ISW-Galaxy Correlation in Braneworld Acceleration Models

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Contents

- Best Model fit to current datasets: 3yr WMAP+SN+KP+BAO
  - LCDM: flat, agreement with KP ----------> best fLCDM
  - sDGP: open, disagreement with KP --------> best ODGP
- ISW-Galaxy cross correlation test
  - KM ansatz *(Koyama and Marteens 05)* -->SSH ansatz *(Song, Sawicki and Hu 06)*
  - Measuring difference between fLCDM and ODGP
  - Targeting high redshift
- CMB temperature spectrum test at large scales
  - We show ODGP CMB temperature power spectra

Prologue

DGP: embed 4D brane on Minkowski bulk- *Dvali, Gabadaze and Porrati 00*

Gravity looks 4D at scales $< r_c$ $(=M_4^2/2M_5^3)$

Gravity looks 5D at scales $> r_c$

Cosmic acceleration found at self accelerating branch- *Deffayet 02*

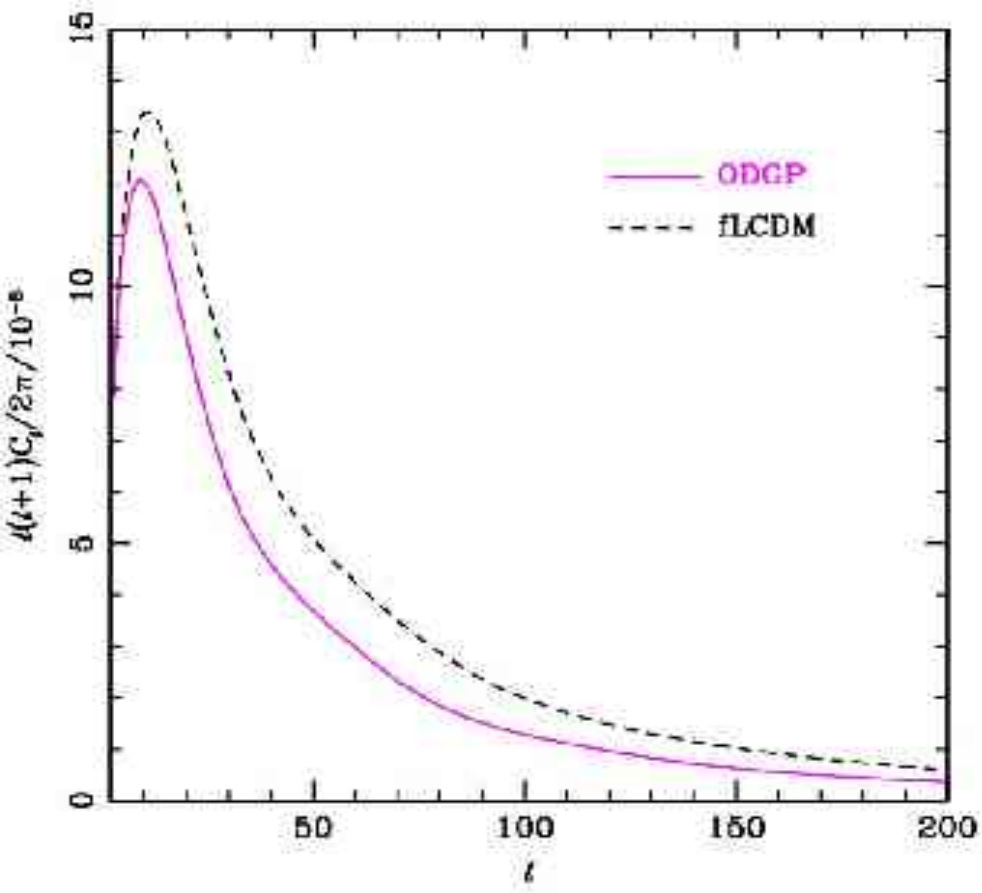
Geometrical test has been done- *Dvali and Tuner 02, Fairbairn and Goobar 05*

Small scales structure formation worked out- *Lue, Starkman and Soccimarro 04, Song 04, Sawicki and Carroll 05, Koyama and Marteens 05*

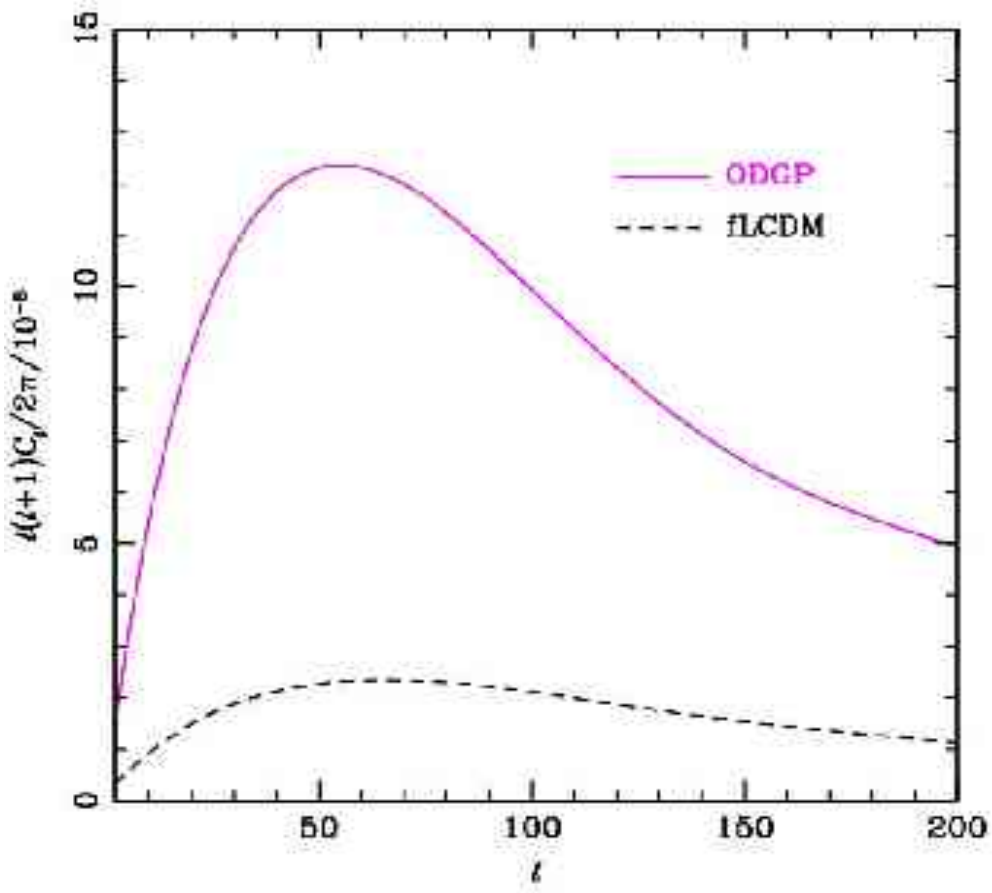
Phenomenological study- *Song 04, Ishak, Upadhye and Spergal 05, Knox, Song and Tyson 05, Linder 05, Schimid, Uzan and Riazuero 05, Stabenau and Jain 06, Zhang 06*

Prologue

Low redshift

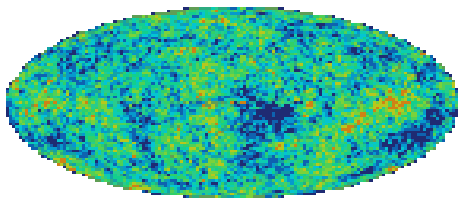


High redshift



Current constraints

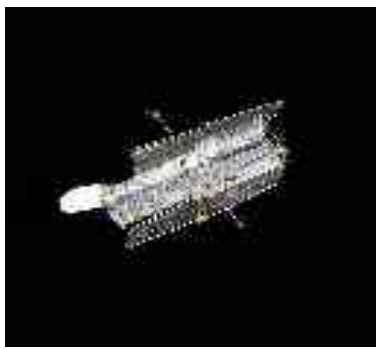
3yr WMAP: w_m, w_b, D(r*), ...



