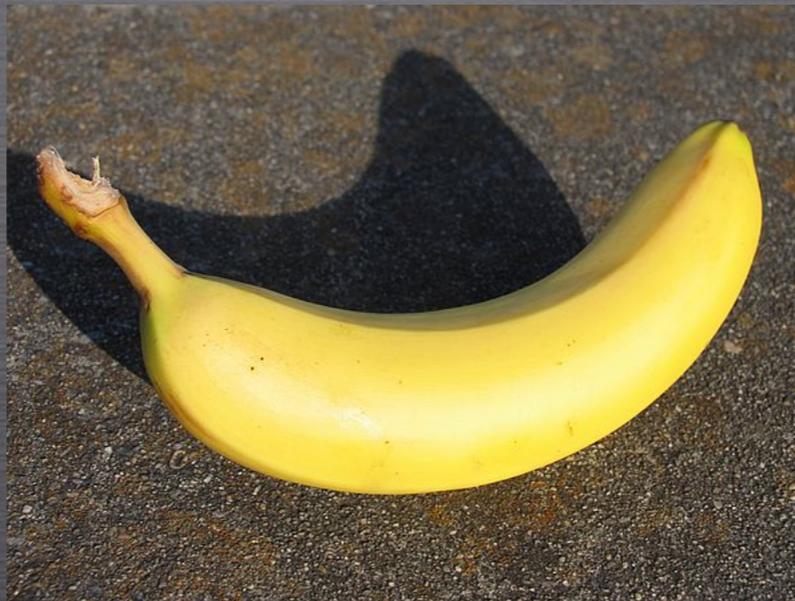


MODIFIED GRAVITY WITH DESPEC



DAVID BACON
ICG PORTSMOUTH

WITH EMMA BEYNON (ICG), KAZUYA KOYAMA (ICG), GONGBO ZHAO (ICG), TOMMASO GIANNANTONIO (MUNICH), LEVON POGOSIAN (SIMON FRASER), ALESSANDRO SILVESTRI (MIT), BOB NICHOL (ICG), YONG-SEON SONG (SEOUL), RUSSELL JOHNSTON (WESTERN CAPE), CATHERINE CRESS (WESTERN CAPE), LUIS TEODORO (NASA AMES)

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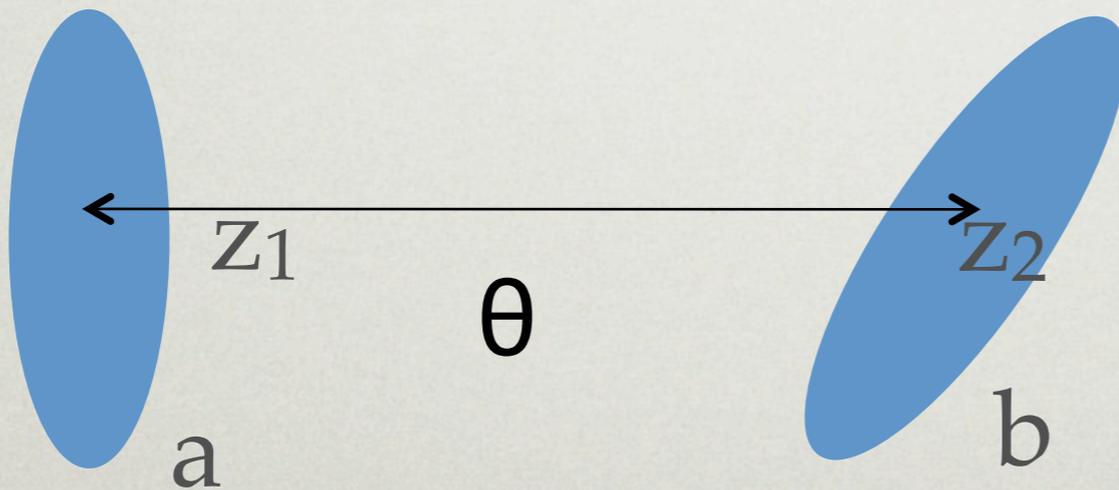
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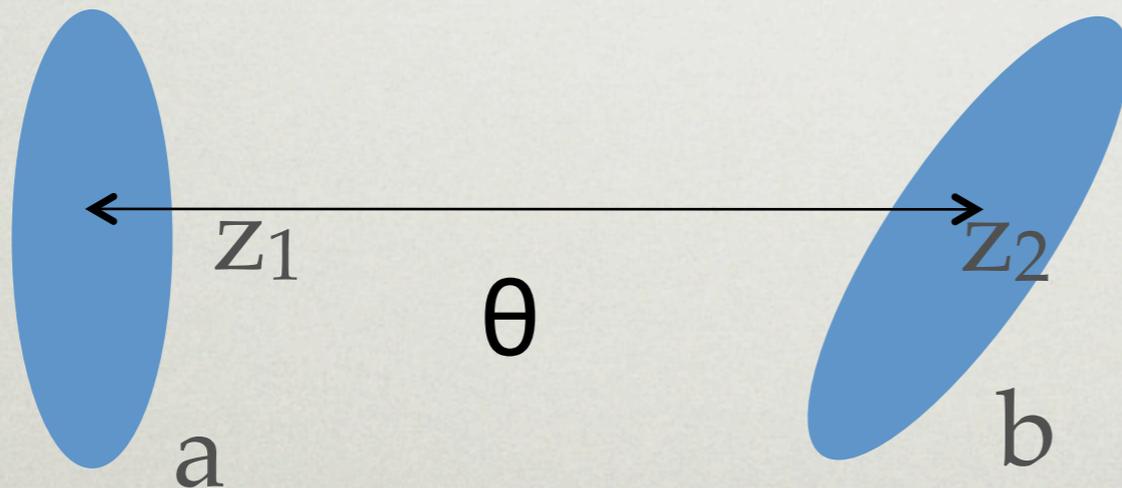
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$$C(\theta, z_1, z_2) = \langle \gamma^a \gamma^b \rangle$$

...and can learn about growth from **peculiar velocities**.

MODIFIED GRAVITIES

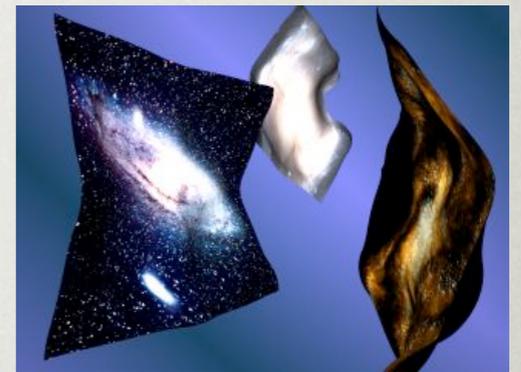
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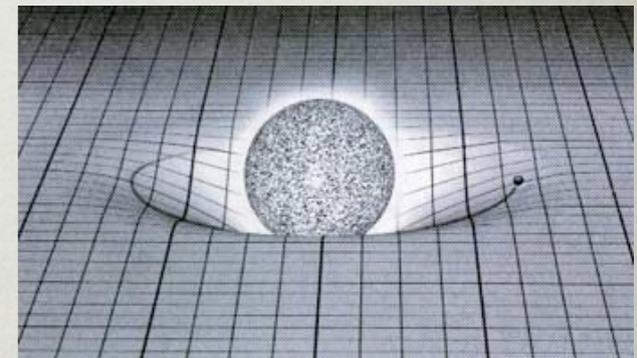
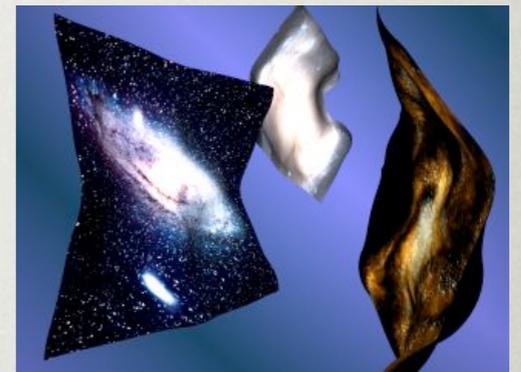
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MODIFIED GRAVITIES

Examples:

- **DGP**: 5D braneworld model
- **$f(R)$** : Modify action to include function of Ricci scalar R



