

Writing and Plotting Scalar Field Data Evolving in a Black Hole Space-time

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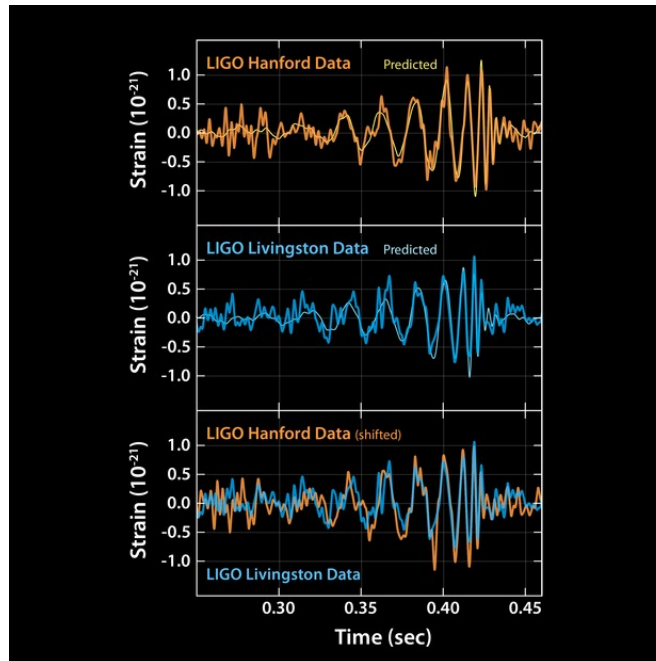
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What are Gravitational Waves?

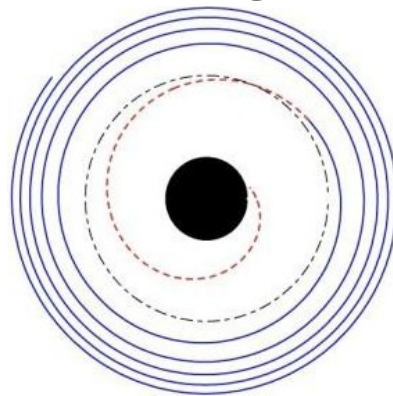
- Predicted by Einstein's General Theory of Relativity
- Wrinkles in space-time cause by massive objects accelerating



- Image From <https://www.ligo.caltech.edu/image/ligo20160211a>

EMRI: Extreme Mass Ratio Inspirals

- A small mass orbiting around a much larger mass
- The system we are focused on is an EMRI of two black holes
- The smaller black hole can be treated as a point mass
- The larger black hole can be treated as stationary
- The gravitational waves produced by this system carry away energy from the system, causing the small black hole to spiral inward



- Image from <http://www.astro.cornell.edu/~favata/research.html>

Perturbation Theory

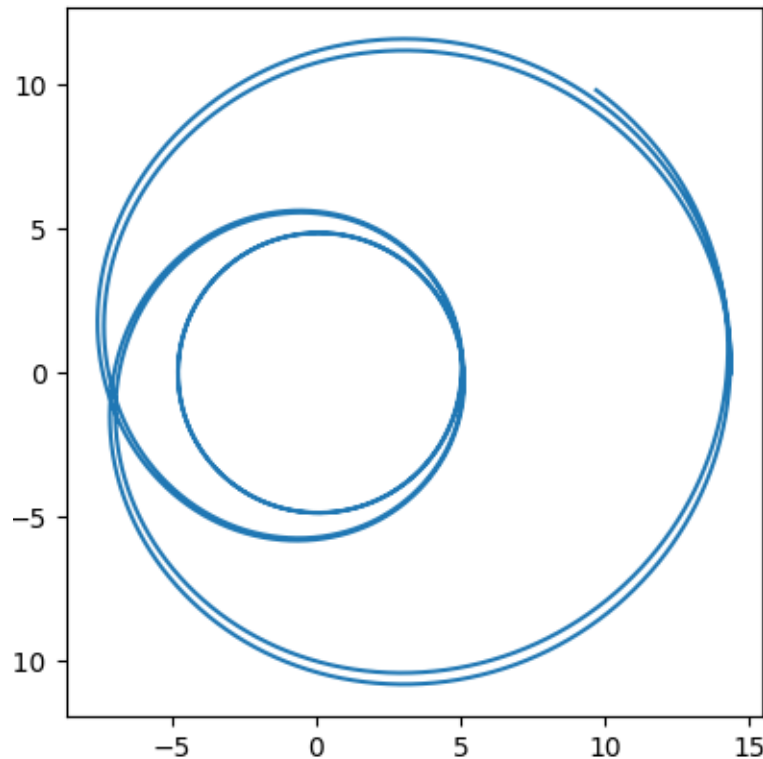
- Must solve Einstein's field equations to describe how space-time is behaving at all points and all times
- Use Perturbation Theory to approximate
- Perturbation Theory: Allows for an approximate solution by using an exact solution to the Einstein equations and adding small perturbations
- The mass ratio between our black holes allow this

Do you want that written in HDF5?

