



Summary of Moriond 2018

Cosmology session

May 14, 2018

Clément Leloup

I. Cosmic Microwave Background

II. Large Scale Structures

III. Dark Matter

IV. Dark Energy and Modified Gravity

I. Cosmic Microwave Background

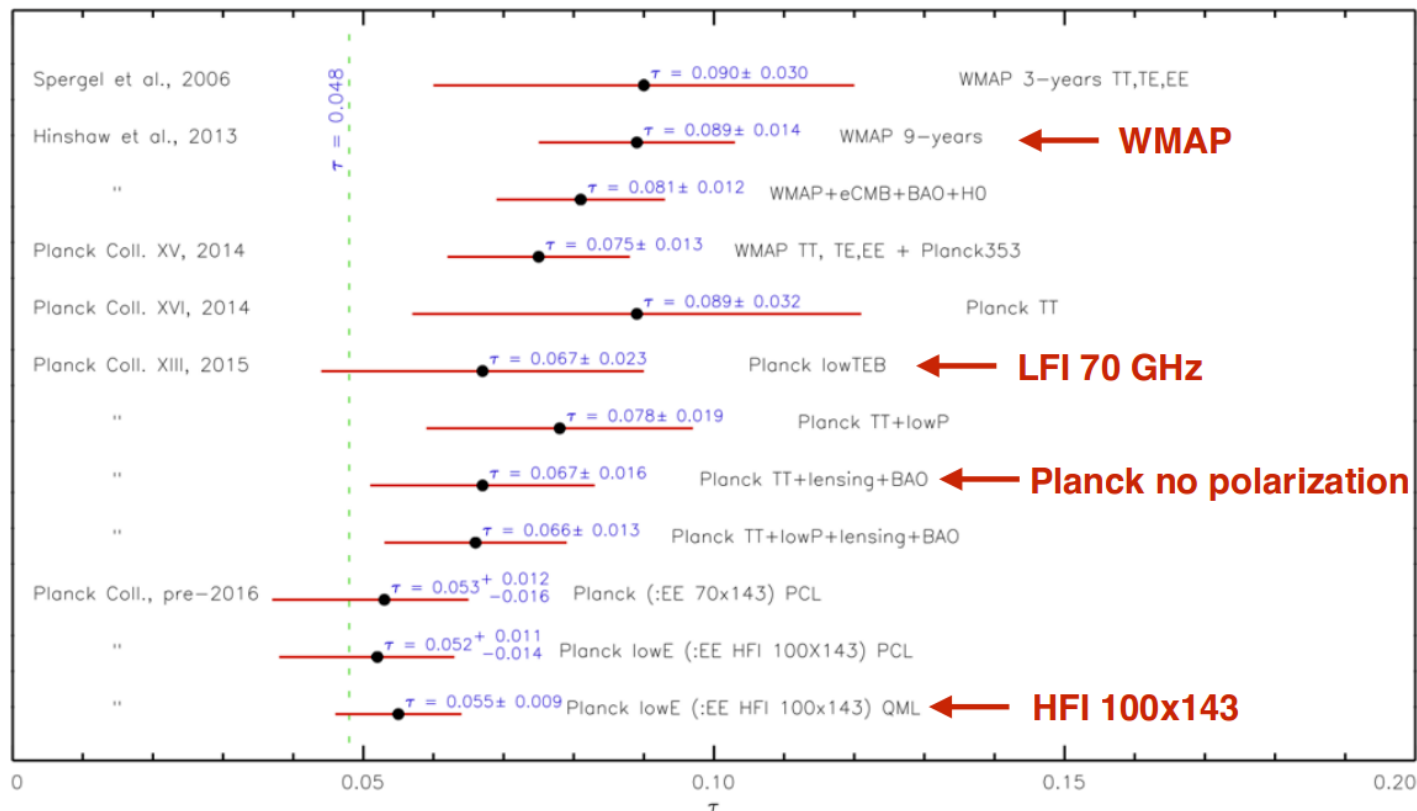
II. Large Scale Structures

III. Dark Matter

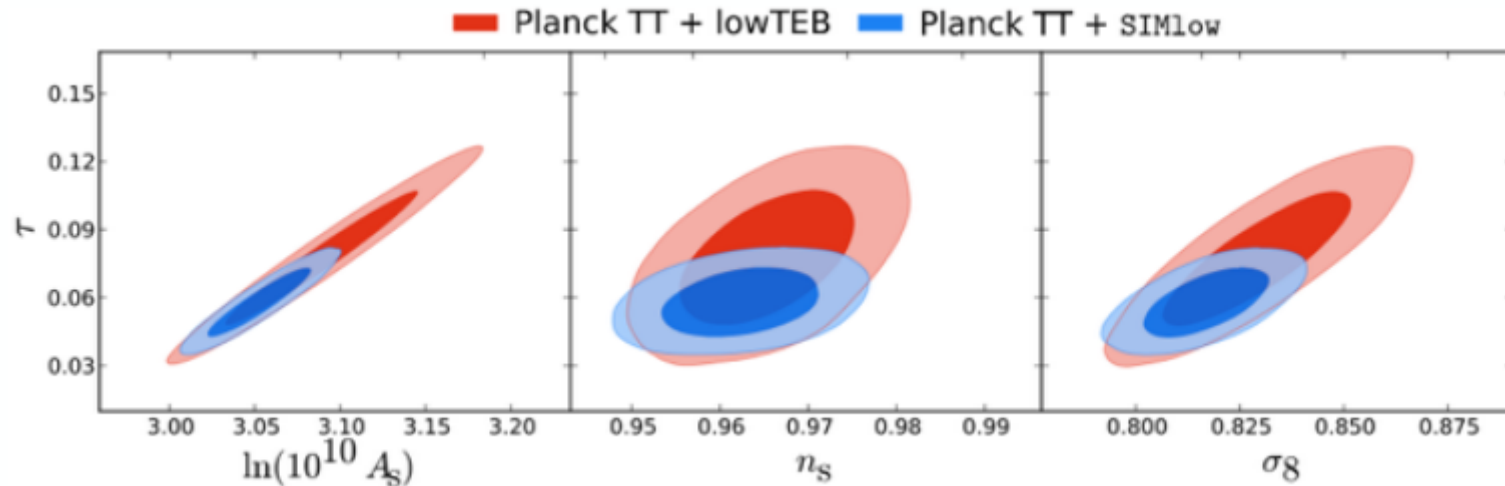
IV. Dark Energy and Modified Gravity

► Planck 2018 release (coming soon) :

- ◆ Final official Planck release
- ◆ HFI large scale EE and BB polarization



- Effect of the low value of τ :



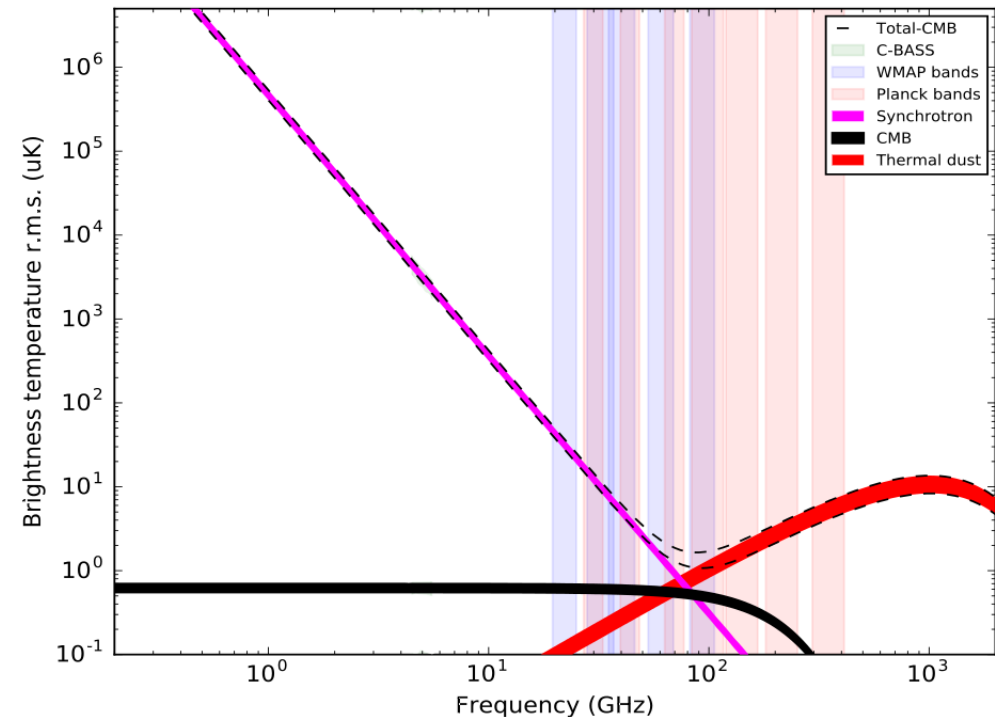
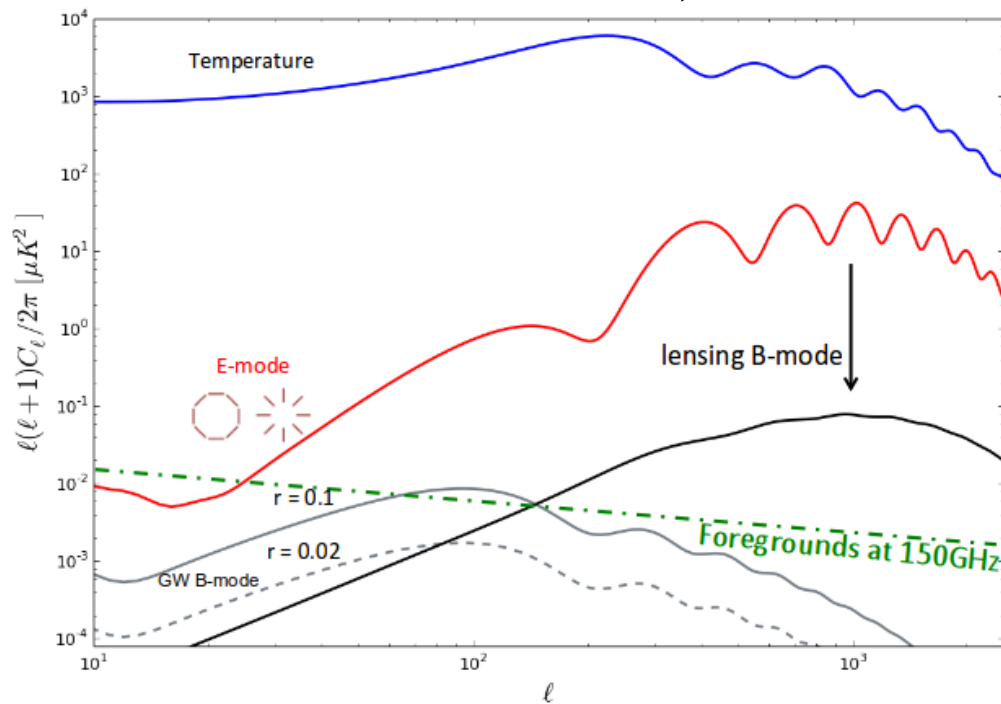
- ◆ Hubble constant down by half- σ , tension now at 3.7σ w.r.t. Riess 2018
- ◆ On the total neutrino mass :

