There could be no transiting exoplanets without brilliant stars looming in the background. Exoplanet atmospheres are dramatically shaped by their host star, especially when they are young and the stars are extremely active. As such, my research straddles the boundary between young exoplanet atmospheres and stellar activity. **Only through these interdisciplinary means can we shed light on the true nature of these systems.**

Recently, I have searched for optical/near infrared signatures of atmospheric escape for the 30-40 Myr super-Neptune V1298 Tau c (Feinstein et al. 2021). We found that the strength of Hα in absorption decrease with time throughout the transit, suggesting the planet is trailed by a hot wind of hydrogen, although we could not rule out stellar activity as the origin of the signal. Additionally, I am invested in detecting such atmospheric molecules to constrain the formation location of hot-gas giants. I am the PI of a Gemini-S/IGRINS proposal to measure the C/O ratio of HIP 67522 b, the youngest known transiting exoplanet (17 Myr). I am also a Co-I on a similar proposal to observe DS Tuc Ab (45 Myr).

To prepare for my own future JWST proposals, I have spent this past summer analyzing JWST/NIRISS-SOSS transit observations of WASP-39 b as part of the JWST Transiting Exoplanet Community Early Release Science Program. I have gained the skills necessary to propose for, analyze, and interpret beautiful JWST transmission spectra. **This work will be submitted to Nature by the end of October, 2022.**

Young stellar activity manifests itself in a variety of ways. I am primarily interested in stellar flares. With the Transiting Exoplanet Survey Satellite (TESS), we now have the data to understand the evolution of short-term high-energy stellar flares as a function of age. In Feinstein et al. (2020b), I completed the largest statistical study of flare rates, using a sample of 3200 stars < 800 Myr. We found that cool stars ($T_{\rm eff} \leq 4000$ K) exhibit the highest flare rates and energies. Additionally, we saw no variation in the flare rates or distributions of these stars. This indicates that planets around low-mass stars live in extreme environments for a billion years, yielding consequences for planetary habitability.

I have studied far-ultraviolet (FUV) flares on the 23 Myr M dwarf AU Mic using the Hubble Space Telescope (Feinstein et al. 2022). We measured flare parameters for 13 flares observed in 5 hours. We created spectroscopic light curves from emission features tracing different temperatures/locations in the stellar atmosphere to understand flare formation and cooling mechanisms. We measured flare energies up to 2×10^{31} erg, which are more energetic than flares seen on the Sun. We were able to measure the continuum flux of AU Mic, which is not easily done for M dwarfs. The continuum flux is the main source of error in exoplanet atmospheric photochemical modeling (Teal et al. 2022). Our accurately modeled transmission spectra for AU Mic b and c are used to motivate future JWST observations.

I have developed two software packages to support exoplanet and stellar science. My first is `eleanor` extracts time-series photometry from the TESS Full-Frame Images for any source in the TESS field-of-view (Feinstein et al. 2019). This publication has 128 citations thus far; the citing papers span exoplanets to supernovae. Additionally, 150 million `eleanor` light curves are hosted on MAST (Powell et al. 2022). My package is `stella`, which includes the convolutional neural network models for flare identification and modules for flare characterization (Feinstein et al. 2020ab). The resulting method allows for flare detection in a single light curve ($\sim 15,000$ data points) in about one second.

Over my five years of graduate studies at the University of Chicago, I have lead 9 first-author and contributed to 24 papers on exoplanets, young stars, and stellar activity. By approaching both exoplanet and stellar astrophysics equally in my research, **I am uniquely poised and qualified to achieve the goals of my proposed research.**