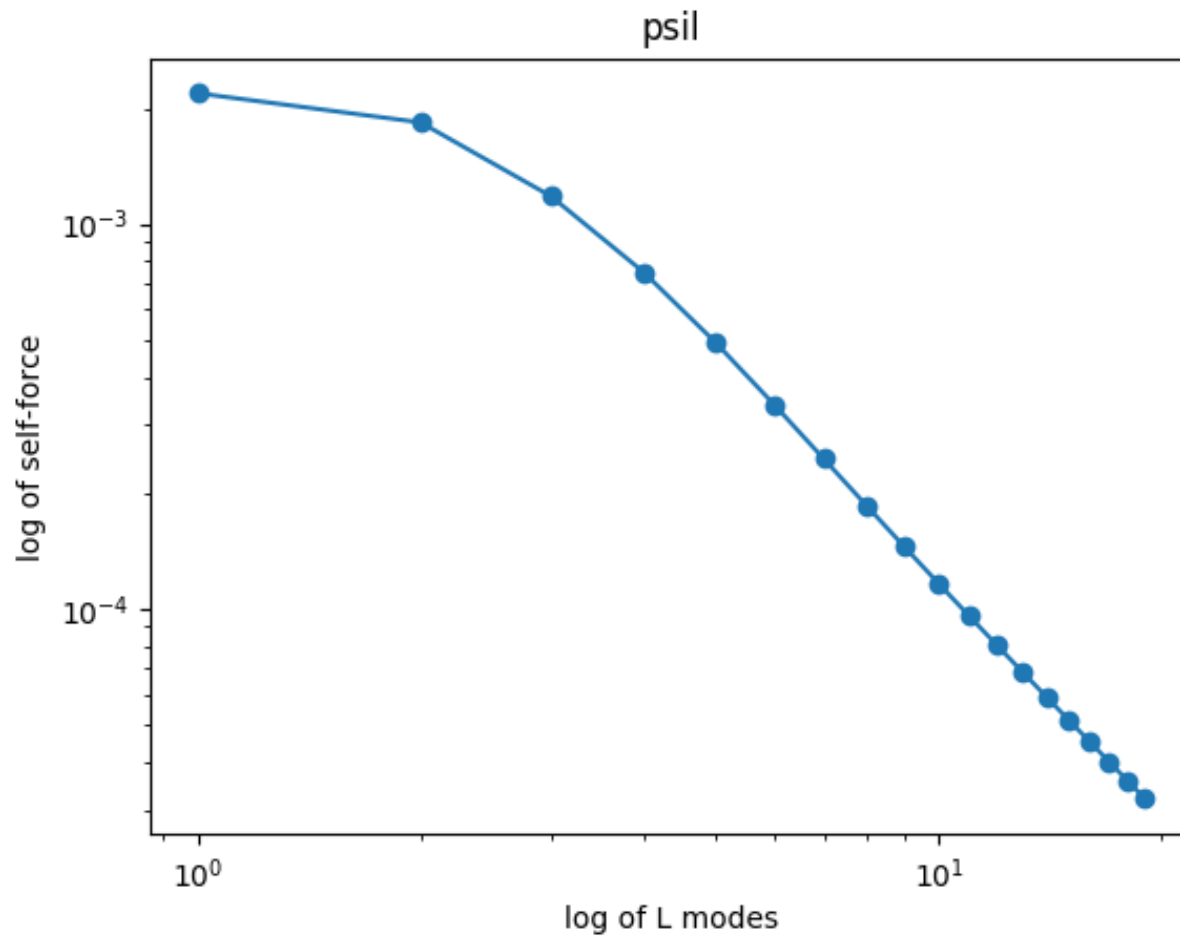
- The original code output data in ASCII
- Wrote Fortran code to write data in HDF5 format
- Reduce disk space of data files from approximately 50GB with ASCII to approximately 4GB in HDF5
- Also introduced a parameter to turn off and on ASCII and HDF5 data
- HDF5 files are easier to navigate and more user friendly

