A Tale Of Two Shells

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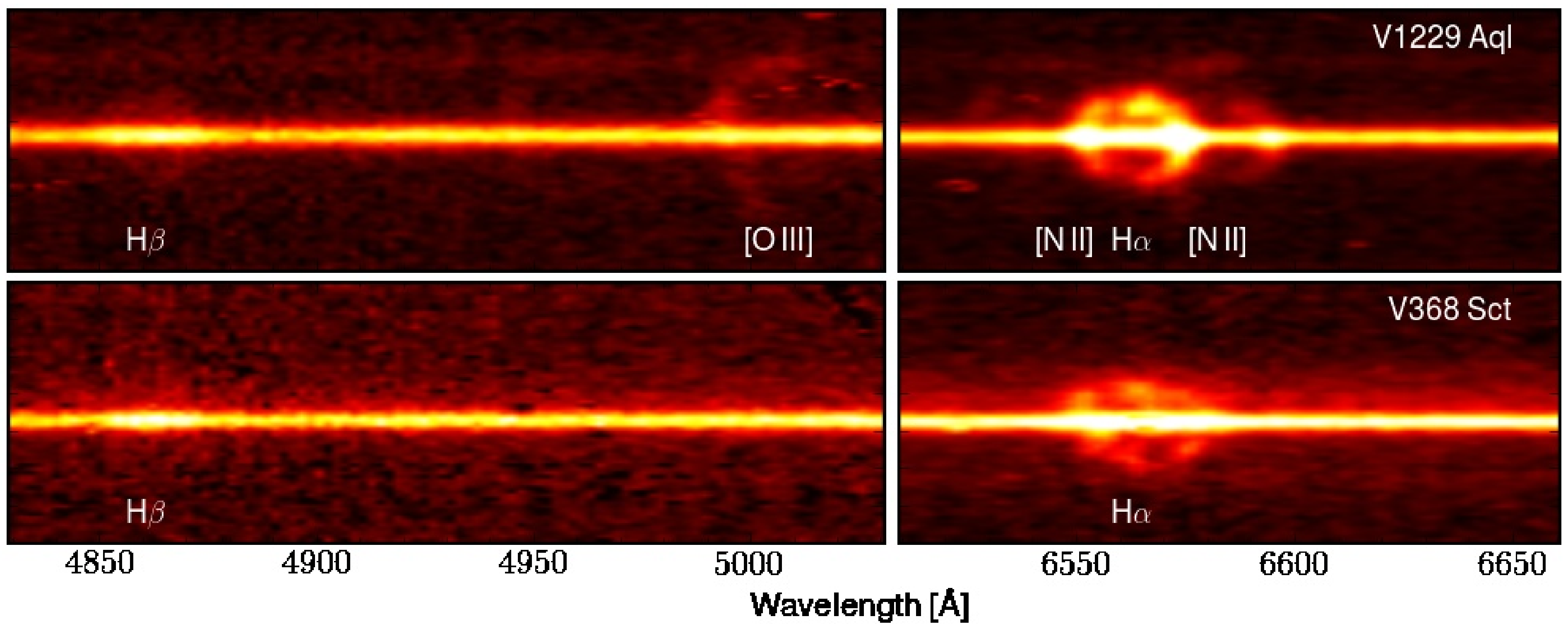
Introduction

It was the best of times, it was the age of nova explosions. This is, of course, an exaggeration. It was only the year 1970. But, among the novae that were recorded in that year, we find the two objects of the present study, V1229 Aql and V368 Sct. At first glance, the two novae appear to have very similar properties: they belong to the same speed class, have similar eruption amplitudes and even the interstellar extinctions are not vastly different (see table below). Additionally, for neither nova existed a proper quiescence spectrum. Data on V1229 Aql taken 22 yr after the eruption showed the optical range still being dominated by the shell emission (della Valle & Duerbeck 1993). We thus included the two systems in our project to study the properties of the cataclysmic binary of novae (e.g., Tappert et al. 2012, 2016). To our chagrin, we found that our GMOS data taken in 2015, 45 yr after the eruption, in both cases still showed a very strong shell contribution.

	year	t_3	$m_{\max}$	$m_{\min}$	Δm	E(B−V)	v_r	r_{shell}	d
V1229 Aql	1970.29	37	6.7	19.3	12.6	0.64(3)	455	1.5	2.9
V368 Sct	1970.58	30	6.9	19.2	12.3	0.86(5)	442	1.5	2.8

