Unix commands to know

- **Commands to know**

  - ls, pwd, cd, mkdir

  - ./, ../, paths

  - **cp, mv, rm, rmdir**

  - cat, **less**

  - nano

  - **cal, date, …**

- **Play along…**

Clicker question #1.9

- Which command makes a new directory called "TestFolder"?

A ls TestFolder

B cd TestFolder

C mkdir TestFolder

D cp TestFolder

Clicker question #1.8

- I want to list the files in the directory I'm in. Which command would I use?

A ls

B cd

C pwd

D nano

Clicker question #1.9

- Which command edits the file "Hello.txt" in the directory I am currently in?

A nano ./Hello.txt

B cat ./Hello.txt

C nano ../Hello.txt

D cat ../Hello.txt

Clicker question #1.9

- Which command removes everything in the current directory, which is not empty?

A   rmdir ./

B   rm -r ./

C   rm -r . /

D   More than one of these will work

Parallel computing

- Supercomputers have lots of cores

- But each core is not much faster than a PC

- To take full advantage, you have to write code that can run on more than one core at the same time

  - That is, code that runs in parallel

Image courtesy Blue Waters

Parallel computing 1

- Log into cocalc

- In a terminal:

```
#Replace YourName with your name
ssh ws2021@ocean.fullerton.edu
cd StudentFolders
cd 2023
mkdir YourName
cd YourName


mkdir PiDart
cd PiDart
```

Parallel computing 2

- # In your terminal, make a file "Hello.py" and put the following Python code into it

- nano Hello.py

```python
print("Hello")
```

- mpirun -np 8 python Hello.py

- **What happens? What happens if you change 8 to another number less than 8?**

What happened?

- mpirun ran many copies of "Hello.py"

- Each copy printed "Hello"

  - But the processors are not working together yet, or even doing anything different

- Next: make different processors do different things

Parallel computing 3

- cp Hello.py MpiHello.py

- nano MpiHello.py

```python
from mpi4py import MPI
comm = MPI.COMM_WORLD
rank = comm.Get_rank()
size = comm.Get_size()
print("Hello from processor "+str(rank)+" out of "+str(size))
```
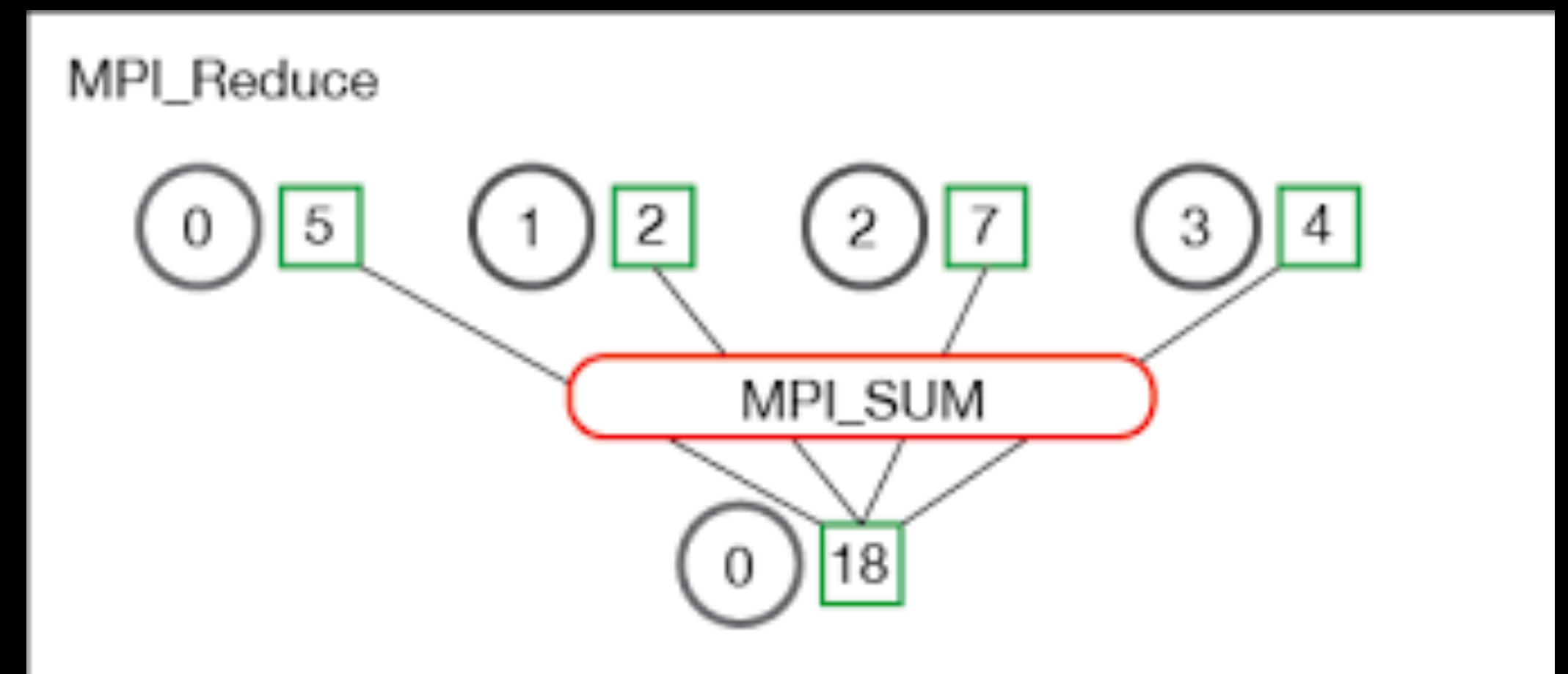
- mpirun -np 4 python MpiHello.py