SNLS: cosmic acceleration

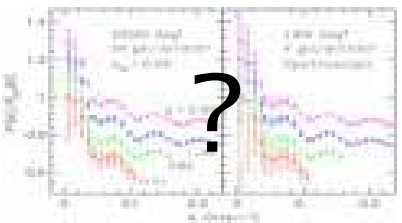
sDGP

Hubble key project: filtering models with h



Pressure

Baryon oscillation



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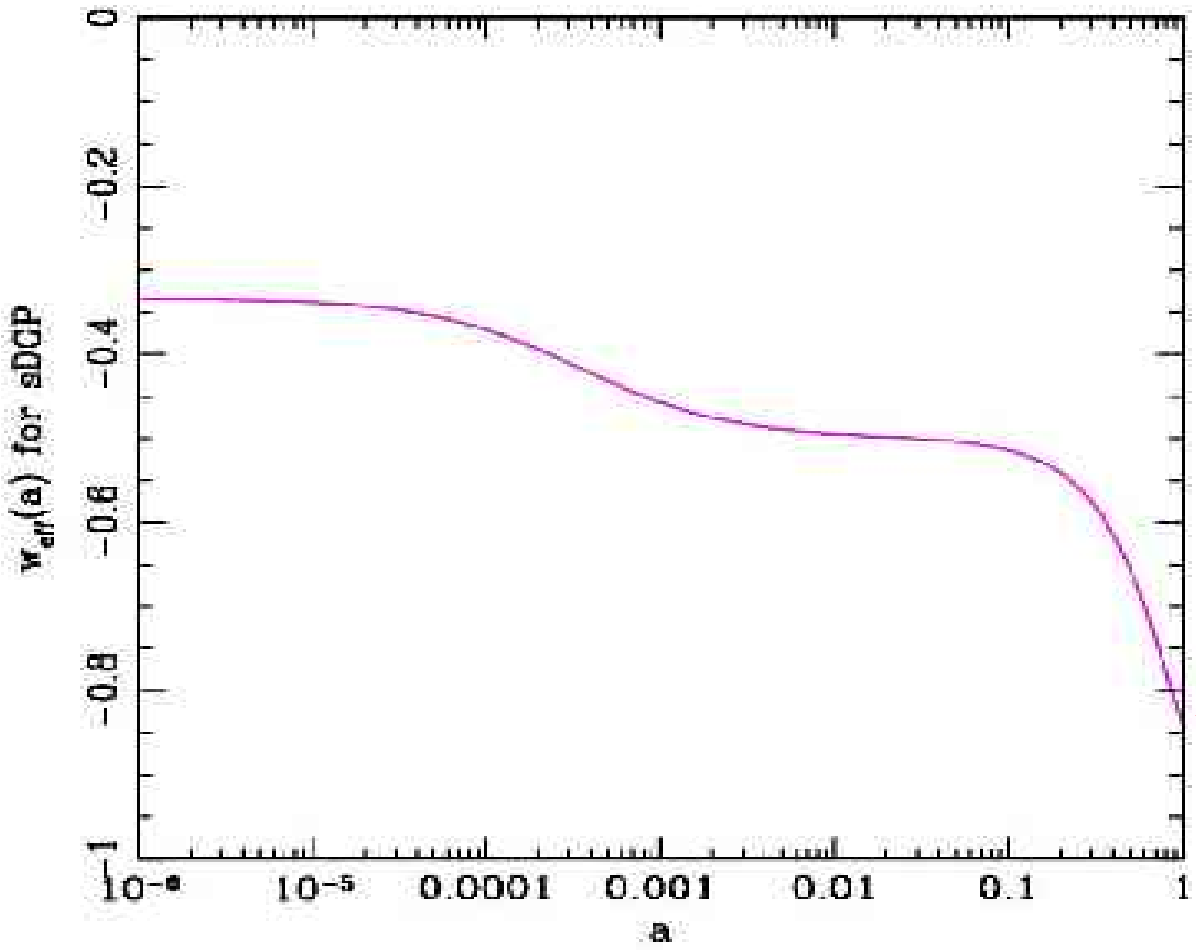
w(a) for sDGP

Best sDGP model is identical to QCDM with the following w(a)



w(a=0) ~ -0.8

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Pressure on sDGP due to high H_0

3yr WMAP constraints on $w_m = 0.127$

i.e. $\Omega_m h^2 = 0.127$

+

SN needs larger Ω_q than Ω_v

if $w_{eff} > -1$

$\Omega_m \downarrow \quad H_0 \uparrow$

Higher H_0 put sDGP under the pressure

with current constraints

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Pressure on sDGP due to high H_0

$\Delta\chi^2$(sDGP-fLCDM)

$\Omega_m = 0.15$

$H_0 = 90$

No KP

$\Delta\chi^2 = -0.2$

Pressure on sDGP due to high H_0

$\Delta\chi^2$(sDGP-fLCDM)

