Hubble Tension

and

Gravitational Wave Measurements of H_0

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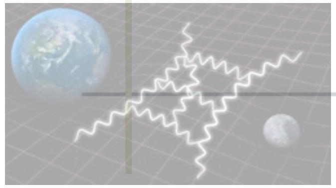
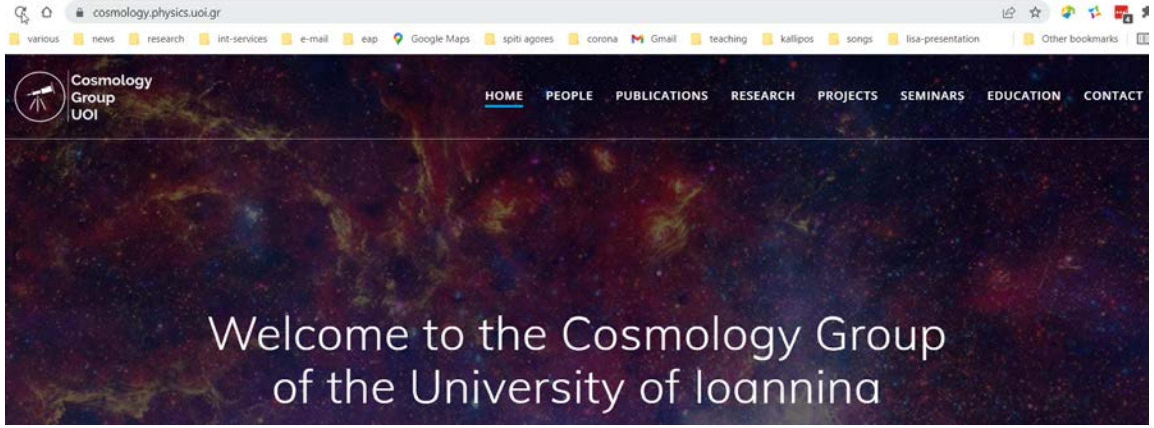
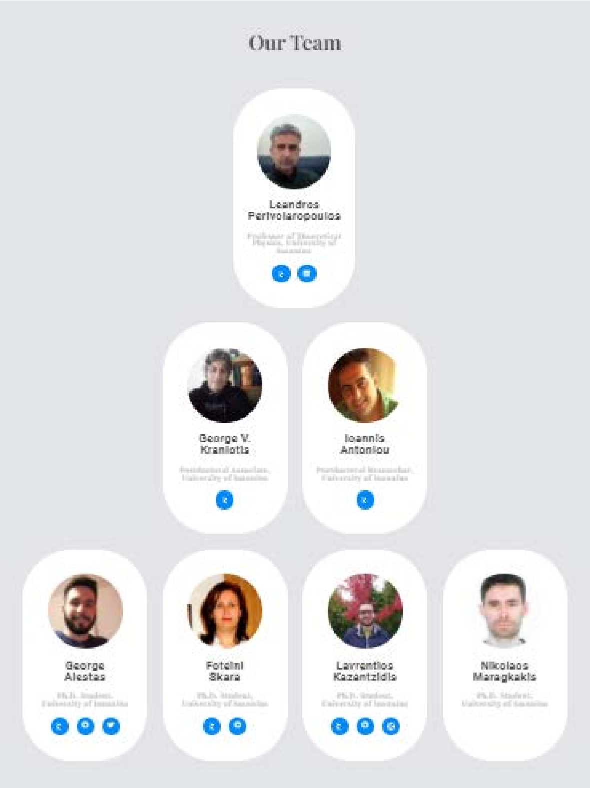
Gravity – Cosmology Groups at Ioannina



L. Perivolaropoulos:
Cosmology-Modified Gravity Group
https://cosmology.physics.uoi.gr/

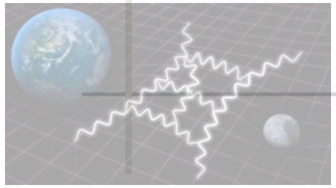




P. Kanti:
New Solutions in Modified Gravity Group (Black Holes etc)

Panagiota Kanti
University of Ioannina | UOI · Department of Physics

The Hubble tension



Degeneracy H_0^2 . L

Fit with Hubble flow SnIa data (0.15>z>0.01)

