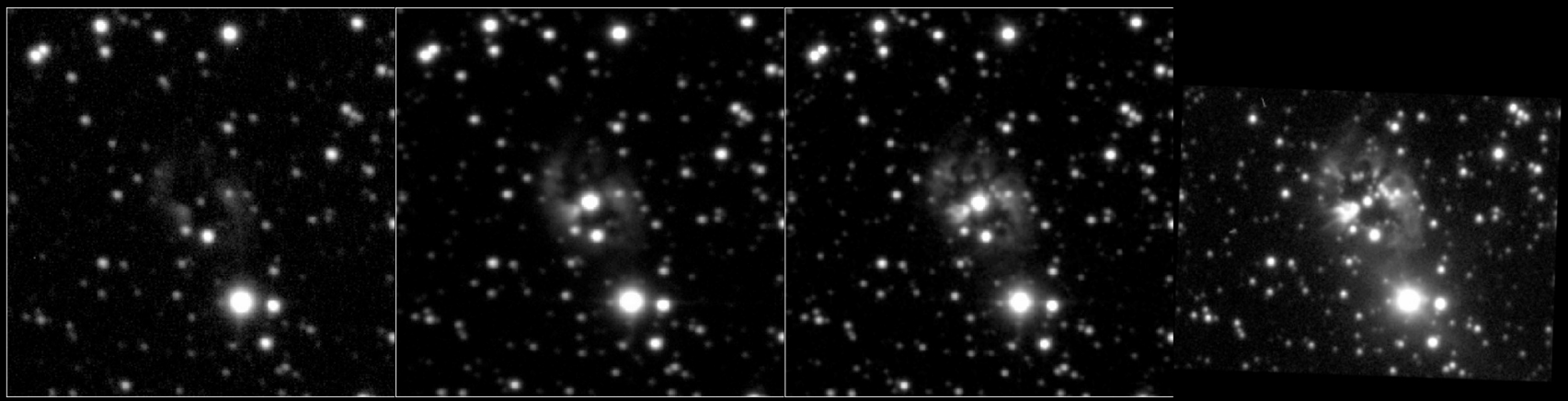
Spatially resolved spectroscopy of V458 Vul



Optical/IR Galactic Plane Surveys Meeting - University of Hertfordshire - 21 July 2011

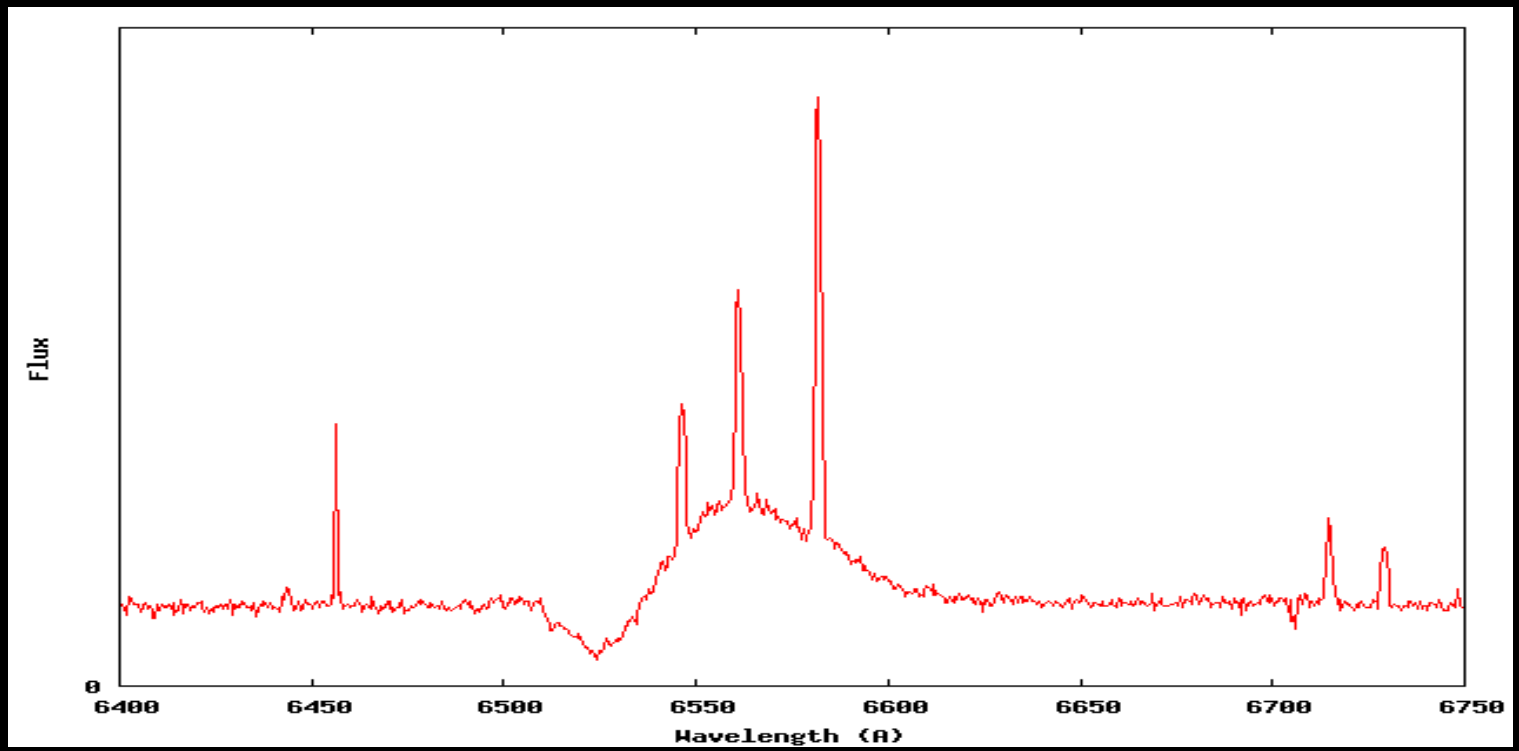
Roger Wesson (University College London)

