Non linear tomographic shear spectra from cosmological simulations

Dark Energy Workshop, Ringberg Castle, 2012

Luciano Casarini
Universidade Federal do Espirito Santo (Brasil)

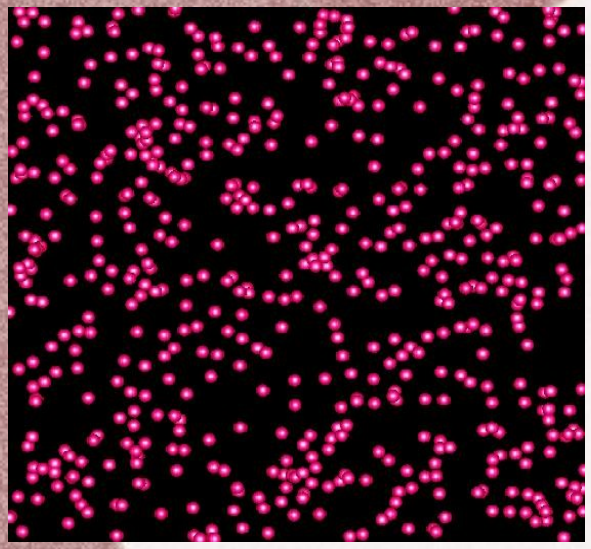
in collaboration with:

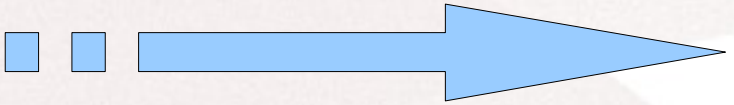
S.Bonometto, S.Borgani, M.Mezzetti & G.Murante (University of Trieste)

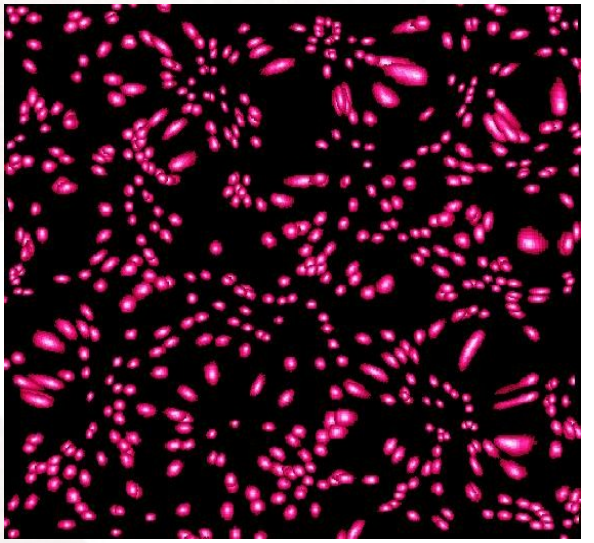
G.La Vacca (University of Milano Bicocca)

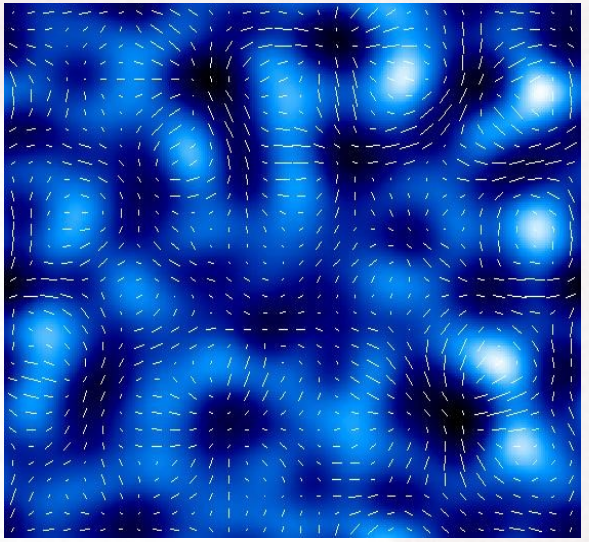
K.Dolag (Max Planck Institute for Astronomy - Garching)

Dark Matter, Dark Energy and Weak Lensing









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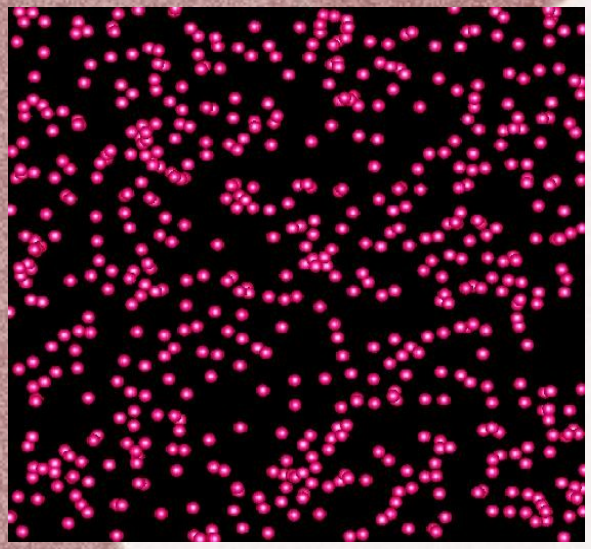

