Spatially resolved spectroscopy

with Abell 30 as an example

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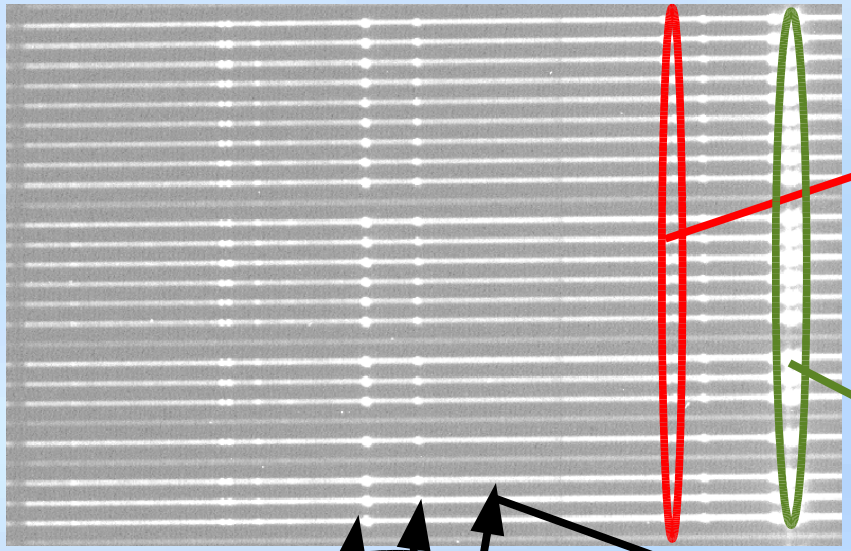
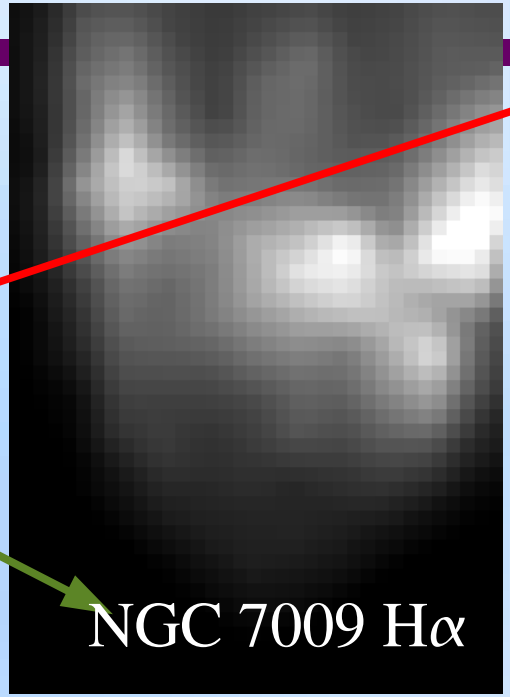
Abell 30 (Hα)

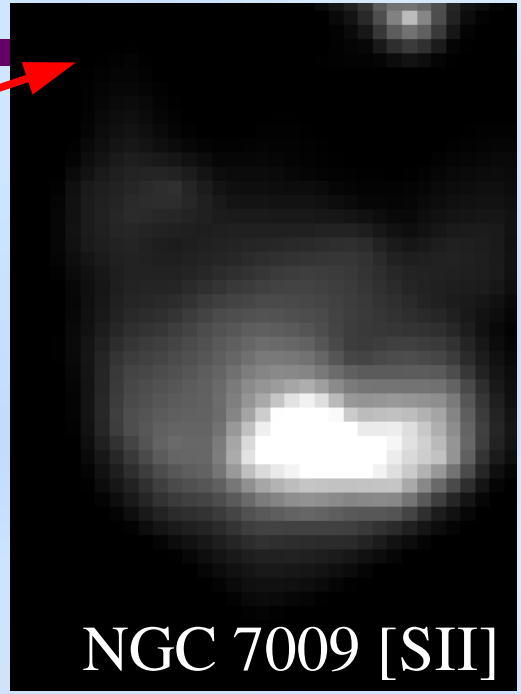
What is Integral Field Spectroscopy (IFS)?

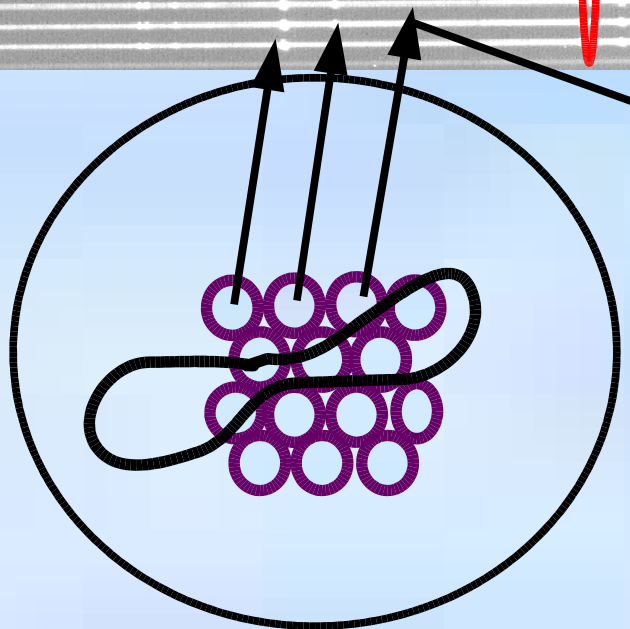
The combination of a spectrograph with an integral field unit – an instrument for observing a spatially continuous field of view. Consists of a series of lenslets or fibres, which are packed together to allow continous spectral observations for a 2-D FoV of up to an arcmin square. The sampling ranges from 0.2″ to 3″.

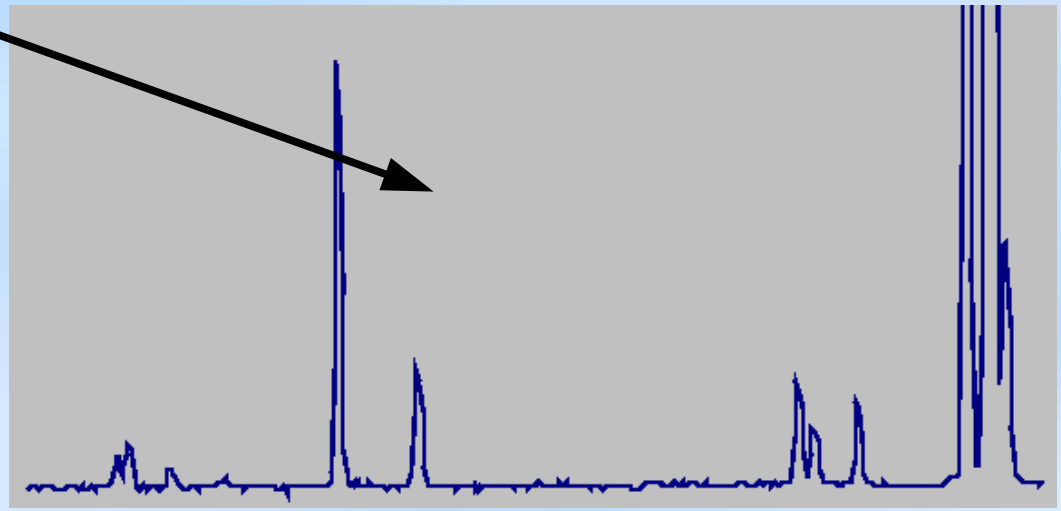
What is Integral Field Spectroscopy (IFS)?



