Time Evolution of Galaxy Intrinsic Alignments

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Weak Lensing in Cosmology

Denise Schmitz -- KICP Workshop

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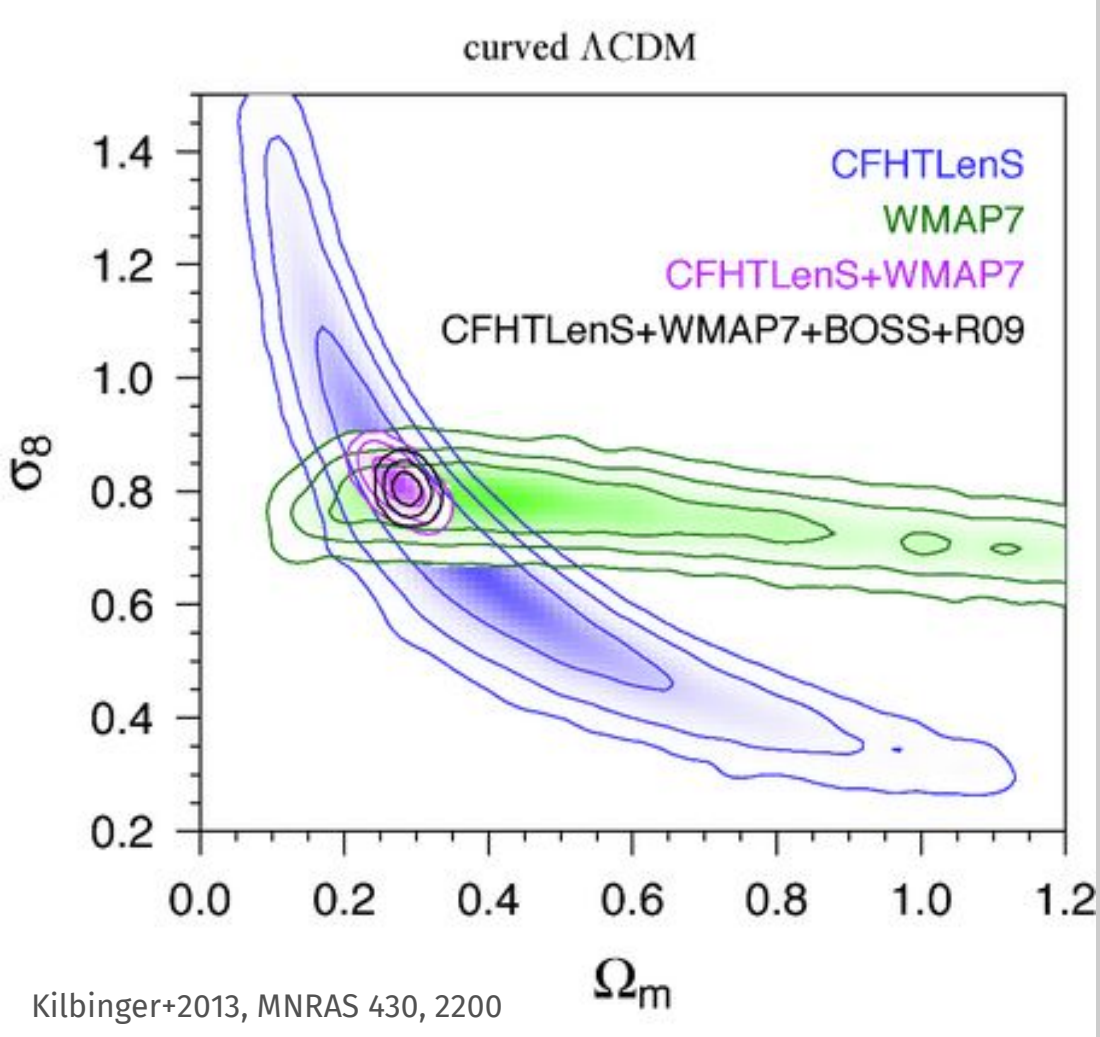