Measure at z<0.01 with Cepheid calibrators

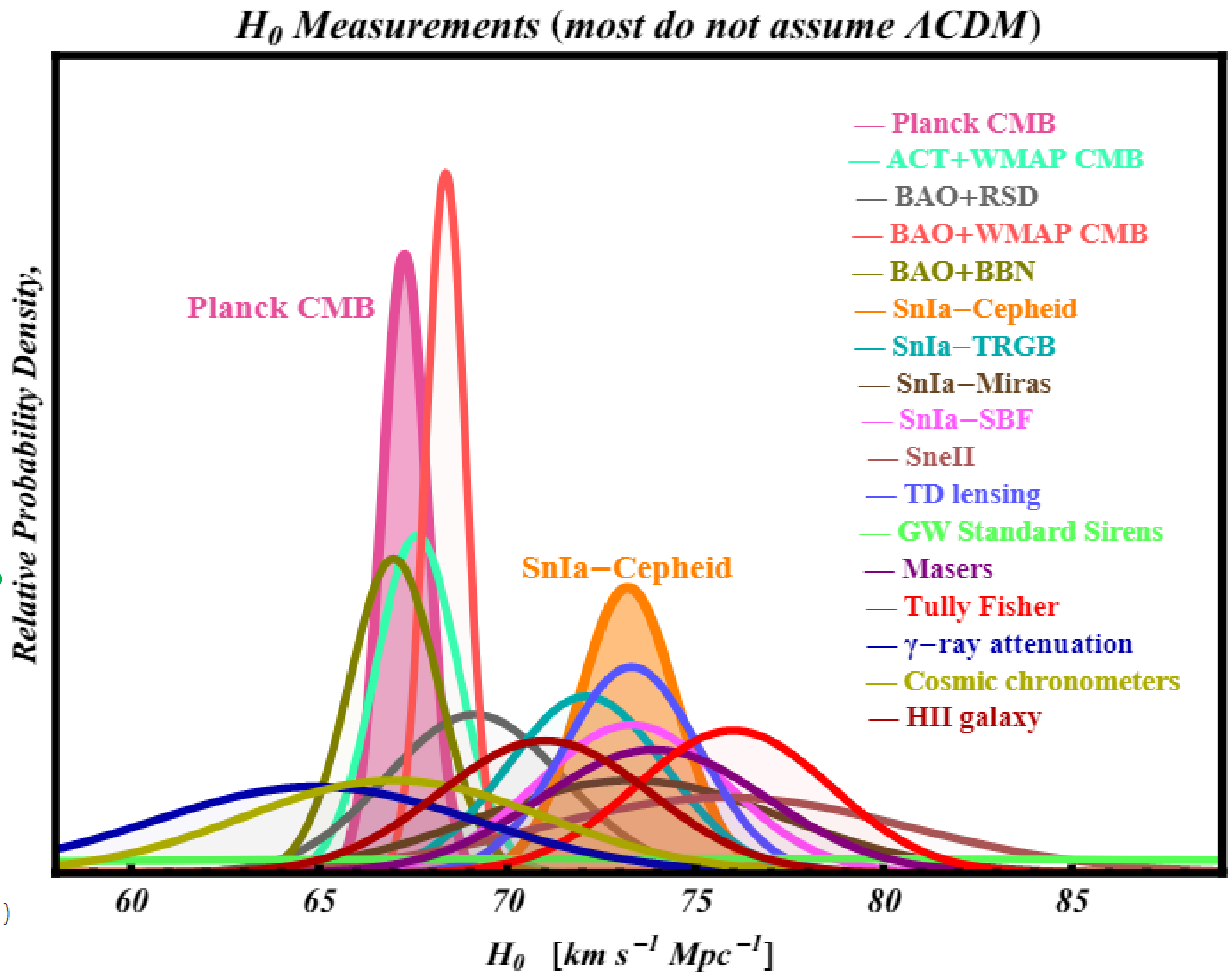
$$l_i = \frac{L}{4\pi d_{Li}^2} \simeq \frac{H_0^2 L}{4\pi c^2 z_i^2}$$

Assumption:

L is the same in the Hubble flow z>0.01 as for the local value for z<0.01?

