

Documentation Of GWFrames

Contact: consider opening a [GitHub issue](#) or find me at m-melching@web.de.

For the most recent version of all the files, see https://github.com/MaxMelching/gw_frames. This file was compiled on October 17, 2025 and the corresponding git commit hash is [9a2ced3](#) (or, in case you need the full one, [9a2ced32f225290ad0a24e726b93e9a221a3d53b](#)).

1 Overview

This repository contains three packages, each providing one command:

- ▶ **cbc_frames_tikz** (command `\drawframes`): plots a selection of source frame, signal frame, and celestial frame that are used to describe gravitational waves emitted by compact binary coalescences.
- ▶ **cbc_binary_tikz** (command `\drawbinary`): plots intrinsic parameters of a system of two compact binary objects. Adapted from code originally written by Jannik Mielke.
- ▶ **earth_tikz** (command `\drawearth`): plots one side of the Earth. Mainly intended for usage through `\drawframes`. Most of the credit for this code goes to Izaak Neutelings, who provided it on https://tikz.net/astronomy_seasons/.

Several examples of how to use this package are shown in the examples folder.

2 List Of Keyword Arguments

Note that certain values cannot be passed to pgfkeys, which is particularly relevant for declaration of labels. If you encounter an issue of this kind, look up the command that this key is stored in (typically something like `\<parameter>Label`), and manually set the command. This can be done using `\def\<parameter>Label<input>`. A practical example would be `\def\OmegaLabel{\Omega= \pi/2 + \mathrlongAscNodes$}`.

2.1 cbc_frames_tikz

This is a list of all keyword arguments (note that all angles are expected to be given in degrees):

- ▶ **mass1**: Mass of the first compact object, determining its size. Ten solar masses correspond to a size of 0.35 cm.
Default = 20
- ▶ **mass2**: Mass of the second compact object, determining its size. Ten solar masses correspond to a size of 0.35 cm.
Default = 20
- ▶ **inclination**: Inclination between orbital plane and sky plane. This rotation is about the ascending node \varnothing .
Default = 0
- ▶ **polarization**: Polarization angle, i.e. rotation of the x -axis in the sky plane (about the line of sight, which coincides with the z -axis of the signal frame).
Default = 0

- ▶ **longascnodes**: Determines the angle between x -axis of the signal frame and the ascending node Ω , which is $\Omega = 90 + \text{longAscNodes}$.
Default = 0
- ▶ **phiref**: Reference angle ϕ_{ref} that determines the rotation between ascending node and x -axis of the signal frame (about the inclined z -axis of the signal frame).
Default = 0
- ▶ **ra**: Angle between Earth's x -axis and the projection of the line of sight onto Earth's equatorial plane.
Default = 0
- ▶ **dec**: Angle between line of sight and Earth's equatorial plane.
Default = 0
- ▶ **eccentricity**: Determines the circularity of the binary black hole orbit
Default = 0
- ▶ **axislen**: Length of the axes of each coordinate system.
Default = 3
- ▶ **axislabelpad**: How far from the axis label is drawn from the axis arrow tip, in multiples of **axislen**.
Default = 0.12
- ▶ **binaryscalefactor**: Distance of binary companions, in multiples of **axislen**.
Default = 0.5
- ▶ **binarydistance**: distance of binary center of mass from Earth, in multiples of the axis length **axislen**.
Default = 3
- ▶ **showcelestialframe**: Whether to show the celestial frame. Has precedence over the other commands for the styling of the celestial frame, such as **celestialframeaxes**.
Default = true
- ▶ **celestialframeaxes**: Whether to show the celestial frame axes.
Default = true
- ▶ **celestialframehelperlines**: Whether to show the celestial frame helper lines.
Default = true
- ▶ **celestialframeangles**: Whether to visualize the celestial frame angles.
Default = true
- ▶ **showlineofsight**: Whether to visualize the line of sight (and accordingly, the luminosity distance).
Default = true
- ▶ **showsignalframe**: Whether to show the signal frame. Has precedence over the other commands for the styling of the signal frame, such as **signalframeaxes**.
Default = true
- ▶ **signalframeaxes**: Whether to show the signal frame axes.
Default = true
- ▶ **signalframehelperlines**: Whether to show the signal frame helper lines.

Default = true

- **signalframeangles**: Whether to visualize the signal frame angles.

Default = true

- **showsourceframe**. Whether to show the source frame. Has precedence over the other commands for the styling of the source frame, such as **sourceframeaxes**.

Default = true

- **sourceframeaxes**: Whether to show the source frame axes.

Default = true

- **sourceframehelperlines**: Whether to show the source frame helper lines.

Default = true

- **earthradius**: Radius of the Earth that is drawn as part of the celestial frame. Passed on the **radius** argument of **earth_tikz**.

Default = 1.25

- **earthtilt**: Tilt of the Earth that is drawn as part of the celestial frame. Passed on the **radius** argument of **earth_tikz**.

Default = 0

- **showifo**: Whether to draw an interferometer on Earth.

Default = true

- **ifoarmlength**: Arm length of the interferometer.

Default = 2

- **showazimuthalangle**: Determines if a specific azimuthal angle used in [this](https://www.nature.com/articles/025-02632-5) paper is visualized.

Default = false

2.2 cbc_binary_tikz

- **mass1**: Mass of the first binary component, in solar masses.

Default = 20

- **mass2**: Mass of the second binary component, in solar masses.

Default = 10

- **spin1x**: x -component of the dimensionless spin of the first binary component.

Default = 0

- **spin1y**: y -component of the dimensionless spin of the first binary component.

Default = 0

- **spin1z**: z -component of the dimensionless spin of the first binary component.

Default = 0

- **spin2x**: x -component of the dimensionless spin of the second binary component.

Default = 0

- **spin2y**: y -component of the dimensionless spin of the second binary component.

Default = 0

- **spin2z**: z -component of the dimensionless spin of the second binary component.

Default = 0

- **inclination**: Inclination of the orbital plane with respect to the xy -plane. (The orbital plane is the plane in which the two binary components orbit each other.)

Default = 0

- **polarization**: Angle or rotation in the orbital plane.

Default = 0

- **eccentricity**: How eccentric the binary orbit is.

Default = 0

- **binaryseparation**: How far the binary components are separated.

Default = 6

- **showcombinedquantities**: Whether to show quantities like the effective or precessing spin, which are combinations of the properties of both binary components.

Default = true

Other quantities of interest are the commands `\BHsizepersolmass` and `\UnitSpinSize`, which determine the size of black holes and spins in the plot.

2.3 earth_tikz

- **radius**: Radius of the Earth

Default = 1

- **tilt**: Tilt of the Earth

Default = 0