Classification and Analysis of Emission Line Spectra in Galaxy Surveys

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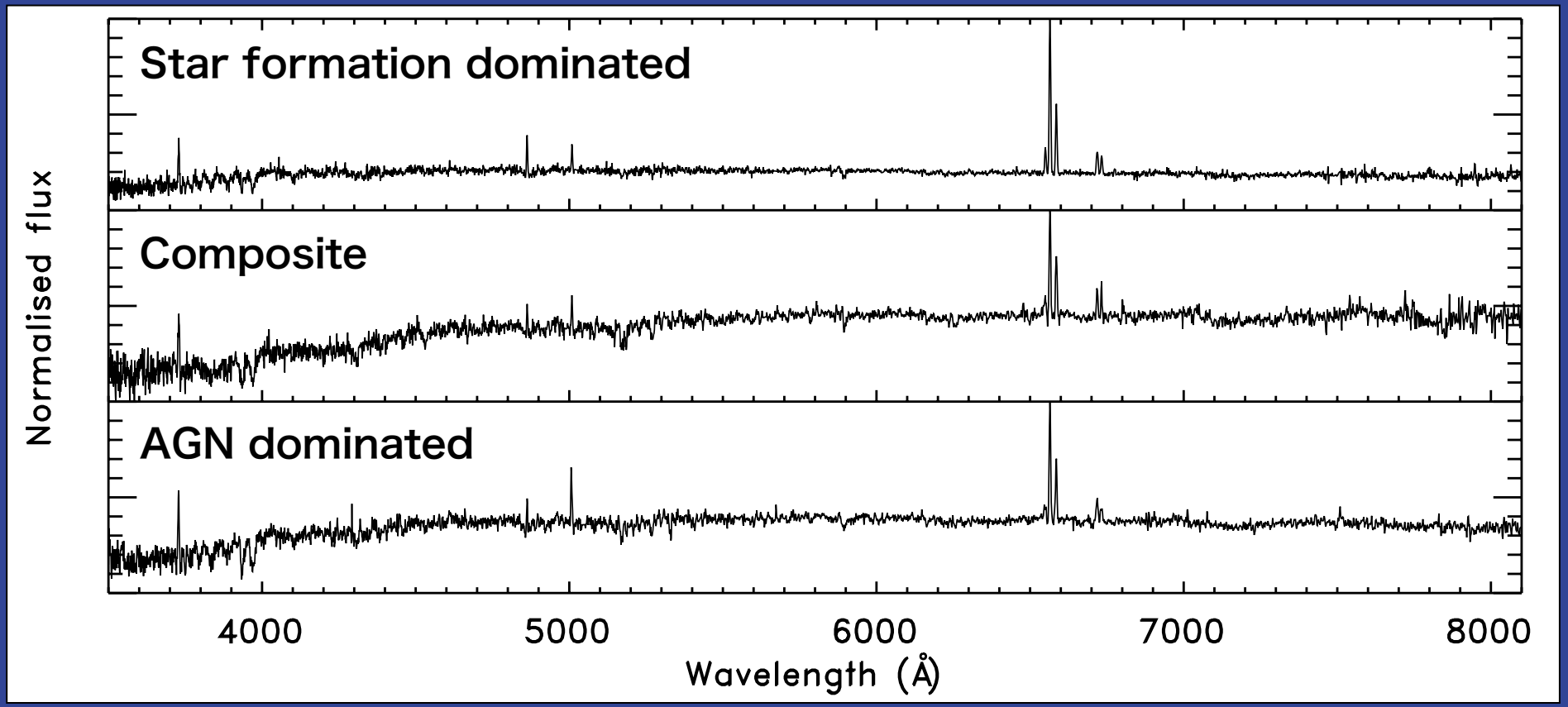
The Difficulties of Separating Star Formation and AGN



