Erratum: Directed searches for gravitational waves from ultralight bosons [Phys. Rev. D 99, 084042 (2019)]

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This erratum reports two inconsistencies in the definitions of the gravitational-wave (GW) amplitude h_0 across the different sections of this paper, as well as an overestimation of the numerically-computed GW timescale τ_{GW}.

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I. STRAIN AMPLITUDE

The first inconsistency only impacts Fig. 1 of this paper, where the numerical h_0 of Eq. (28) is compared to the analytic approximation of Eq. (29). Although Eqs. (28) and (29) are correct, they assume slightly different definitions for the strain amplitudes and should not be directly compared: the latter has been averaged over source orientation, while the former has not (cf. Eq. (12) in [1]). As a consequence, the analytic amplitude of Eq. (29) should be multiplied by a factor of $\sqrt{2\pi}$ to be directly comparable to Eq. (28). This only impacts Fig. 1 in this paper, which we correct here in Fig. 1.

A second inconsistency was found affecting the computation of detection horizons. Throughout most of the paper, the h_0 quantity is assumed to be defined as stated in Eqs. (25) and (26), i.e.,

$$h^I(t) = F^I_+(t) a_+ \cos\phi(t) + F^I_\times(t) a_\times \sin\phi(t), \tag{1}$$

$$a_{+/\times} = -\sum_{\tilde{l}\geq 2l} h_0^{(\tilde{l})} [{}_{-2}S_{\tilde{l}\,\tilde{m}\,\tilde{\omega}} \pm (-1)^{\tilde{l}}\, {}_{-2}S_{\tilde{l}-\tilde{m}-\tilde{\omega}}], \tag{2}$$

where $h^I(t)$ is the GW strain measured by detector I at time t, $F^I_{+/\times}(t)$ are the corresponding antenna patterns, $\phi(t)$ is the GW phase, and the ${}_{-2}S_{\tilde{l}\,\tilde{m}\,\tilde{\omega}}$ are the spin-weighted spheroidal harmonics, which implicitly depend on the source inclination ι.[1] However, the discussion about directed searches in Sec. IV tacitly assumes the h_0 quantity to be given by (for $\tilde{l} = |\tilde{m}| = 2$)

$$a_+ = h_0 \frac{1}{2}(1 + \cos^2\iota), \qquad a_\times = h_0 \cos\iota, \tag{3}$$

instead of Eq. (2) above. The amplitude under this convention, which we will here denote $\bar{h}_0$, differs from h_0 in the rest of the paper by a constant factor, such that

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[1]The $(-1)^{\tilde{l}}$ factor in Eq. (2) was missing in this paper but this had no consequence on our results, which always assumed $\tilde{l} = \tilde{m} = 2$.

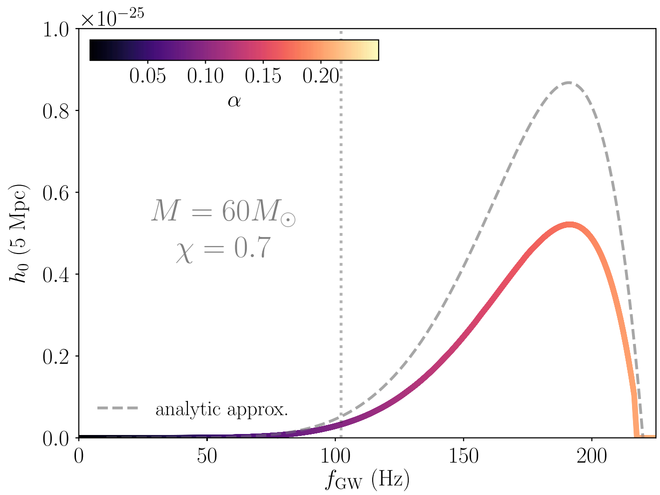

FIG. 1. Corrected version of Fig. 1 in this paper. The analytic curve has been multiplied by $\sqrt{2\pi}$.