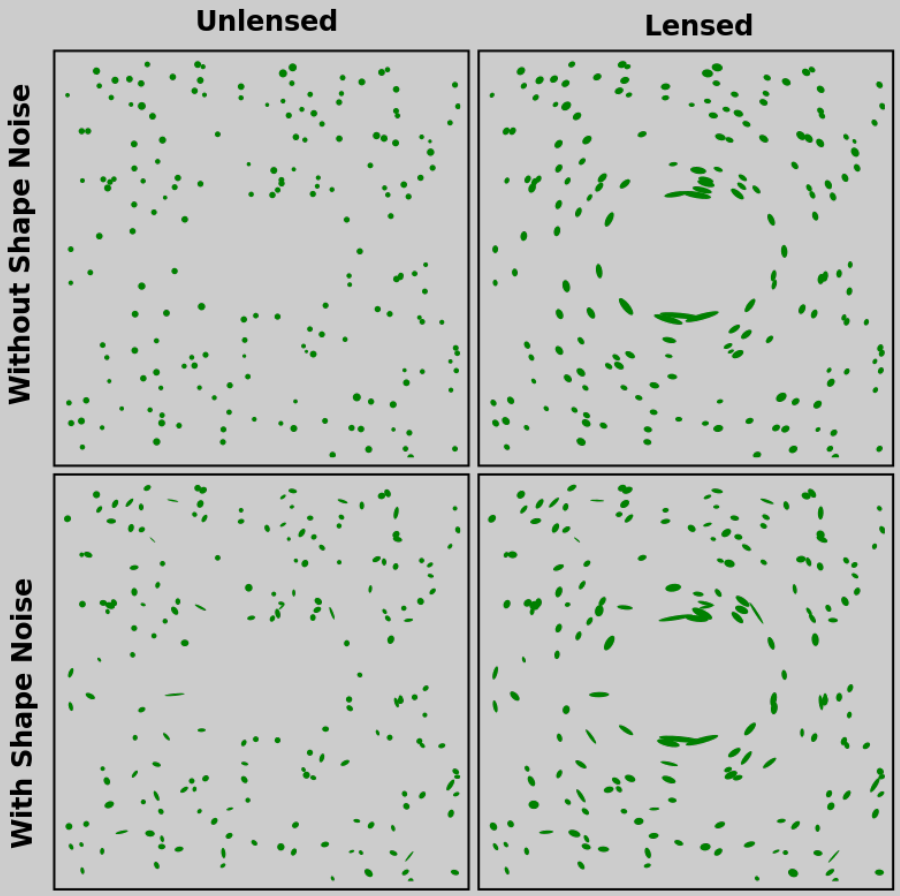
  - In era of precision cosmology, WL is an important technique for studying large-scale structure
  - Used in conjunction with CMB, galaxy clustering, etc. to constrain cosmological parameters

