Airborne Instrumentation for Solar Coronal Studies. E. E. DeLuca[1], J. E. Samra[1] and A. Caspi[2] [1]Center for Astrophysics | Harvard & Smithsonian, 60 Garden Street, Cambridge MA 02138 edeluca@cfa.harvard.edu, jsamra@cfa.harvard.edu, [2]Southwest Research Institute 1050 Walnut St., Suite 300 Boulder, CO 80302 amir@boulder.swri.edu.

Introduction: Airborne instrumentation has been used to explore the mid-infrared corona through solar eclipse observations [1], [2]. Existing platforms, the NSF/NCAR Gulfstream V (GV) and NASA's WB-57F, provide infrastructure that future instrumentation can utilize. We give an overview of recent science from airborne eclipse observations. We then describe the Airborne Stabilized Platform for InfraRed Experimentation (ASPIRE) for the GV and the potential for new instrumentation on the WB-57s using the existing Airborne Imaging and Recording System (AIRS) pointing platform and possible future options.

GV & WB-57 Science: During the 2017 and 2019 total solar eclipses Samra and collaborators used a newly built infrared spectrograph to explore six coronal emission lines in the 1.4–4 µm wavelength region. Figure 1 shows the line intensity measured in 2019 as a function of distance above the solar. These two flights demonstrate the ability to use the high-altitude research aircraft for stabilized imaging spectroscopy.

The NASA WB-57 aircraft is a more challenging platform to modify. During the 2017 eclipse, Caspi and collaborators demonstrated the utility and feasibility of the platform for eclipses, using existing instrumentation (DyNAMITE) to make wideband (3–5 µm) images, Figure 2. Twin WB-57 aircraft were flown along the eclipse path, allowing a combined 457 s of totality. AIRS is a nose-mounted 2-axis gimbaled "turret" and provides an optical bench and computer interface that can be used for new instrumentation, but with limited volume.

ASPIRE: Samra and collaborators built on the success of the AIR-Spec program to build a general-purpose pointing and stabilization system for the NSF/NCAR GV. This system allows the researcher to select one of several viewports in the GV depending on solar elevation and on hemisphere of the totality pass. ASPIRE has a large feed mirror that can deliver a 20 cm diameter solar beam if eclipse conditions permit use of the largest viewport.

A new infrared imaging Fourier transform spectrometer is being built to take advantage of the ASIPRE platform during the upcoming 2024 total solar eclipse. The purpose of that instrument is to survey coronal emission over the entire 1–4 µm passband as a function of different solar conditions.

ASPIRE will be a certified user facility at NCAR. As such, anyone may propose to NSF to build instrumentation that needs its high-throughput solar-pointed stabilized beam. This type of facility can enable exploration and evaluation of new instrumentation quickly and cost-effectively.

WB-57: Development proposals for new instrumentation on the NASA WB-57 platform are possible, but at NASA Heliophysics these can only be implemented as part of a science investigation that must also fund facility use. We have seen the potential for innovative research supported through the NSF MRI program and a similar scale program at NASA for utilization of the WB-57 aircraft could be equally productive. NSF and NCAR operate the research aircraft as a community facility. The NASA WB-57 does not operate in this model, posing a challenge to developing new instrumentation for community usage.

Drawbacks: For coronal studies, pressurized airborne platforms are only useful during total solar eclipses, as the scattering from the entrance window is unacceptably large for coronagraphic telescopes. This limits the utilization of the aircraft and more significantly the duration of the observations.

While the NCAR GV is able to travel nearly anywhere in the world at modest cost, the NASA WB-57s is more challenging and costly. However, the WB-57 flies to 65 kft, compared to 45 kft for the GV.

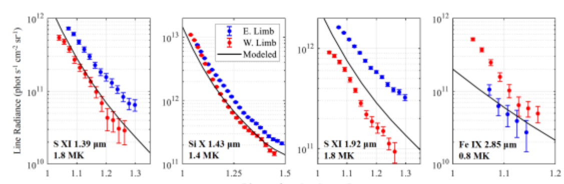

Figure 1 AIR-Spec 2019 Eclipse line intensities

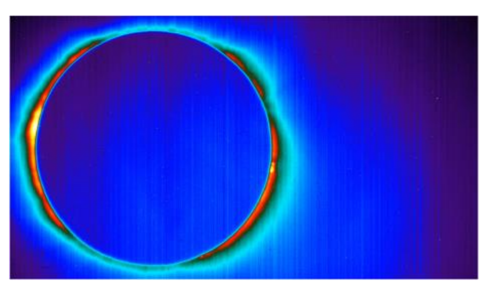

Figure 2 WB-57 2017 Eclipse IR image

References: [1] Samra. *et al.* (2018) *ApJL., 856,* L29. [2] Caspi A. *et al.* (2020) *ApJ, 895,* 131