Generating Gravitational-Wave Signals with LALSimulation and gwsignal

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Summary

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C interface

The C interface is written in the same language as the traditional LALSimulation, the C99 language. It aims to enhance the waveform generation functionalities by introducing several new features. This interface allows to generate the gravitational wave polarizations and individual modes of all the models implemented in LALSimulation, but also allows the evaluation of external waveform models implemented both in C or in the Python language through a standarized framework. Furthermore, the interface introduces the flexibility for the user to specify different combinations of input arguments through a dictionary-like object instead of having to introduce a fixed list of parameters.

In order to leverage the full set of new functionalities, the user will need to switch to a new set of standard functions that superseed the waveform generation functions used so far. However, the user can also choose to continue using the old functions as done so far, the old set of functions are backwards compatible and do not require the user to modify their code if they do not need the new functionalites. We shall now describe in more detail the new set of functions and new functionalities and compare them to the old functions/functionalities.

In Table @ref(tab:old-vs-new-functions) it is shown the old and new set of standard functions for waveform generation. Functions in the left and right columns generate exactly the same output.

	Old interface	New interface
+,x polarizations in Time/Fourier domain	XLALSimInspiralChooseTD(FD)Waveform	XLALSimInspiralGenerateTD(FD)Waveform

	Old interface	New interface
+,x polarizations in Time/Fourier domain with conditioning for Fourier transforms	XLALSimInspiralTD(FD)	XLALSimInspiralGenerateTD(FD)Waveform
Individual modes in Time/Fourier domain	XLALSimInspiralChooseTD(FD)Modes	XLALSimInspiralGenerateTD(FD)Modes

Firstly, we will briefly review the old set of functions and spell out their differences.

- XLALSimInspiralChooseTDWaveform generates the time domain polarizations for time domain models but also Fourier domain models by internally performing an inverse Fourier transform.
- XLALSimInspiralChooseFDWaveform generates the Fourier domain polarizations of only Fourier domain models. It does not support time domain models.
- XLALSimInspiralTD generates time domain polarizations both for time and Fourier domain models. When the model is in the time domain, it will condition it so that if a Fourier transform is applied, the result is sensible. In XLALSimInspiralChooseTDWaveform this conditioning is not applied. In the case of Fourier domain models, an inverse Fourier transform is applied and the result should agree with XLALSimInspiralChooseTDWaveform.
- XLALSimInspiralFD generates Fourier domain polarizations both for time and Fourier domain models. For time domain models it will perform an direct Fourier transform. For Fourier domain models, it only applies the conditioning so that if the waveform is transformed to the time domain the result will be sensible.
- XLALSimInspiralChooseTDModes generates the individual time domain modes of a time domain model. There are no Fourier transforms or conditioning.
- XLALSimInspiralChooseFDModes generates the individual Fourier domain modes of a Fourier domain model. There are no Fourier transforms or conditioning.

In all the Fourier transforms applied in the functions above there is a conditioning step which prepares the waveform so that its transform produces sensible results. The new set of functions can optionally perform the conditioning and Fourier transforms, preventing the duplication of the number of functions.