V458 Vul - a nova inside a planetary nebula

- V458 Vul discovered on 8 August 2007
- Observed by IPHAS in June 2007
- IPHAS images revealed Hα emission around the nova progenitor

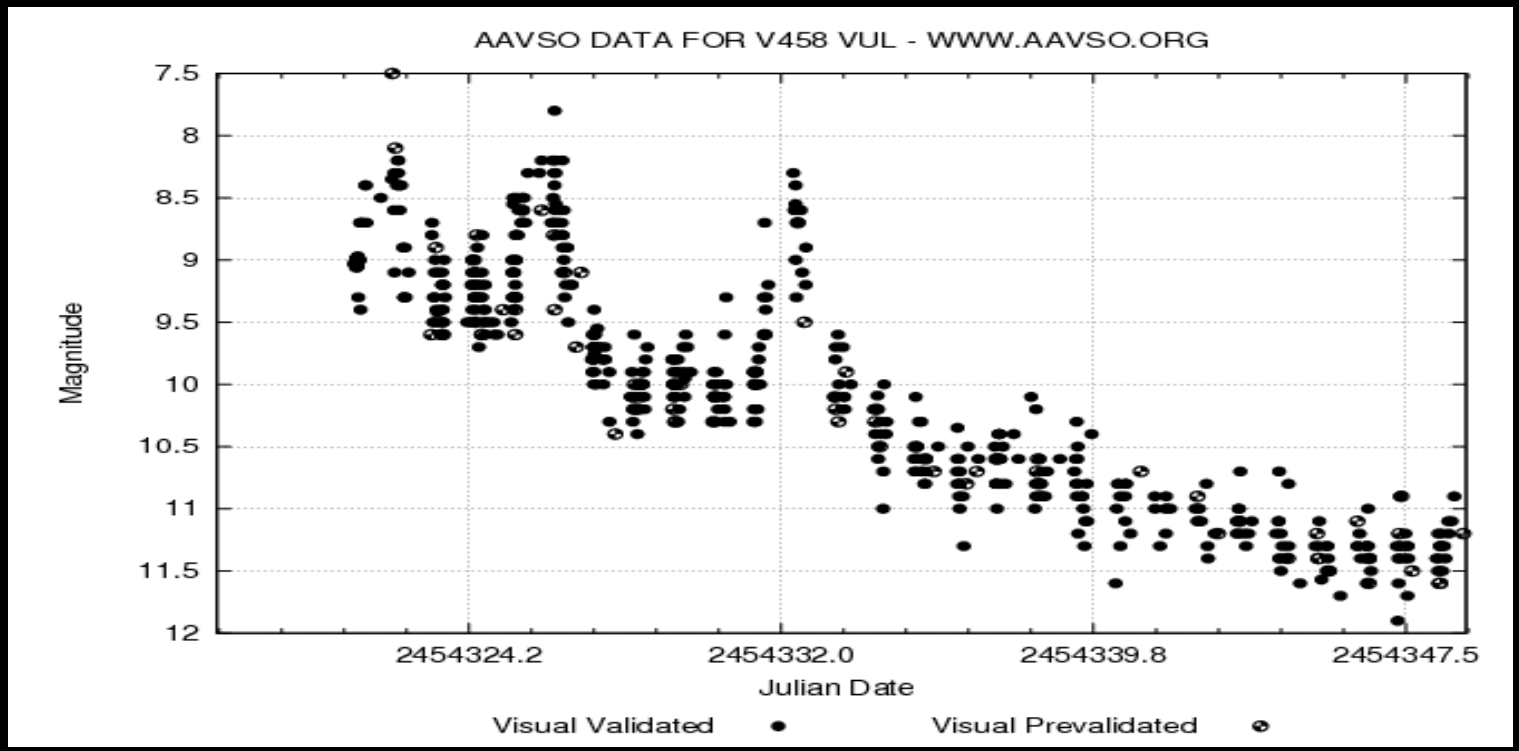
V458 Vul - a nova inside a planetary nebula

- Spectroscopic observations revealed narrow emission lines
- Ionised mass $\sim$0.2M$_\odot$.
- Not consistent with nova ejecta, but instead with being a planetary nebula
- Strong [N II] emission relative to Hα implies Type I PN with massive progenitor.