LENSING + PHOTO-Z ALONE CAN CONSTRAIN MODELS

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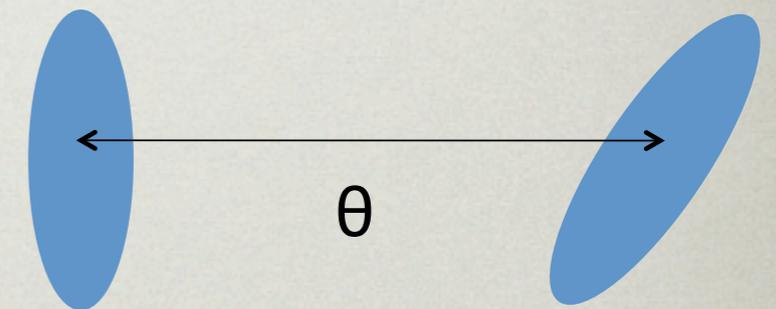
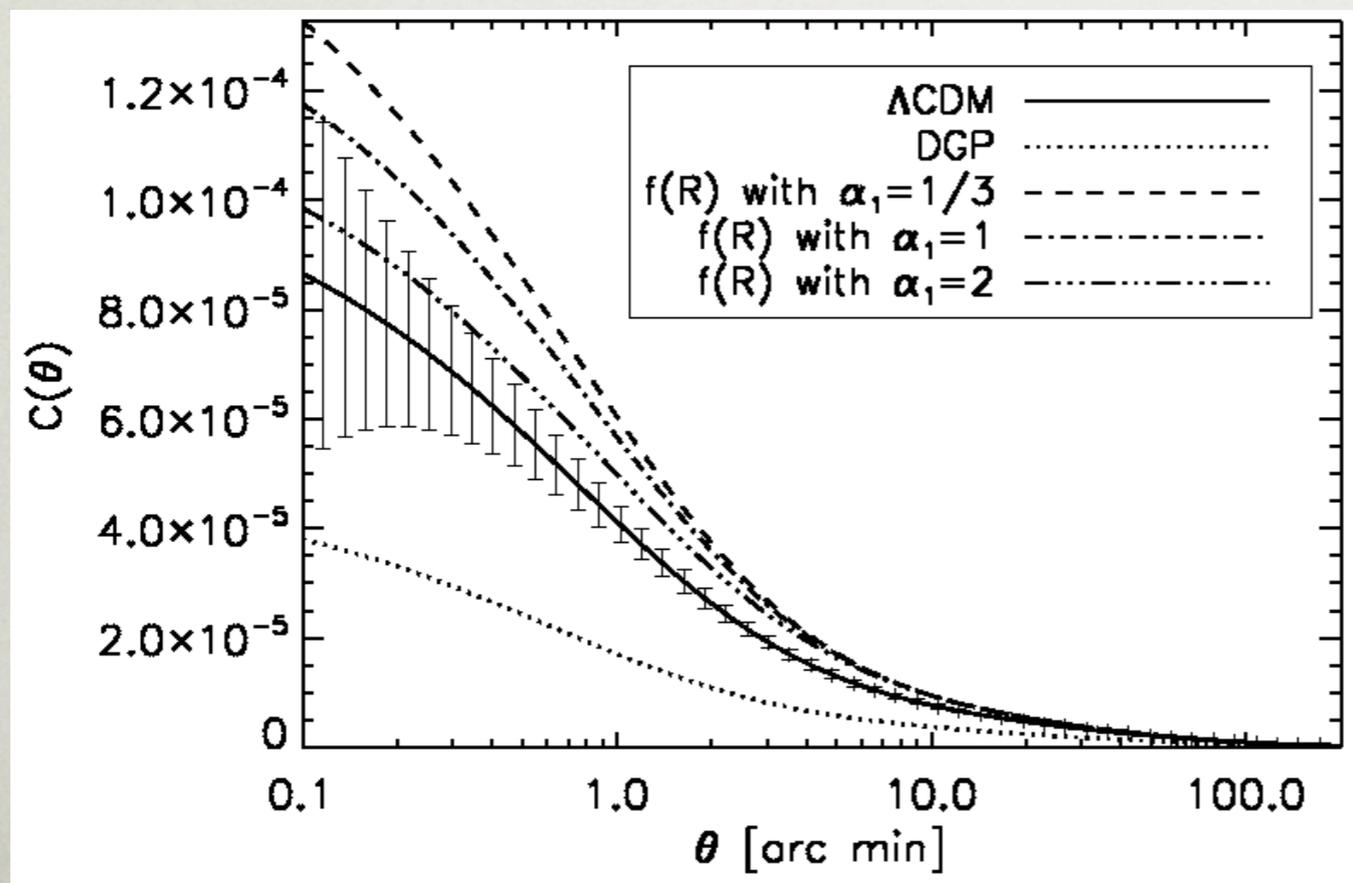
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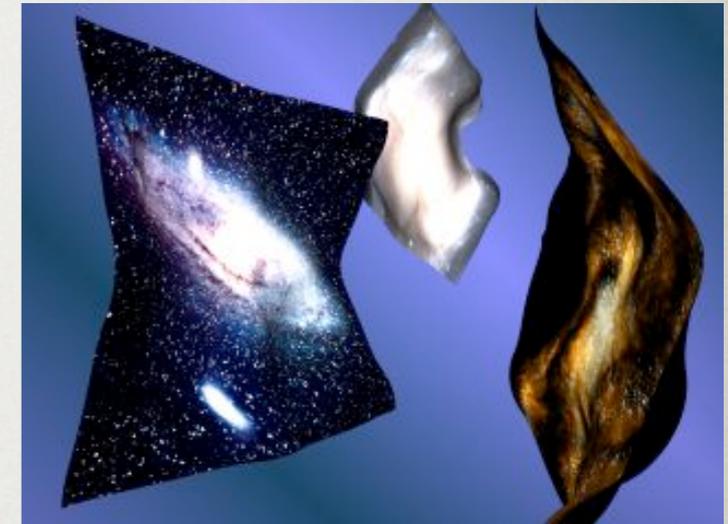
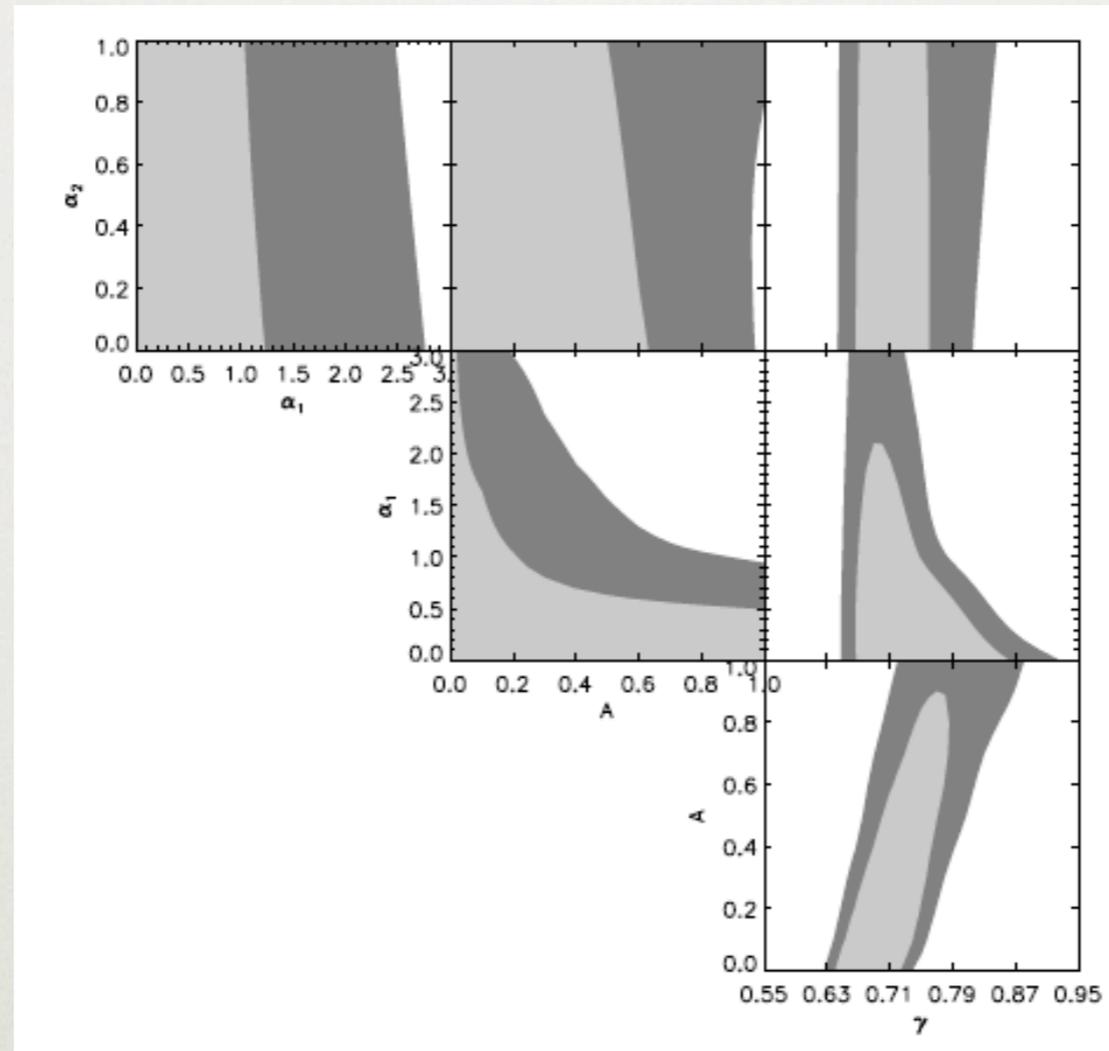
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Beynon, Bacon
& Koyama 10

