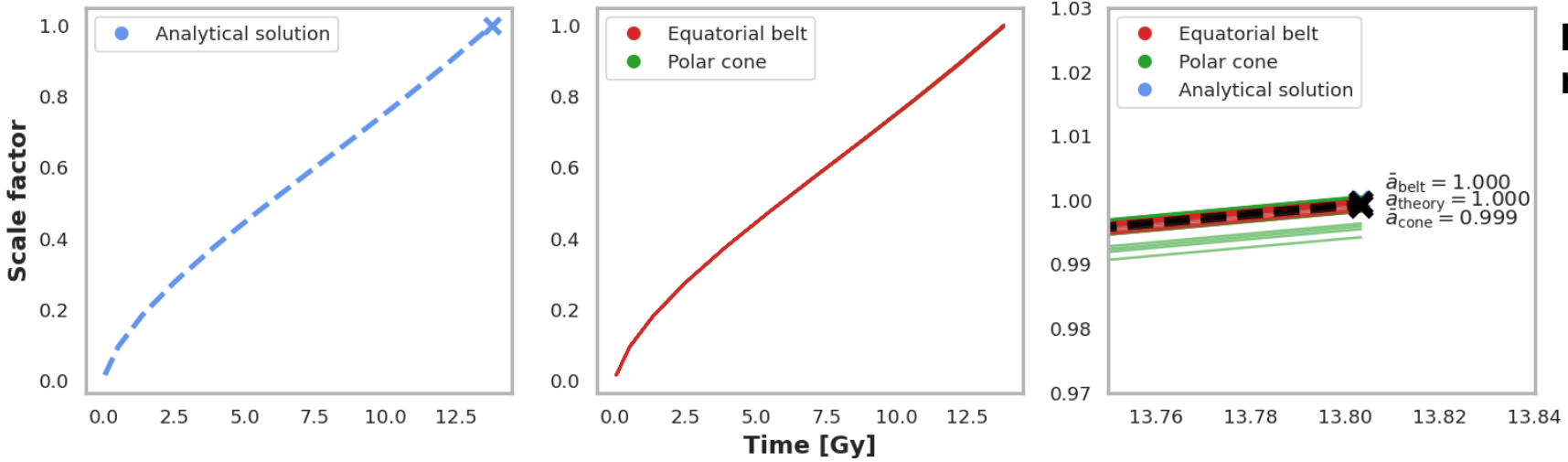
Equatorial belt





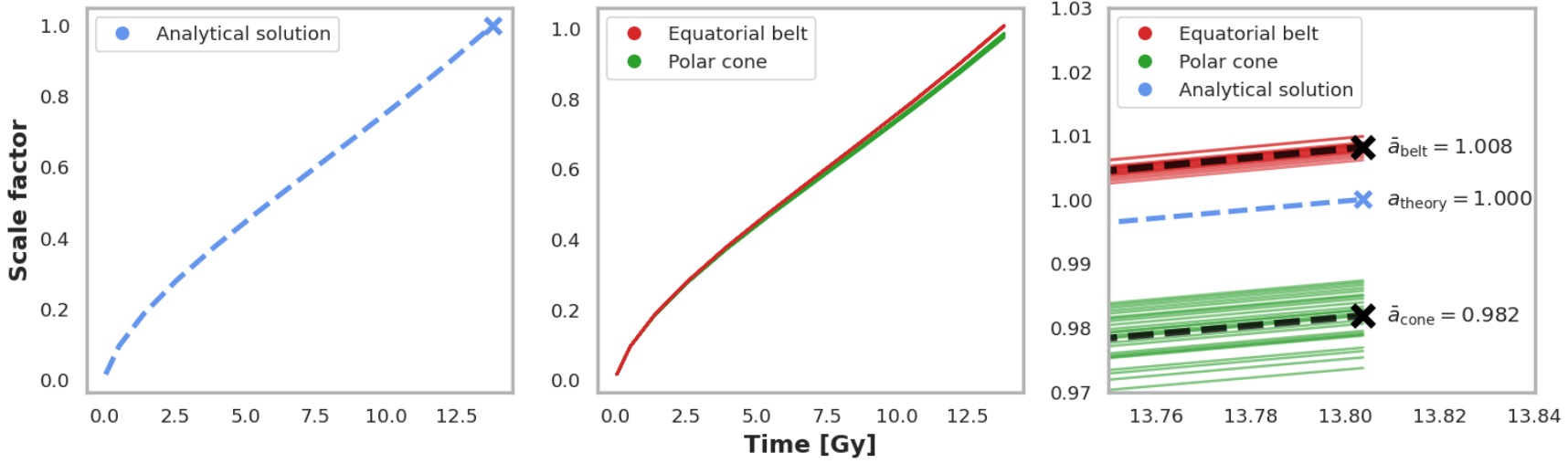


Scale factor in orthogonal directions (ΛCDM)



Isotropic (non-rotating) case

Rotating case
***ω* = *10*$^{-3}$ rad Gy^{-1}**



Thank you for the attention!