$$\sum m_\nu < 0.34\text{eV} \quad \text{PlanckTTTEEE} + \text{lowP}$$

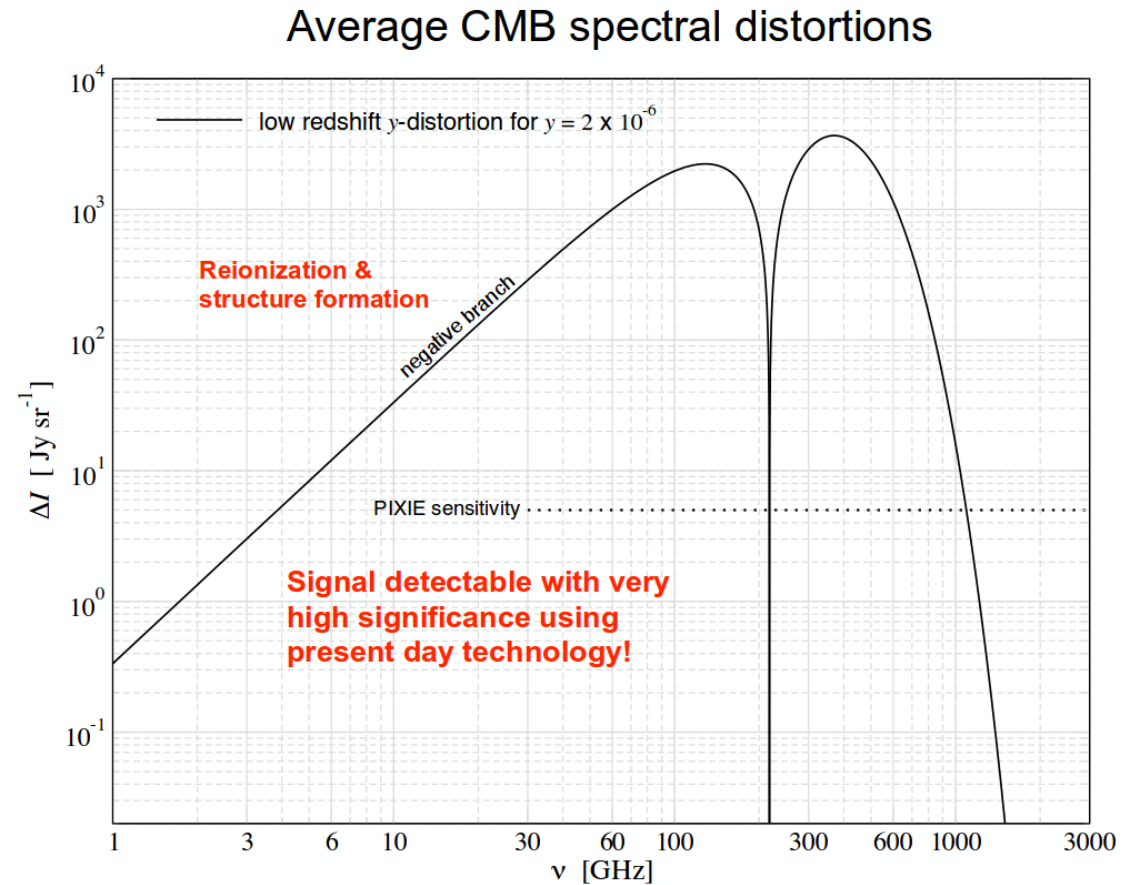
$$\sum m_\nu < 0.49\text{eV} \quad \text{PlanckTTTEEE} + \text{SimLow}$$

$$\sum m_\nu < 0.14\text{eV} \quad \text{PlanckTTTEEE} + \text{SimLow} + \text{BAO}$$

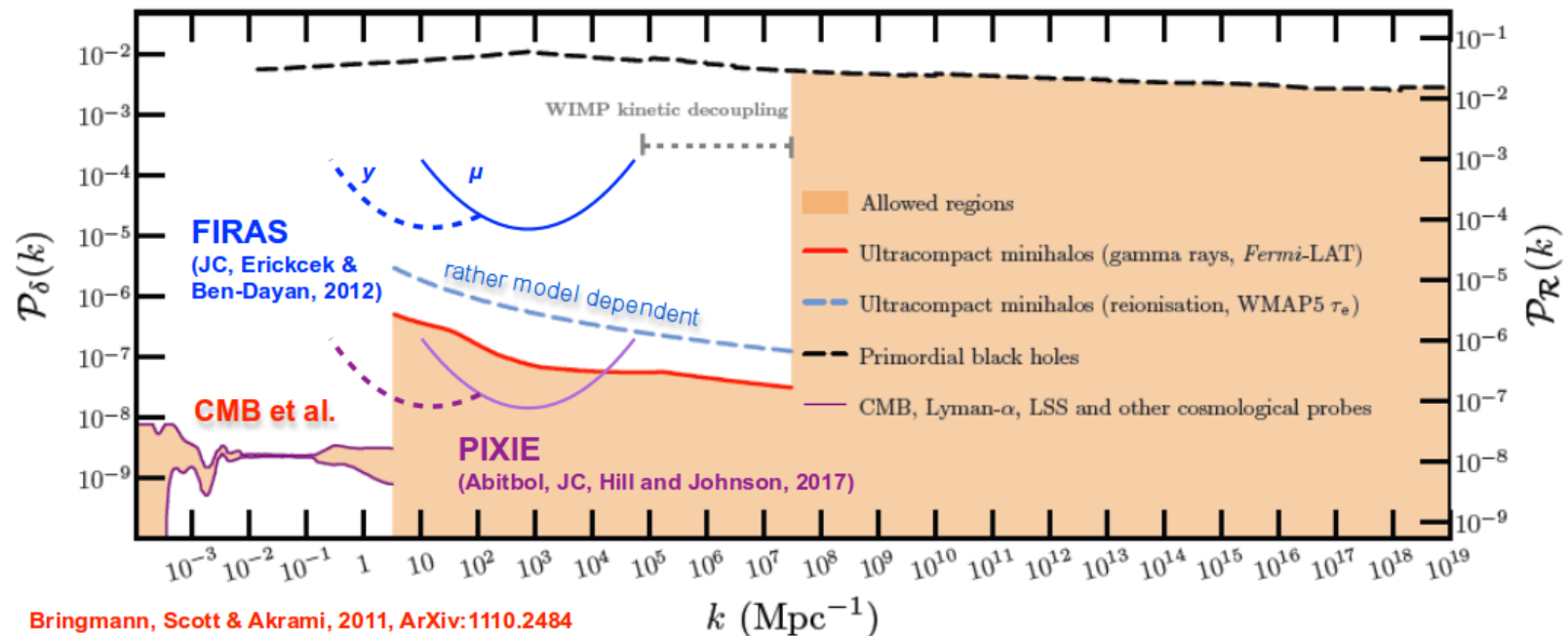
- Big effort on E and B polarization modes :
 - ◆ Foreground removal (Quijote, C-BASS, ...)
 - ◆ B-modes measurement and delensing (SPT, BICEP/Keck, ...)



- CMB spectral distortions (Pixie ?) :
 - ◆ Easy to detect



- CMB spectral distortions (Pixie ?) :
 - ◆ Easy to detect
 - ◆ Complementary with other probes
 - ◆ Multipurpose (DM, recombination, reionization, inflation, ...)