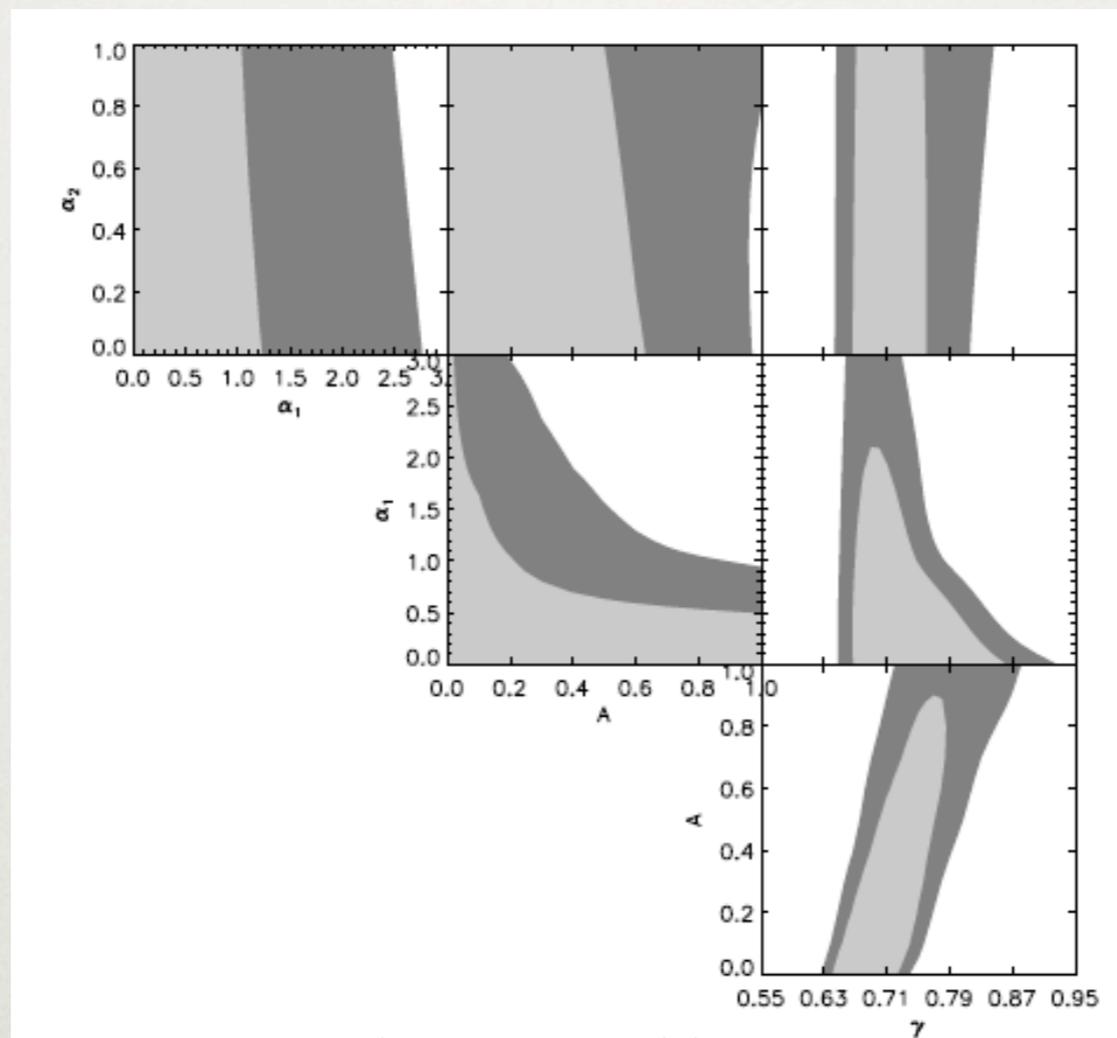
DES LENSING CONSTRAINTS

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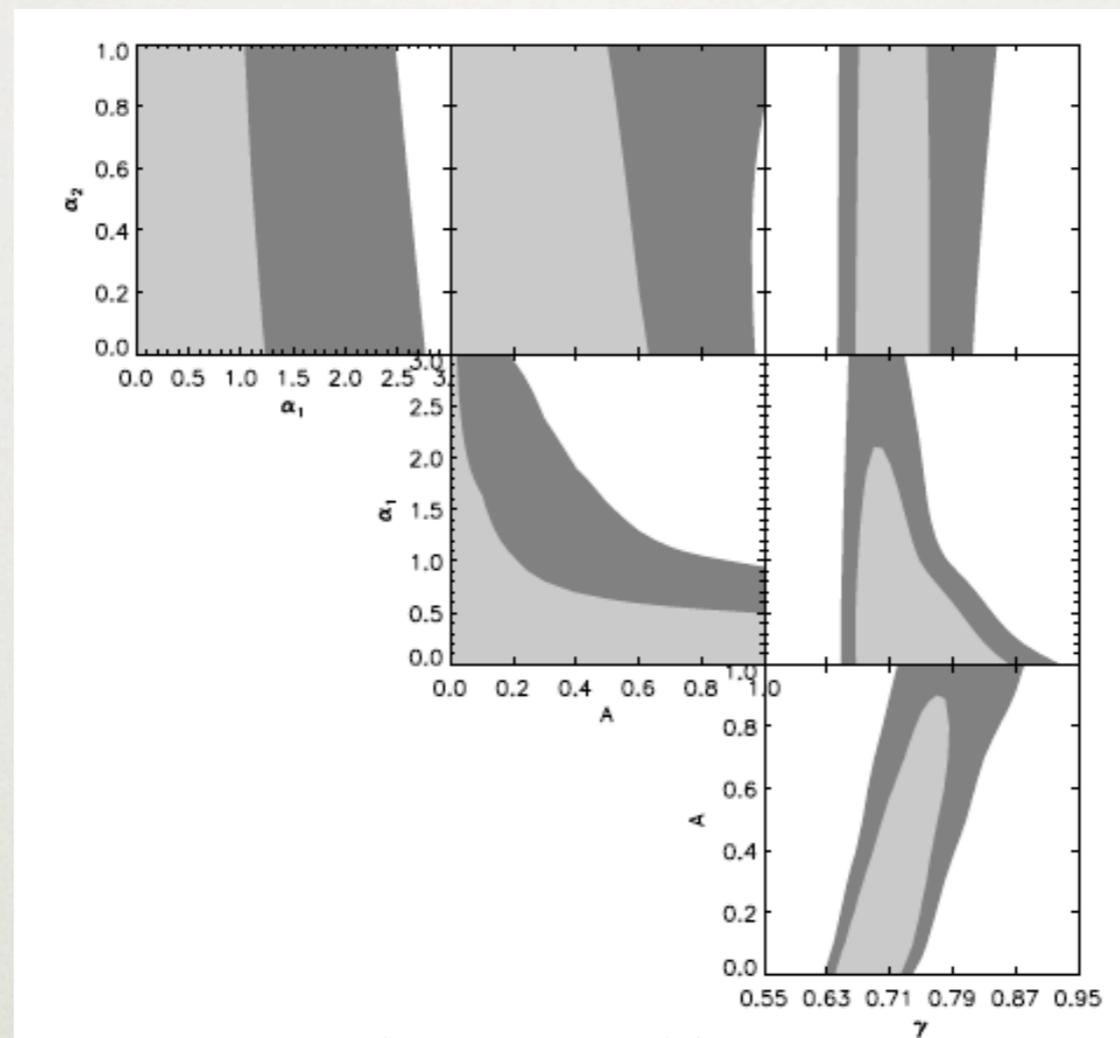
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The **growth rate** can be well measured, and strongly distinguished from GR for a simple brane-world

DES LENSING CONSTRAINTS

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Spectra **don't help much** (except for catastrophic photo-zs and systematics)

PARAMETERIZING MODIFIED GRAVITY

With modified
metric

$$ds^2 = -a^2(\tau)[(1 + 2\Psi)d\tau^2 - (1 - 2\Phi)d\vec{x}^2],$$

e.g. Zhao et al 2010

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Calculate probe models with
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growth

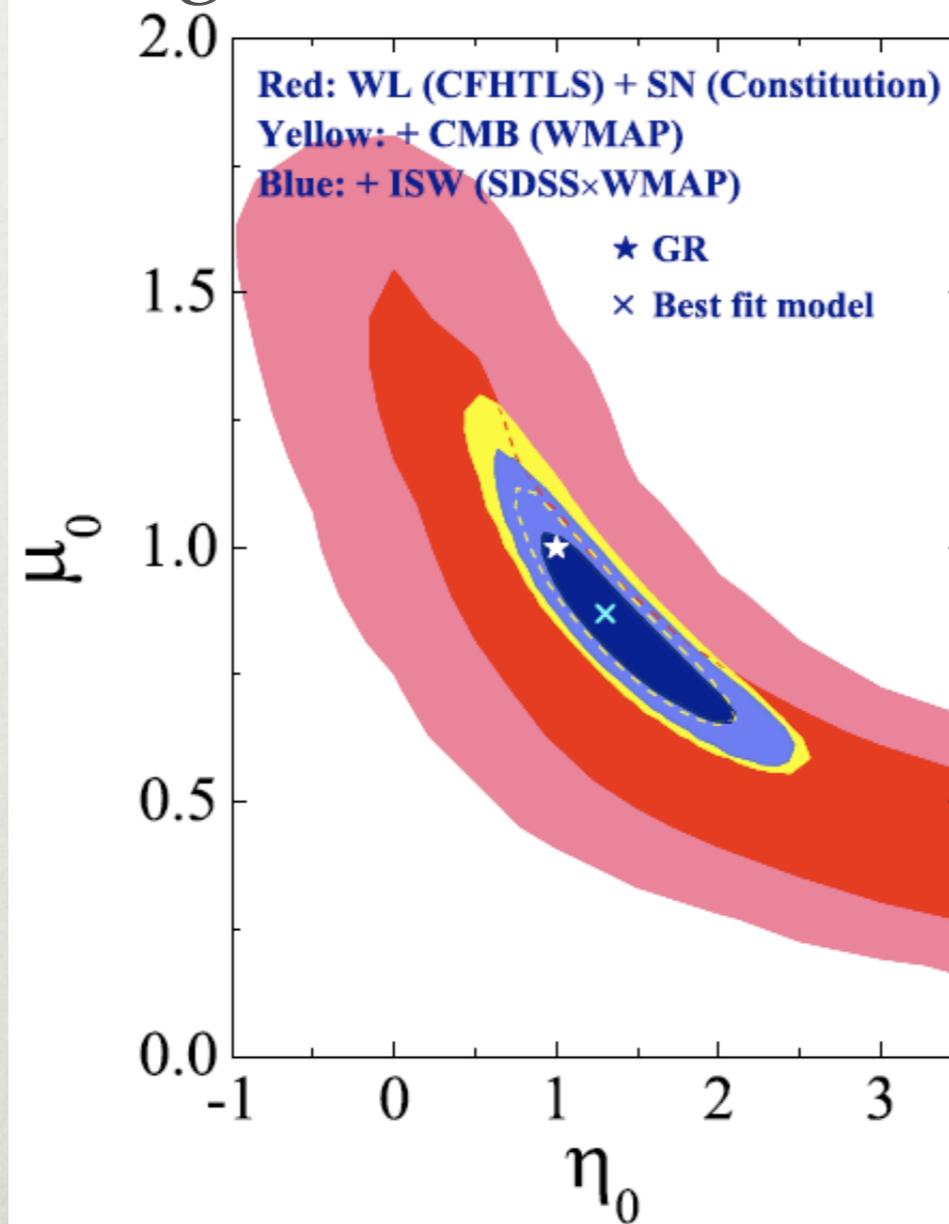
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Already, combining CFHTLS, WMAP + SNe (Zhao et al 10):

