

# Black Hole Cluster with Blender

June 9, 2025

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# 1 Blender Code for BH Cluster

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If you once want to use the Blender code for BH cluster in the GUI, here is what you should do. Here I assume you know the basic navigation on Blender.

## 1.1 Get the data

Before you start, make sure you have the position, size, and spin of the BH in CSV format. The raw data from the simulation should be in the .dat format. The first file you are looking for is [punctures.dat](#); this file contains the position of each black hole. Now run the [find\\_BH\\_mergers.py](#); this code group the black hole and create a new black hole if two black hole merged and from another black holes. You will see an output named [Monoenergetic\\_N25\\_yc0.819\\_all\\_BHs\\_punctures.dat](#). In this file, if we have 25 black holes, the black hole 1-25 are the initial black holes, and black hole 26 and beyond are the black holes that from after merger. The other file [Monoenergetic\\_N25\\_yc0.819\\_merger\\_info.dat](#) contain the information of the merged time for all black holes, and it is used to compute the mass and spin of the black holes.

To make the blender code work, we need to convert all files into CSV format. For Mac, it can be done by the "Numbers" function. Convert [Monoenergetic\\_N25\\_yc0.819\\_all\\_BHs\\_punctures.dat](#) into [position.csv](#). Also convert [Monoenergetic\\_N25\\_yc0.819\\_merger\\_info.dat](#) into [size.csv](#), note here we are only using the first two columns, and the other columns can be removed. **Remove all extra space when you convert to csv**

For the spin csv, you need to do a bit extra work. The spin information are contain in the AH\_data directory. After you get the directory, run [copy\\_txt.sh](#); this file convert all dat file to txt file to python knows how to read. Afterward, run [grab\\_data.py](#) and [increase\\_res.py](#); the first piece of code create a combined csv file that includes only spin for each blackhole, while the second piece smooth the data to match with time step of the revolution. Take the file and apply [remove\\_spin.py](#). Inside the remove\_spin.py, you need to manually add the merger time of each black hole, and this information can be find in the [Monoenergetic\\_N25\\_yc0.819\\_merger\\_info.dat](#). **The remove\_spin.py will directly edit the spin.csv file**

Now you have the [position.csv](#), [size.csv](#), and [spin.csv](#)

## 1.2 Blender file

First, get the code file from Github, open the file and you will see this:

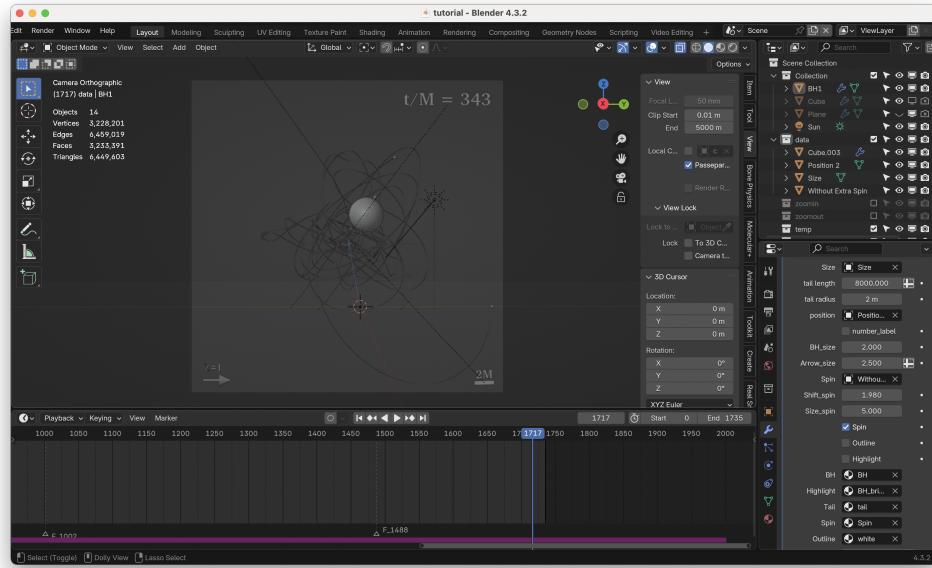


Figure 1: Blender file look like this

The first thing you want to do is run the script that came with the file. Go to top right and click "script". This script creates a way to read csv files.

