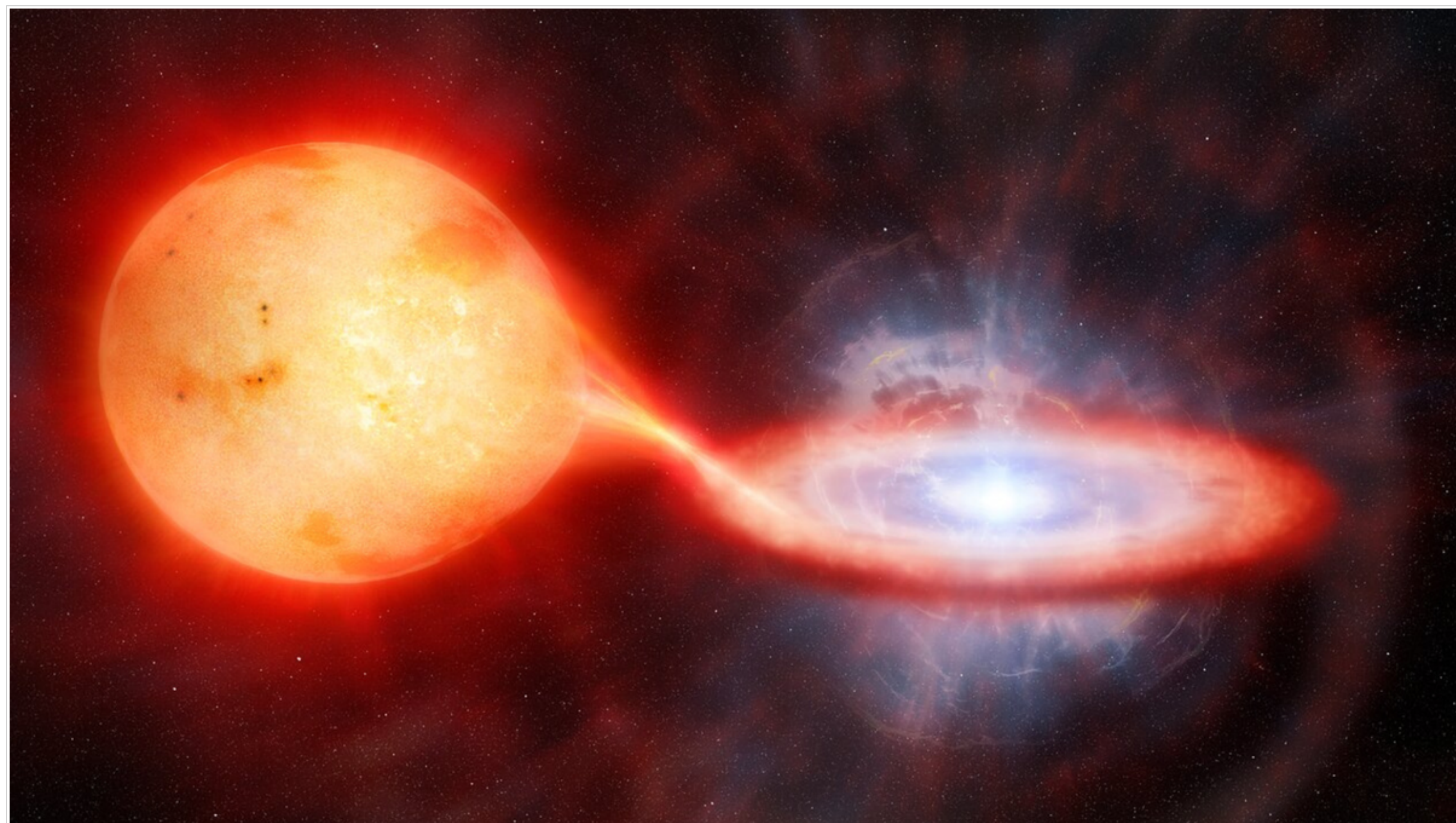


From Light to Sound: Spectroscopic Evolution & Sonification of the flaring Nova V612 Scuti

