Probe of Dark Sectors at LISA:Standard vs Null Diagonistics

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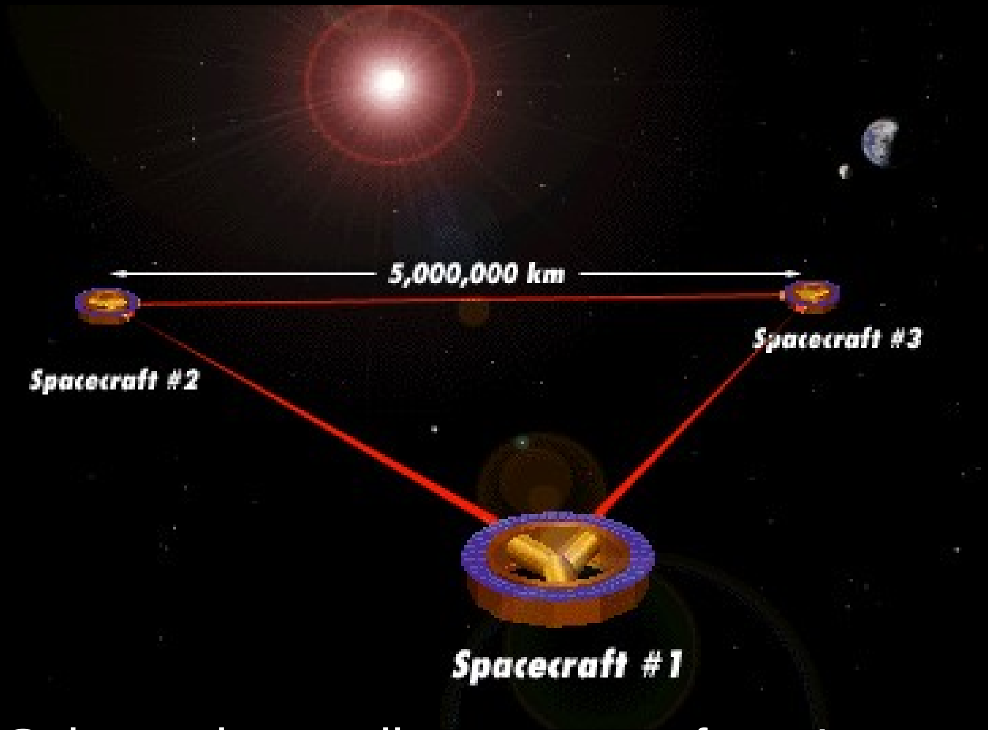
Based on arXiv: 2005.07231[astro-ph]



Schematic diagram of Laser Interferometer Space Antenna (LISA)
From Abenteur Universum

Motivation for studying Dark Sectors

Hubble constant (H_0) measured directly from the local Universe (age > 10^{10} yrs; z < 2) does not agree with indirect measurents from the very early Universe (age ~ 4 * 10^5 yrs; z~1100). Several other tensions also exist pointing at something fundamentally wrong in the standard cosmological model.

The Universe is homogeneous and isotropic is primarily parametrized by amount of matter (Ω_{0m}) (both luminous and `dark') and amount of a mysterious energy ($\Omega_{0\Lambda}$) that pushes everything away from us. Also these components have a equation of state (EoS) parameter which tells how they evolve with time.

$$E^2(z) = \Omega_{0m}(1+z)^{3(1+w_{dm})} + \Omega_{0\Lambda}(1+z)^{3(1+w)}$$

Matter EoS param.=0 in standard paradigm

Density Parameters

Dark Energy EoS=-1 in standard paradigm

Accurate EoS parameter measurement is required!!

PROBLEMS	SOLUTIONS
• Uncertainities in Ω_{0m} and $\Omega_{0\Lambda}$ introduces errors in EoS parameters. • All direct measurements are for the local Universe.	• Use *Om* parametrization Sahni et al. arXiv:0807.3548 [astro-ph]. • Measure the intermidiate Universe using supermassive black hole binary (SMBHB) mergers in LISA.

Parametrizations of Dark Sectors

i. w_0CDM: $w_{dm} = 0$ 1 Parameter (w_0)

ii. CPLCDM: $w_{dm}=0$; $w=w_0+w_a z/(1+z)$ 2 Parameters(w_0 , w_a)

iii. IDE: $w = w_0 + w_a z/(1+z)$ 3 Parameters (w_0 , w_a, w_{dm})

Since LISA is not operational yet we forecast errors of the EoS parameters using Fisher Matrix analysis and *Om* parametrization and compare those with standard parametrization.