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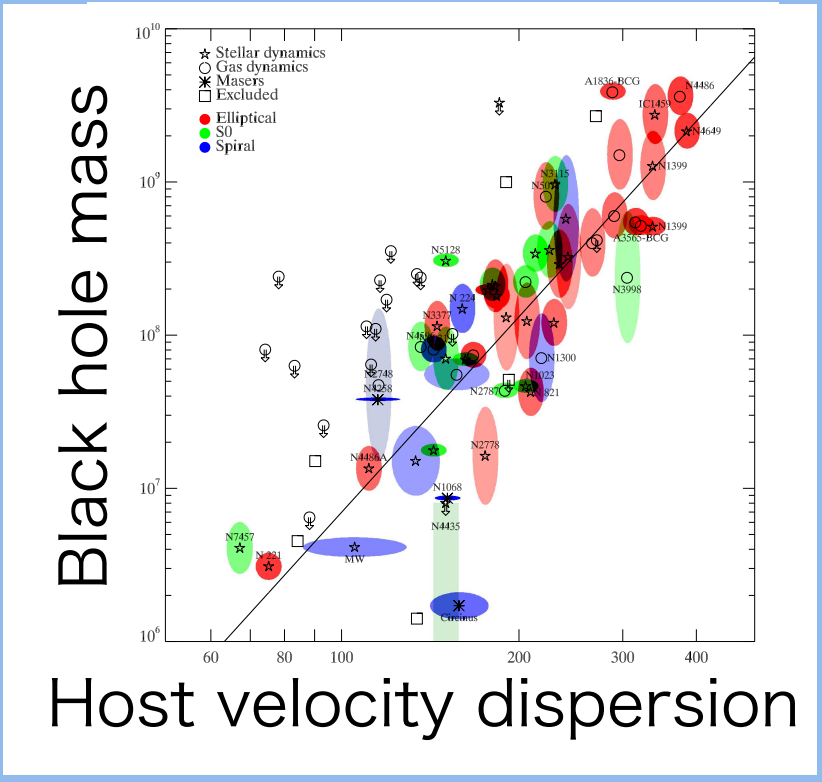
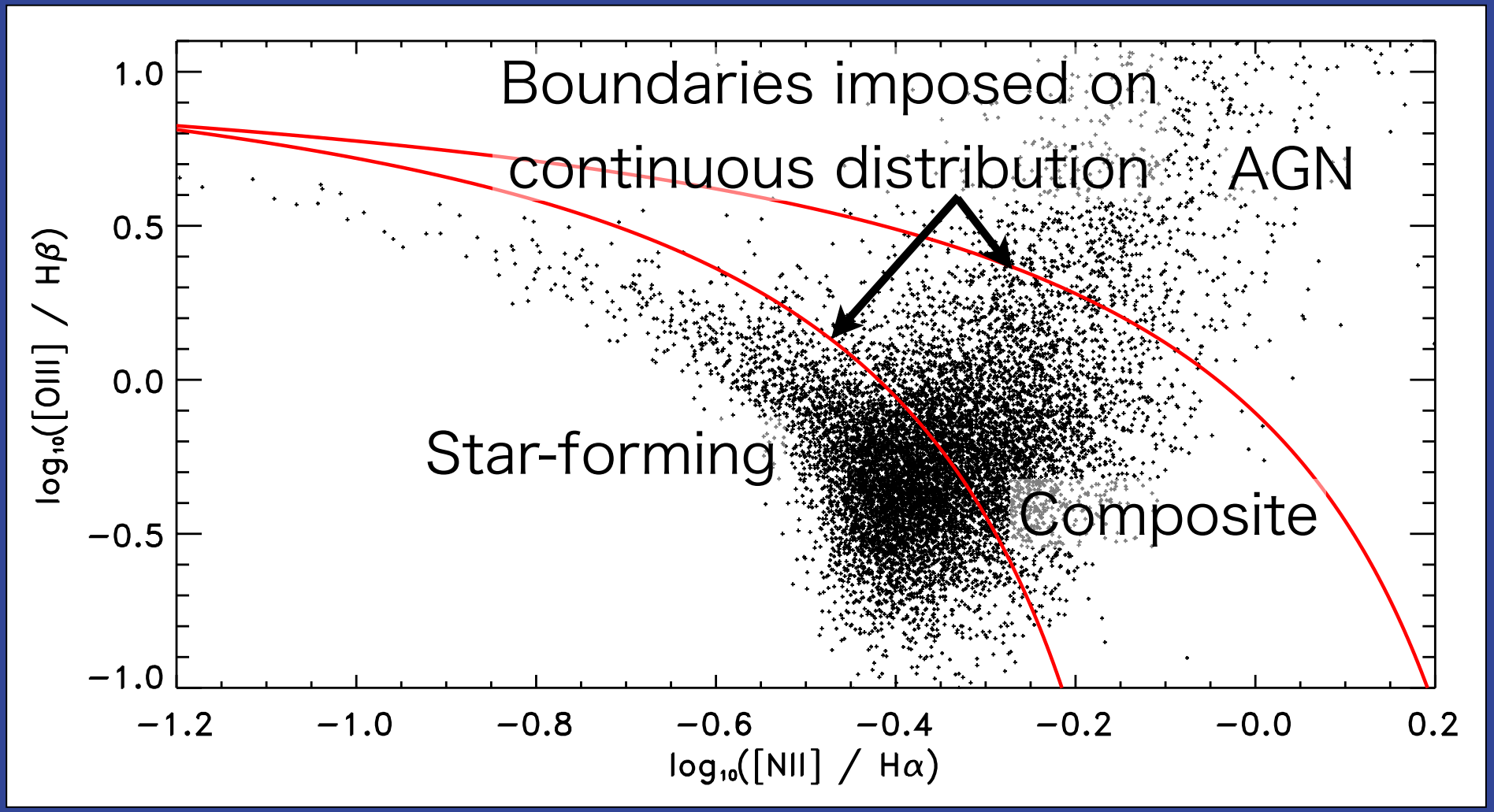
Star Formation–AGN Connection

- Indirect evidence of link between star formation and black hole growth
- Need to be able to measure SFR and AGN activity, including low level contributions



Gültekin et al. 2009

Line Diagnostics



Additional Information

- Observed spectrum is a combination of a few components
  - Component spectra do not vary greatly between objects
  - Relative weight of each component varies a lot