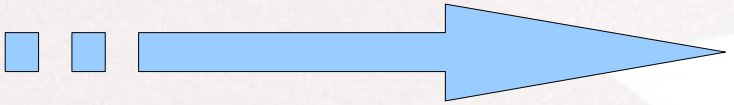

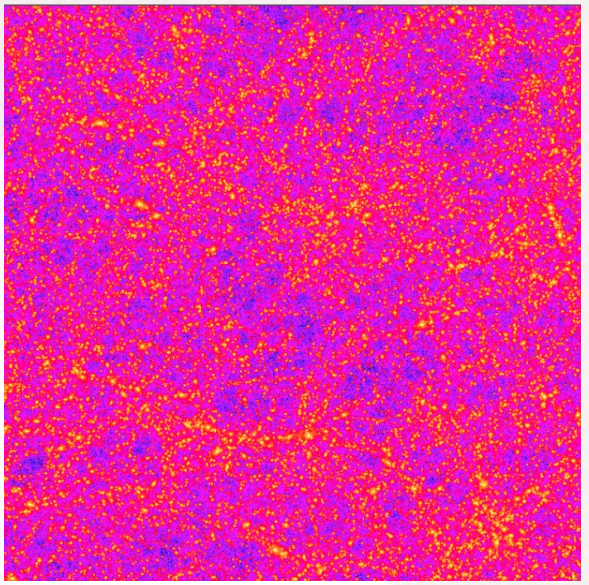

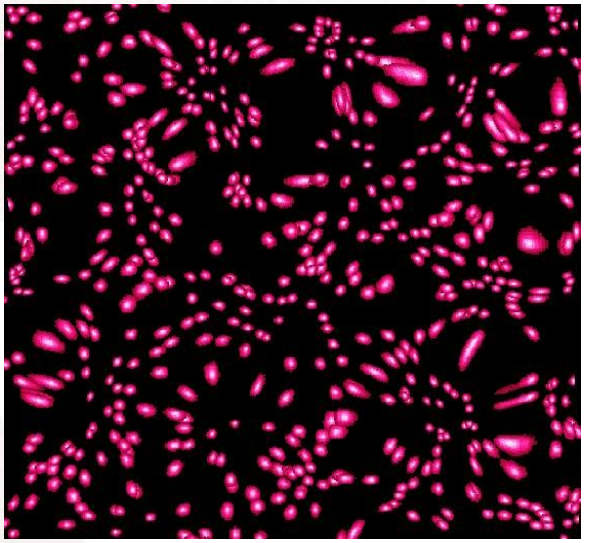

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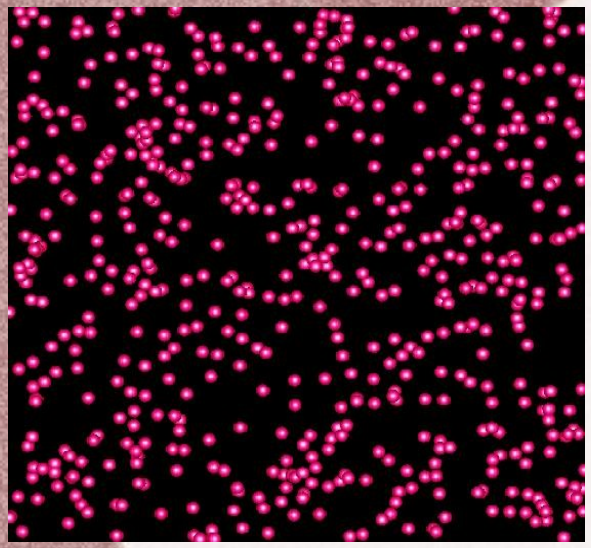
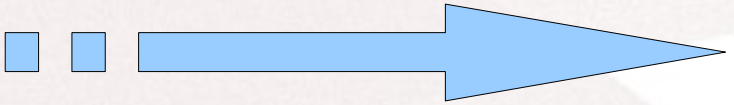
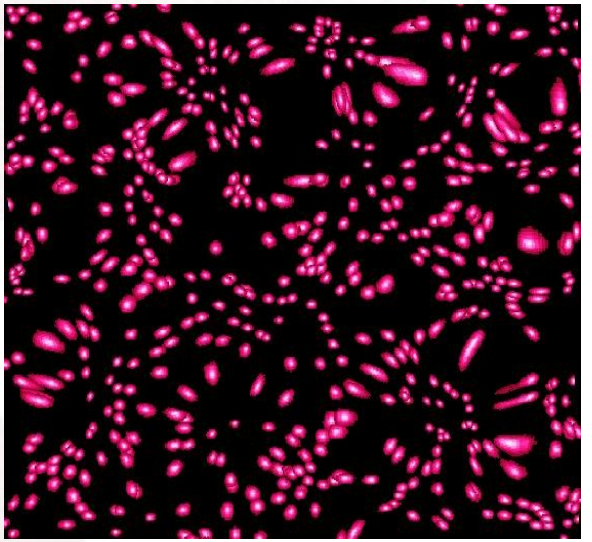
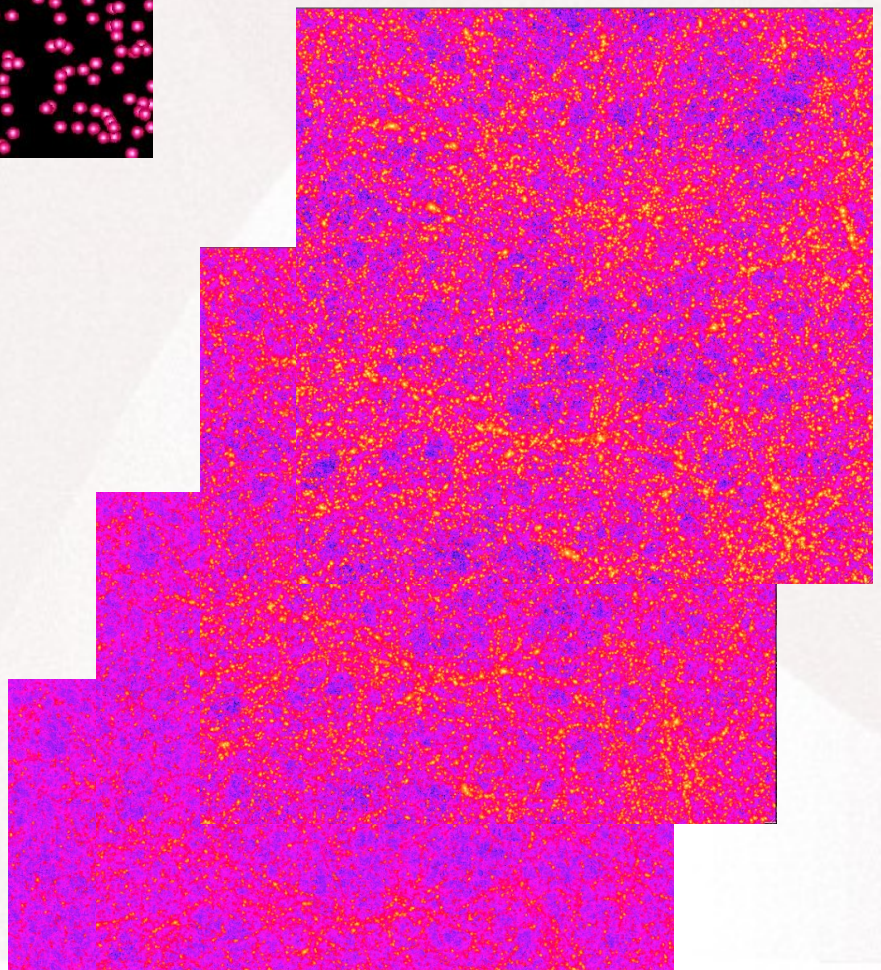








z

Practically

- Tomographic cosmic shear:

measure of the whole matter distribution at various redshifts and scales (P(k,z))

Huterer & Takada, 2005, Aph, 23, 369: accuracy ~1% obtainable

- Strategic aim:

from P(k,z) to w(z) [& “all” cosmological parameters]

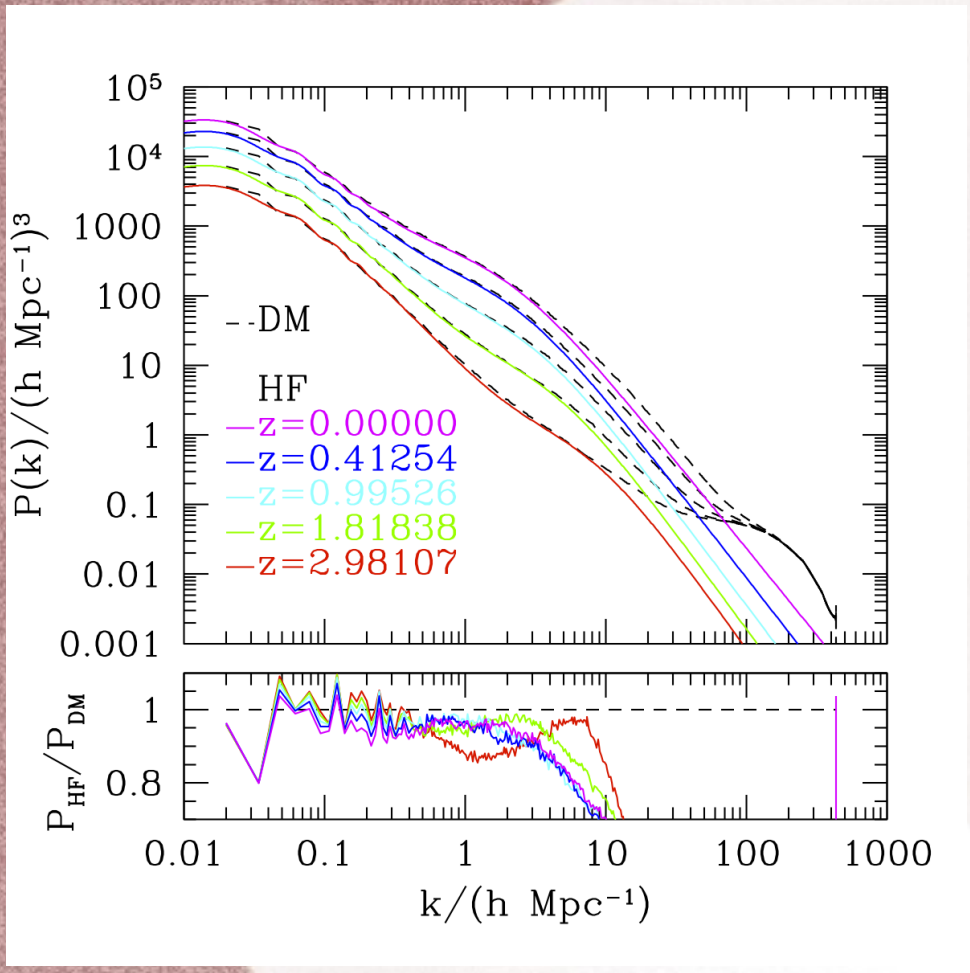
large tomographic shear survey dedicated (e.g. Euclid, DES, JPAS ...)

- From data to model:

have to build fitting procedure exploiting NON-LINEAR power spectra, BUT: no CAMB, no CMBFAST for matter to relate soon parameters to spectra.

Halofit expression (Smith+ 2003, MNRAS, 341, 1311) provide a prediction for only ΛCDM with not enough precision, and **do not include other models and baryons effect!**