V458 Vul - a nova inside a planetary nebula

- Nova light curve showed it to be fast nova, with unusual rebrightenings
- Maximum magnitude-rate of decline relationships used to estimate absolute magnitude
- Massive (>1$M_{\odot}$) progenitor at $\sim$10-13 kpc implied)



V458 Vul - a nova inside a planetary nebula

- Light travel time considerations also give 13kpc distance

V458 Vul - a nova inside a planetary nebula

- Initial results published in Wesson et al. (2008, ApJL, 688, 21)
- Spectroscopic observations of central star in 2008-2009 revealed orbital period of 98 minutes (Rodríguez-Gil et al, 2010, MNRAS, 407, 21)
- Shortest period for a PN binary central star

V458 Vul - a nova inside a planetary nebula

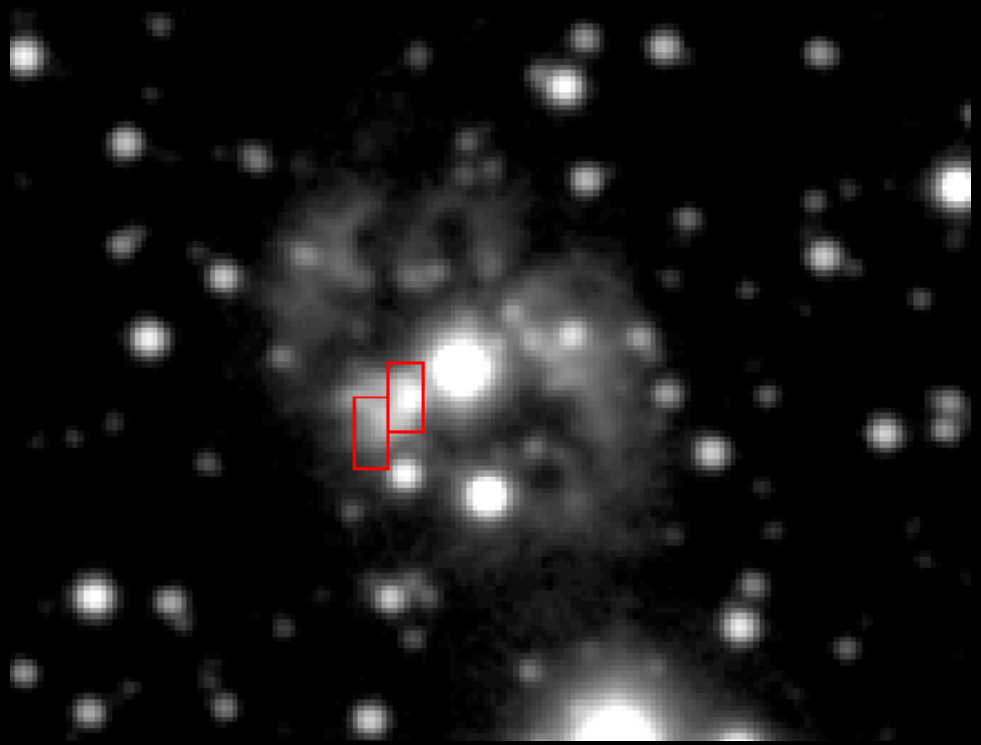
- Plausible evolutionary scenario: nebula was formed by common envelope 14,000 years ago
- Age derived from nebular expansion is consistent with that derived from photoionisation modelling and post-AGB evolutionary tracks
- $>$1M$_o$*dot* white dwarf accreting from $\sim$0.6M$_\odot$ post-AGB star
- Total mass is greater than Chandrasekhar limit and the system is a potential Type Ia supernova progenitor

V458 Vul - X-shooter observations

- X-shooter - first 2nd generation instrument on VLT, can obtain spectra from 3000Å to 2.5μm.
- Three arms cover 3000-5500Å (UVB), 5500Å-1μm (VIS), and 1–2.5μm
- We obtained observations of V458 Vul during X-shooter's Science Verification, October 2009.