$\Omega_m = 0.18$

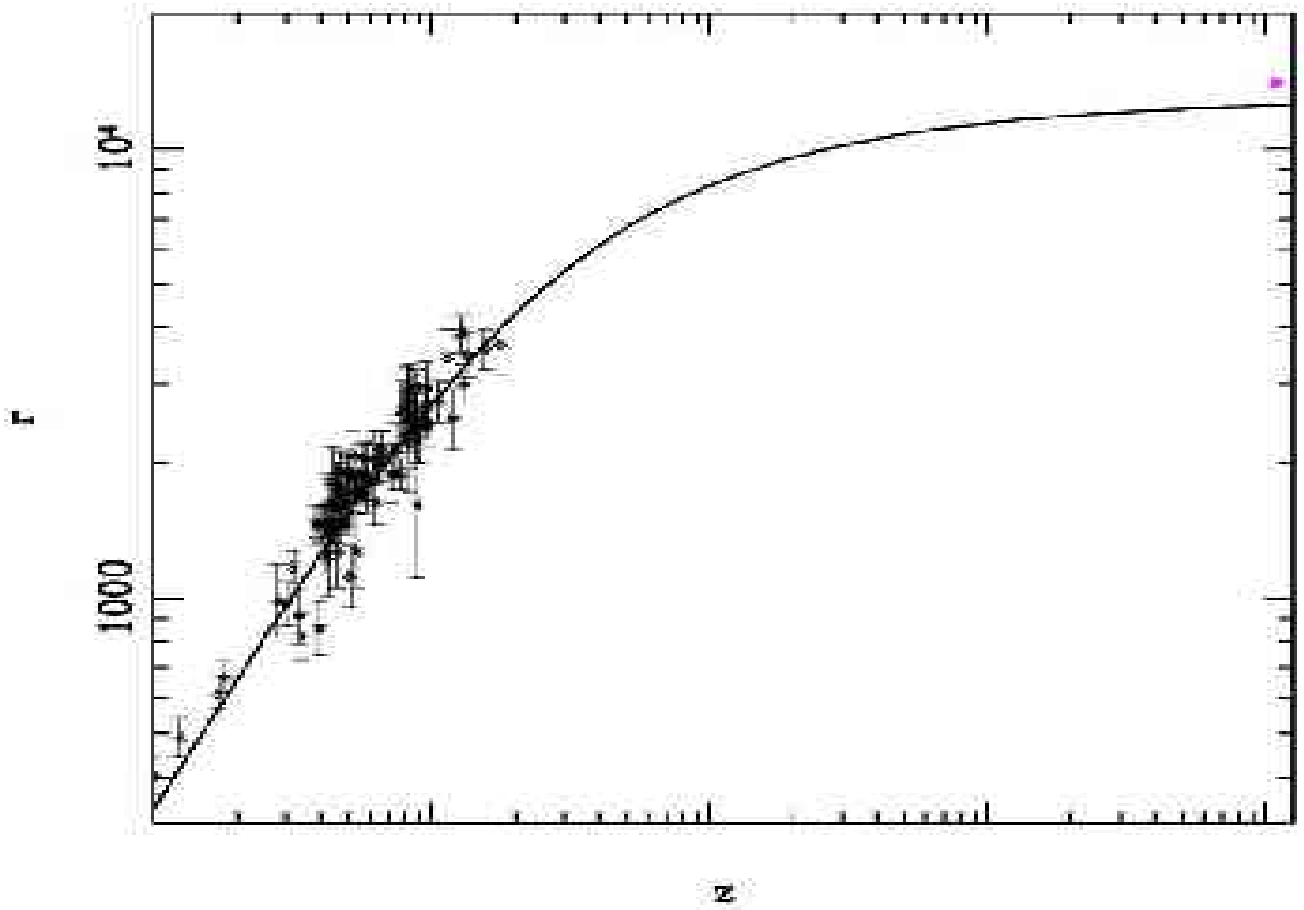
$H_0 = 82$

+ KP

$H_0 = 0.72 \pm 0.8$

$\Delta\chi^2 = 2.5$

Curvature for sDGP



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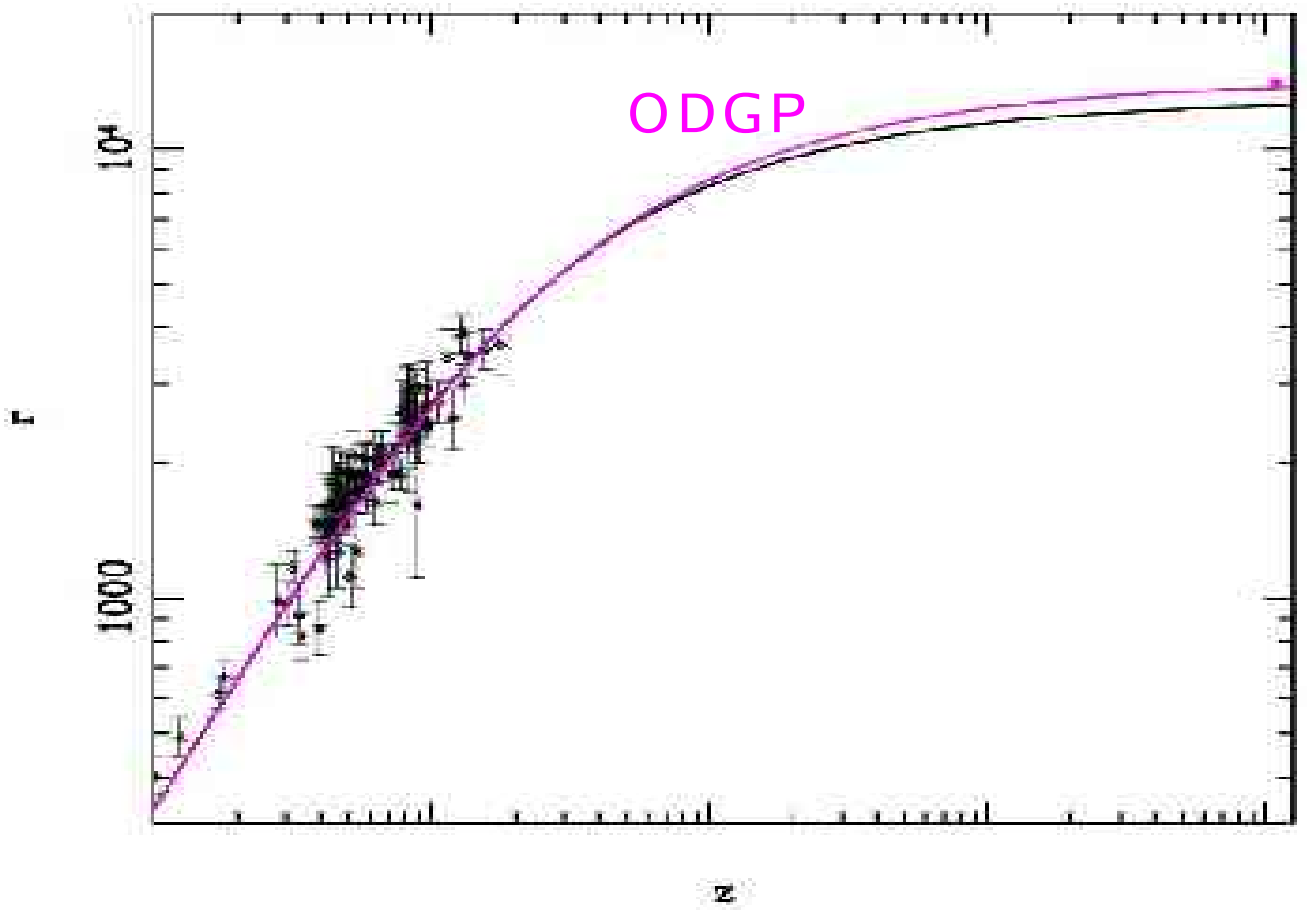
Curvature for sDGP

Open curvature is requested to fit D(r*) measured by WMAP. Flat DGP is excluded by 3-σ level



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History of DGP structure formation solution

1) Lue, Starkman and Soccimarro 04 (LSS): Spherical collapsing model leads to decaying Φ-Ψ which is coupled to photon. No modification on Φ-Ψ. The extra decay comes from Ψ sourcing matter perturbation. They found Φ-$\Psi \neq 0$ without understanding the nature of it.

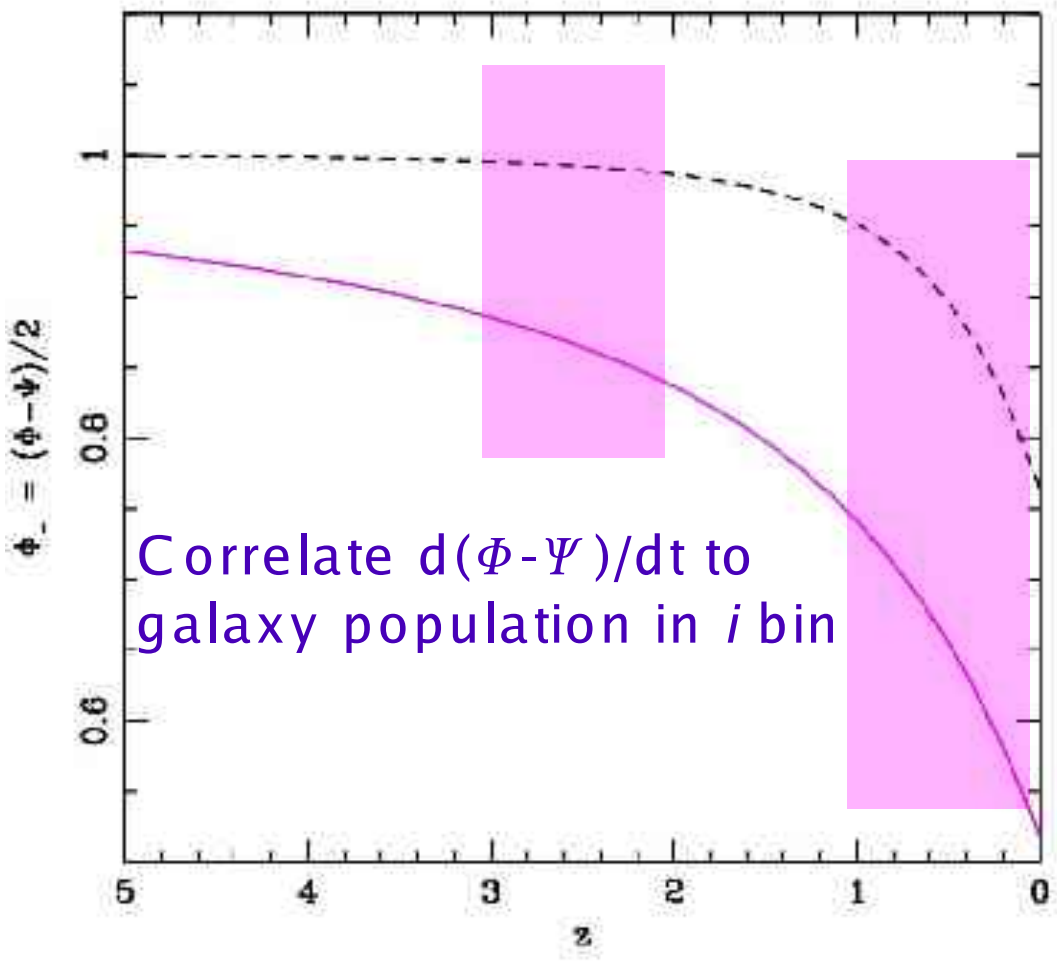
2) Song 04, Carroll and Sawicki 05: Proposing an alternative approach by using Gaussian Normal gauge with negligible Weyl fluid ansatz. ---> opposite sign of ISW-galaxy correlation.