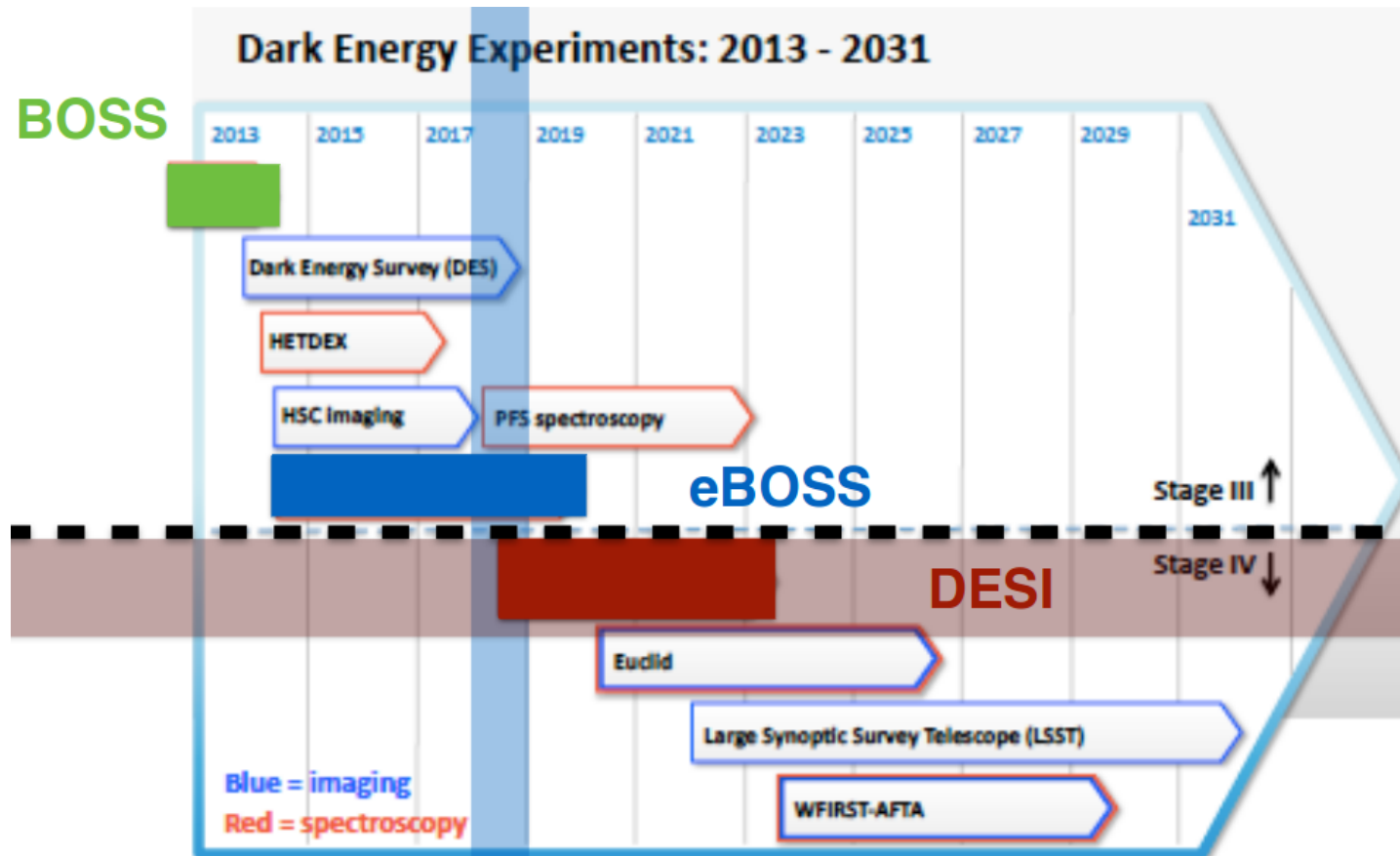
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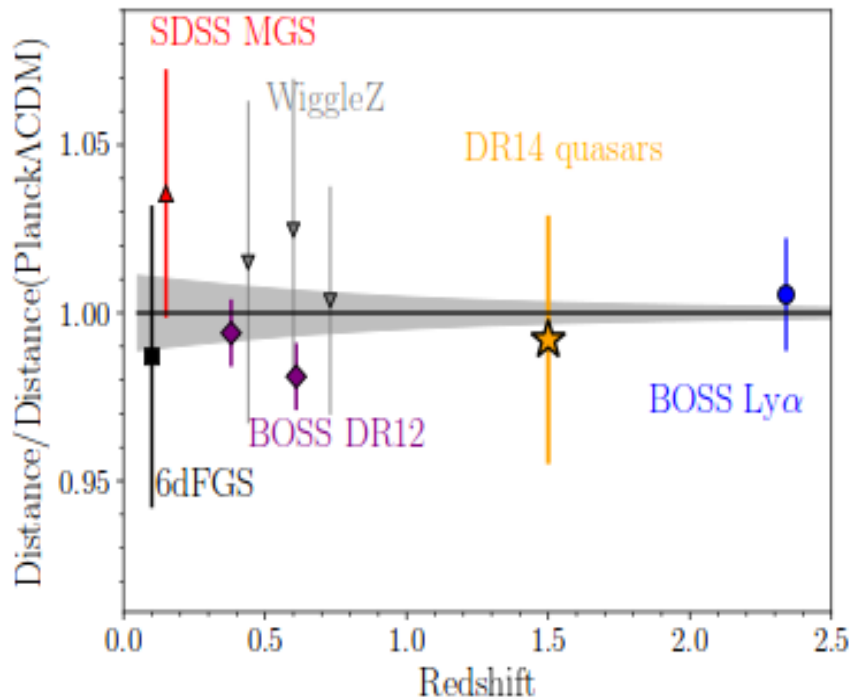
IV. Dark Energy and Modified Gravity

➤ Entering stage IV era :

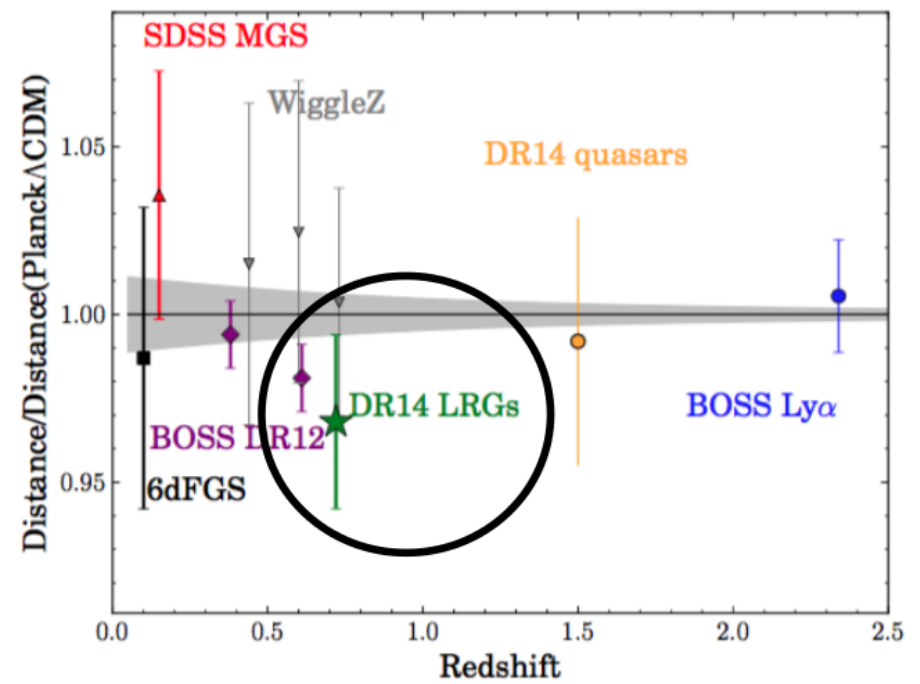


- Measurements from overdensities with eBOSS :
 - ◆ BAO scale

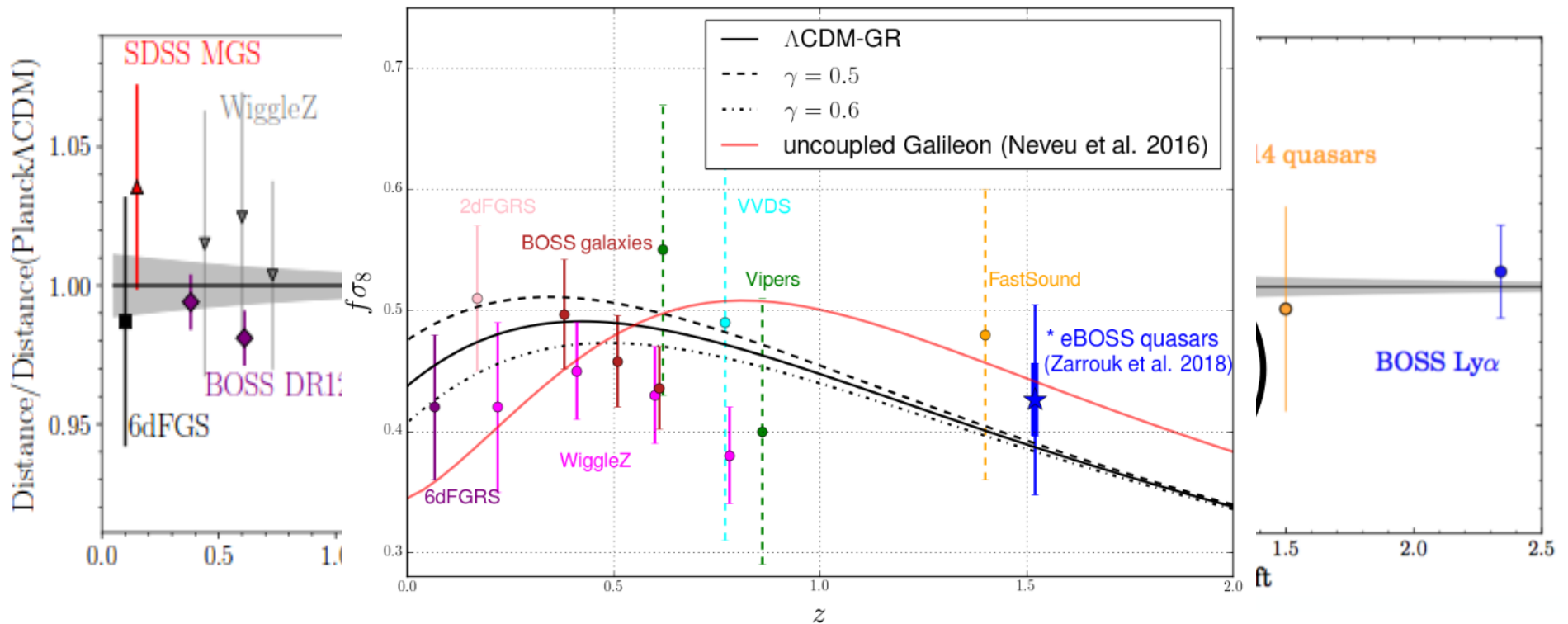
(Hector Gil-Marin's talk or Ata et al. 2017)



(Julian Bautista's talk)



- Measurements from overdensities with eBOSS :
 - ◆ BAO scale
 - ◆ Growth rate of structures