$$D_i(\lambda) = \sum_k W_{ik} C_k(\lambda)$$

Data = Weights × Components

Blind Source Separation

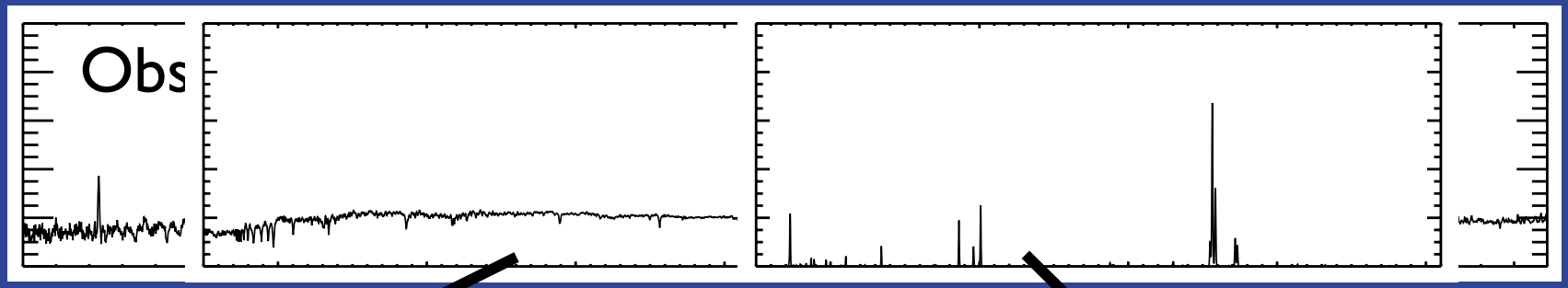
Data = Weights X Components

$$D = W C$$

Known Unknown

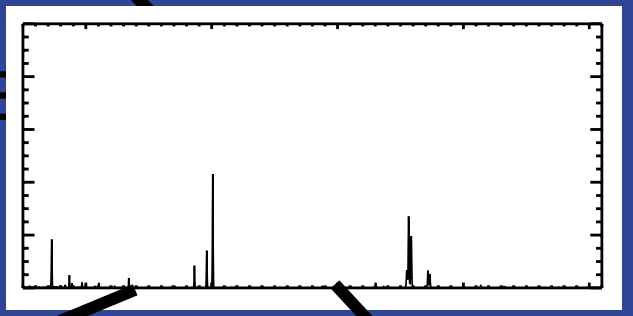
- Blind source separation (BSS) techniques:
  - Principal Component Analysis (PCA)
  - Mean field independent component analysis (MFICA) is better suited to analysis of spectra