3) Koyama and Marteens 05 (KM): With the same gauge choice with Song 04, but with another ansatz on Weyl anisotropy stress, KM reconfirm LSS. It works fine just on the small scales.

4) Sawicki, Song and Hu 06 (SSH-to be published next week): Extending KM at larger scales to apply DGP for ISW scales.

ISW-galaxy correlation with KM solution

Request on the tomographic ISW view on the potential Φ_- by using ISW-galaxy cross correlation



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Test KM ansatz at ISW-galaxy scales-matter

Constraint eq. From Einstein eq.

$$k^2 \Phi = a^2 \frac{\mu^2 \rho_m}{3} \left(\frac{2 H r_c}{2 H r_c - 1} \Delta_m + \frac{1}{2 H r_c - 1} \Delta_E \right)$$

Conservation on matter components

$$\dot{\Delta}_m = \left(\frac{k^2}{a^2} - 3 \dot{H} + \frac{3 \mu^2 \rho_m 2 H r_c}{2 H r_c - 1} \right) q_m - \frac{2 \mu^2 \rho_m / 3}{2 H r_c - 1} q_E$$

$$\dot{q}_m = -\Psi$$

Test KM ansatz at ISW-galaxy scales-Weyl

Conservation on Weyl components

$$\dot{\delta}_E + H\,\delta_E - \frac{k^2}{a^2} q_E = 0$$

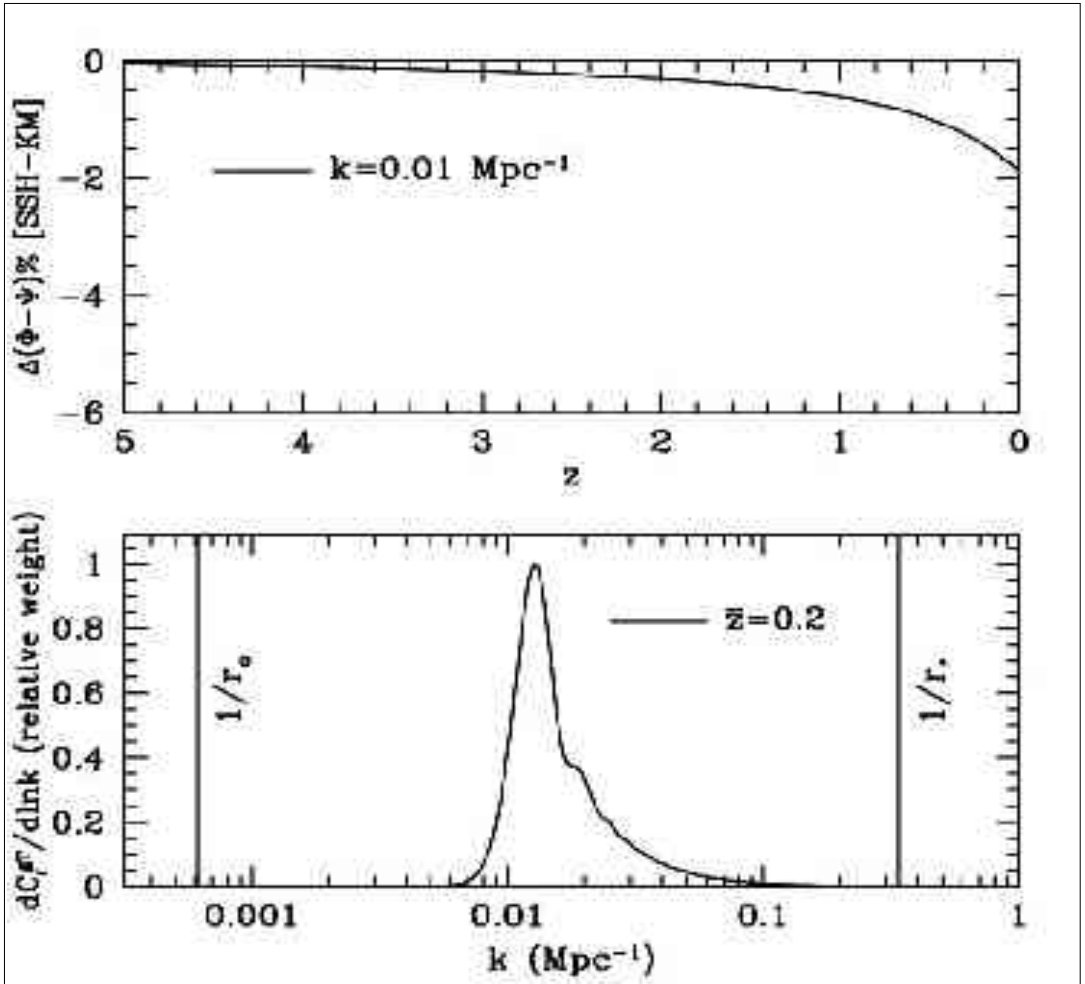
$$\dot{q}_E + \frac{1}{3}\delta_E - \frac{2}{9} k^2 \pi_E = S(\Delta_m, \Delta_E, \pi_E)$$

Correction on KM ansatz at ISW-galaxy scales

$$\mu^2 \rho_m \delta_E = -\frac{k^4}{3\,a^5}\,\Omega$$

$$\mu^2 \rho_m \pi_E = -\frac{1}{2\,a^3}\left(\ddot{\Omega} - 3\,H\,\dot{\Omega} + \frac{k^2}{a^2}\,\Omega - \frac{3\,\dot{H}}{H}\,\Omega'\right)$$