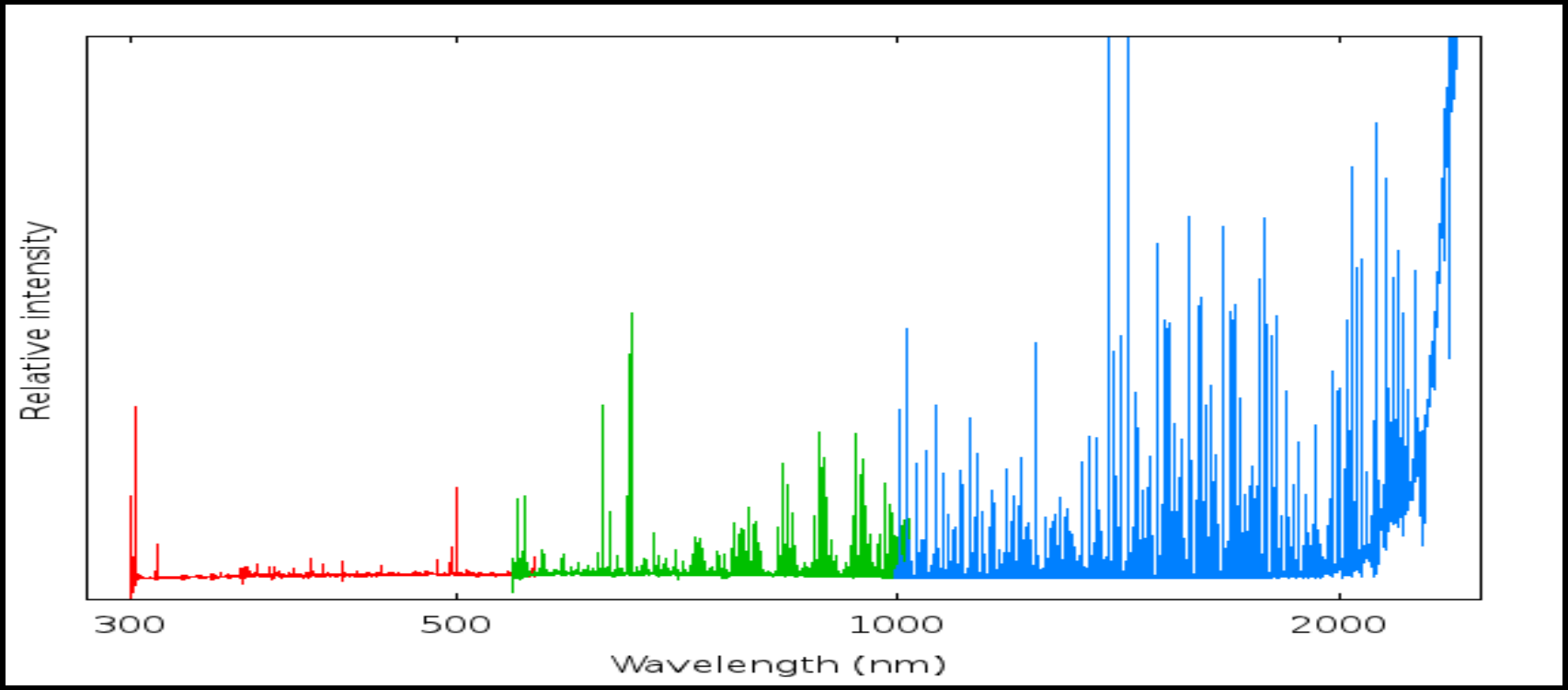
V458 Vul - X-shooter observations

- Observed V458 Vul using the X-shooter IFU (field of view 4x1.8 arcsec)
- Two adjacent fields observed, covering bright knot and a region further away from central star



