Upgrading Stability of an Airborne Infrared Spectrometer (AIR-Spec) for Coronal Observations

Marissa Menzel¹, Jenna Samra², Vanessa Marquez², Peter Cheimets², Edward DeLuca²

¹Wellesley College
²Smithsonian Astrophysical Observatory

Although mid-infrared (IR) emission lines are potentially promising for measuring coronal magnetic fields, few measurements of these lines exist. The Airborne Infrared Spectrometer (AIR-Spec) was created as a pathfinder mission that would measure emission line properties and develop technology for mid-IR coronal spectroscopy. During the 2017 eclipse over North America, AIR-Spec flew aboard the NSF/NCAR Gulfstream-V research aircraft at an altitude of 14.3 km and measured lines of Si X, S XI, Fe IX, Mg VIII, and Si IX between 1.4 and 4 microns. For the 2019 solar eclipse the AIR-Spec camera exposure time will be lengthened from 60 milliseconds to 1 second, in order to boost the signal to noise ratio. A closed loop control system will be used to reduce the image jitter below the 4.6 arcsecond Nyquist Limit for each 1 second exposure. A proof-of-concept stabilization system was implemented via a Proportional Integral Derivative (PID) controller. Image motion from the 2017 eclipse flight was recreated in the lab for testing the PID gains. The best set of PID gains resulted in a total root mean square (RMS) of 82.5% under the 4.6 arcsecond limit. The RMS for the x and y directions were 96.4% and 88.7% under the limit, respectively. A smoothing filter was applied to reduce oscillation during changes to the setpoint. Future work will include creating a 2D model, adapting the system for variable delays, and predicting delays before they exist. The upgraded closed loop stabilization system will be implemented during the 2019 solar eclipse.

Keywords: Solar Instruments, Solar Corona, Solar Eclipses, Instrumentation

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