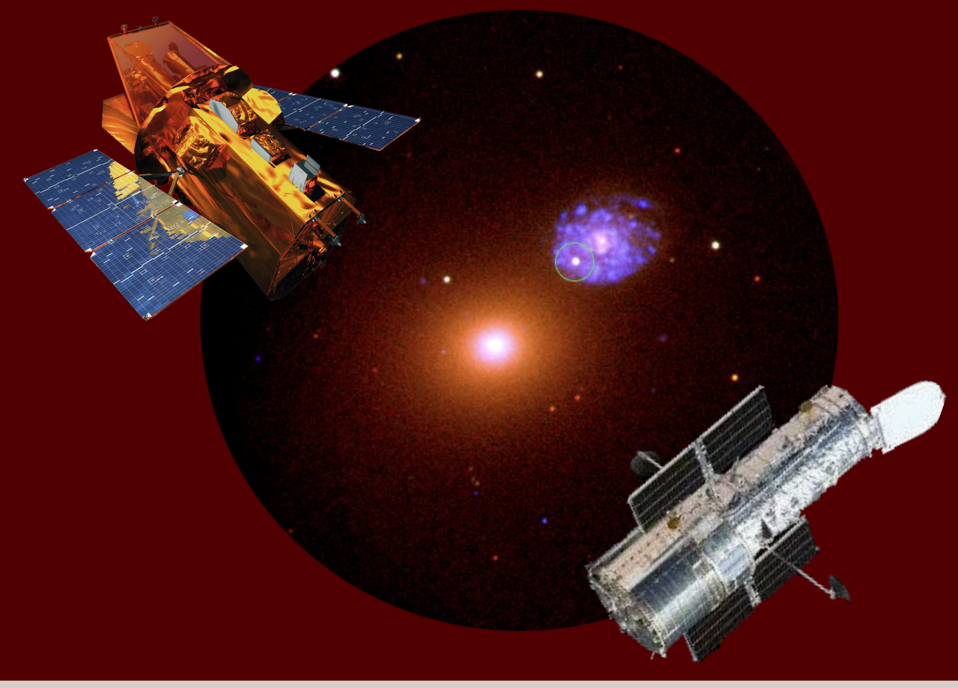

All about the High-Velocity SN Ia 2022hrs

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Despite their optical uniformity, Type Ia supernovae (SNe Ia) exhibit considerable diversity in the ultraviolet (UV) spectrum. This variation is particularly pronounced in "High-Velocity" (HV) SNe Ia, which have been shown to possess intrinsically different colors compared to their normal counterparts [1]. Understanding the cause of this divergence is crucial for refining SNe Ia as standard candles, addressing systematic uncertainties in intrinsic color and reddening estimates.

We present the first-ever UV spectra of a HV SN Ia, SN 2022hrs, observed with the HST!

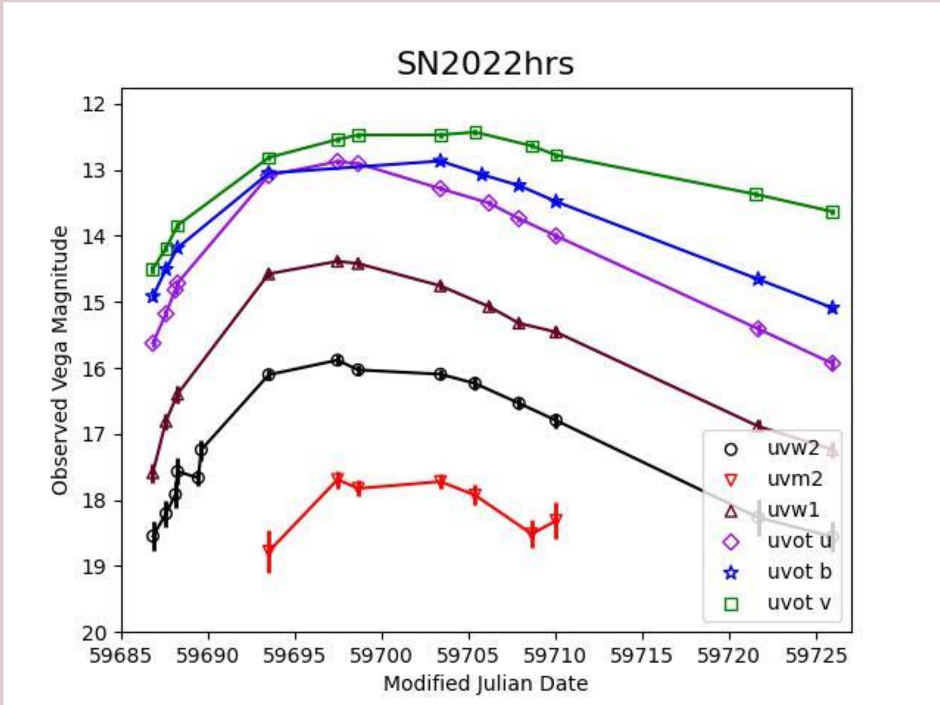

Figure 1 – Photometry of SN 2022hrs from *Swift*/UVOT.

