Intrinsic Alignments of Galaxies and Halos

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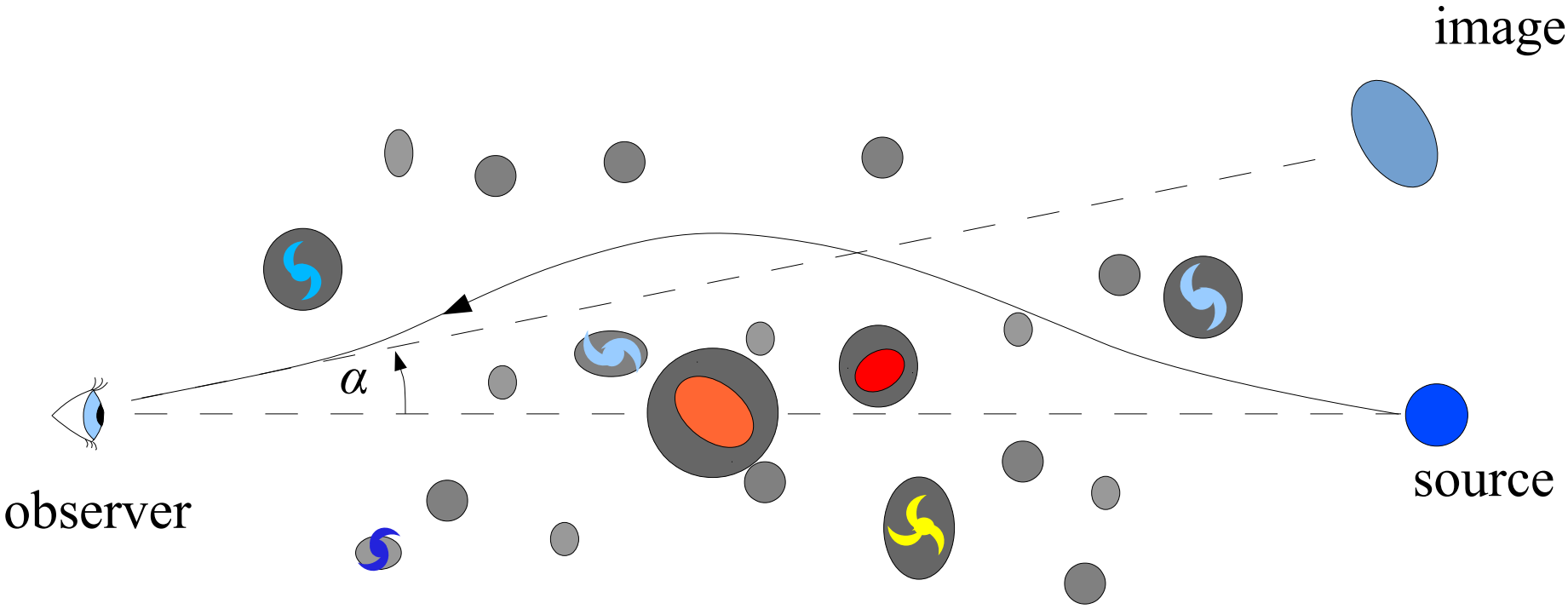
CFHTLenS Team (Tim Schrabback,...)

Outline

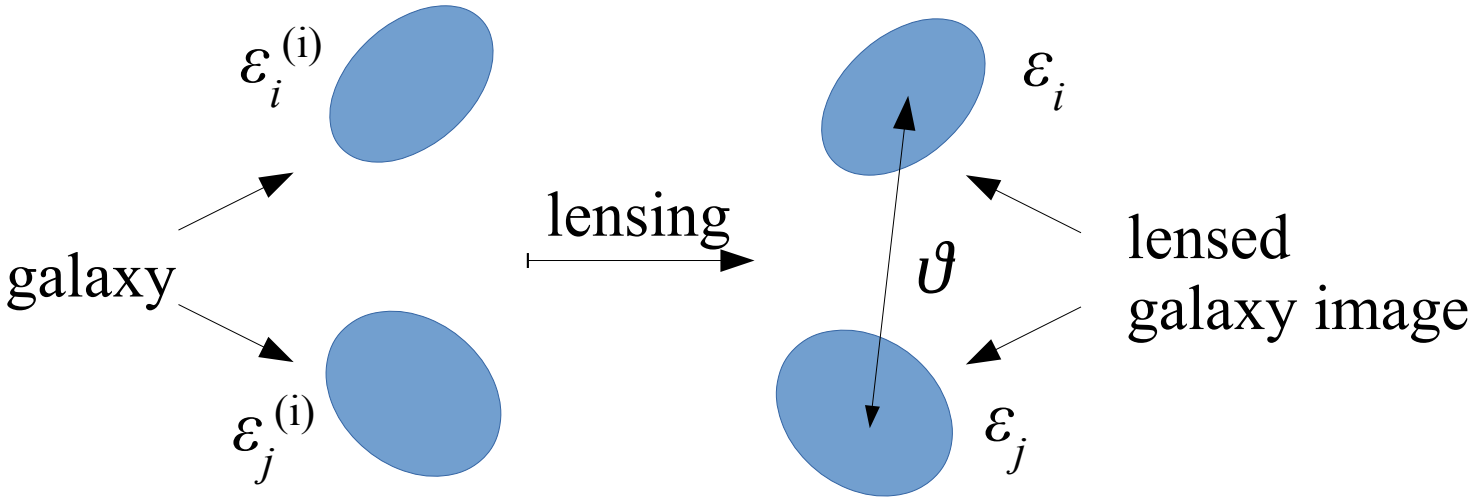
- Introduction
- Intrinsic Alignments in Illustris Simulations
- (Galaxy-Halo (Mis)Alignments in CFHTLenS: see arxiv:1507.04301)
- Summary and Outlook

LSS & Gravitational Lensing



- deflection $\alpha \rightarrow$ shift in apparent position
- differential deflection $\partial\alpha/\partial\vartheta \rightarrow$ image distortion

Correlating Image Distortions



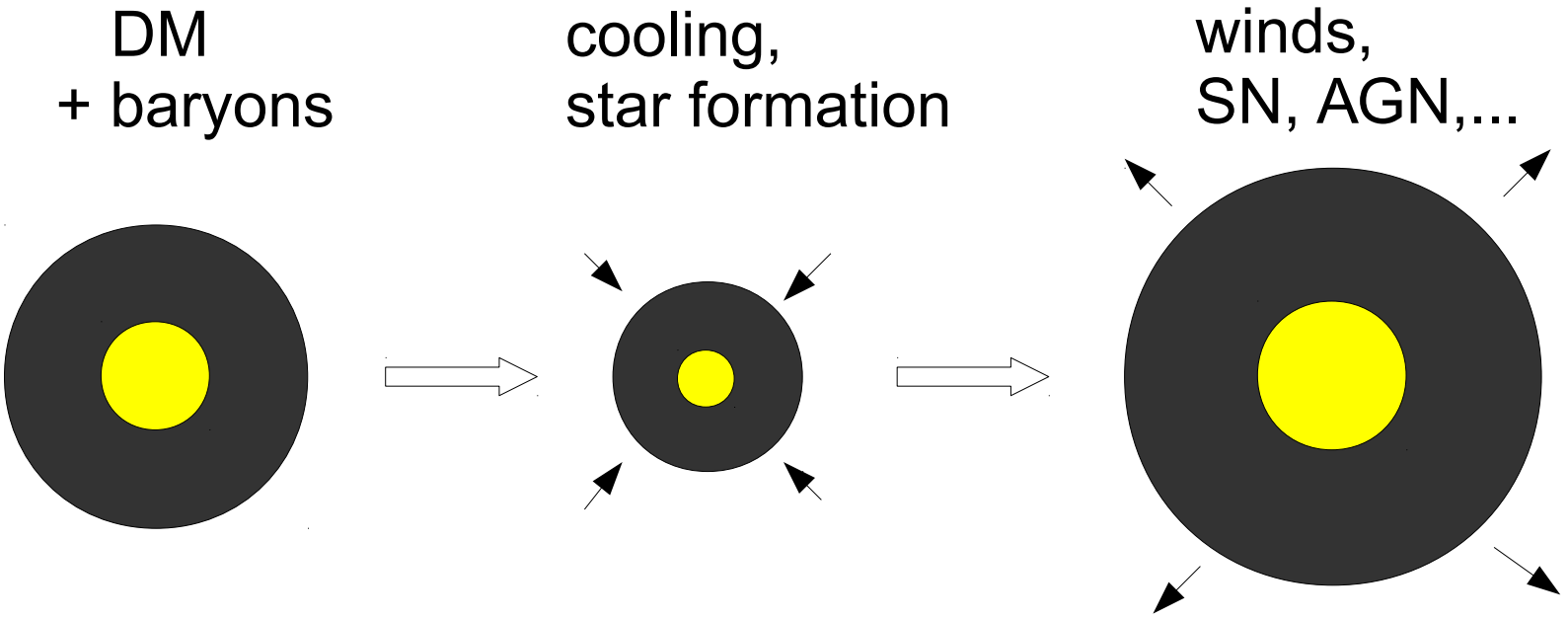
$$\langle \varepsilon_i^* \varepsilon_j \rangle \approx \langle \gamma^* \gamma \rangle (\vartheta) = \xi_+(\vartheta) \approx \int \mathrm{d}\, z\, g(z)\, w_+(\vartheta, z)$$