Corrections on KM solution at ISW-galaxy scales



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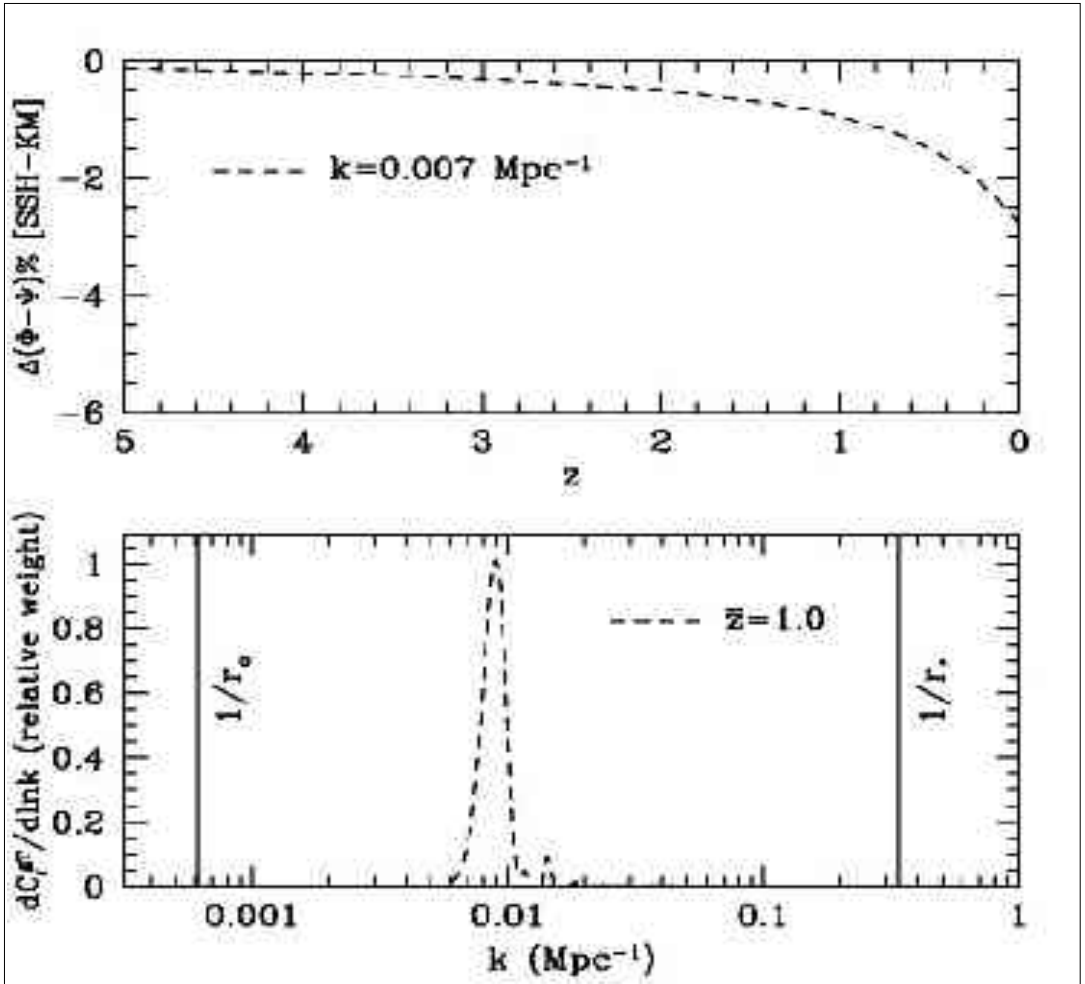
Corrections on KM solution at ISW-galaxy scales



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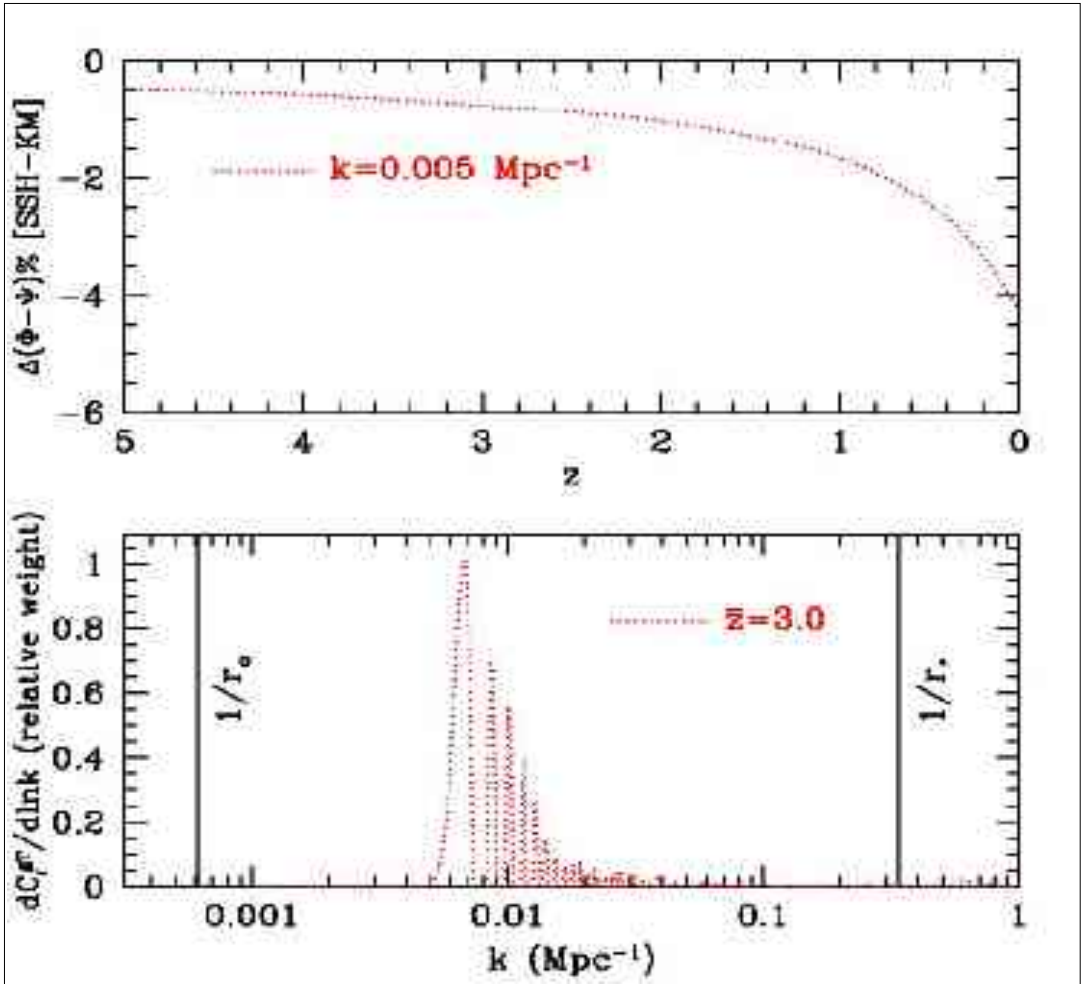
Corrections on KM solution at ISW-galaxy scales