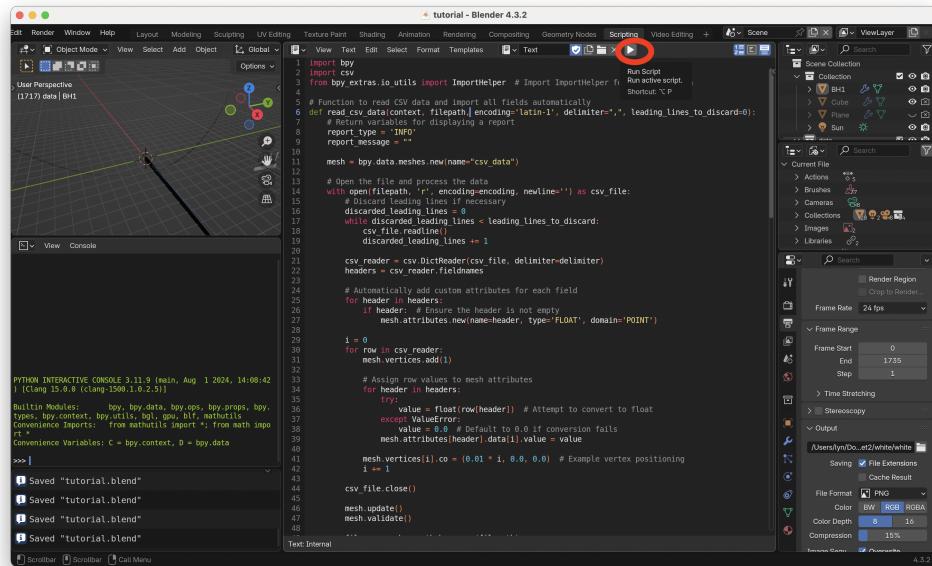


Figure 2: The script that reads CSV file

Now add the import the position.csv, size.csv, and spin.csv. If you don't have them, read previous section.

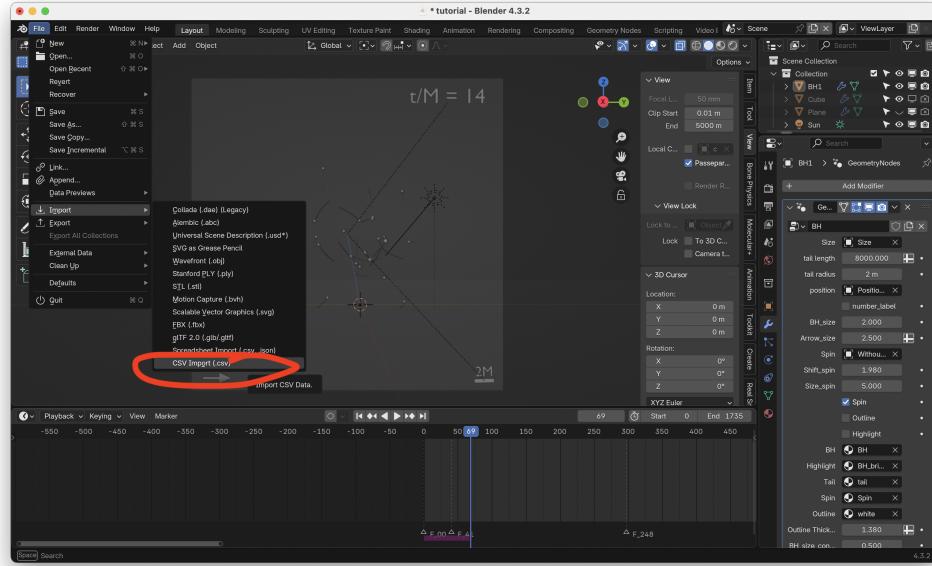


Figure 3: Import the csv file

The right modifier has all the parameter of the black hole cluster.

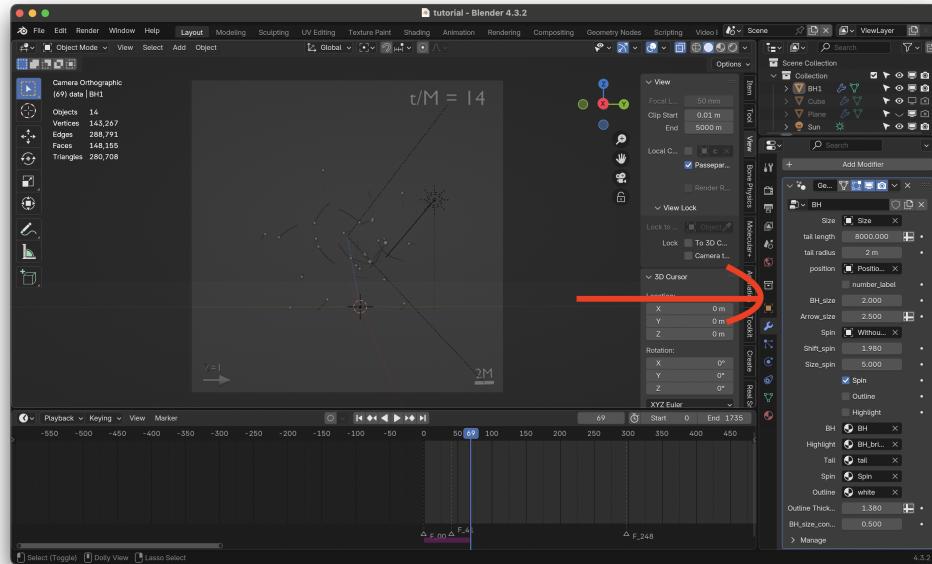


Figure 4: Parameter for BH cluster

- **Size:** Choose the size csv file
- **tail length:** the length of the trajectory in frames. i.e. making it 200 will show 200 frames of trajectory.
- **tail radius:** size of the tail
- **position:** Choose the position csv file.

