

Spectroscopic Analysis of the Helium Nova V445 Puppis

Sally Macfarlane

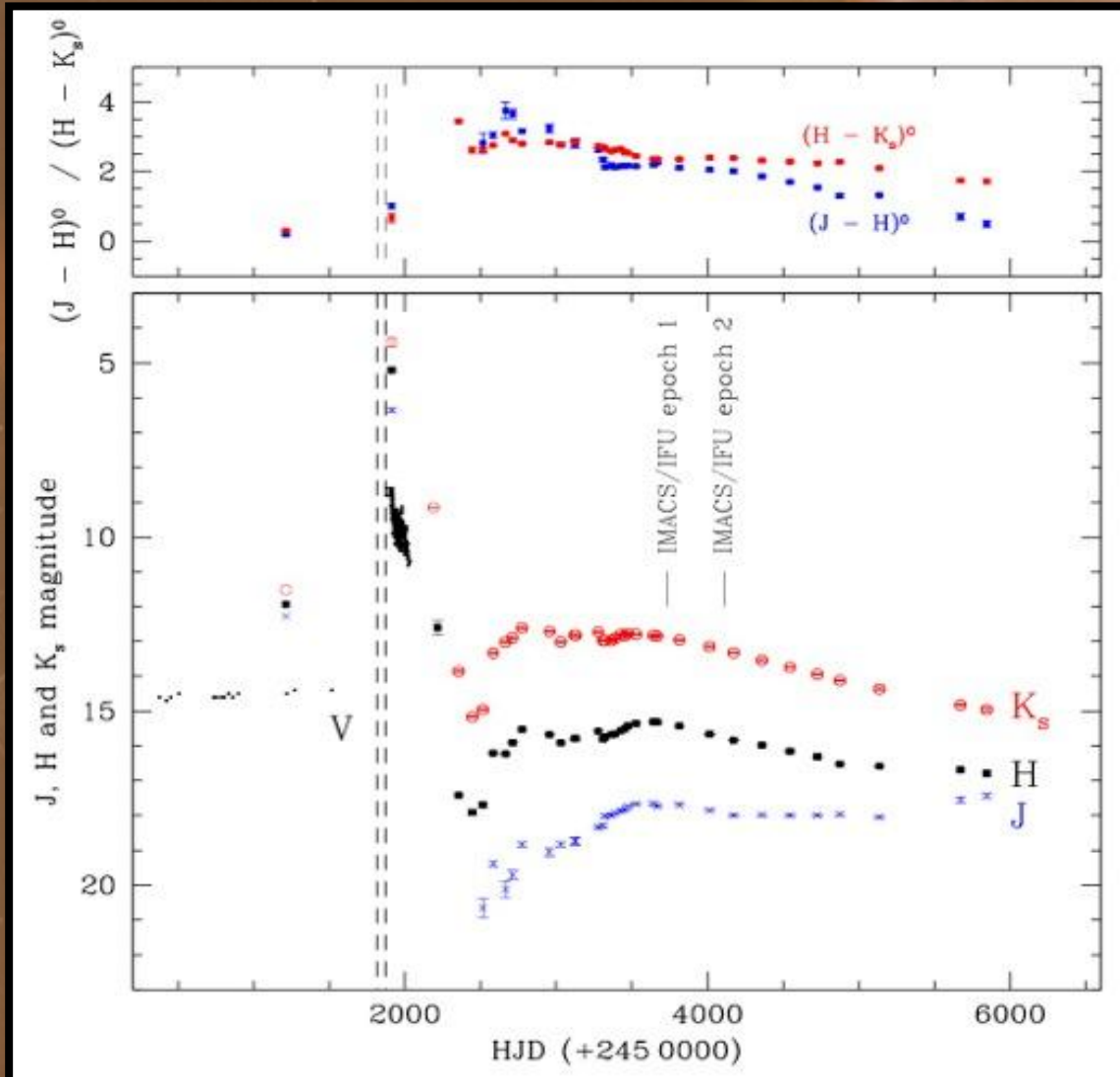
UCT Astronomy Department, ACGC; Radboud University Nijmegen, IMAPP

3rd AM CVn Workshop, University of Warwick



**The helium nova V445 Puppis observed in
March 2007 using the NACO adaptive optics
instrument on the VLT.
(Woudt 2009)**

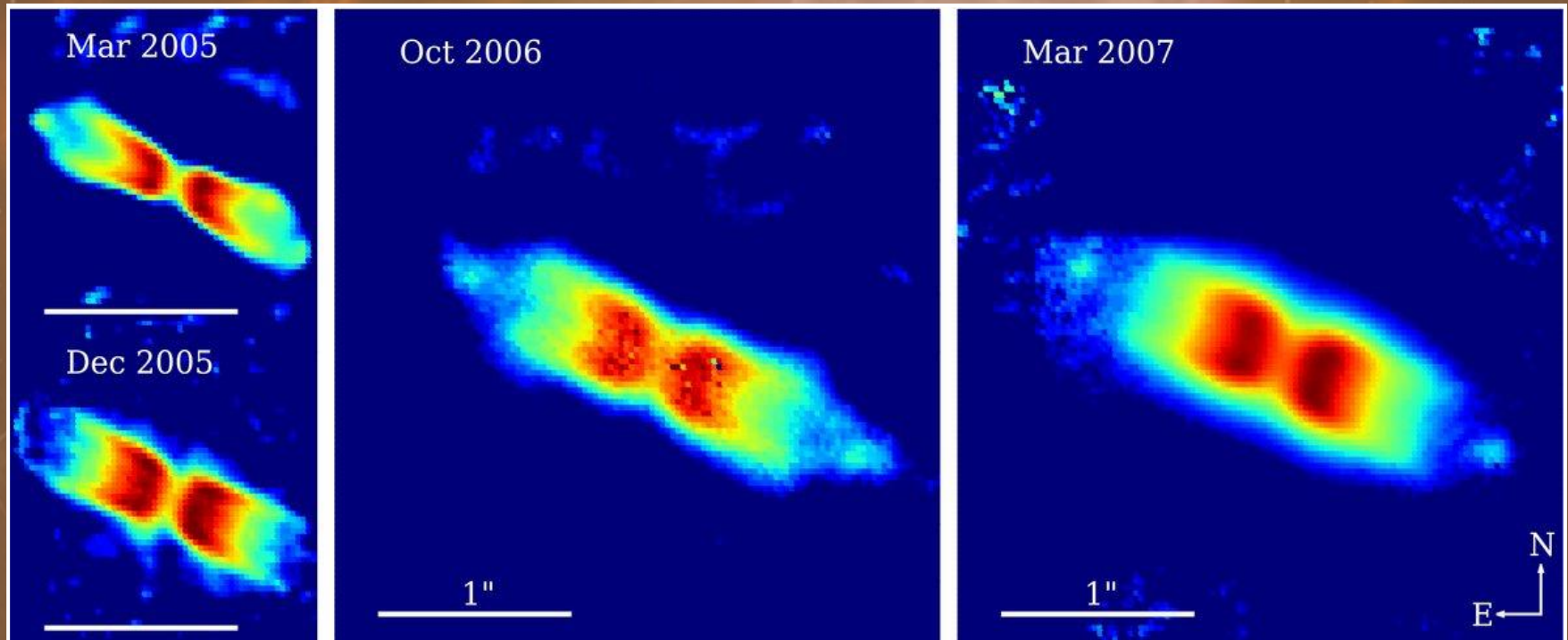
V445 Puppis as a helium nova



Top Panel: Infrared colour evolution of V445 Puppis (corrected for Galactic foreground extinction).

Lower panel: Near-infrared light curves of V445 Puppis before, during and after outburst.

Expanding shell of V445 Pup



Evolving nova shell of V445 Puppis obtained with NAOS/CONICA on the VLT.
(Woudt et al. 2009)

Thesis Aim

To reduce and analyse multi fibre data of the helium nova V445 Puppis for spatial kinematic modelling, leading to a clear picture of the expansion of the helium nova.

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RESULT:

An excess of oxygen at the extremes of the nova shell!



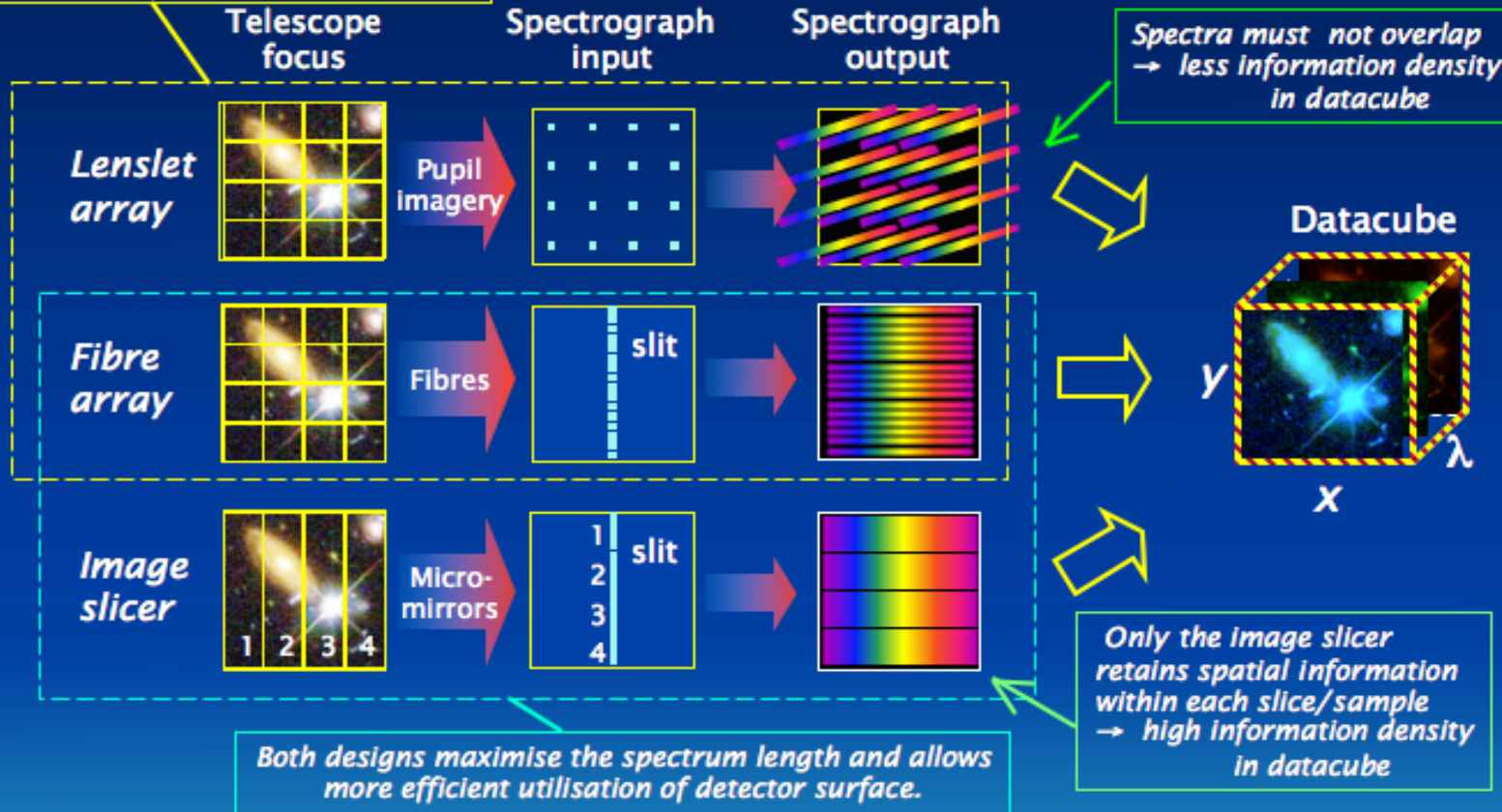
Observations

Sally Macfarlane 3rd AM CVn Workshop April 2012
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Integral Field Spectroscopy