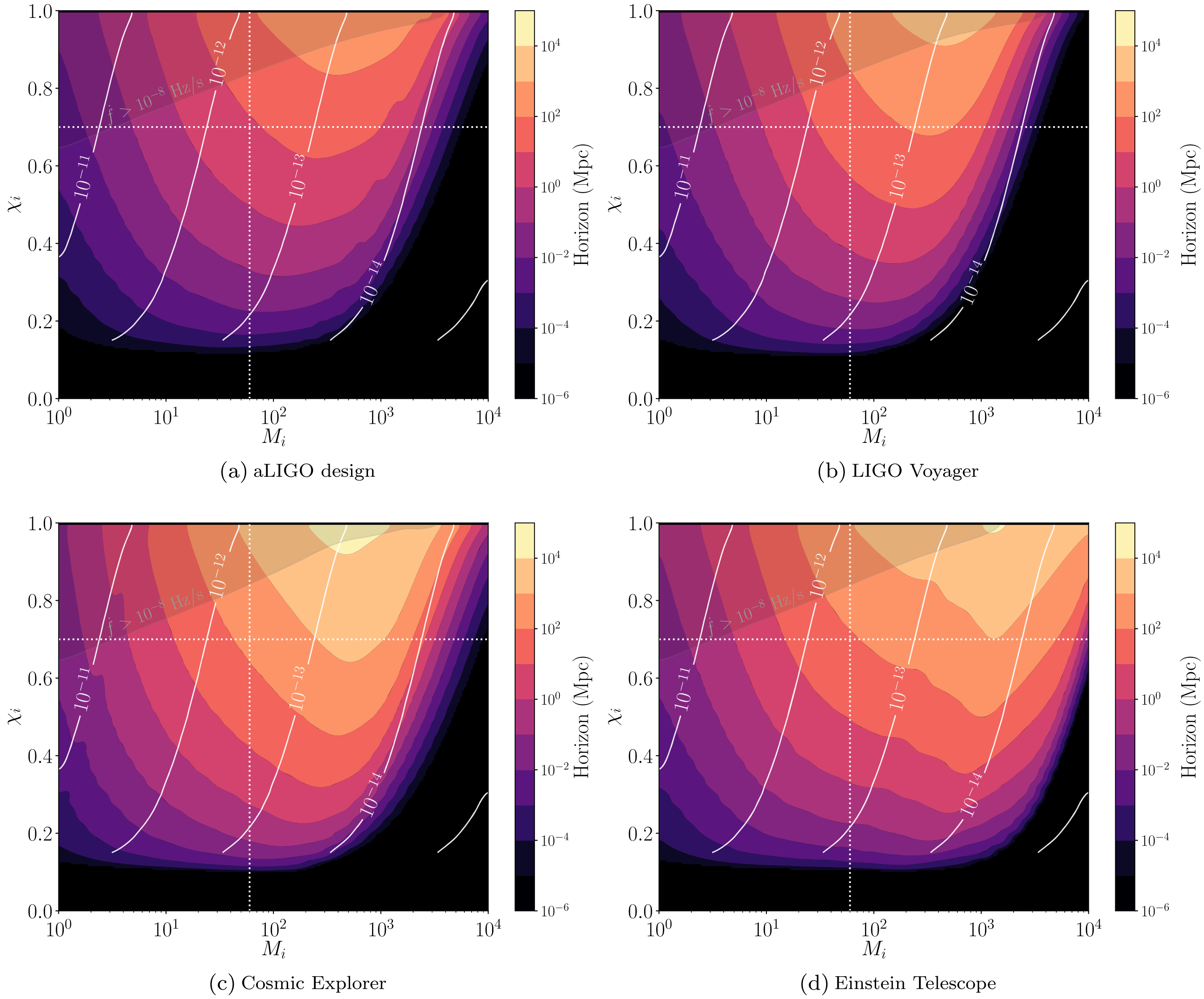

FIG. 2. Corrected version of Fig. 12 in this paper. All horizons have been multiplied by $\sqrt{5/(4\pi)} \approx 0.63$.

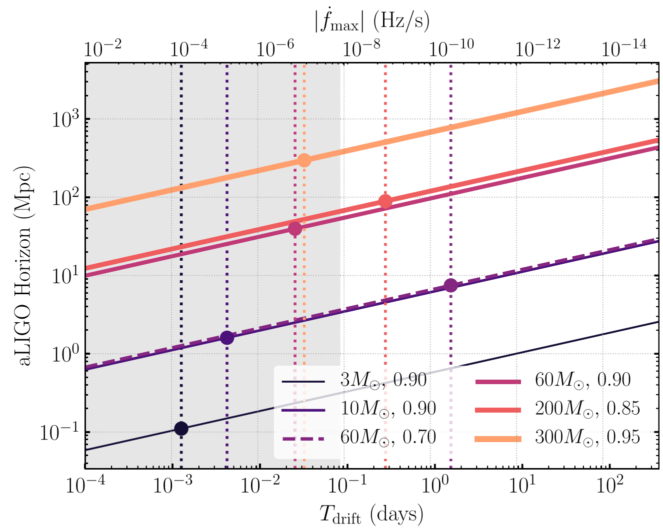

FIG. 3. Corrected Fig. 13 in this paper. All horizons have been multiplied by $\sqrt{5/(4\pi)} \approx 0.63$.

$$\bar{h}_0 = \sqrt{\frac{5}{4\pi}} h_0. \tag{4}$$

Since the discussion in Sec. IV is mostly self-contained, the impact of this inconsistency is limited. However, it does affect the computation of detection horizons (Sec. IVB2), since those were obtained incorrectly assuming $\bar{h}_0 = h_0$. As a consequence, horizons were underestimated by a factor of $\sqrt{5/(4\pi)} \approx 0.63$. In particular, this affects Figs. 12 and 13, as well as Table V, which we correct here in Figs. 2, 3 and Table I respectively. The change in the figures is only slight due to the log scale. General conclusions about detectability do not change qualitatively.