- mpirun -np 8 python MpiHello.py

Paralleizing the dartboard

• **What if we combined results from the whole class's π dartboard?**

• **Even better**

   • Run lots of copies of the dartboard on lots of cores

   • At the end, each copy tells the others how many hits it had

   • Each copy adds up the number of hits on all processors and computes pi

Parallelizing the dartboard 2

- `cp /home/ws2021/solutions/PiDart/PiDart.py .`

- `nano PiDart.py`

- `#Add the same mpi4py lines at the top`

```python
from mpi4py import MPI
comm = MPI.COMM_WORLD
rank = comm.Get_rank()
size = comm.Get_size()
```

Parallelizing the dartboard 3

- nano PiDart.py

- #At the bottom, instead of getting pi, print the number of hits on each processor

```python
print(str(hits)+" hits on processor "+str(rank)+" out of "+str(int(throws))+" throws.")
```

- mpirun -np 12 python piEstimate.py

  - What happens?

```python
from mpi4py import MPI

comm = MPI.COMM_WORLD
rank = comm.Get_rank()
size = comm.Get_size()
```

Parallelizing the dartboard 4

- nano PiDart.py

- #Divide the darts to throw
  among the processors, instead
  of each processor
  throwing the total

```python
hits = 0
throws = 1e7 // size
# … rest of program
```

- mpirun -np 12 python piEstimate.py

- What happens?

Parallelizing the dartboard 5

- nano `PiDart.py`

- #Have on processor add up the totals across all processors

```python
print(str(hits)+" hits on processor "+str(rank)+" out of "+str(throws)+" throws.")


throwsAllProcessors = throws * size
hitsAllProcessors = comm.allreduce(hits, op=MPI.SUM)


if rank == 0:
    print(str(hitsAllProcessors)+" hits on all processors, with "+str(throwsAllProcessors)+" throws.")
```

-

Parallelizing the dartboard 6

- nano PiDart.py

- #Compute pi

```python
if rank == 0:
    print(str(hitsAllProcessors)+" hits on all processors,
with "+str(throwsAllProcessors)+" throws.")


    pi = 4.0 * float(hitsAllProcessors) /
float(throwsAllProcessors)
    print(pi)
```