Blind Source Separation



Continuum

E

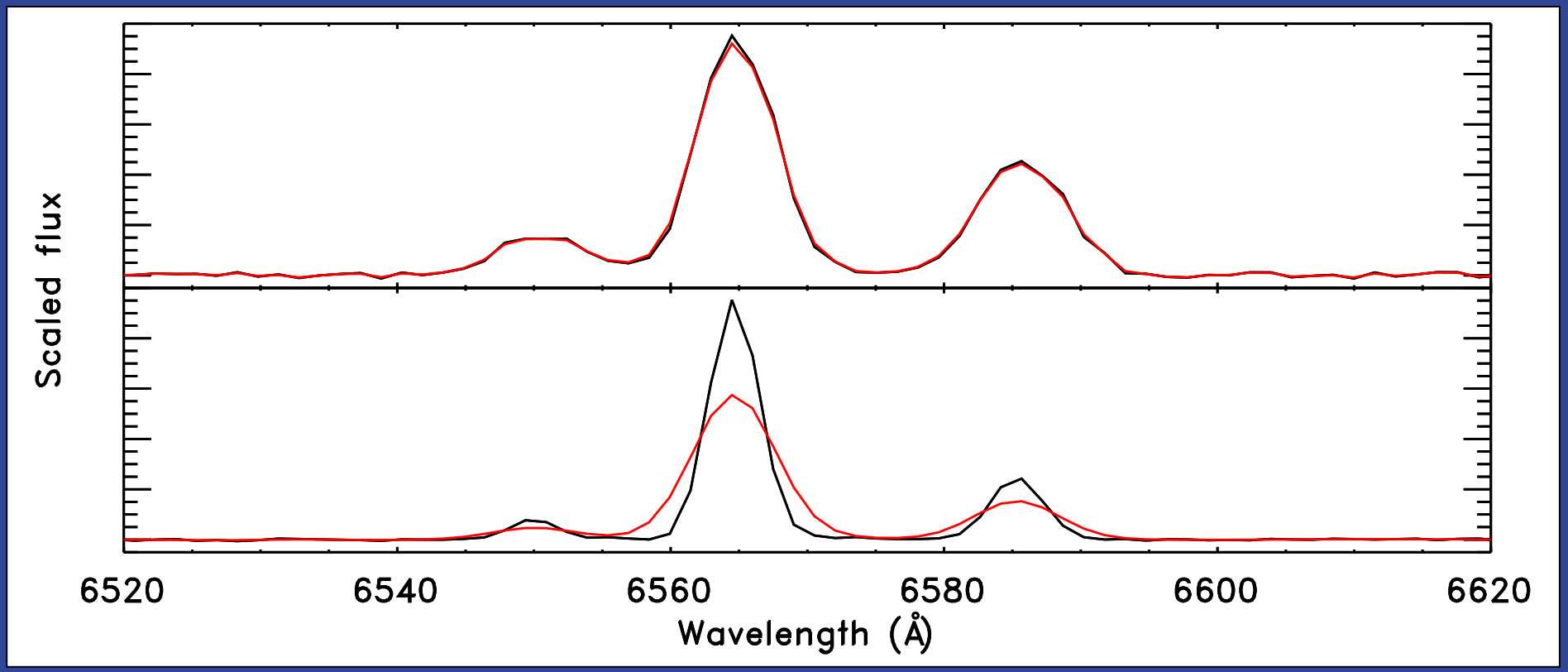


Star formation

AGN

“Blurring” emission lines

- “Blur” the emission lines to have the same width