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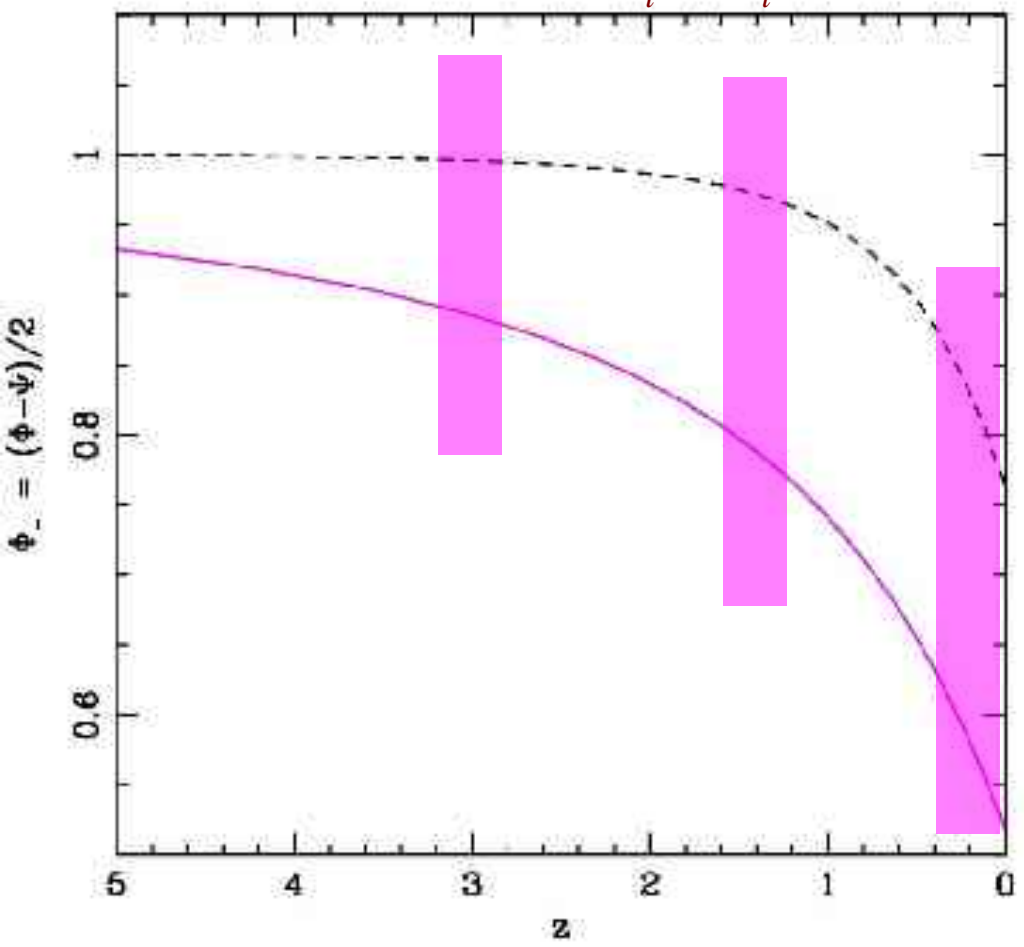
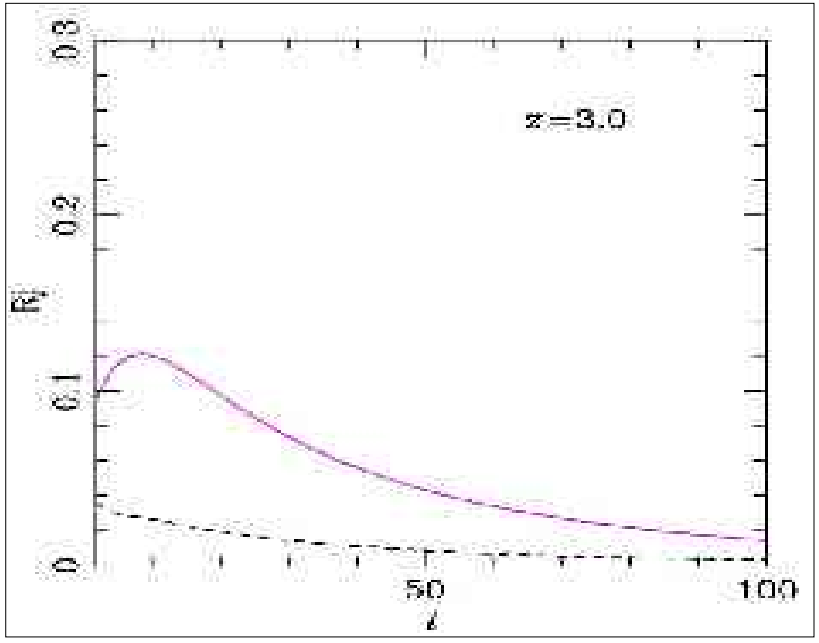
R-cross correlation coefficient

$$R_l^i = \frac{C_l^{g\,T}}{\sqrt{C_l^{T\,T}\, C_l^{g\,g}}}$$





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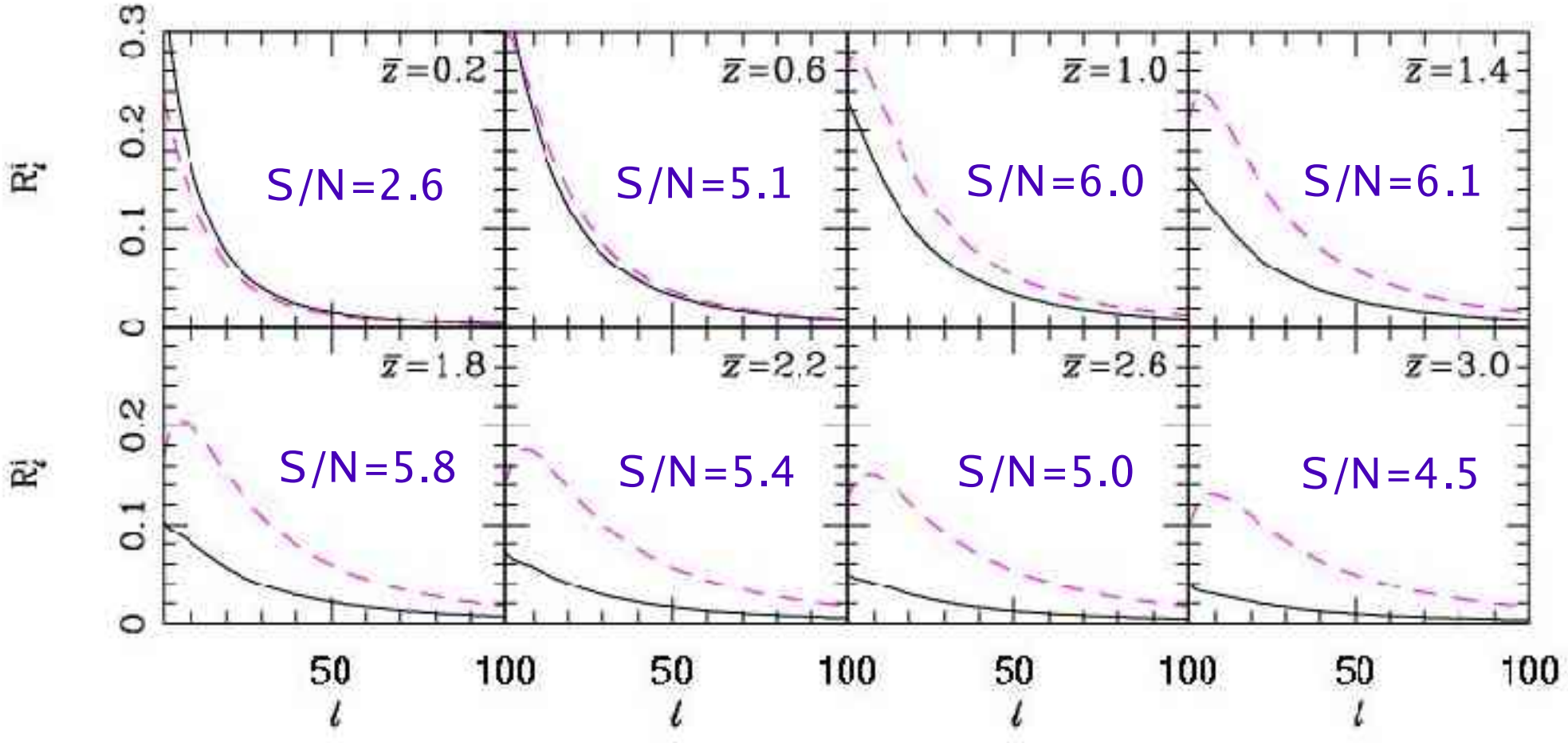
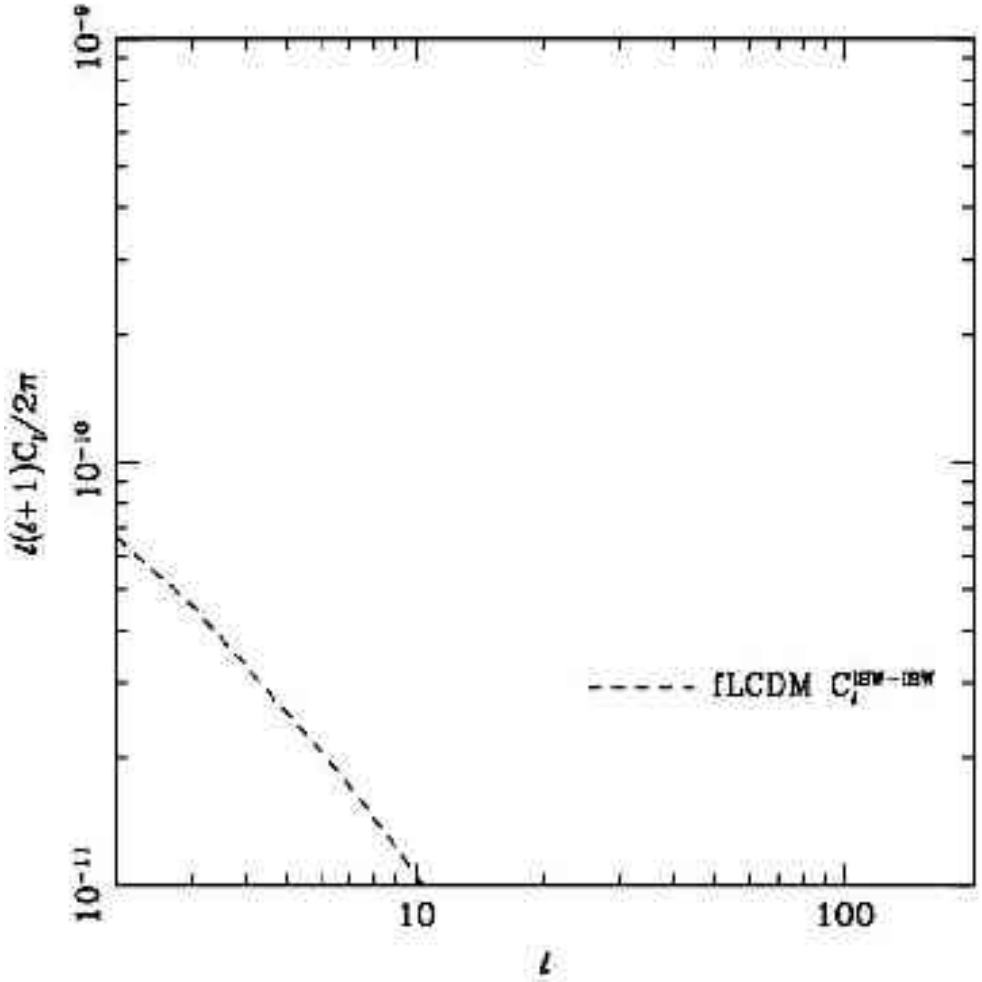
Signal to noise