What if L was larger for z>0.01 than for z<0.01?

What if there was a gravitational transition at z_t~0.01?



Challenges for ΛCDM: An update

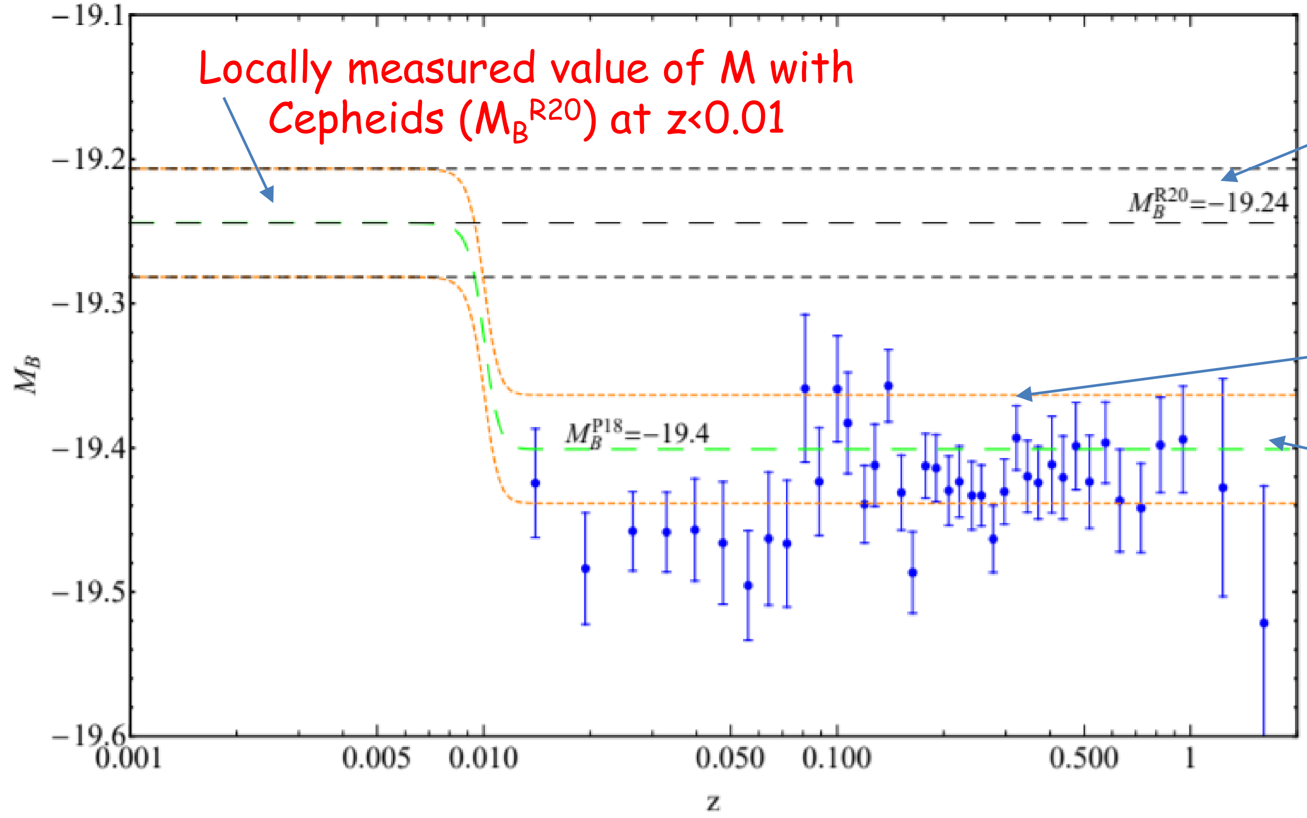
Leandros Perivolaropoulos (Ioannina U.), Foteini Skara (Ioannina U.) (May 11, 2021)

e-Print: 2105.05208 [astro-ph.CO]