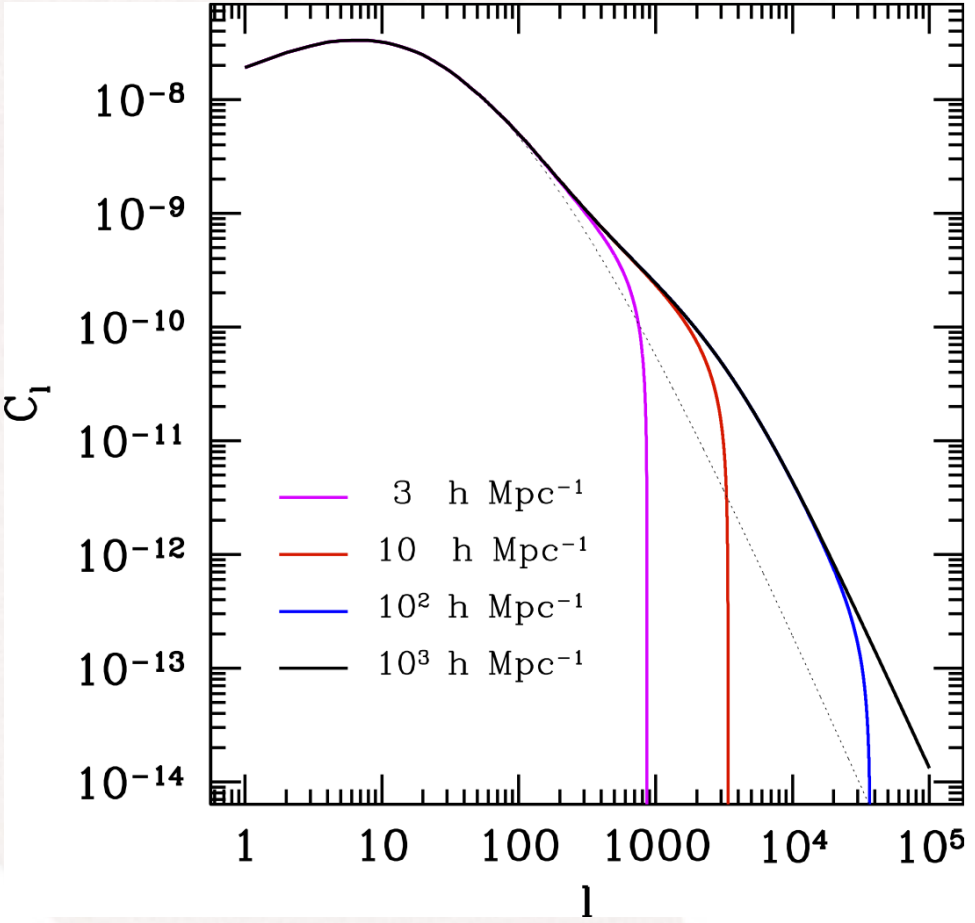
P(k): Halofit VS N-body



ΛCDM-WMAP7,N-body
Gadget III (Springel+ 2005)
L = 410 Mpc/h, Np = 1024^3

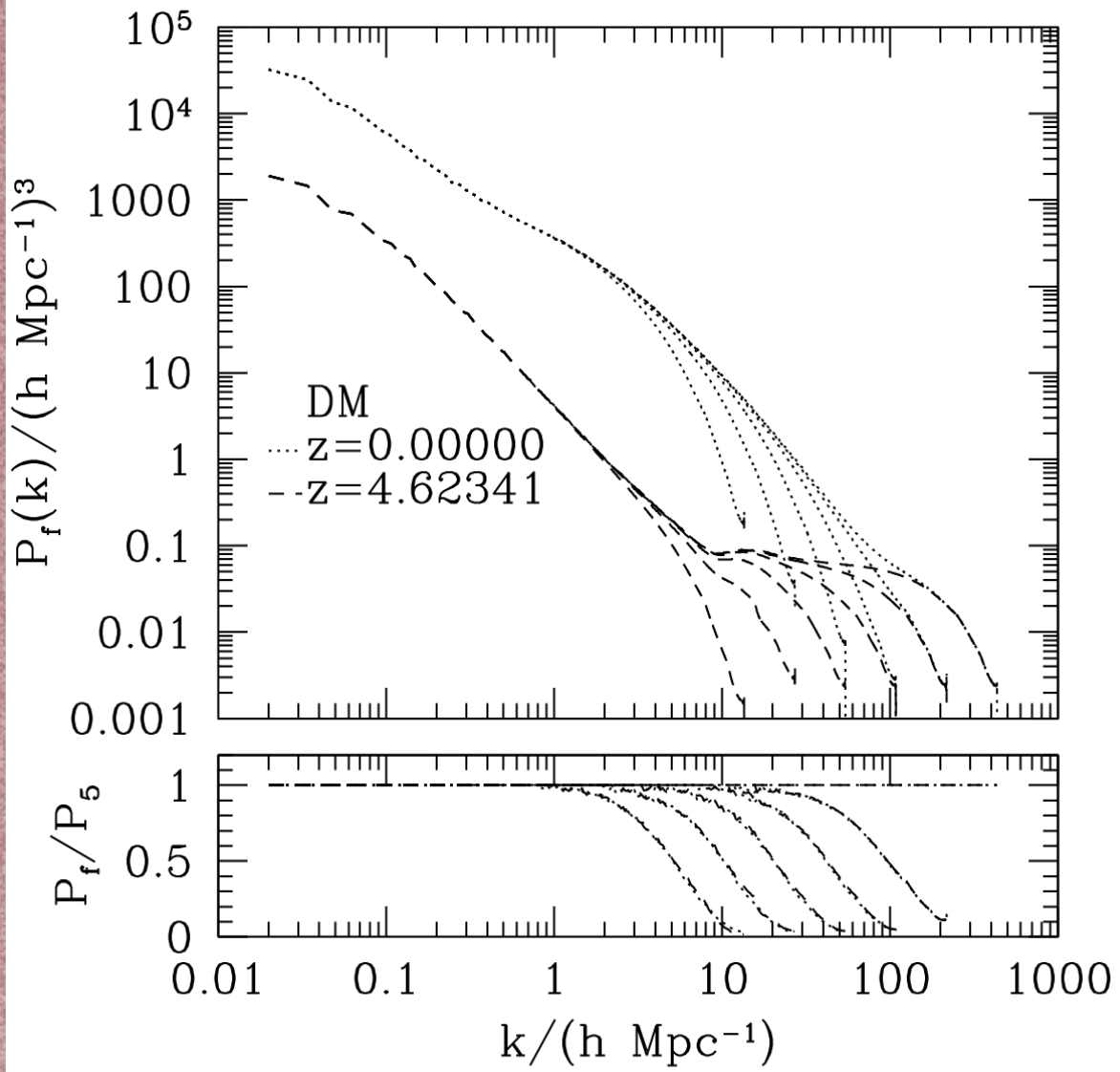
L.Casarini et al. 2012, A&A, 542, 126
Confirm L.Casarini et al. 2009, Hilbert et al 2009.

P(k) ---> WL(l)



$$P_{ij}(\ell) = H_0^3 \int_0^\infty \frac{dz}{E(z)} W_i(z) W_j(z)\, P_{nl}\left(\frac{H_0 \ell}{r(z)}, z\right)$$

Cloud in Cell resolution



Simulation:
ΛCDM-WMAP7, Gadget III
L = 410 Mpc/h, Np = 1024^3

Power Spectrum:
CIC: particles to density grid
Ncells=$Ngrid^3$
(Ngrid=1024xf
f=1,2,4,8,16,32)
after FFT 3d

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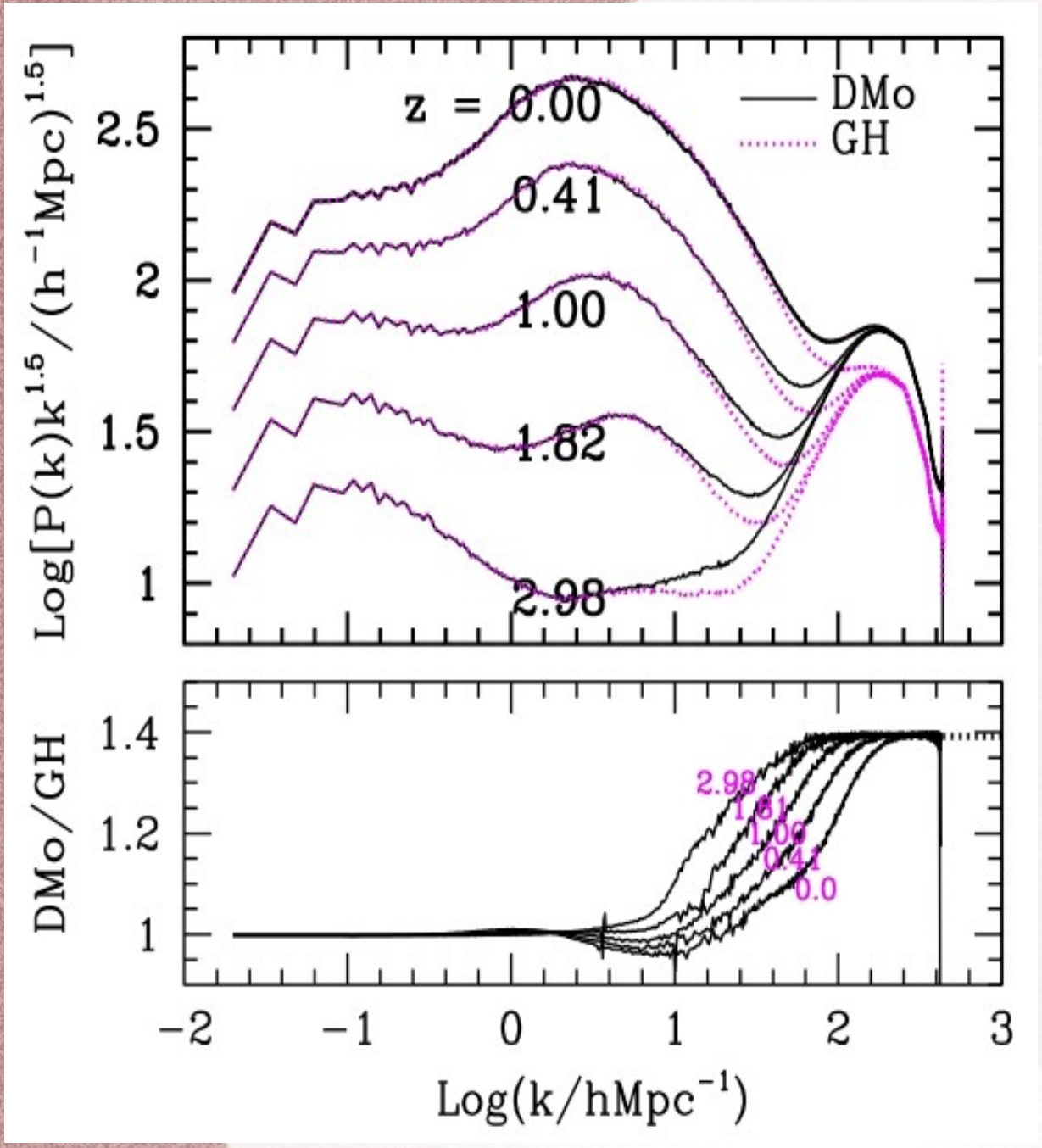
L.Casarini et al 2012, A&A, 542, 126