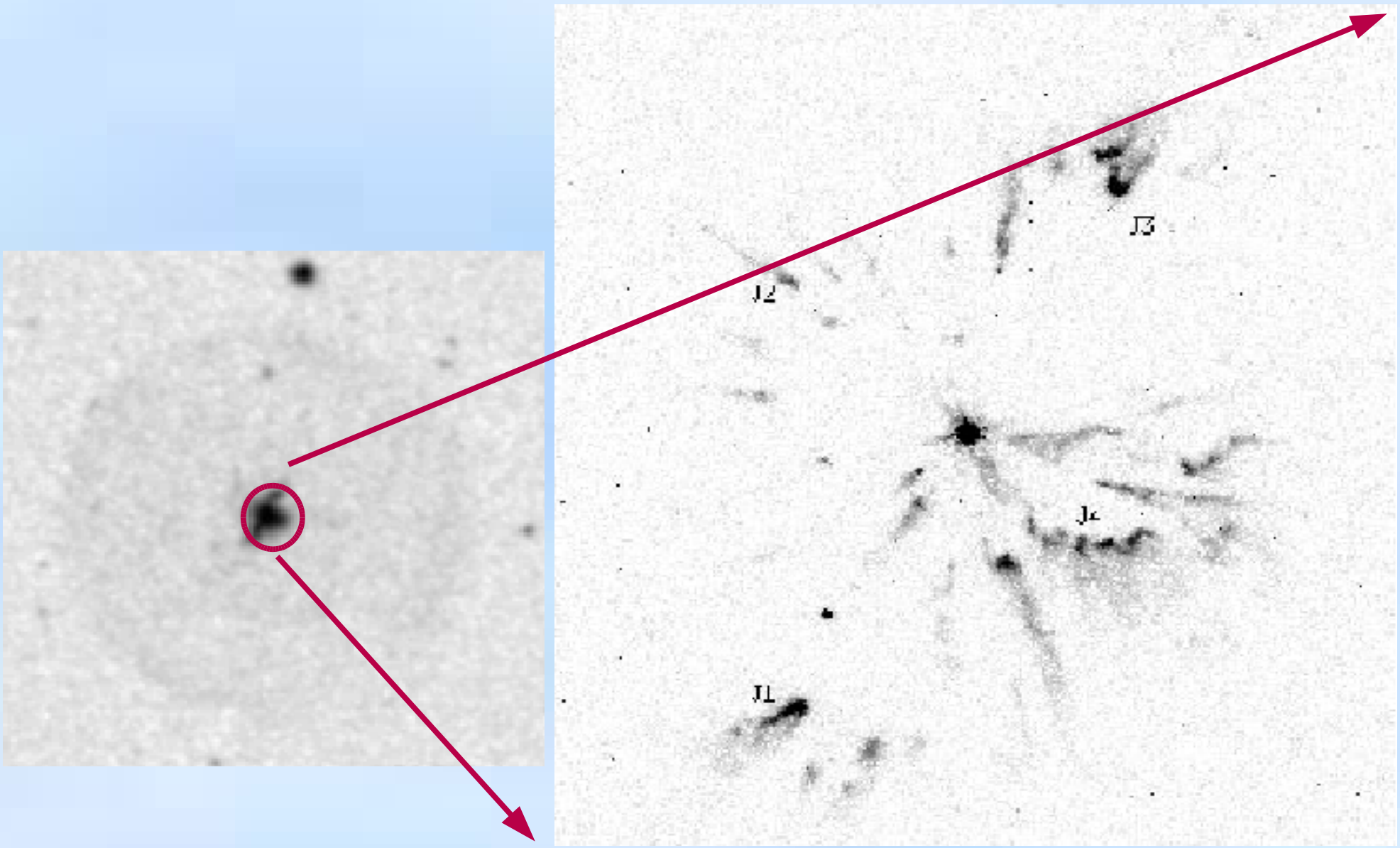






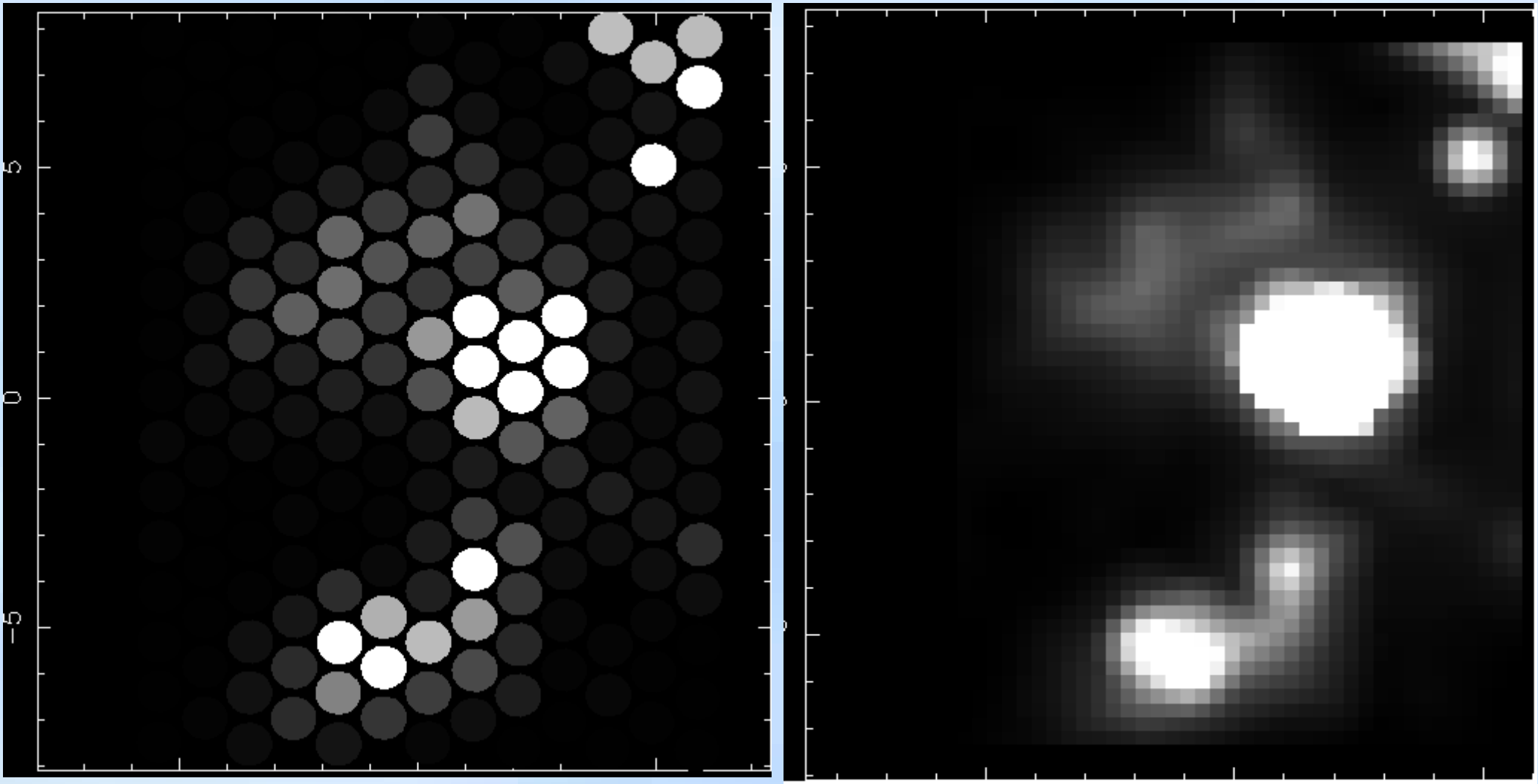


Abell 30



Abell 30

- Shows a large (x100s for the polar knots: Wesson etal '03) ORL-CEL discrepancy (lower T_e and higher abundances for ORLs). (almost all PNe have this discrepancy to some degree.)
- Is this due to cool, metal-rich clumps (eg. Liu etal 2000): ORLs arise from cold core, CELs from surrounding hotter part of the knots?
- So we look for spatial relationships between the ORL-CEL discrepancy, and variations in physical conditions.