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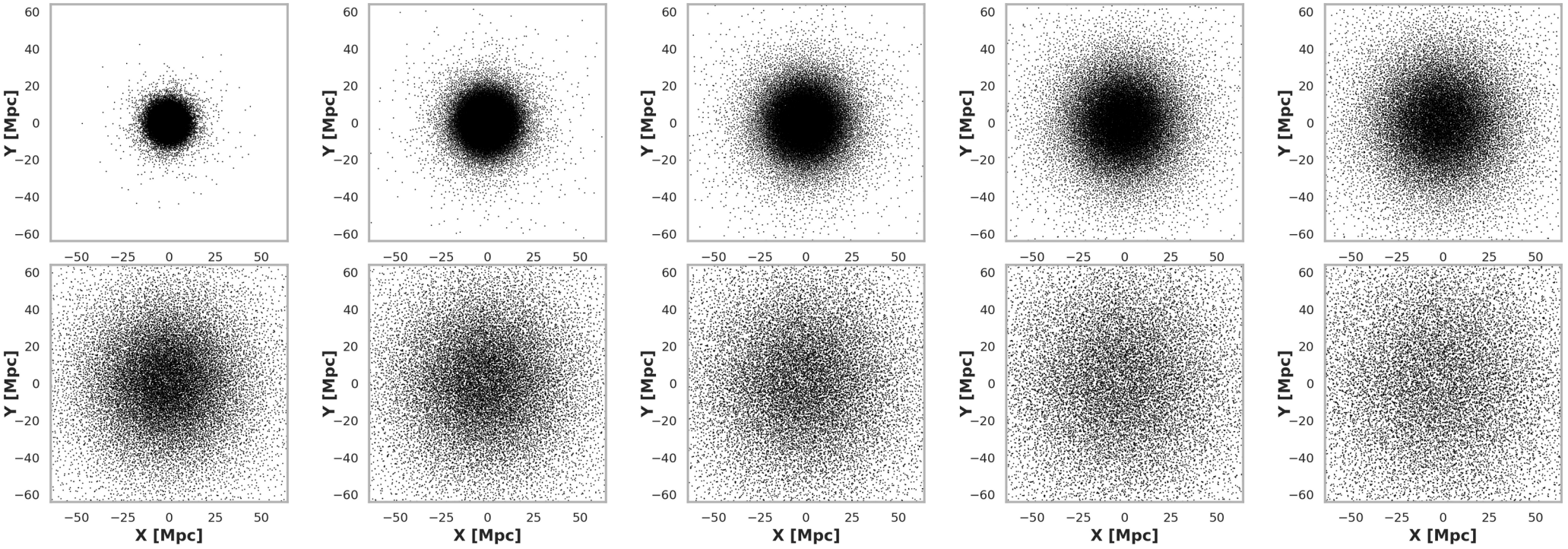
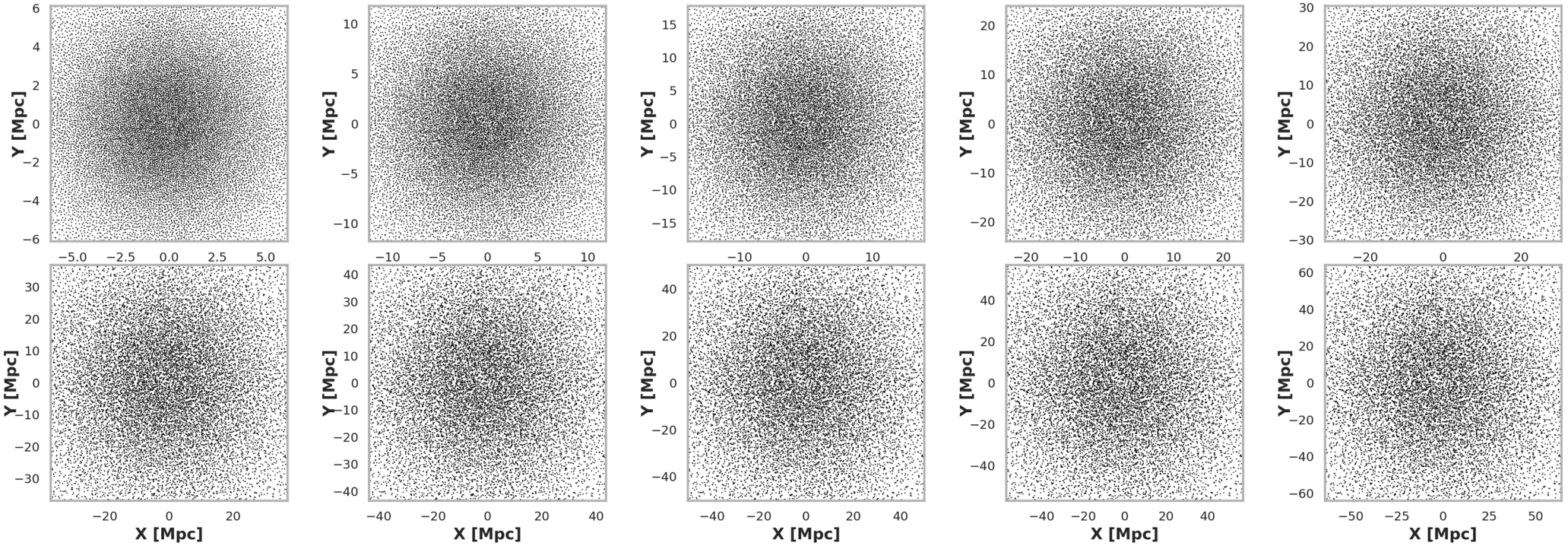
Bonus slides