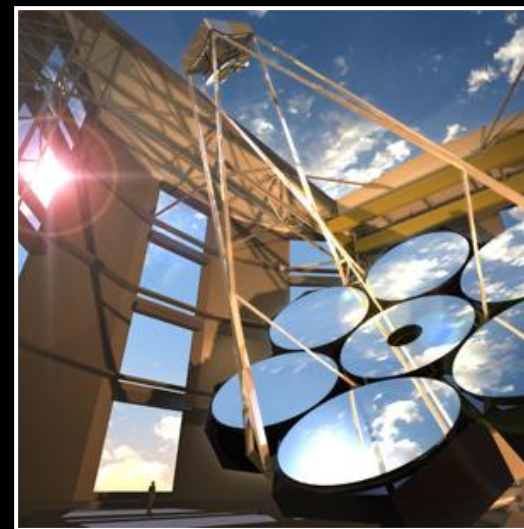
Divides the field in two dimensions



The Magellan Telescopes

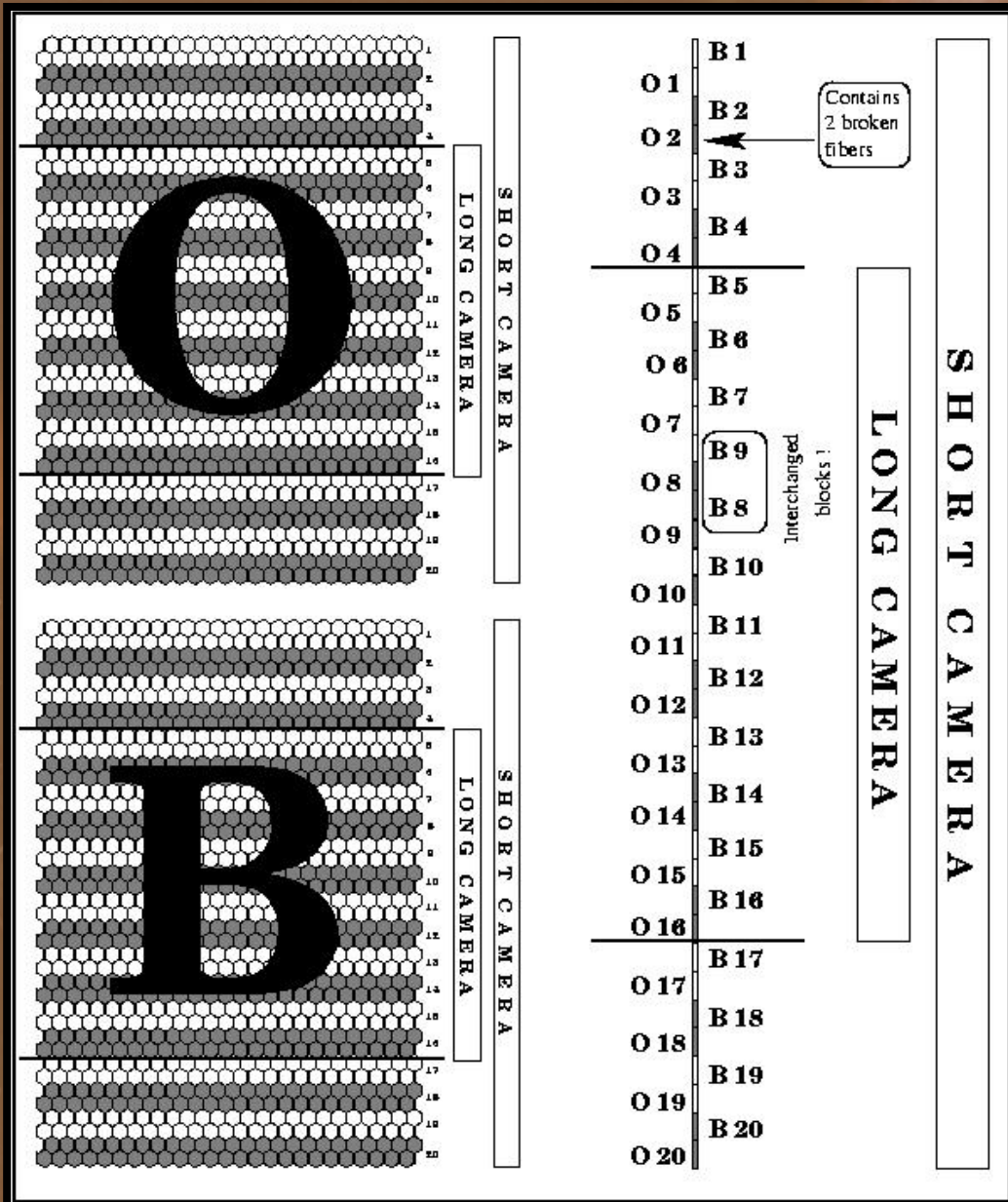


*The 6.5-m Magellan telescopes at Las Campanas Observatory situated in La Serena, Chile.
Credit: <http://occult.mit.edu/observatories>*



Credit: Giant Magellan Telescope - Carnegie Observatories

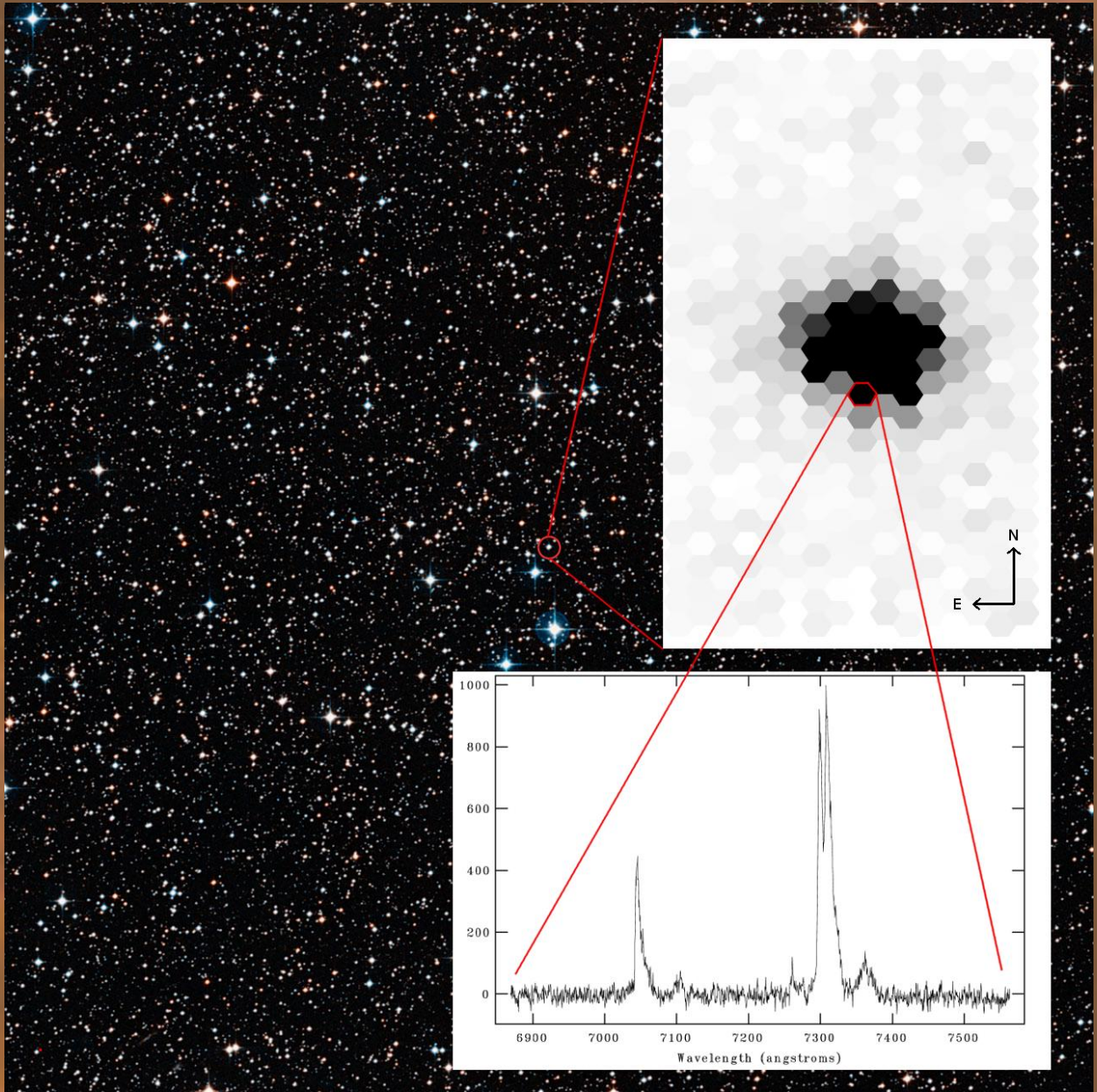




- 2000 fibres dispersed over an object field and background field
- each field is 5 by 7 square arcseconds, separated by ~1'
- sampled at 0.2" per fibre element
- Covers wavelength regime: ~400nm to ~900nm.