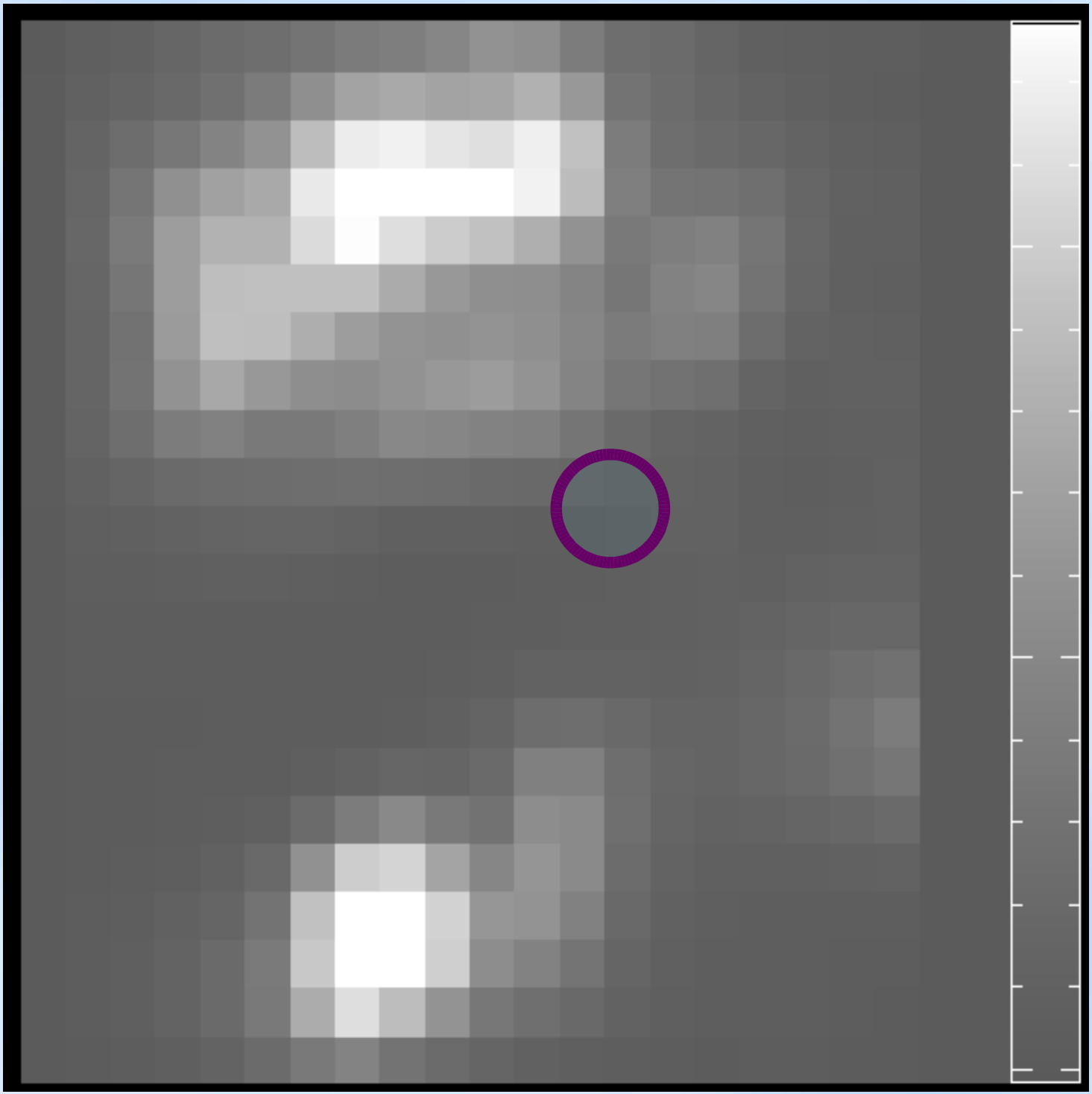
LEFT: original spectral-image of A30 RIGHT: interpolated version

Data Reduction/Analysis

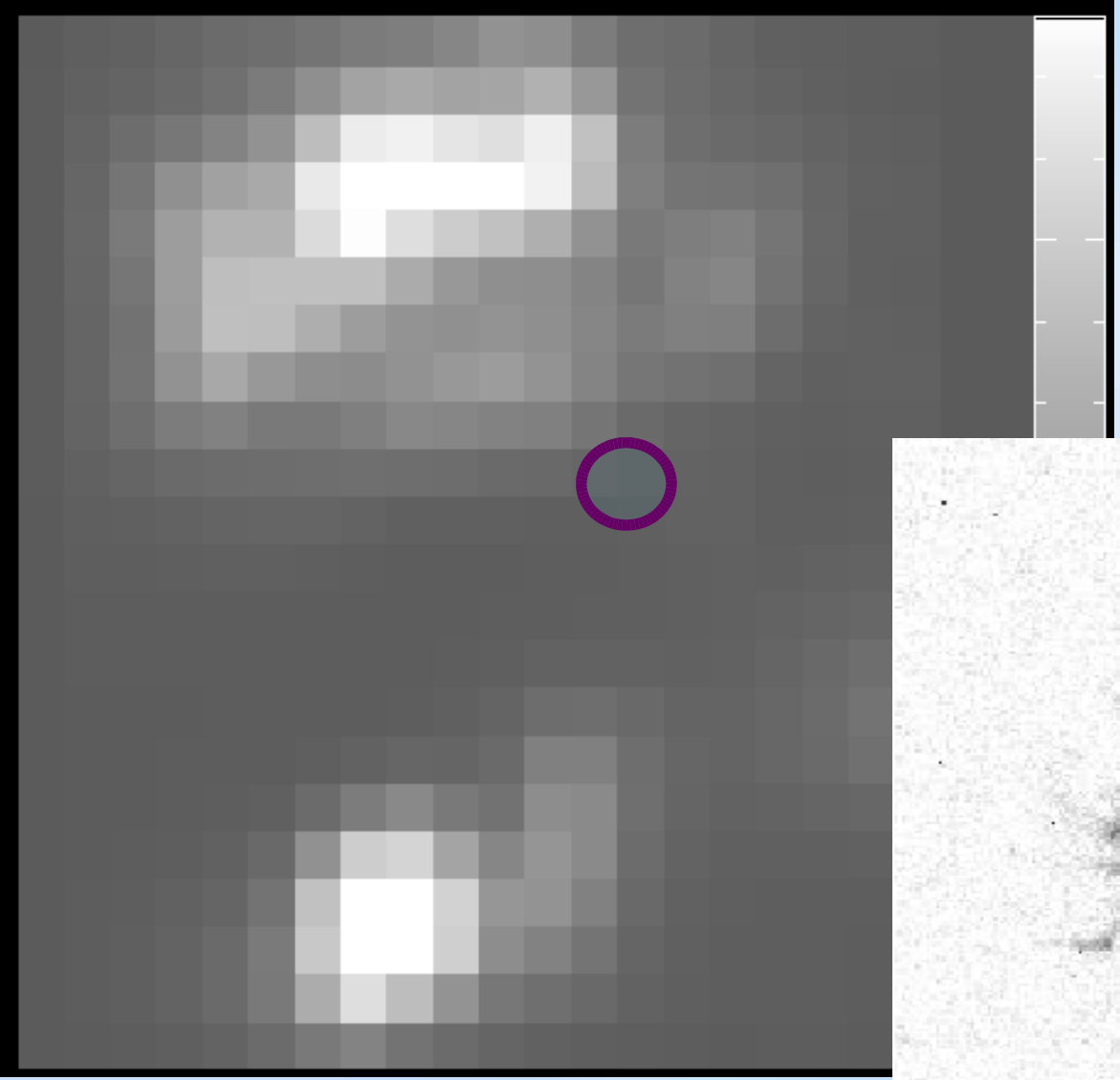
- Extract spectra from CCD, fibre-throughput correction, wavelength and flux calibration.
- Correct for the differential atmospheric refraction (need spatially contiguous spectral images; may need a spatial interpolation).
- Add the exposures together, with mosaicing.