Weak Lensing in Cosmology



Kilbinger+2013, MNRAS 430, 2200

Weak Lensing is Hard



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- One of the major sources of error in WL is the “actual” (unlensed) shapes of galaxies
  - Random component: shape noise
  - Correlated component: **intrinsic alignments**
- Shape noise can be dealt with by using large samples for better statistics
- Intrinsic alignments, in contrast, are systematic

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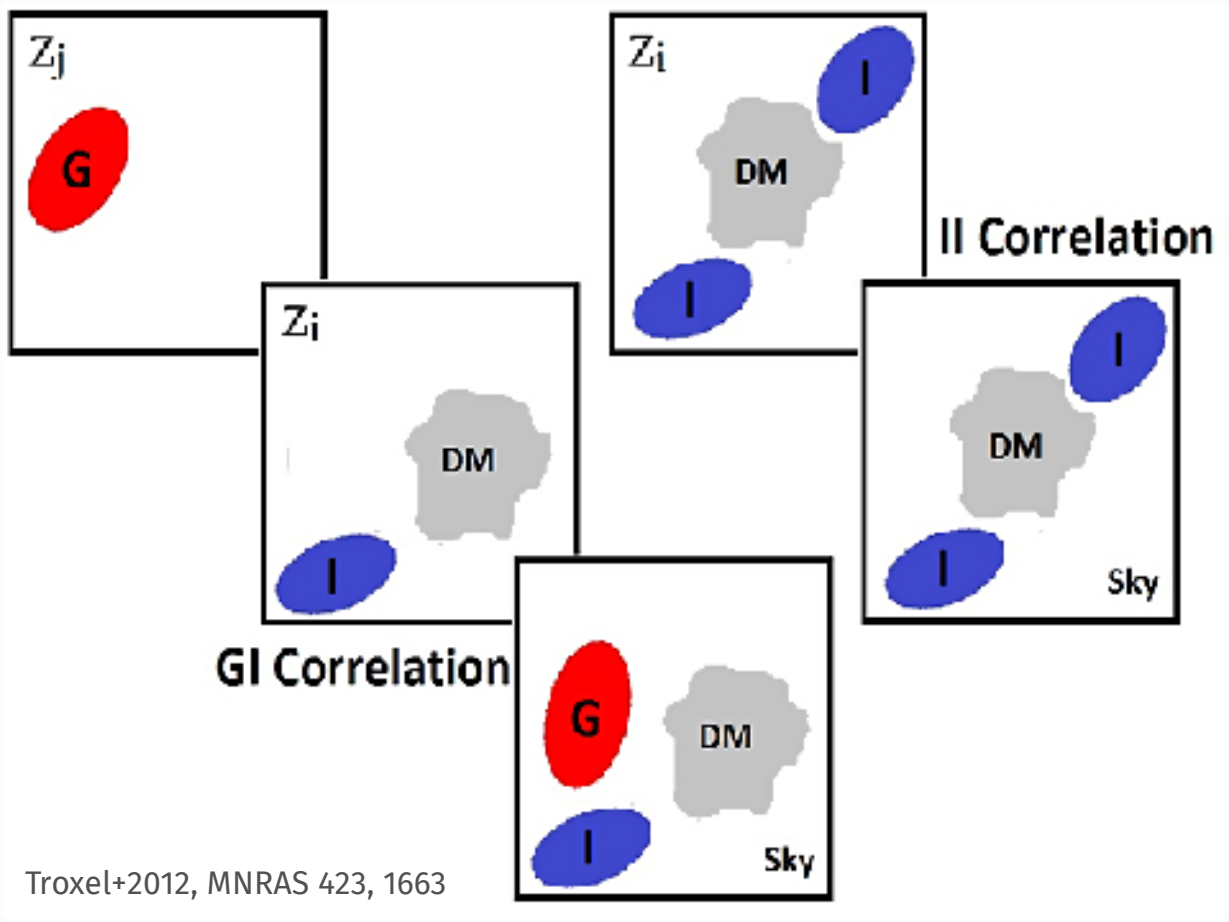