- **BH\_size:** controls how big the black holes are. This correspond to the mass of the black holes, and 1 is the exact size. To make the black holes visible, you might need to adjust size to be greater than 1.
- **Arrow\_size:** Intent to control the cylinder size of the spin arrow. Currently under development and does nothing.
- **Spin:** Choose the spin csv file
- **Shift\_spin:** How much do you want the spin to point away from the black holes.
- **Size\_spin:** Size of spin arrow
- **Spin/Outline/Highlight:** If you want to show spin/outline/highlight. Outline is for the outline of the black hole, so they become more visible in certain background. Highlight is for change in color when merge.
- **BH/Highlight/Tail/Spin/Outline:** These are controls for the material
- **Outline Thickness:** Bigger number means thicker outline
- **BH\_size\_constant:** To make the black holes visible, we use the formula  $actual\ size * BH\ size + BH\ size\ constant$

Now you are ready to render the video

### 1.3 If you want to modify the blender code

The blender code is based on geometry node, and if you want to understand the code, you might want to learn a little bit of geometry node.

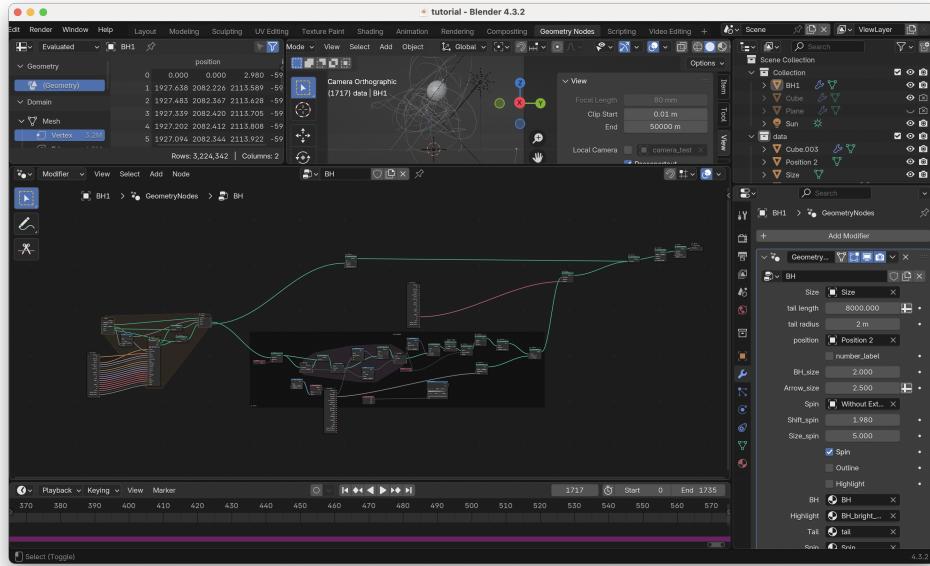


Figure 5: Geometry node setup for the BH cluster

For BH cluster, the code has two sections. The first one controls the black holes and it's spin, the second one gives the trajectory. There are subgroup in the part of the that plot the black holes, and if you don't understand it, ask Yinuan.

Also note the t/M, spin bar and the scale bar are also done with geometry node. These are easier to understand and modify. These are parent to the camera, so when the camera moves they will move with the camera. Also note that the scale for the scale bar automatically adjust itself when the camera moves.