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INTRODUCTION

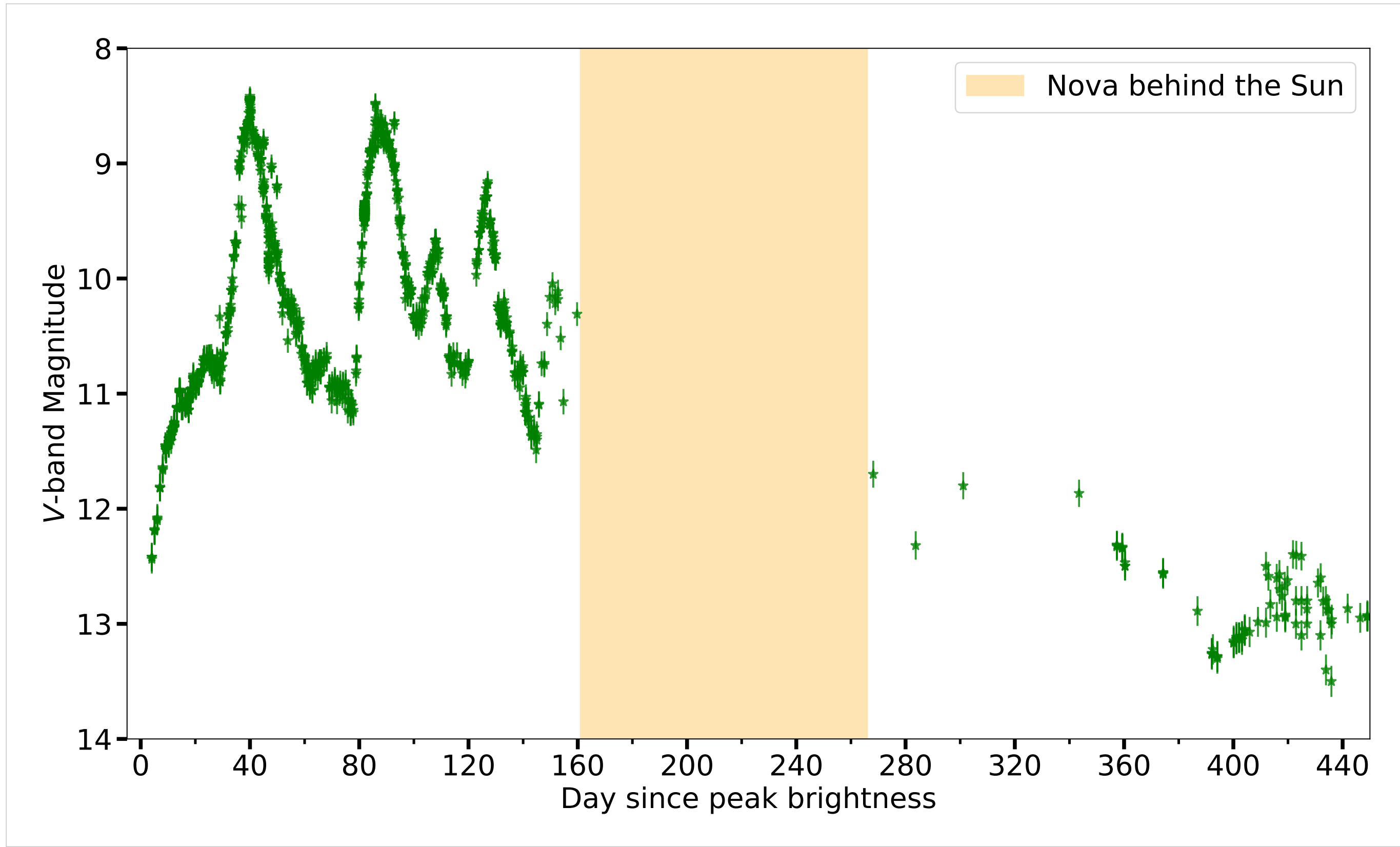


Artistic impression of a nova eruption. Credit: NOIRLab/NSF/AURA/M. Garlick, M. Zamani

Classical novae are thermonuclear explosions on accreting white dwarfs (Bode & Evans 2008).