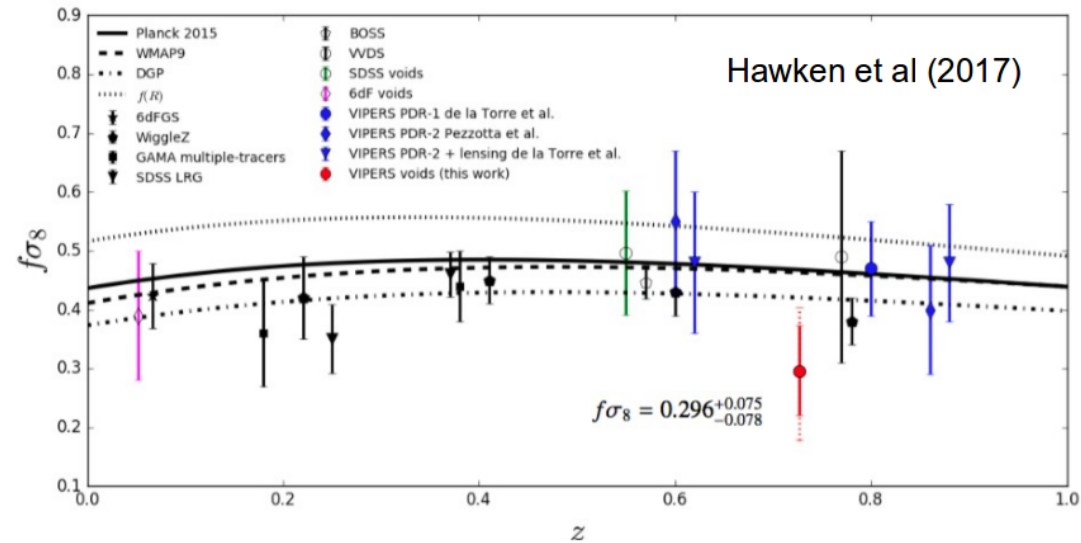
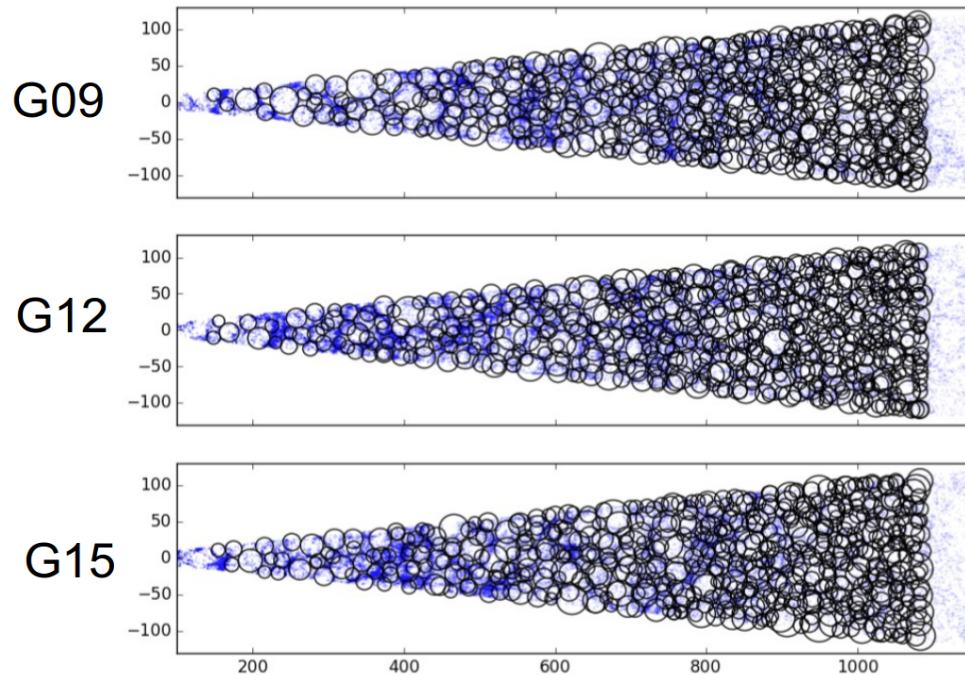
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(Pauline Zarrouk's talk or Zarrouk et al. 2018)

- Measurements from underdensities (voids) :
 - ◆ Growth rate of structures

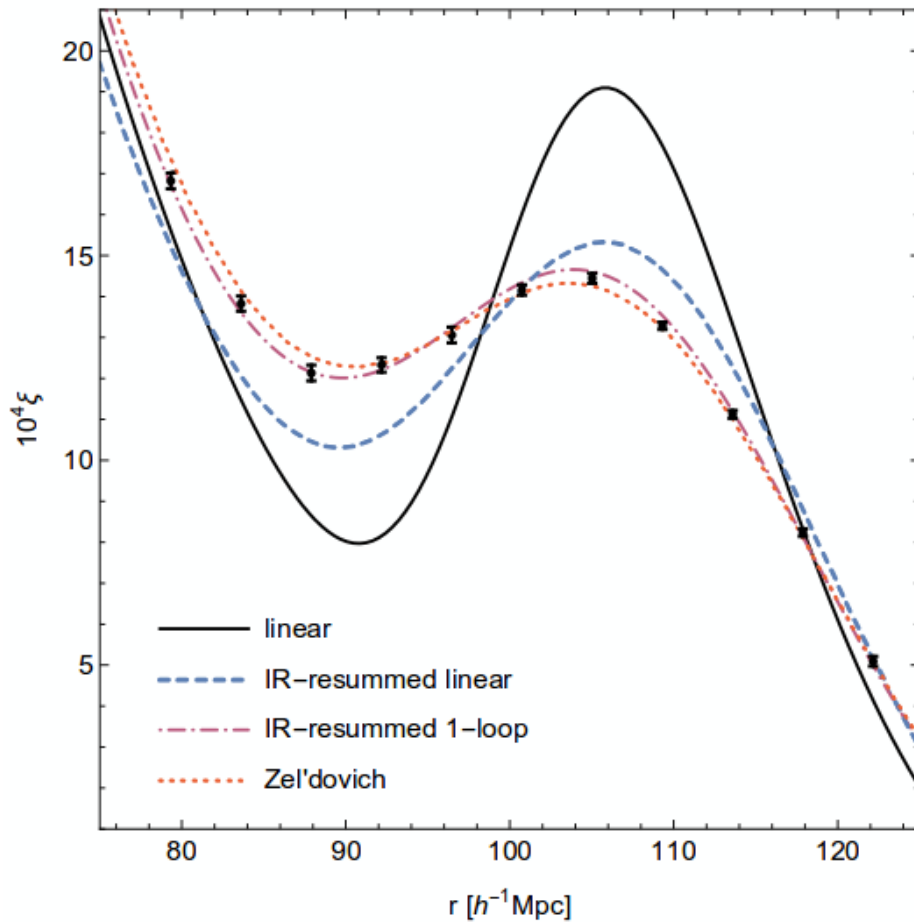


- Measurements from underdensities (voids) :
 - ◆ Growth rate of structures

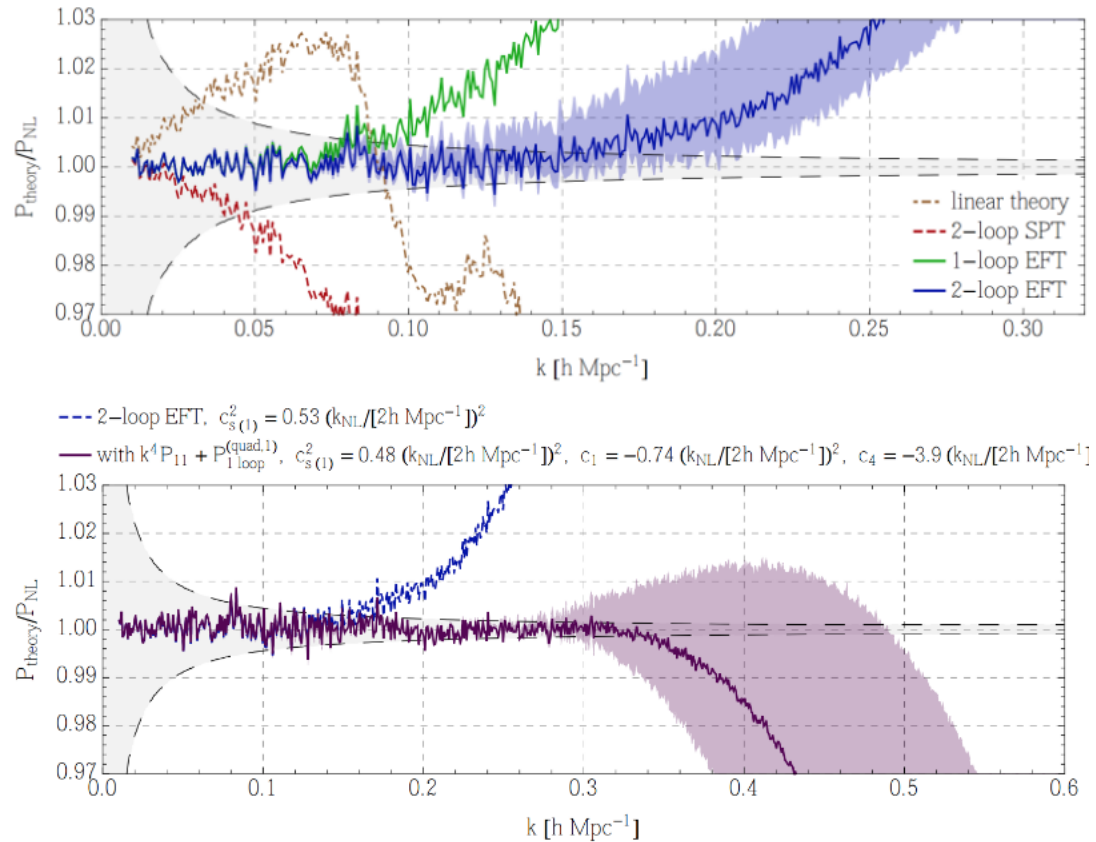


(Adam Hawken's talk)

➤ EFT of Large Scale Structure :



(Marko Simonovic's talk)



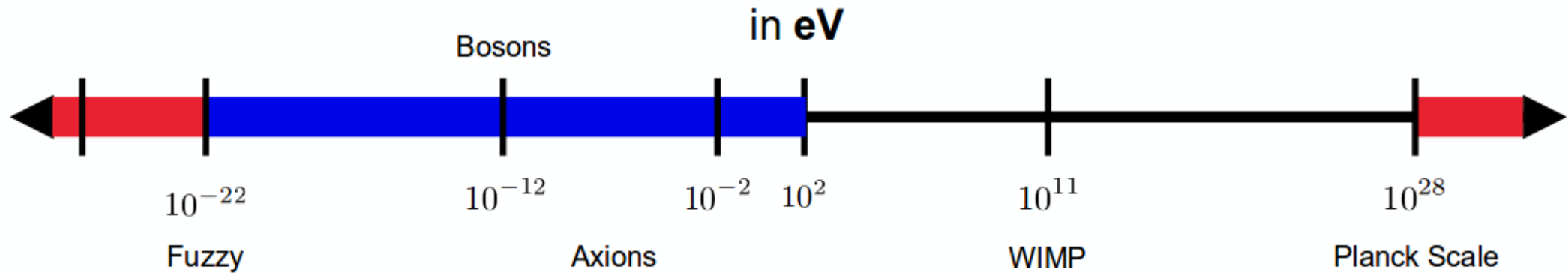
(Matthew Lewandowski's talk or Foreman et al. 2016)

