Application Statement
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As a master's student at McGill Space Institute, I am working with Professor Eve J. Lee and Nicolas Cowan on the formation of terrestrial planets in the early Solar System. The recent publication by Williams (2019) substantiates the long-standing model that primordial solar nebular (PSN) are dissolved within the magma ocean during its early accretion onto the proto-Earth embryos [1-6]. By sampling the noble gas isotopic ratio within the deep mantle, scientists have found its value, $^{20}Ne/^{22}Ne \sim 13.03$, to be closest to that of the nebula ratio around $^{20}Ne/^{22}Ne \sim 13.36 \pm 0.18$ [7]. During the planet's early formation, its surface temperature is hot enough to transform the entire mantle into melted magma. The presence of such a magma ocean, under equilibrium, allows the exchange of inert volatiles between the atmosphere and the magma ocean, governed via Henry's law [8].

My research aims to constrain the nebular density of the protoplanetary disks that allow for the dissolution of targeted Neon (Ne) content. We start from a pure adiabatic temperature and pressure profile to explore the suitable ranges of core mass and nebular density that led to such a Ne reservoir. Then we compare the desired parameter spaces of nebular density to that of the minimum-mass solar nebula (MMSN) and offer insights into the formation timescale of those protoplanetary embryos. In addition, we are interested in the mass ranges of protoplanetary cores leading to giant impact collision(s) that can still retain the amount of Ne we observed on Earth.

By constraining the Ne volume within Earth's atmosphere and mantle, our work provides insight into the chemical and molecular properties of the embryo's atmosphere. In addition, our research furthers the understanding of how the stellar XUV emission, responsible for hydrodynamical escape, can potentially change the Ne content available to dissolve within the magma ocean. Those align strongly with the broad theme of exoplanet atmosphere modeling and contribute as theoretical models to the spectrum observations. Furthermore, our work simulates the pressure and temperature condition of a magma ocean surface, a scenario widely hypothesized to exist on planets beyond the Solar System [9]. Hence, by modeling the interior structure and mantle dynamics of the terrestrial planets in the Solar System, we can make strong inferences about the young exoplanets that we observe.

During the ExoExplorer Program, I hope to participate in cohort-driven activities relating to diversity and equity within the exoplanet science community. In the course of the program, I believe it is crucial to have monthly discussions on the issues faced by the minorities of our science community to raise public awareness and offer conceivable solutions. As a Chinese Singaporean, the emergence of anti-Asian hate within North America has posed a serious threat to our academic life, mental health, and safety. Asian society not only faces verbal harassment and physical assault but also discrimination in the workplace. Asian scientists within the Exoplanet community may experience difficulties in traveling to places with strong anti-Asian racism or even encounter challenges in fair treatment in their professional careers. I hope by participating in those monthly meetings, more attention can be drawn to mitigate those concerns and increase my awareness of other controversies in the community as well.

In addition, I believe interdisciplinary discussions with ‘ExoGuides’ in both exoplanet science and engineering would help establish external connections and expand knowledge beyond each student’s expertise. Those discussions can include the latest scientific needs and hottest debate outlined by the exoplanet community and the potential ways for engineers to resolve them. Those meetings not only allow young scientists and engineers to learn about the latest scientific obstacles and ways to tackle them, but also urge members of each discipline to understand the needs of the other side and brainstorm original ideas for the next generation scientific instruments.

By participating in ExoExplorers, a cross-country professional development program, I hope to further my understanding of the bigger picture undertaken by the exoplanet community. The ExoExplorers program serves as the ideal platform for me to engage in deep conversations with my peers and prominent researchers. As a planet formation theorist, I aim to learn about the latest findings and difficulties in pertaining areas such as direct imaging and spectrum modeling. I hope to use this as a chance to bring together theory and observations in topics such as exoplanet formation and atmospheric modeling to initiate further endeavors and collaborations. In addition, I also hope to increase my visibility within the field to help raise public awareness of minority issues persisting throughout North America. Beyond the anti-Asian hate described above, I also pay strong attention to the role of implicit bias toward women in physics and how this affects their retainment in science. Since my undergraduate, I have seen countless subtle discrimination against women scientists’ ability and productivity based on gender bias. I wish to use ExoExplorer as the first step to identify the sources of those biases and engage in attainable interventions beyond the McGill community.

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