- ε_i observed image ellipticity
- γ shear
- ξ_+ cosmic shear correlation function
- g geometric weight
- w_+ (projected) matter correlation function

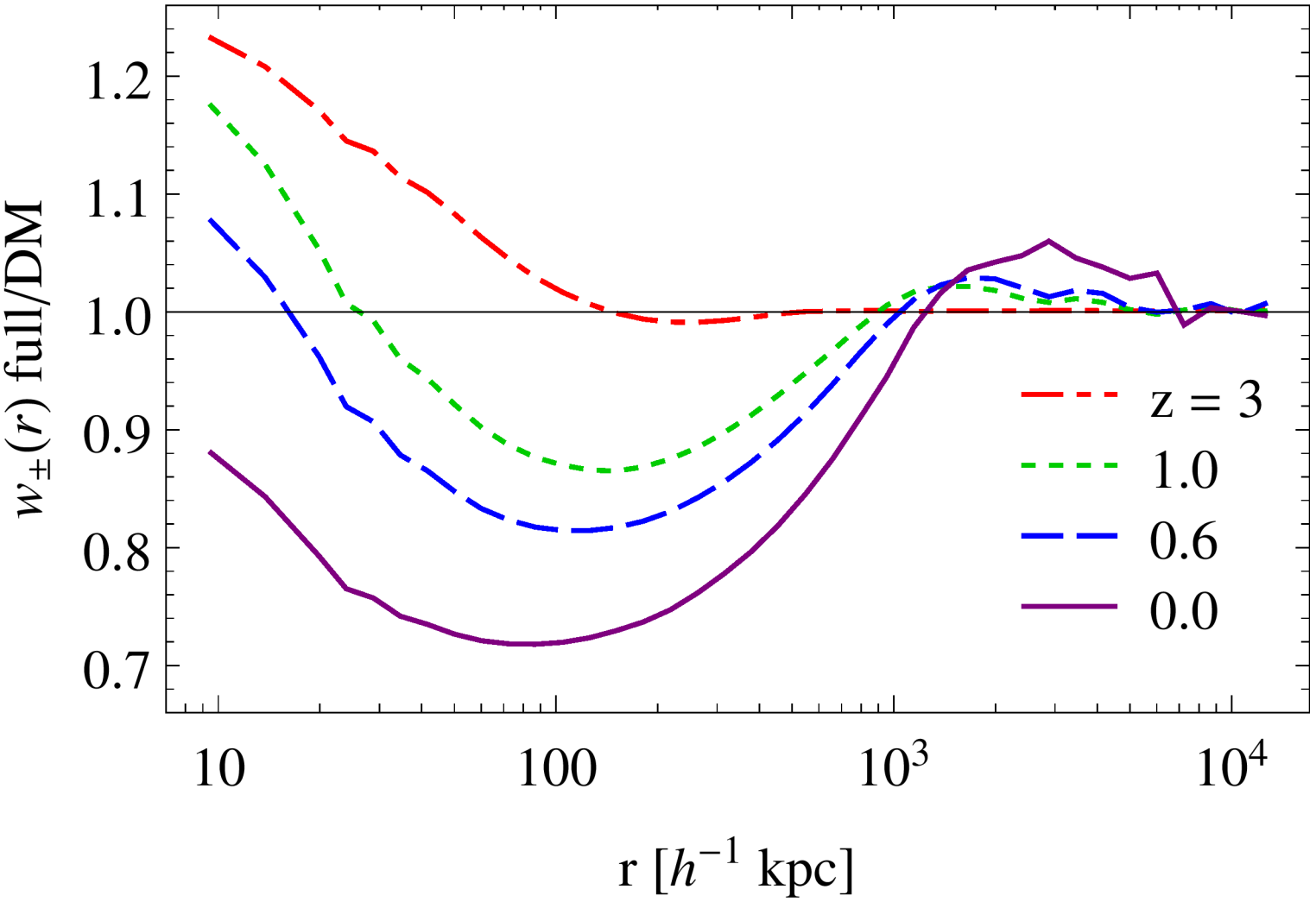
Illustris Simulation Project

- suite of simulations:
  - box size 25 – 100 Mpc
  - mass resolution ~ 10^6 M_{solar}
  - spatial resolution: ~ 1 kpc
- various recipes for baryon physics (incl. DM only)
- using moving-mesh code Arepo (Springel 2010)