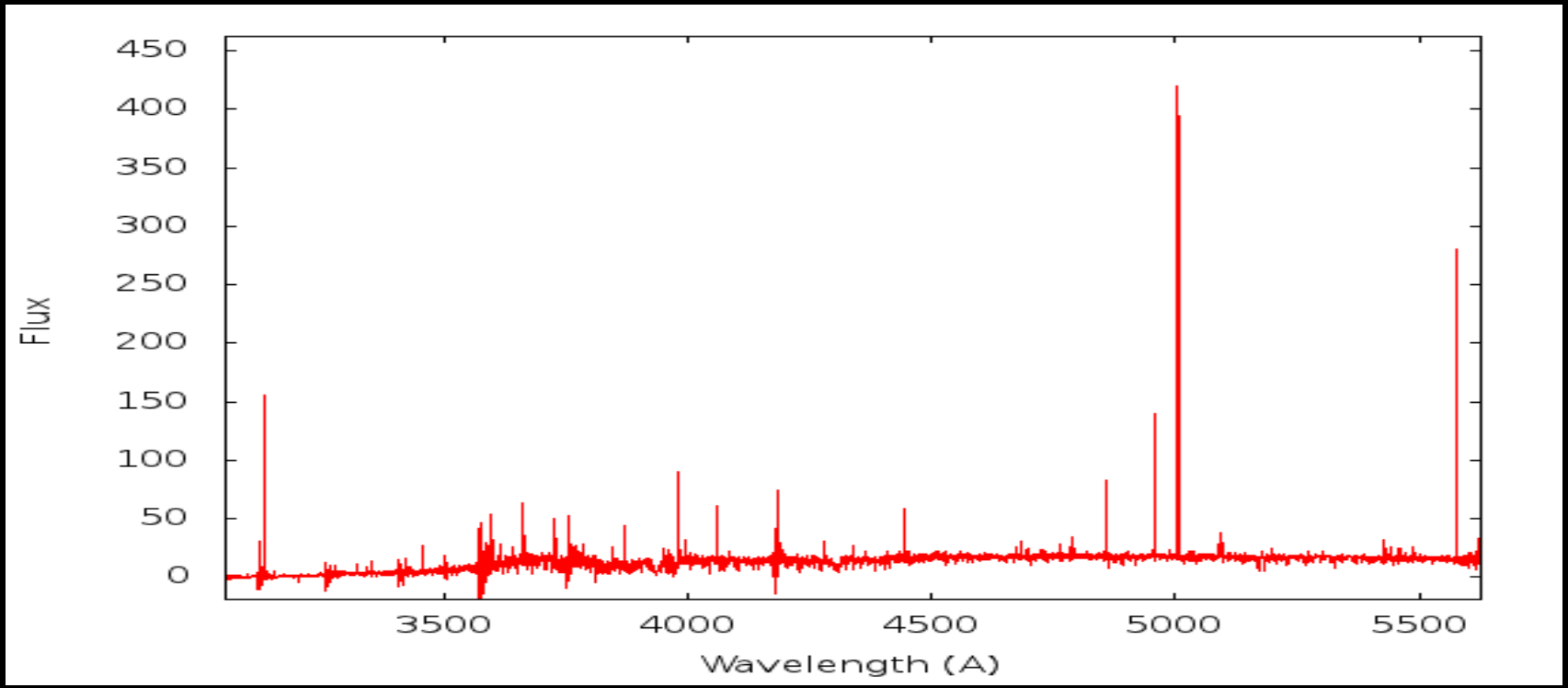
V458 Vul - X-shooter observations

- October 2009 was a while ago... data reduction challenging!
- Latest version of pipeline provides reasonable reduction in all three arms



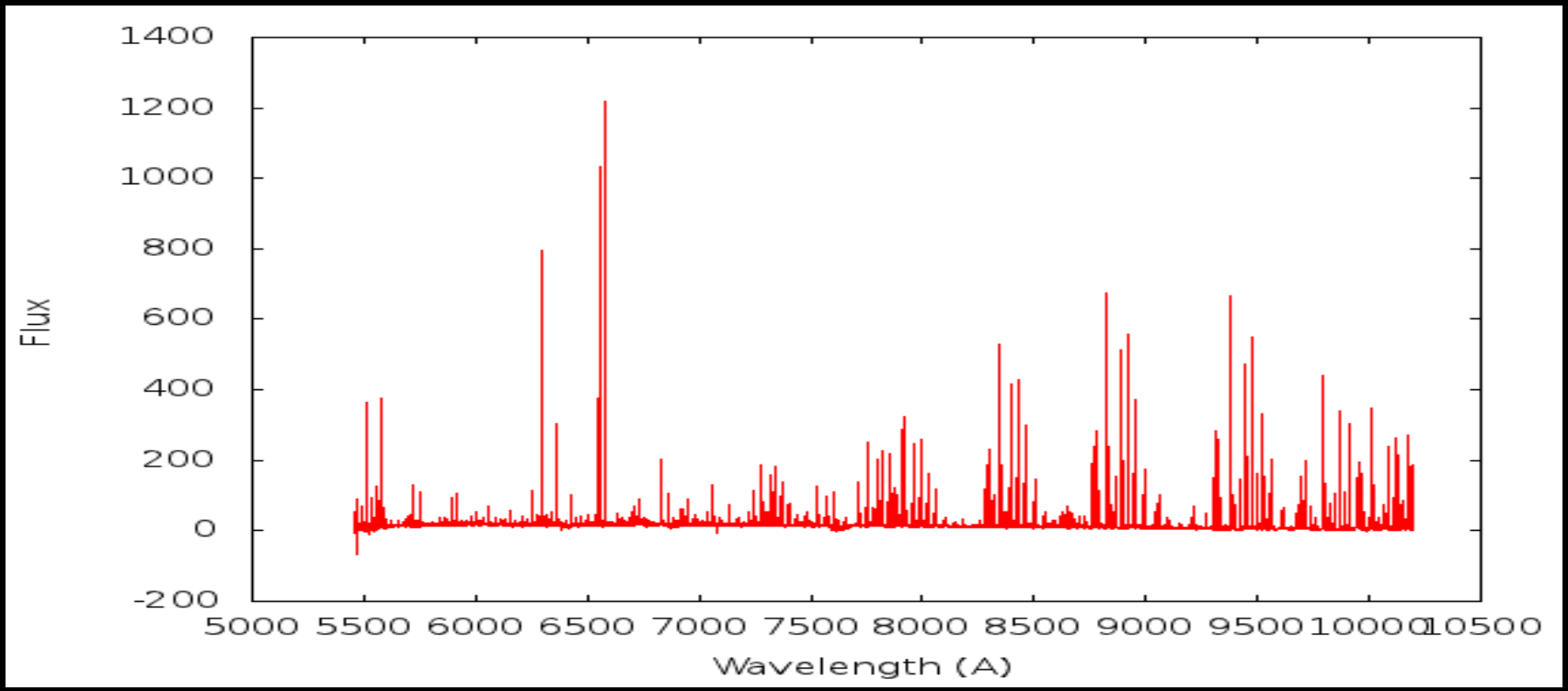
V458 Vul - X-shooter observations

- UVB - [O II] 3727/3729 density diagnostic lines, [O III] 4363 weakly detected.
- Poor SNR in calibration frames gives noisy spectrum at order ends.