IMACS
IFU

Final Mapping of the IMACS IFU. (Schmoll, 2004)





Reduction Procedure

1

BIAS SUBTRACTION & TRIMMING

2

COSMIC RAY SUBTRACTION

3

APERTURE EXTRACTION, TRACE FITTING,
FLATFIELDING, THROUGHPUT CORRECTION

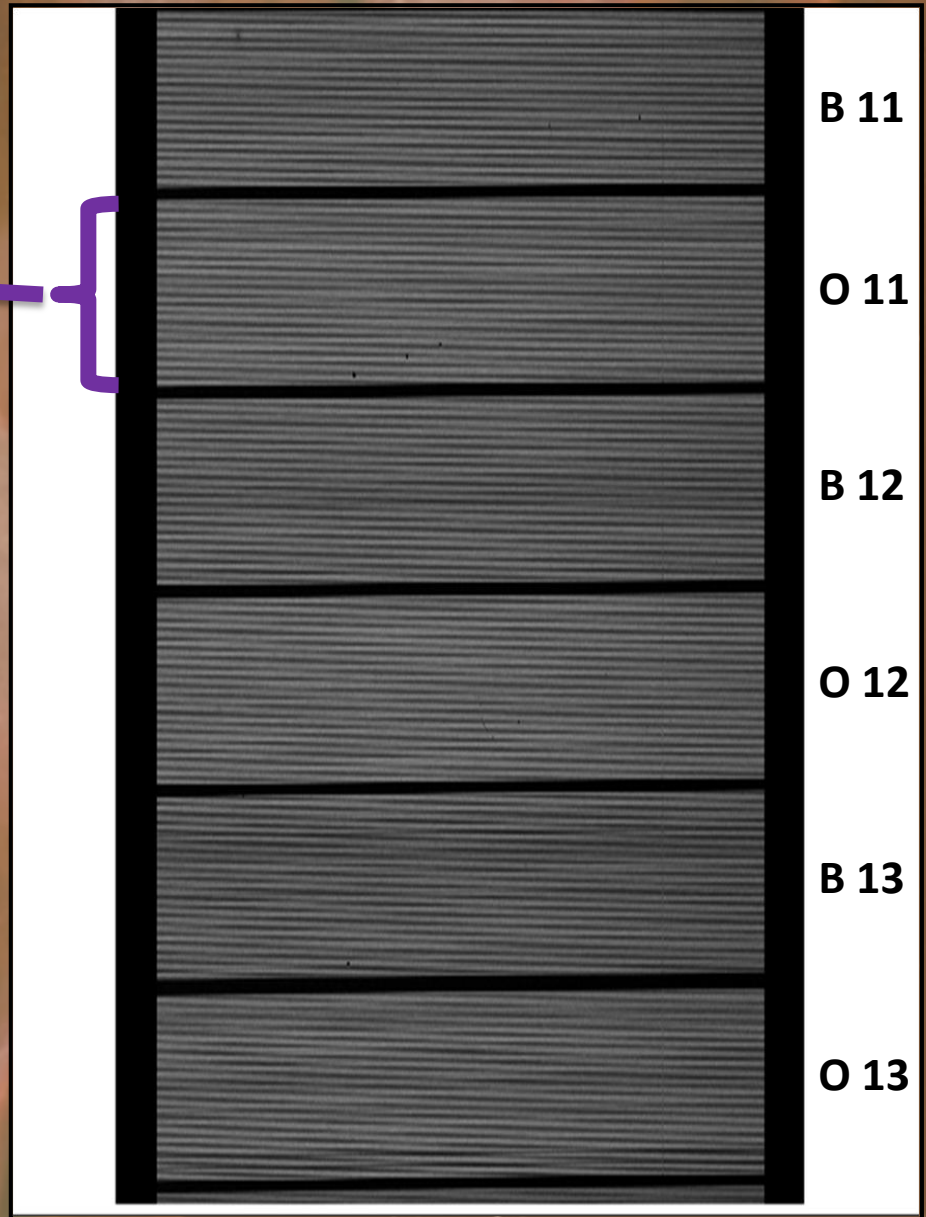
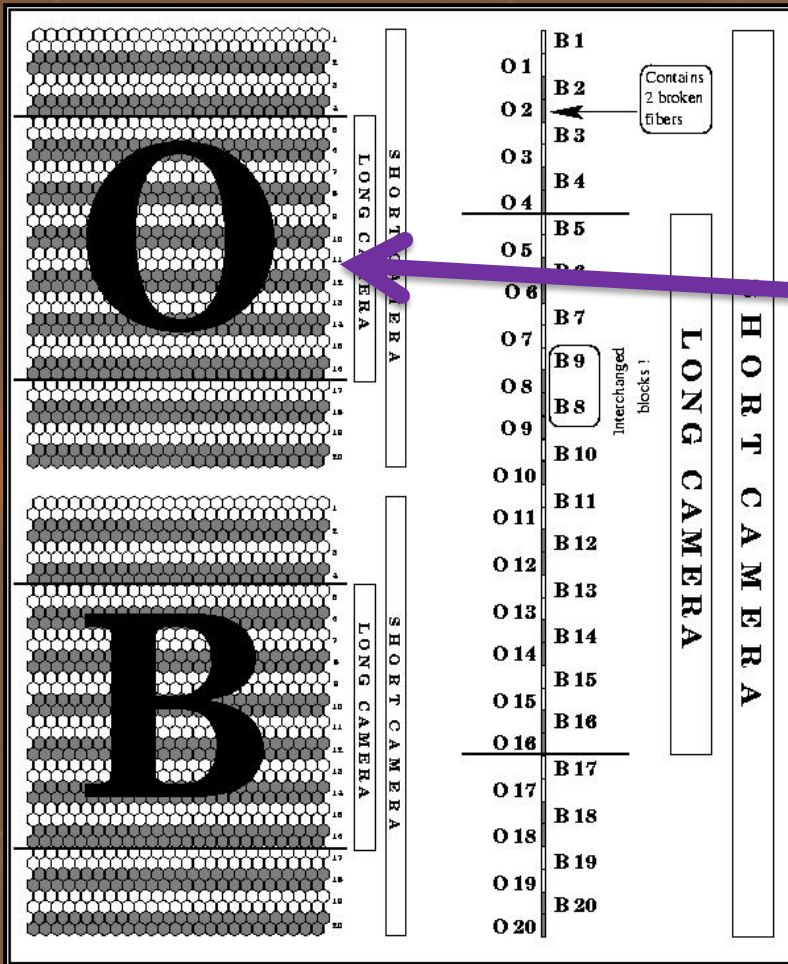
4