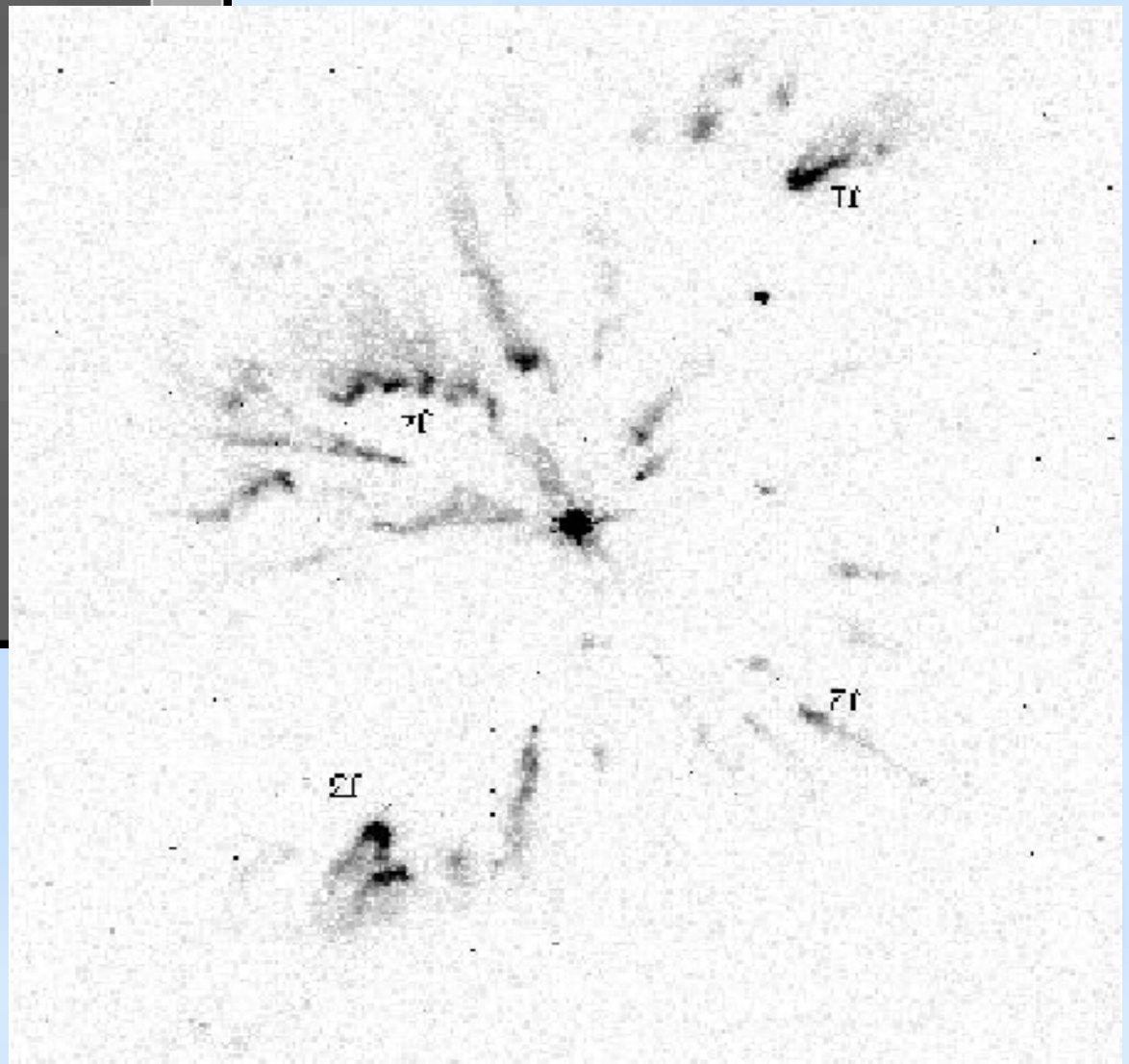
Data Reduction/Analysis

- Background (sky, nebula) subtraction.
- Create line flux, line ratio maps.
- Extract knot spectra, measure them.