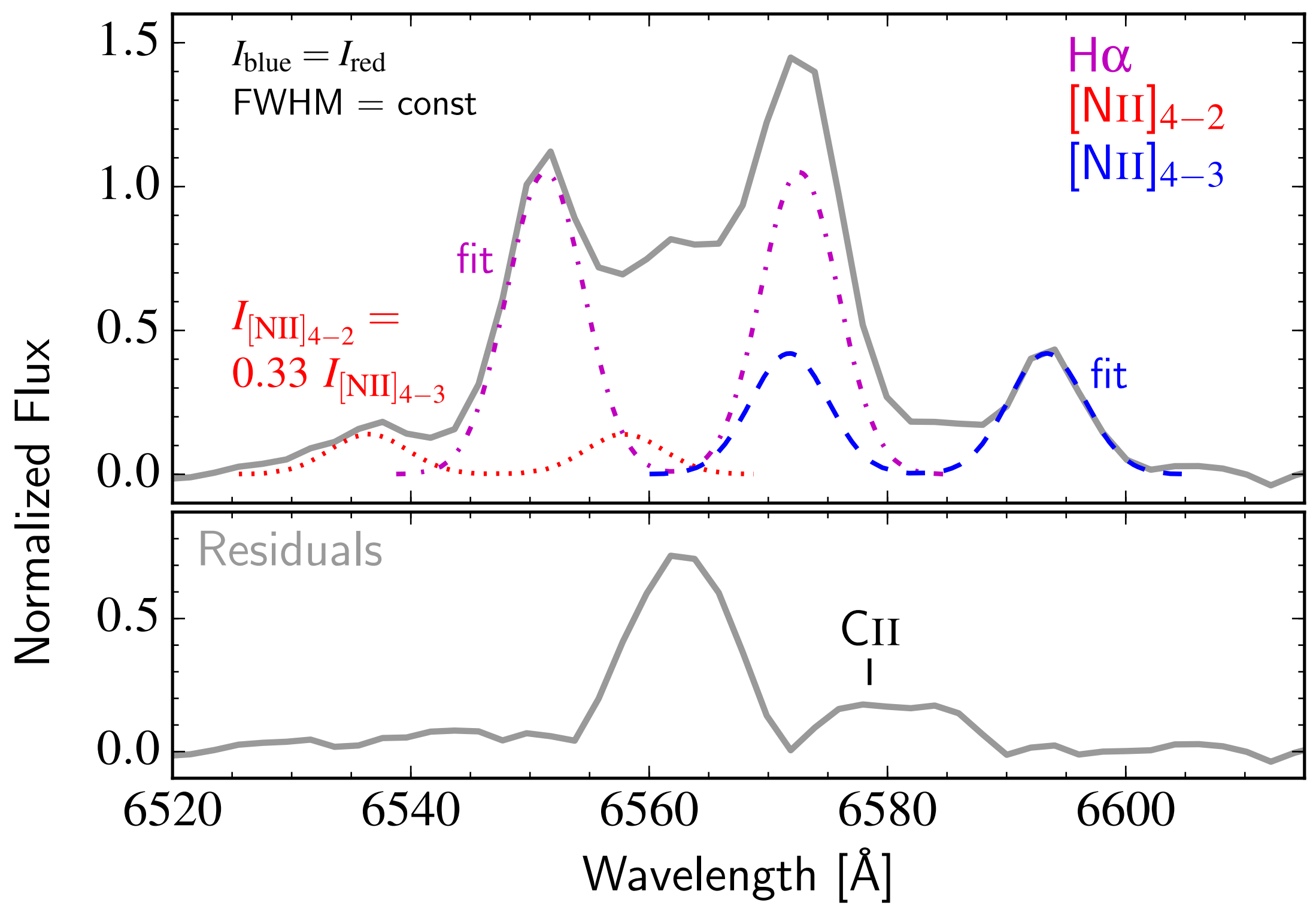
columns: year of eruption – decline rate down to 3 mag below maximum in days – maximum magnitude – post-nova brightness in the *R*-band – resulting eruption amplitude (ignoring filter differences) – extinction (IRAS website, Schlafly & Finkbeiner 2011) – average projected shell velocity in km/s – projected shell radius in arcsec – resulting distance in kpc (assuming an unlikely spherical shell geometry)