WAVELENGTH CALIBRATION

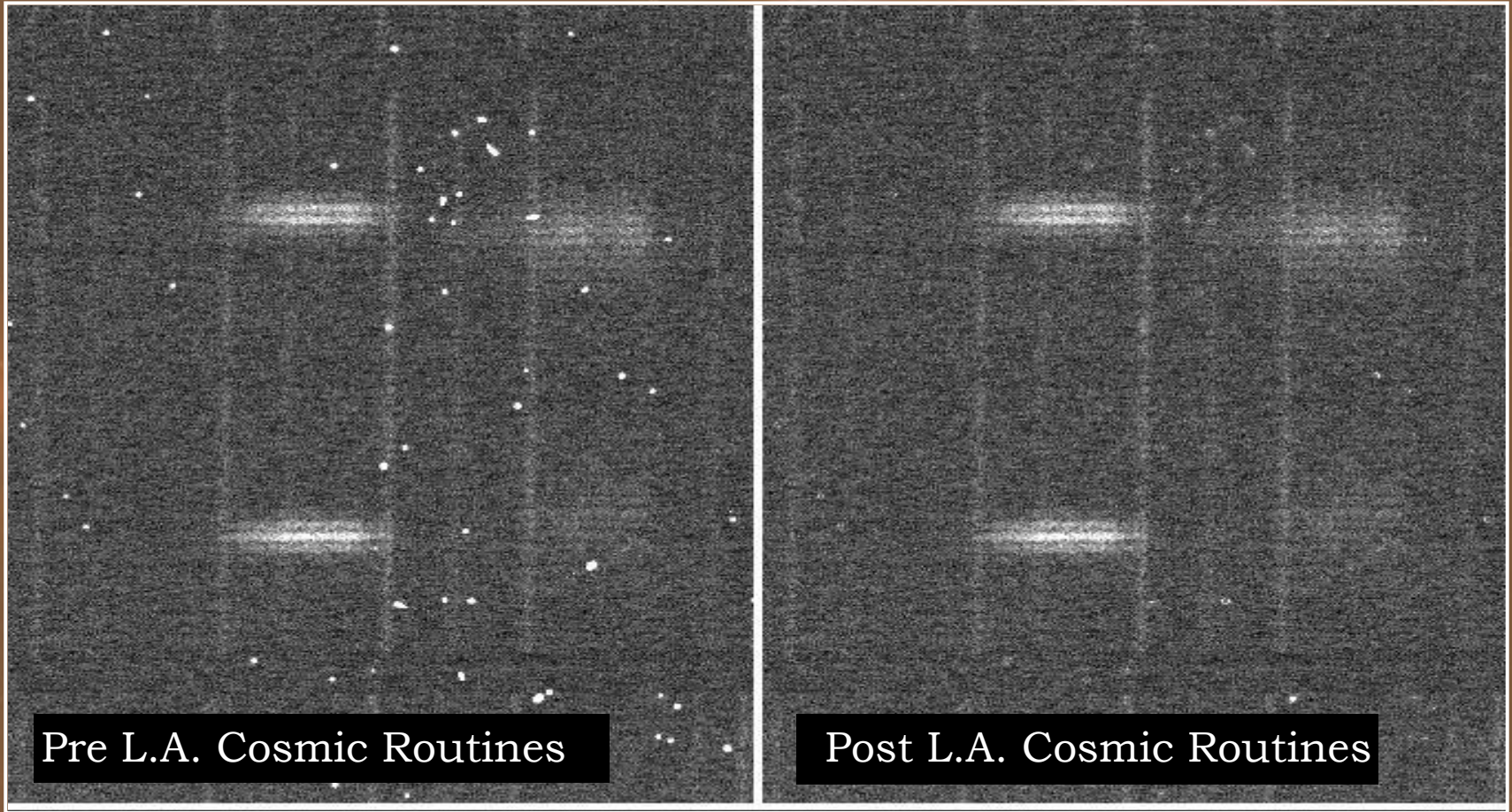
5

SKY SUBTRACTION



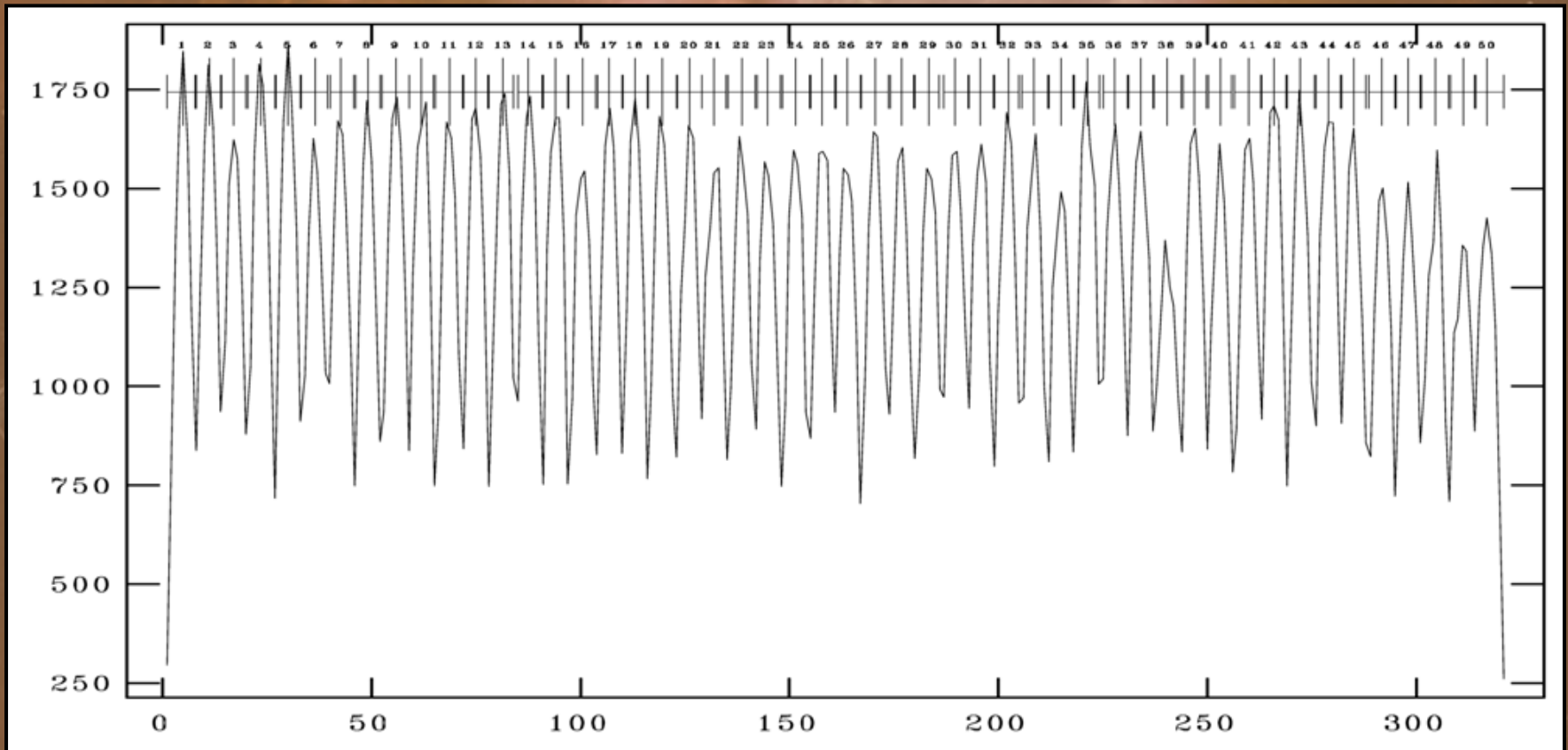


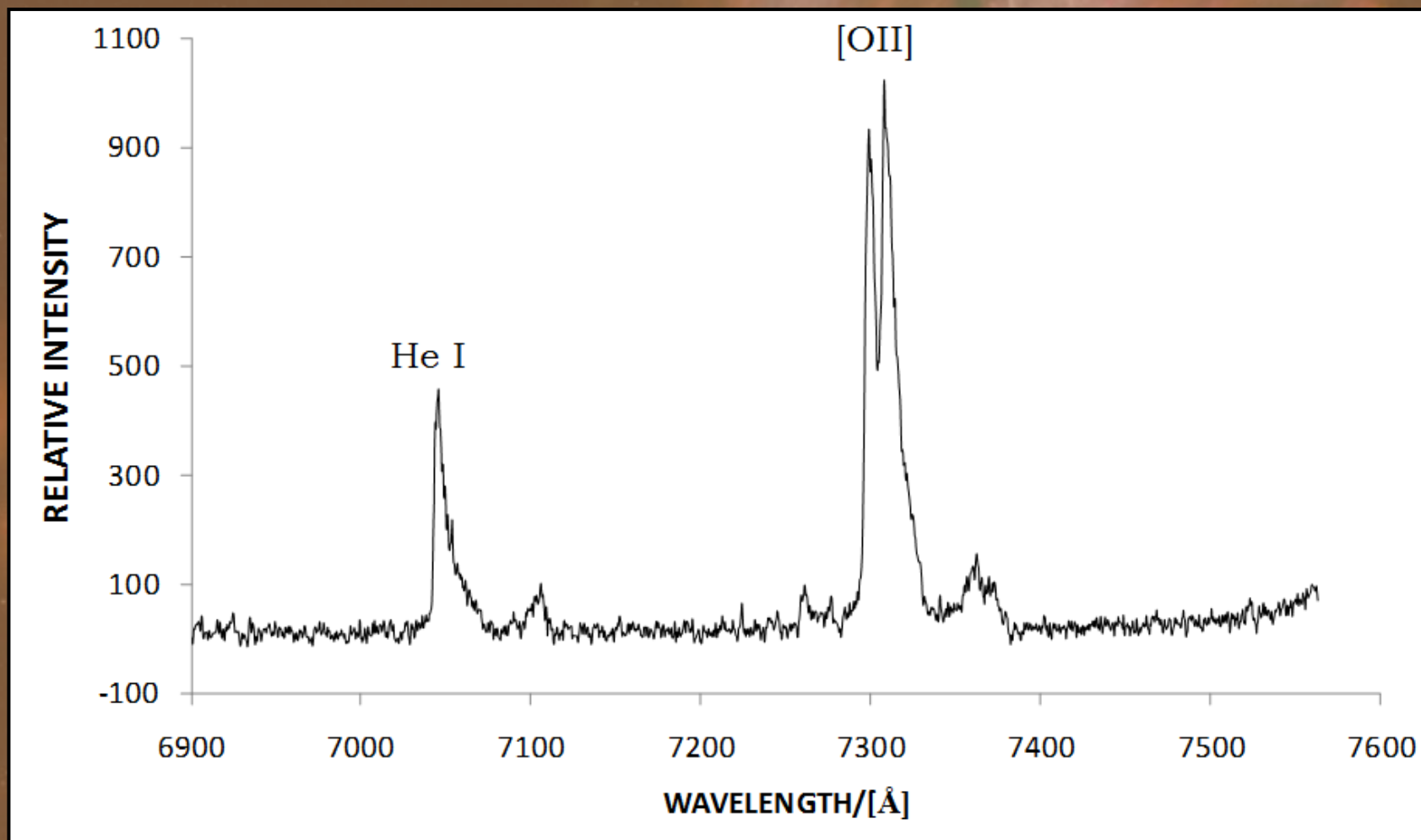
1. Trimming & Bias Subtraction



2. Cosmic Ray Subtraction

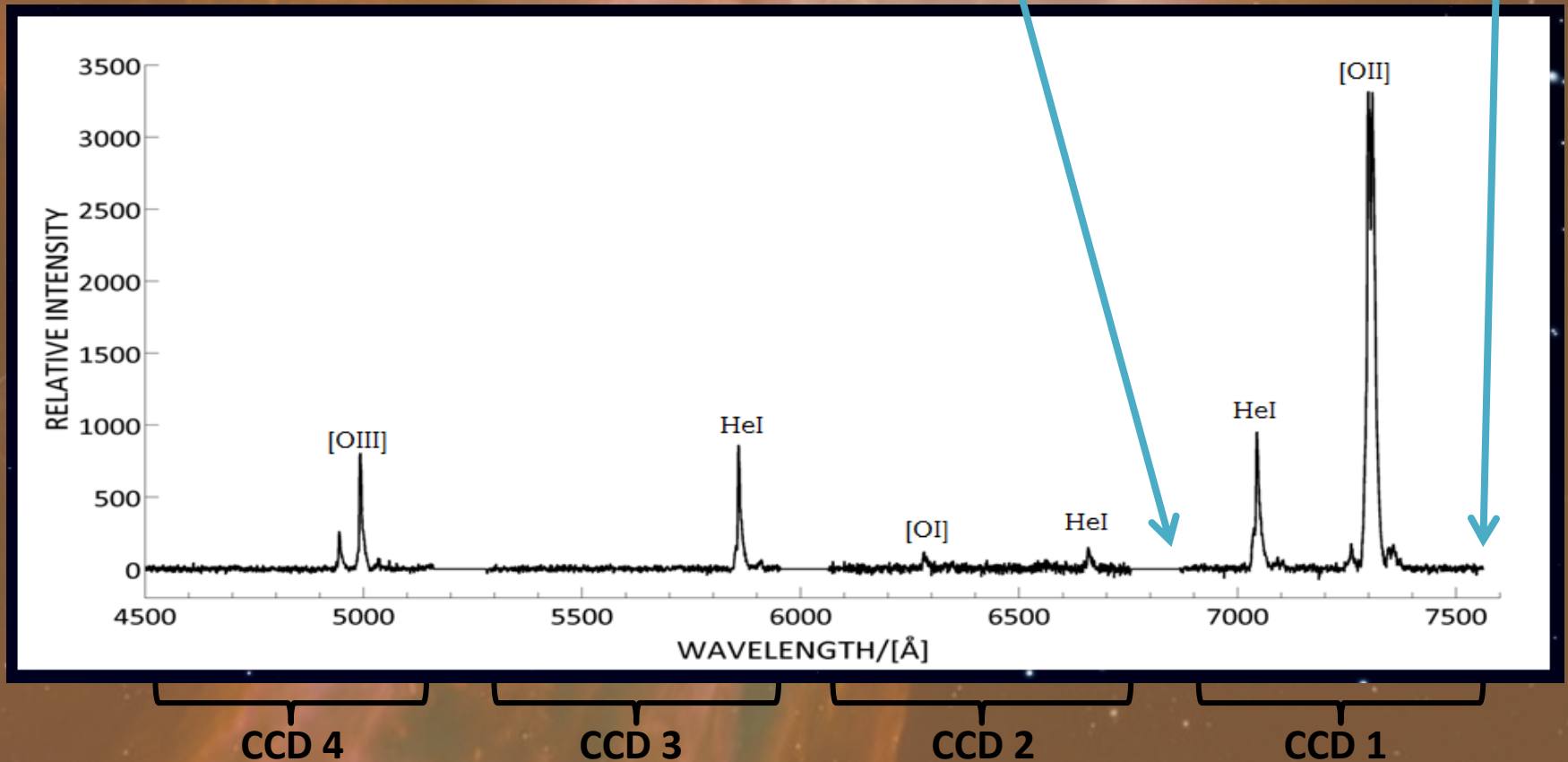
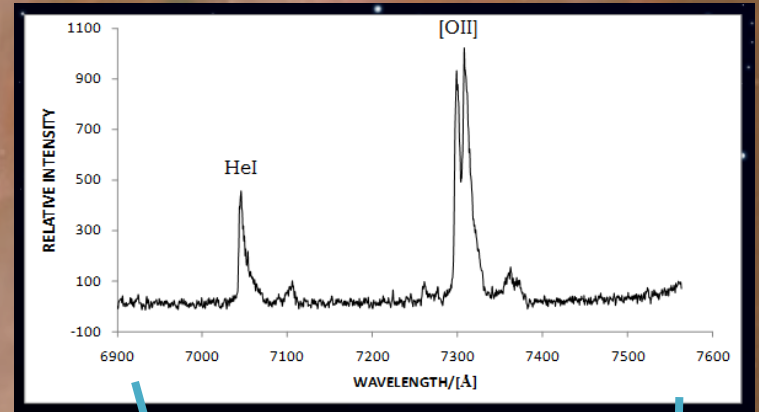
3. Aperture extraction,
trace fitting, flat fielding &
throughput correction