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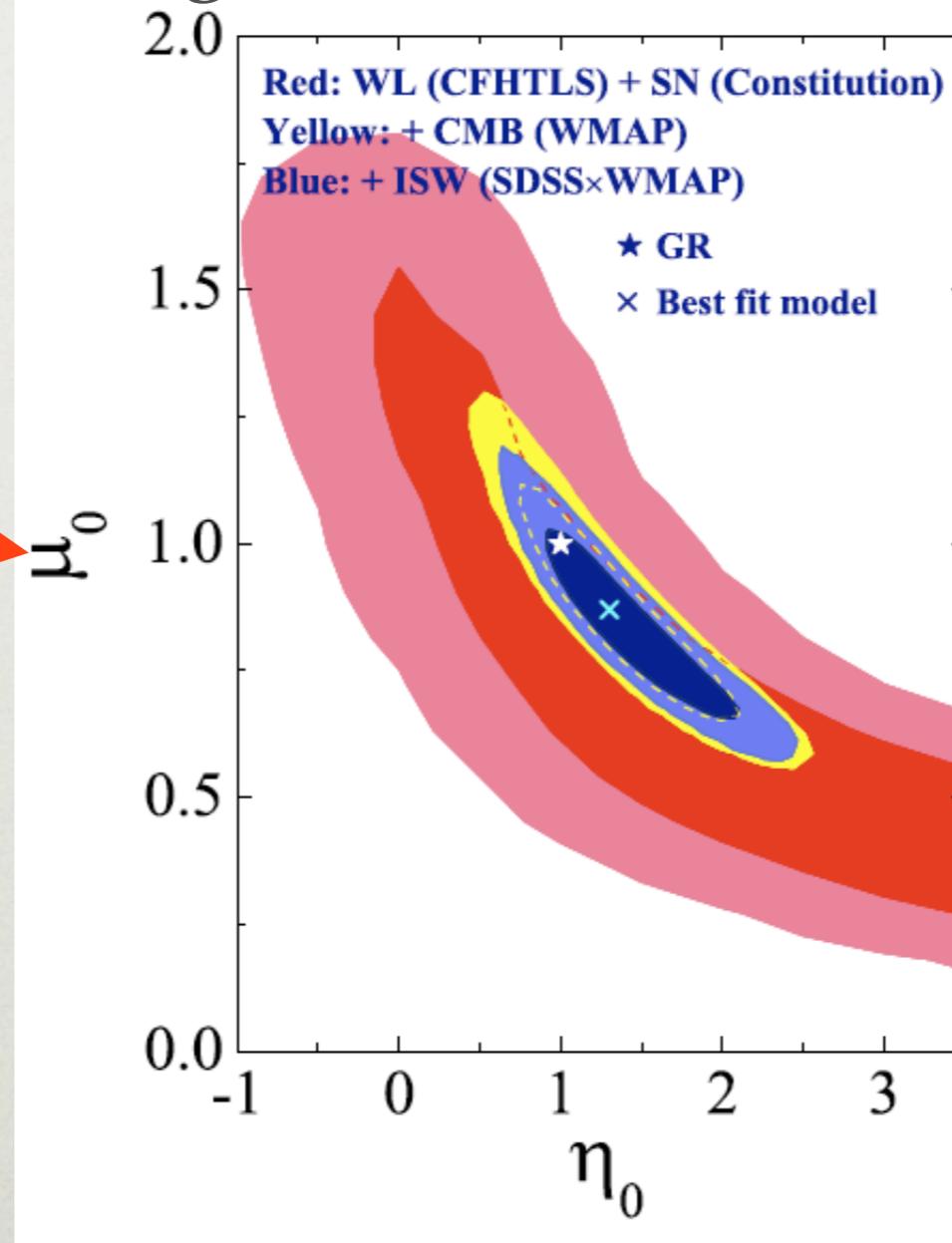
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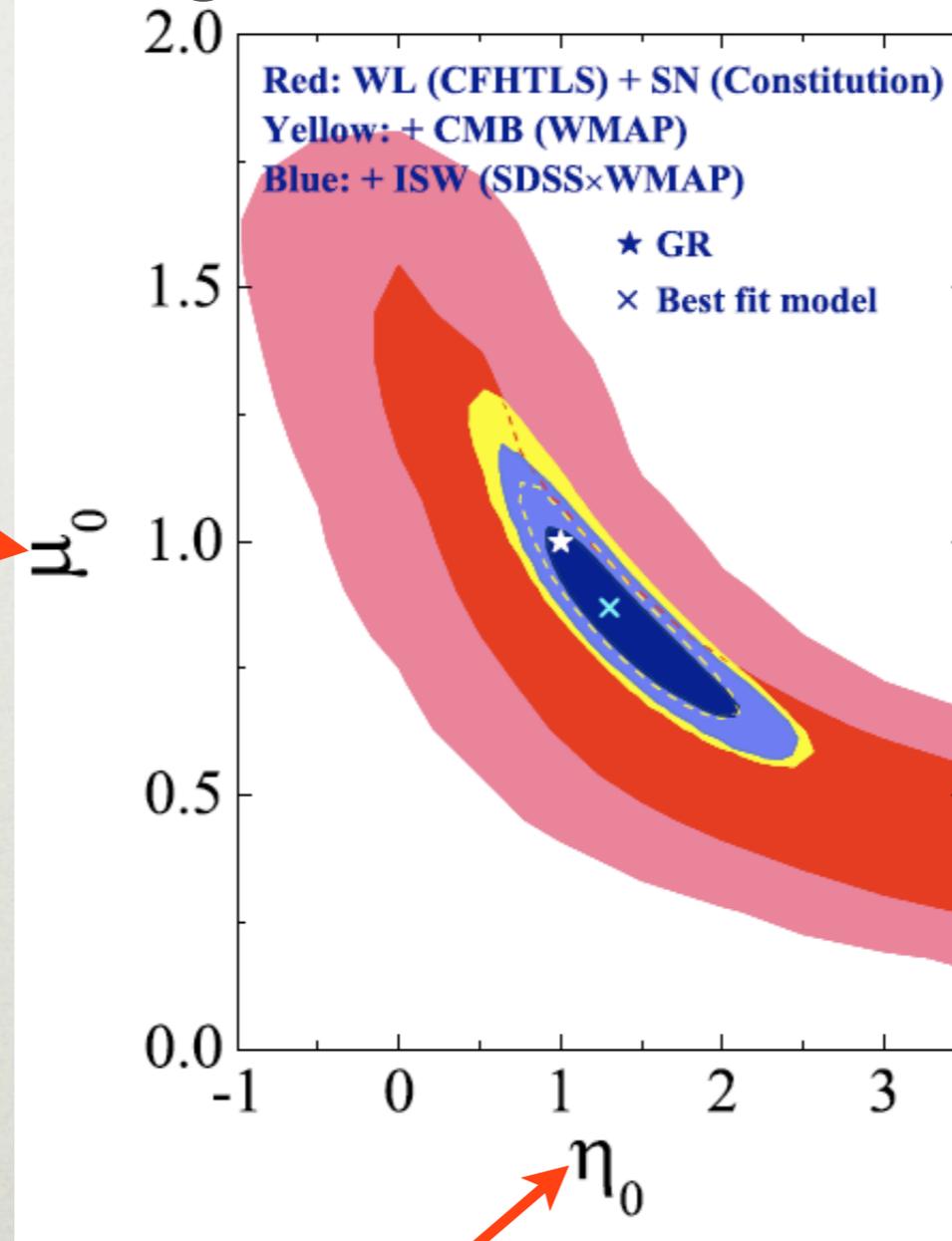
Poisson
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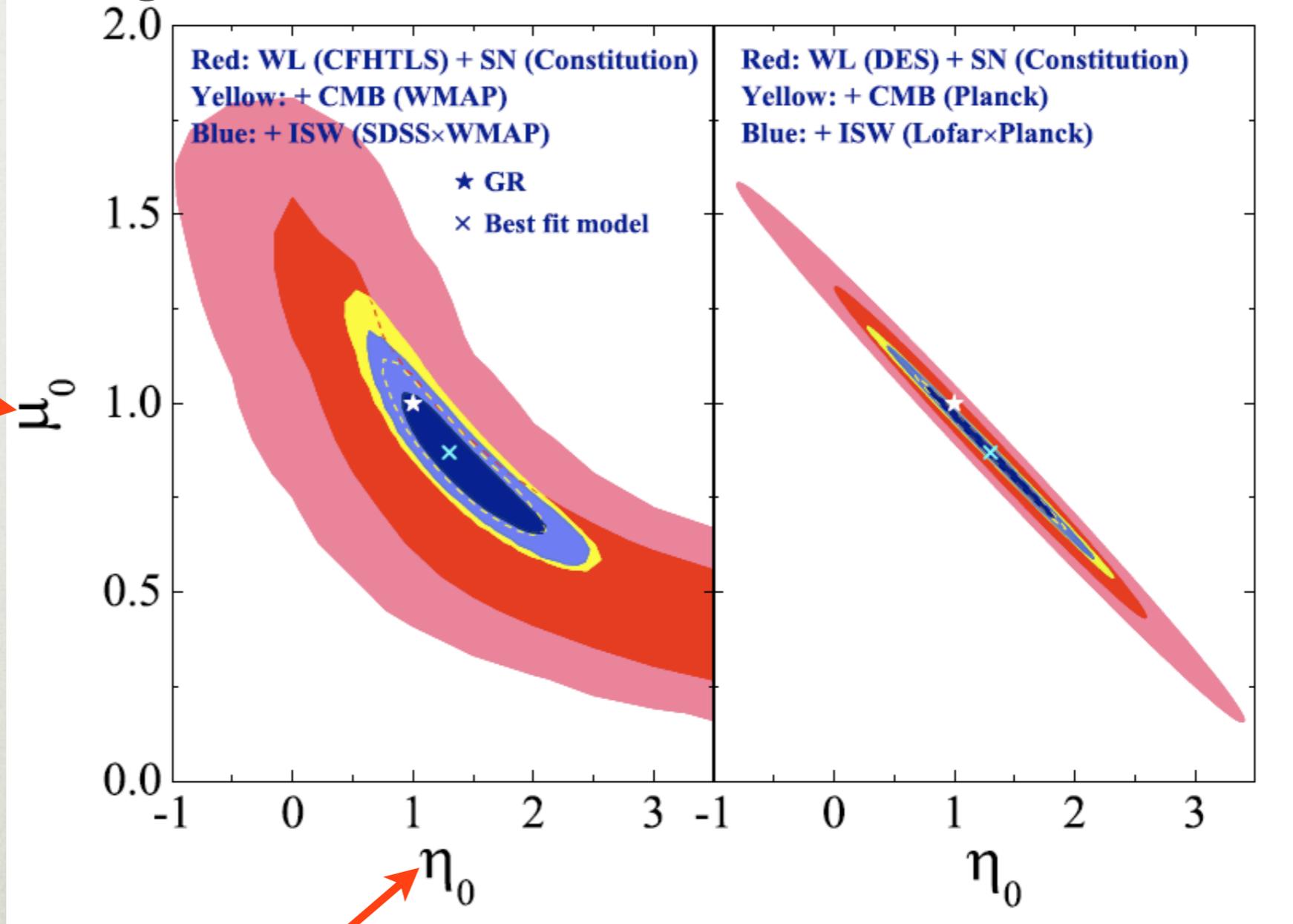


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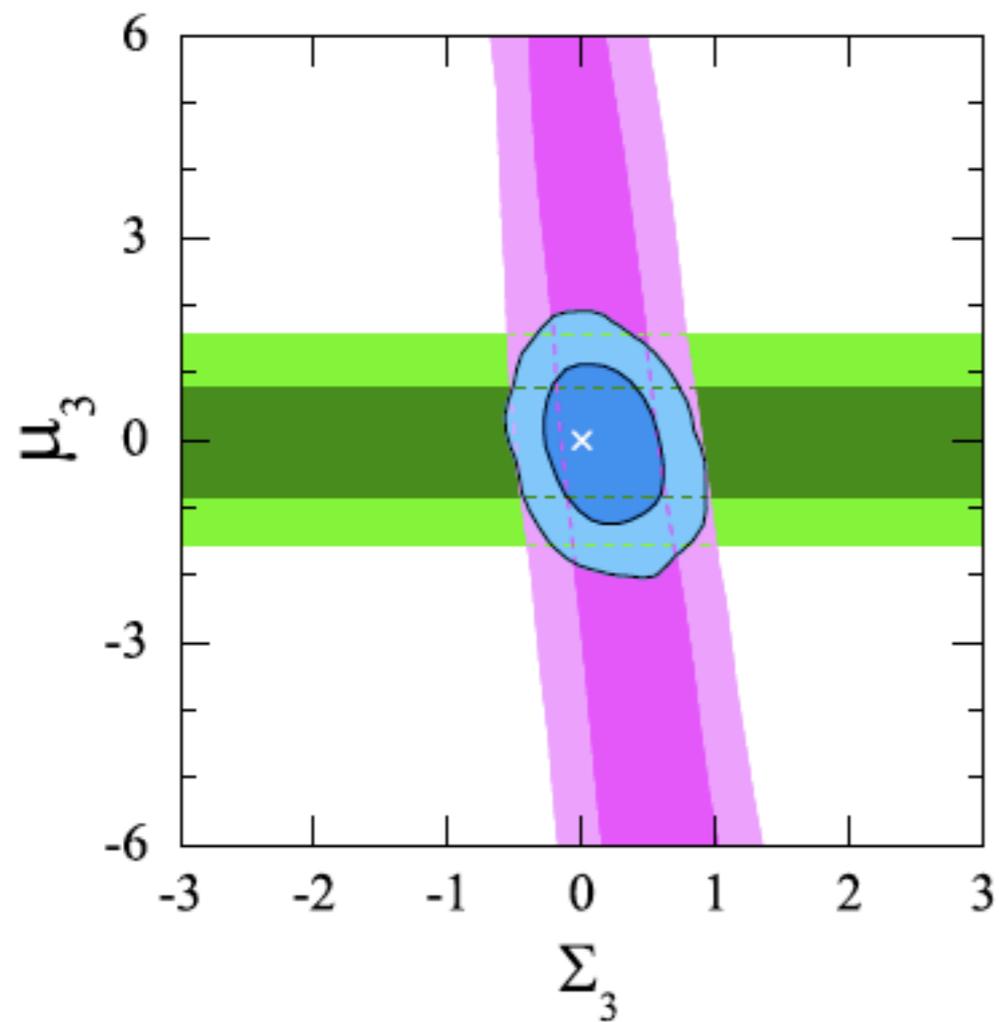
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Dominates MG effect on WL