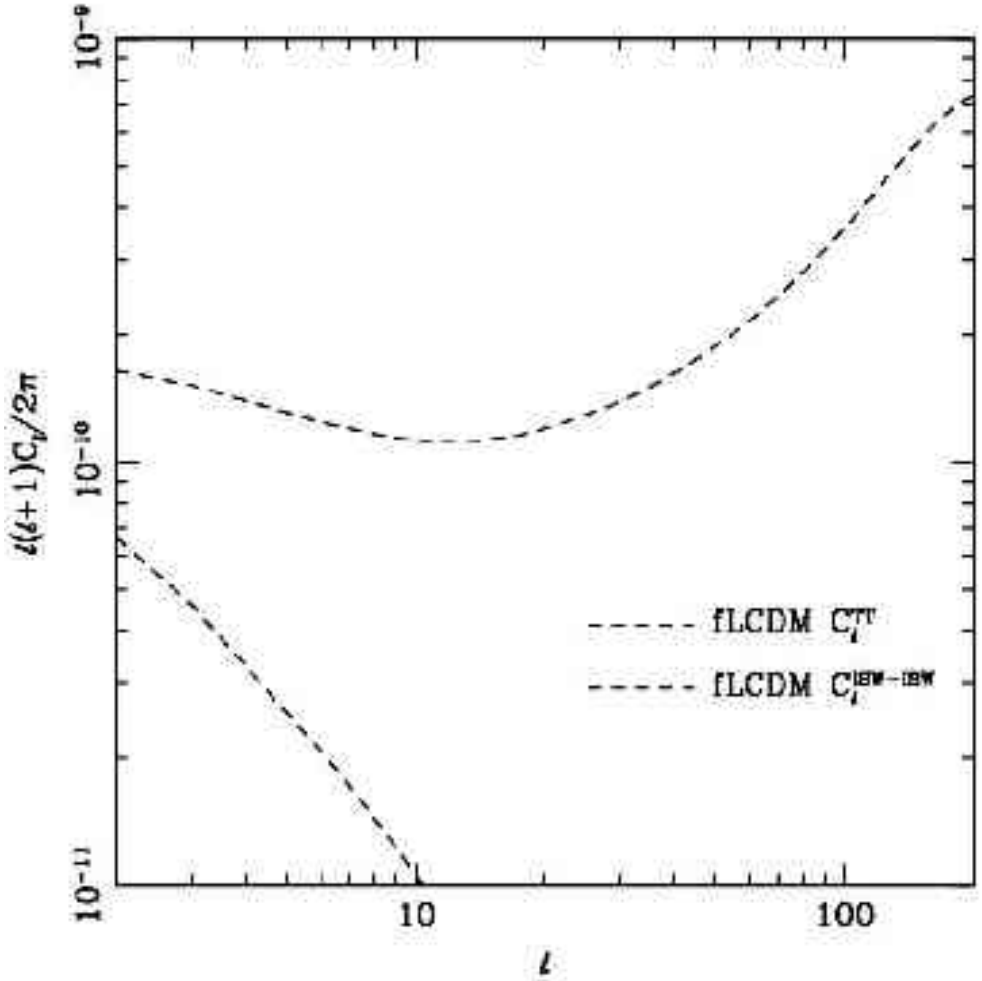
With $f_{sky}=1$



CMB temperature power spectra



CMB temperature power spectra



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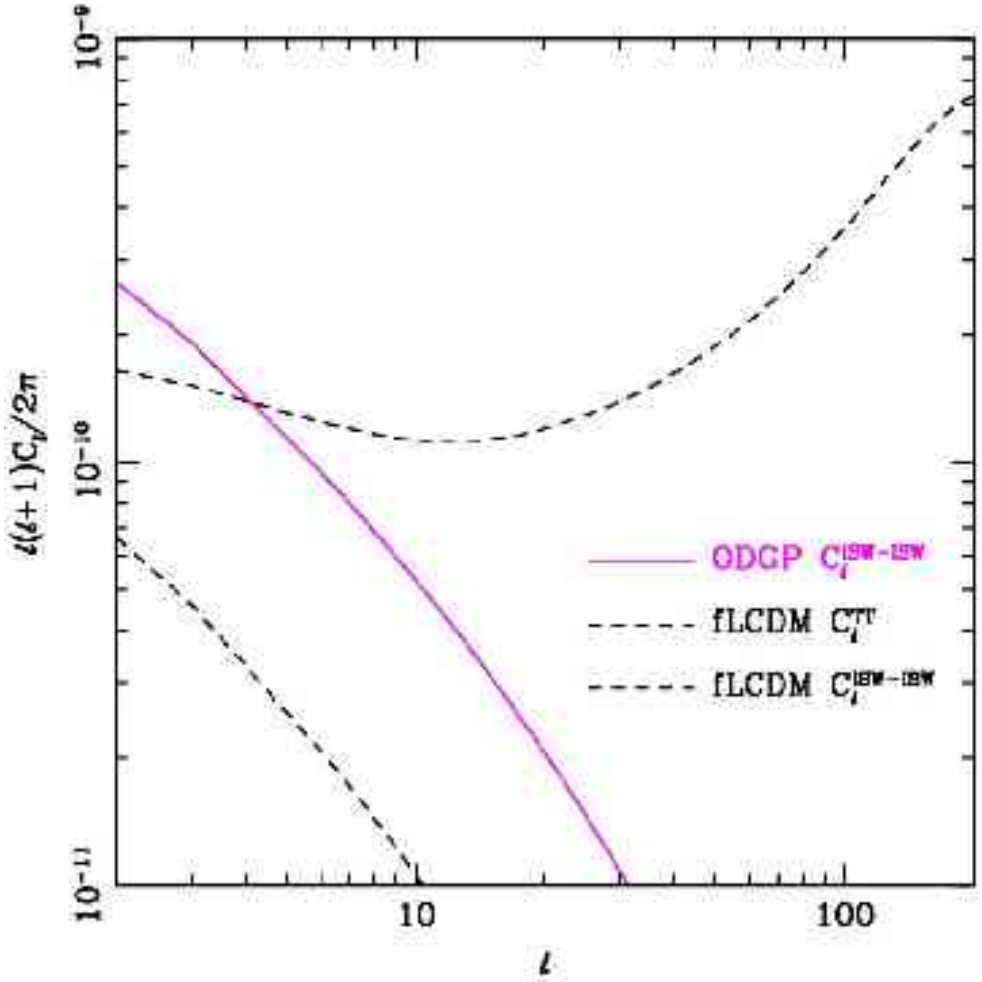