4. Wavelength Calibration

5. Sky Subtraction

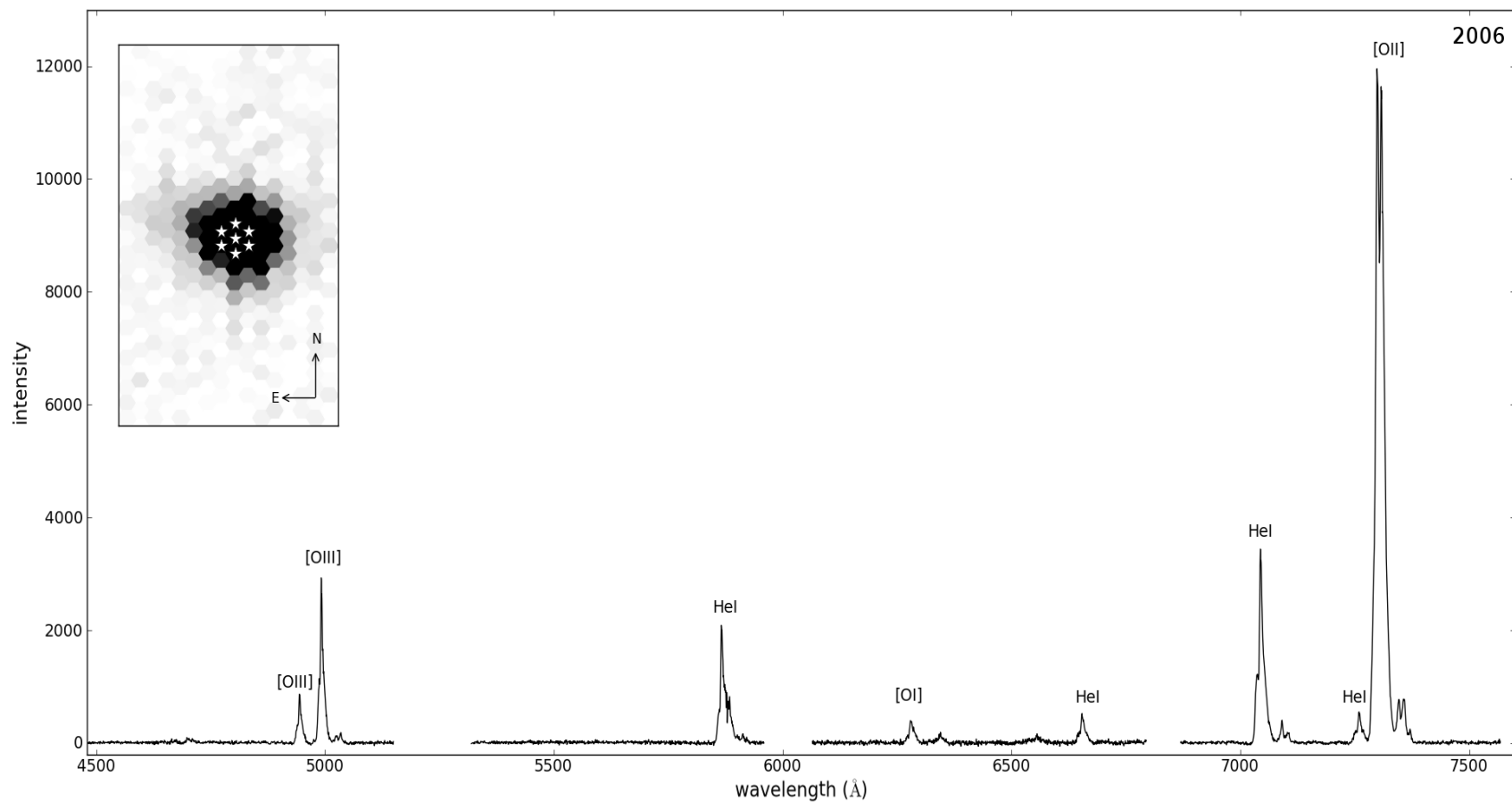




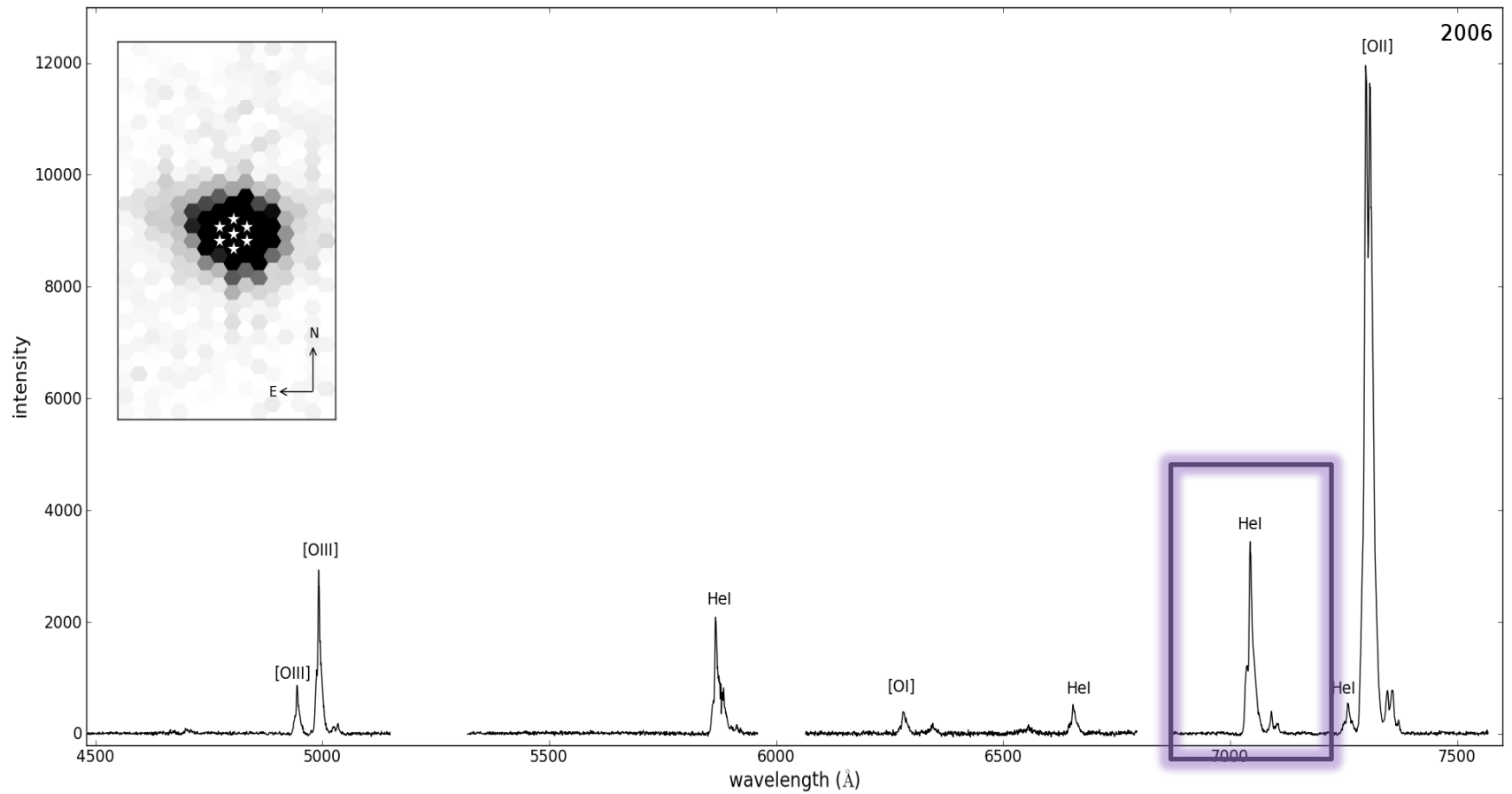
Results

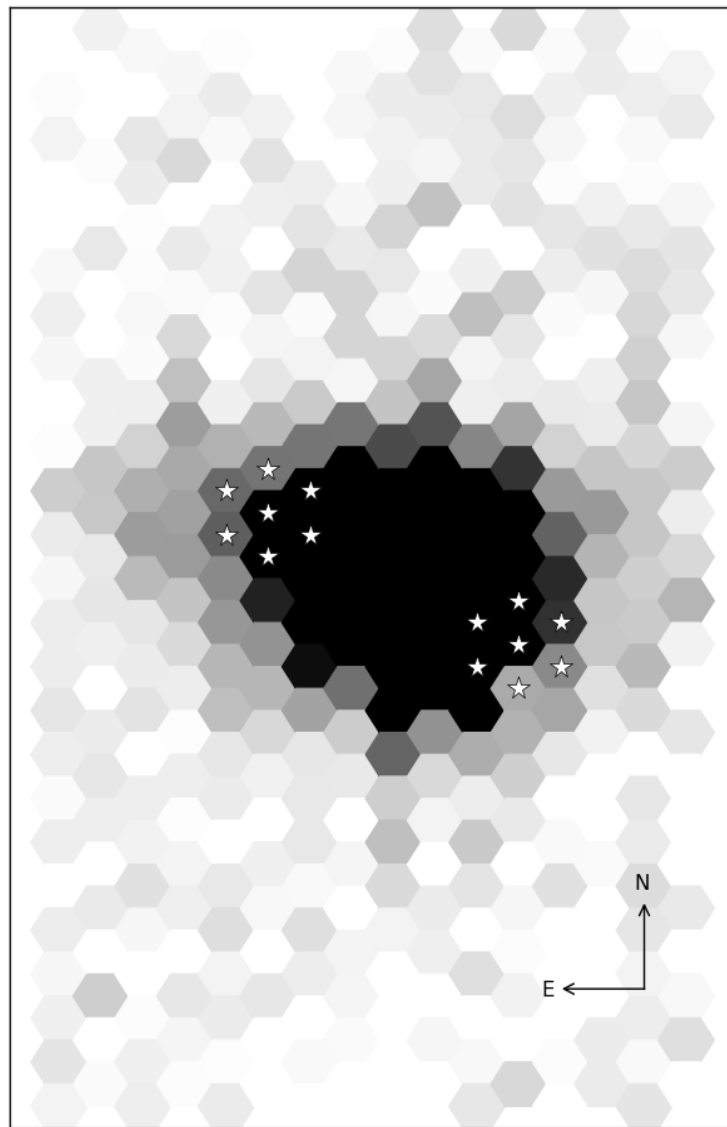
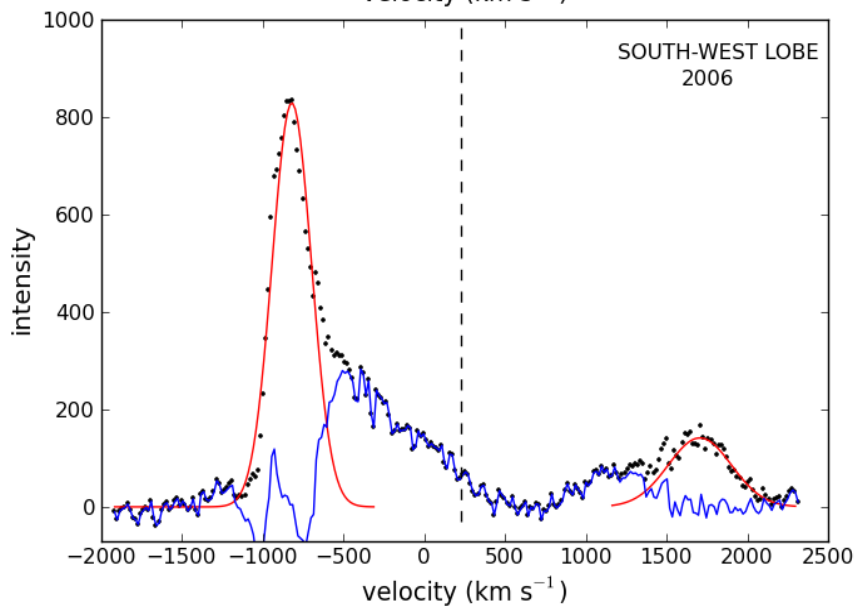
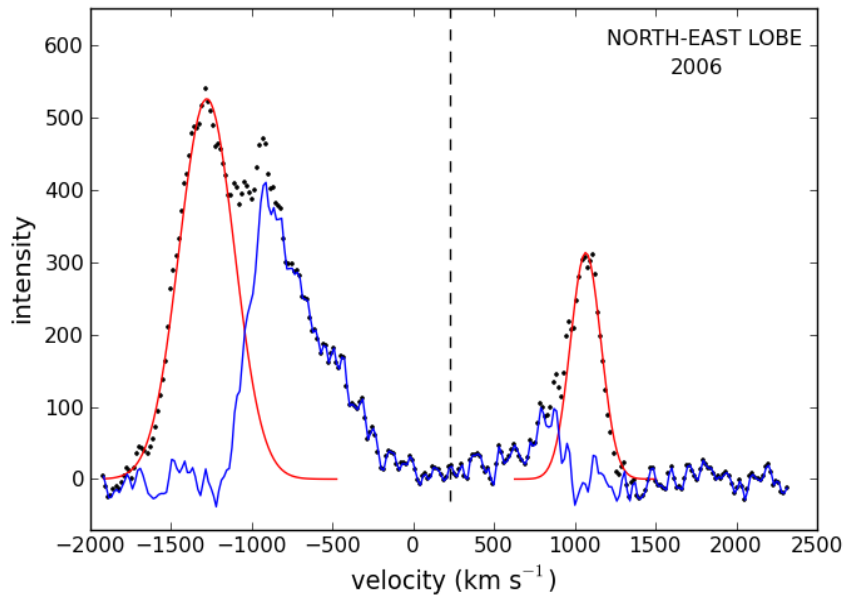


