OUTBURSTS IN SYMBIOTIC BINARIES (FUSE 2000)

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Annual Report

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During the past year, we made good progress on analysis of FUSE observations of the symbiotic binary Z And. For background, Z And is a binary system composed of a red giant and a hot component of unknown status. The orbital period is roughly 750 days. The hot component undergoes large-scale eruptions every 10–20 yr. An outburst began several years ago, triggering this FUSE opportunity.

First, we obtained an excellent set of ground-based optical data in support of the FUSE observations. We used FAST, a high throughput low resolution spectrograph on the 1.5-m telescope at Mt. Hopkins, Arizona. A 300 g mm^{-1} grating blazed at 4750 Å, a 3″ slit, and a thinned Loral 512 × 2688 CCD gave us spectra covering 3800–7500 Å at a resolution of 6 Å. The wavelength solution for each spectrum has a probable error of ±0.5 Å or better. Most of the resulting spectra have moderate signal-to-noise, S/N $\gtrsim$ 30 per pixel.

The time coverage for these spectra is excellent. Typically, we acquired spectra every 1-2 nights during dark runs at Mt. Hopkins. These data cover most of the rise and all of the decline of the recent outburst. The spectra show a wealth of emission lines, including H I, He I, He II, [Fe VII], and the Raman scattering bands at 6830 Å and 7088 Å. The Raman bands and other high ionization features vary considerably throughout the outburst. These features will enable us to correlate variations in the FUSE spectra with variations in the optical spectra.

Second, we began an analysis of FUSE spectra of Z And. We have carefully examined the spectra, identifying real features and defects. We have identified and measured fluxes for all strong emission lines, including the O VI doublet at 1032 Å and 1038 Å. These and several other strong emission lines display pronounced P Cygni absorption components indicative of outflowing gas. We will attempt to correlate these velocities with similar profiles observed on optical spectra. The line velocities – together with line variations – will yield physical parameters for the expanding shell of gas in the outer atmosphere of the hot component.

We also worked on several diagnostic tools, including upgrades to photoionization programs developed by the PI and others. We plan to use these tools to derive electron densities and temperatures from intercombination and forbidden lines observed on optical and FUSE spectra. Preliminary results indicate a large electron density, $n_e \geq 10^{10}$ cm^{-3} and a modest electron temperature, $T_e \sim$ 20,000 K. We see no evidence for shocked gas as observed in some other symbiotics. However, we have yet to include several important lines of [Fe VII] and [Ne V] in the analysis. Inclusion of these lines will yield an improved estimate of the electron temperature in the gas.

Finally, we have one additional FUSE spectrum planned for acquisition during this cycle. These data will provide important information concerning the state of the system farther along in its decline. Once we have this spectrum in hand, we plan to complete our analysis and publish our results.