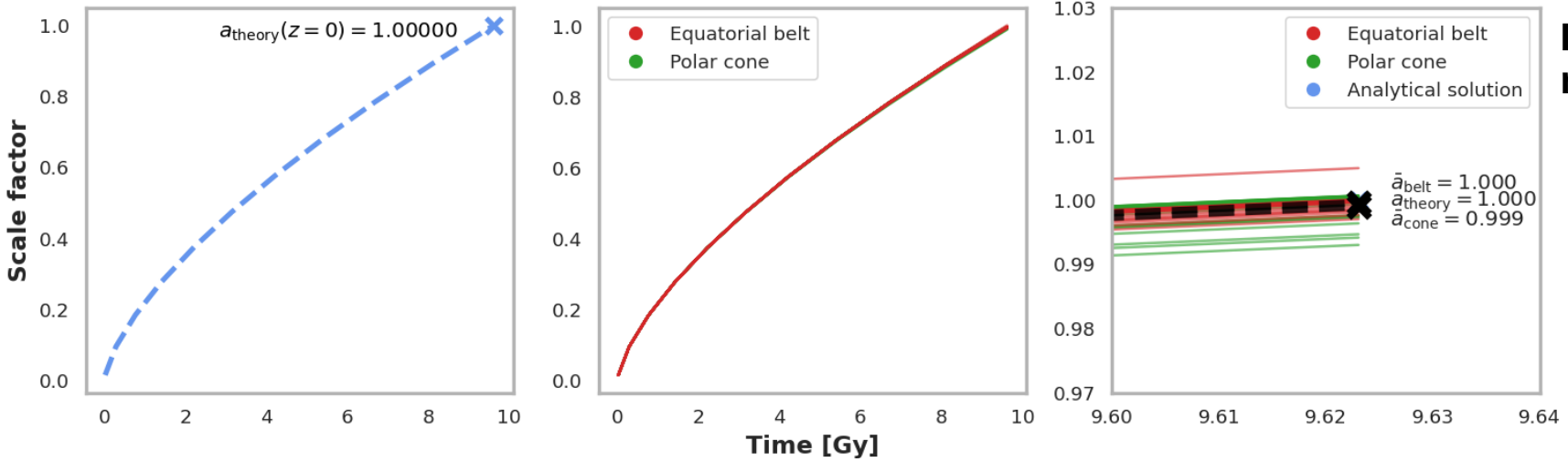
Evolution in physical/proper coordinates



Evolution in comoving coordinates



Scale factor in orthogonal directions (EdS)



Isotropic (non-rotating) case

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