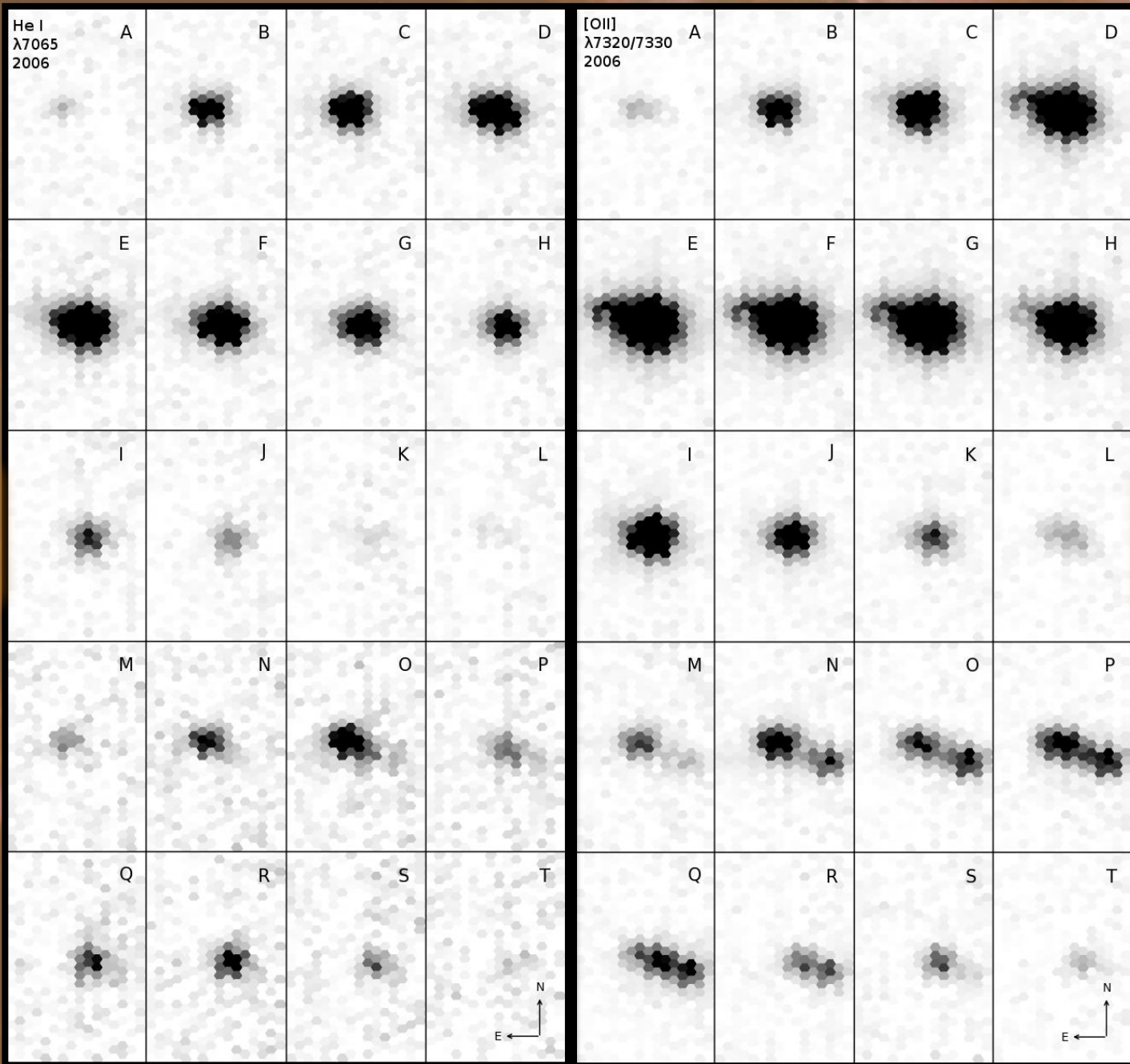
V445 Puppis Spectrum 2006



V445 Puppis Spectrum 2006



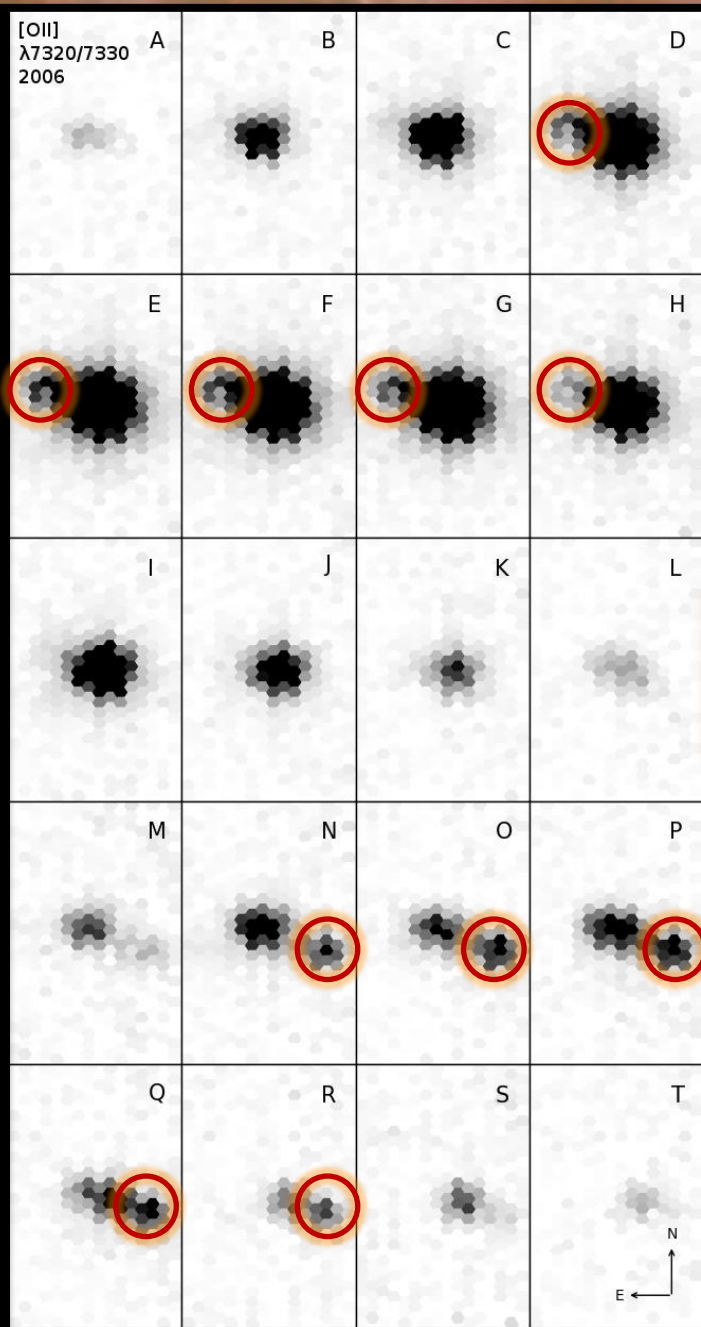
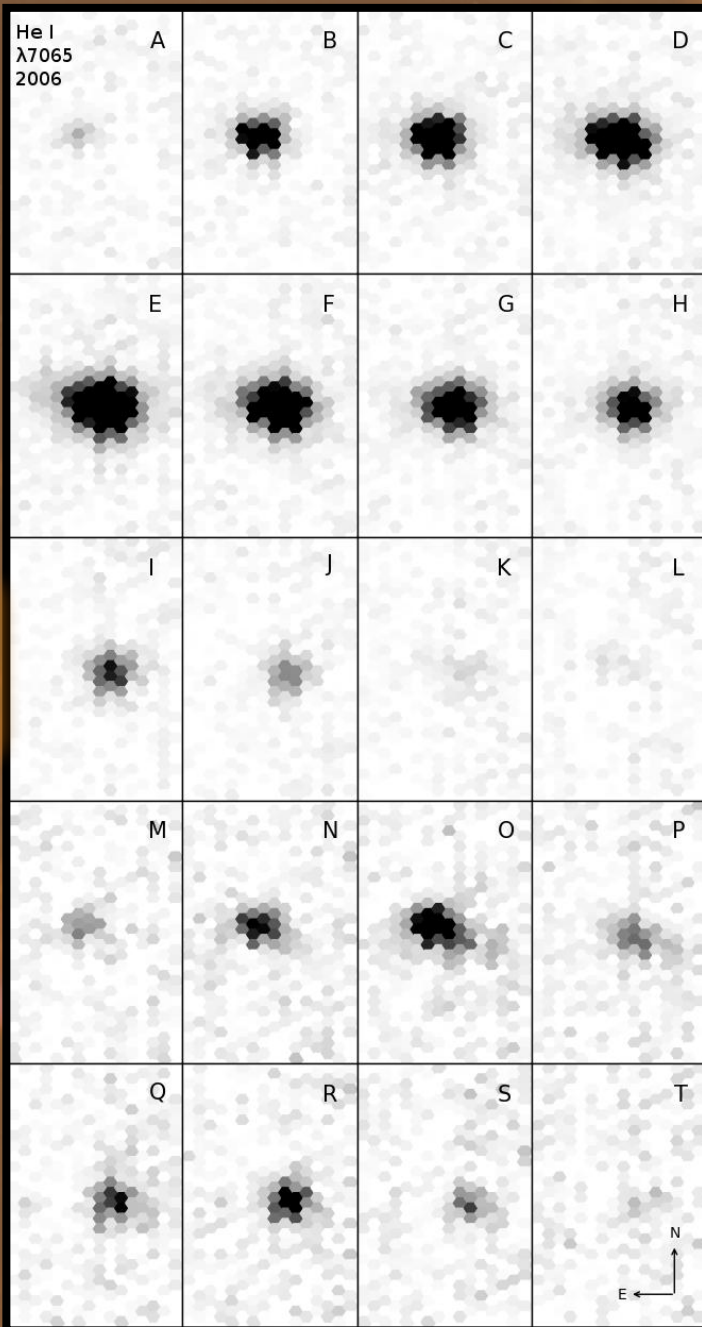