The M tension-Hubble tension and the transition hypothesis

M is the SnIa absolute magnitude (standardized luminosity)

Locally measured value of M with Cepheids (M_B^{R20}) at z<0.01



$$M_i = m(z_i) + 5\log_{10}\left[H_0^{P18}\cdot \mathrm{Mpc}/c\right] - 5\log_{10}(D_L(z_i)) - 25$$

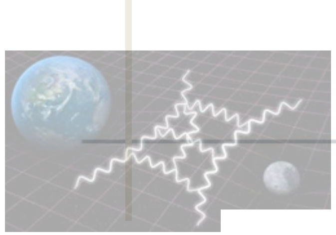
Value of M implied by the value of H_0 based on the CMB sound horizon from Planck18 (H_0^{P18}) at z>0.01

A fundamental physics transition induces a transition of M (absolute magnitude or luminosity) at z<0.01.

Resolves M tension and Hubble tension.

Can potentially also resolve growth tension if the transition is connected with weaker gravity at $z>z_t$

Hubble constant from Gravitational Waves



Measurement of $d_L(z)$

$$h_+(\tau,\theta,\varphi) = \frac{4}{d_L(z)}(G\mathcal{M}_c)^{5/3}[\pi f(\tau)]^{2/3}\left(\frac{1+\cos^2\theta}{2}\right)\cos(2\Phi(\tau))$$

$$h_\times(\tau,\theta,\varphi) = \frac{4}{d_L(z)}(G\mathcal{M}_c)^{5/3}[\pi f(\tau)]^{2/3}\cos\theta\,\sin(2\Phi(\tau))$$

$$\dot{f} = \frac{96\pi^{8/3}}{5}(G\mathcal{M}_c)^{5/3}f^{11/3}$$

$$\mathcal{M}_c = (1+z)M_c$$

Redshifted chirp mass

From observed frequency f and its time derivative measure the redshifted chirp mass

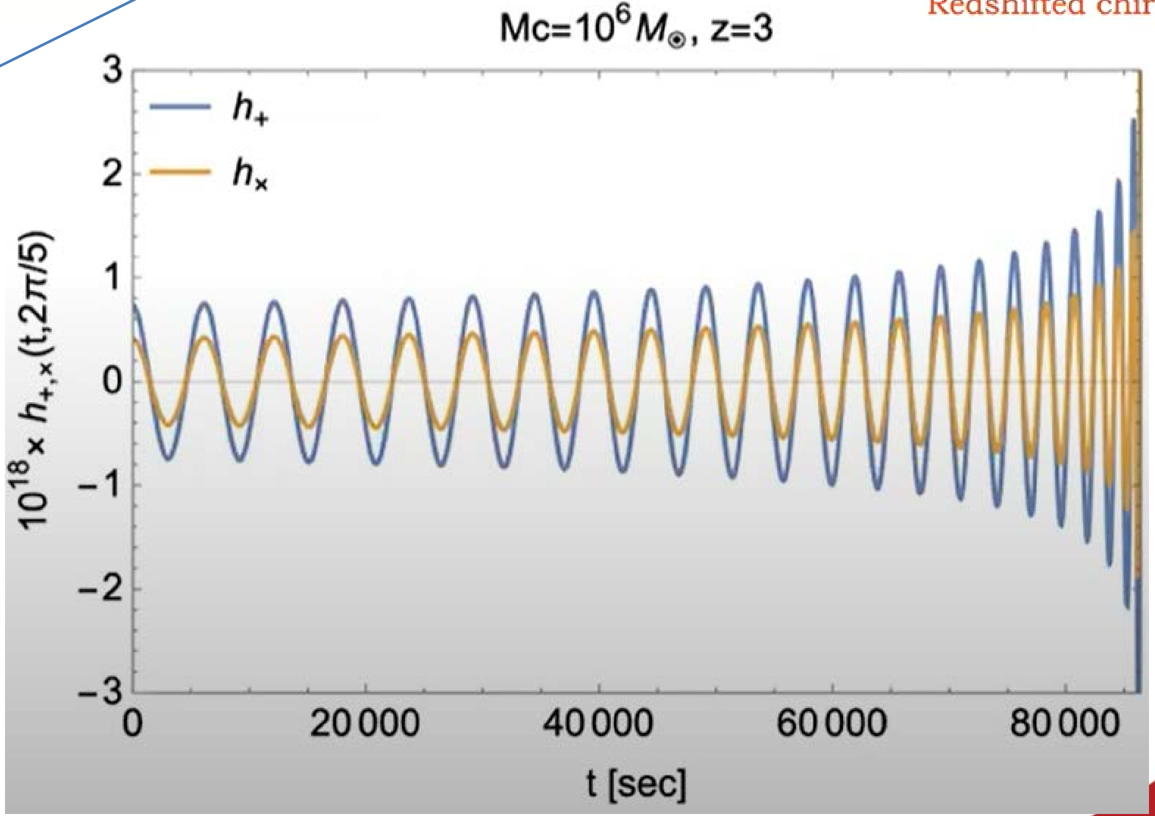
From the measured ratio h_+/h_X find the inclination θ of the orbit.

