# Statement of Purpose: **UVA**

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## About Me

As an undergraduate student in astrophysics, I have a strong urge to pursue a Ph.D degree because to me, the subtle balance of astonishing physical pictures and beautiful mathematical structures is perfectly attained in astrophysics.

One of my greatest pursuits is to combine state-of-the-art observations with powerful computational methods to understand complex astrophysical environments. This sweet 'temptation' has driven me to explore observational and computational astrophysics from astrochemistry within interstellar medium to various binary systems.

## Research Experience

My first scientific project started at the end of my second year under the supervision of **Prof. Xian Chen** in ***Kavli Institute for Astronomy and Astrophysics, Peking University*** and **Prof. Fujun Du** in ***Purple Mountain Observatory, Chinese Academy of Sciences***. Starting from a 'crazy' implication of recent observations that the supermassive black hole in the Milky Way was active about 2-8 Myr ago, when tremendous hard X-ray could penetrate the dusty Galactic disk to cause the synthesis of complex molecules related to the origin of life, I worked as an 'archaeologist' digging out the astrochemical history of our galaxy. To run the long term astrochemical simulation, I built our chemical network based on a classic gas-phase model (`osu_01_2007`). For self-consistency, I included necessary surface processes important for molecule formation. Under a detailed AGN and galactic absorption model, I carefully embedded X-ray ionization at various distances from the galactic center in the network. With the simulation executed by the `KROME` package, we are extremely excited to see that several typical prebiotic species show observable changes in Galactic distribution given former AGN events. Our paper, of which I am the first author, is under final revision and will be submitted to ApJ within the next month.

My research was not limited to one single subfield. In the summer of 2019, I went to ***Caltech*** as part of the Summer Undergraduate Research Fellowship (SURF) program and explored the field of transients for the first time under the mentorship of **Prof. Shri Kulkarni**. With light curves from Zwicky Transient Facility (ZTF), a state-of-the-art optical time-domain survey with unprecedented field of view and survey efficiency, I conducted a systematic search for periodic white dwarfs (WDs). I performed a cross match between the so-far most complete catalog by *Gaia* and ZTF, selecting a subset of ∼90,000 sources with rich ZTF data. My carefully designed periodogram based on the Lomb-Scargle method was then applied to the extracted light curves. A sample of 81 periodic WDs with periods between 1 and 3 hr stood out. With combined analysis of both shapes of light curves and color information from Gaia and PanSTARRS, I classified several unusual sources including a contact binary candidate with possibly the shortest period known and a strongly ellipsoidal-modulated double WD system with an extremely low-mass (ELM) component. Our paper will be updated with continuing follow-ups before submission to ApJ.

After working on various stellar systems with degenerate components in observational way, I grow intensely interested in the intrinsic physics of compact binaries. At present I am a visiting undergraduate student at ***UC Santa Cruz*** working on my thesis on the mass transfer in compact binaries with **Prof. Enrico Ramirez-Ruiz**. We focus on the direct impact systems, of which the components are WDs so close to each other that the mass transfer flow strikes the accretor as opposed to forming a disk. They dominate gravitational waves sources in the band of space-based interferometers (like *LISA*). To gain an intuition, I independently built a 3-body integrator in Fortran to calculate the ballistic trajectory of a particle in Roche lobe overflow, and successfully reproduced the trajectories and angular momenta transition in literature. Since then I

have been conducting hydrodynamical simulations with the radiation MHD simulation code `FLASH` to test the long-term stability of direct impact mass transfer. With the Python package `yt`, I visualized the torque density to analyze how the orbital angular momentum evolves. In the long run, we will try to predict electromagnetic and gravitational radiation properties of these systems given model parameters.

Conducting research in the most advanced facilities around the world enables me to sample leading-edge subfields and develop skills of data analysis, visualization, and simulations. My proficiency in English has risen to a new level after working overseas for months. More importantly, I have gradually learned how to stay out of frustration, anxiety, and loneliness, in order to persist in a long-term project.

## Why UVA? - Academic Interests

University of Virginia is famous for its breadth and depth in astronomical research. Deeply involved in the most advanced facilities, UVA has rich observation resources from radio band to visible band (VLA, ALMA, and a bunch of optical telescopes). Powerful computational methods are applied to understand the data from the state-of-the-art instrument in an era of multi-messenger astronomy. For graduate students at UVA, both independent research and course learning are highly emphasized. They have access to diverse cutting-edge astrophysical knowledge when meeting with faculty members and when attending numerous seminars and conferences.

I am not too surprised to find that UVA meets so perfectly with my research. Since I started my project on astrochemistry, I have been admiring **Prof. Eric Herbst**'s profound contribution in molecular astronomy. I also really appreciate **Prof. Ilse Cleeves**' research on the chemical and physical origins of planetary systems, especially the time-domain study of X-ray's impact on protoplanetary disks. Besides, with experience in simulations of compact binaries and mass transfer, I am interested in **Prof. Shane Davis**' exciting work on modeling the evolution of relativistic, radiation-dominated flows around compact objects and **Prof. Roger Chevalier**'s work on supernova remnants and their interaction with molecular cloud medium.

I do appreciate it if you could consider my application. I am looking forward to meeting with you for a more detailed talk soon.