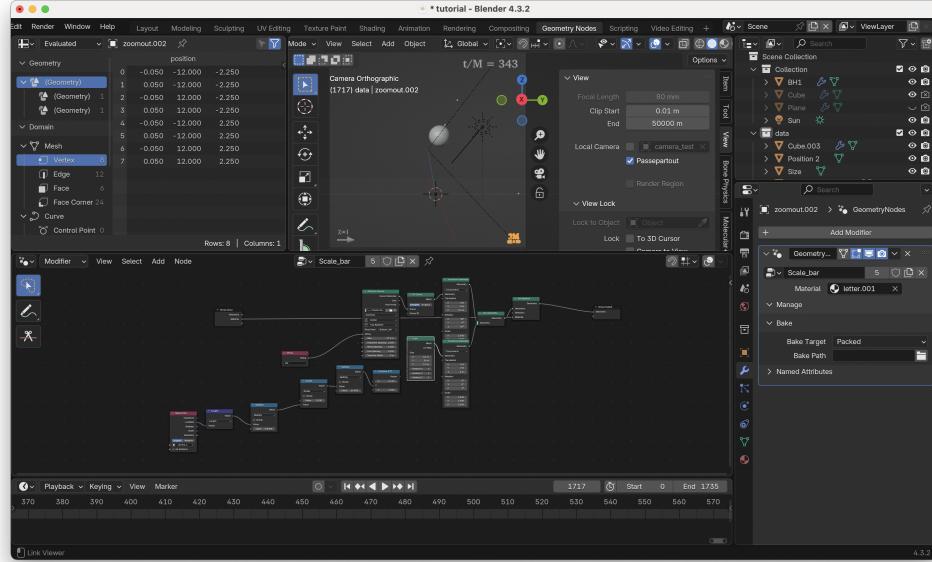


Figure 6: Scale bar

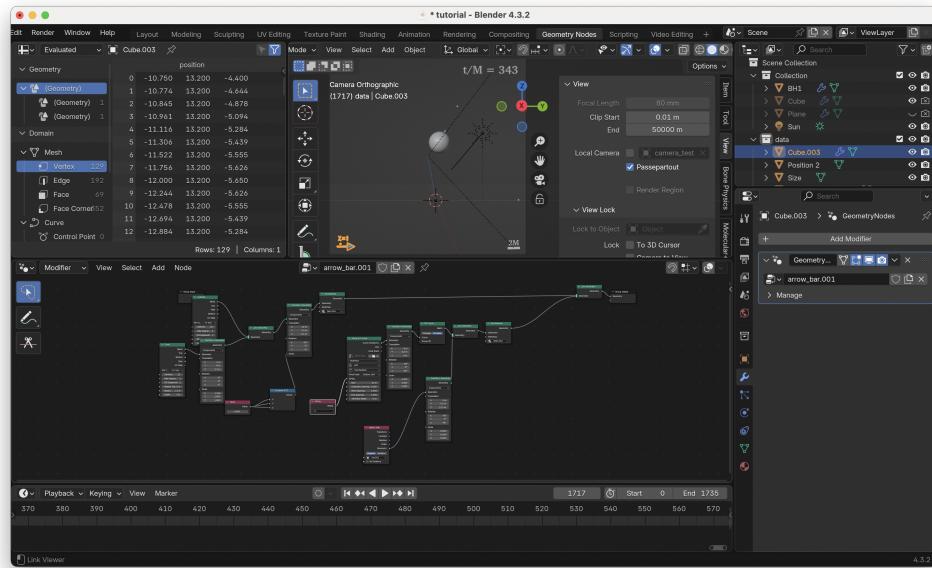


Figure 7: Spin arrow bar

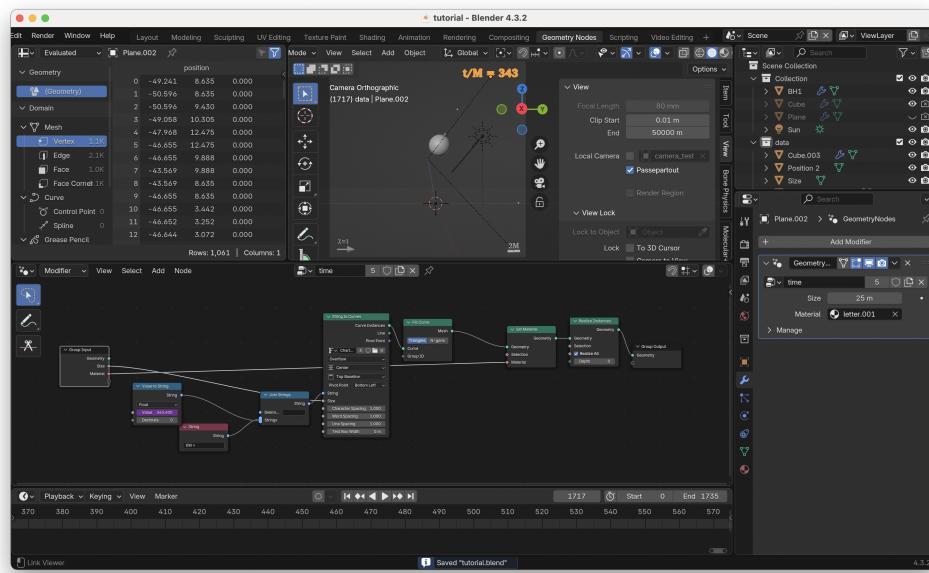


Figure 8: t/M bar