

Erratum: Prospects for cosmological constraints using gravitational wave memory [Phys. Rev. D **111**, 083548 (2025)]

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In our original article, we identified an error in the derivation of the gravitational wave (GW) memory for a Friedmann-Lemaître-Robertson-Walker (FLRW) background. Specifically, in the text immediately preceding Eq. (19), we incorrectly assumed the kinematic relation $\tilde{\Sigma} = -\tilde{\Theta}/3$. This assumption is strictly invalid for an unperturbed FLRW spacetime, where the background expansion is isotropic and the shear must identically vanish.

By applying the correct background FLRW kinematics, the propagation of the shear tensor and the resulting integration over conformal time must be modified. This correction alters the mapping relations for the prefactor and the integrand used to evaluate the physical strain.

To begin with, the governing shear tensor due to GW perturbation [Eq. (18) in the published paper] is

$$\Sigma'_{\vartheta\vartheta} + \Gamma(\eta)\Sigma_{\vartheta\vartheta} = \frac{a(\eta)}{6\mathcal{H}} f(r, \vartheta, \phi) h''''_{\vartheta\vartheta}(\eta). \quad (1)$$

However, due to vanishing of Σ , the corrected $\Gamma(\eta)$ is

$$\Gamma = \frac{1}{3} \left(\frac{\mathcal{H}'}{\mathcal{H}} - \mathcal{H} \right).$$

All the other terms retain their original definitions as given in the published article.

Repeating the steps as given in the published version, GW memory detectable at Earth is

$$\mathcal{N}_+ = \frac{h_{\oplus}}{3E^{2/3}(z_0)} \int_0^{z_0} dz \frac{1+z}{E^{4/3}(z)} \quad (2)$$

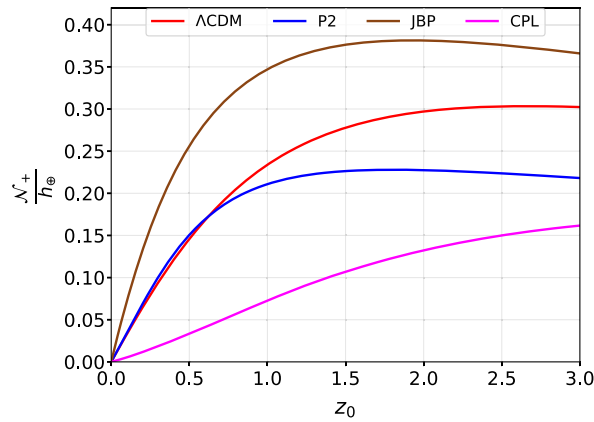


FIG. 1. Evolution of the integrated cosmological memory observable, $\mathcal{N}_+ / h_{\oplus}$, as a function of redshift z_0 for different cosmological models: Λ CDM, P2, JBP, and CPL. The figure illustrates how the accumulation of the memory signal depends on the cosmic expansion history encoded in each dark-energy parametrization.

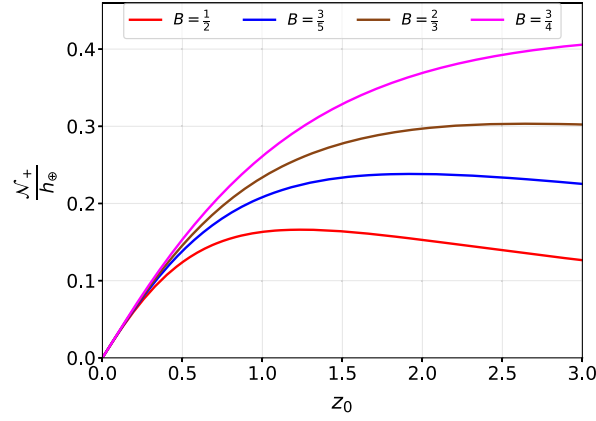


FIG. 2. Evolution of the integrated cosmological memory observable for different cosmological expansion parameter B .

where

$$h_\oplus = \frac{\mathcal{A}_p f(\vartheta, \phi)(1+z)}{D_L H_0^2}.$$

We find that the corrected memory amplitude decreases due to the requirement that $\Sigma = 0$ in an unperturbed FLRW background. As shown in Fig. 1, for the integrated memory signal for different cosmological models (Λ CDM, P2, JBP, and CPL) the overall amplitude is reduced. Specifically, for the Λ CDM model, the overall amplitude is reduced by nearly a factor of 1/2. However, the behavior begins to flatten earlier at higher redshifts compared to the trend reported in the originally published analysis for different cosmological models.

While this factor of 1/2 is quantitatively significant for upcoming precision cosmological observations, it represents only a uniform rescaling of the amplitude. The qualitative behavior of the memory ratio as a function of the source redshift z_0 , as well as its overall behavior on the cosmological expansion parameter B [defined through $H(z) = H_0 \sqrt{\Omega_{m0}(1+z)^{2/B} + (1 - \Omega_{m0})}$], remains unchanged, as shown in Fig. 2.

Thus, the central theoretical conclusions of the original paper remain completely unchanged.

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