He I

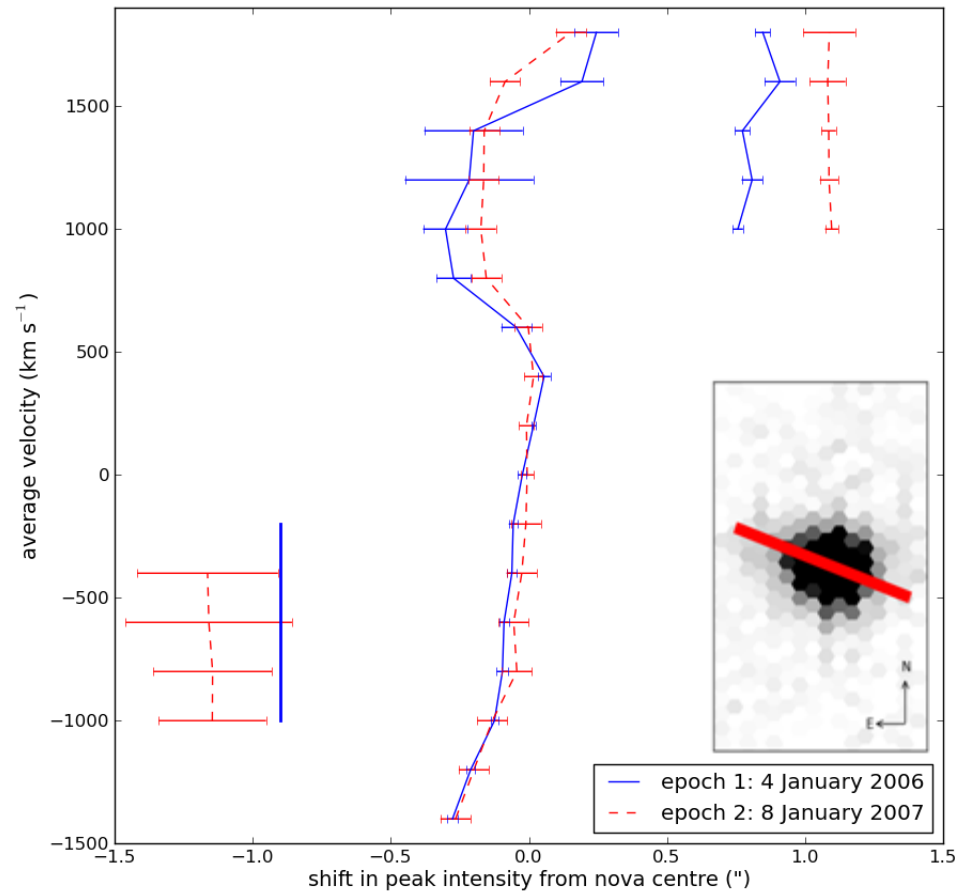
[O II]

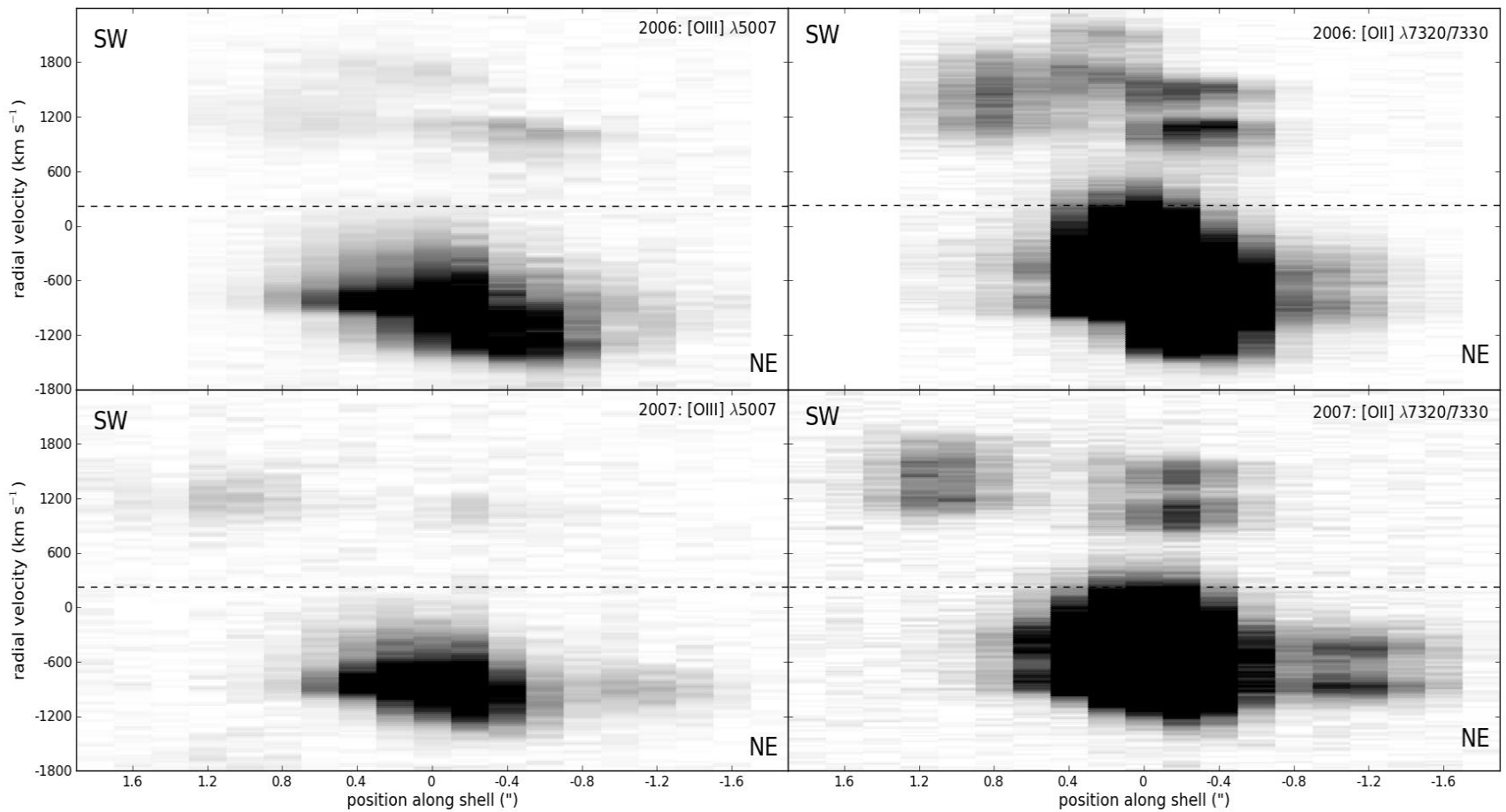
He I



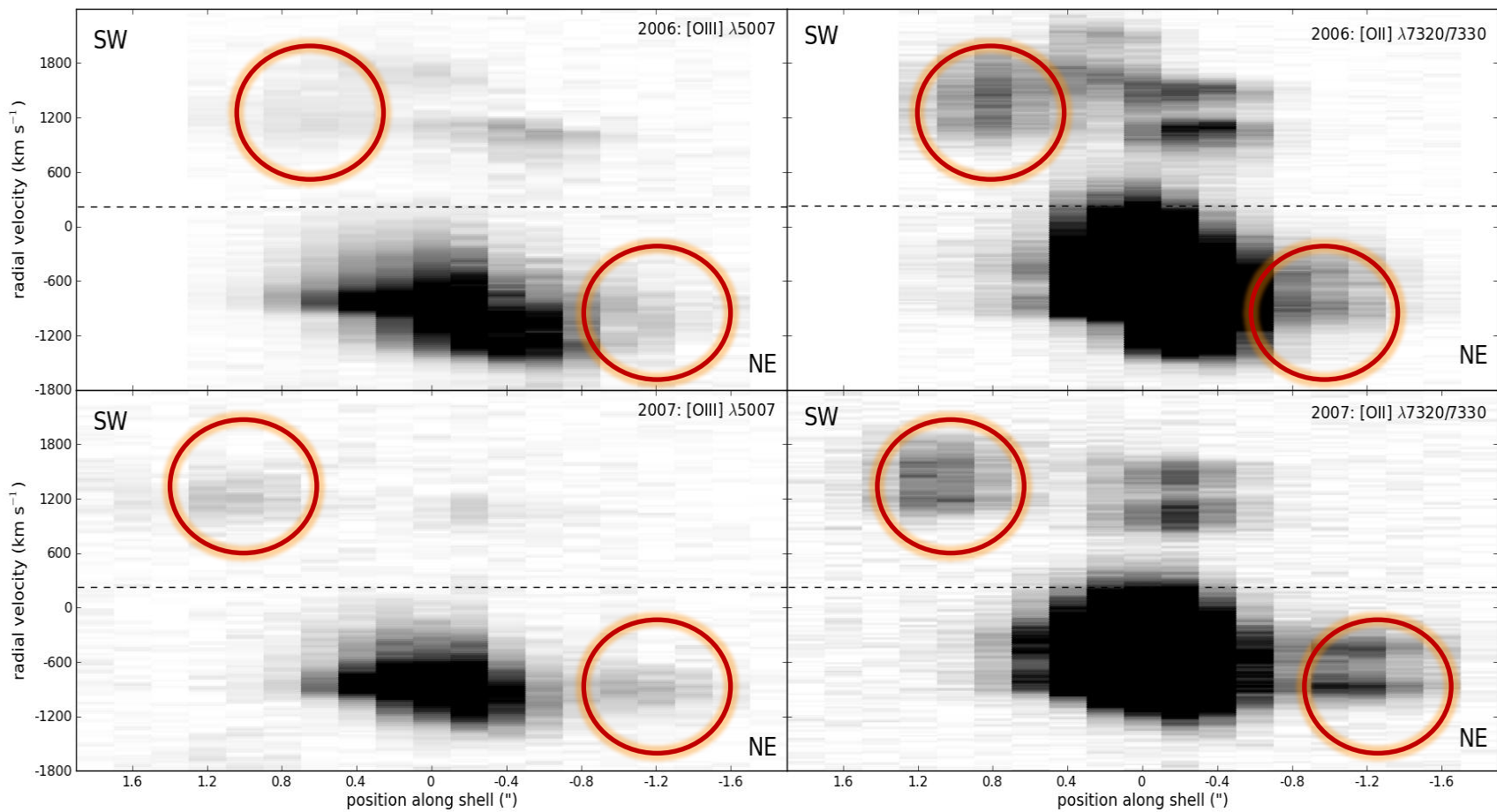
[O II]

An Excess of Oxygen?