Troxel+2012, MNRAS 423, 1663

Intrinsic Alignments

- Theory relies on models of galaxy formation: how do galaxies acquire alignments?
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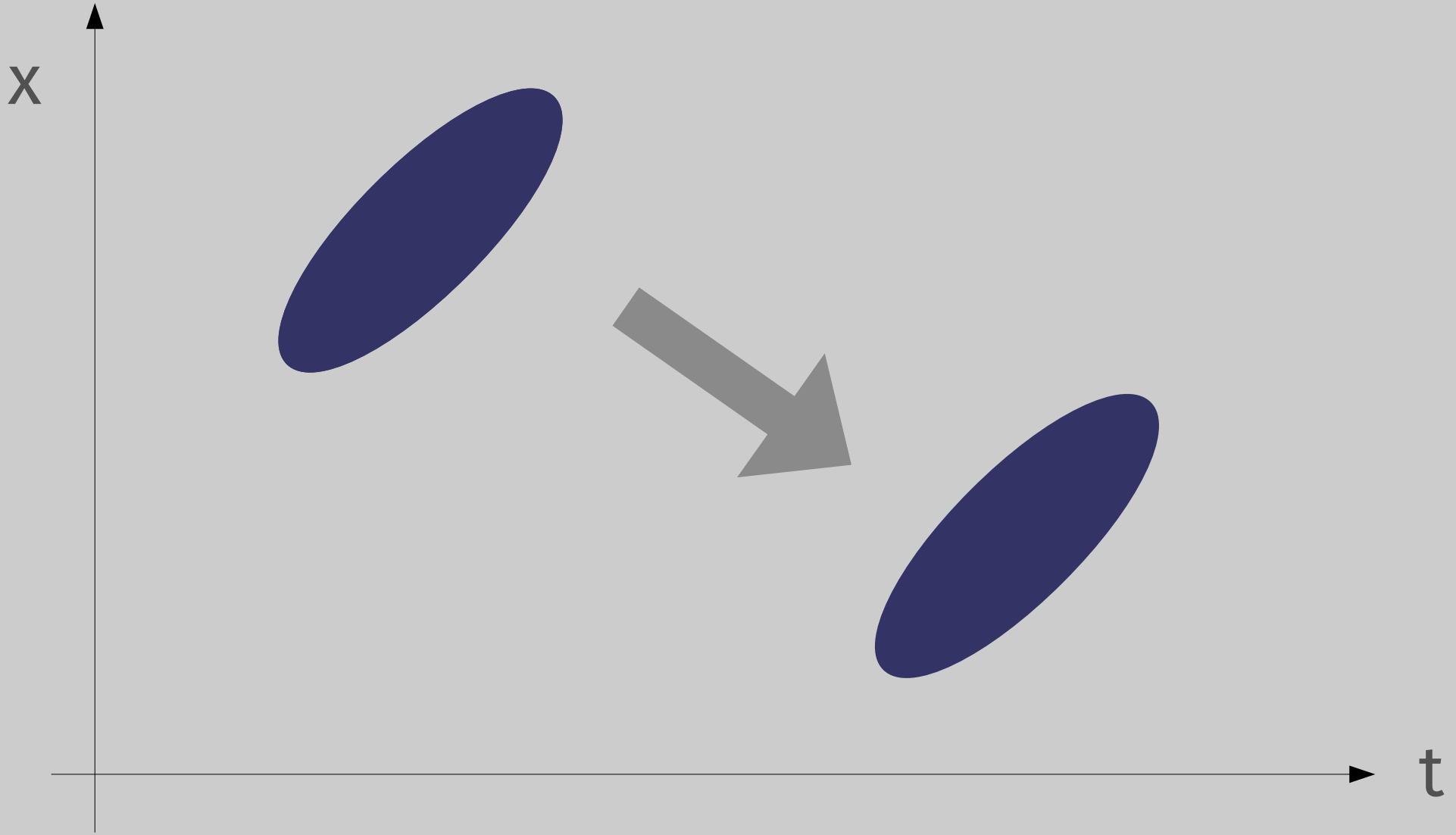
  - An untapped window onto galaxy formation!
- One aspect not previously studied: **time evolution**

Time Evolution of IA



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- Consequences:
  - Density, tidal field at final t are different from tidal field at initial t
    - Different “apparent” **dependence on LSS**
  - Galaxy positions change due to peculiar velocities
    - **Spatial correlations** are scrambled up

PT calculation

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- Perturbation theory dictates how these quantities depend on the linear matter density

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$$\begin{pmatrix} c_s(z_{\rm obs}) \\ c_{s\otimes s}(z_{\rm obs}) \\ c_{\delta s}(z_{\rm obs}) \\ c_t(z_{\rm obs}) \end{pmatrix} = \begin{pmatrix} T_{s,s} & 0 & 0 & 0 \\ T_{s\otimes s,s} & T_{s\otimes s,s\otimes s} & 0 & 0 \\ T_{\delta s,s} & 0 & T_{\delta s,\delta s} & 0 \\ T_{t,s} & 0 & 0 & T_{t,t} \end{pmatrix} \begin{pmatrix} c_s(z_{\rm form}) \\ c_{s\otimes s}(z_{\rm form}) \\ c_{\delta s}(z_{\rm form}) \\ c_t(z_{\rm form}) \end{pmatrix}$$