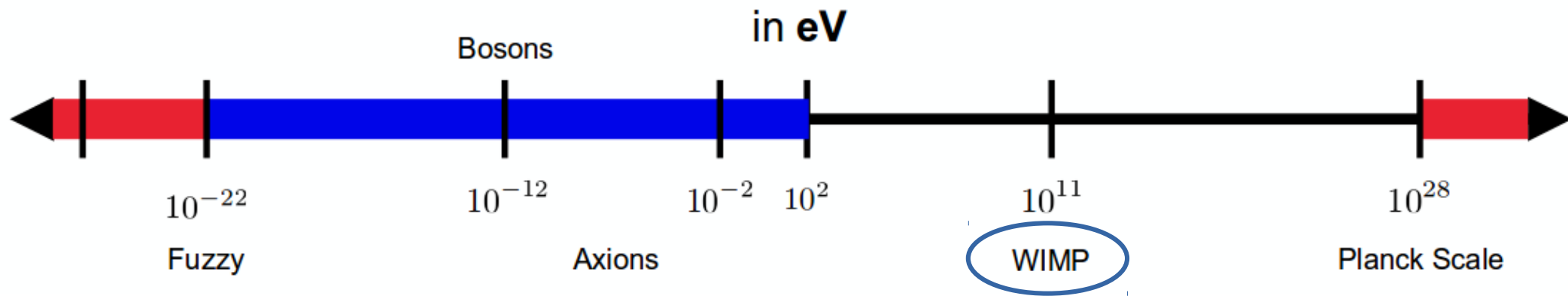
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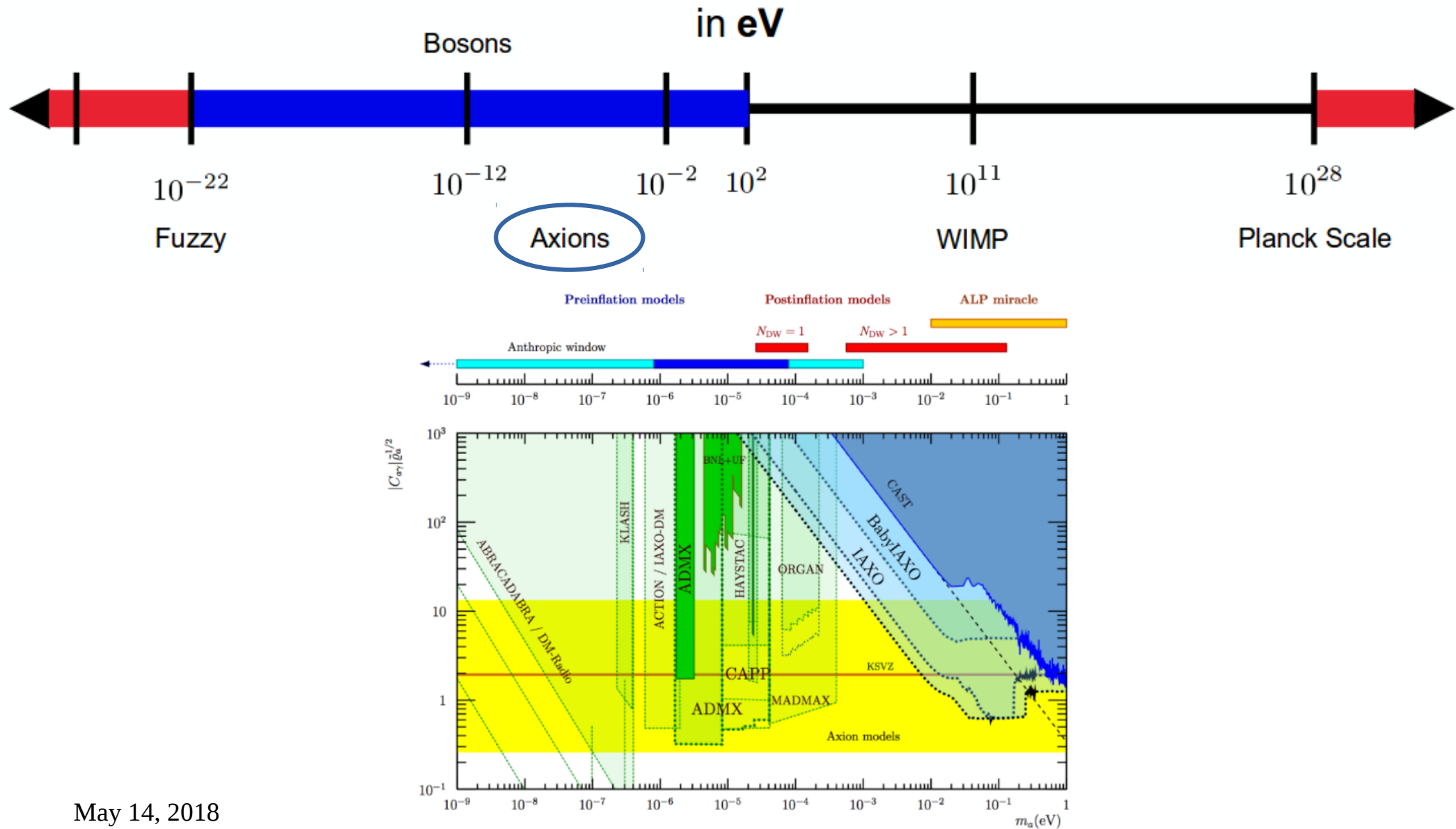
III. Dark Matter

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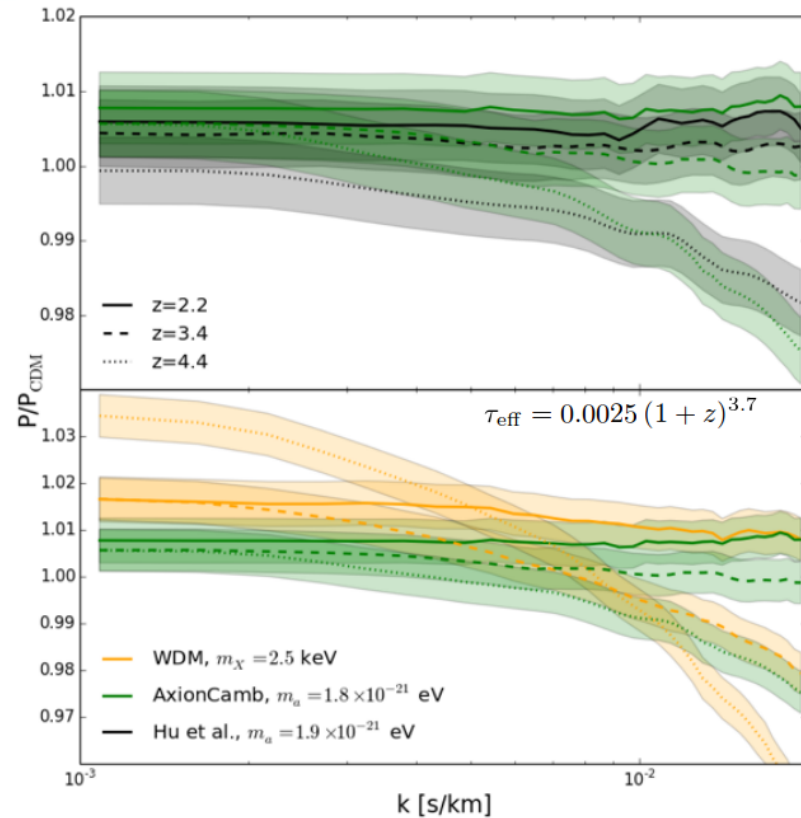
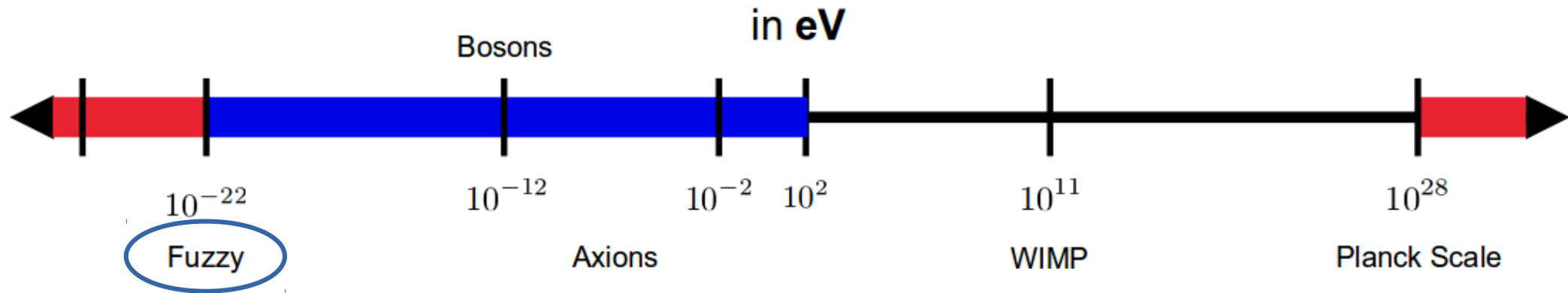