How Om parameters solve Problem 1

1) **Define a new paramer $Om_g(x)$ in terms of $E(x)$.**

2) **Define $R_g(x_1,x_2,x_3,x_4)$ in terms Om_g and this parameter is independent of the density parameters.**

$$Om_g(x) = \frac{[E(x)]^2 - 1}{x^{3(1+w_{dm})} - 1}$$

$$R_g = \frac{Om_g(x_1) - Om_g(x_2)}{Om_g(x_3) - Om_g(x_4)} = \frac{\frac{x_1^{3(1+w)}-1}{x_1^{3(1+w_{dm})}-1} - \frac{x_2^{3(1+w)}-1}{x_2^{3(1+w_{dm})}-1}}{\frac{x_3^{3(1+w)}-1}{x_3^{3(1+w_{dm})}-1} - \frac{x_4^{3(1+w)}-1}{x_4^{3(1+w_{dm})}-1}}$$

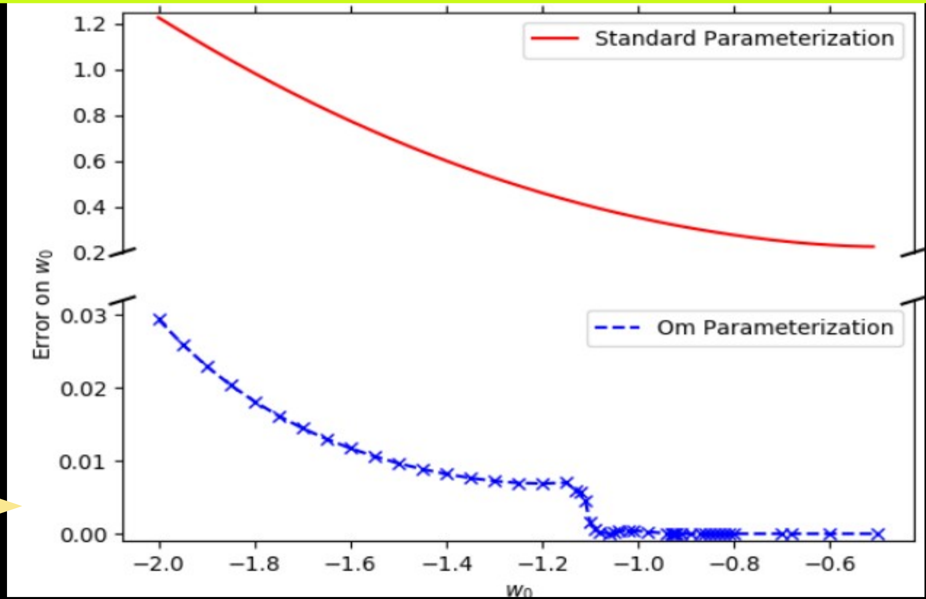
$$x = 1 + z$$

Results

1. w_0CDM

Error in standard parameterization is much higher than that of *Om* parametrization. This trend shall be observed throughout.

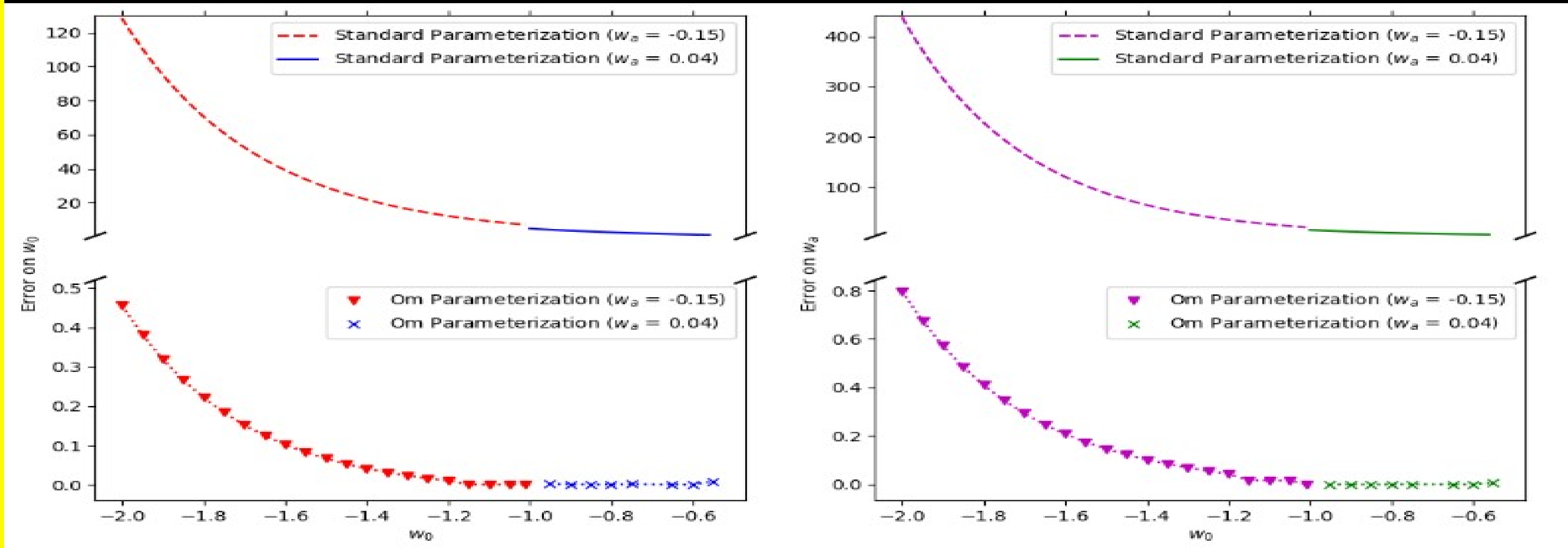
Plot showing errors on w_0 for various fiducial values of w_0.