More math

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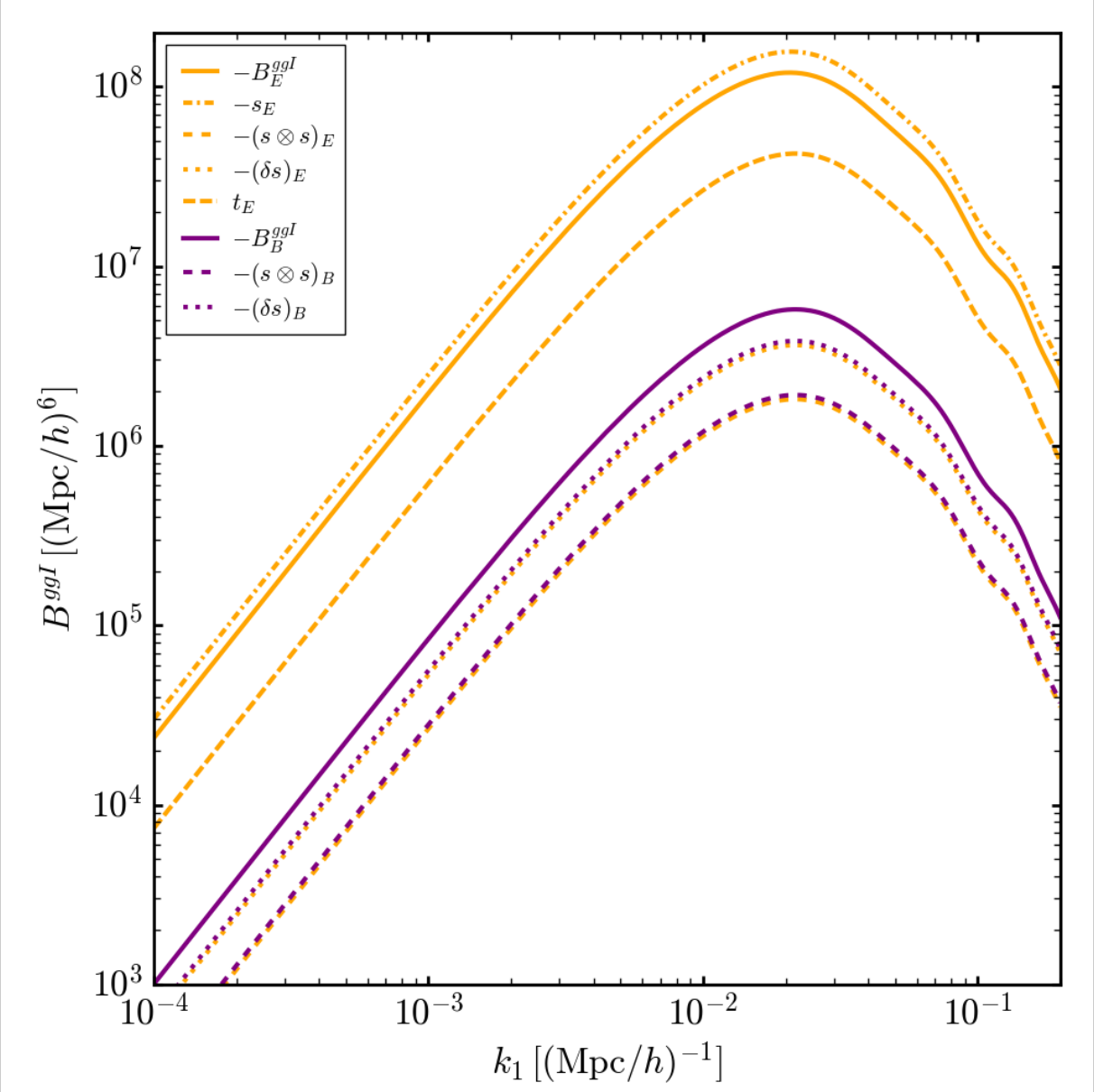