2D Spectra

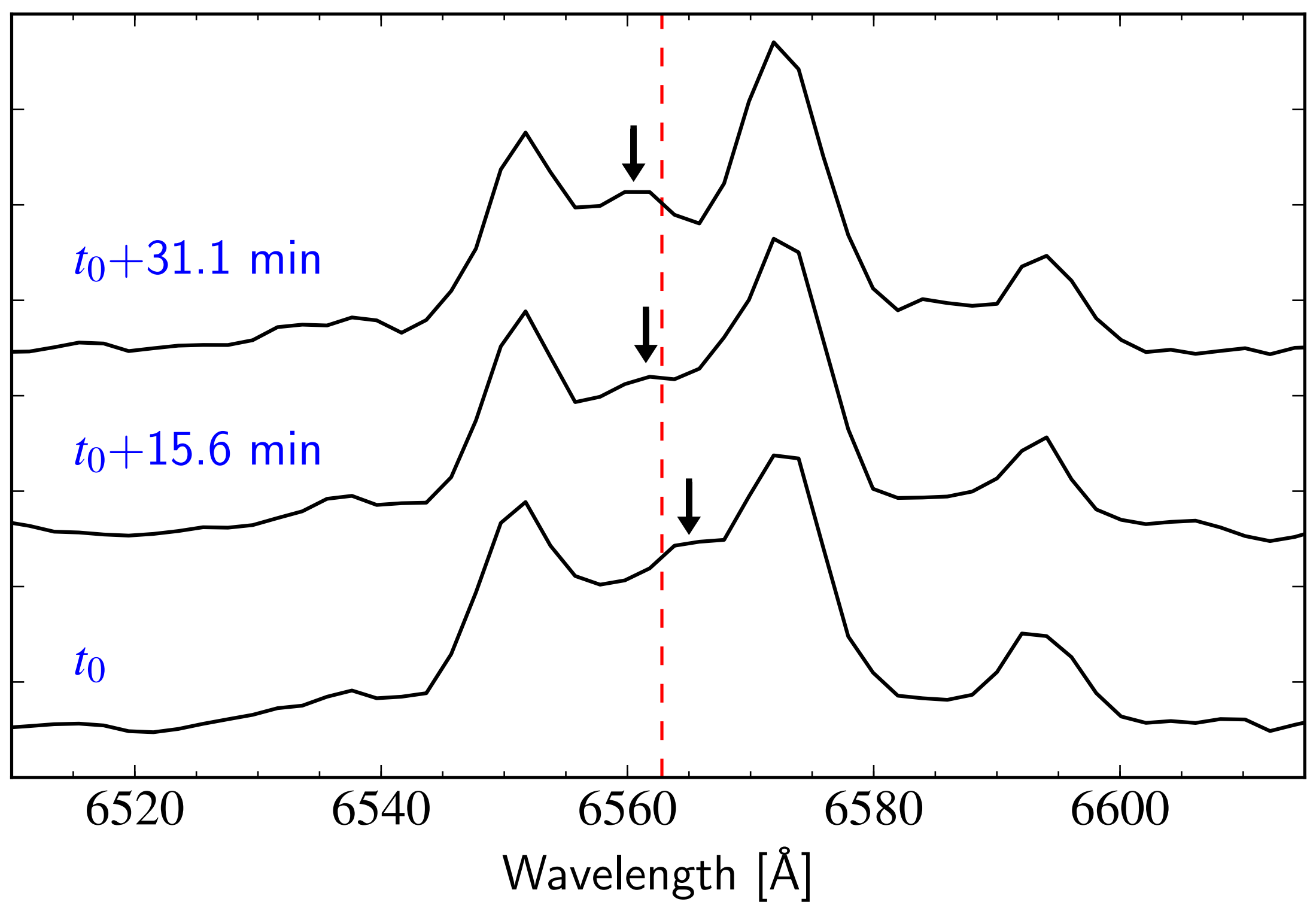


In the 2-D spectroscopic GMOS data (with the y-axis representing the spatial direction such that East is up and West is down) the first significant difference between the two objects becomes apparent: while V1229 Aql still presents strong features of 'nebular', forbidden lines, such are absent in V368 Sct. On the other hand, projected velocities, spatial extension, and even the geometry, of the two shells show strong similarities.