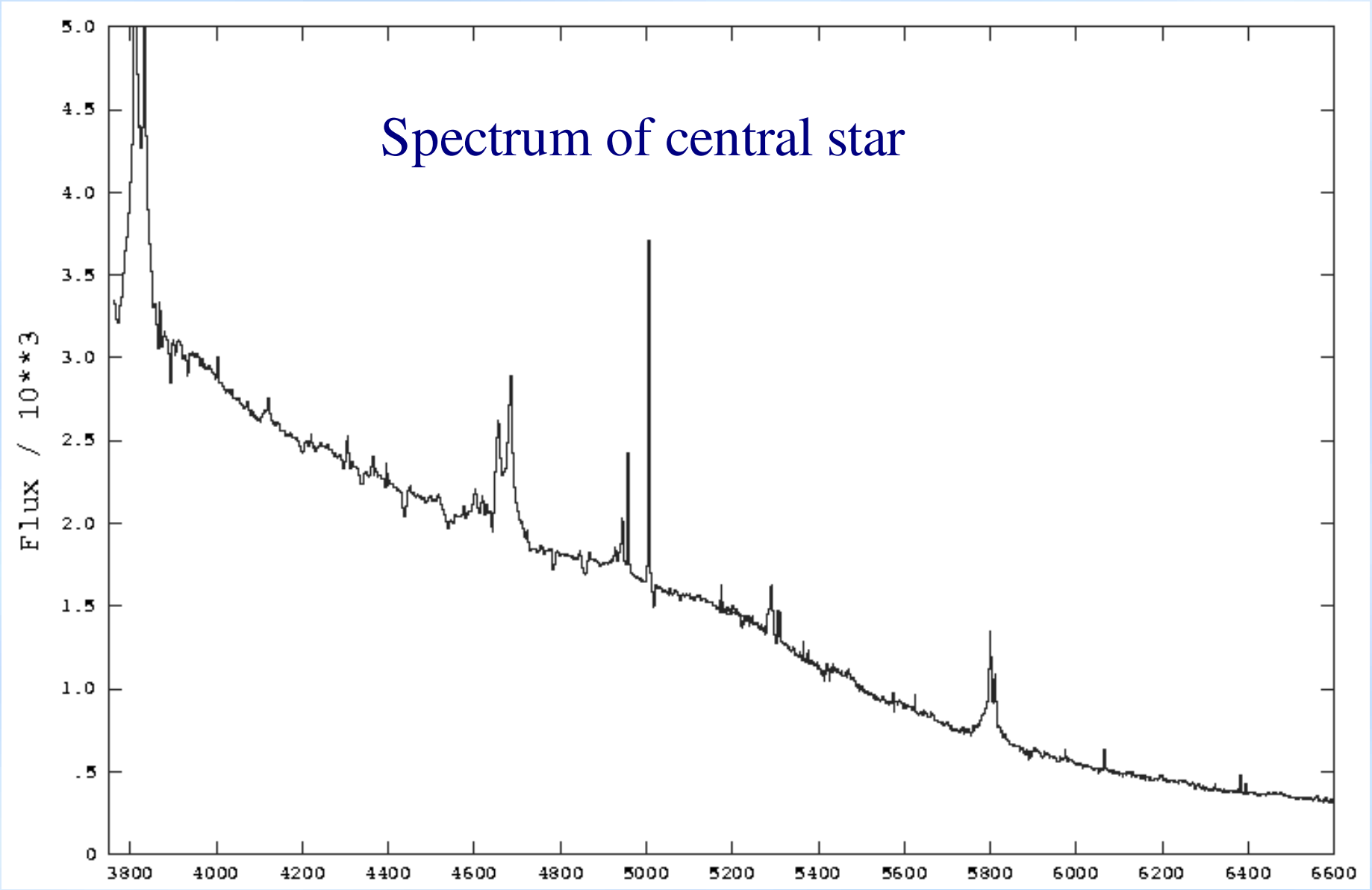


A30 [OIII] with central star removed from field of view. Spaxels of 0.6” (originally 0.9” circular).