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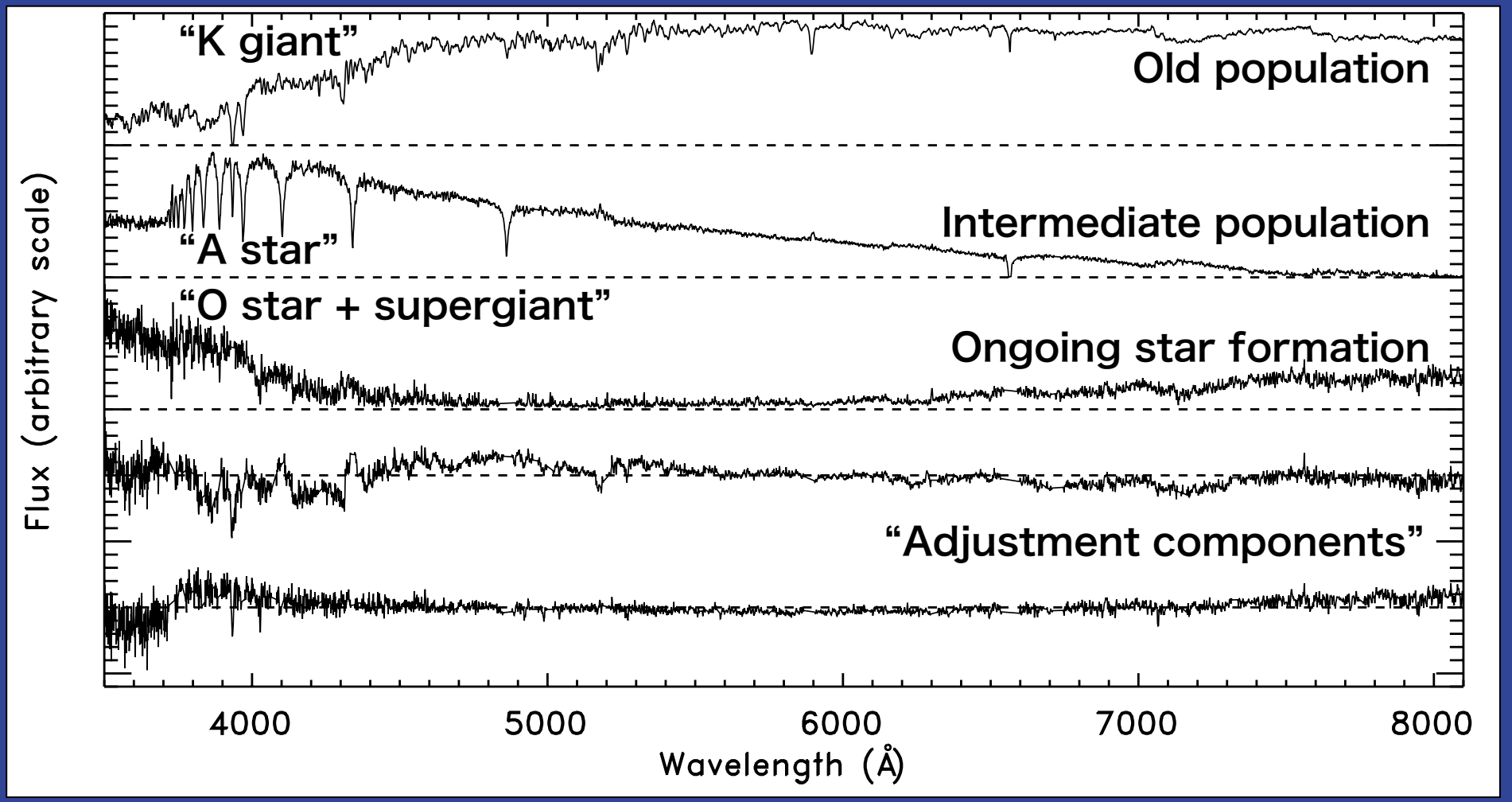
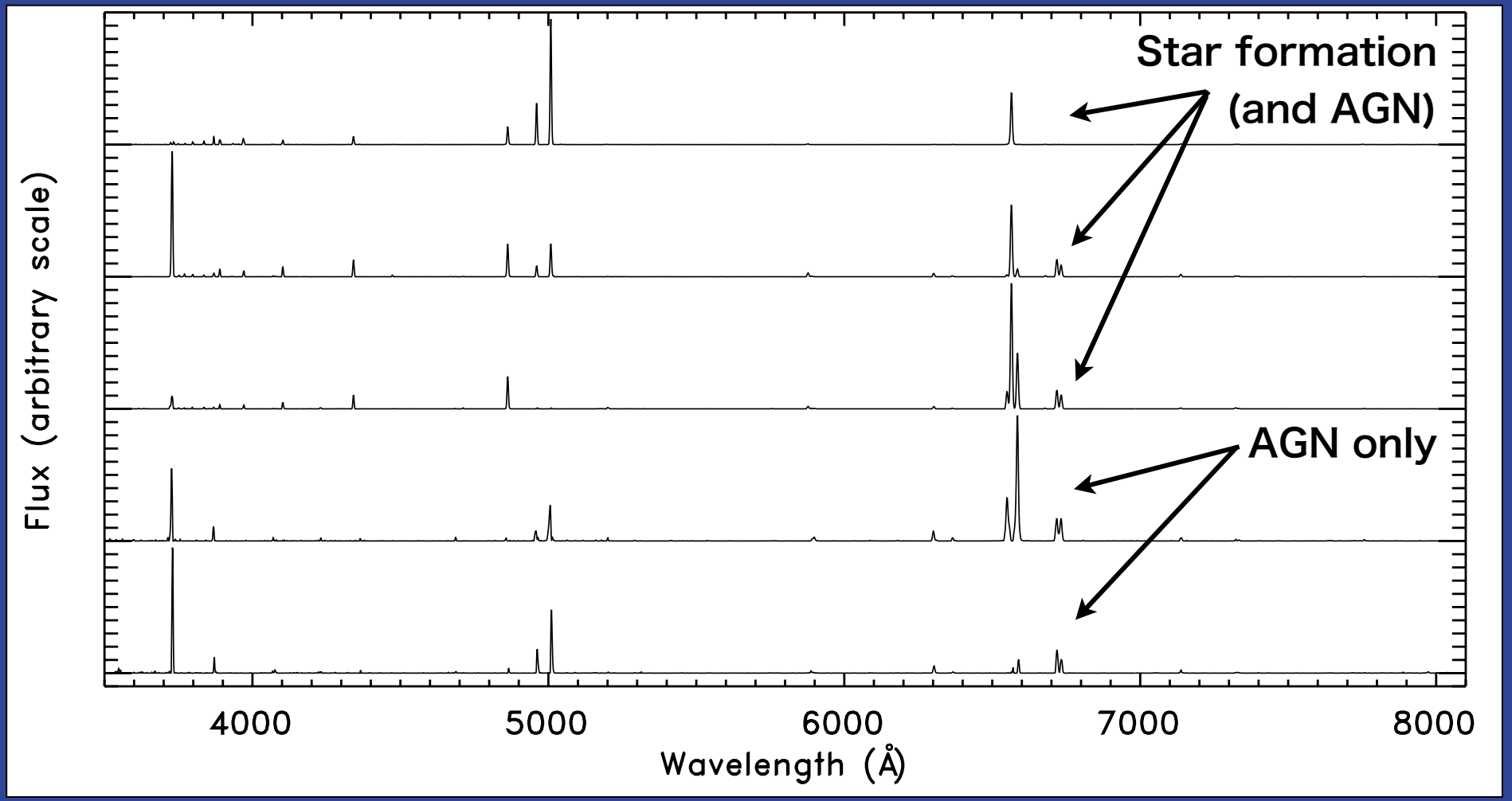
Results...