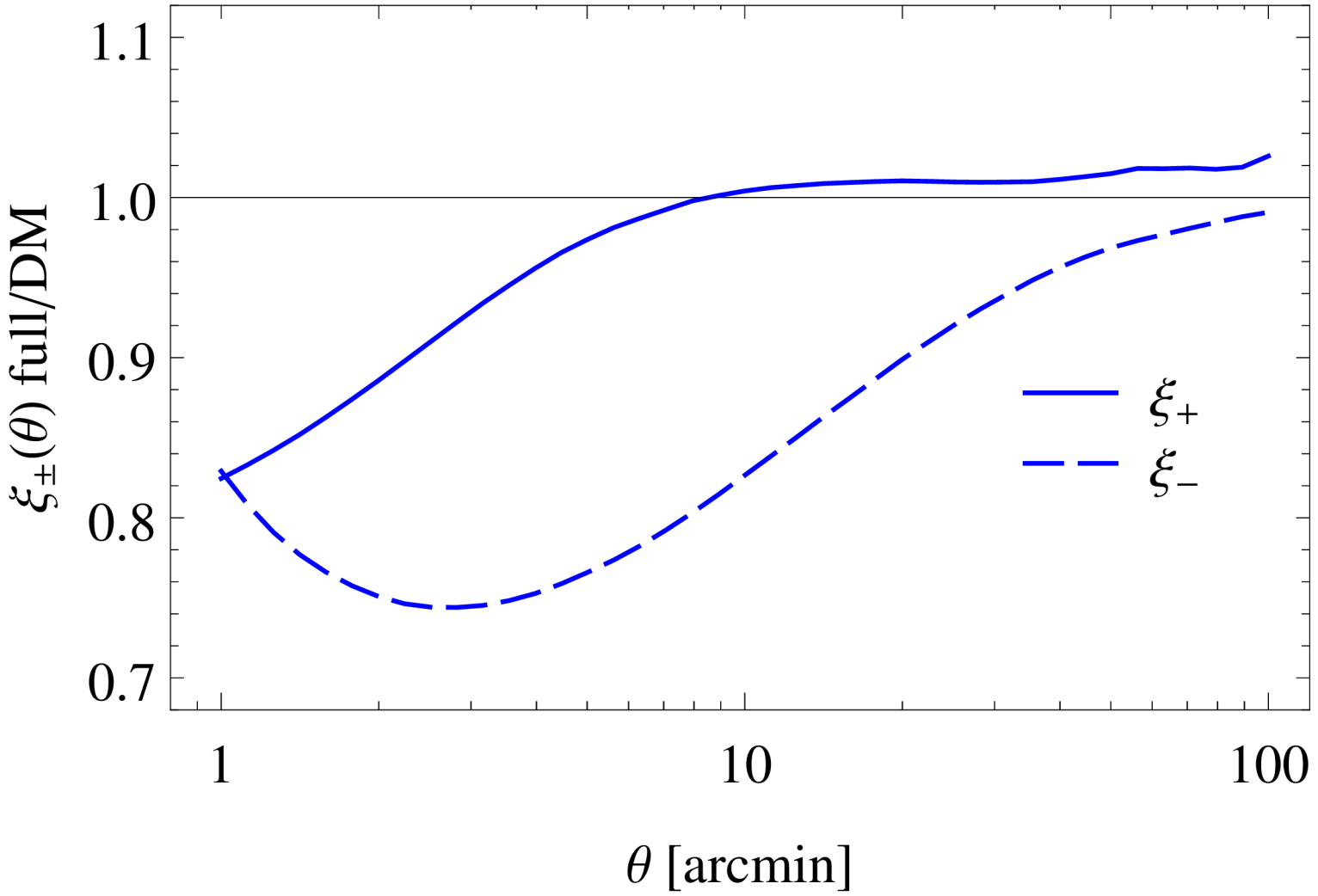
Impact of Baryons



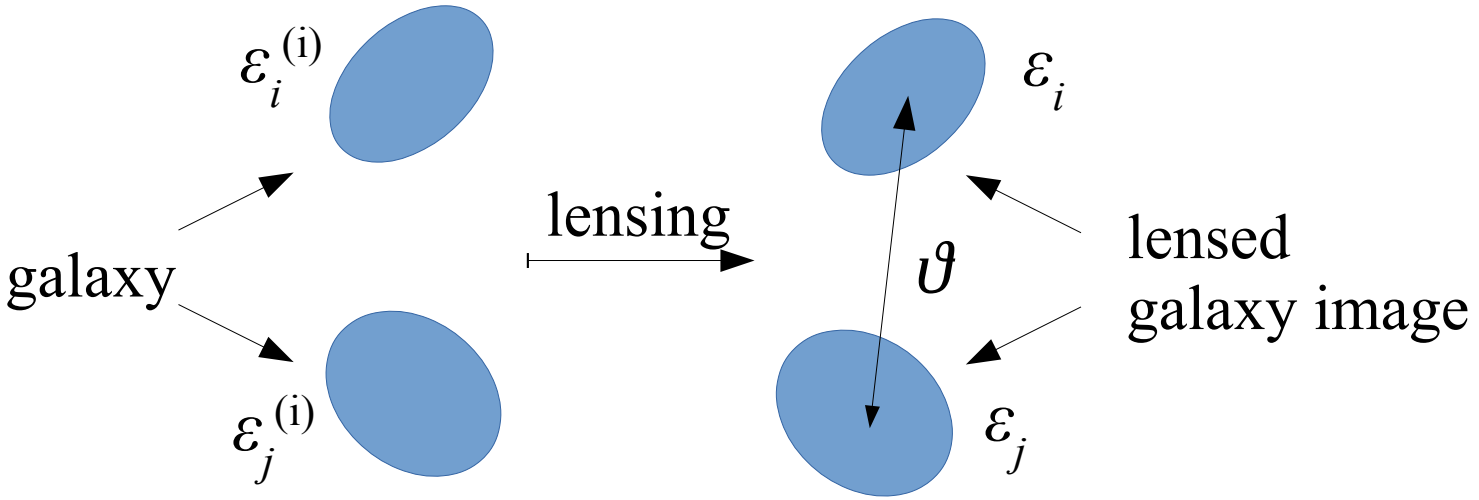
Projected Matter Correlations



Cosmic Shear Correlations

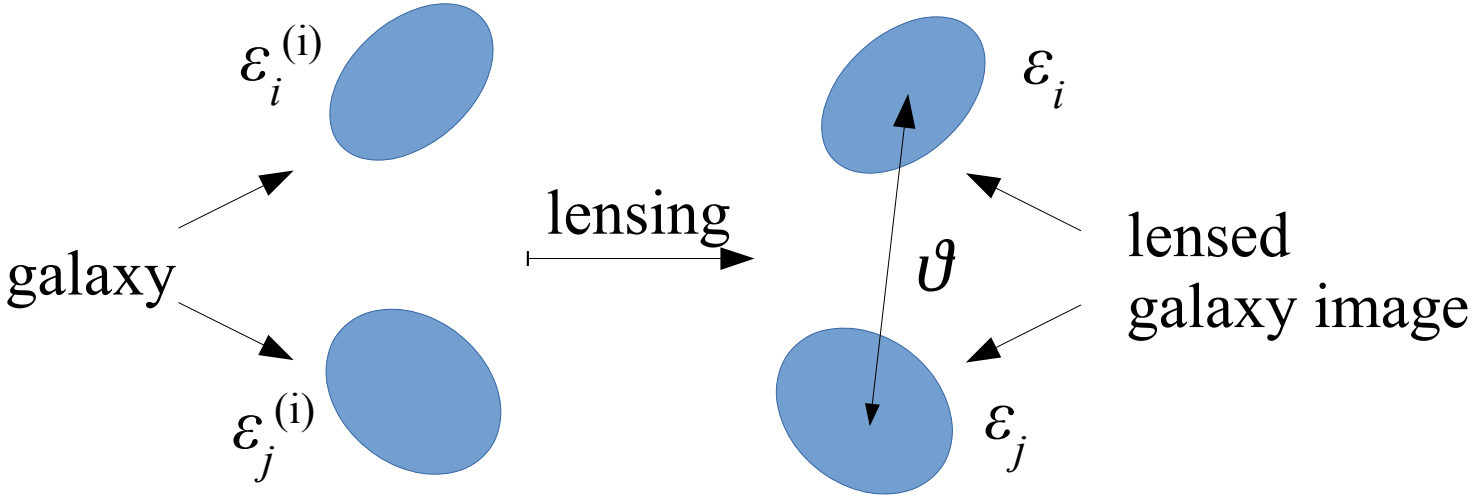


Intrinsic Alignment



$$\langle \varepsilon_i^* \varepsilon_j \rangle \approx \langle \gamma^* \gamma \rangle (\vartheta)$$

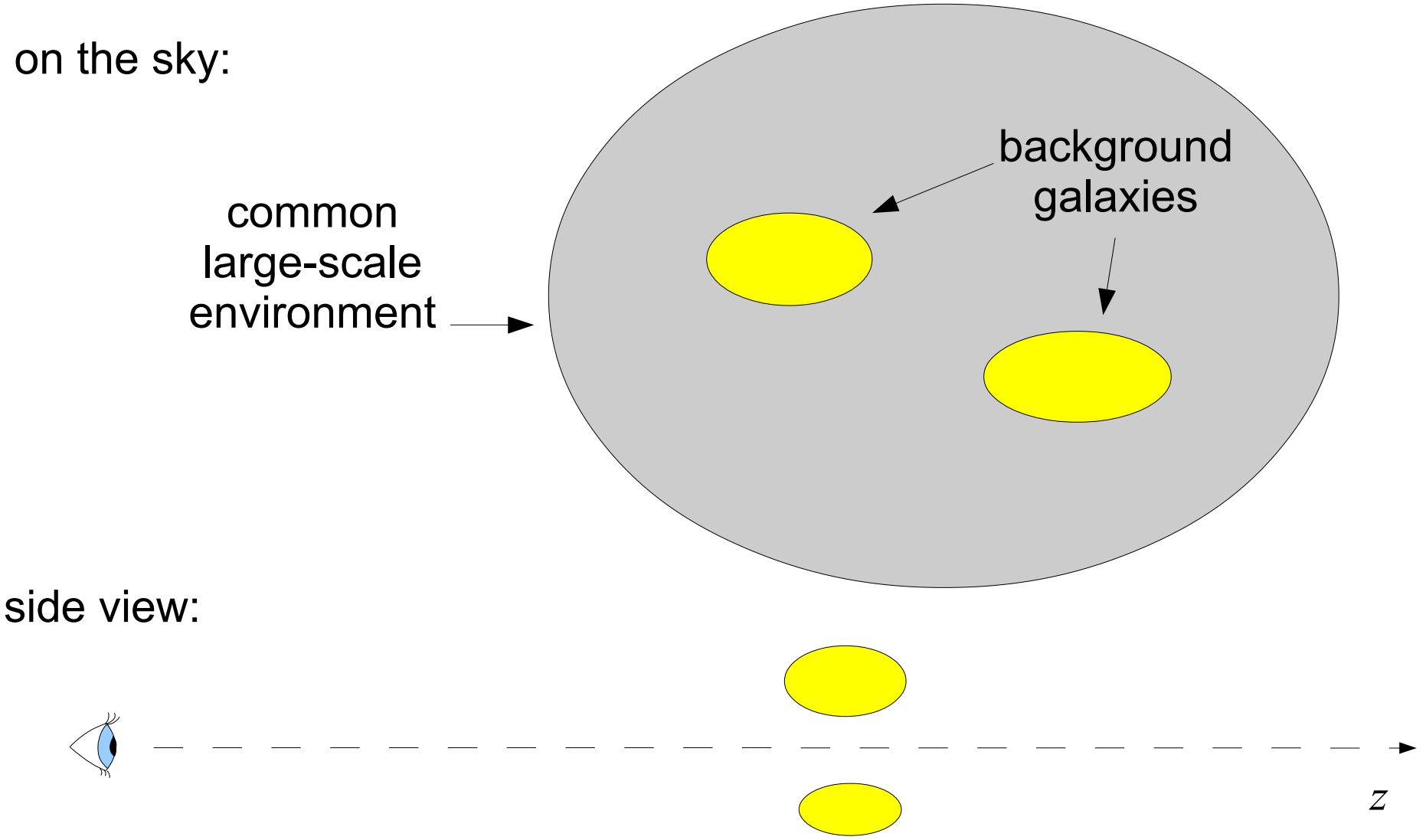
Intrinsic Alignment



$$\langle \varepsilon_i^* \varepsilon_j \rangle \approx \langle \gamma^* \gamma \rangle(\vartheta) + \langle \gamma^* \varepsilon_j^{(i)} \rangle(\vartheta) + \langle \varepsilon_i^{*(i)} \gamma \rangle(\vartheta) + \langle \varepsilon_i^{*(i)} \varepsilon_j^{(i)} \rangle(\vartheta)$$