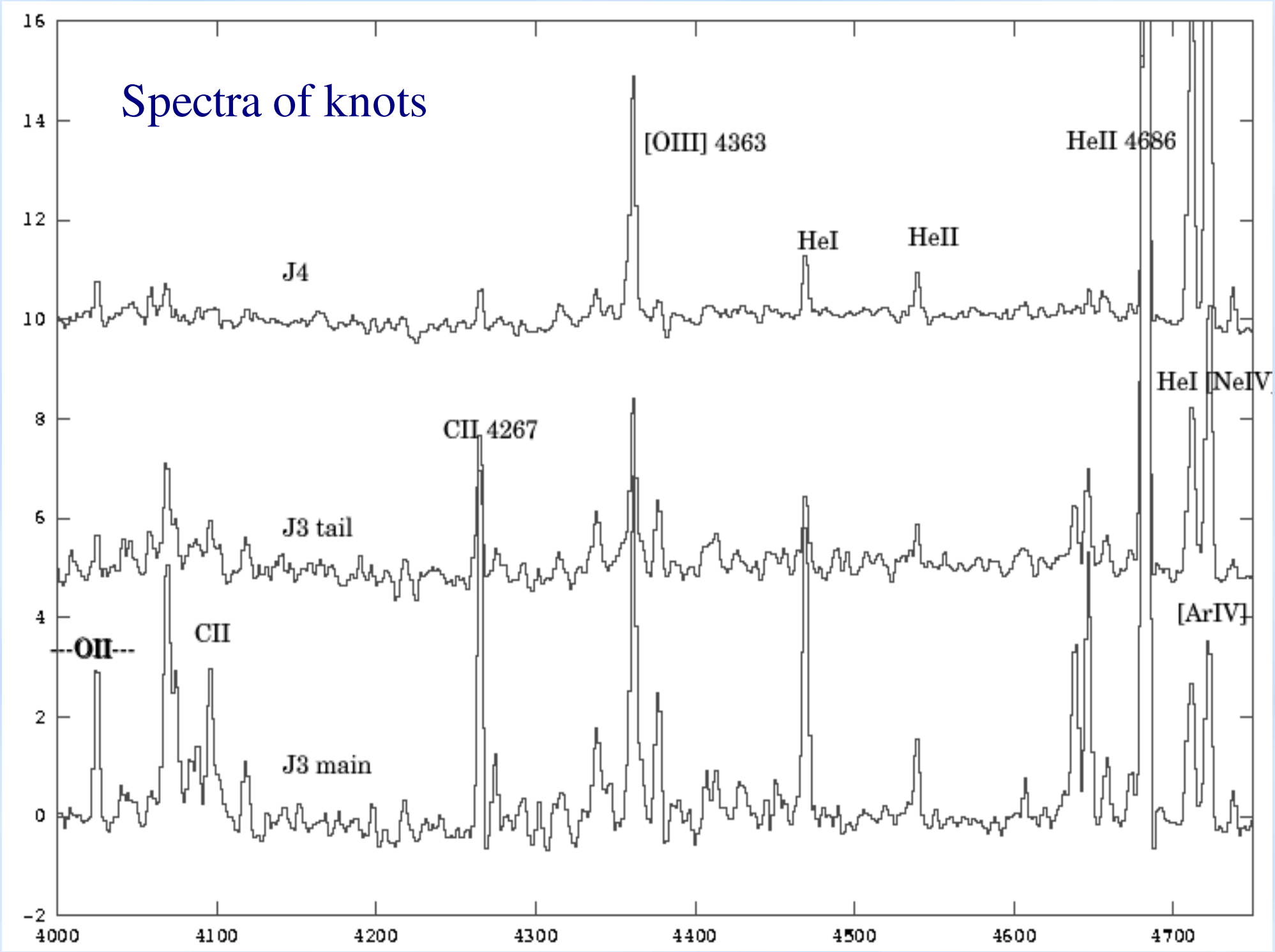


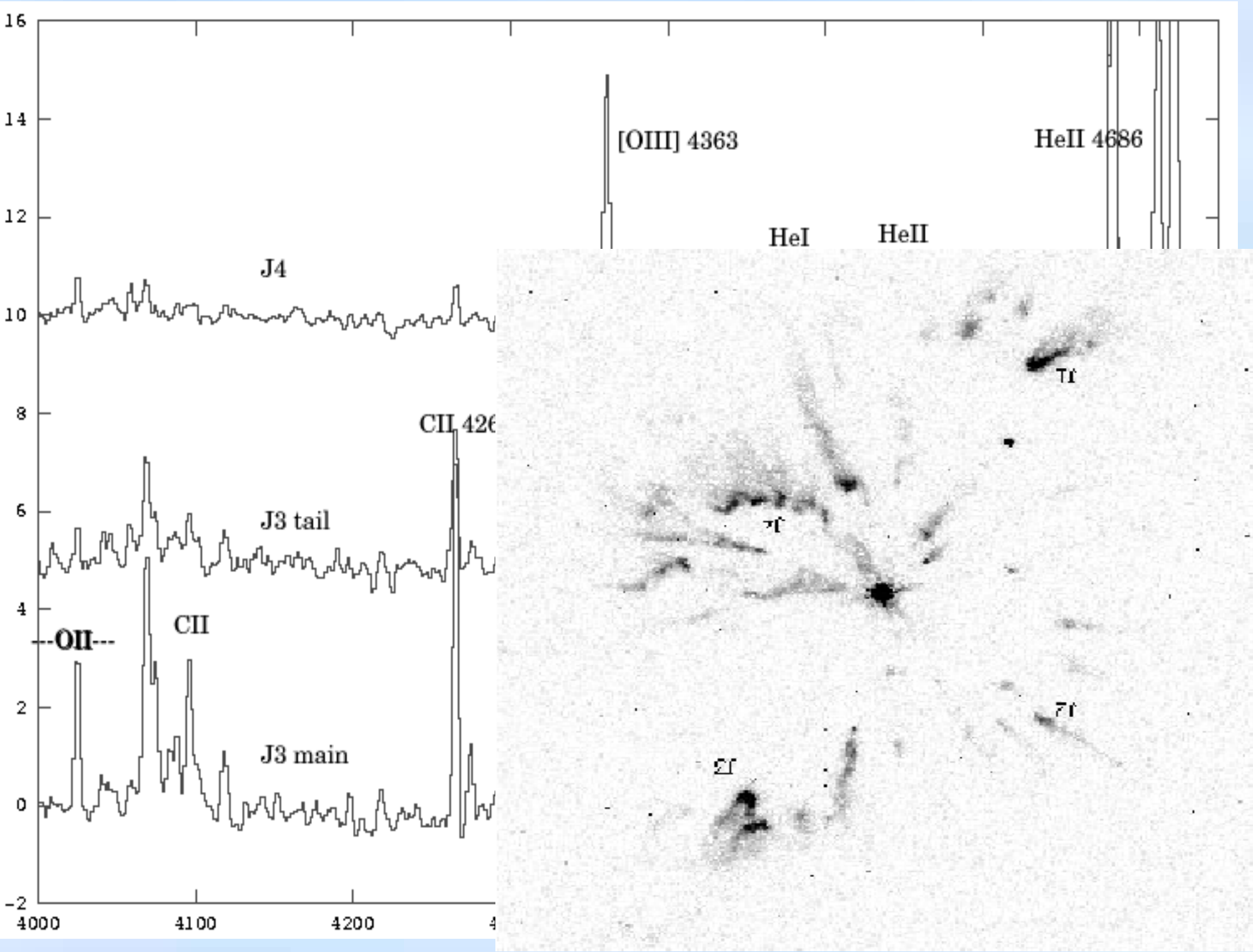


Spectrum of central star

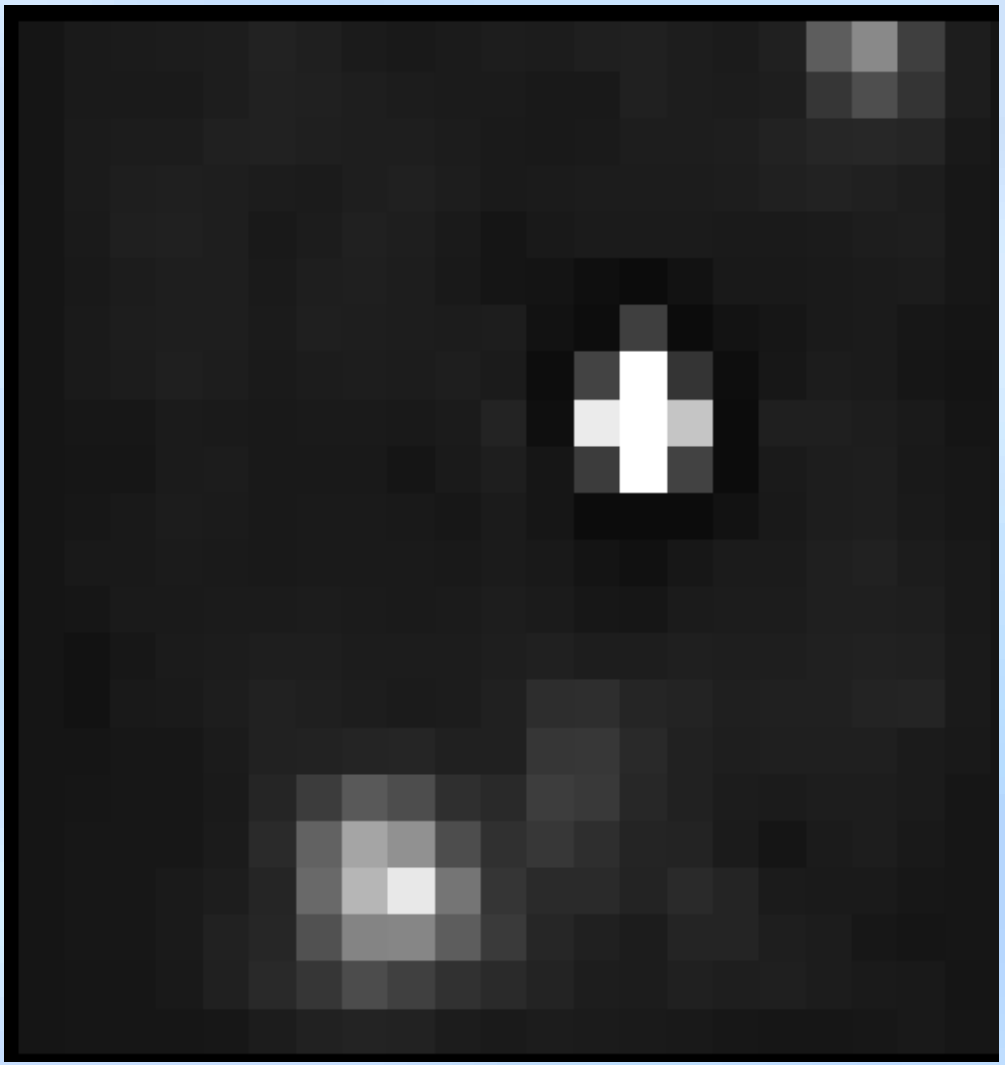


Spectra of knots



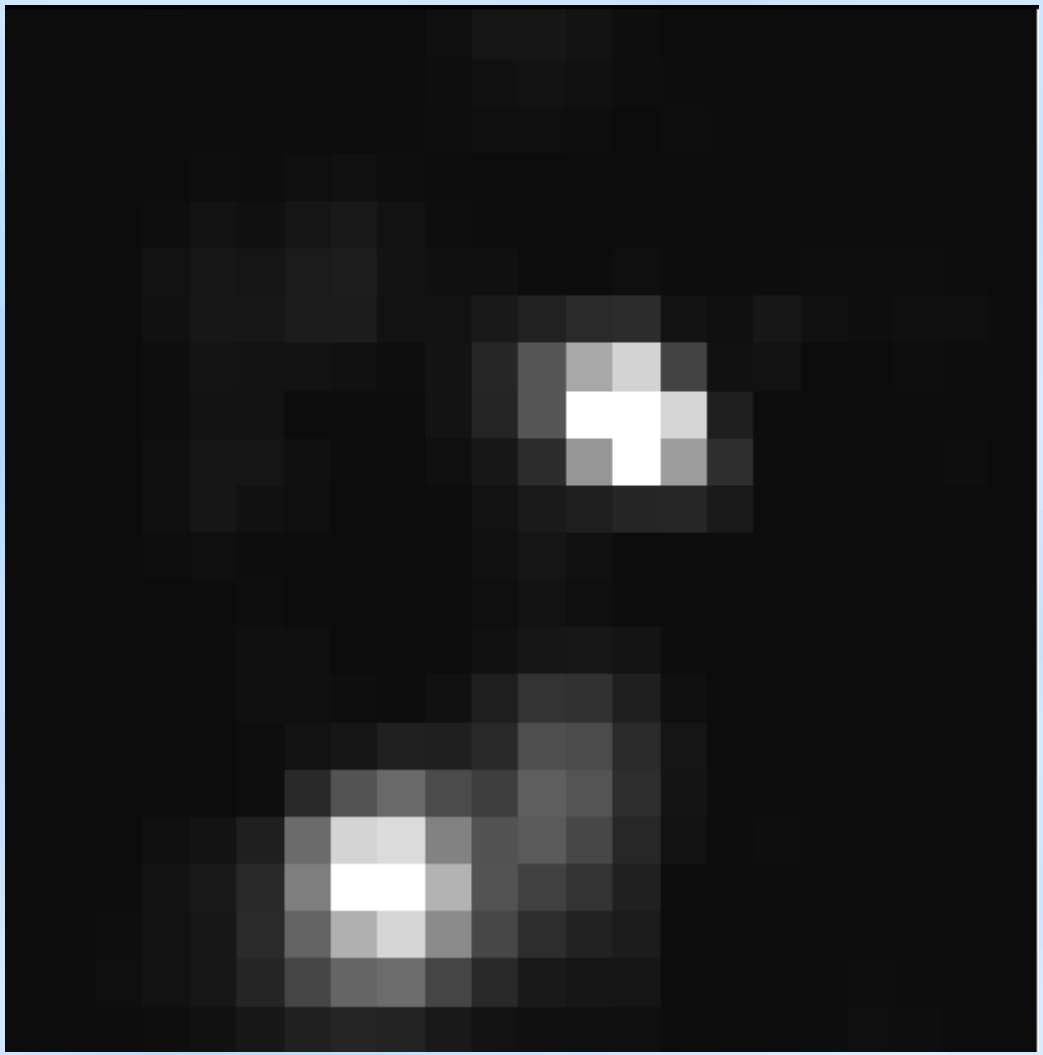