Results - Continuum Components



Results - Narrow Line Components



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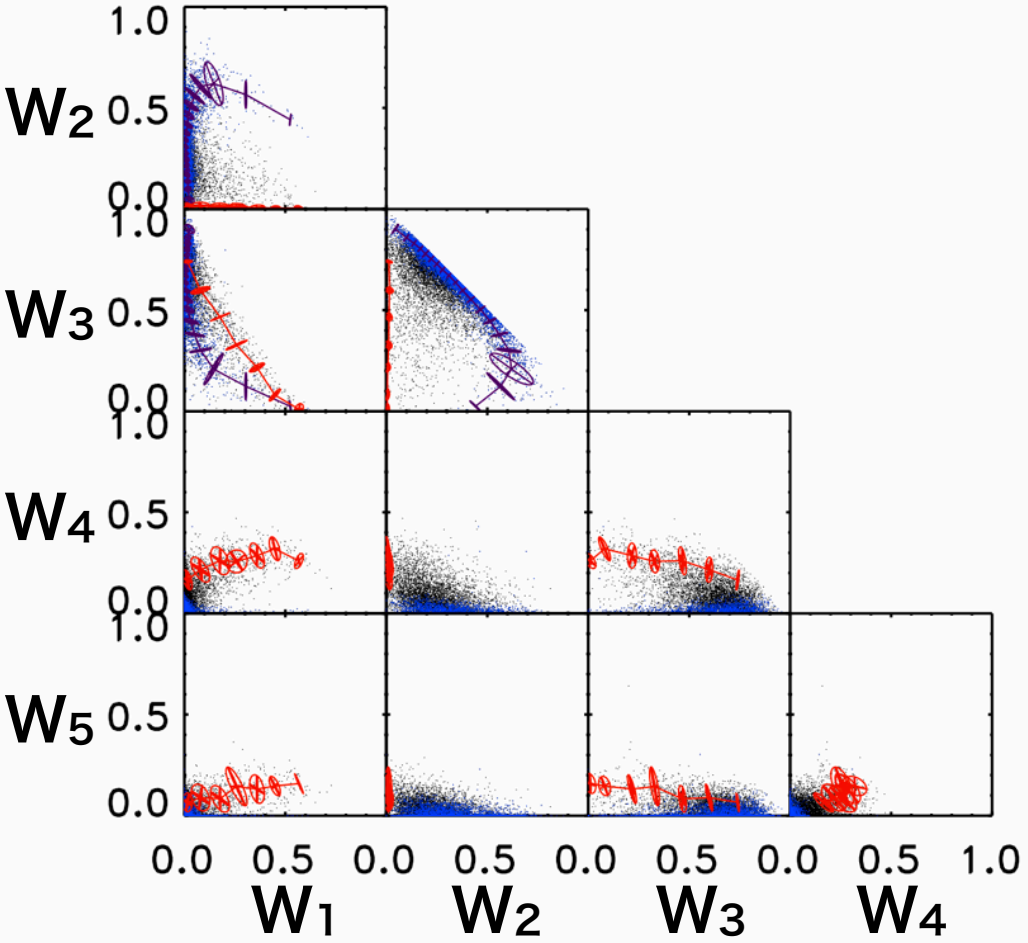
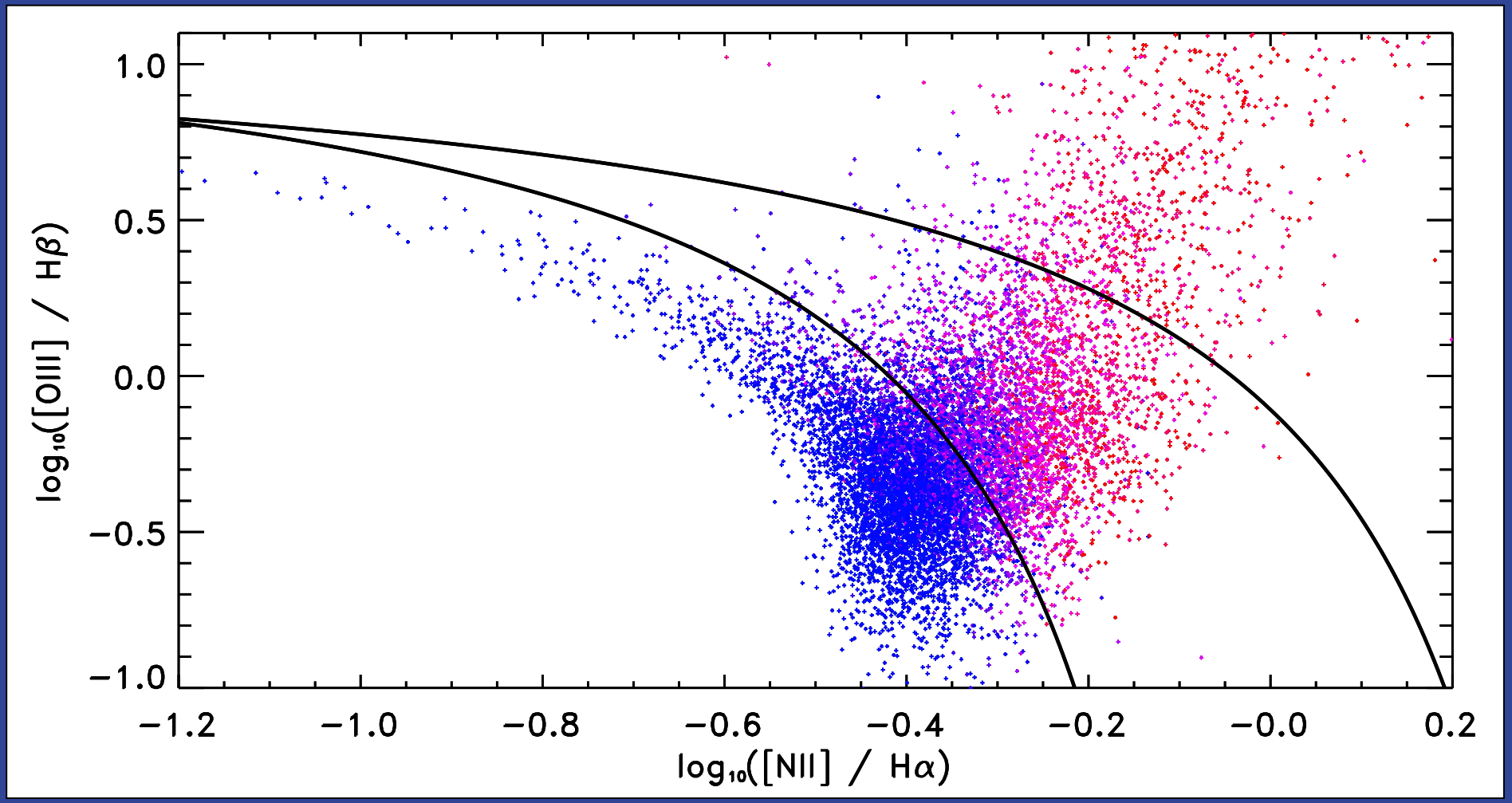
Identifying SF/AGN contributions



