

# Haolan Zheng

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## Education

- **Ph.D. Student in Computational Science and Engineering** Sept. 2023 - Now  
*Advisor: Prof. Yanlai Chen*  
*Department of Mathematics, University of Massachusetts Dartmouth (UMassD)* *N. Dartmouth, MA, US*
- **B.S. in Physics** Sept. 2018 - July 2022  
*School for the Gifted Young, University of Science & Technology of China (USTC)* *Hefei, Anhui, China*

## Research

- **Reduced Basis Neural Operator (ReBaNO)** Sept. 2023 - Now  
Department of Mathematics, UMassD, North Dartmouth, MA, US,  
Advisor: Prof. Yanlai Chen
  - ReBaNO is an operator learning algorithm that relies on the Reduced Basis Method and greedy algorithm. ReBaNO learns the mappings between infinite-dimensional function spaces by building up a one-layer neural network adaptively offline. On the offline stage, the network grows its every neuron by greedy selection process, where a set of representative inputs is sought from the input manifold, and a Physics-Informed Neural Network (PINN) is trained for each representative input to serve as an activation function.
  - After training, ReBaNO forms a compact architecture only requiring minimal computational cost on the online stage while embedding physics. Our experiments demonstrated that ReBaNO is at least equally accurate in comparison to other data-driven neural operators (such as PCA-Net, DeepONet and FNO) while significantly outperforming them in shrinking the generalization gap for both in-distribution and out-of-distribution tests.
- **Waveforms of gravitational waves (GWs) from hierarchical triple black holes** Aug. 2022 - June 2023  
Department of Astronomy, Peking University, Beijing, China,  
Advisor: Prof. Xian Chen
  - Studied the gravitational radiation from stellar binary black holes (BBHs) circling around a supermassive black hole in the equatorial plane at a distance of several Schwarzschild radii.
  - Considered equatorial inner and outer circular orbits and used Teukolsky equation to compute the waveforms to investigate the impact of the SMBH on the GWs from BBHs.
  - Found magnification and frequency shift due to time-dependent Doppler effect, gravitational lensing and relativistic beaming effect on GWs arising from the acceleration of the circular motion of BBHs.
- **Gravitational radiation from test particle-neutron star (NS) system** May 2021 - June 2022  
Guelph Gravity Group, University of Guelph, Guelph, Ontario, Canada,  
Advisor: Prof. Huan Yang
  - Studied black hole perturbation theory and reviewed analytical solution and numerical algorithms for solving Teukolsky equation and familiarized with Gremlin codes from Black Hole Perturbation Toolkit.
  - Considered test particle-NS system to obtain the modification on the GWs from BH-NS and NS-NS binaries due to the deformation of neutron stars up to zeroth order of mass ratio.
  - Derived equations governing the metric perturbation functions inside and outside a non-spinning neutron star and computed the waveforms and energy fluxes of GWs.