Contact: baralpratyusava@gmail.com for clarifications and comments

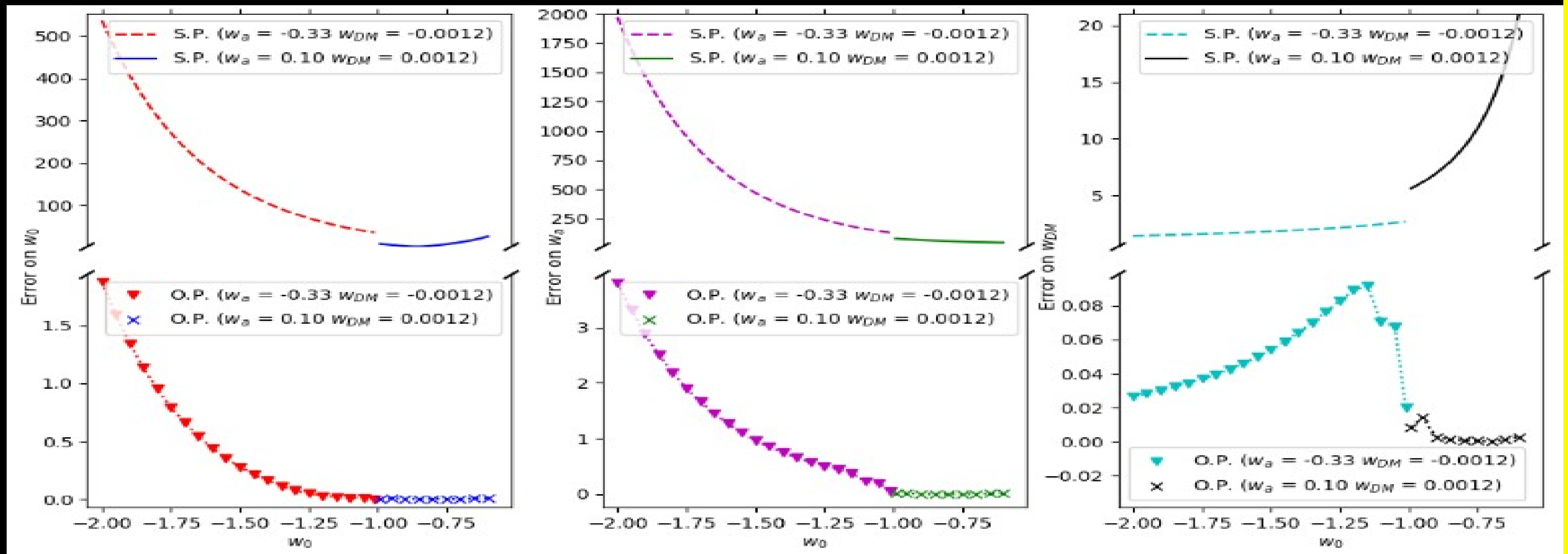
Results

2. CPLCDM



Error on w_0 (left) and w_a (right) for various fiducial values of w_0

3. IDE



Error on w_0 (left), w_a (middle) and w_{dm} (right) for various fiducial values of w_0

Conclusion: *Om* parameterization can be used to efficiently constrain the EoS parameters at LISA.