Sensors for planetary exploration are necessary for navigation and scientific data collection, but due to current limitations of silicon electronics, these need to be heavily shielded from the intense radiation and heated for thermal stability – electronics can freeze out and drift in low temperature environments (<-100^{o}C). However, materials like GaN can be used in heterostructure configurations to enable lower temperature operations. During my PhD I've focused on the nanofabrication, analysis, and development of silicon carbide (SiC) and gallium nitride (GaN) based sensors to operate in extreme conditions for aero-astro solutions. In particular, sensors (magnetometers) that withstand high temperature range environments (-180^{o}C to 600^{o}C). I'm studying the potential operation of these sensors to be used for a scientific probe for application on an ocean world (e.g Europa or Enceladus – moons of Jupiter and Saturn).

My work includes improving manufacturing methods for wide-bandgap semiconductors (WBGs), designing new sensor topologies, and creating test platforms for these sensors. I've published a technique for machining SiC into narrow channels on the micrometer scale. This was in collaboration with Prof. Goodson's heat transfer group and will be used to create a microfluidic cooling system that enables high power density electronics. I'm also studying fundamentally how GaN operates in cold environments through investigation of hall effect sensors. I mentored undergraduate students this summer to create a cube-satellite experiment to operate these hall sensors on a suborbital launch.

These key technologies push higher power densities into smaller area to enable improved electric mobile systems. Improved electrification is crucial to reduce petroleum emissions and contribute to cleaner energy for the earth. There's lots of potential to expand this research into various applications beyond space and power electronics, and that's where I'd like to focus my future work.

As a professor, I want to create miniature-scale systems for oceanography and geologic studies. This effort will contribute scientifically through the development of new instrumentation: novel sensing materials, creative mechanisms overcoming power management, sensor reliability, and connectivity. Additionally, gathering novel environmental data will be a major need in the next century given the challenges with climate change – studying impact on ocean currents and weather patterns. pollution level measurement, sea life, etc. Also, this effort will support space exploration: thermal vents and cold ocean temperatures are great candidates for simulating extreme environments found in outer space, such as asteroids, Mars, Europa, Venus, and other celestial bodies.

My strategy would be to use a novel sensor development in tandem with system level approach to implement components. I want to use WBGs to improve the working temperature range and operational environments for MEMS devices such as accelerometers and energy harvesters. The ocean environment is a great test bed to evaluate autonomous control in a dynamic environment. There's various challenges to pursue including shielding from noise, long term corrosion (acidification and salinity), data collection, and nonlinearity in WBG sensors.

I want make an impact on the scientific front – enabling new discoveries in the field of sensors for extreme environments, and enable knowledge to progress in other studies through the technology my team will develop. My skills in sensor development through fabrication and semiconductor design will enable unique solutions in broad areas from power electronics to environmental studies. Ultimately, I want my work to contribute to solving the world's toughest problems and improve the common good.