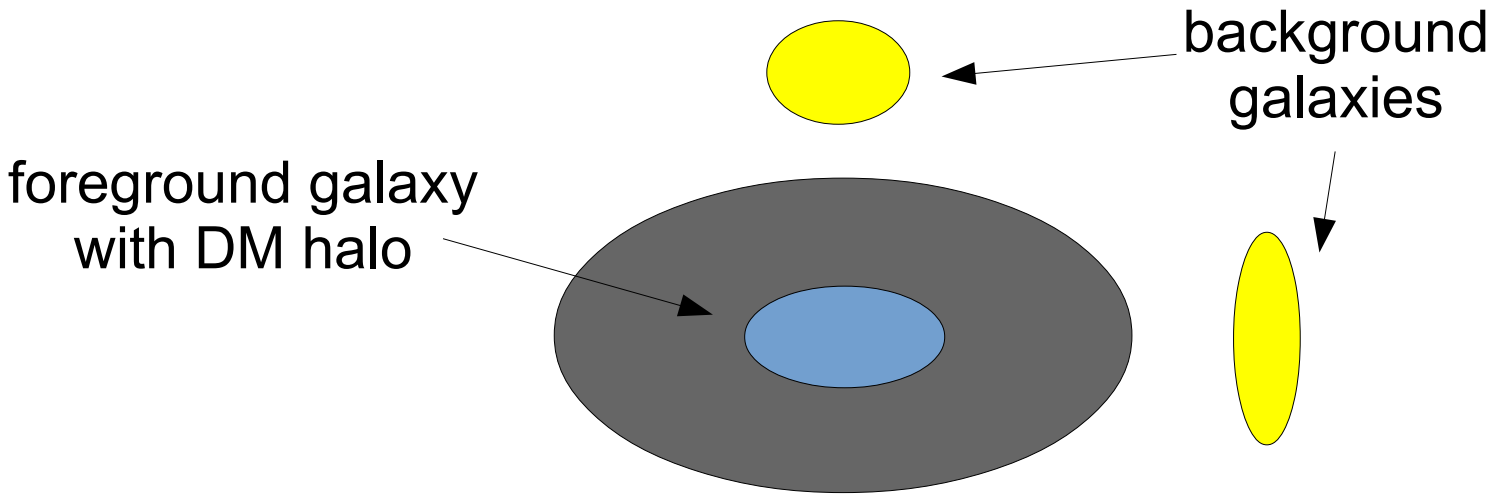
$$= \quad \mathrm{GG} \quad + \quad \mathrm{GI} \quad + \quad \mathrm{IG} \quad + \quad \mathrm{II}$$

Intrinsic Alignment: II

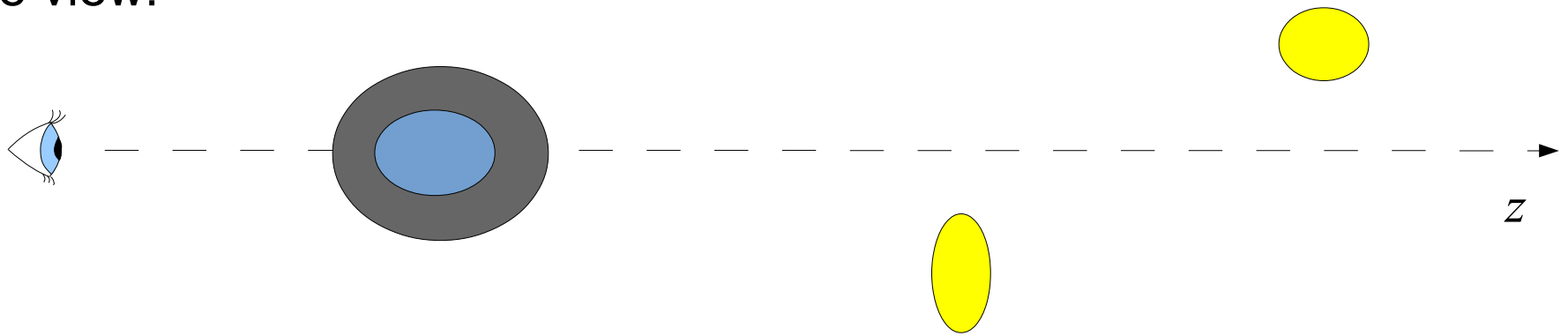


Intrinsic Alignment: GI

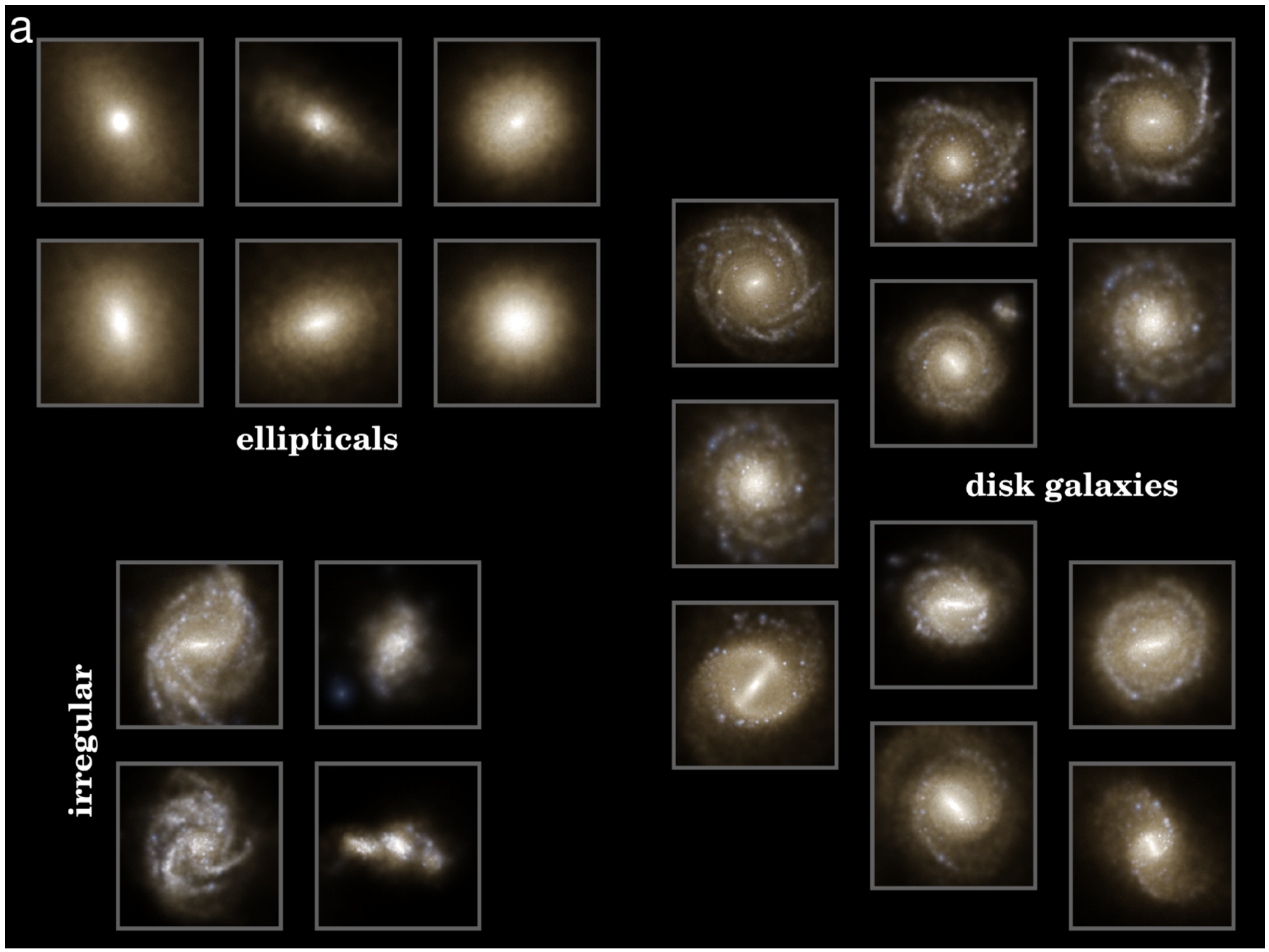
on the sky:



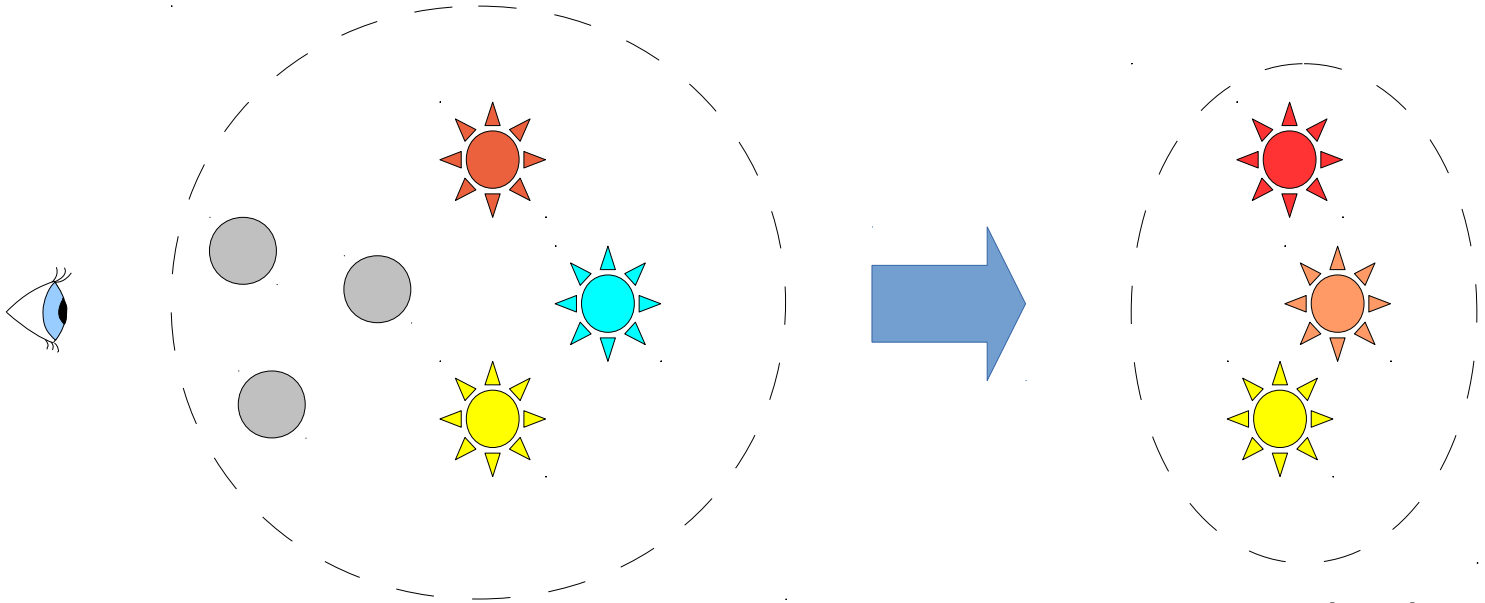
side view:



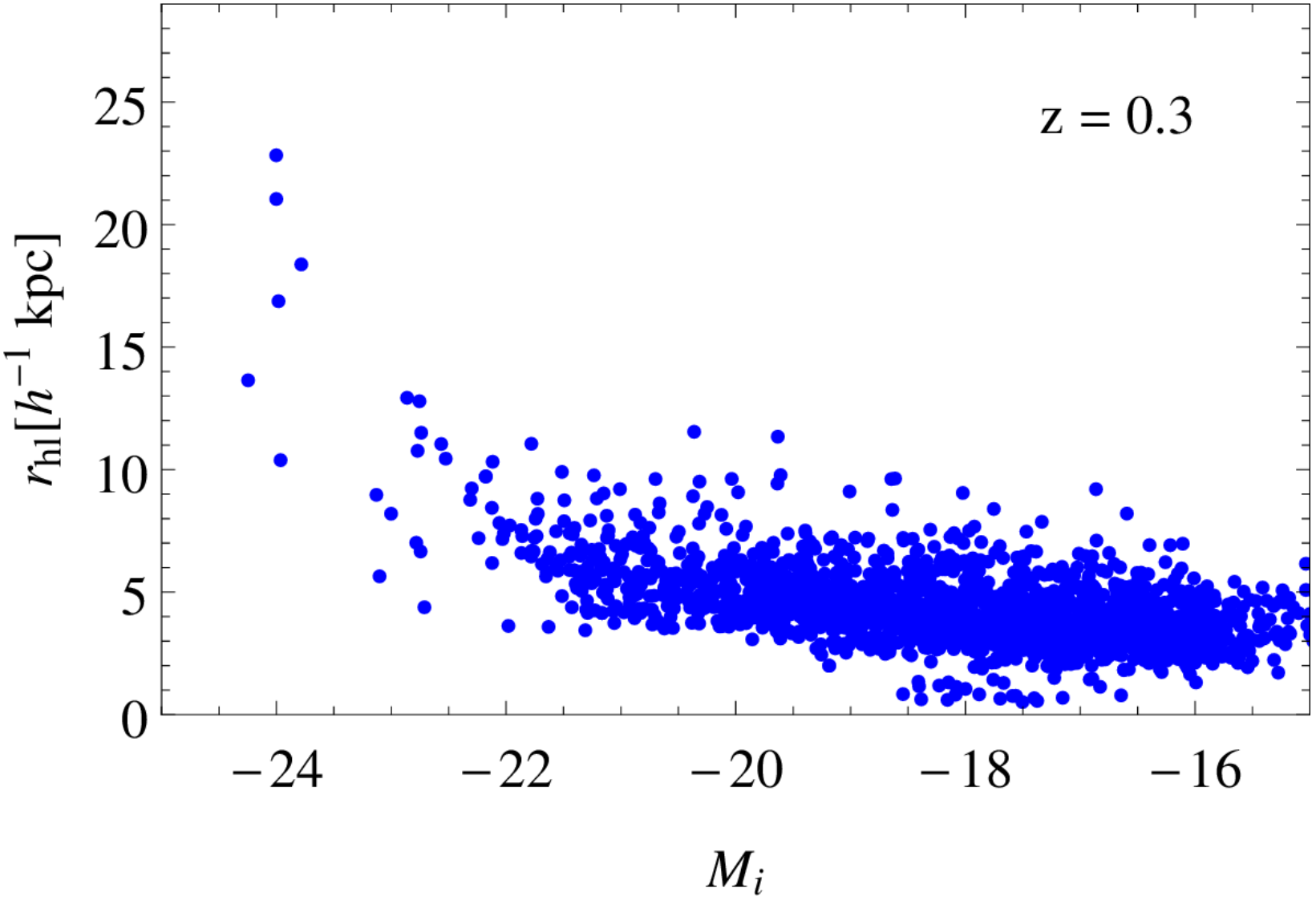
Galaxy Images


a
ellipticals
disk galaxies
irregular

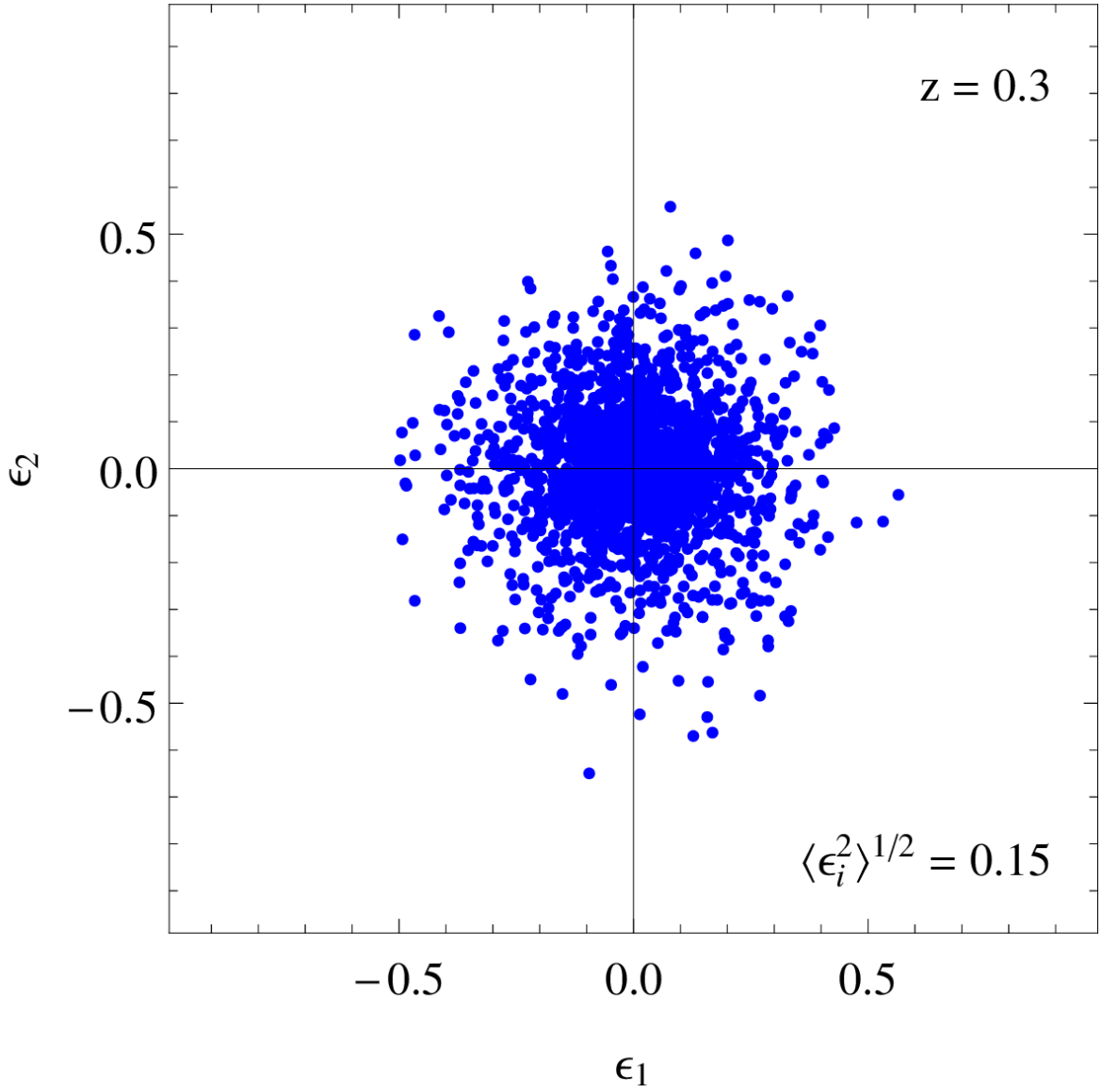
Galaxy Images



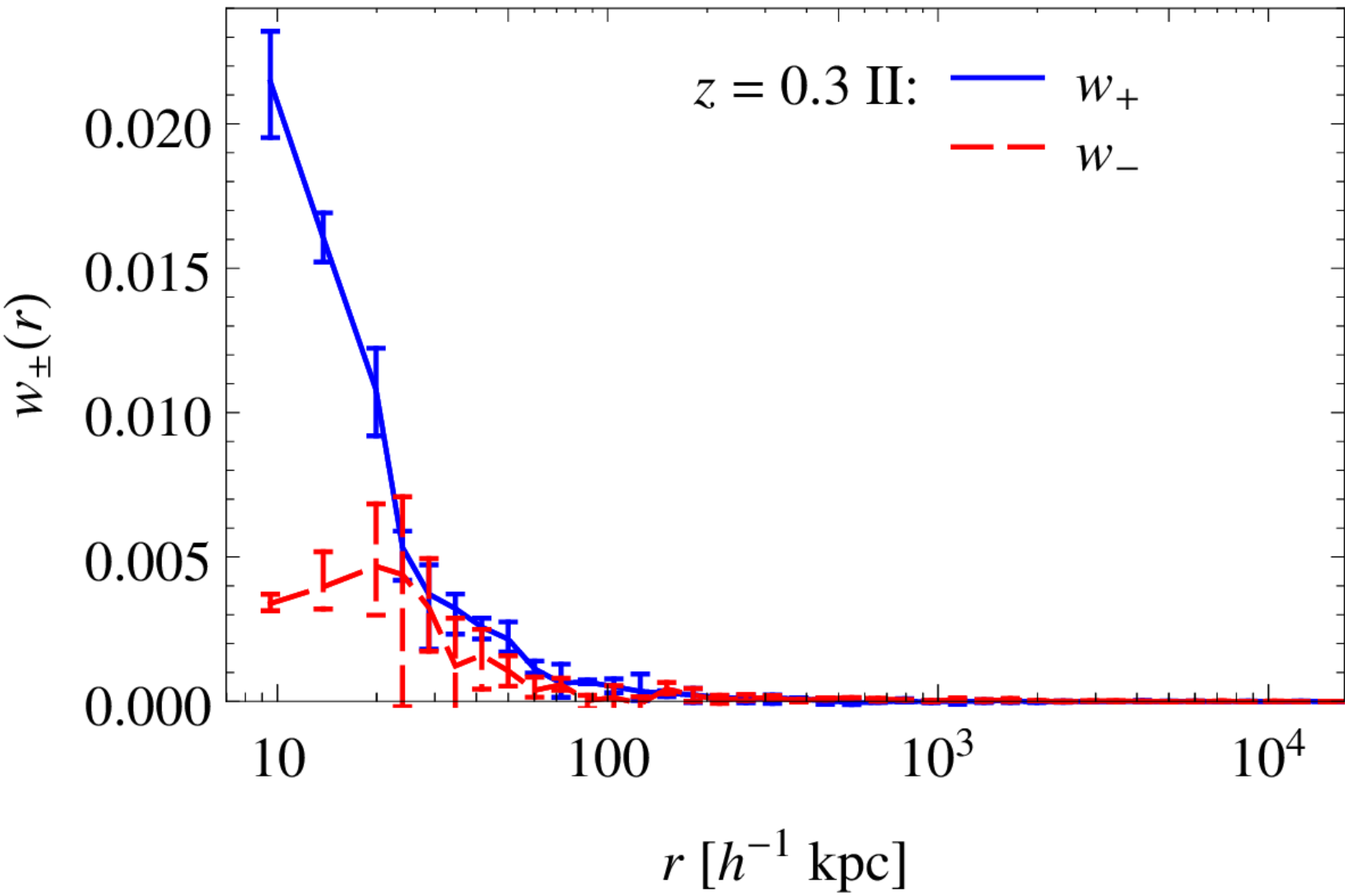
Illustris: Galaxy Sizes



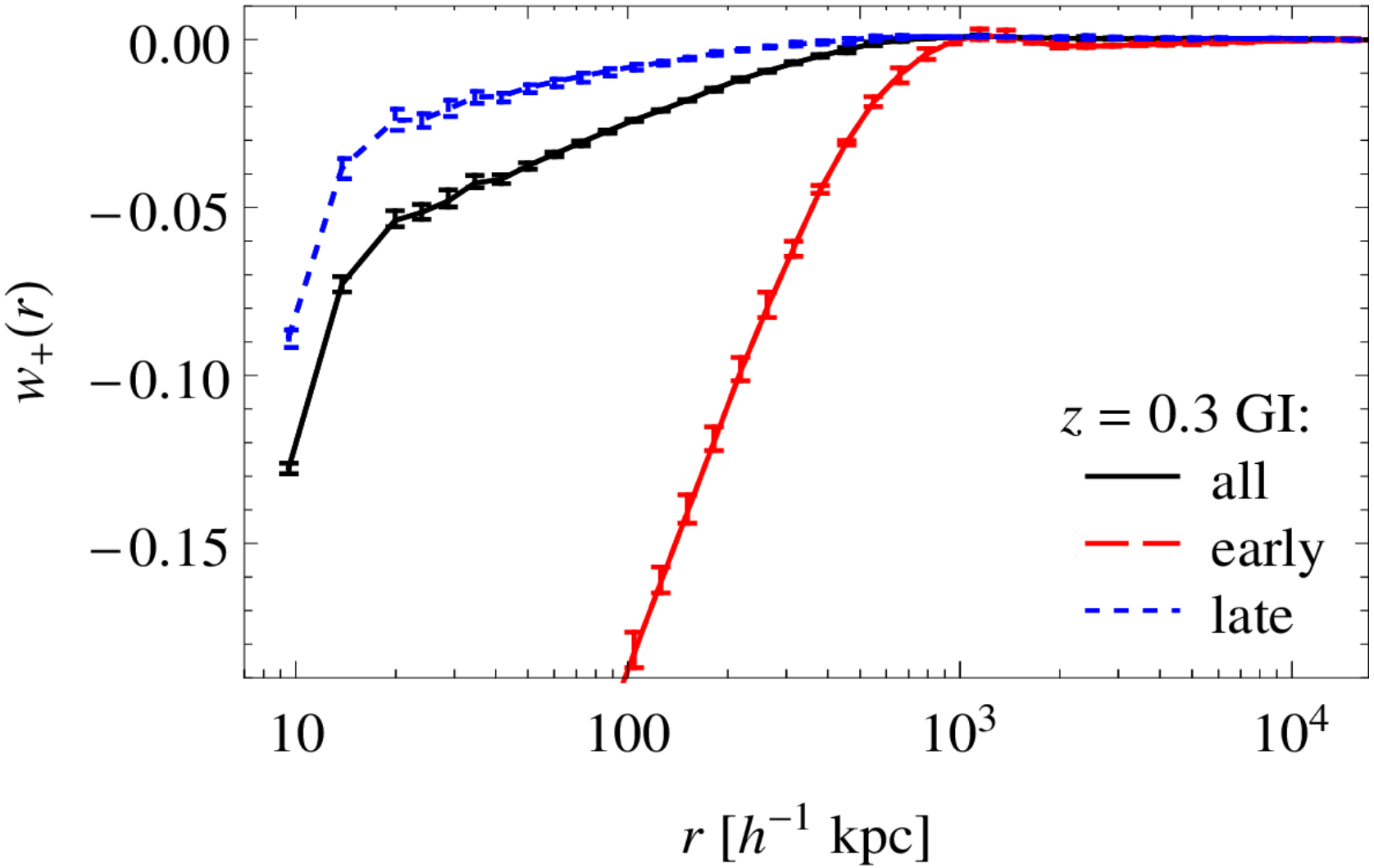