-

Connect to ocean

- Open cocalc

- Open your terminal

- ssh ws2021@ocean.fullerton.edu

- Passphrase: see whiteboard

Start your own simulation of merging black holes

- Start from rest, collide head-on

- Choose mass ratio between 1 and 1.2

- Choose spin = 0,0,0 on the smaller black hole (B)

- Choose spin = 0,0,X on the larger black hole (A), where X is between 0 and 0.2

- Set Omega0 = 0, adot0=0, D0=35

```
cd $HOME
cd StudentFolders
cd YOURNAME # replace YOURNAME with the name of your folder
```

```
cd $HOME
cd StudentFolders
cd YOURNAME # replace YOURNAME with the name of your folder
mkdir BlackHoleMerger
cd BlackHoleMerger
```
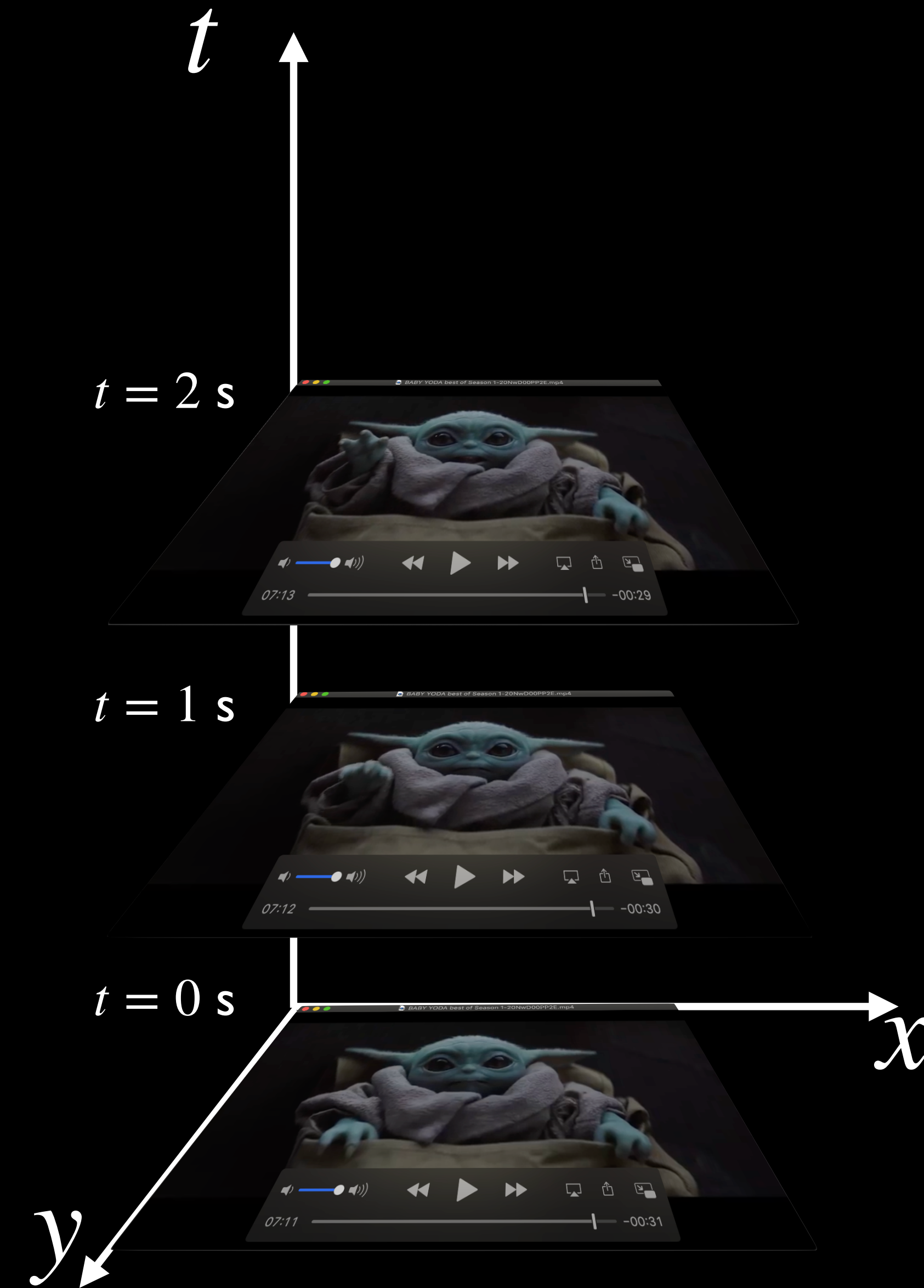
```
cd $HOME
cd StudentFolders
cd YOURNAME # replace YOURNAME with the name of your folder
mkdir BlackHoleMerger
cd BlackHoleMerger
source $HOME/spec/MakefileRules/this_machine.env
```

```
cd $HOME
cd StudentFolders
cd YOURNAME # replace YOURNAME with the name of your folder
mkdir BlackHoleMerger
cd BlackHoleMerger
source $HOME/spec/MakefileRules/this_machine.env
PrepareID -t bbh2 -no-reduce-ecc
```

