The Bayesian toolbox for inference in the observational era: parallel nested sampling and reduced order models

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The observational era of gravitational-wave astronomy has changed our understanding of compact binaries. The most exciting discoveries in LIGO/Virgo's third observing run provided clear evidence for higher order gravitational-wave modes, black hole spin, unexpectedly high-mass black holes, an unexpectedly low-mass black hole, among other discoveries. These inferences are made possible by increasingly sophisticated and computationally demanding Bayesian analyses. I will discuss recent innovations which have been crucial to LIGO/Virgo's recent discoveries: parallel nested sampling and reduced order modelling. Both methods individually accelerate Bayesian inference by several orders of magnitude, reducing computational wall time from months(years) down to hours(days), and can be used with the latest state of the art waveform models. I will highlight several applications of these methods in LIGO's third observing run, and discuss challenges facing inference in gravitational-wave astronomy in future observing runs. Finally, I will discuss how these methods are being developed to produce optimal, rapid sky localization of binary neutron star mergers.