Grid Noise



- DM : N-body

  N-body IC particles distribution

  1024^3 (m~2.7e9 M_s/h)

- GH : hydro non radiative

  hydro IC particles distribution

  1024^3 (m~2.3e9 M_s/h) + 1024^3 (m~3.9e8 M_s/h)

L.Casarini et al 2012, A&A, 542, 126

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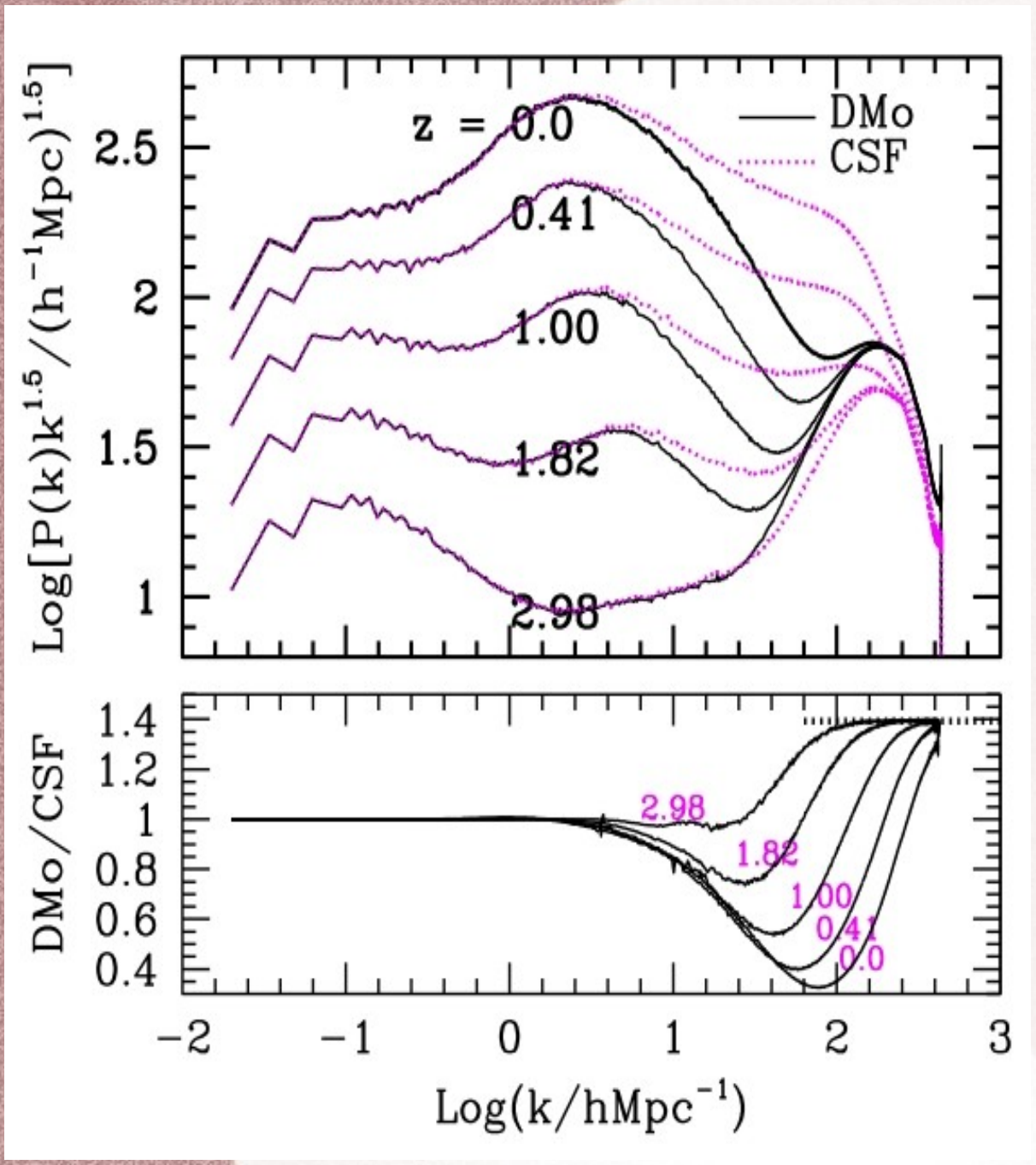


- DM : purely gravitational N-body

  classic IC particles distribution

  1024^3 (m~2.7e9 M_s/h)

- CSF : hydro sim with cooling, star formation, SN feedback, UV background

  1024^3 (m~2.3e9 M_s/h) + 1024^3 (m~3.9e8 M_s/h)

.

ΛCDM-WMAP7, Gadget III

L = 410 Mpc/h , Np = 2 x 1024^3

L.Casarini et al 2012, A&A, 542, 126

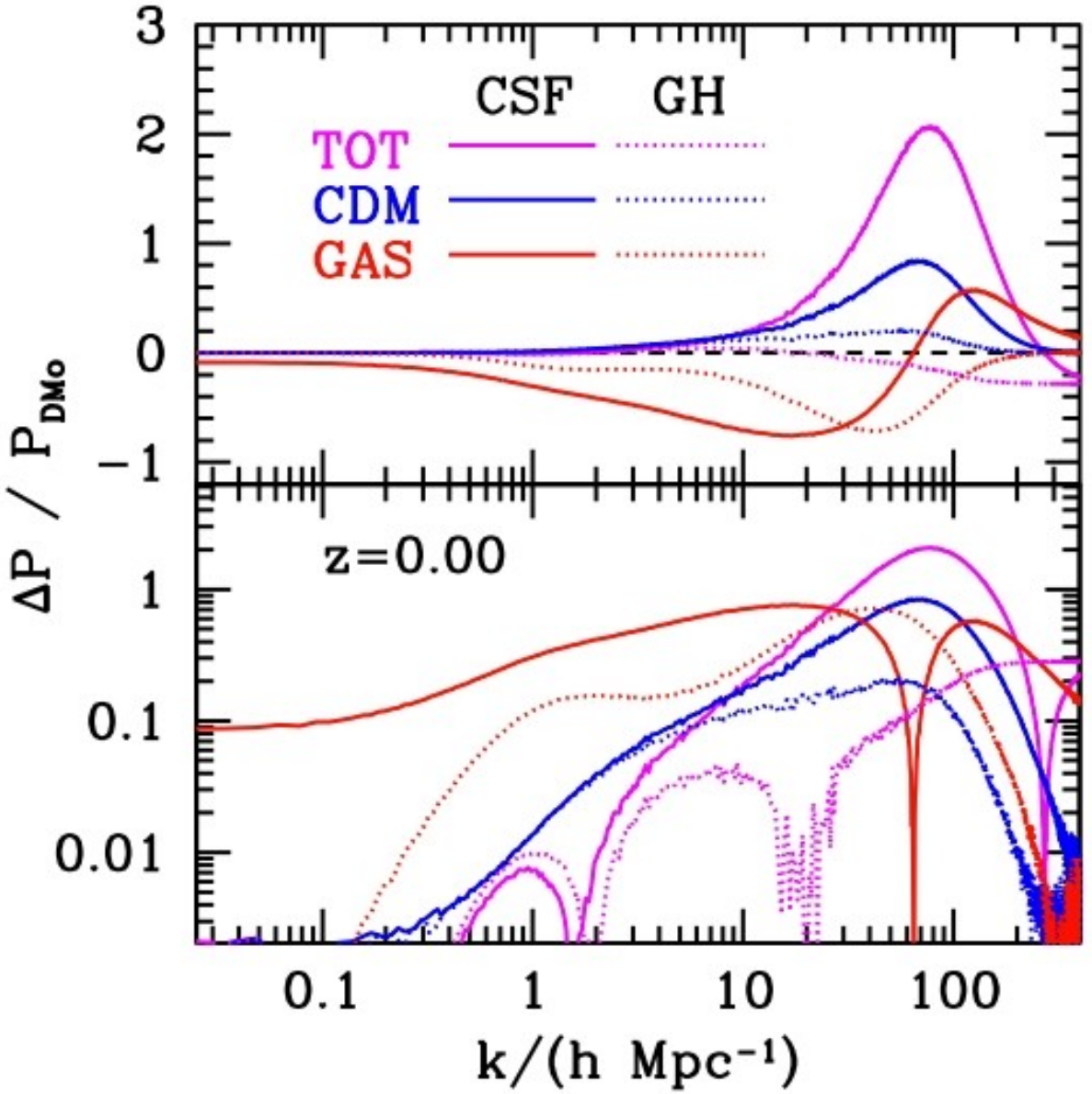
N-body vs Hydro (ΛCDM)

