Supplementary information for the letter: “Long-lived inverse chirp signals from core collapse in massive scalar-tensor gravity”

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**Code tests** – In order to test the code for stellar collapse in massive scalar-tensor (ST) theory of gravity, we have repeated the convergence analysis displayed in Fig. 3 of [1] but now using a massive scalar field with \( \mu = 10^{-14} \) eV and \( \alpha_0 = 10^{-4} \) and \( \beta_0 = -20 \). We observe the same convergence between first and second order, in agreement with the first and second order schemes used in the code.

As a further test, we have evolved the 12 \( M_\odot \) zero-age-main-sequence progenitor WH12 of the catalog of realistic pre-SN models [2] for the same \( \mu, \alpha_0 \) and \( \beta_0 \), employing a uniform grid with \( \Delta r \) inside \( r = 40 \) km and logarithmically increasing grid spacing up to the outer boundary at \( 1.8 \times 10^5 \) km. Convergence of \( r \phi \) extracted at \( r_{\text{ex}} = 3 \times 10^5 \) cm is tested with three different resolutions \( \Delta r_1 = 250 \) m, \( \Delta r_2 = 125 \) m, \( \Delta r = 62.5 \) m in the interior and a total number of \( N_1 = 5 \times 10^4 \), \( N_2 = 10 \times 10^4 \), \( N_3 = 20 \times 10^4 \) grid points, respectively, so that the differences between high, medium and low resolution are expected to scale with \( Q_1 = 2 \) for first and \( Q_2 = 4 \) for second-order convergence. This expectation is borne out by Fig. 1 where we study the convergence of the strong peak signal generated at core bounce at \( t - r_{\text{ex}} \approx 38 \) ms which dominates all our wave signals. The good agreement between the solid and dotted curves demonstrates convergence close to second order and implies a discretization error of about 6 \% (3 \%) for coarse (medium) resolution. In the simulations used for our study, we use \( \Delta r = 166 \) m and extend the outer grid to \( 9 \times 10^5 \) km while keeping the resolution in the extraction zone unchanged.

![Convergence of wave signal](image)

**FIG. 1.** Convergence of the wave signal at \( r_{\text{ex}} = 3 \times 10^4 \) km from a typical, strongly scalarized collapse of the WH12 profile with \( \Gamma_1 = 1.3 \), \( \Gamma_2 = 2.5 \), \( \Gamma_{\text{bh}} = 1.35 \), \( \alpha_0 = 10^{-4} \), \( \beta_0 = -20 \). The solid curve shows the difference of the coarse and medium resolution runs and is compared with that between medium and high resolution rescaled for first-order (dashed) and second-order (dotted curve) convergence factor. For reference, we show the signal \( r_{\text{ex}} \phi \) in the bottom panel where the vertical dotted line at \( t - r_{\text{ex}} = 38 \) ms marks the core bounce.

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