While some novae exhibit a smooth post-maximum decline (Strope et al. 2010), Some novae show **repeated large-amplitude optical flares**. This was the case of Nova V612 Scuti, which was discovered on 2017-09-24 (t_0).

The origin of such flares remains poorly understood. Proposed explanations range from variations in the luminosity of the white dwarf to multiple ejection episodes during the eruption leading to shock-powered emission, arising from the colliding outflows.



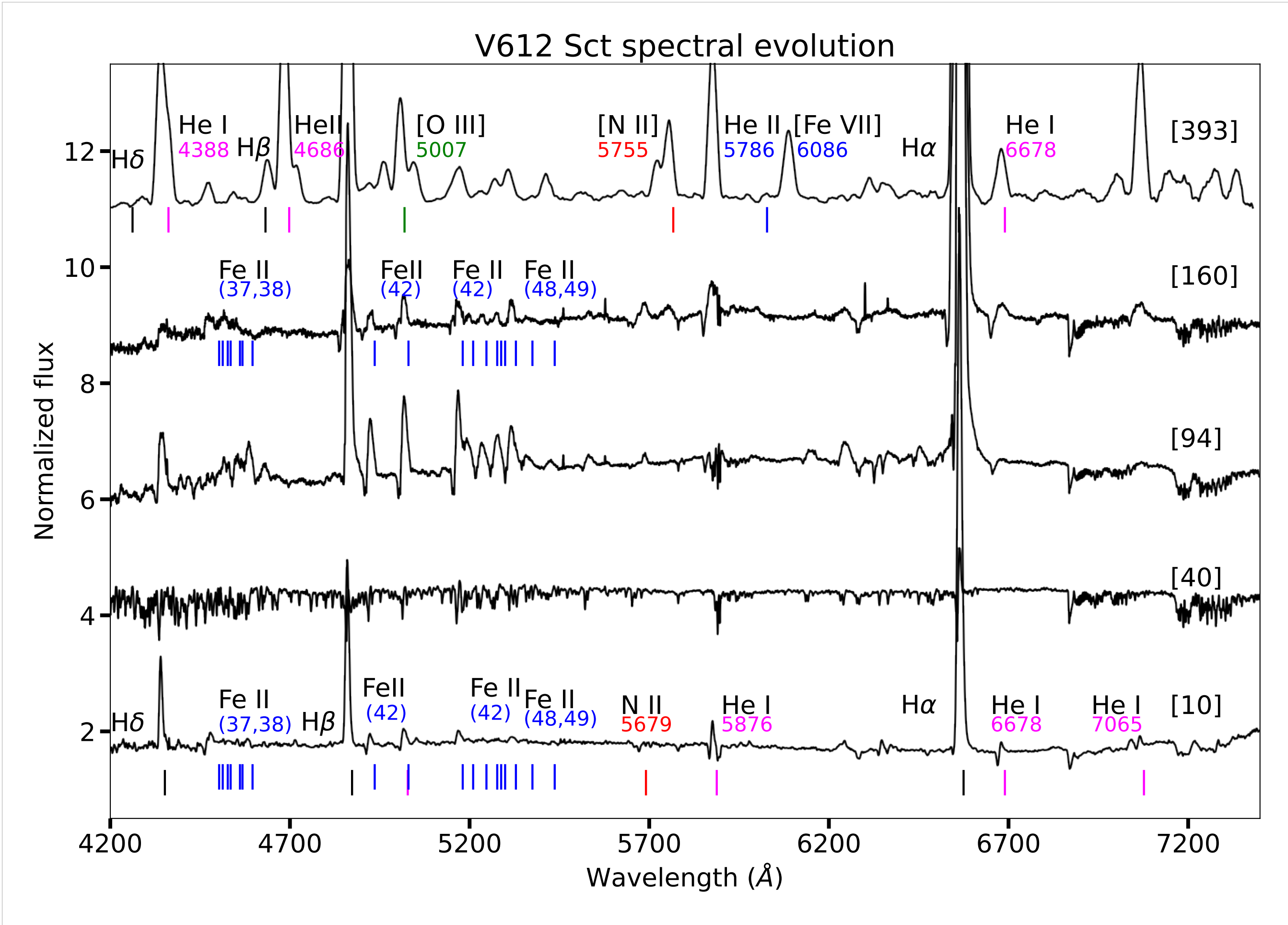
The optical light curve of Nova V612 Sct, showing multiple large-amplitude flares.

