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Greetings Members of the Caltech PhD Admissions Committee,

I am currently pursuing a master's degree in astronomy at the University of Amsterdam to prepare myself to excel in Caltech's PhD program. My research is focused on Fast Radio Bursts (FRBs). Caltech's PhD program offers a unique opportunity to continue this work under the guidance of Professors Gregg Hallinan, Vikram Ravi, and Katie Bouman. I completed my undergraduate degree in physics & astrophysics at the University of Toronto, where I received the John Pounder Prize twice for achieving the highest grades in first- and second-year astronomy courses. During my undergraduate studies, I gained extensive teaching, and research experience, culminating in a [first-author publication](#). I have a strong passion for radio astronomy, particularly FRBs, and I am excited by their potential to reveal new insights about the cosmos. My research interests also include radio transients, multi-wavelength astronomy, radio polarization, cosmic magnetism, scintillation, observational cosmology, techniques, surveys, algorithms, instrumentation, and data science in astronomy.

For my masters thesis, I am working with Professor Ziggy Pleunis and Professor Jason Hessels, on exploring the time-variability of scintillation in repeating FRBs detected by [CHIME](#). This is a promising technique for constraining FRB emission models, and identifying potential orbital periods of their sources. In November, I presented the interim results of my thesis to Professor Masui's research group at the Massachusetts Institute of Technology (MIT). This past summer, I worked as a summer research fellow at Astron in the Netherlands using the historic [25m Dwingeloo Radio Telescope \(DRT\)](#). The DRT was the largest radio telescope in the world when it was built in 1956, and is now a museum, and national monument in the Netherlands. I worked closely with Dr. Tammo Jan Dijkema, and Professor Jason Hessels on this project, where I operated the DRT and developed a real-time detection pipeline in [Python](#) for repeating FRBs using [Presto](#) and [Fetch](#). The pipeline processes data at a rate of ~ 1 Gb/s. A highlight of the project was [detecting a burst from FRB20240619D](#). These results will contribute to an upcoming publication, and the DRT will be utilized in future FRB observation campaigns. I am excited to continue similar research at Caltech.

During my undergraduate studies at the University of Toronto, I worked on four research projects and completed two theses by special request. I was awarded a competitive summer research fellowship three years in a row. For my second thesis, I searched for γ -ray counterparts to FRBs detected by CHIME using [Swift/BAT](#) data. Working with Dr. Paul Scholz and Dr. Ziggy Pleunis, I developed a pipeline to analyze archival Swift/BAT data, producing lightcurves and images. While some parts of the script utilized functions from [HEASoft](#) - the specialized software for Swift/BAT, I had to implement several components myself, as the software was not designed for my applications. My fluence limits agreed with the literature values. Additionally, I completed two fellowships that focused on rotation measure (RM) synthesis, a key technique for studying cosmic magnetism through Faraday Rotation. Working with Dr. Cameron Van Eck, and Professor Bryan Gaensler, I developed a new RM synthesis algorithm for cases of extreme bandwidth depolarization - where the classical algorithm begins to break down. The results have been integrated into the [RM-Tools Python](#) package, and culminated in my [first-author publication](#) in the Monthly Notices of the Royal Astronomical Society. These experiences solidified my passion for astronomy research.

Beyond academics, I am involved in community engagement. At the University of Toronto, I represented the physics department on the student union, managed a free physics tutoring center, and led facilitated study groups for first-year physics courses. I also organized outreach events, including a field trip for the Perseid meteor shower, and sidewalk telescope viewings. I am eager to continue similar outreach initiatives, and look forward to the opportunity to develop a new public outreach project as part of Caltech's PhD program.

My primary motivation for applying to Caltech is the opportunity to work with Professors Gregg Hallinan, Vikram Ravi, and Katie Bouman. on Fast Radio Bursts (FRBs). Their work with the [DSA-110](#), and the upcoming [DSA-2000](#) closely aligns with my research experience, and academic interests. I am particularly excited about leveraging FRBs as tools to study cosmology, and contributing to the commissioning of the DSA-2000, a cutting-edge radio telescope array that promises to revolutionize radio transient science. With my background in FRBs and radio astronomy, I am confident I can make meaningful contributions at Caltech, while honing my skills in radio astronomy, growing into a professional astronomer, and addressing fundamental questions about the universe.

Looking forward, I aspire to become a professional astronomer, either as a research professor or in a national lab. Pursuing a PhD is not just a means to an end but a worthwhile journey in itself. I am eager to see where this path takes me, and I am confident that Caltech is the right place to continue this journey. Thank you for considering my application.

Astronomy is looking up!

Maxwell A. Fine

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