No talk

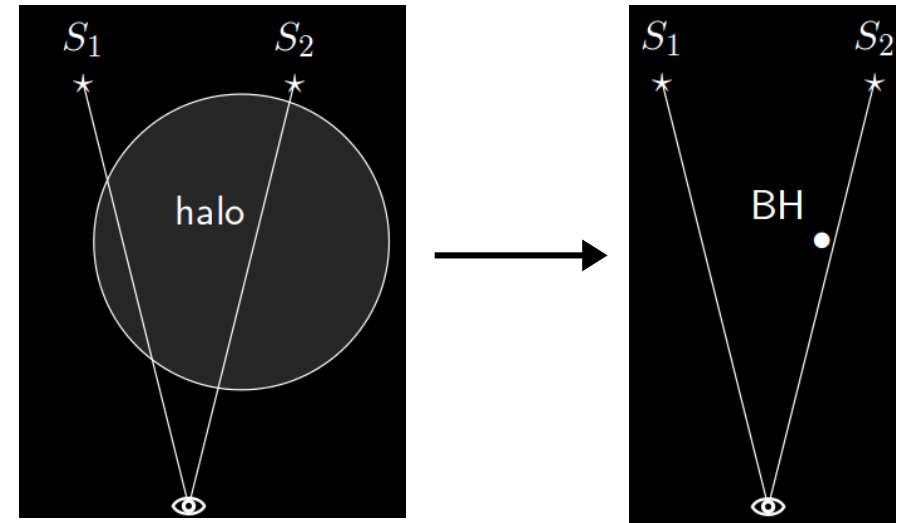
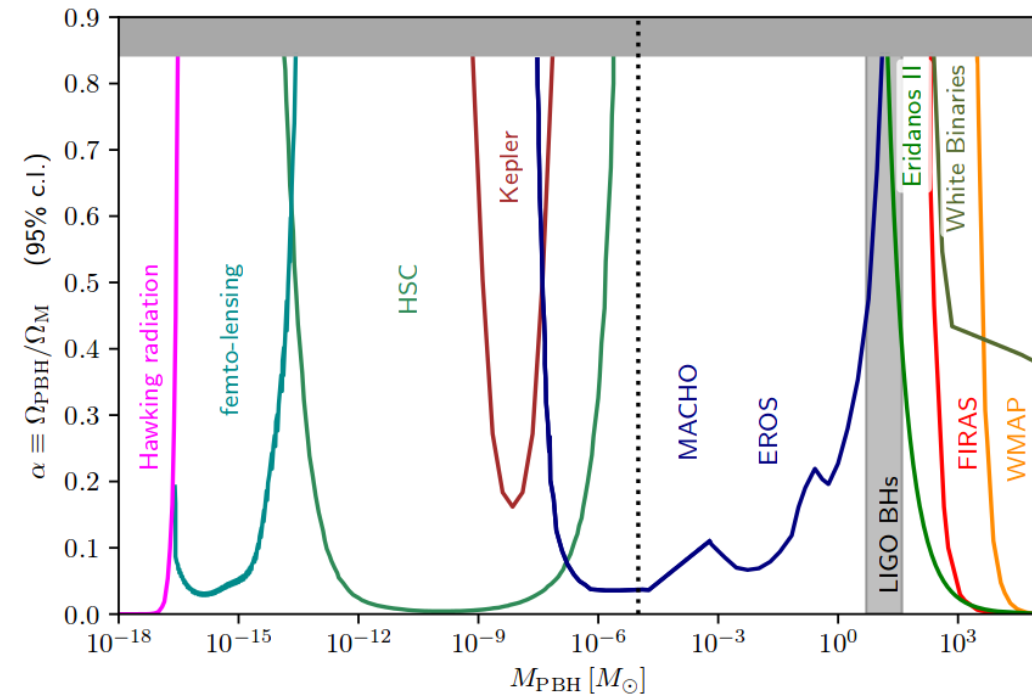


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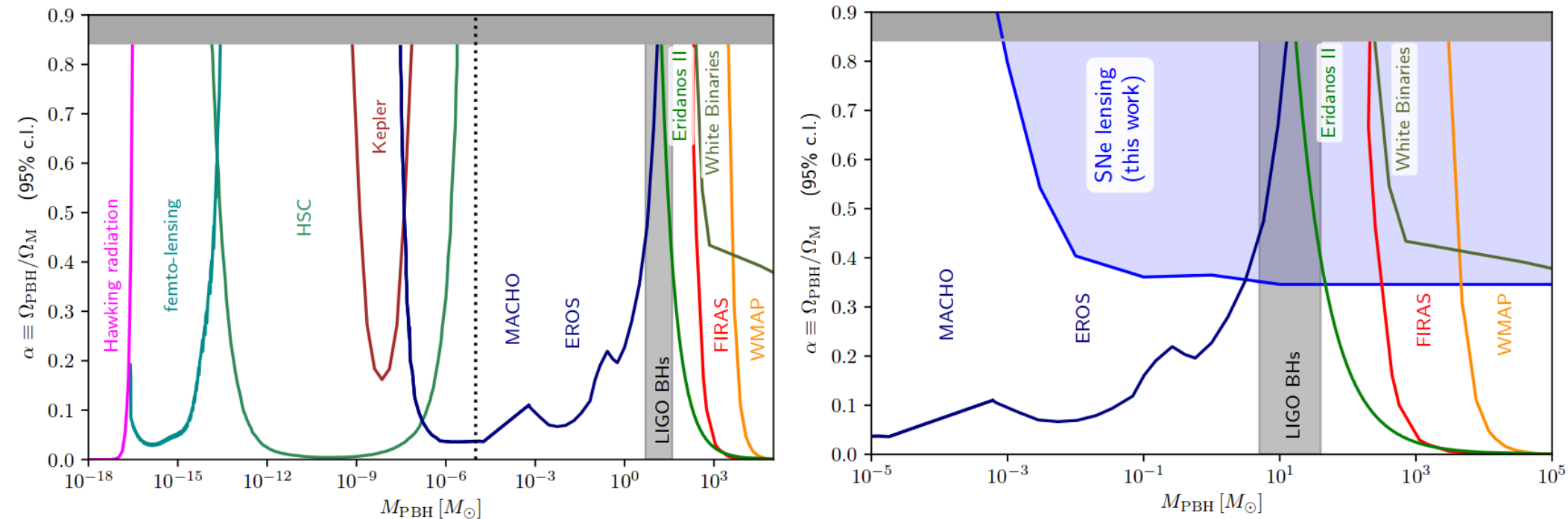
(Andreas Ringwald's talk or Irastorza&Redondo 2018)



➤ No LIGO MACHOs :

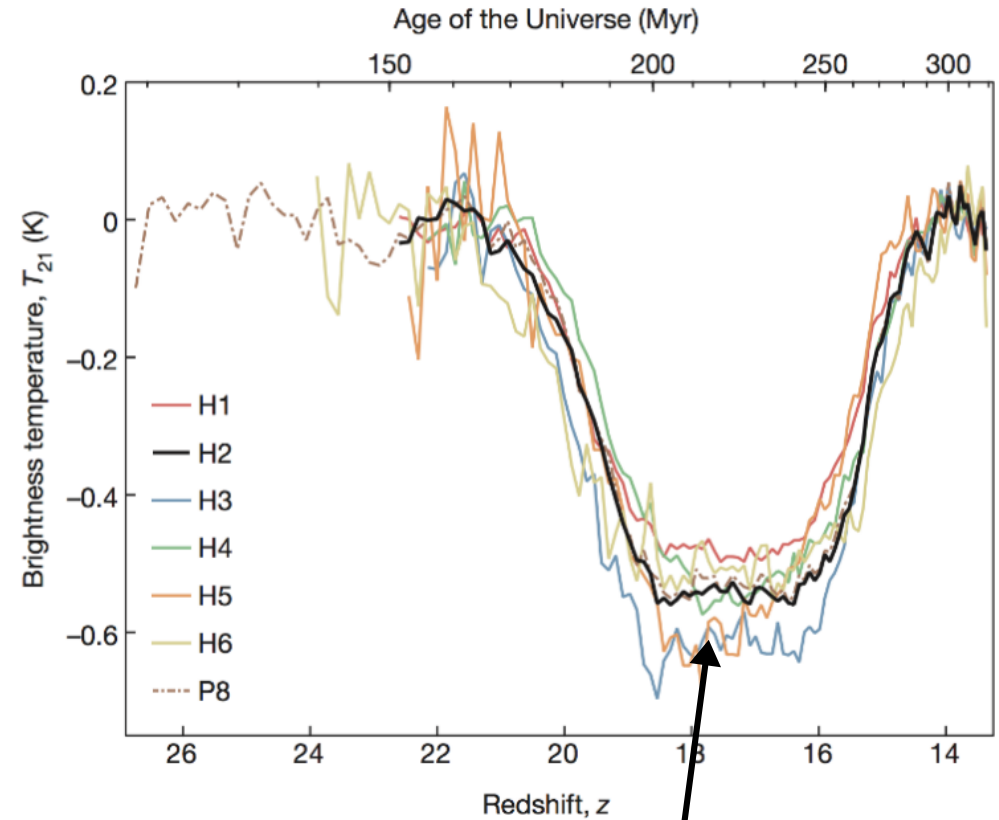
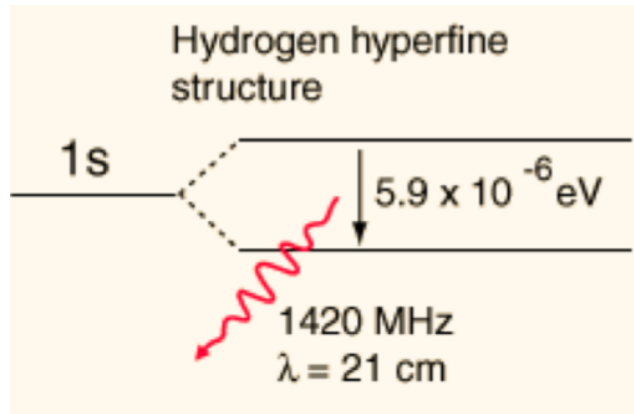