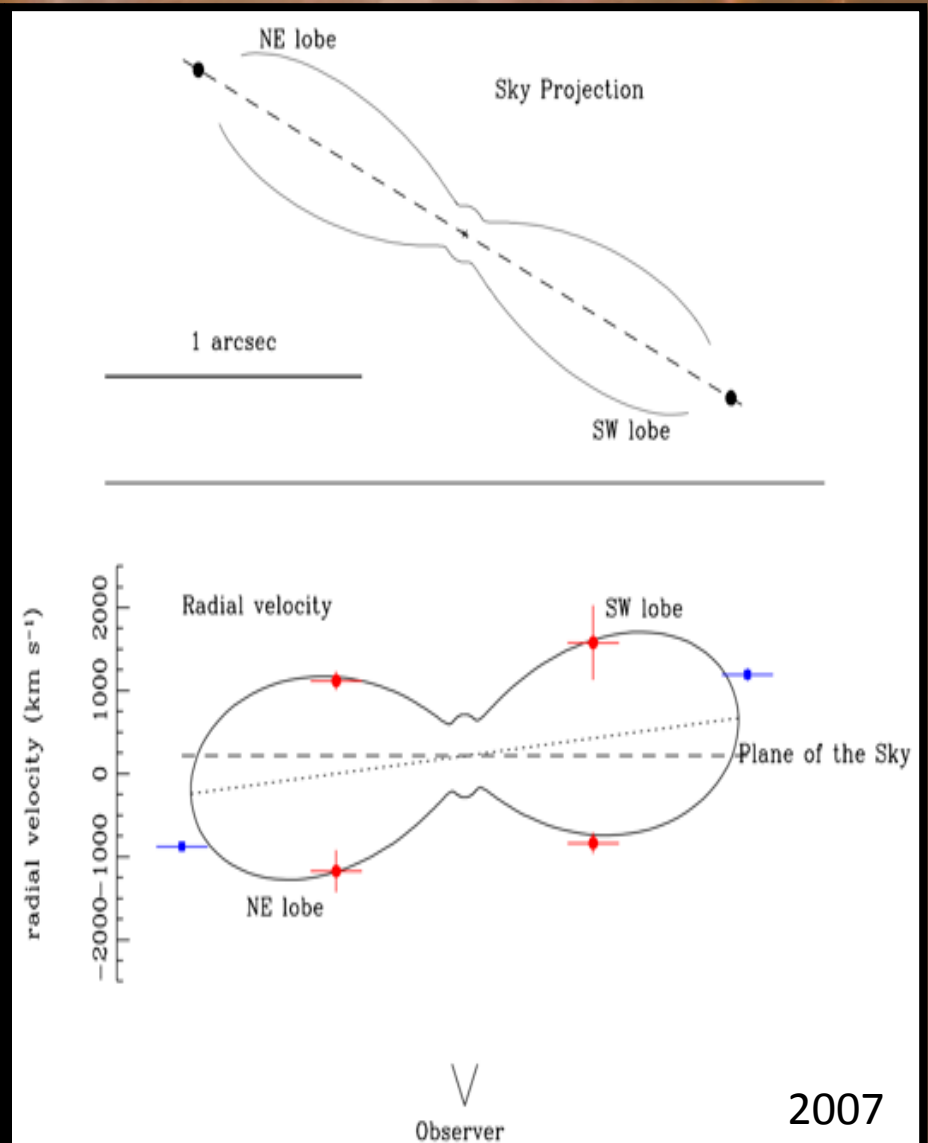
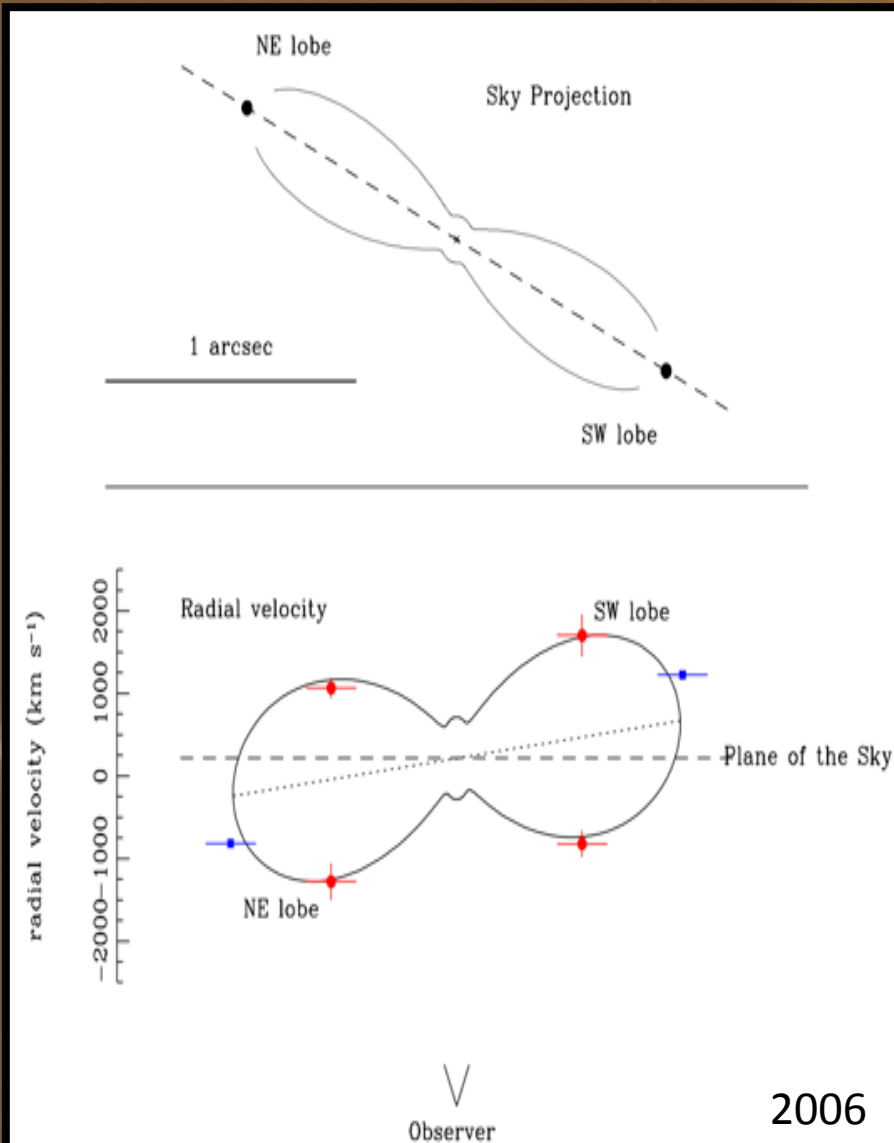


Spatially-resolved velocity profiles of the emission line [O III] 5007 (left panels) and the [O II] 7320/7330 doublet (right panels)



Spatially-resolved velocity profiles of the emission line [O III] 5007 (left panels) and the [O II] 7320/7330 doublet (right panels)

Spatio-kinematic Modelling





Origin of Excess?

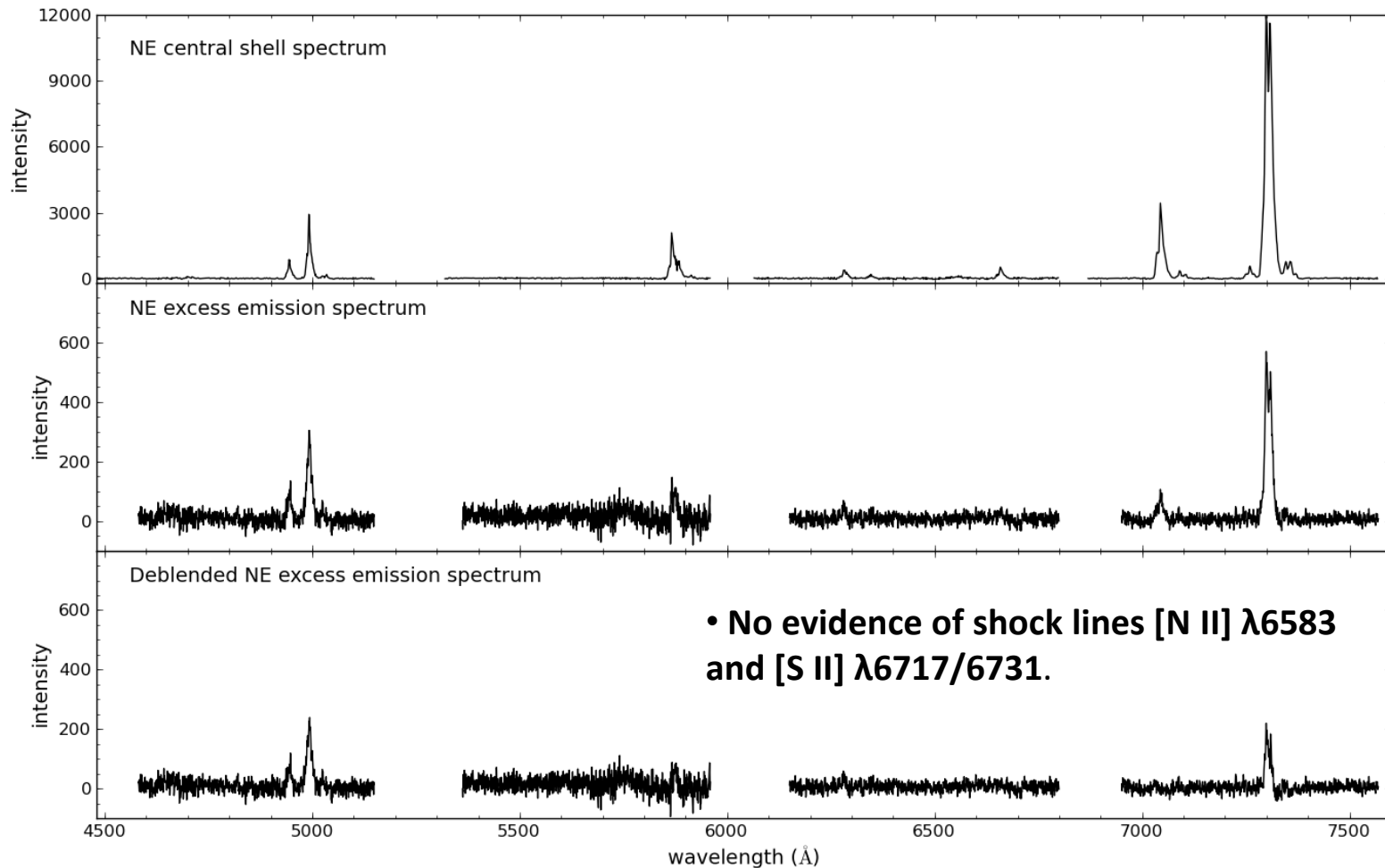
Bow shocks
or
Ionisation Fronts?

Bow Shocks?

- due to highly collimated outflows in the nova shell.
V445 Pup has:
 - An initially very narrow waist.
 - two high speed knots associated with an excess of [O II] and [O III]
- comparable to 1D hydro-dynamical planetary nebulae models (Schönberner et al. 2005, Raga et al. 2008)
 - Some PNe have jet structures called FLIERS (fast low ionisation emission regions)
- similar to recurrent nova RS Ophiuci



Evidence of shock?





Ionisation Front?

- **extreme velocities do not represent the bulk motion of the ejecta or of the knots (Schönberner et al. 2005)**



Future Analysis

- **results can be used in hydrodynamic simulations of axis-symmetric planetary nebulae**
- **multi-wavelength observations when the equatorial dust disc is clear and the nova remnant is observable will help determine the source of the excess oxygen.**