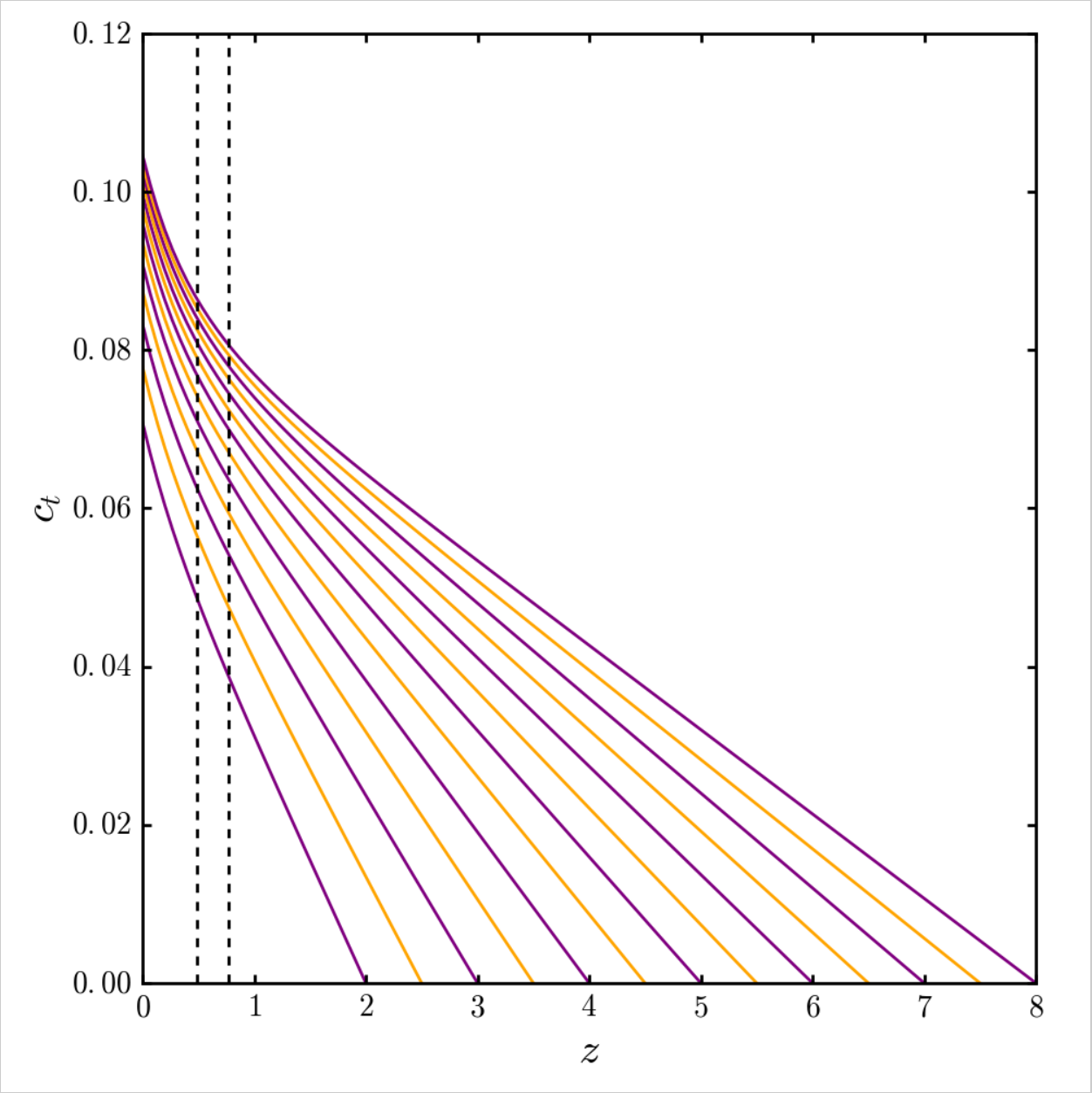
...and **calculate the matrix elements** in terms of redshifts and cosmological parameters