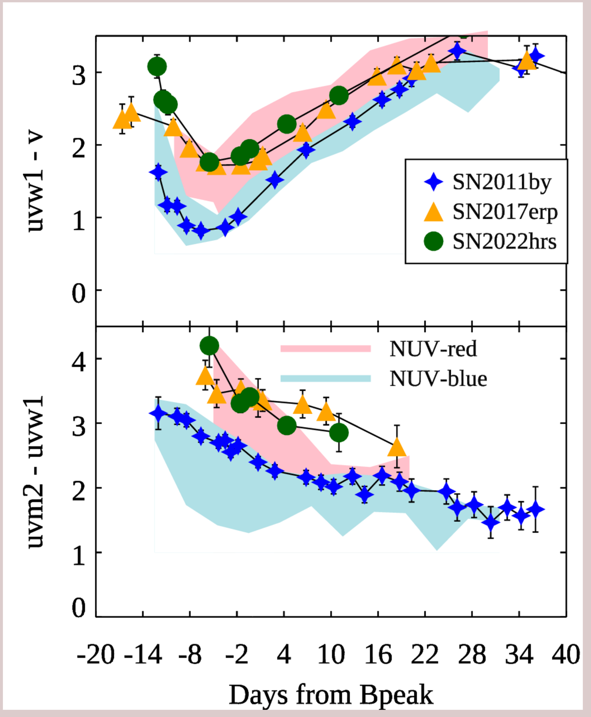

Figure 2 - Observed uvw1-v and uvm2-uvw1 color comparison for SN 2022hrs, SN 2017erp, and SN 2011by.

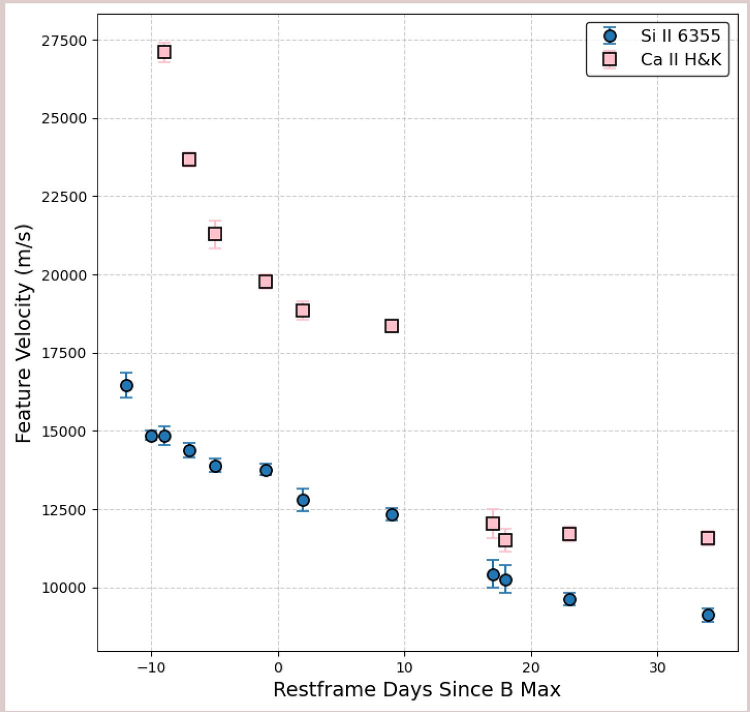

Figure 3 – Temporal evolution of the expansion velocities of Si II λ6355 (blue circles) and Ca II H&K (pink squares).