Results - SF/AGN Fraction



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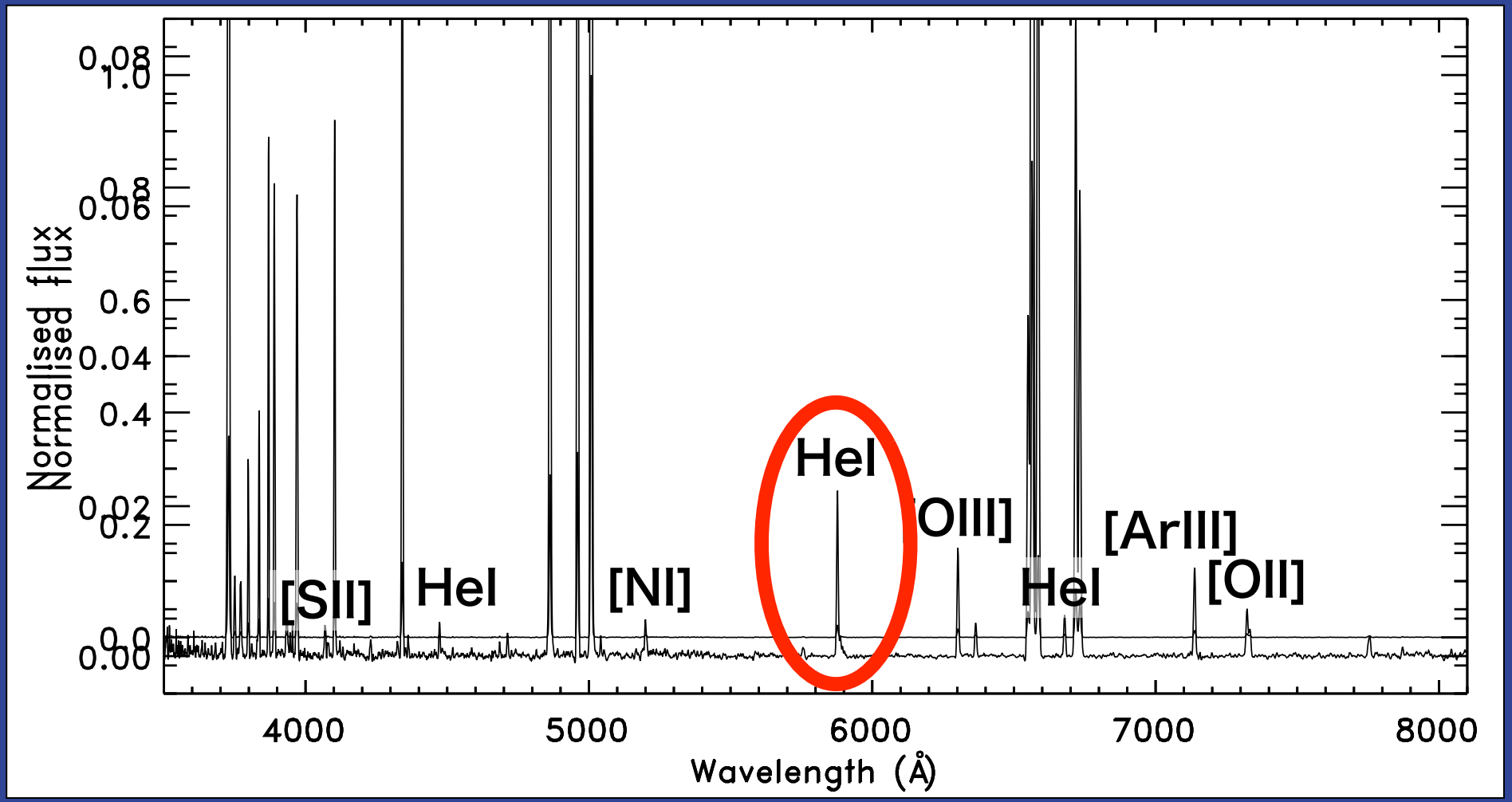
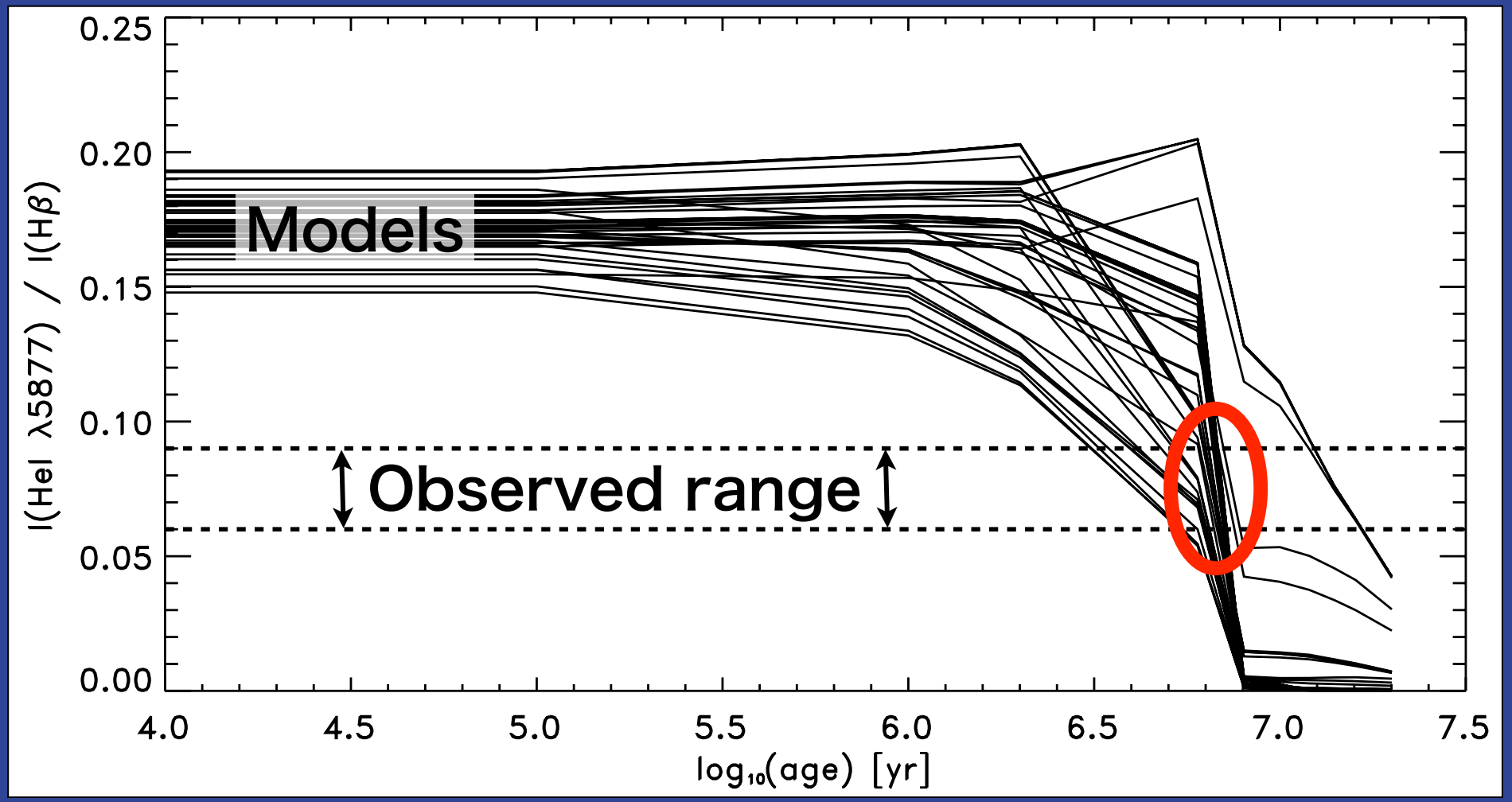
Results - Faint Emission Lines