Illustris: Galaxy Ellipticities



Illustris: Intrinsic Alignment: II



Illustris: Intrinsic Alignment: GI



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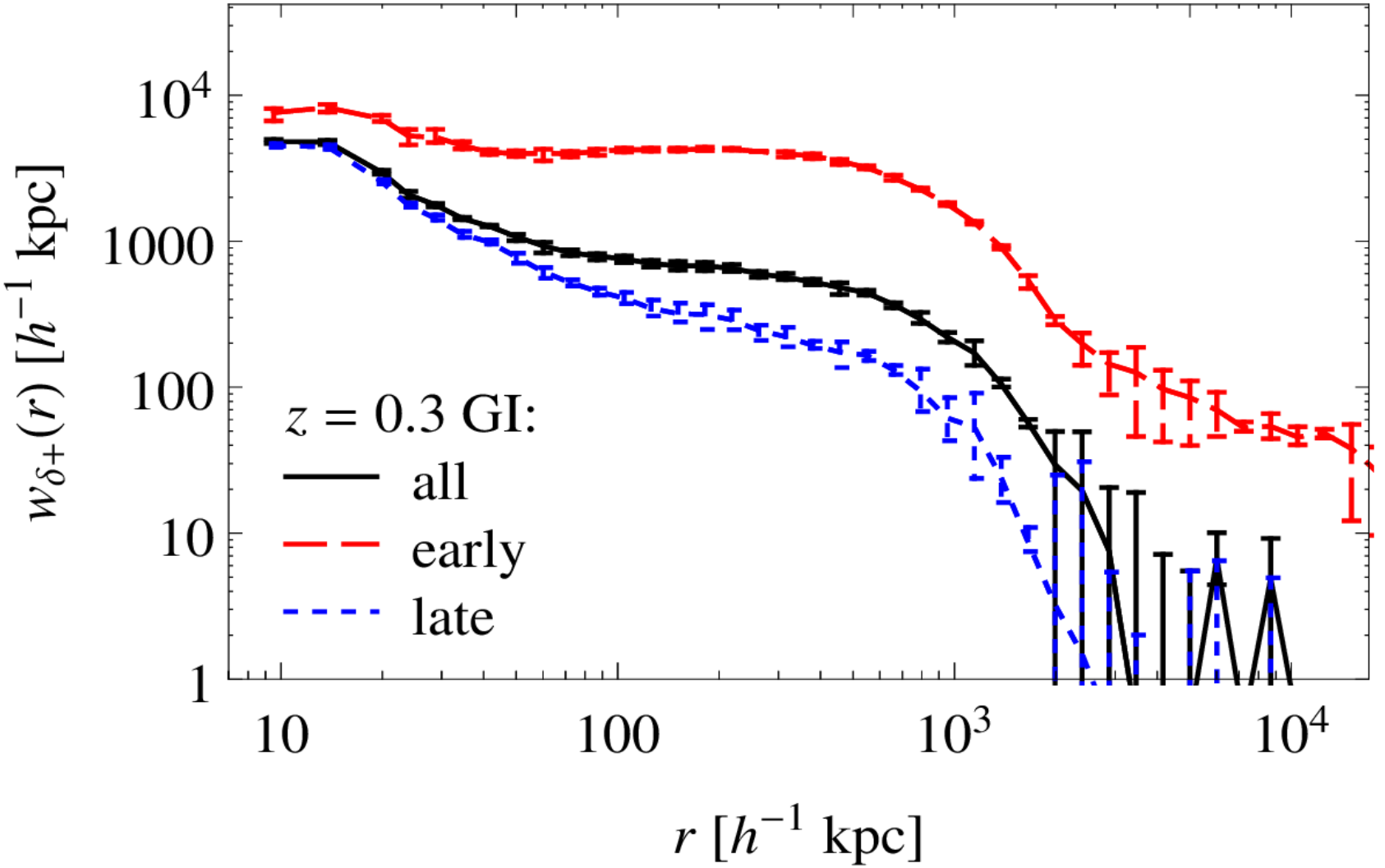
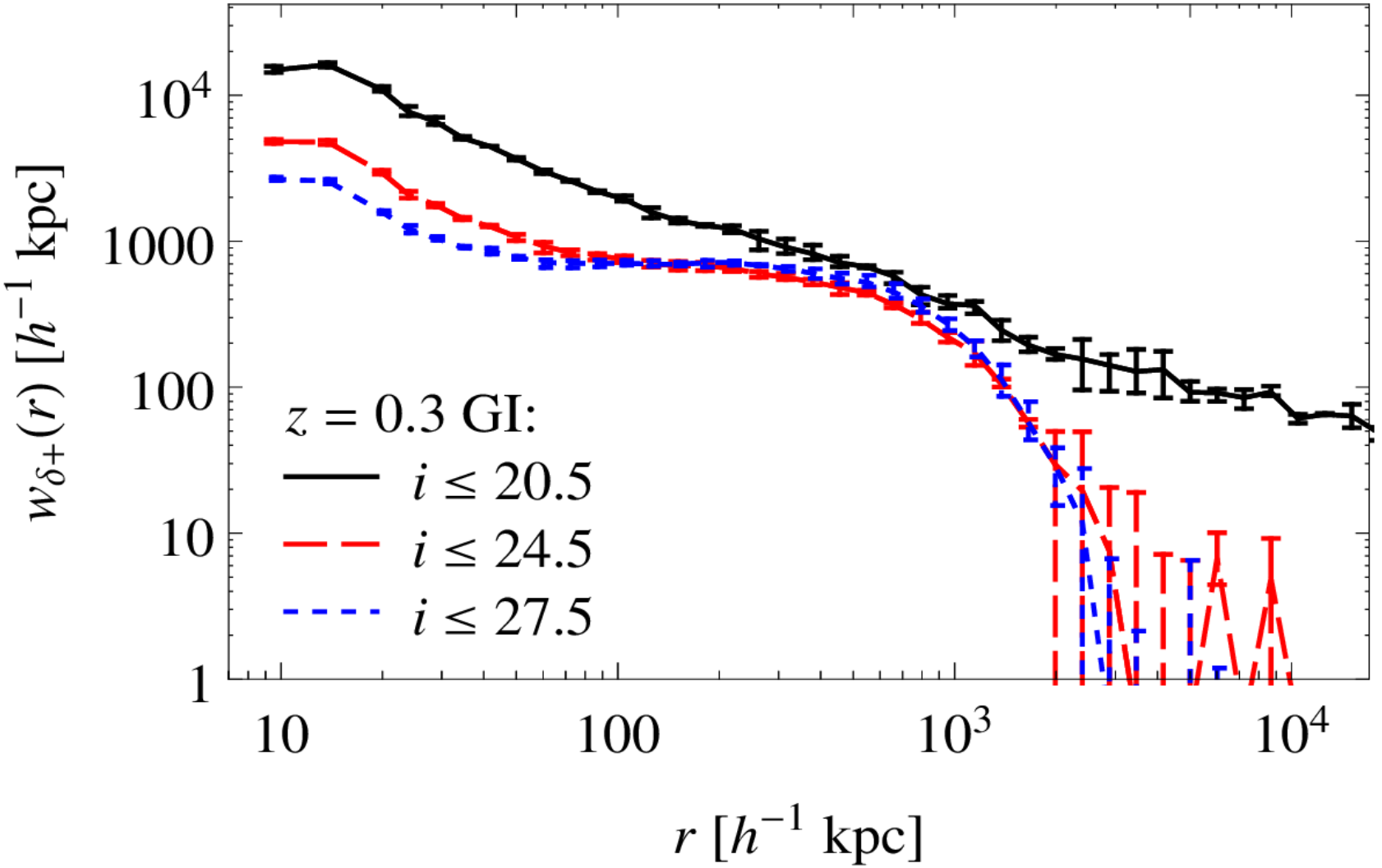
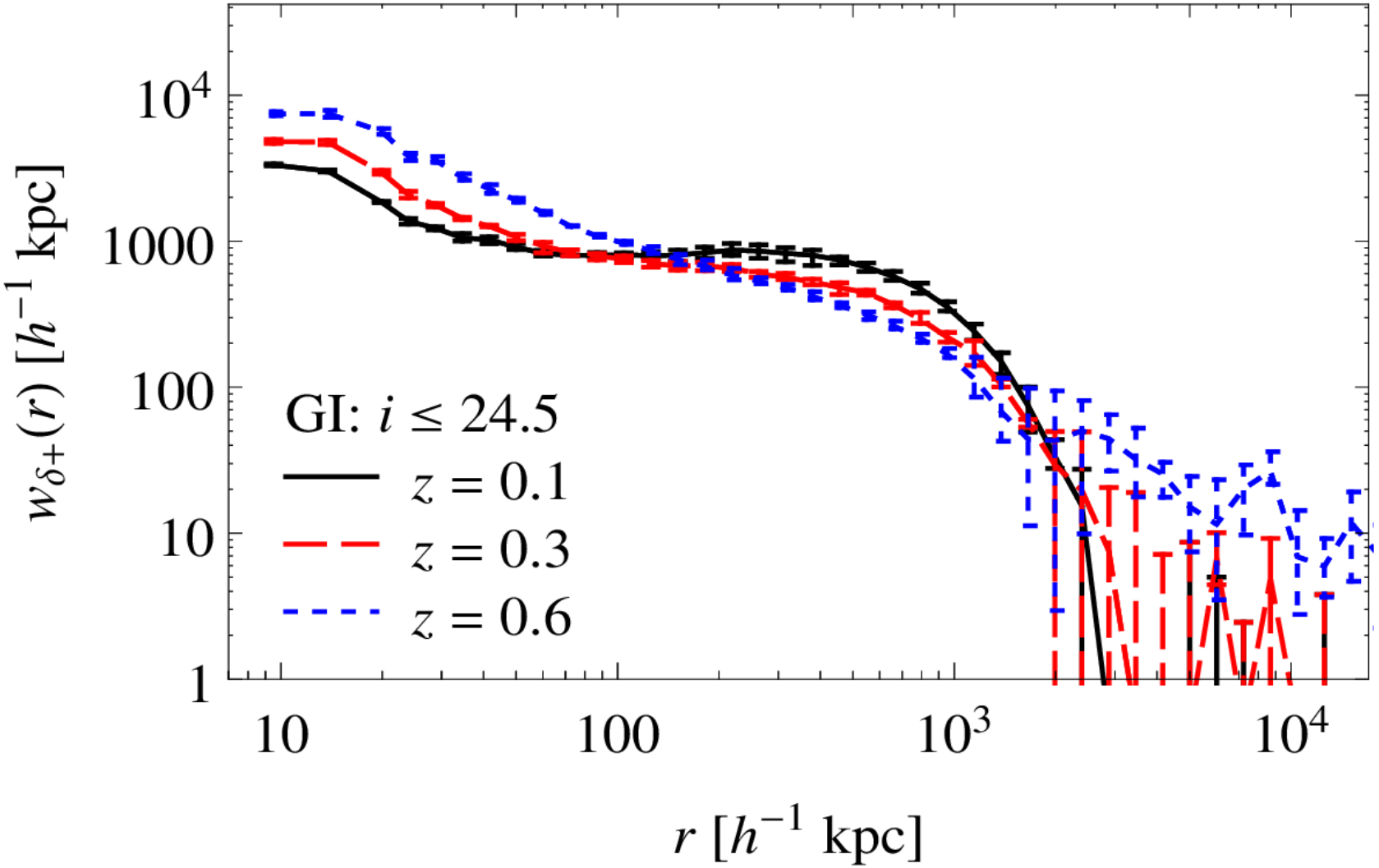


