Gravitational waves within post-Newtonian theory

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Course Description

This course is a humble attempt from Kaushik Paul to explain the role of post-Newtonian theory to General Relativity in gravitational radiation emitted by inspiralling compact binaries (ICBs), which are primary targets of current generation interferometric gravitational wave detectors. In this course, we will learn (in a superficial manner, in the sense that I will not derive **everything** on the board) about the multipolar-post-minkowskian post-Newtonian (MPM-PN) formalism that has been successfully applied to derive various observables (such as energy flux) related to gravitational radiation over the past few decades.

We will also do a couple of hands-on sessions on `xTensor` - which is a tensor algebra package used in `Mathematica` to perform these calculations (if time permits). In any case, here is a GitHub repository that contains a `Mathematica` notebook outlining basic commands of xTensor to perform PN calculations and link to two recorded lectures (I gave three but forgot to record the first lecture! sorry for that).

References

- **Textbook:**
  - *Any standard GR textbook such as Hartle or Ray d'Inverno.*
  - *Gravitational Waves, Volume 1: Theory and Experiments*, by Michele Maggiore. Chapters: 1, 3, 4, 5
- **Review article:**
  - *Post-Newtonian theory for gravitational waves*, by Luc Blanchet, Liv. Rev. Rel., volume 27, article number 4, (2024). (This is our BIBLE!)
  - Review article on Self-force/BHPT (a) *Analytic black hole perturbation approach to gravitational radiation* arXiv:gr-qc/0306120, (b) *Self-force and radiation reaction in general relativity* arXiv:1805.10385, (c) *Black hole perturbation theory and gravitational self-force* arXiv:2101.04592.
  - A. Gopakumar's PhD thesis (See Chapter 2 for discussion on STF tensors).
- **Software:** Access to a computer with a stable version (> 11.2) of `Mathematica` installed. Additionally, we would also need xAct to perform PN calculations. Please follow these instructions to install xAct on your system.
- Link to the folder containing the lectures.