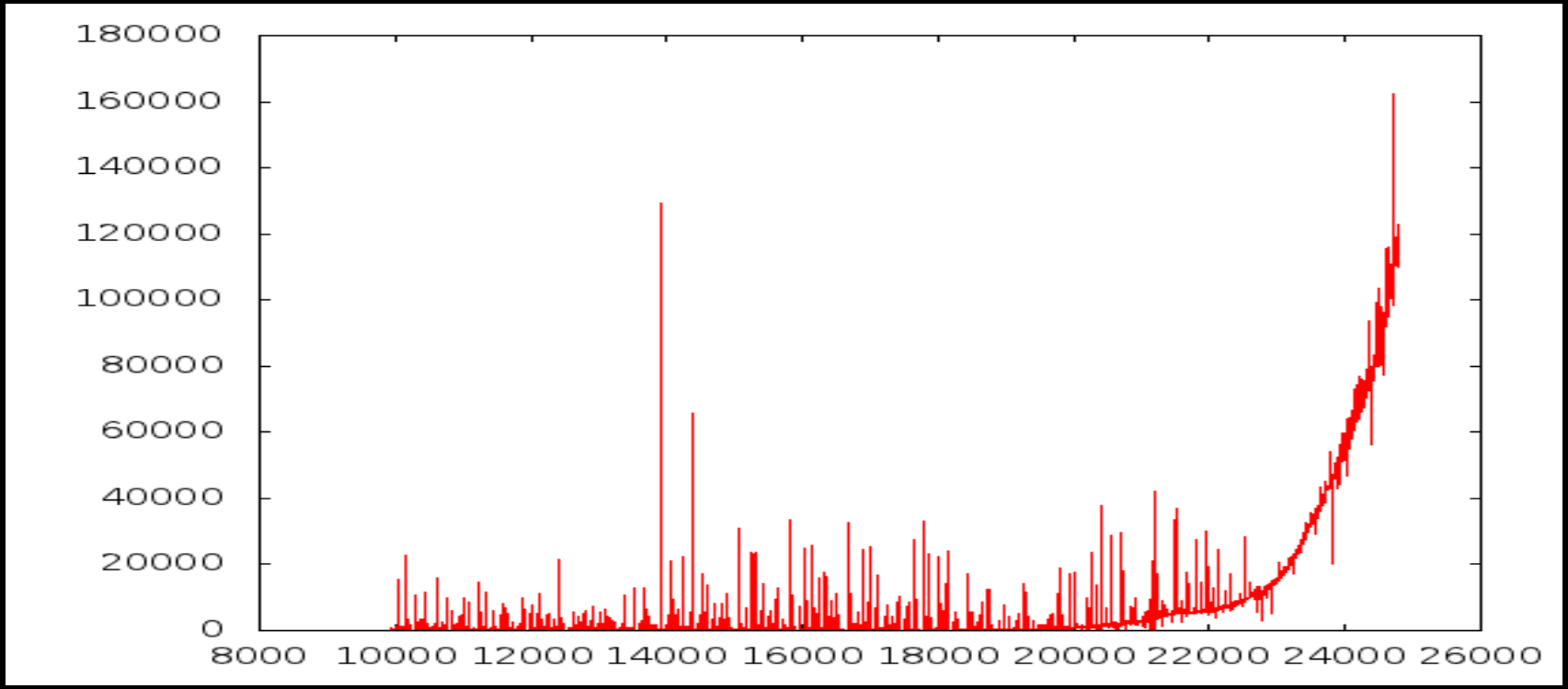
V458 Vul - X-shooter observations

- VIS - [O I], [N II], [S II], Hα bright
- Airglow dominates at longer wavelength