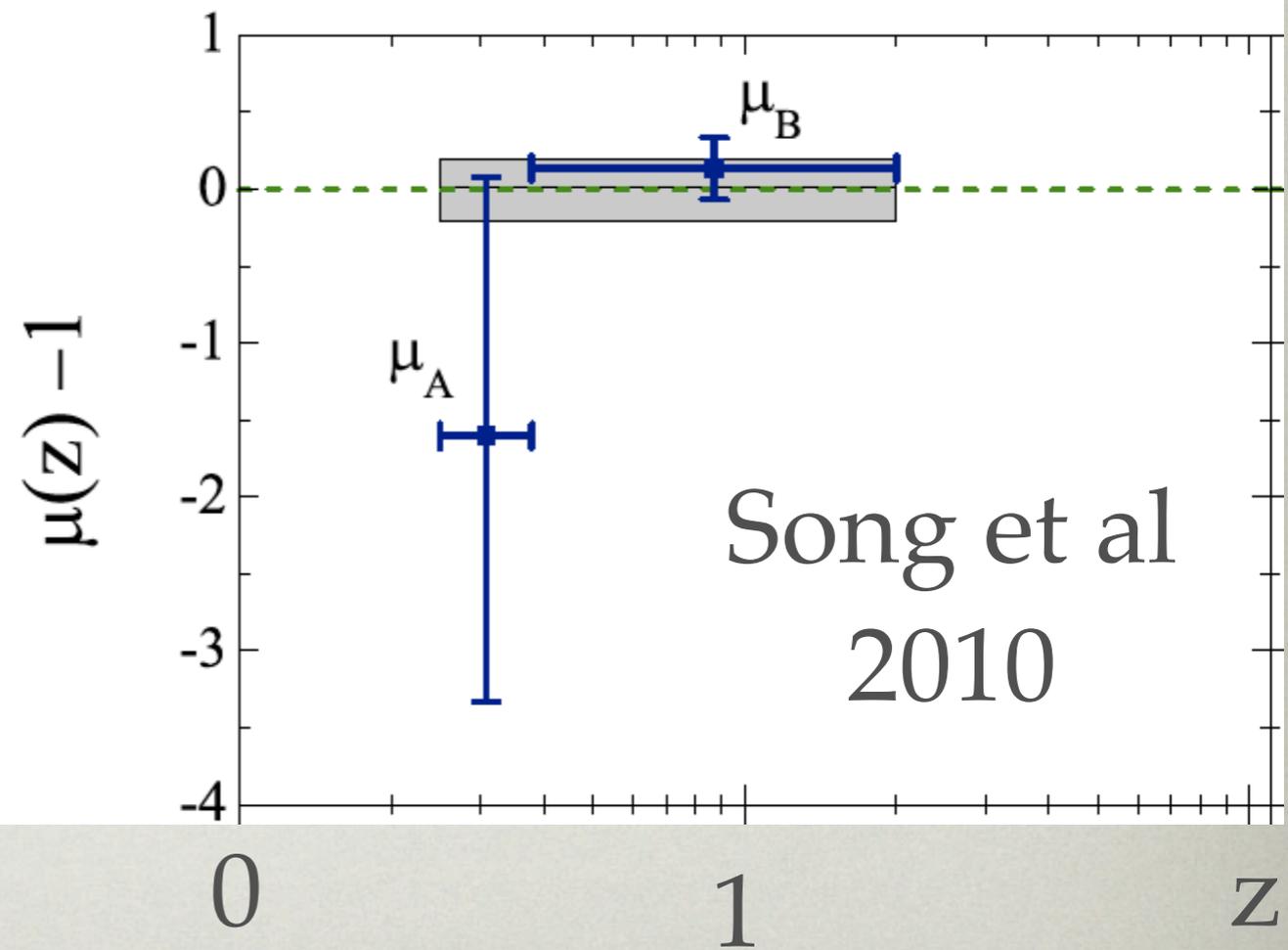
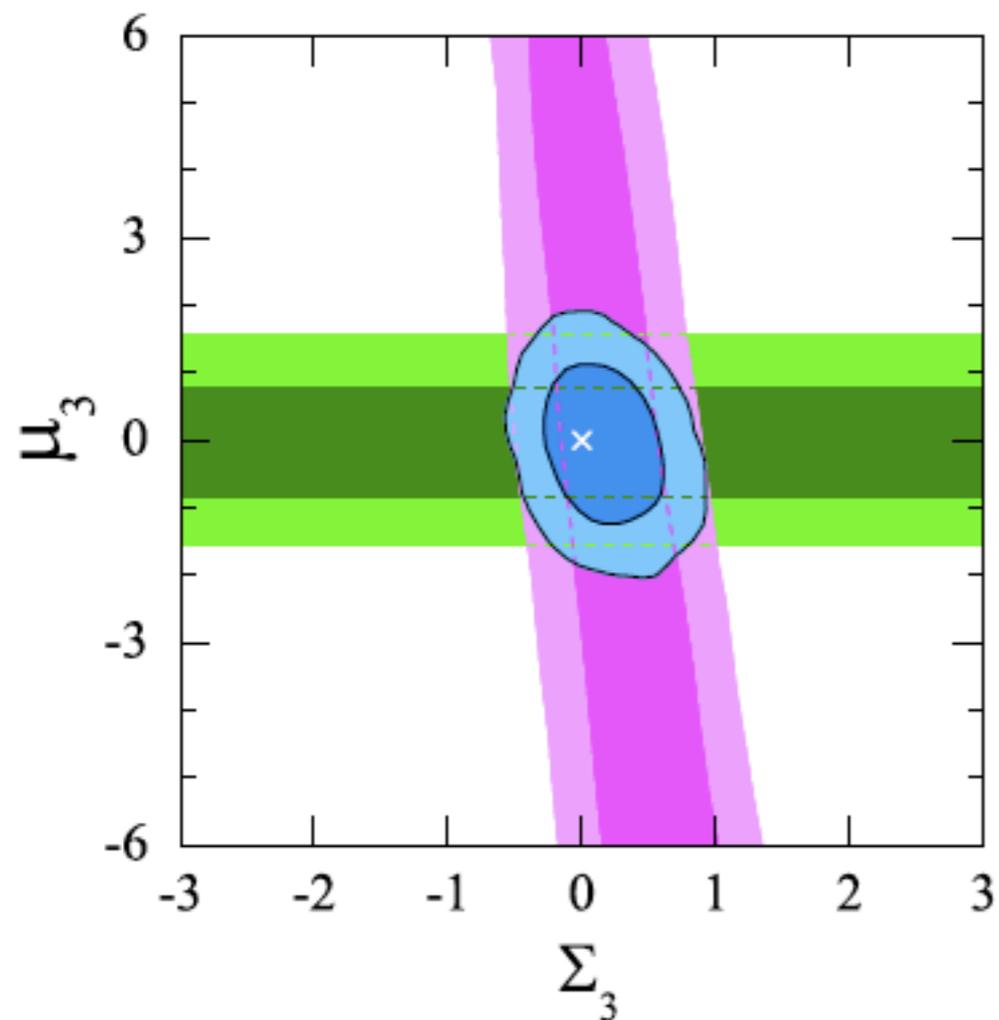
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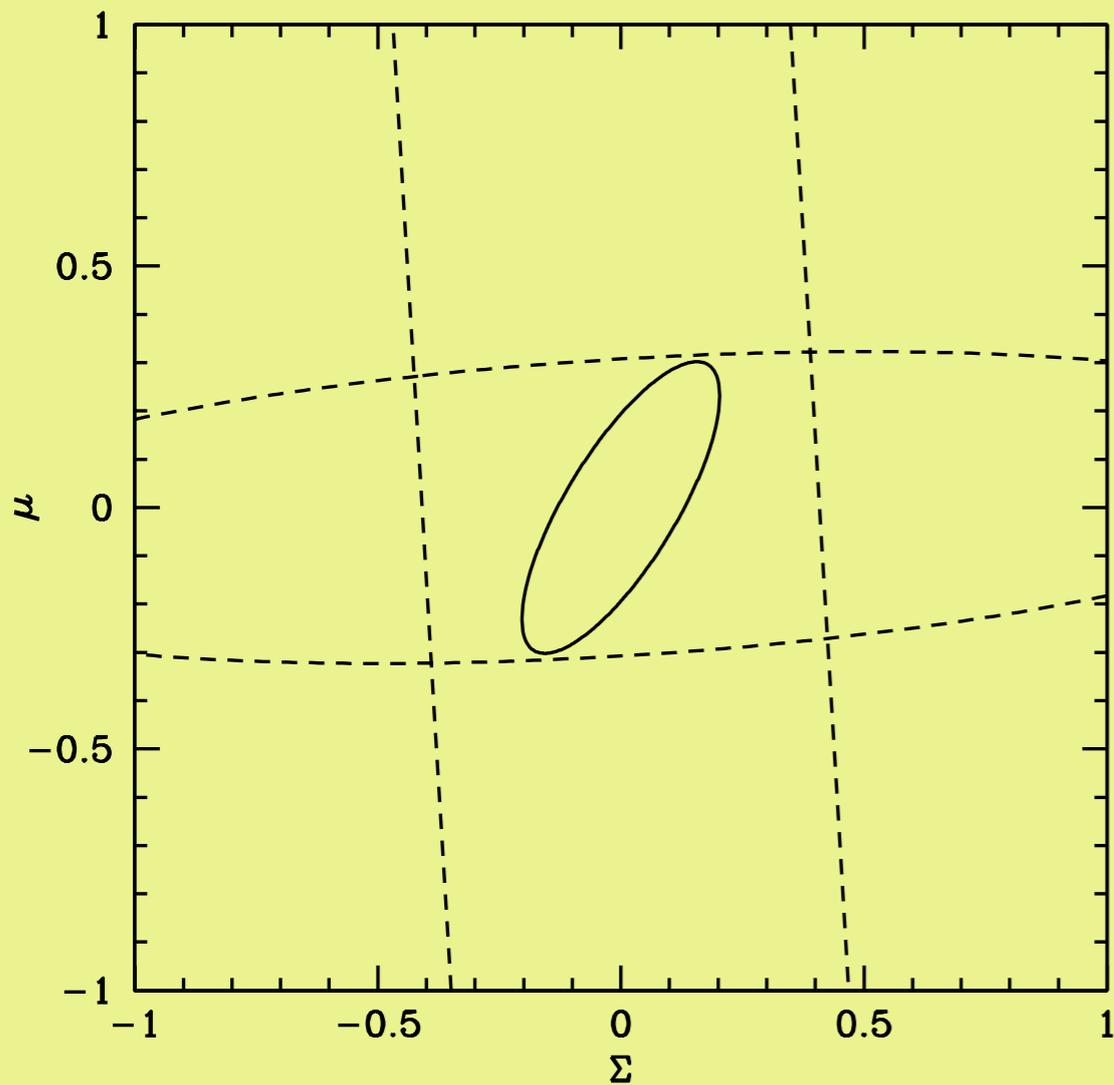