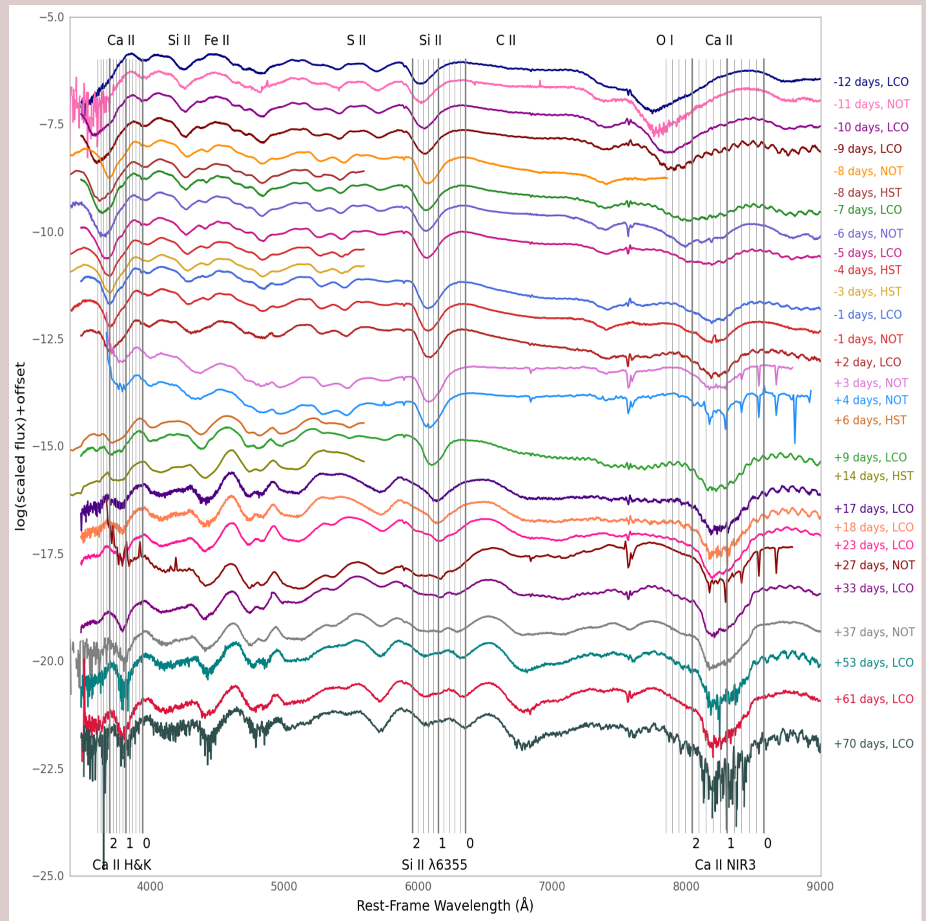

Figure 4 – Spectral time series of SN 2022hrs. The solid gray line represents the wavelengths corresponding to 0, -10,000, and -20,000 km/s around the Si II, Ca II H&K, and Ca II NIR triplet features, with 2000 km/s intervals denoted by light gray lines.

