



Virginia d'Emilio

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Gravitational-Waves Astrophysics

Project title:

Measuring the properties of black holes and neutron stars with gravitational waves.

I work as part of the LIGO Scientific Collaboration on parameter estimation of gravitational waves sources, such as black holes and neutron stars binaries. The properties of these astrophysical objects are encoded in the gravitational waveform. By comparing waveform templates, generated with numerical relativity, it is possible to evaluate what combinations of the parameters can produce gravitational waves that match the data. This technique is referred to as parameter estimation. More specifically, this consists in applying stochastic inference algorithms, such as markov chain monte carlo (mcmc), to evaluate the probability distribution for the values of the source parameters.

Science/Research area:

Gravitational-waves were predicted by Einstein's theory of General Relativity in 1916 and detected for the first time in 2016 by the LIGO Scientific Collaboration. Their detection has been of extraordinary importance for the field of astrophysics. Gravitational-waves open a new window on the universe, allowing us to "see" previously invisible objects such as black holes and to understand the physics of neutron stars and of supernova explosions. The greatest hope is that they will bring physicists closer to develop a unified theory of general relativity and quantum theory.

About me:

I am an astrophysics graduate from Royal Holloway University of London, where I was awarded a first class MSci degree. I am originally from Milan, in Italy and I moved to the UK in 2014 for my university studies. My problem solving mindset and determination allowed me to overcome the many challenges of studying physics in a foreign language and progressing up to PhD level. I often go back to Italy to visit family and friends and it's my favourite place to spend my holidays at. In my free time I enjoy solving puzzles (especially Sudoku) and playing board games with friends. I also enjoy very much being outdoors and hiking in the beautiful Brecon Beacons National Park.

Data Intensive Research Skills and Interests etc.:

As part of the CDT program I've taken courses in Machine Learning, Statistical Data Analysis, Pattern recognition & Data mining and Data Visualisation. I apply many of these skills in my PhD, as gravitational-waves physics is a data intensive area of research that requires many data analysis and statistical techniques. For instance, I've been working on applying variational inference techniques to speed up stochastic parameter estimation of compact binary coalescences. A topic that I find particularly interesting in Machine Learning is Bayesian Optimisation and how it could be exploited for estimating probability density functions.