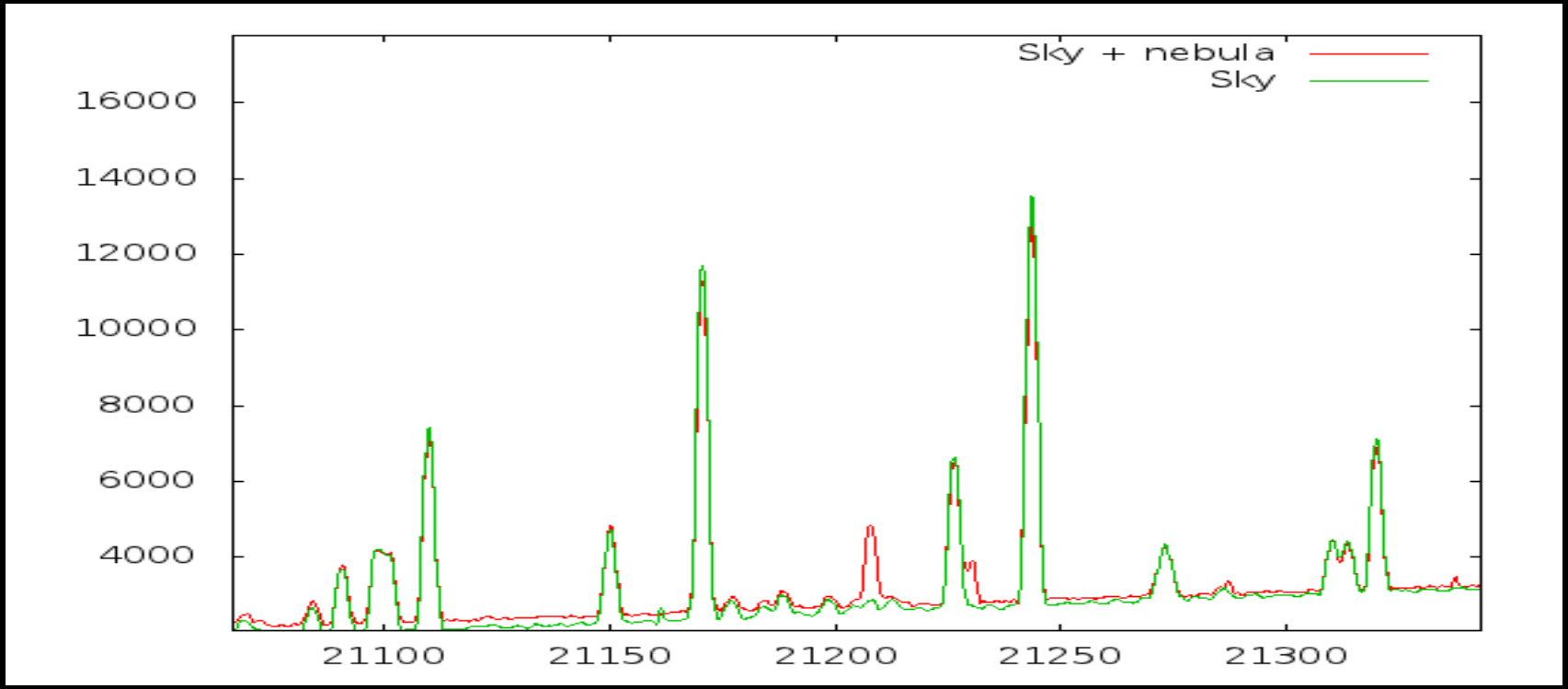
V458 Vul - X-shooter observations

- NIR - dominated by atmospheric emission
- No separate sky frame taken.



V458 Vul - X-shooter observations

- Sky background estimated using pixels with little nebular emission
- Reveals molecular hydrogen emission at 2.12μm

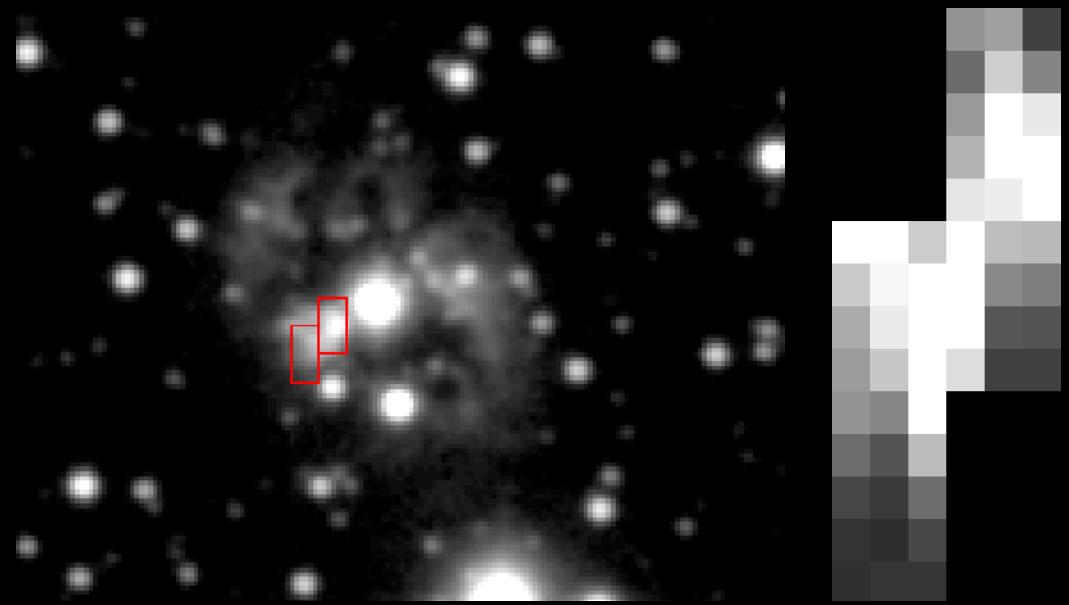


V458 Vul - X-shooter observations

- Plan for better sky subtraction:
- LBLRTM (line-by-line radiative transfer model) can be used to model sky emission
- Potentially as good or better than separate sky frame