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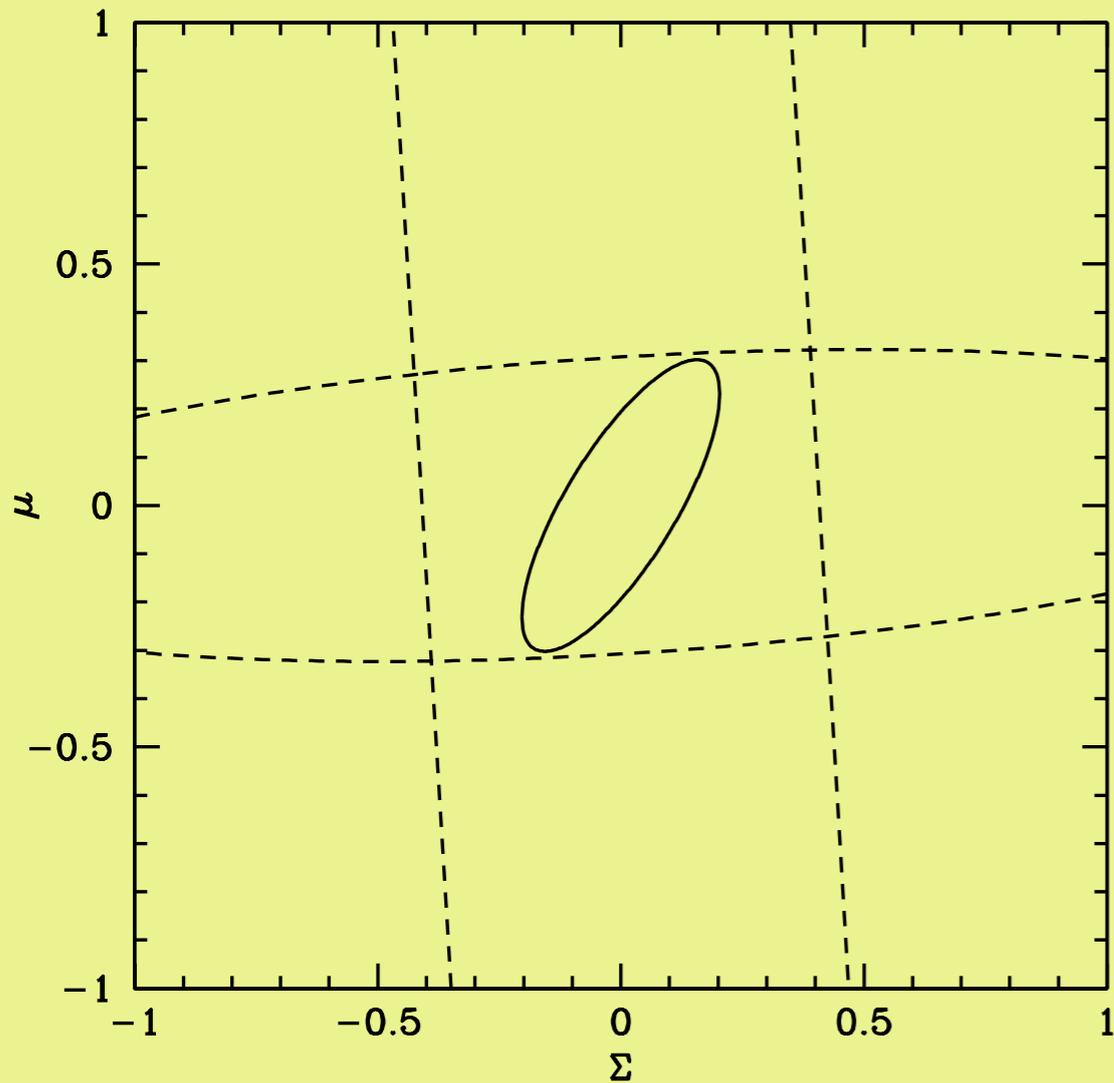
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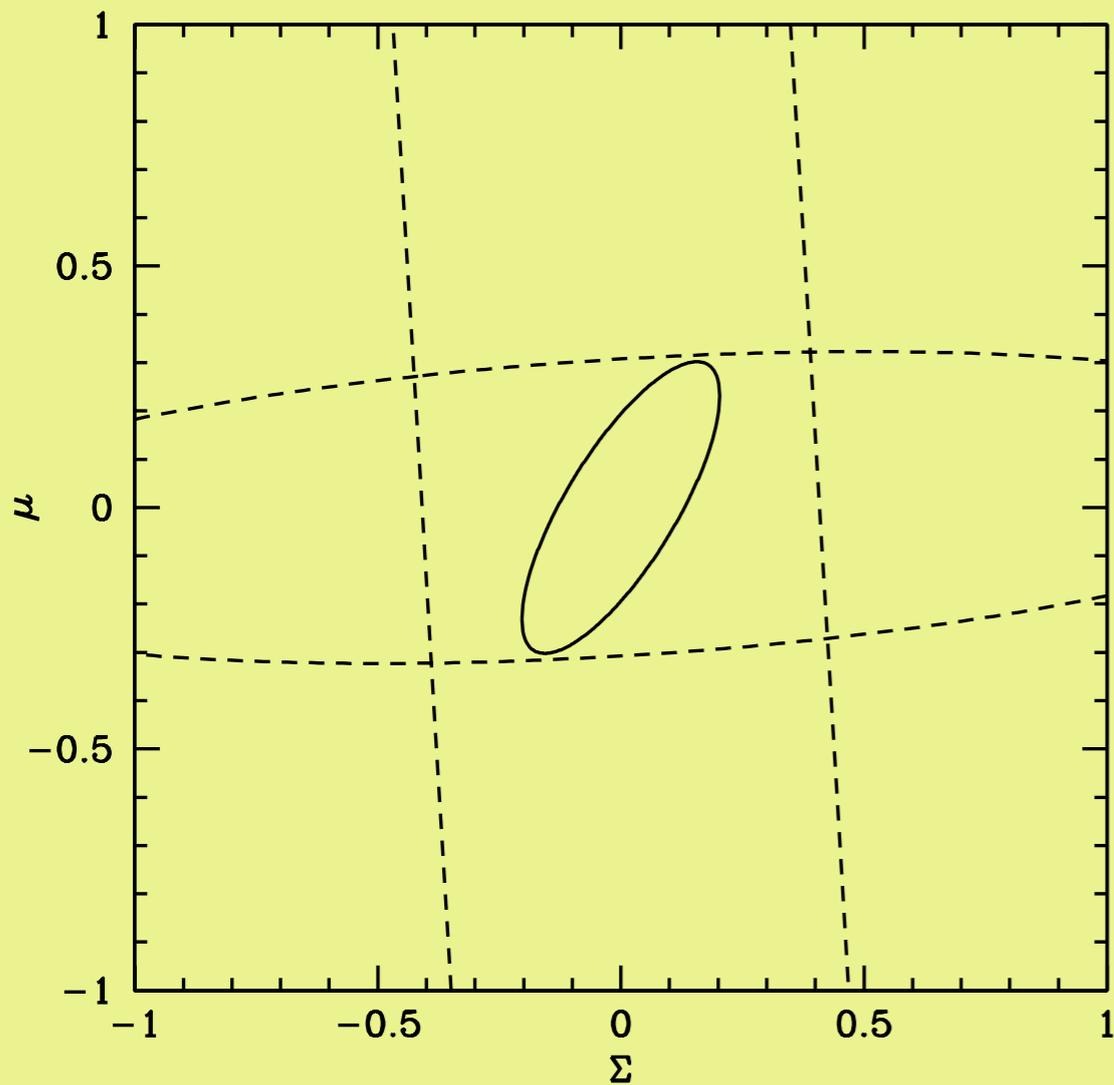
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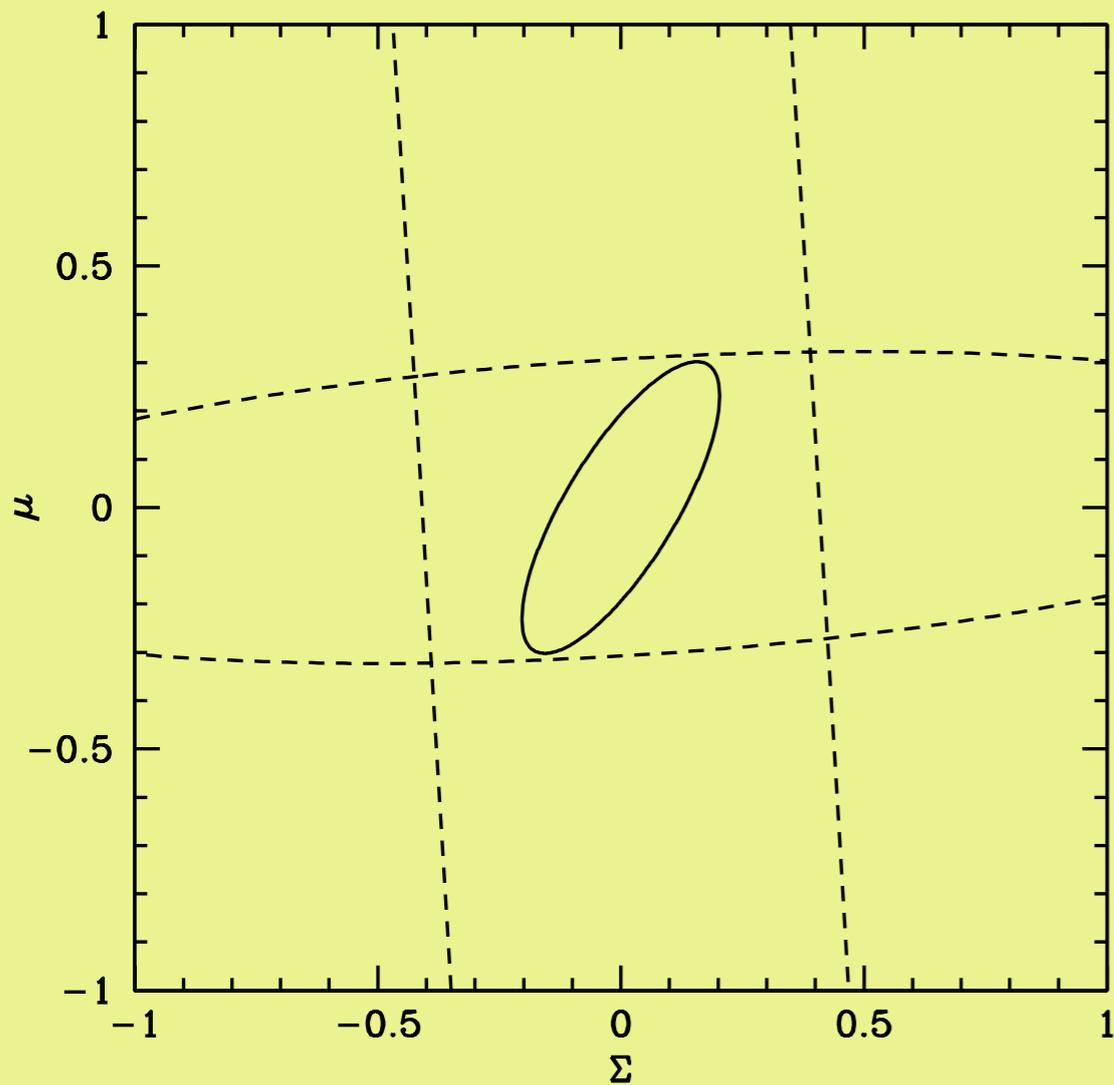


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Varying

$(\omega_b, \omega_c, \Theta_s, z_{reion}, n_s, A_s, w_0, w_a, \mu_s, \Sigma_s)$

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~20% error on distance for one galaxy
(e.g. Bernardi et al 03)

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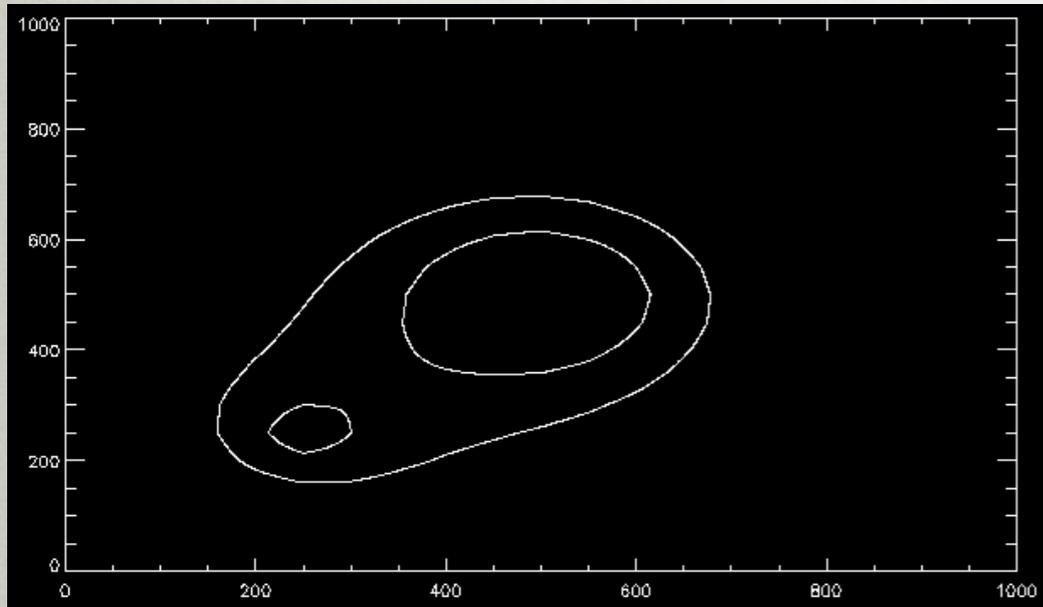
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ie a **spatially resolved comparison** of the 2 gravitational potentials! (c.f. the impact of the Bullet Cluster)