[OIII] 4363
HeII 4686
HeI
HeII
J4
CII 426
J3 tail
OII
CII
J3 main
16
14
12
10
8
6
4
2
0
-2
4000
4100
4200

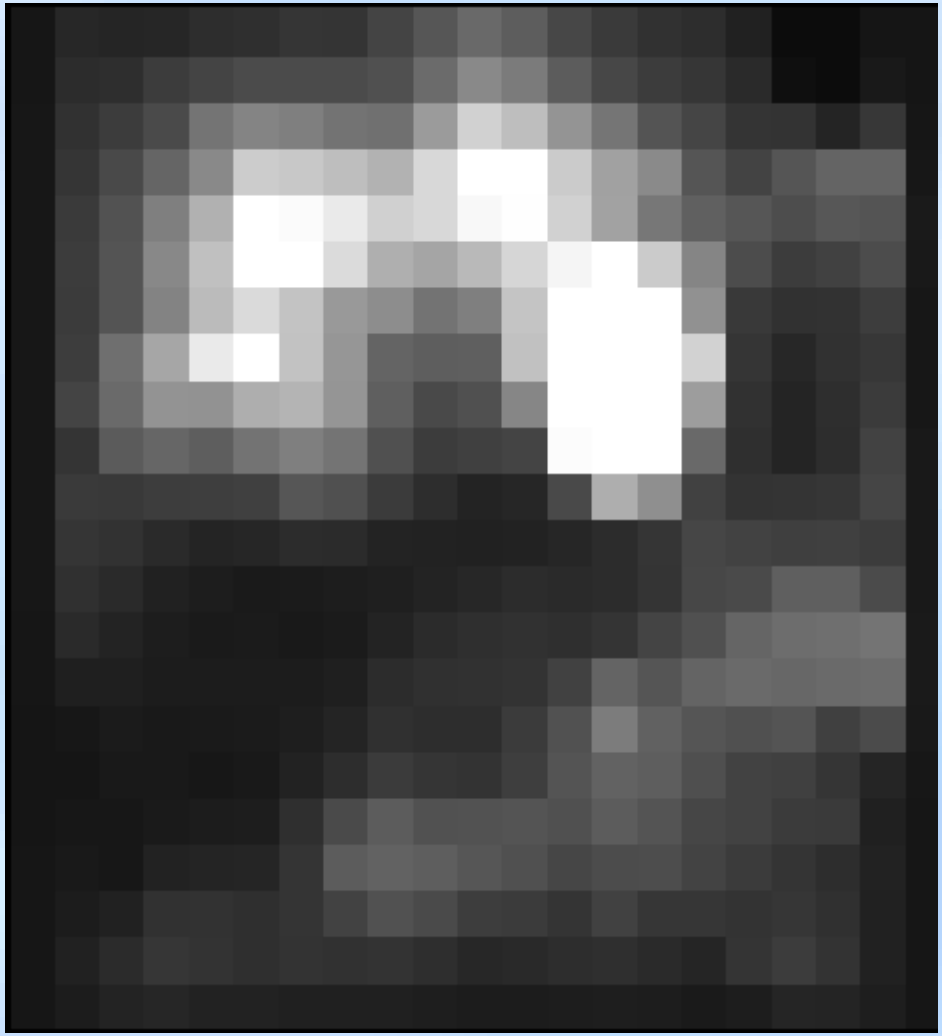
Selected spectral-images



4060-90 Å (OII?, CIII)