Use the expressions for h_+ h_X to find d_L.

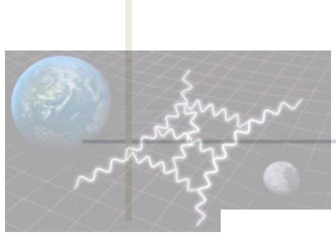
To estimate z, use electromagnetic counterpart of GW or cross correlate the sky position of the GW with galaxy catalogues.

From $d_L(z)$ find H_0 using

$$H_0 = \frac{cz_i}{d_L(z_i)}$$



Testing the gravitational transition hypothesis with LISA



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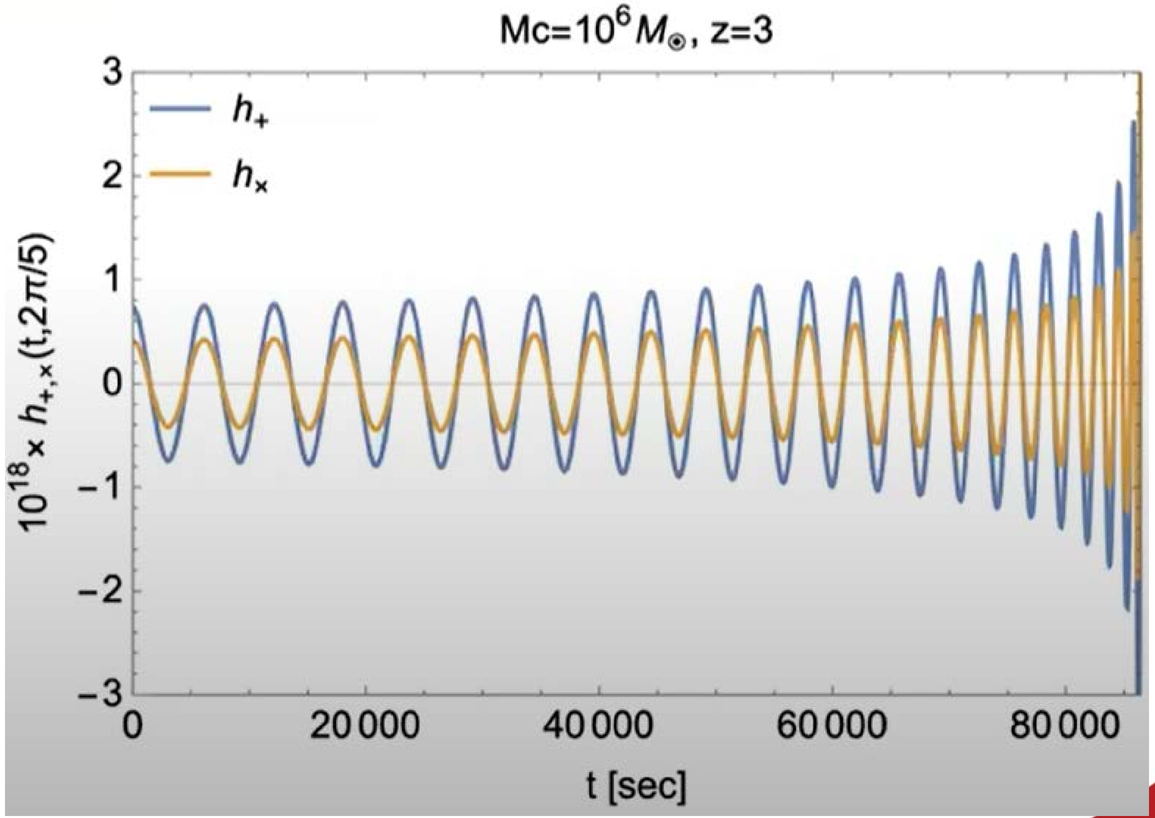
$$\dot{f} = \frac{96\pi^{8/3}}{5}(G\mathcal{M}_c)^{5/3} f^{11/3}$$