Spacetime
Visualizing with diagrams

- Set of points, but each point is an event

  - Event = a specific place at a specific time

    - 3 dimensions of space + 1 dimension of time

t

$t = 2$ s

$t = 1$ s

$t = 0$ s

x

y

```
cd $HOME
cd StudentFolders
cd YOURNAME # replace YOURNAME with the name of your folder
mkdir BlackHoleMerger
cd BlackHoleMerger
source $HOME/spec/MakefileRules/this_machine.env
PrepareID -t bbh2 -no-reduce-ecc
```

```
cd $HOME
cd StudentFolders
cd YOURNAME # replace YOURNAME with the name of your folder
mkdir BlackHoleMerger
cd BlackHoleMerger
source $HOME/spec/MakefileRules/this_machine.env
PrepareID -t bbh2 -no-reduce-ecc
nano Params.input
Omega0 = 0.0;
adot0 = 0.0;
D0 = 35.0;
MassRatio = 1.2; #or 1.0, or something in between
@SpinA = (0.0, 0.0, 0.0); #can make 1 component up to 0.2 instead of
0.1
@SpinB = (0.0, 0.0, 0.0);
```

```
cd $HOME
cd StudentFolders
cd YOURNAME # replace YOURNAME with the name of your folder
mkdir BlackHoleMerger
cd BlackHoleMerger
source $HOME/spec/MakefileRules/this_machine.env
PrepareID -t bbh2 -no-reduce-ecc
nano Params.input
# Omega0 = 0.0
# adot0 = 0.0
# D0 = 35.0
# MassRatio = 1.2 #or 1.0, or something in between
# @SpinA = (0.0, 0.0, 0.0) #can make 1 component up to 0.2 instead
of 0.1
# @SpinB = (0.0, 0.0, 0.0)
nano Ev/DoMultipleRuns.input
# my MaxLev = 1
```

```
cd $HOME
cd StudentFolders
cd YOURNAME # replace YOURNAME with the name of your folder
mkdir BlackHoleMerger
cd BlackHoleMerger
source $HOME/spec/MakefileRules/this_machine.env
PrepareID -t bbh2 -no-reduce-ecc
nano Params.input
# Omega0 = 0.0
# adot0 = 0.0
# D0 = 35.0
# MassRatio = 1.2 #or 1.0, or something in between
# @SpinA = (0.0, 0.0, 0.0) #can make 1 component up to 0.2 instead
of 0.1
# @SpinB = (0.0, 0.0, 0.0)
nano Ev/DoMultipleRuns.input
# my MaxLev = 1
./StartJob.sh
```

```
squeue
scontrol show jobid -dd YOUR_JOB_ID
ShowQueue
```