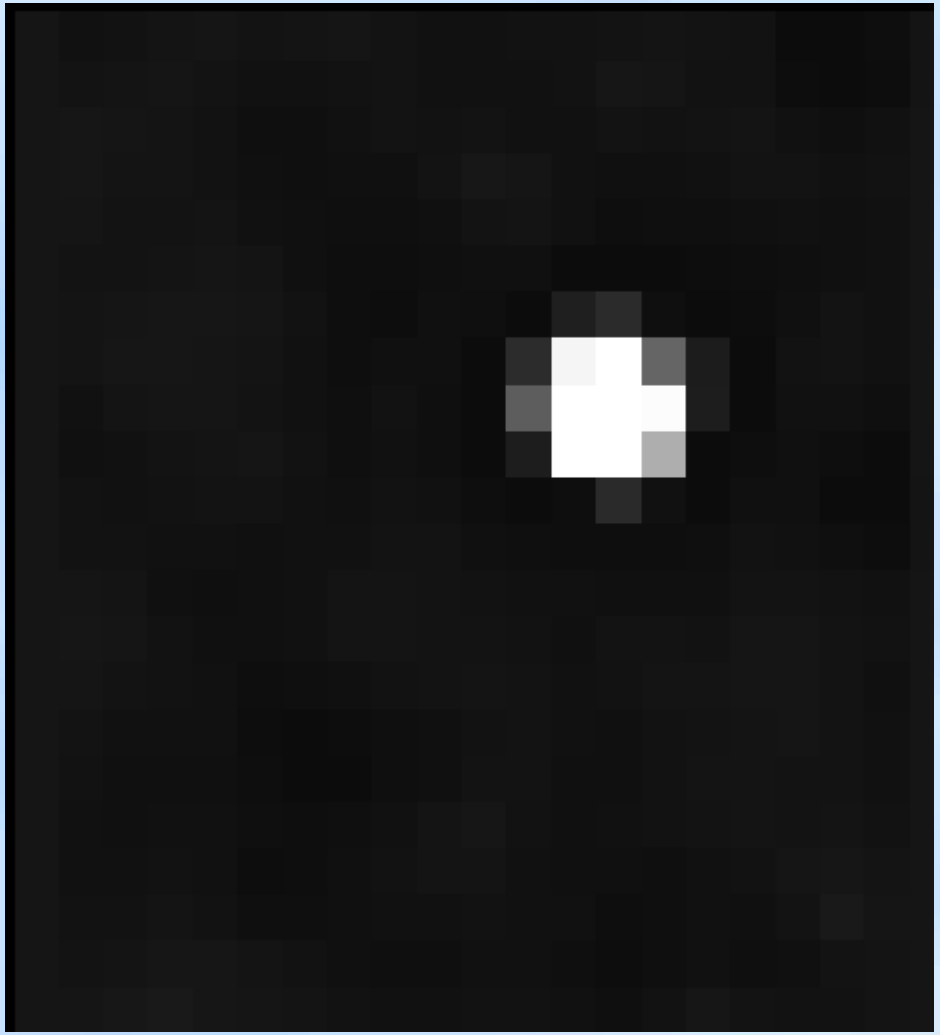
CIII 4267 Å

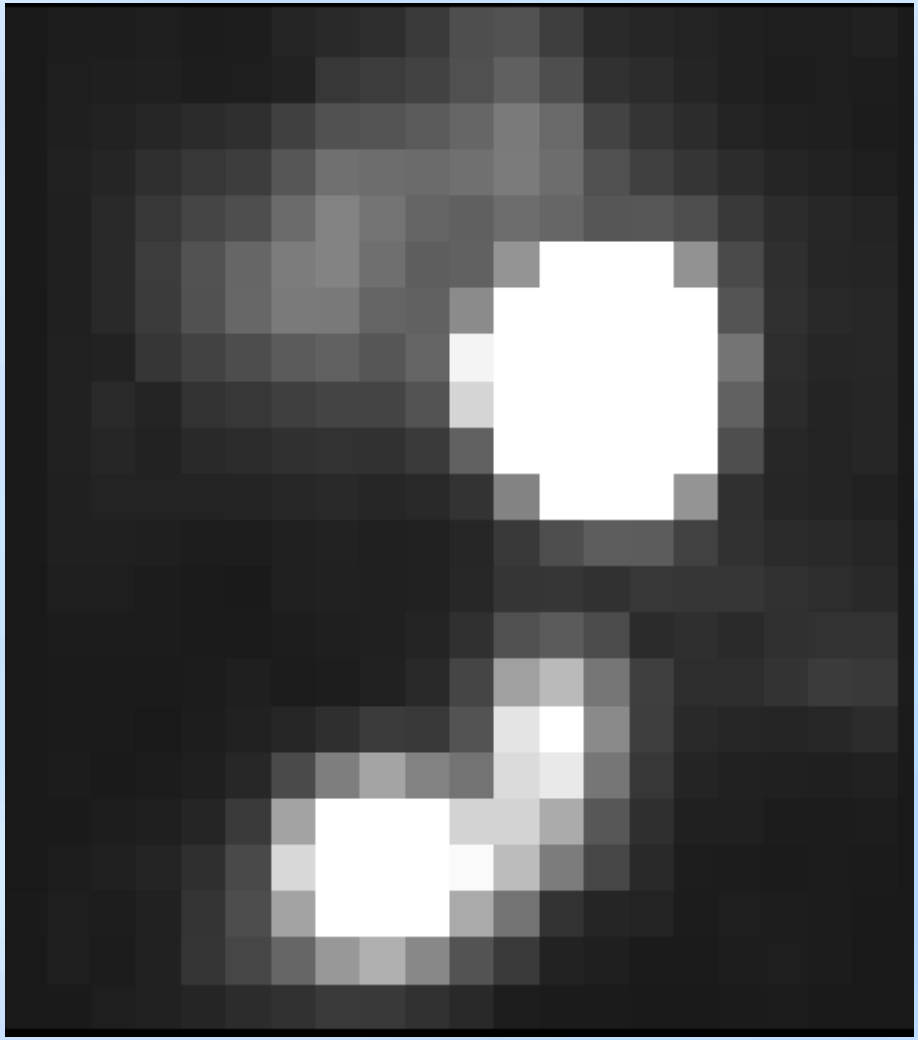




4700-30 Å (HeI, [NeIV], [ArIV])

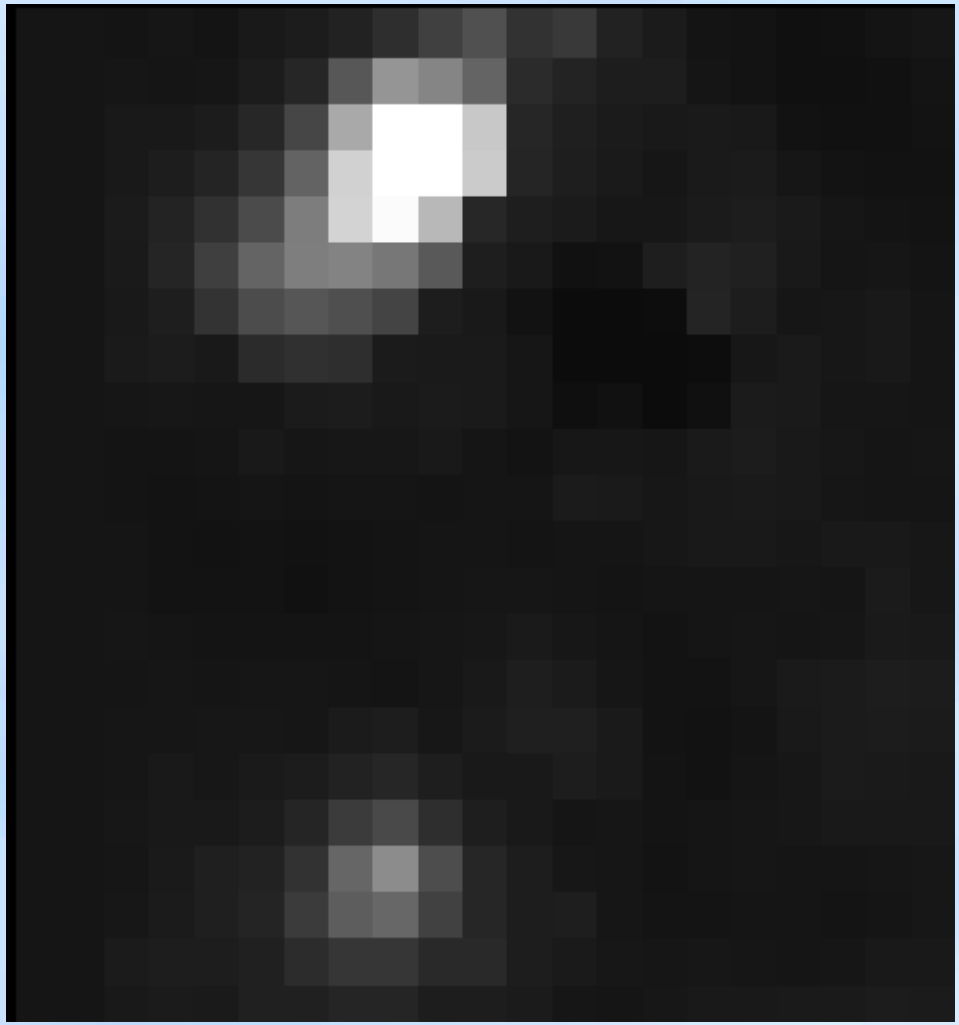
4730-50 Å ([ArIV])





HeII 4686 Å

[NII] 6584 Å



study spatial variations within the knots, analysis of the physical and chemical conditions in the knots

for this, semi-automated spectral line fitting software is necessary (even for INTEGRAL data, you have 188 spectra X dozens of emission lines to measure)

more precise maps of the line fluxes (in principle also the velocities) can be made, as well as maps of T_e, n_e and abundances