Forecasts


$-B_E^{ggI}$
$-s_E$
$-(s \otimes s)_E$
$-(\delta s)_E$
t_E
$-B_B^{ggI}$
$-(s \otimes s)_B$
$-(\delta s)_B$
$B^{ggI}\,[(\mathrm{Mpc}/h)^6]$
$k_1\,[(\mathrm{Mpc}/h)^{-1}]$
10^8
10^7
10^6
10^5
10^4
10^3
10^{-4}
10^{-3}
10^{-2}
10^{-1}

More interesting forecasts!



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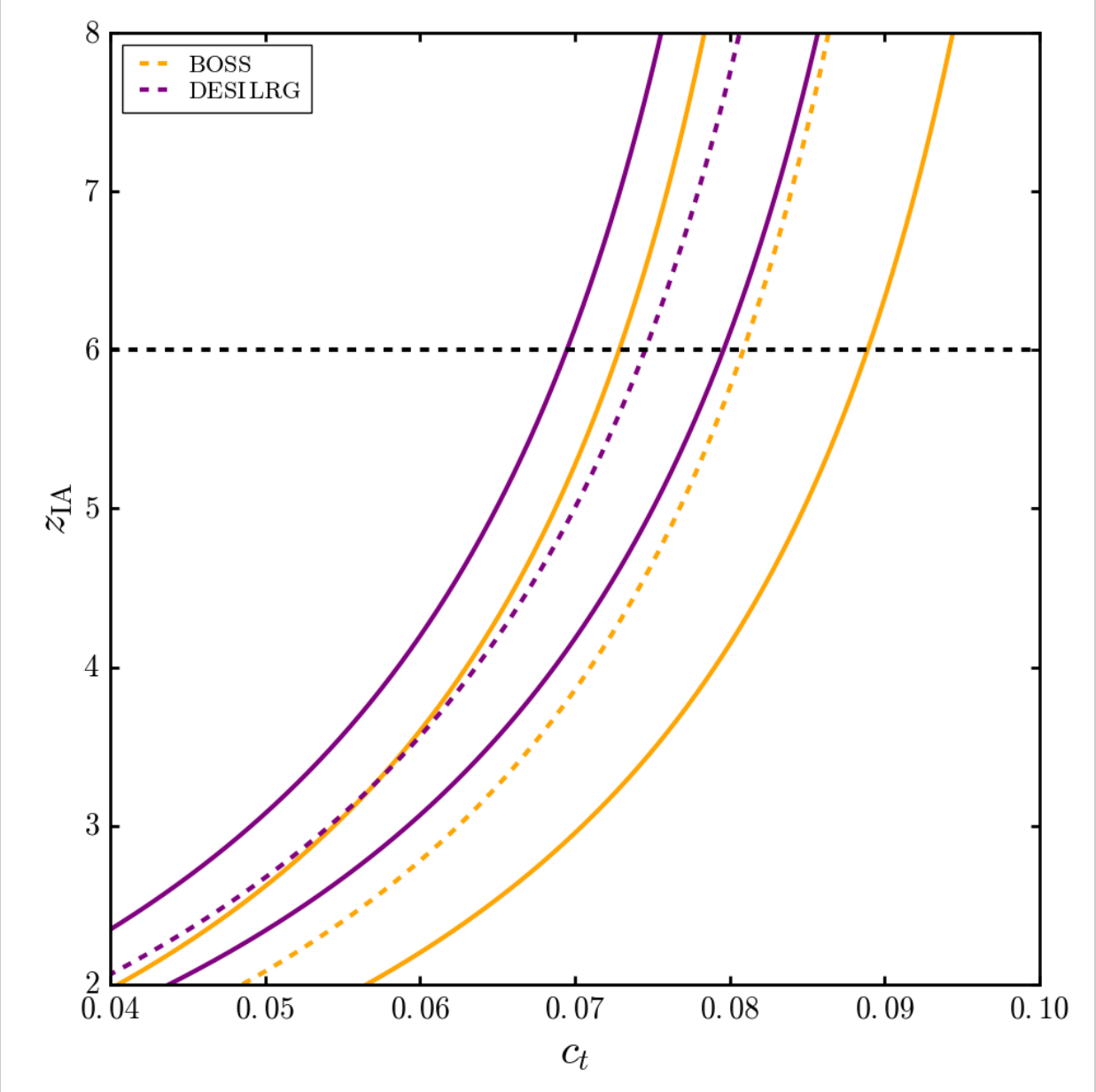

The punchline

- Intrinsic alignments will give us a new window onto the **effects of environment on galaxy formation**
- Ongoing and upcoming surveys should give interesting constraints!

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