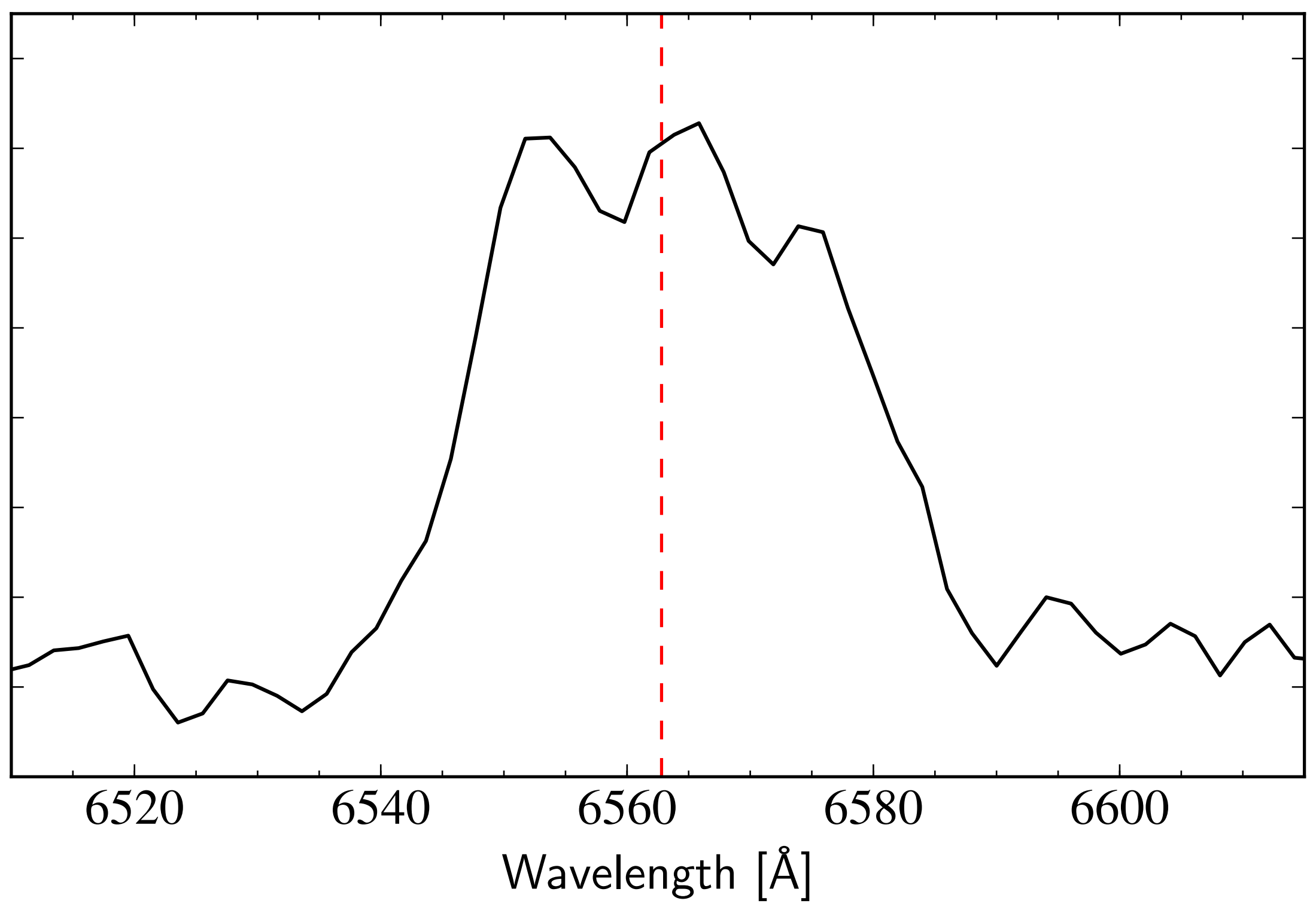
Line profiles



V1229 Aql: The emission line complex around Hα is principally formed from the blue- and redshifted shell components of [NII] 4–2, [NII] 4–3 and Hα. Subtracting those lines yields the residual spectrum in the lower plot. There, we tentatively identify a CII $\lambda_0$6578 component (Tappert et al. 2013), which, like (most of) the residual Hα emission, would originate in the binary. This line is in principle a doublet with another component at $\lambda_0$6583, fitting well the observed line at its red side. Still, this could also be a zero velocity component of [NII] 4–3.