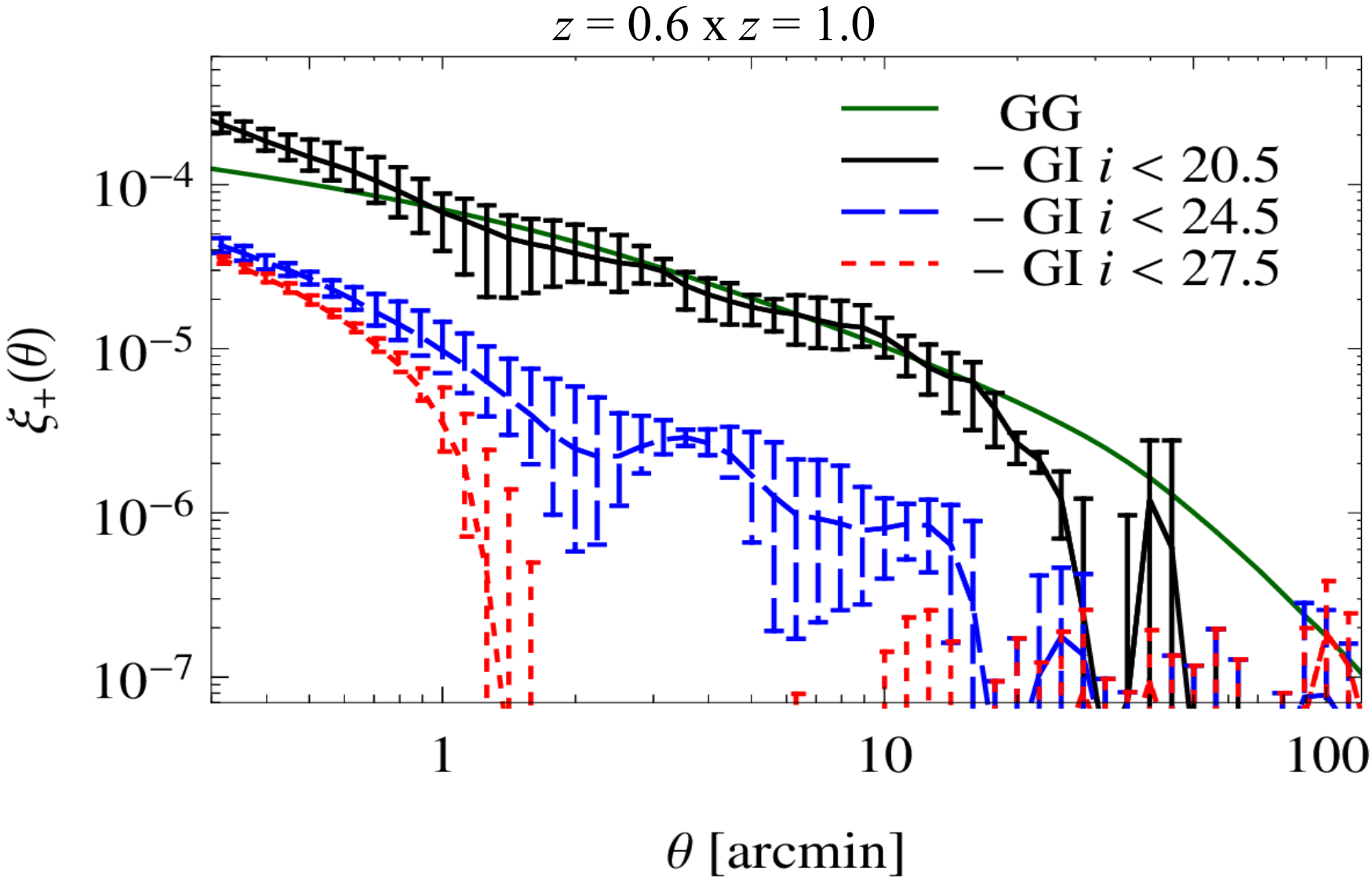
Illustris: Intrinsic Alignment: GI



Illustris: Intrinsic Alignment: GI



Illustris: Intrinsic Alignment: GI



Summary

- interpreting weak lensing surveys:
  - DES, KiDS, etc. need error on prediction < few %
  - Euclid, LSST need < 1%
- impact of baryon physics:
  - $\leq$ 20% on matter correlations & cosmic shear corr.
  - sign & magnitude depend on scale and redshift
- intrinsic alignment of galaxies:
  - dep. on scale, redshift, galaxy properties
  - ~10% contamination for cosmic shear signal

Outlook

- to do:
  - alignment model parameters
  - test more physical alingment models (3D)
  - more/better simulations to constrain impact of baryon physics on matter distribution and intrinsic alignment
  - better (semi)analytic models
  - ...

Thanks
for
Your Attention!