Haotian Song |*haotian.song@student.manchester.ac.uk* | *Personal Web*: https://haotian-song.github.io/

My main research interests include Astrophysics and Astronomy, in particular, high-energy astronomy, binary evolution and machine learning. I am currently studying in Mphys(Hons) program at the University of Manchester (UoM). I graduated in ***Tsien Hsue-shen Talent Program*** (top 10% students) at Xi'an Jiaotong University (XJTU) and have been involved in the following research activities:

1. I worked with Prof. Zhaoyu Zuo at XJTU and led a team researching super-fast X-ray transients. Then I study on Ultra-luminous X-ray Sources (ULXs). I published an article on wind accreting ULXs with neutron stars on *Astronomy & Astrophysics* **[1],** and write a manuscript on ULXs population synthesis in Ring galaxies **[2]**.

2. I was working with Texas A&M University (TAMU) under the supervision of Prof. Marlan Scully. I submitted article to *Scientific Reports* **[3]** as the first author. At the moment, I am working on manipulating speckles via a deep learning approach **[4]**.

3. Currently, I worked with Prof. Ian Browne at UoM on "Galaxies alignments" and Prof. Anna Scaife on "hierarchical Fanaroff-Riley classification".

To begin with, I led a team conducting research on Super X-ray Transients(SFXTs). I generally acquire the characteristics of SFXTs and learned popular mechanisms explaining SFXTs. Motivated by this, I started my research on ultra-luminous X-ray sources (ULXs) under the supervision of Prof. Zuo. We found that some X-ray sources are impossible to be ULXs via Roche-lobe overflow in binary system, and simulation on Wind Roche-lobe overflow (WRLOF) reveal a brand-new possible mass-transfer mechanism for ULXs. I utilize an evolutionary population synthesis method to testify WRLOF in ULXs **[1]**. After accumulating ULXs experience during the first project, I learned how to build sophisticated simulations in general and fostered a habit of reading academic papers regularly. I started to focus on ULXs in Star-burst galaxies and combined WRLOF and Roche-lobe overflow. Population synthesis displayed WRLOF contributed partly to ULXs and coincide with Observation in several Ring Galaxies **[2]**.

To broaden my knowledge, I attended a summer school sponsored by XJTU at Peking University, China. During my visit, I attended various activities and lectures. I involved in the group work and gave a presentation on Machine Learning in Physics. From this program, I realized that a good researcher should be insightful and should be able to comprehend a broad spectrum of information from different backgrounds and resources. This program also awakened my interest in quantum optics. Since then, I started to dabble in machine learning and started AMO projects with TAMU.

As a result of my interest in quantum optics, I worked in a group on Computational GI (CGI) last year at TAMU. The main disadvantage of CGI compared to conventional photography is the large sampling number. I thus proposed combining Deep Learning and pink noise to achieve a low sampling number (0.8% Nyquist limit). I built the CNN framework, simulated the CGI process, conducted experiments via remote control as well as wrote a firsthand manuscript **[3]**. Inspired by a convolutional process in CNN, I conceived that a convolutional kernel could generate speckles. I built an unprecedented workflow for the Deep Learning process and successfully retrieved complicated objects at a lower sampling rate **[4]**. Moreover, I collaborated with Prof. Zhedong Zhang, City University of Hong Kong. I programmed a workflow for the deep-learning process and contributed the idea of the structure of Deep-Learned Time-Resolved Coherent Raman Spectroscopy **[5]**.

Apart from doing researches, I joined lots of competitions to expand my knowledge base. I was awarded the **First Prize** in the 5th Chinese Undergraduate Physics Experiment Competition and the journey through the competition

has significantly improved my experiment skills. I also won the **First Prize** in the Contemporary Undergraduate Mathematical Contest in Modelling in Shaanxi province as part of a team. I understand the importance of teamwork and communication and have always played an important role in a team. Moreover, I am always eager to attend seminars and meetings to learn how other researchers conduct their experiments.

Currently, I am doing researches with Prof. Ian Browne and Prof. Anna Scaife at the University of Manchester. For the hierarchical Fanaroff-Riley classification of radio galaxies, I built a branch convolutional neural network and optimized the loss function for better performances. In Galaxy alignment, I access the SDSS and FIRST original catalogue and enlarge the samples for radio and optical galaxies alignments.

My academic and research experiences gained in Astronomy, quantum optics and machine learning, have provided unique insights and clarified my career goals. I am eager to learn physics and disciplines needed, and to become a physicist.

[1]. Z. Zuo†, **H. Song**, H. Xue, "Population synthesis on ultra-luminous X-ray sources with an accreting neutron star: Wind Roche-lobe overflow cases". A&A 649, L2 (2021)
[2]. **H. Song**, Z. Zuo†, "Ultra-luminous X-Ray sources with wind Roche lobe overflow in Ring galaxies".
[3]. **H. Song**, X. Nie, H. Su, H. Chen, Y. Zhou, X. Zhao, T. Peng†, M. O. Scully, "0.8% Nyquist noise-free computational ghost imaging via non-experimental deep learning", submitted to Scientific Report, arXiv:2108.07673
[4]. T. Peng†, **H. Song**, Z. Zhang†, and M. O. Scully, "Deep-learned speckle patterns and its application to ghost imaging".
[5]. Y. Ma, Z. Han, **H. Song**, T. Peng†, Z. Zhang†, and M. O. Scully, "Deep-Learned Time-Resolved Coherent Raman Spectroscopy".