Plotting

- Implemented a python script to draw several important plots from the HDF5 data
- Made an html page with all relevant plots for quick access
- Able to plot the orbit of the particle for all types of orbits



Example Plot



End Goal

- To provide a template of gravitational waves produced by black-hole EMRIs
- Allow future detection methods to identify these waves
- LISA (Laser Interferometer Space Antenna) scheduled launch: 2030

LISA

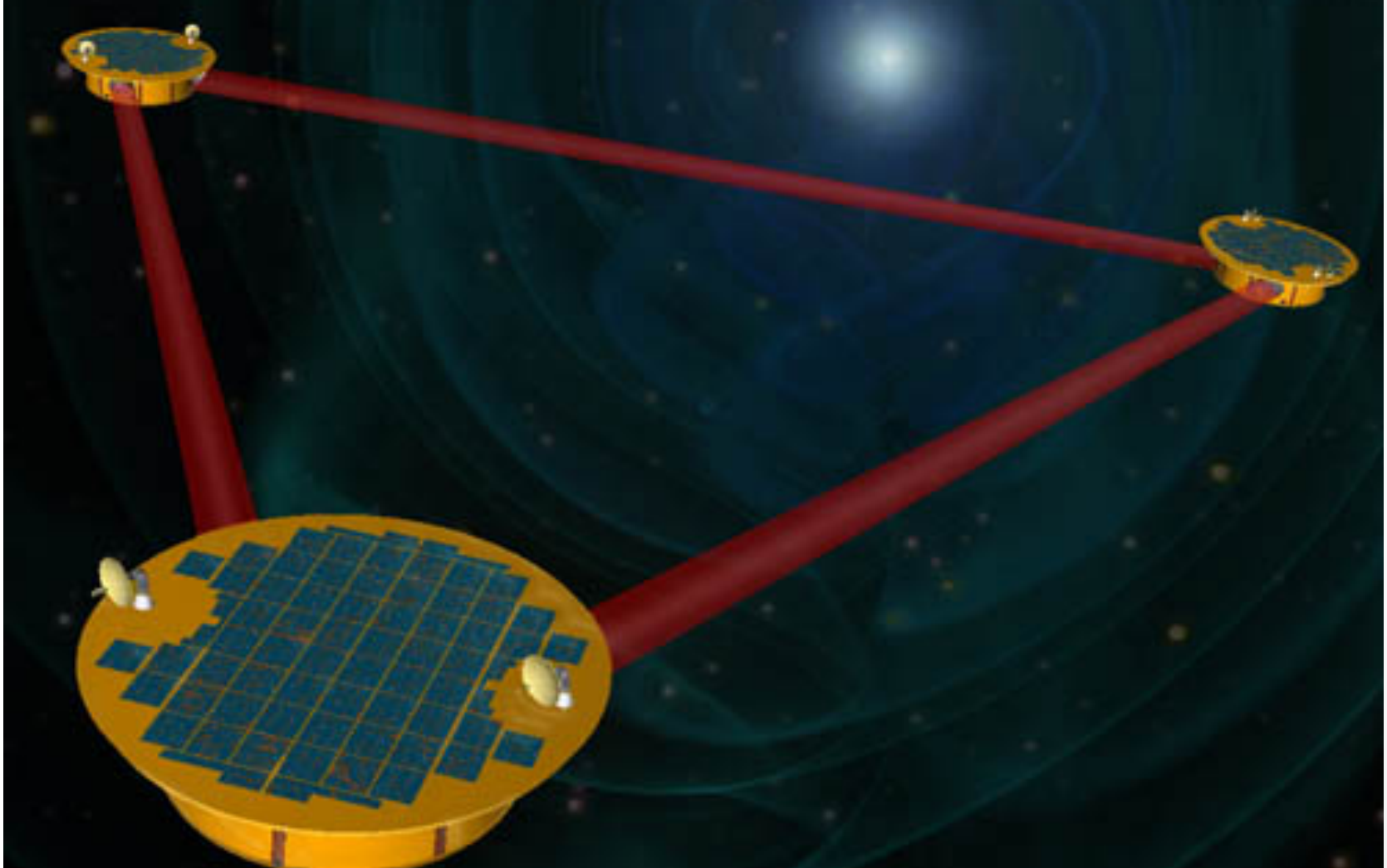


Image from <https://lisa.nasa.gov>

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