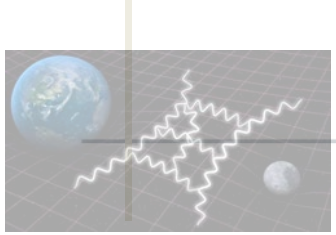
1. Construct the dataset $GM_c(d_L)$.

2. Search for rapid variation of $GM_c(d_L)$. at distances in the range of 15-40Mpc which can not be justified by a change of redshift or mass.

3. Compare with other astrophysical data (Tully-Fisher, Cepheid etc).



Conclusion



1. A large number of GW signals from binary systems in the Hubble flow (d_L>40Mpc) can be used to find the value of the H_0 in a manner independent of local calibrators.

2. The gravitational transition hypothesis would predict in this context a value of H_0 consistent with the CMB measurement and inconsistent with the local Cepheid calibrators.

3. A large number of GW signals from local binary systems outside the Hubble flow (d_L<40Mpc) can be used to test the gravitational transition hypothesis for the resolution of the Hubble tension.

Constraining a late time transition of G_{eff} using low-z galaxy survey data

G. Alestas (Ioannina U.), L. Perivolaropoulos (Ioannina U.), K. Tanidis (Prague, Inst. Phys.) (Jan 15, 2022)

e-Print: 2201.05846 [astro-ph.CO]

Rapid transition of Geff at zt≃0.01 as a possible solution of the Hubble and growth tensions

Valerio Marra (Espirito Santo U. and Trieste Observ. and SISSA, Trieste and INFN, Trieste), Leandros Perivolaropoulos (Ioannina U.) (Feb 11, 2021)

Published in: *Phys.Rev.D* 104 (2021) 2, L021303 • e-Print: 2102.06012 [astro-ph.CO]

Late-transition vs smooth $H(z)$ deformation models for the resolution of the Hubble crisis

George Alestas (Ioannina U.), David Camarena, Eleonora Di Valentino (Sheffield U.), Lavrentios Kazantzidis (Ioannina U.), Valerio Marra (Trieste Observ. and IFPU, Trieste) et al. (Oct 8, 2021)

e-Print: 2110.04336 [astro-ph.CO]

Hints for a Gravitational Transition in Tully–Fisher Data

George Alestas (Ioannina U.), Ioannis Antoniou (Ioannina U.), Leandros Perivolaropoulos (Ioannina U.) (Apr 29, 2021)

Published in: *Universe* 7 (2021) 10, 366 • e-Print: 2104.14481 [astro-ph.CO]