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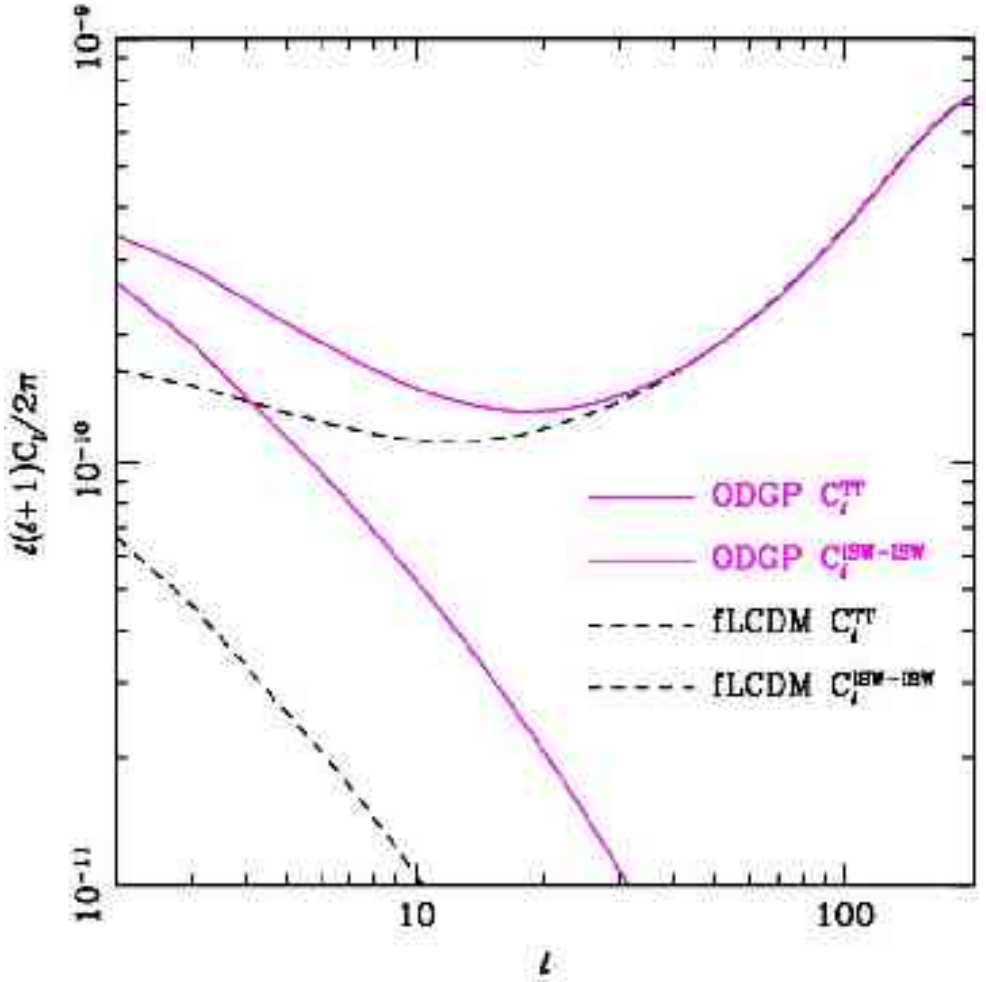
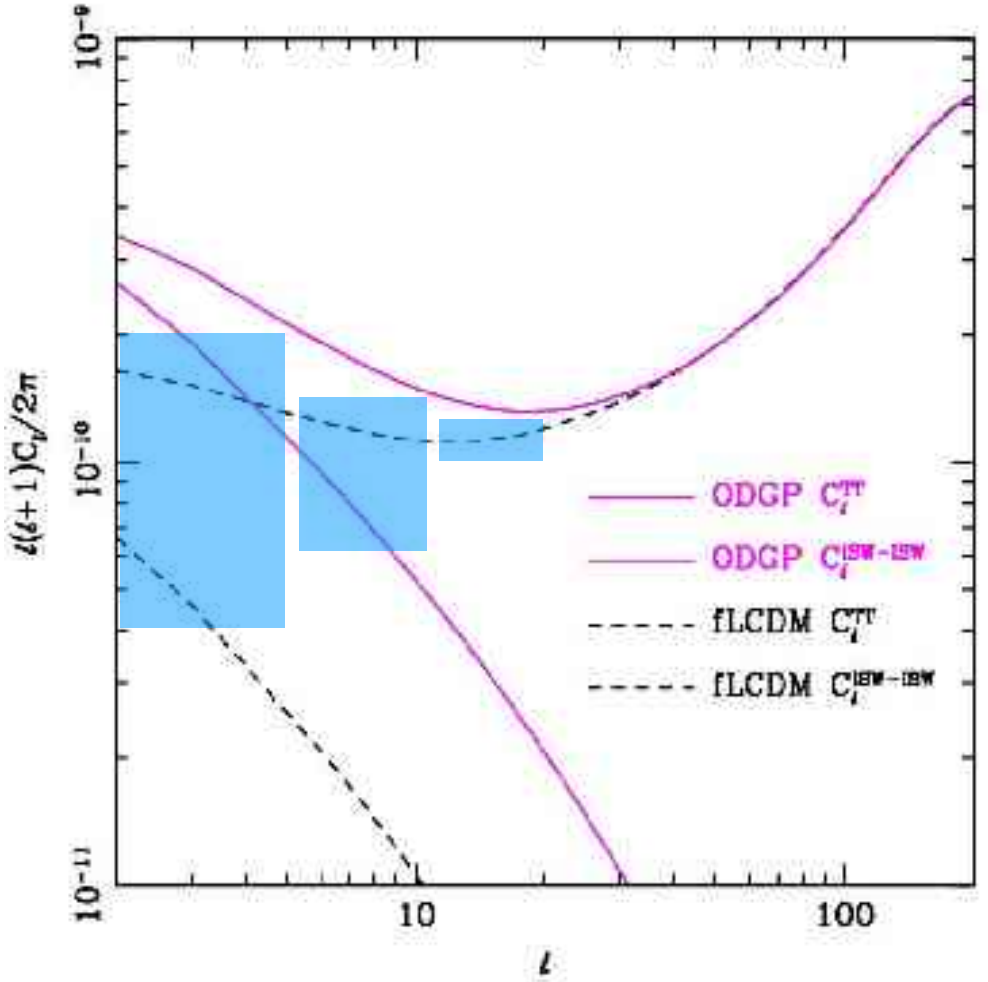


CMB temperature power spectra



Epilogue

1) sDGP is under pressure due to high H0.

2) Measurement of ISW-galaxy at high redshift can be used as an independent test of sDGP.

3) Strategy: galaxy survey at high redshift, e.g. Z ~ 3, can test sDGP in both ways,

- To use BAO rules out (or support) sDGP by H0
- ISW-galaxy correlation