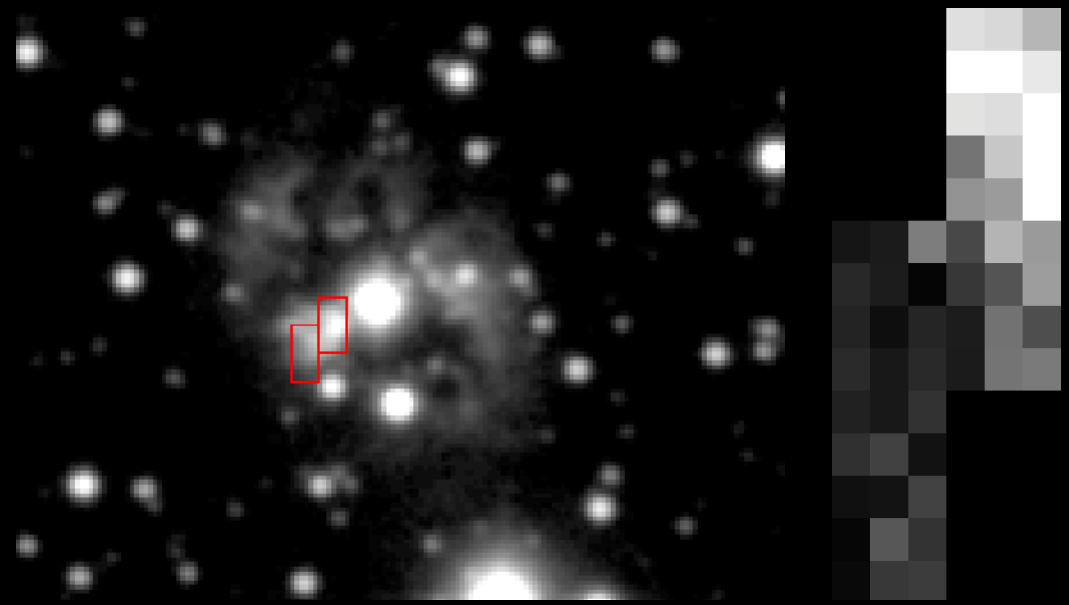
V458 Vul - X-shooter observations

- Mapping of nebular properties
- Hα emission: far side of knot brightened between June and October 2009



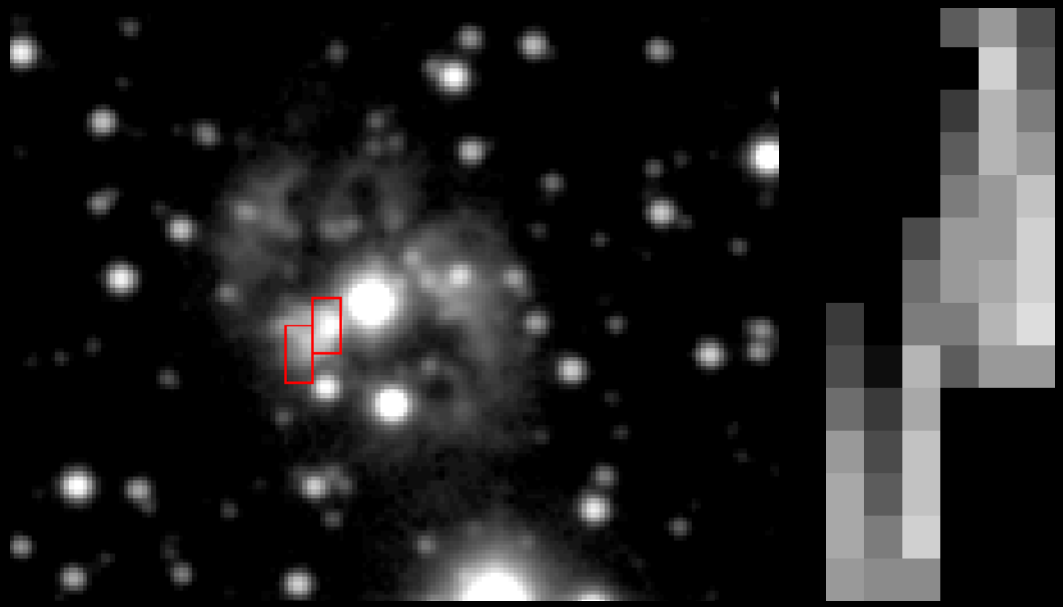
V458 Vul - X-shooter observations

- Mapping of nebular properties
- Density from [S II] lines: near side of knot is $\sim$10 times denser than far side



V458 Vul - X-shooter observations

- Mapping of nebular properties
- Velocities derived from [O III] λ5007 show little variation across field ($60 \pm 5\,\mathrm{km\,s^{-}1}$)



V458 Vul - X-shooter observations

- Next plans: improve reduction if possible
- Better sky subtraction - model-based approach
- Flux calibration - not yet possible directly on IFU data, have to reduce it as slit spectrum then slice it manually
- Then do spatially resolved abundance analysis