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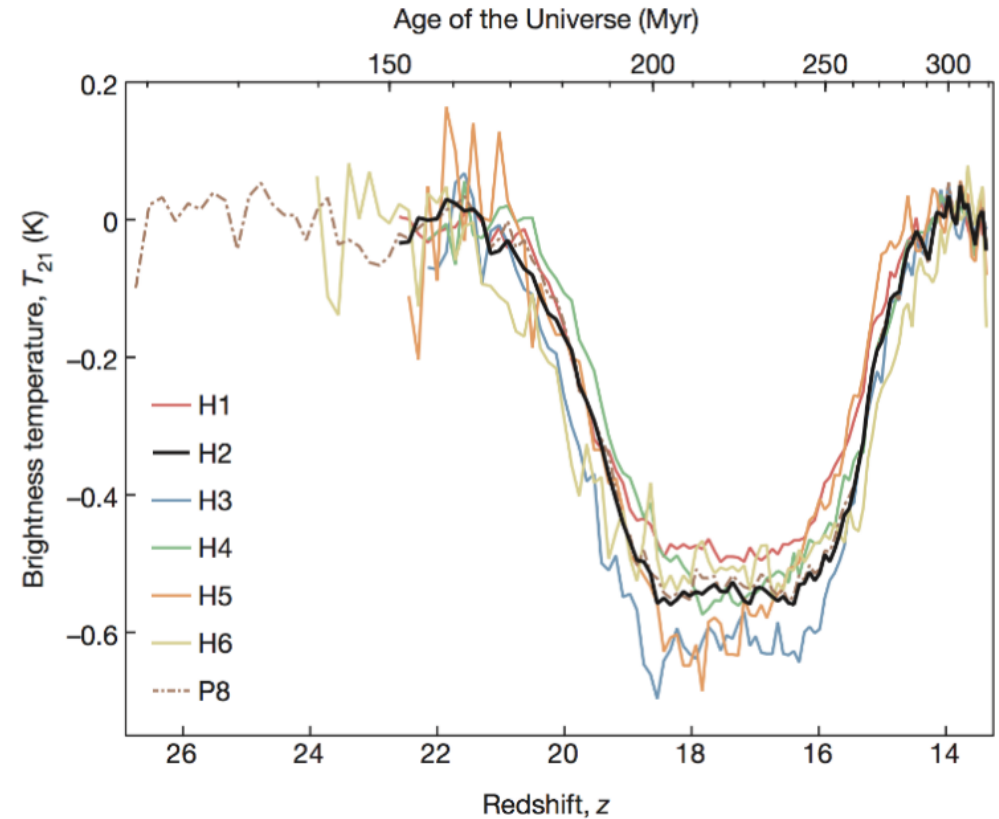
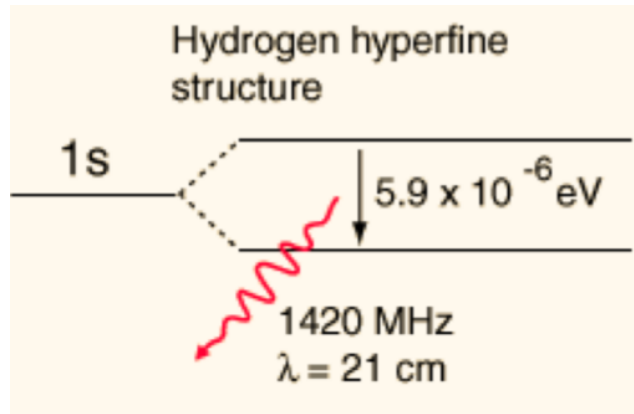
➤ 100% DM excluded at 4.9σ : $\frac{\Omega_{PBH}}{\Omega_M} < 0.35$

➤ EDGES detection of Dark Matter ?



~ 2 times too deep

EDGES detection of Dark Matter ?



- “explaining EDGES by non-finely-tuned modifications of background cosmology is highly unlikely” (Collin Hill) and “already the SM is out at 3.8σ ” (Guido d'Amico)

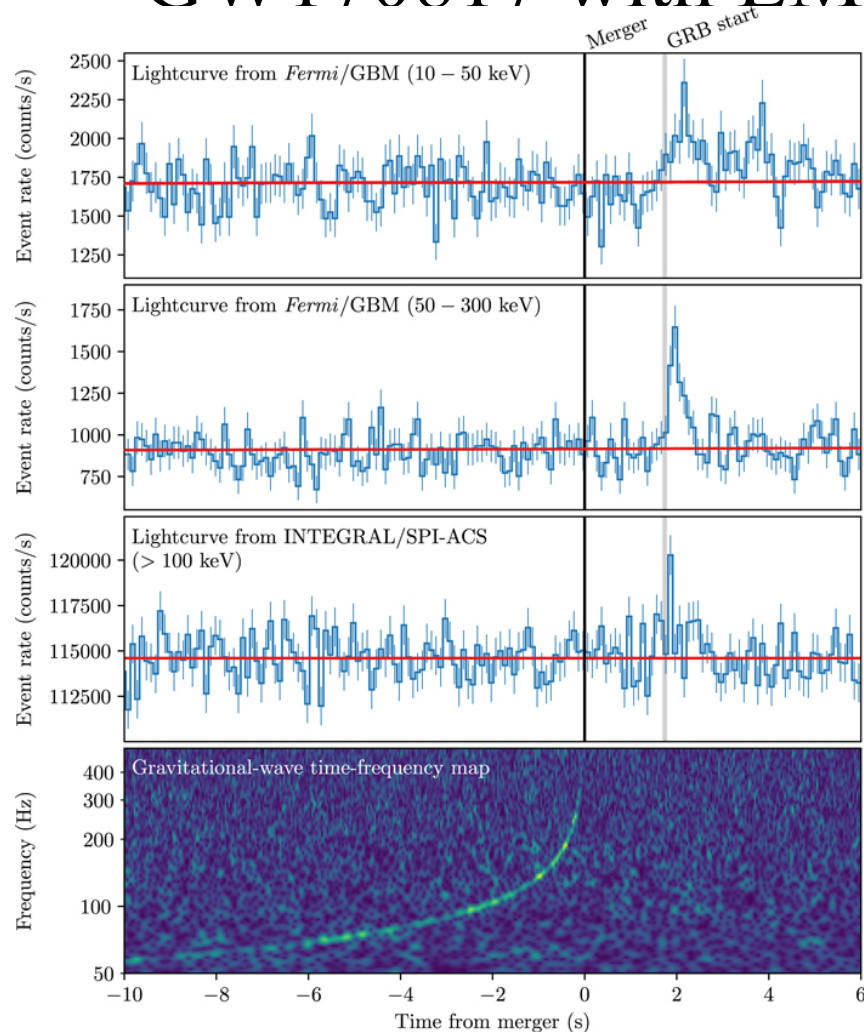
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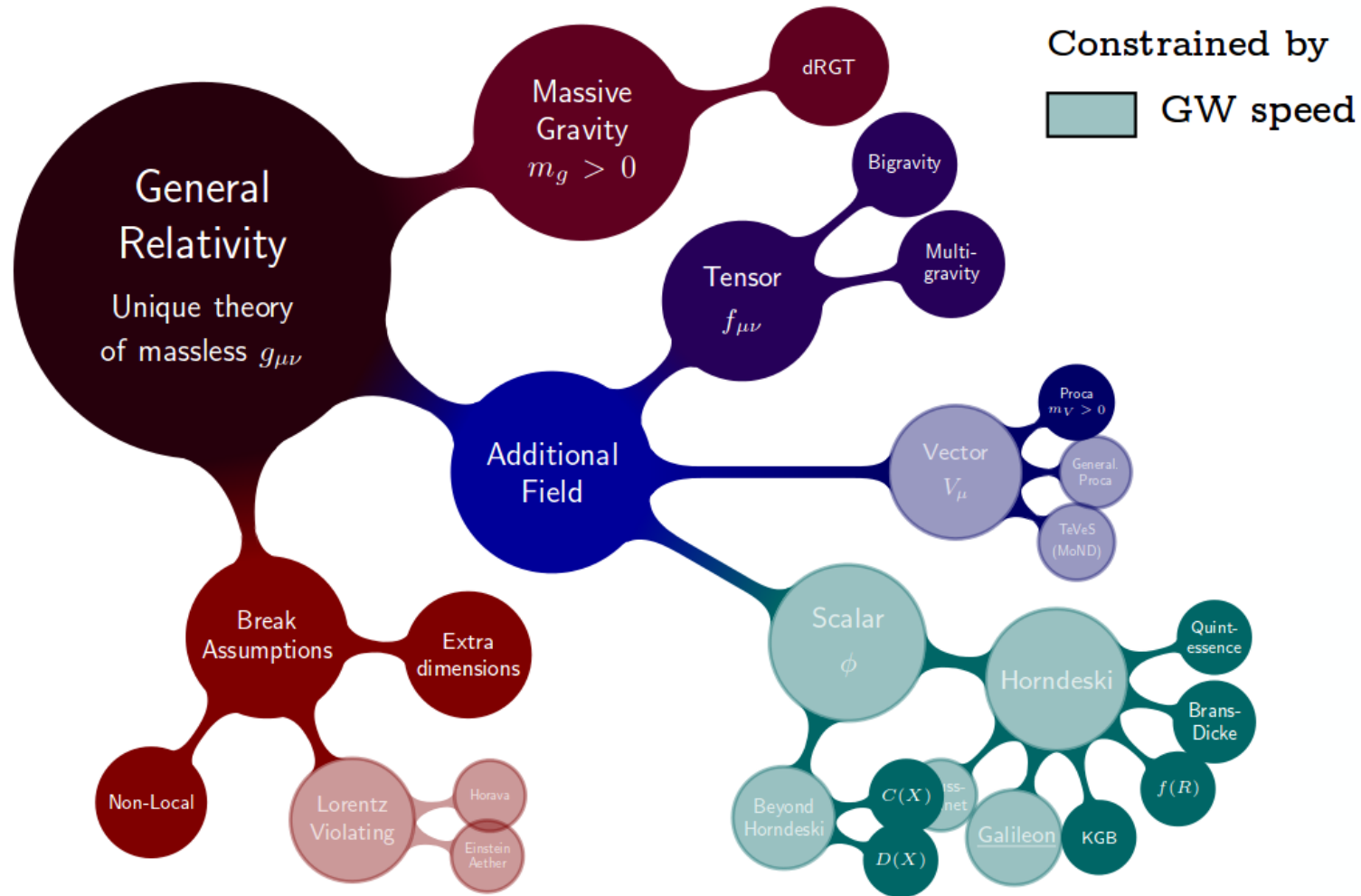
➤ GW170817 with EM counterpart :