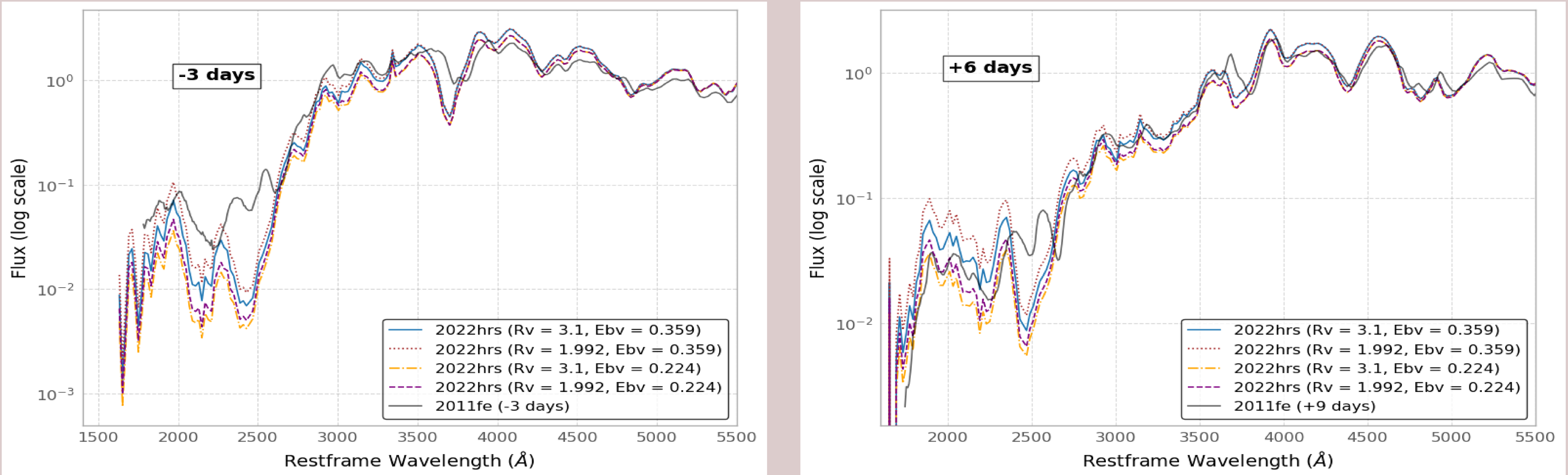

Figure 1 – *Left Panel:* HST Spectra of SN 2022hrs, -3 days before B-band maximum, corrected for different R_V and E(B-V), compared to the HST spectrum of SN 2011fe at the same phase. *Right Panel:* Same comparison with spectra of SN 2022hrs at +6 days post B-band maximum, compared to SN 2011fe at +9 days. Each spectrum is normalized by the V band wavelength range.

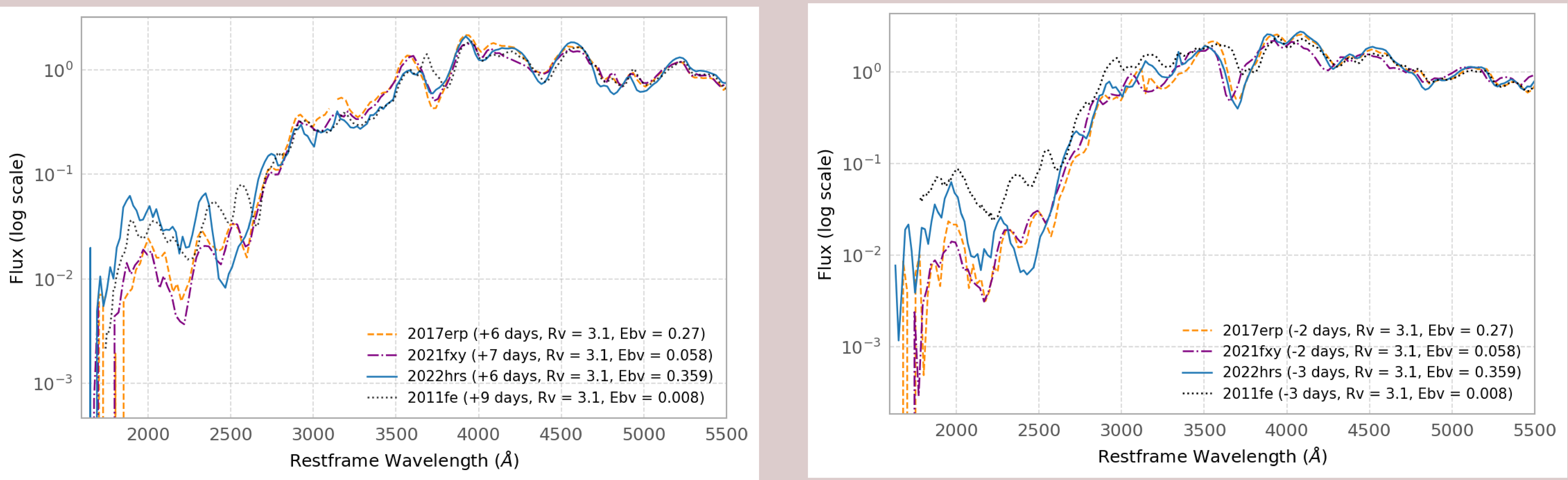

Figure 2 – *Left Panel:* HST Spectra of SN 2022hrs (-3 days before B-band maximum) compared with SN 2017erp (-2 days before B-band maximum) [4], SN 2021fxy (-2 days before B-band maximum) [5], and SN 2011fe (-3 days before B-band maximum) [6]. Each spectrum is normalized by the V band wavelength range.

We estimated the values of R_V and E(B–V) by fitting the light curve of SN 2022hrs using SNooPy. The performed the fitting initially by including all available filters (B, V, I, u, g, and r), and then excluding the bluest filters (B, u, and g). We then applied reddening corrections for different combinations of R_V and E(B–V) . Our analysis shows that assuming a similar intrinsic color for SN 2022hrs and SN 2011fe yields comparable spectra in the pre-maximum phase. However, in the post-maximum phase, better spectral agreement is achieved when corrections are applied under the assumption of a redder intrinsic color for SN 2022hrs.