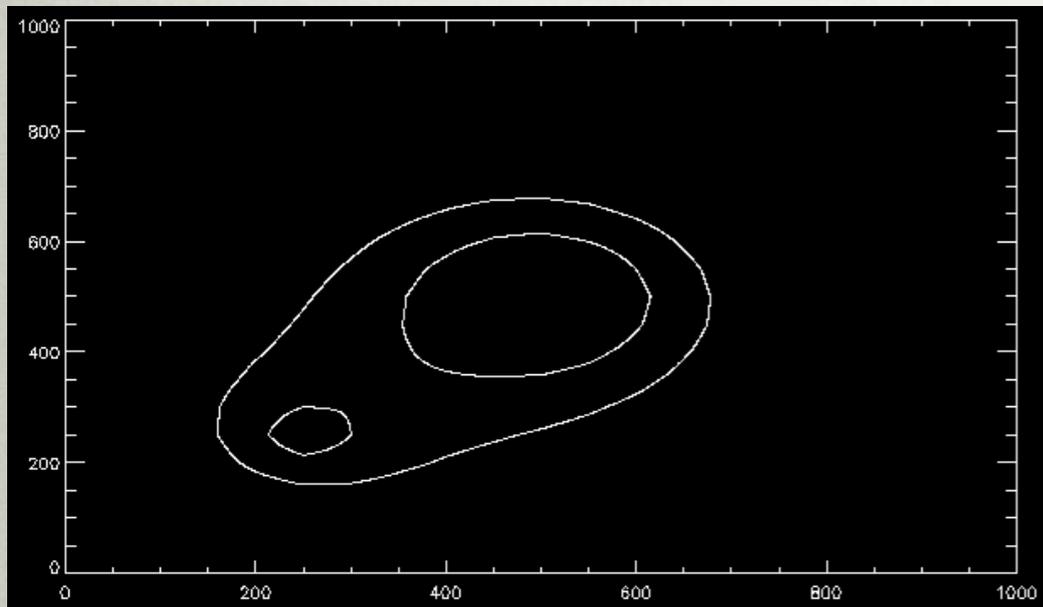
EXAMPLE MAP



$10^{14} M_{\text{sun}}$
Cluster
at $z=0.2$

Original Ψ

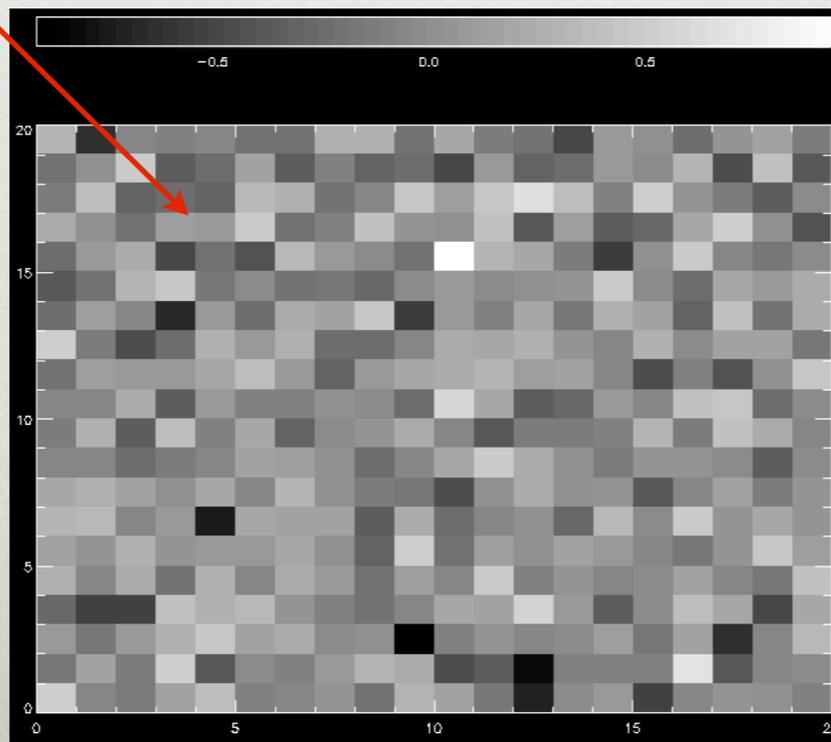
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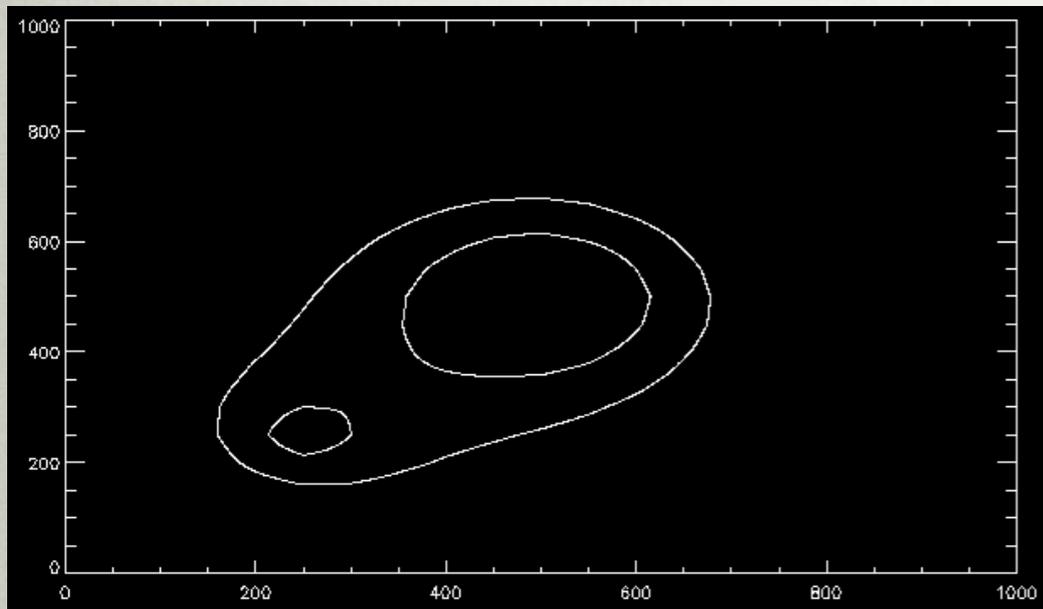
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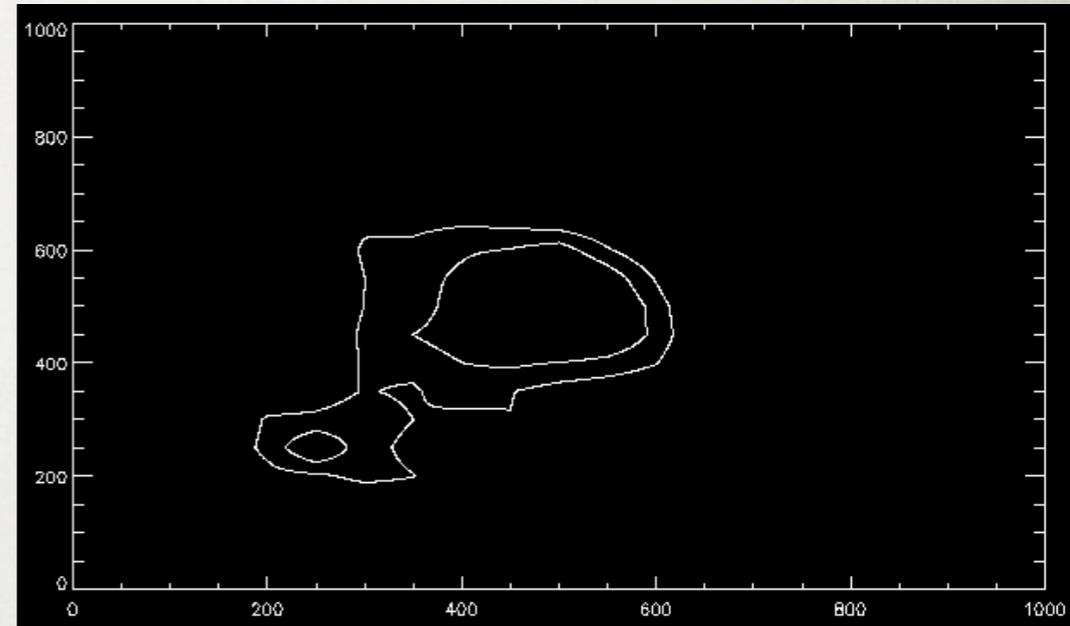


Radial
PV

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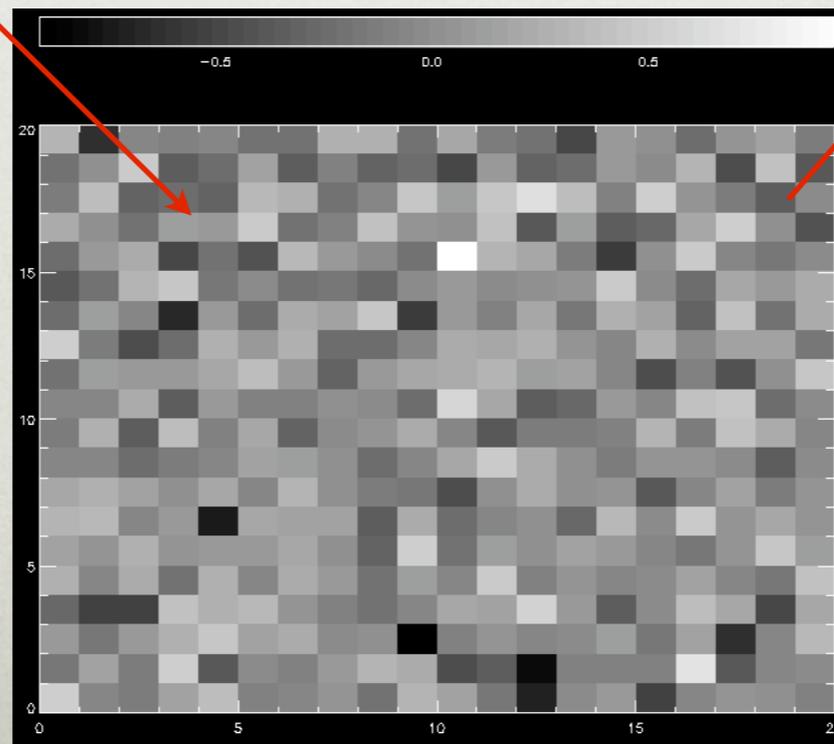