OBSERVATIONS

We use publicly available optical photometry from AAVSO and ASAS-SN to track the brightness evolution throughout the eruption.

We use publicly available high-resolution spectra from ARAS to probe changes in the spectral line profile and survey the dynamics of the ejecta.

Combining photometry and spectroscopy enables a **time-resolved view** of ejecta evolution.



A sample of the spectral evolution of nova V612 Sct throughout the eruption. Numbers between brackets are days since t_0 .

RESULTS

Photometry:

The slowly evolving light curve shows **multiple $\sim 2\text{--}3$ mag rebrightenings** lasting for several weeks each.

Spectroscopy:

Broad Balmer (hydrogen), Fe II, O I dominate the spectra — typical for nova spectra.

Individual line profiles exhibit drastic changes contemporaneous with the flaring in the light curve: multiple velocity components at progressively higher velocities, coinciding with new flares — indicating **multiple ejection episodes** at increasing velocities.

This trend can be clearly distinguished in the 2D dynamic spectra, which show absorption features at progressively higher velocities **appearing simultaneously with the flares** in the light curve.

LISTEN TO THE NOVA

The nova spectra are converted into sound through a sonification process, allowing temporal correlations to become more apparent and enhancing the visual interpretation of these spectral features.

Spectral wavelength is first converted to electromagnetic frequency using $\nu = \frac{c}{\lambda}$, where c is the speed of light and λ is the wavelength.

The frequency is then scaled into the audible range to generate sound: $f_{\text{sound}} = k \nu$, where k is a scaling factor chosen to bring the frequencies into the human hearing range.