GH
hydro sim,
no cooling
no star formation

CSF
hydro sim with
cooling, star formation,
SN feedback, UV background

ΛCDM-WMAP7, Gadget III

L = 410 Mpc/h
Np = 2 x 1024^3



L.Casarini et al. 2012, A&A, 542, 126

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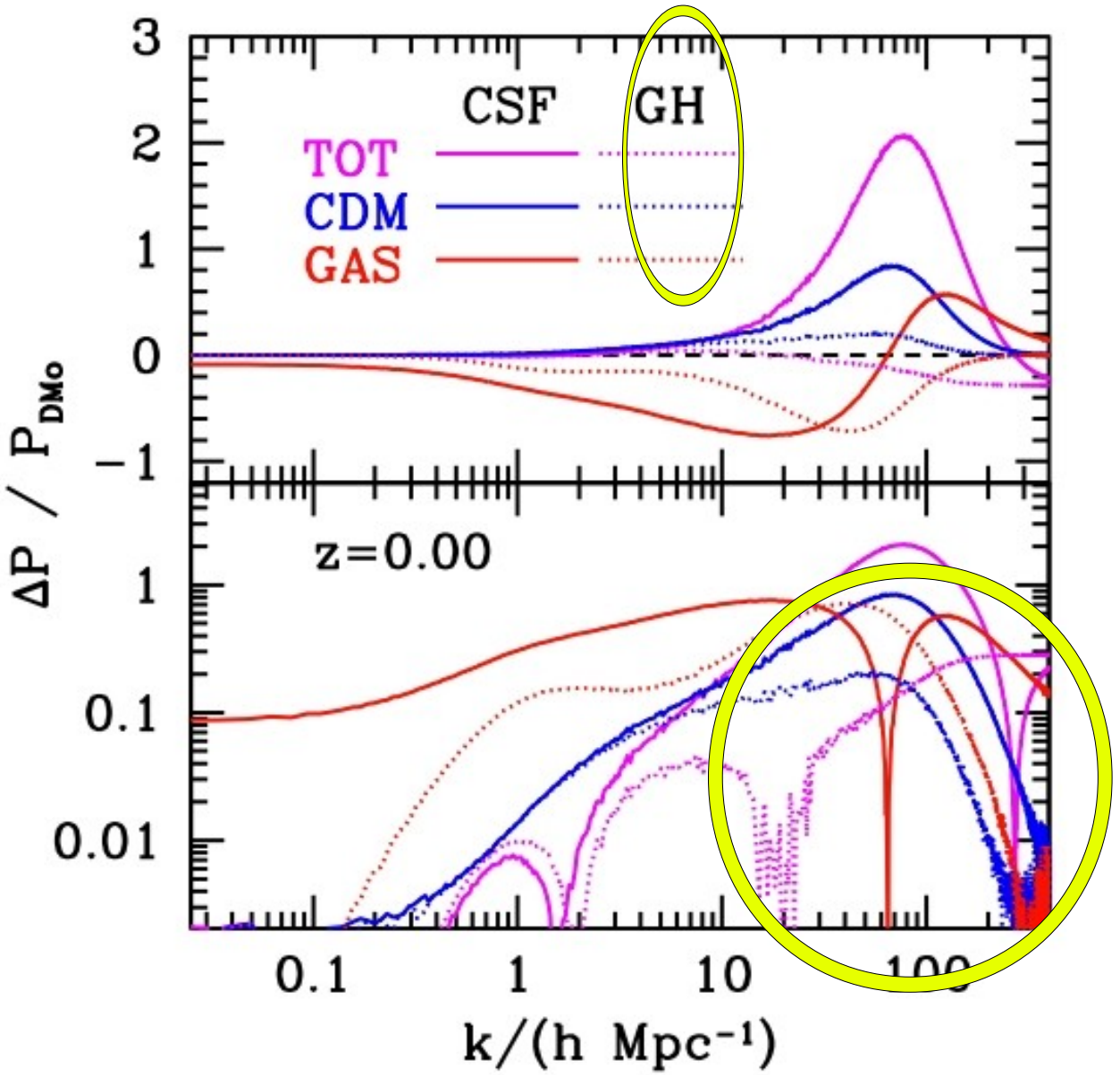

L.Casarini et al. 2012, A&A 542,126

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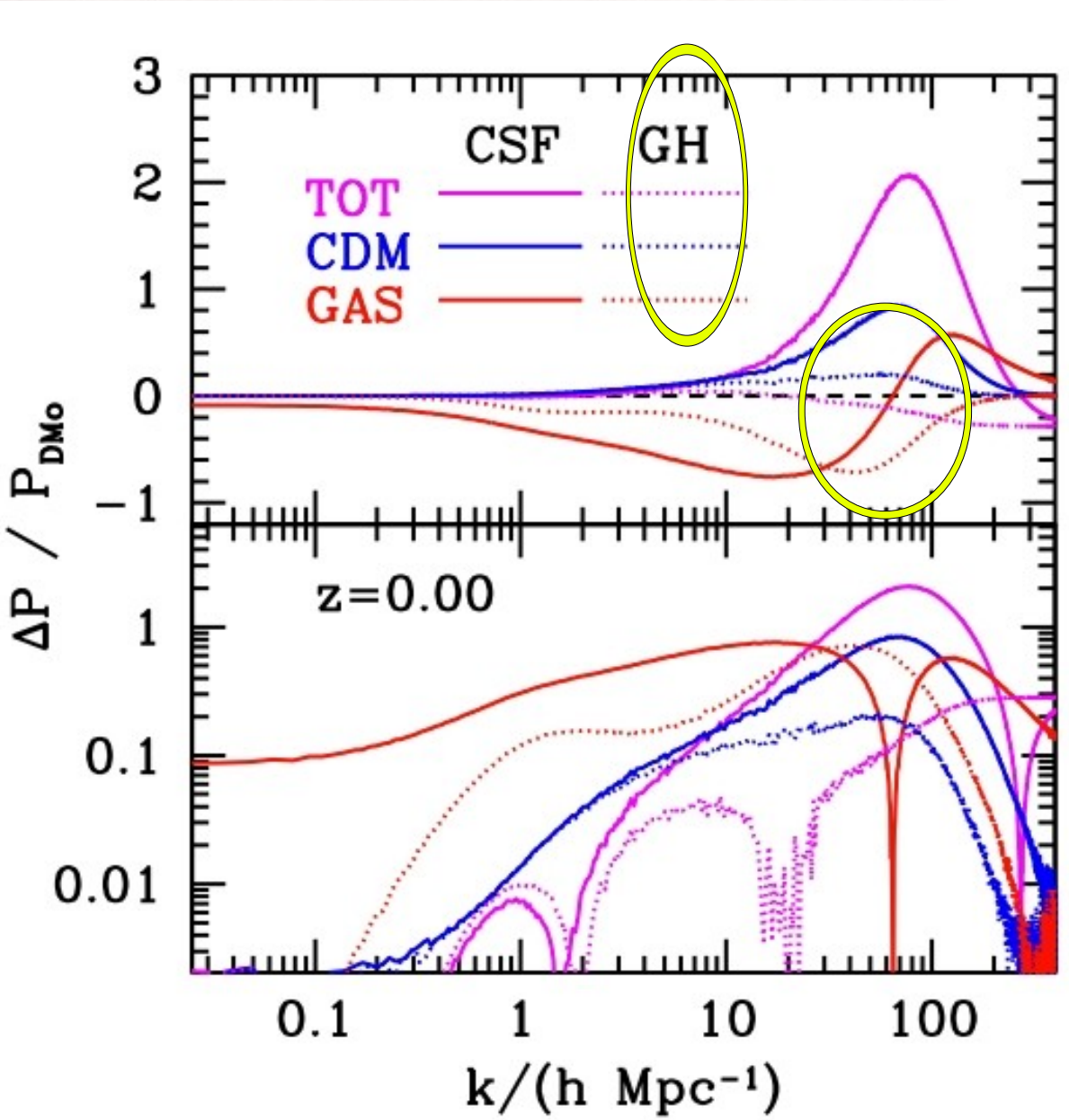
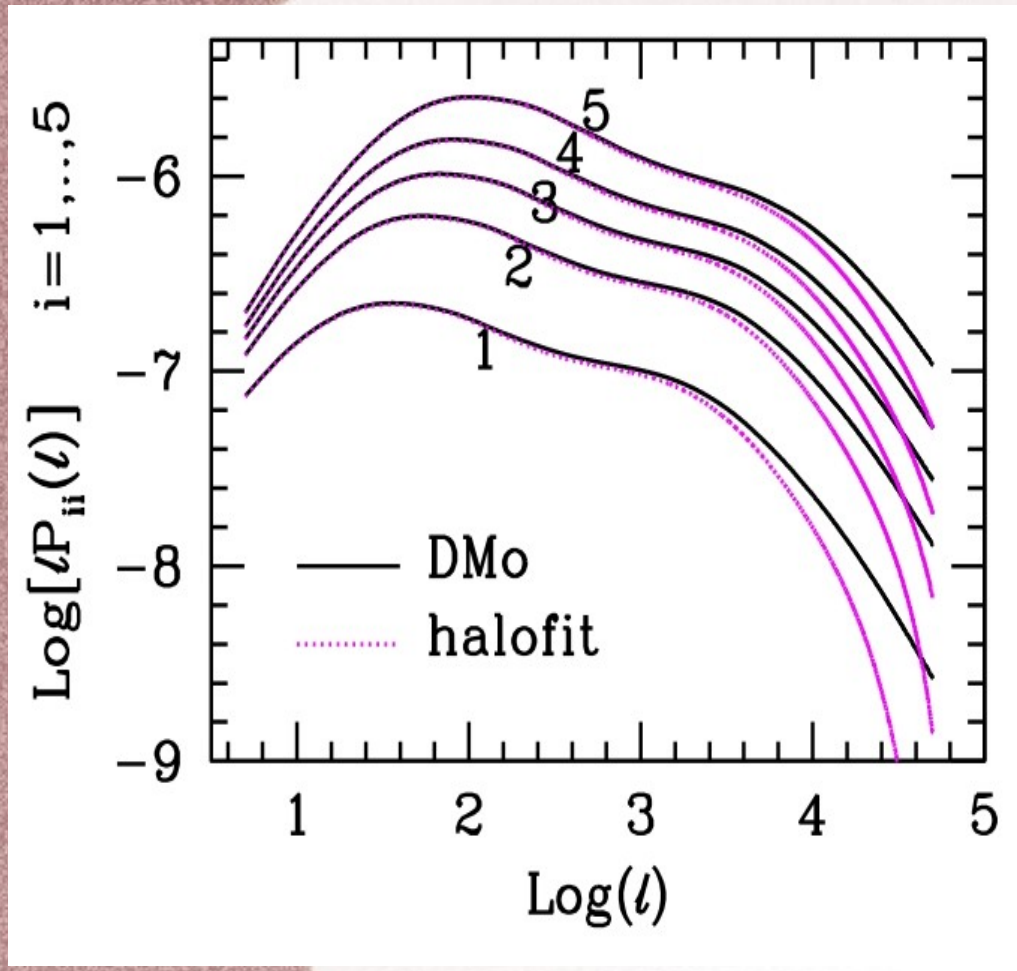
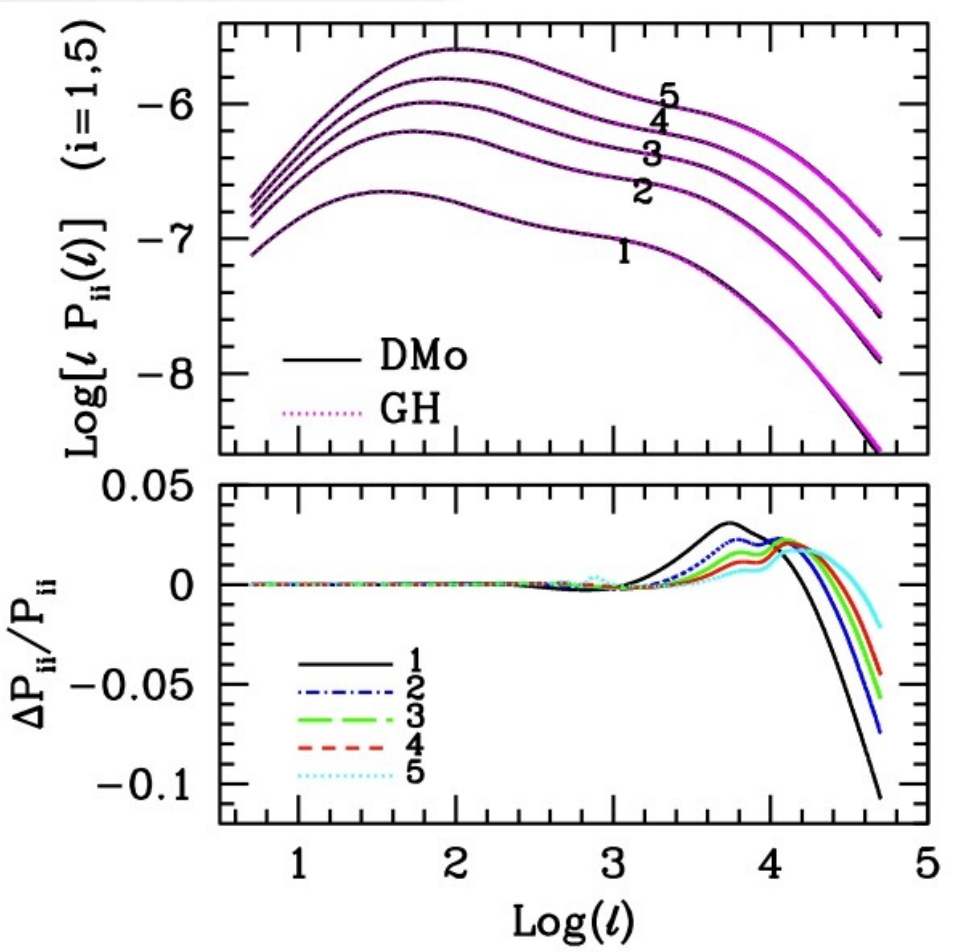