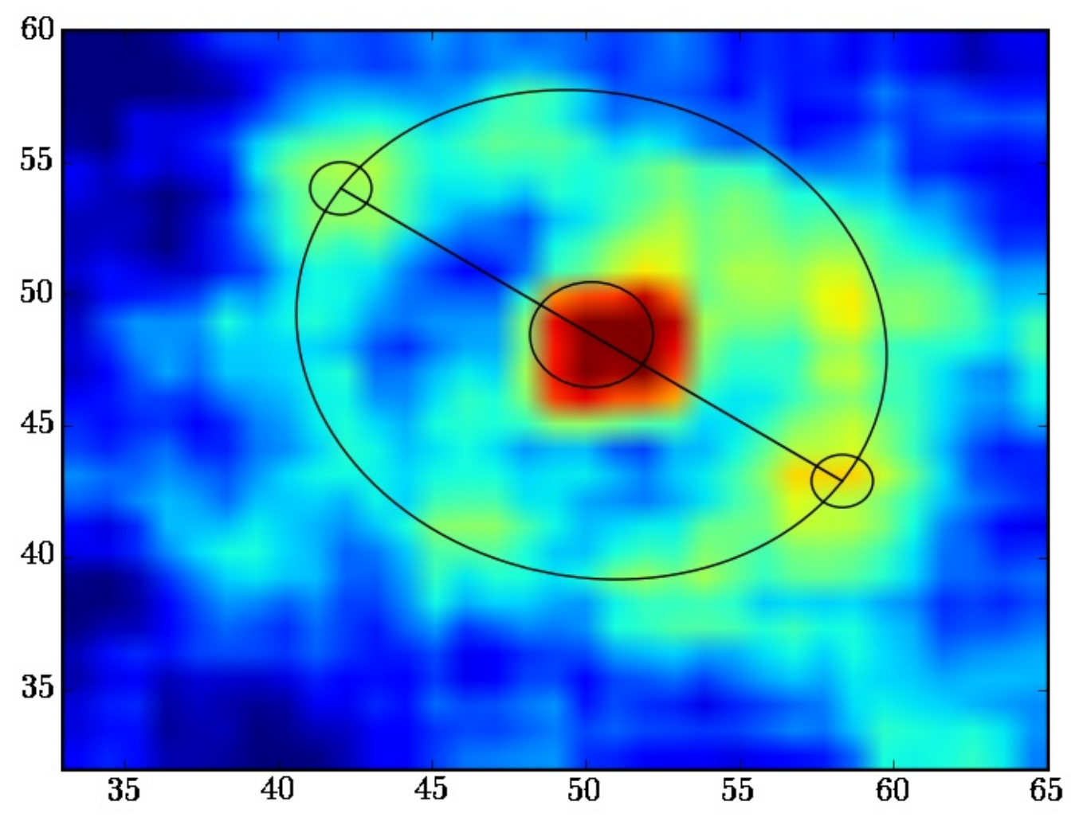


V1229 Aql: The spectroscopic data consist of three subsequent 15 min exposures. In the sequence of the individual spectra, we find a variable component that moves within the stationary shell lines, covering a velocity range of ~200 km/s in 30 min. Identifying this as a component from the binary indicates a comparatively high inclination and short orbital period. However, a preliminary reduction of recent time-series photometry did not yield any conclusive results with respect to an orbital modulation.



V368 Sct: No forbidden shell emission is detected. The line complex should thus be composed of the blue- and redshifted Hα shell emission and emission from the binary. An additional zero velocity shell component could also be present. The difference in intensity between the blue and the red peak (also easily noticeable in the 2D spectrum) thus appears intrinsic rather than caused by the presence of other emission lines (as in the case of V1229 Aql). The V368 Sct data have significantly lower S/N, and a proper analysis is still in progress.

Geometry



V1229 Aql: HST Hα imaging (North up, East to the left), taken 27 yr after the eruption. We have manually included an ellipse to guide the eye. It was fixed to extend to the two major emission blobs (marked with small circles) and to match the South-Eastern emission arc.

The large circle marks the calculated centre of the ellipse. While it appears slightly offset with respect to the binary, the involved uncertainties likely still allow for positional identity. However, it is clear that the emission distribution in general is asymmetric.

Future Plans

- proper analysis of the available data; potentially additional imaging of the V368 Sct shell
- modelling of the shell geometries by Valerio Ribeiro, Botswana International University; modelling of the shell properties using CLOUDY (Daniela Barria)
- extend the research to further novae in order to investigate the evolution and persistence of nova shells, and to refine the corresponding work by Downes et al. (2001)

References

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