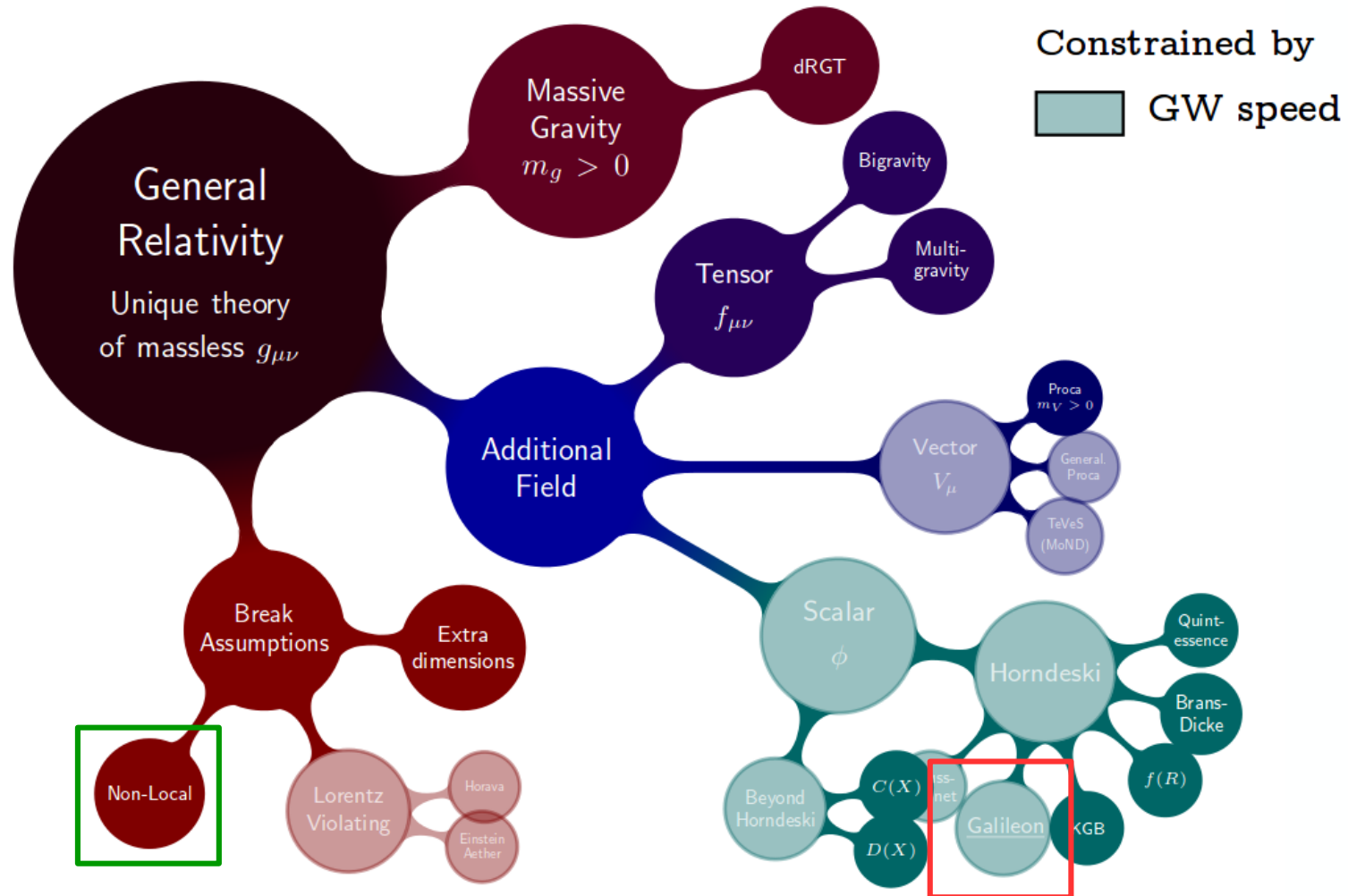


$$\Delta t = \int_{a_e}^1 \frac{da}{aH} \left(1 - \frac{c}{c_g(a)} \right) + \delta t$$

$$= 1.74 \pm 0.05 \text{ s}$$

$$-3 \times 10^{-15} \leq \frac{c_{gw}}{c} - 1 \leq 7 \times 10^{-16}$$





➤ CMB :

- ◆ TT and Planck almost finished
- ◆ Lots of things happening with E and B polarization modes
- ◆ Future → more B modes and spectral distortions ?

➤ LSS :

- ◆ Stage IV era
- ◆ Ongoing BAO and growth rate measurements
- ◆ Improvements of analytical solutions

➤ DM :

- ◆ Paradigm shift : away from the WIMPs ?
- ◆ Axions and ALP promising
- ◆ EDGES : for now, let's be careful

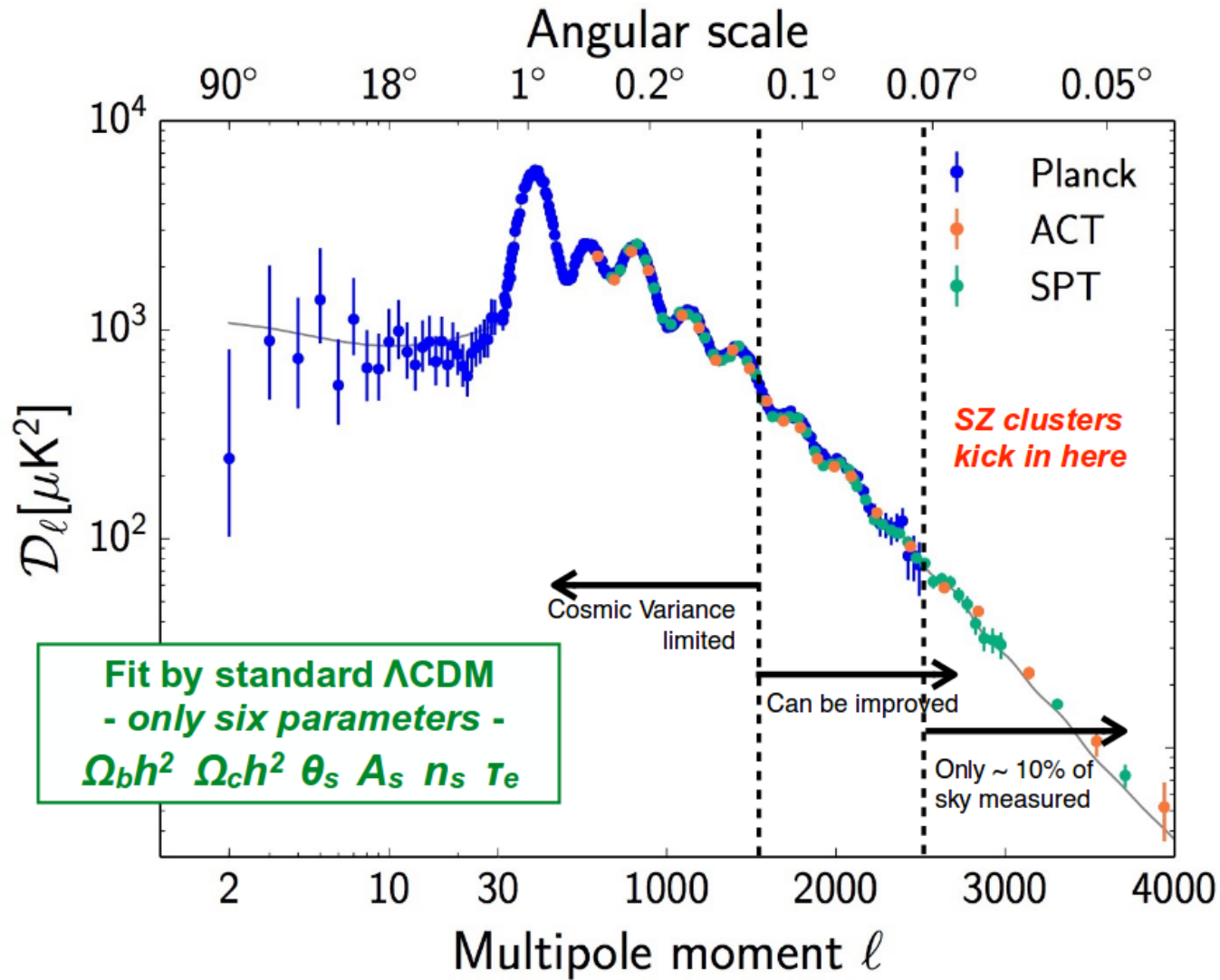
➤ DE and MG :

- ◆ Λ is working great
- ◆ Many models ruled out by gravitational wave speed constraint
- ◆ But theorists are resourceful → still many compatible models

Thank you !



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► Future CMB space experiments :

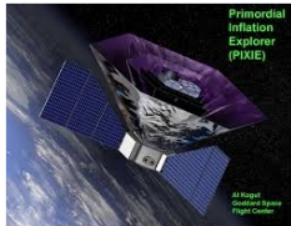


LiteBIRD (JAXA – Phase A)

Matsumura et al, 2013

40 – 402 GHz

2.5 $\mu\text{K}\cdot\text{arcmin}$



PIXIE (NASA?)

Kogut et al., 2011

30 – 6000 GHz

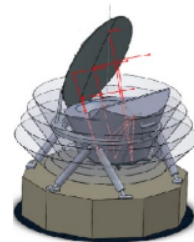
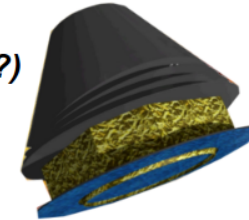
**6.6 $\mu\text{K}\cdot\text{arcmin}$
for $\Delta\nu=30$ GHz**

CORE (ESA? ISRO?)

Delabrouille et al, 2017

60 – 600 GHz

1.7 $\mu\text{K}\cdot\text{arcmin}$



PICO (NASA?)

S. Hannany, priv. comm.

21 – 800 GHz

1 $\mu\text{K}\cdot\text{arcmin}$

$$\frac{n_1}{n_0} = 3e^{-E_{21}/T_S}$$

$$T_S^{-1} = \frac{T_\gamma^{-1} + x_c T_{gas}^{-1} + x_\alpha T_\alpha^{-1}}{1 + x_c + x_\alpha}$$

$$\delta T_b \approx 21\text{mK } x_{\text{HI}} \left(1 - \frac{T_\gamma}{T_S}\right) \sqrt{\frac{1+z}{10}}$$