II. GW TIMESCALE

Throughout this paper, $\tau_{\rm GW}$ is estimated by means of Eq. (22), with the GW power $\dot{E}_{\rm GW}$ computed numerically as in Eq. (19). That equation correctly gives the GW power radiated in a specific $(\tilde{l}, \tilde{m})$ angular mode. However, when studying the GW signal lifetime (which $\tau_{\rm GW}$ is meant to encode) it is appropriate to account for radiated power in *all* relevant angular modes. For emission in the dominant quadrupolar mode, both $\tilde{l} = \tilde{m} = 2$ and $\tilde{l} = -\tilde{m} = 2$ must be considered. Nevertheless, $\tau_{\rm GW}$ computations in this paper only factored in a single mode and, therefore, overestimated the timescale by a factor of two. In most cases, $\tau_{\rm GW}$ is only interesting up to order of magnitude and, therefore, the impact of this correction is minor. Figures 4 and 5 in this erratum are updated versions of Figs. 6 and 8 in the original text (the differences are barely discernible due to the log scale). All values of $\tau_{\rm GW}$ in Tabl I should be divided by two, as done here in Table II.

TABLE I. Corrected Table V in this paper. All horizons have been multiplied by $\sqrt{5/(4\pi)} \approx 0.63$ (modulo rounding).

M_i ($M_\odot$)	χ_i	aLIGO	Voy	CE	ET
3	0.90	0.1	0.3	1.3	1.0
10	0.90	1.6	3.9	23	15
60	**0.70**	**7.5**	**31**	$\mathbf{1.6 \times 10^2}$	79
60	0.90	40	1.5×10^2	7.9×10^2	4.2×10^2
200	0.85	89	4.0×10^2	2.8×10^3	8.8×10^2
300	0.95	2.9×10^2	1.3×10^3	1.0×10^4	2.5×10^3

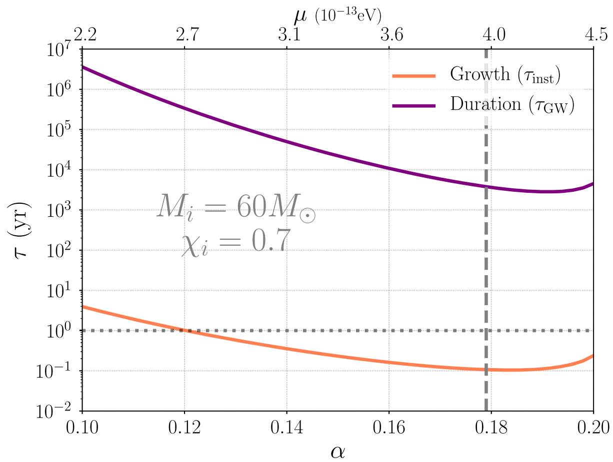

FIG. 4. Corrected version of Fig. 6 in this paper. $\tau_{\rm GW}$ has been reduced by a factor of two.

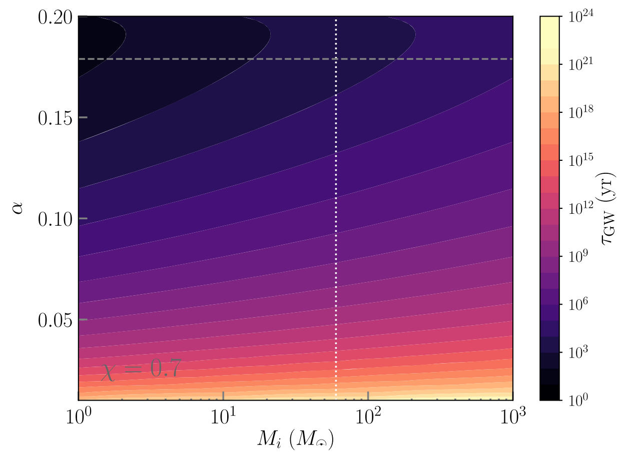

FIG. 5. Corrected version of Fig. 8 in this paper. $\tau_{\rm GW}$ has been reduced by a factor of two and the lines now intersect at $\tau_{\rm GW} = 3.7 \times 10^3$ yr.

TABLE II. Corrected Table I in this paper. All values of $\tau_{\rm GW}$ have been divided by two.

M_i $M_\odot$	χ_i	μ 10^{-13} eV	α_i	f Hz	h_0 5 Mpc/r	$\tau_{\rm inst}$ day	$\tau_{\rm GW}$ yr
3	0.90	122	0.273	5.8k	4×10^{-26}	0.1	1
10	0.90	36	0.273	1.7k	1×10^{-25}	0.3	3
60	**0.70**	**4.0**	**0.179**	**191**	$\mathbf{5 \times 10^{-26}}$	**39**	**4k**
60	0.90	6.0	0.273	290	7×10^{-25}	2	19
200	0.85	1.6	0.243	77	1×10^{-24}	12	256
300	0.95	1.4	0.311	66	8×10^{-24}	4	20

[1] A. Arvanitaki, M. Baryakhtar, and X. Huang, Phys. Rev. D **91**, 084011 (2015).