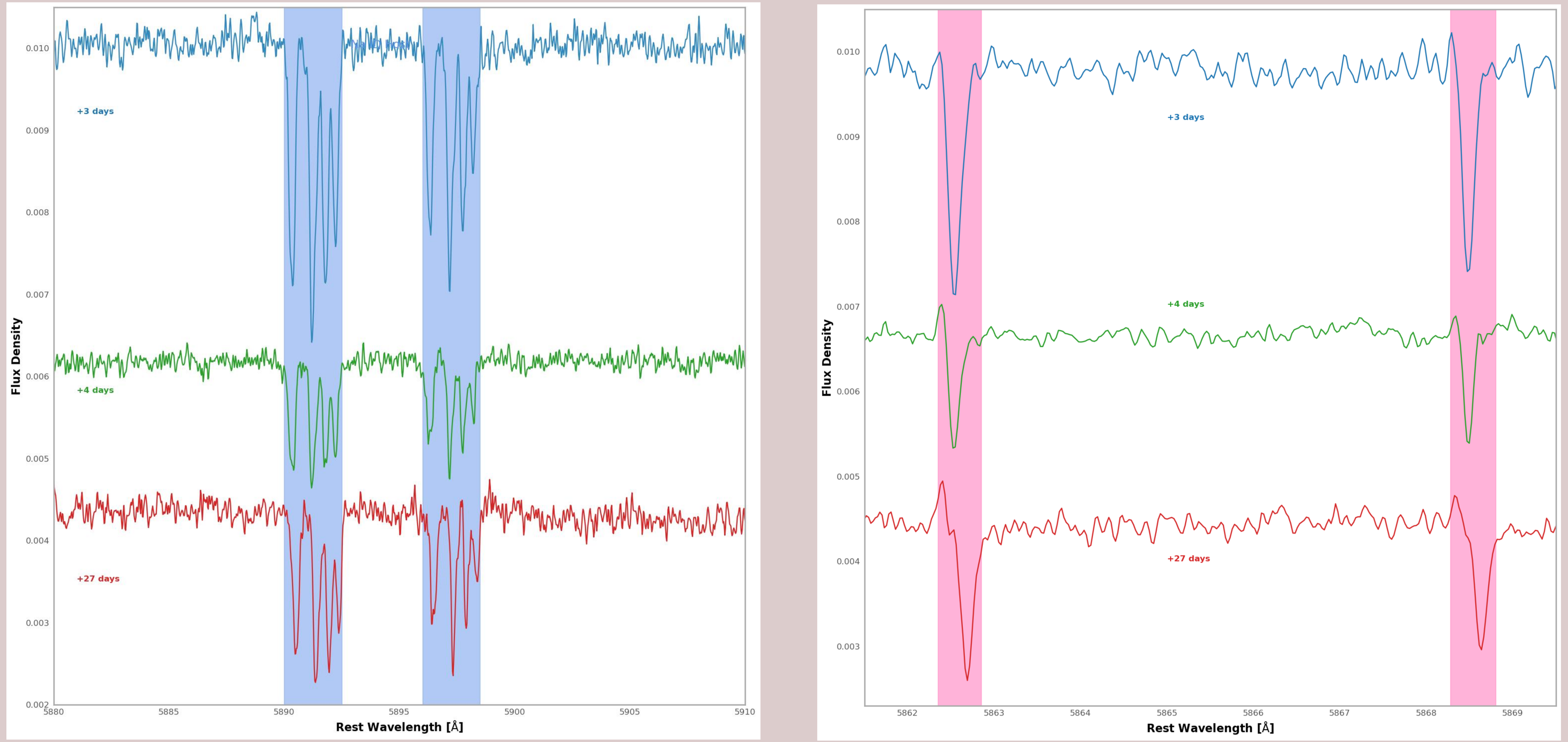

Figure 6 – *Left Panel:* Na I D doublet absorption feature from the Milky Way. *Right Panel:* Na I D doublet absorption from the host galaxy, NGC 4647. Spectra were obtained at three epochs: +3 days, +4 days, and +27 days relative to B-band maximum.

We examined the temporal evolution of Na I D absorption features and found no significant changes. Additionally, we estimated reddening using the EW of Na I D absorption features, following the empirical relations from [2]. The MW E(B-V) was comparable to the E(B-V) values derived from [3]. However, we could not independently confirm the accuracy of the derived E(B-V) value for the host galaxy.

References

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[6] Shappee, B. J., et al. (2017) (ApJ, 841, 1, 48)