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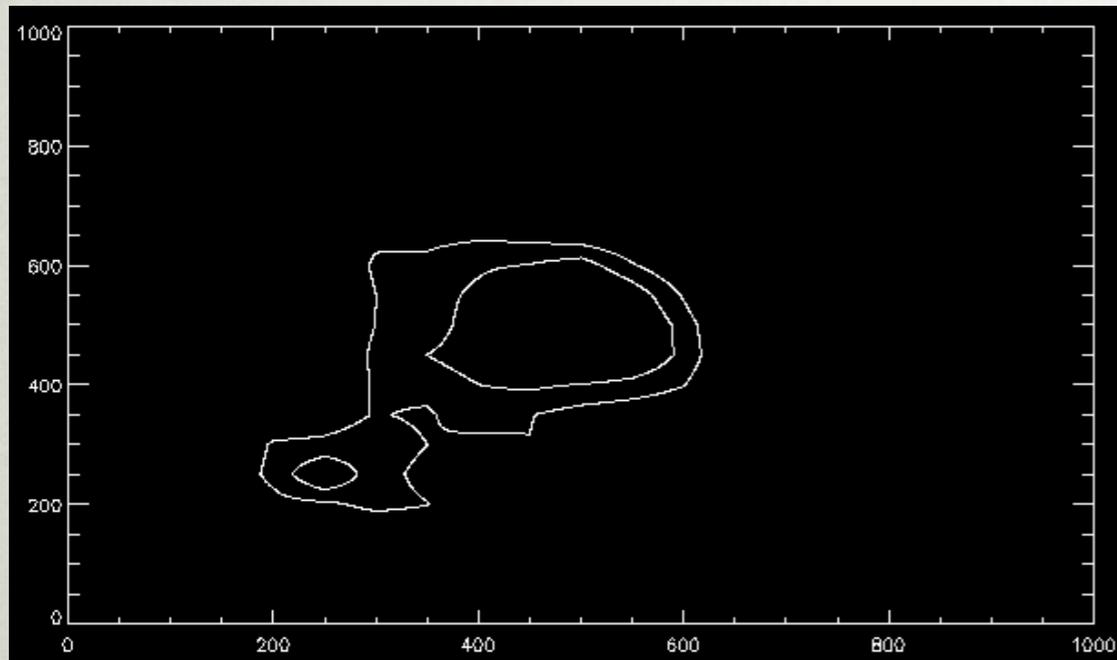


Reconstruction

Radial
PV

COMPARE WITH 3D LENSING MAP

Example with DES / DESpec errors:

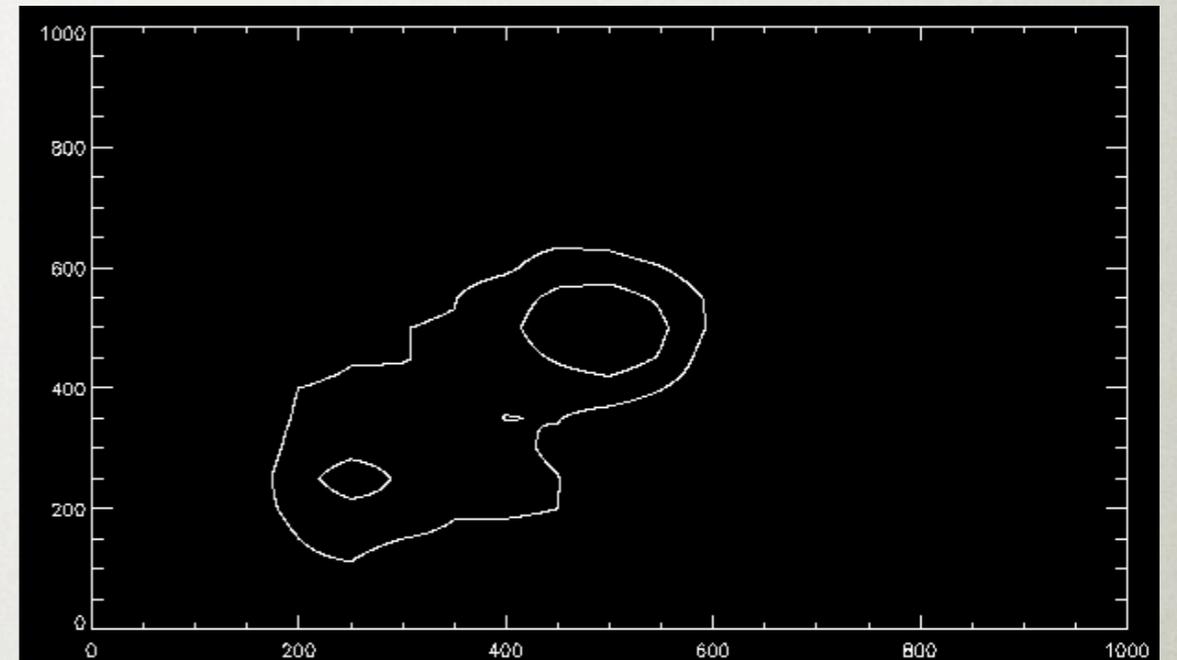
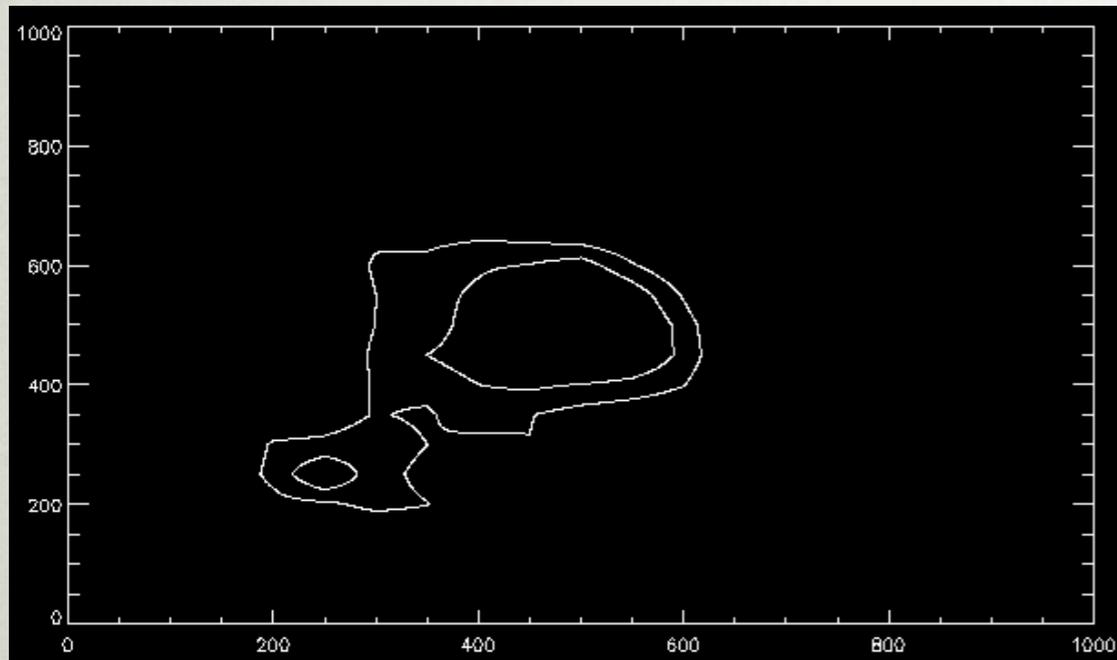


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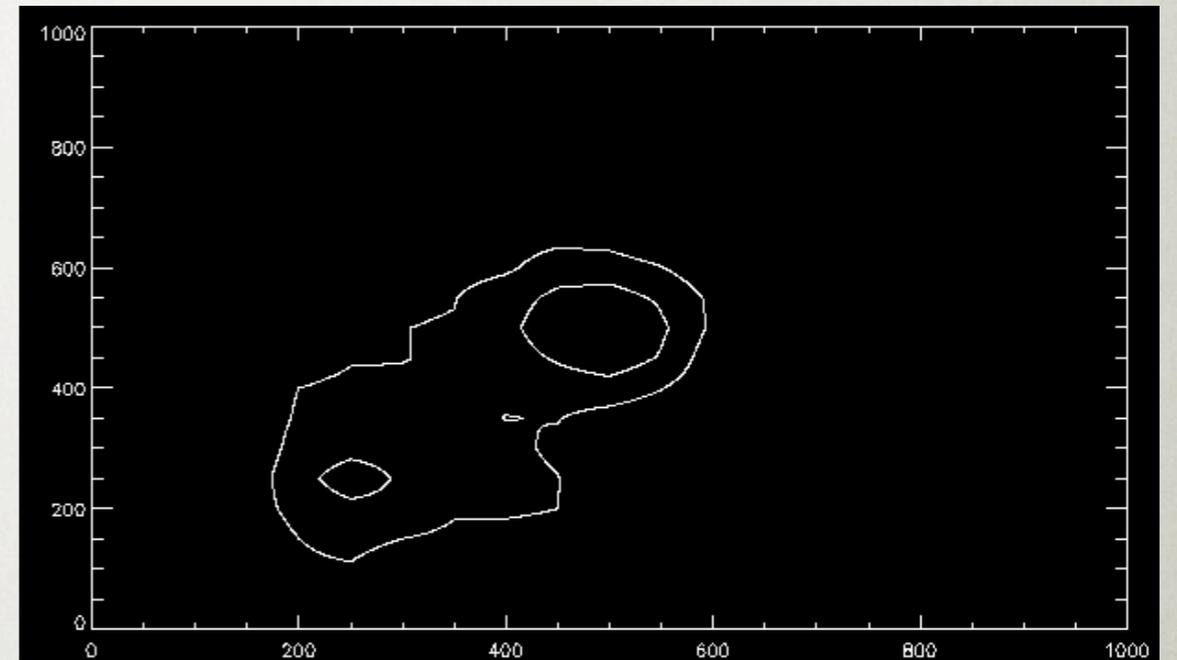
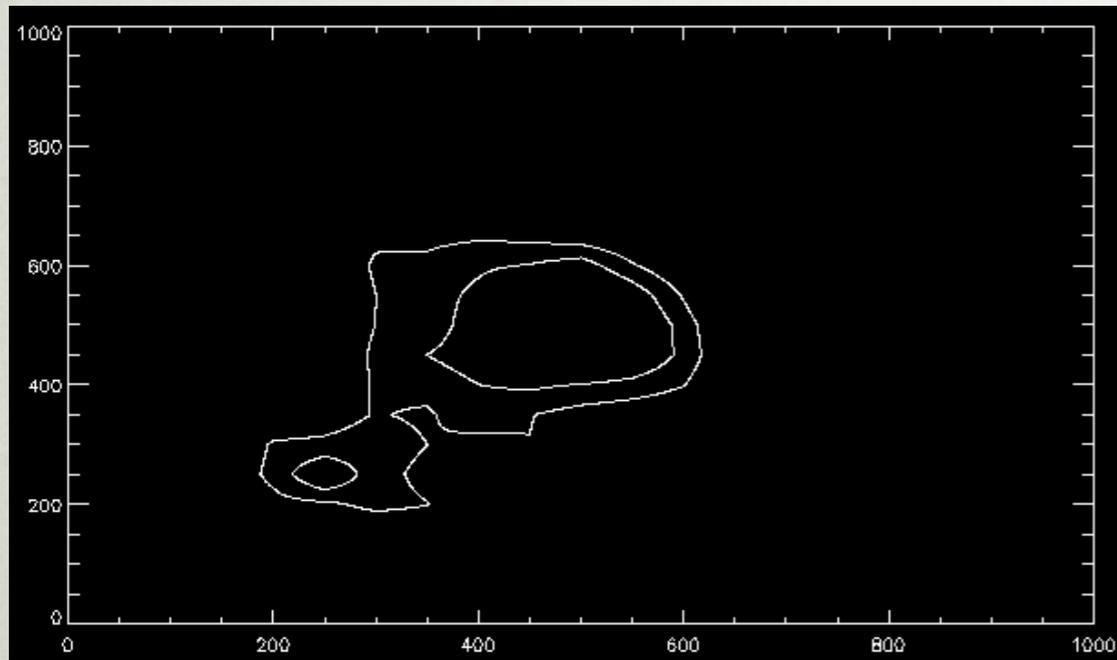
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WL

at $z=0.2$

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Now doing full analysis with **N-body simulations**.

CONCLUSIONS

PV DESpec +WL DES allow greatly improved constraints
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We could try to make and compare Ψ **and** Φ maps.