L.Casarini et al. 2012, A&A 542,126

from simulations to weak lensing





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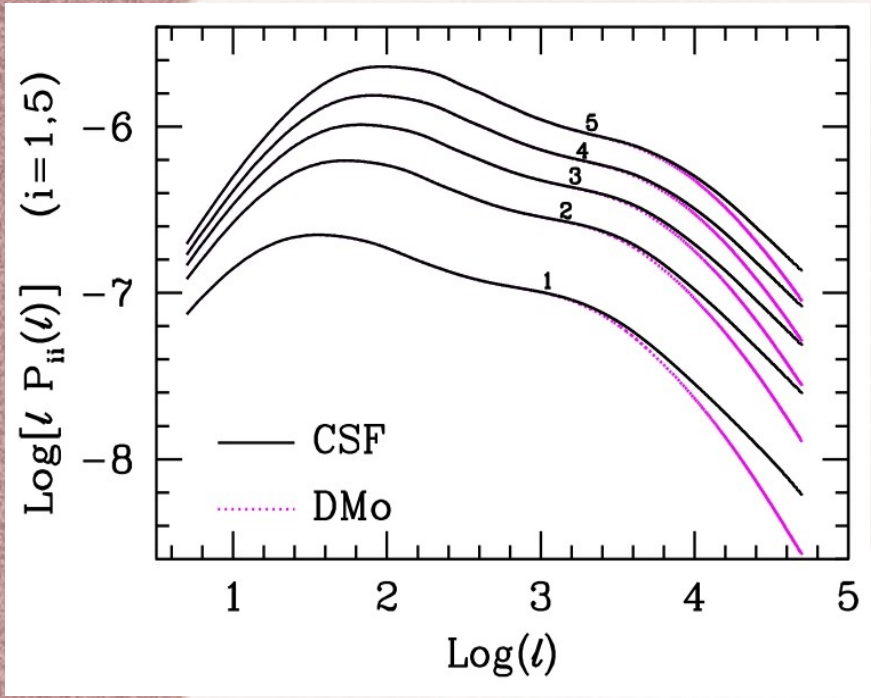

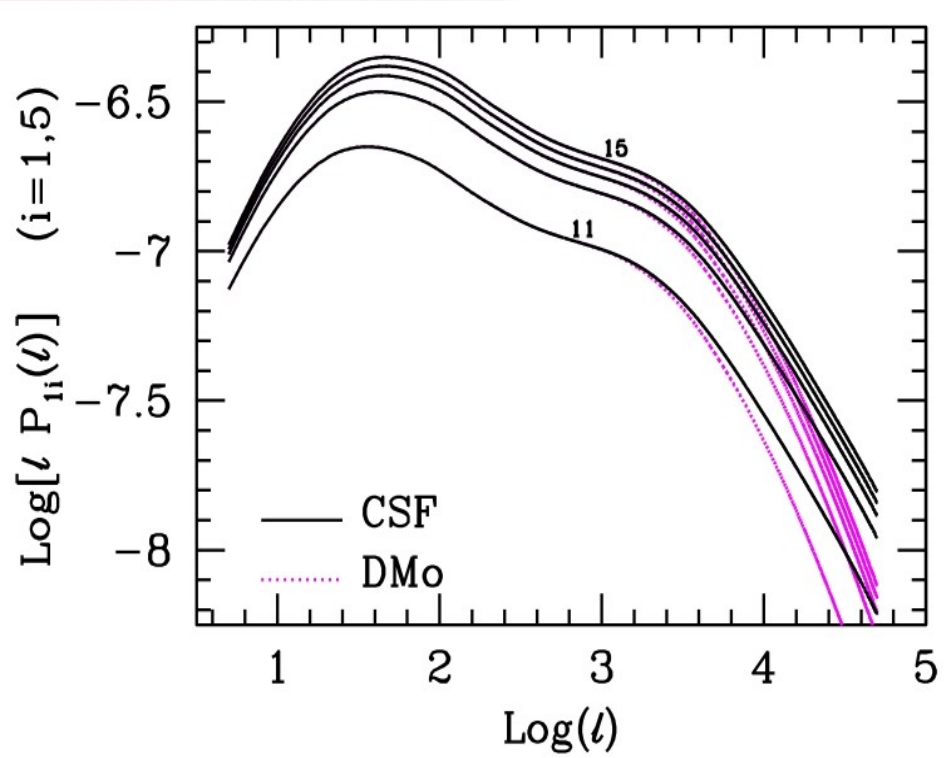

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L.Casarini et al. 2012, A&A, 542, 126

