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| Journal Name: | [**International Astronomy and Astrophysics Research Journal**](https://journaliaarj.com/index.php/IAARJ) |
| Manuscript Number: | **Ms\_IAARJ\_137414** |
| Title of the Manuscript: | **Mathematical Modelling of Compact Binary Coalescences: A Stochastic Approach to Gravitational Wave Analysis** |
| Type of the Article | **Original Research Article** |

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| PART 1: Comments | | |
|  | Reviewer’s comment **Artificial Intelligence (AI) generated or assisted review comments are strictly prohibited during peer review.** | **Author’s Feedback** (It is mandatory that authors should write his/her feedback here) |
| **Please write a few sentences regarding the importance of this manuscript for the scientific community. A minimum of 3-4 sentences may be required for this part.** | This manuscript presents an innovative stochastic framework for modeling gravitational wave signals from Compact Binary Coalescences (CBCs), addressing a critical gap left by traditional deterministic methods. By incorporating stochastic differential equations to account for uncertainties in system parameters and observational noise, the study enhances the realism and robustness of waveform predictions. This contribution is particularly valuable for improving signal detection in low signal-to-noise conditions and for refining parameter estimation in gravitational wave astronomy. As gravitational wave observatories continue to increase in sensitivity and frequency of detections, the proposed approach offers a timely and impactful tool for the scientific community. The work not only advances theoretical modeling but also provides practical benefits for data analysis pipelines in current and future observatories. |  |
| **Is the title of the article suitable?**  **(If not please suggest an alternative title)** | Yes. The article has a coherent title and is appropriate for the research, but the title “Stochastic Modeling of Compact Binary Coalescences for Gravitational Wave Analysis” sounds better. |  |
| Is the abstract of the article comprehensive? Do you suggest the addition (or deletion) of some points in this section? Please write your suggestions here. | Lack of methodological detail and no mention of results or impact. Add one sentence summarizing the mathematical or computational approach (e.g., “We use Monte Carlo simulation and stochastic differential equations to model parameter uncertainties in CBC evolution.” and add a sentence indicating what the stochastic model achieves or improves, such as: “The model improves waveform prediction accuracy under uncertainty and enhances detection reliability in low signal-to-noise regimes.” |  |
| Is the manuscript scientifically, correct? Please write here. | Yes, the manuscript is scientifically correct in its foundation and objectives. The use of stochastic methods in gravitational wave modeling is both timely and justified. However, to ensure completeness and robustness, care must be taken in the full mathematical treatment of SDEs, the numerical implementation details and the validation with real data. |  |
| **Are the references sufficient and recent? If you have suggestions of additional references, please mention them in the review form.** | Partially. They're scientifically solid but not recent or diverse enough, especially regarding the stochastic modeling techniques. Add at least more 10 references from 2020 to 2024. |  |
| Is the language/English quality of the article suitable for scholarly communications? | Yes, the manuscript's English is suitable for publication, though a light language editing pass (preferably by a native English-speaking editor or automated grammar tool like Grammarly or LanguageTool) would help optimize clarity and flow for international readers. |  |
| Optional/General comments | -The paper lacks empirical validation using real LIGO/Virgo data.  -No comparative results with deterministic models are presented.  -The model parameters (drift and diffusion terms) should be more rigorously defined.  -Simulation results are mentioned but not illustrated; graphical outputs would strengthen the work.  -The python scripts must be available  -The manuscript would benefit from a discussion of computational cost and model sensitivity. |  |

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| **PART 2:** | | |
|  | **Reviewer’s comment** | **Author’s comment** *(if agreed with reviewer, correct the manuscript and highlight that part in the manuscript. It is mandatory that authors should write his/her feedback here)* |
| **Are there ethical issues in this manuscript?** | *(If yes, Kindly please write down the ethical issues here in details)* |  |

**Reviewer details:**

**Edivaldo Costa Sousa Junior, Brazil**