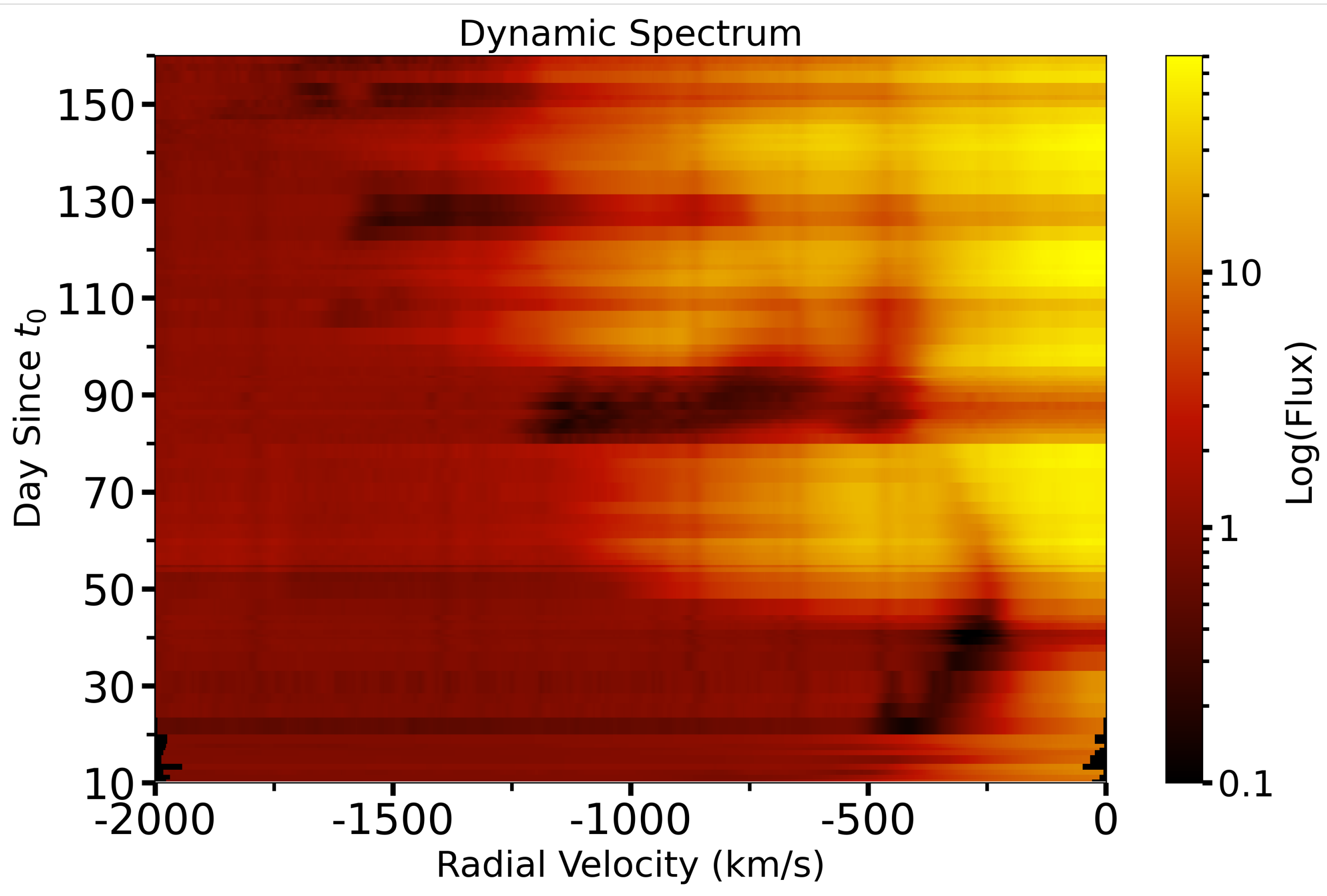


INTERPRETATION

The **simultaneous appearance of optical flares and higher-velocity spectral components** suggests that the flares are associated with **multiple episodes of mass ejection** during the eruption. These successive ejection events can lead to **interactions between faster and slower ejecta**, producing internal shocks within the nova outflow (Aydi et al. 2020a)

Such shock interactions are expected to accelerate particles and can give rise to **high-energy emission**, including γ -rays, as observed in several classical novae (Aydi et al. 2020b)

The absence of detected γ -ray emission from V612 Sct is likely due to its **large distance**, which would make any high-energy signal too faint to be detected by current instruments.



2D dynamic spectra of Nova V612 Sct during the first 100 days of eruption, revealing multiple absorption components (black features) emerging at progressively higher velocities.

CONCLUSION & SIGNIFICANCE

The temporal correlation between spectral evolution and photometric flares supports a scenario in which the eruption proceeds through **multiple episodes of mass ejection and mass loss**.

Interactions between successive ejecta layers may generate **internal shocks**, a mechanism known to produce γ -ray emission in classical novae.

We also introduce a **sonification technique** that converts the evolving nova spectra into sound, providing a novel way to illustrate how a nova eruption might be experienced acoustically and highlighting temporal correlations in the data.

REFERENCES

Aydi et al. (2020a). APJ, 905, 62.
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