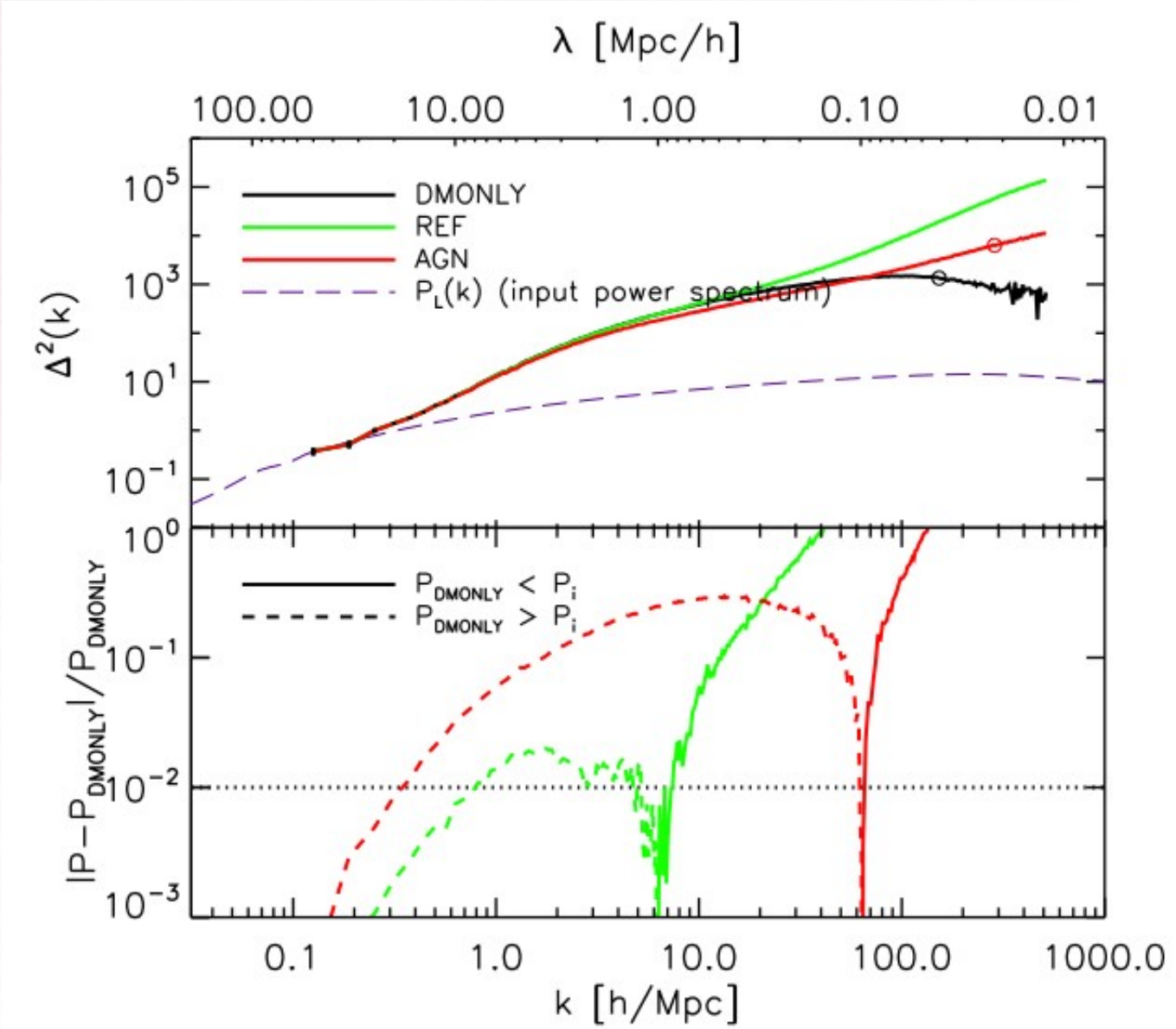
N-body vs Hydro (ΛCDM)

+
AGN
feedback

hydro sim with
cooling, star formation,
SN feedback, UV background

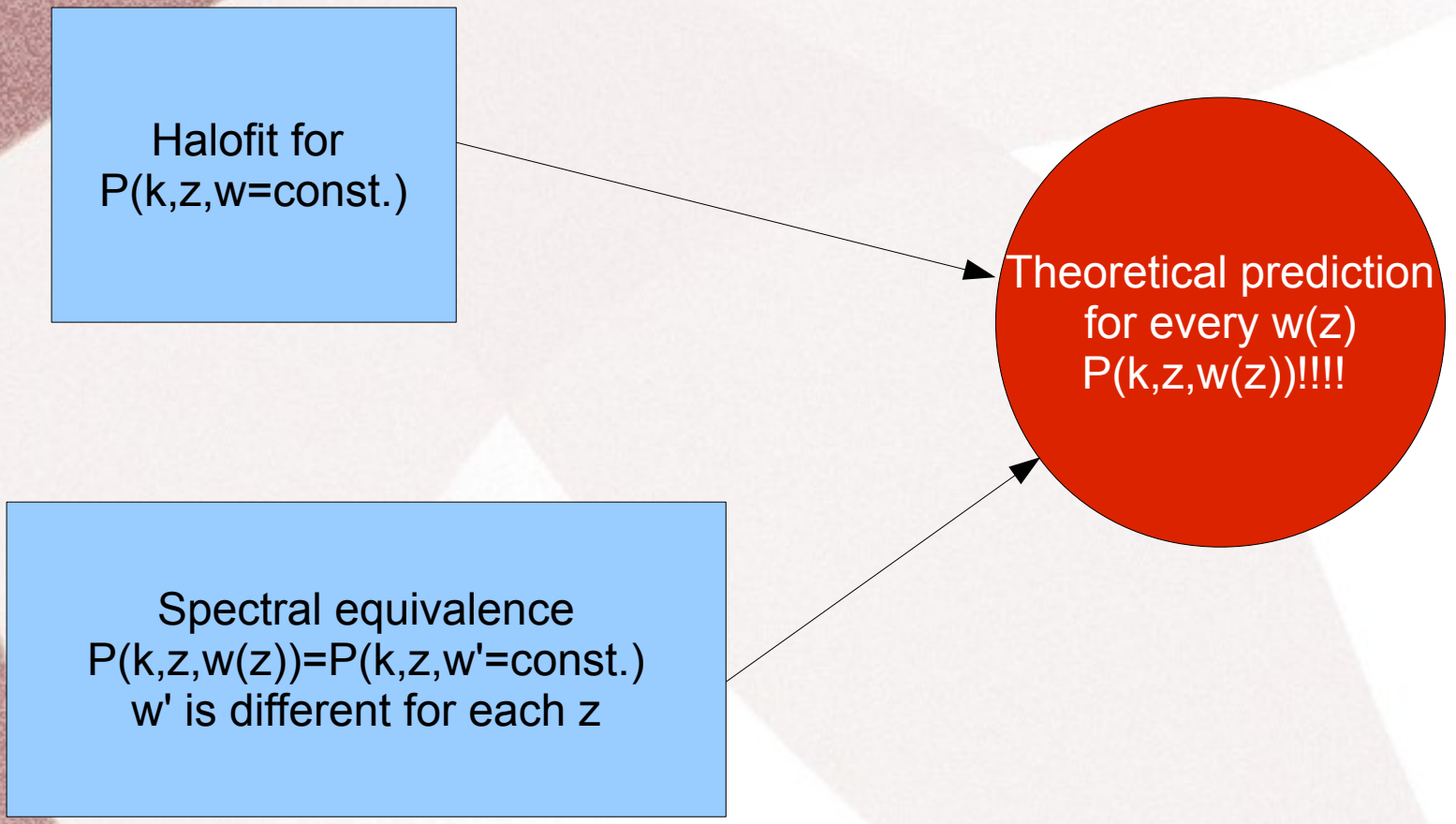
ΛCDM-WMAP7, Gadget III

L = 100 Mpc/h
Np = 2×512^3

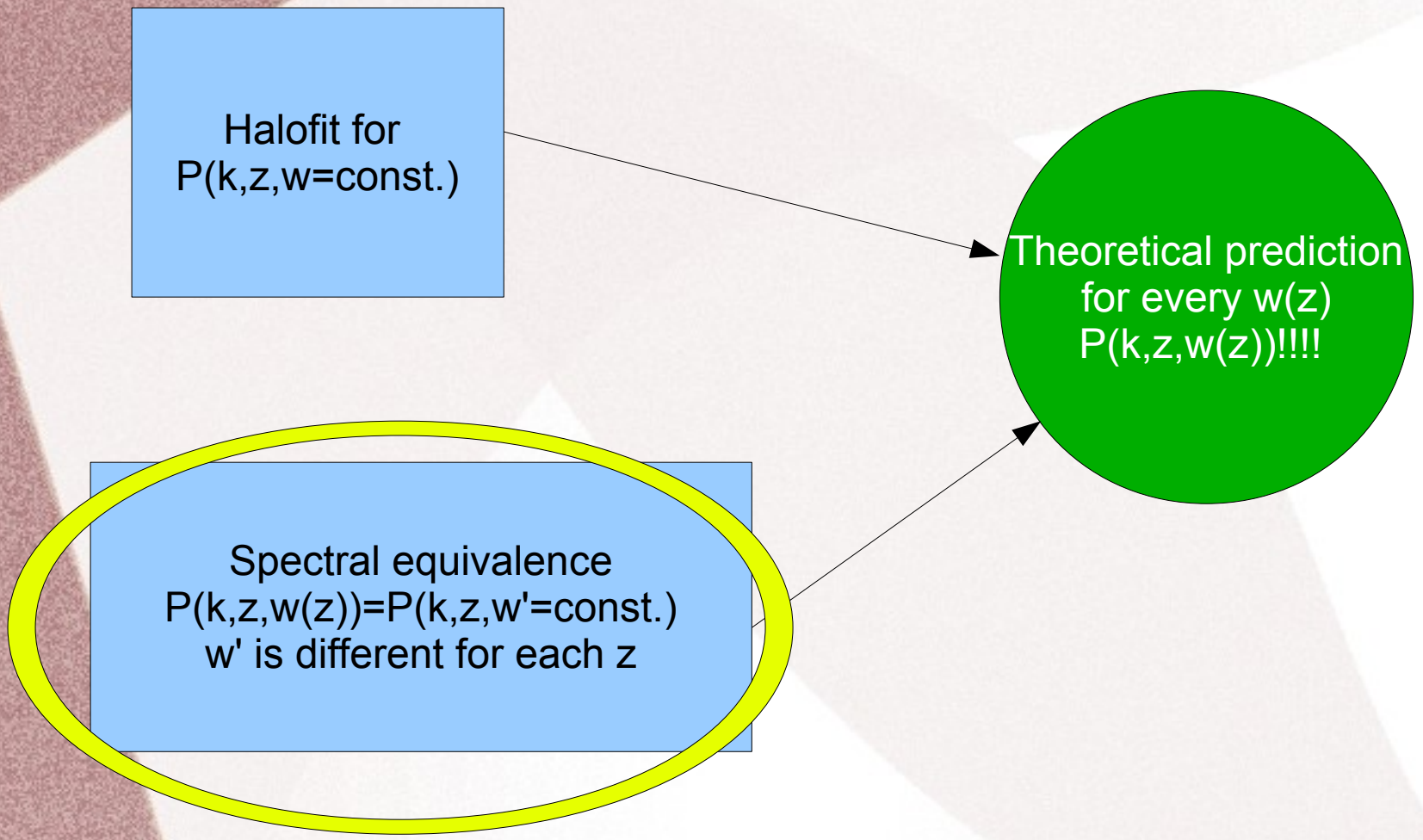


M.Vaan Daalen, J.Schaye, C.Booth, C.Dalla Vecchia, 2011, MNRAS, 415, 3649

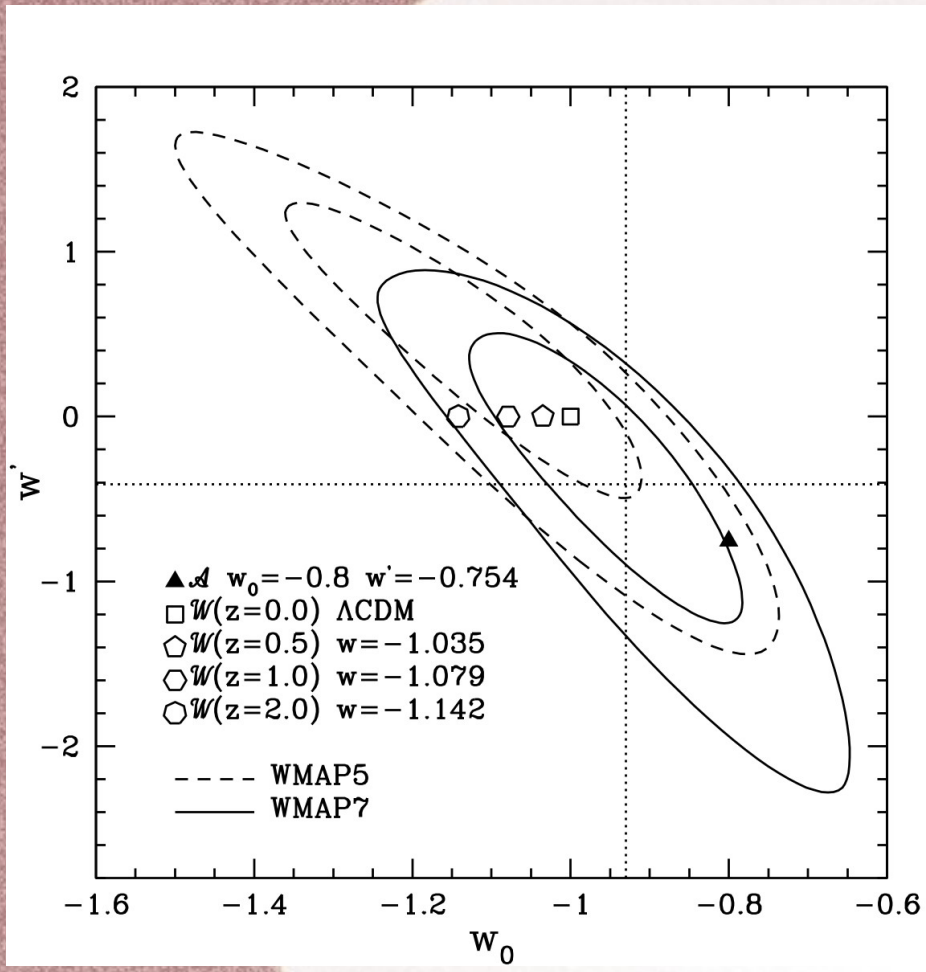
Halofit for every cosmology:

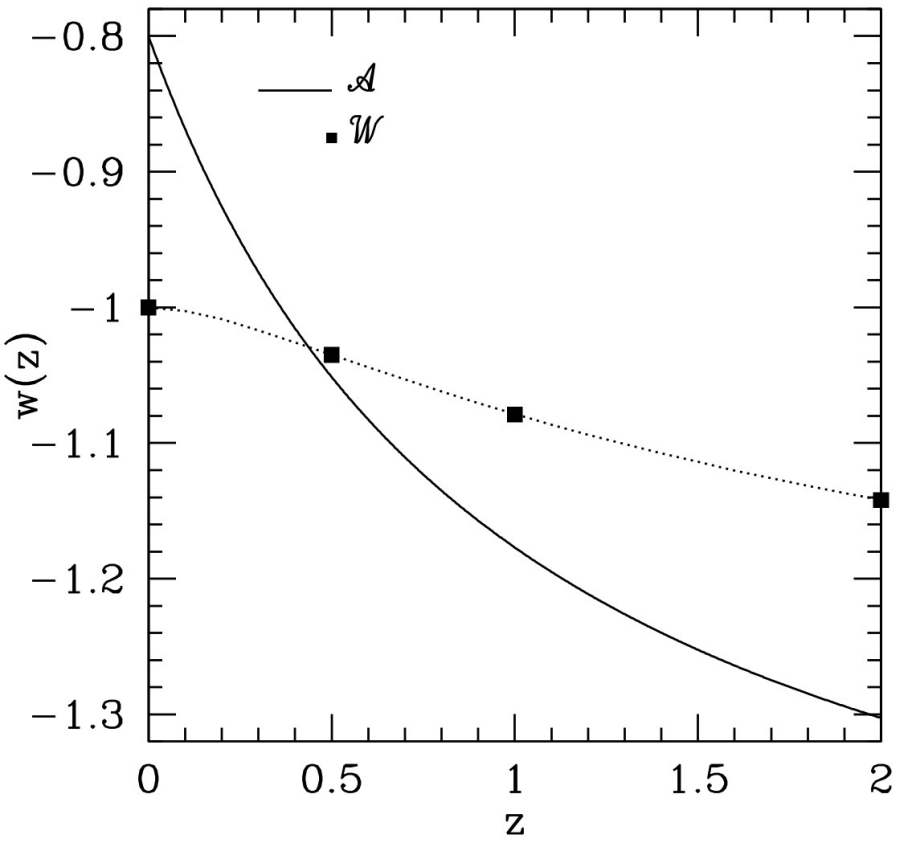


Halofit for every cosmology:



Spectral Equivalence





GASOLINE
gas cooling, star formation, UV background, SN feedback
L = 256 Mpc/h, Np = 2 X 256^3

L.Casarini, A.Maccio', S.Bonometto & G.Stinson 2011, MNRAS, 412, 911

Conclusions

we need a theoretical tool to predict the non linear matter power spectrum
- Halofit works only for k<3 at >3% for N-body and LCDM
- future lensing data provide spectrum also at l>>10^3

we have to take in account:
- in nature there are baryons! Large influence at non linear scales
- LCDM is not the only answer, for example we are interested to Dynamical Dark Energy

simulations accuracy:
- grid noise
- mass segregation
- box size – sample variance
- AGN feedback

Dark Energy:
- there is a spectral equivalence from w(z) to w=const(z) working with baryons!
- finding a prediction for w=const models is sufficient!