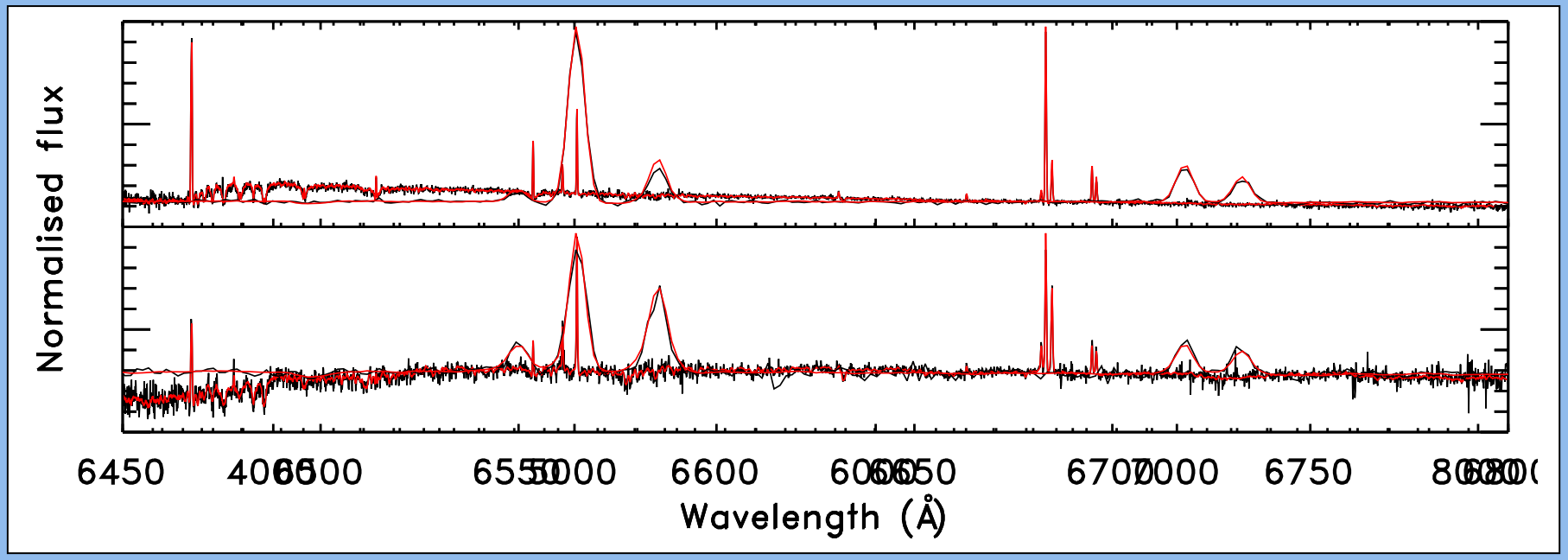
Results - Ageing Star Formation



Summary

- MFICA allows the information from large numbers of galaxy spectra to be combined and analysed as a single entity
- Application to SDSS spectra has allowed an accurate separation of star formation and AGN
- High S/N reconstructions allow exploration of physical conditions within emitting regions

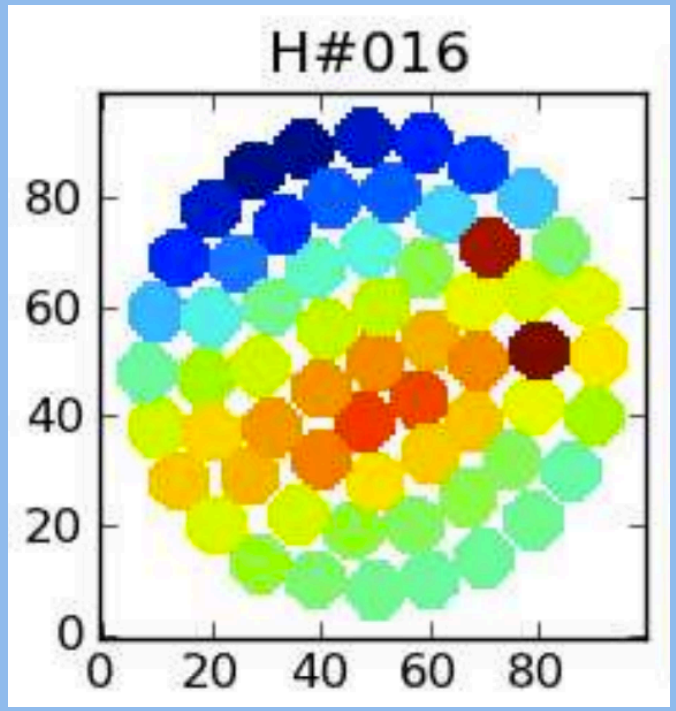
Results - Reconstructions



High quality reconstructions with only 10 components (5 continuum, 5 emission line)

Application to IFU Data

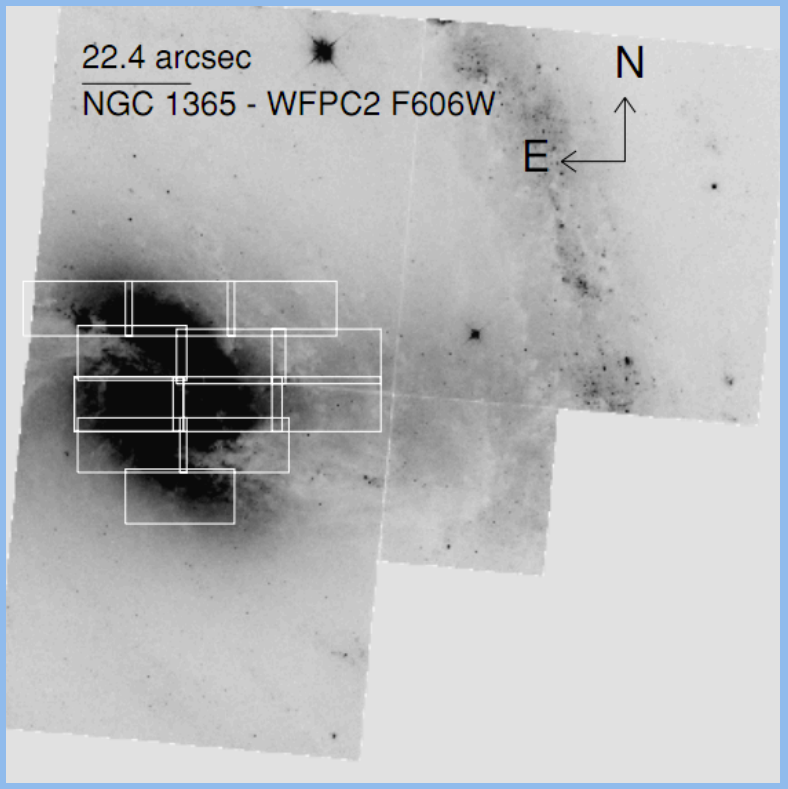
- Information from individual spectra in an IFU datacube can be combined in the same way as spectra from a traditional survey
- A single galaxy can be used, or the data from multiple galaxies can be combined



Croom et al. 2011

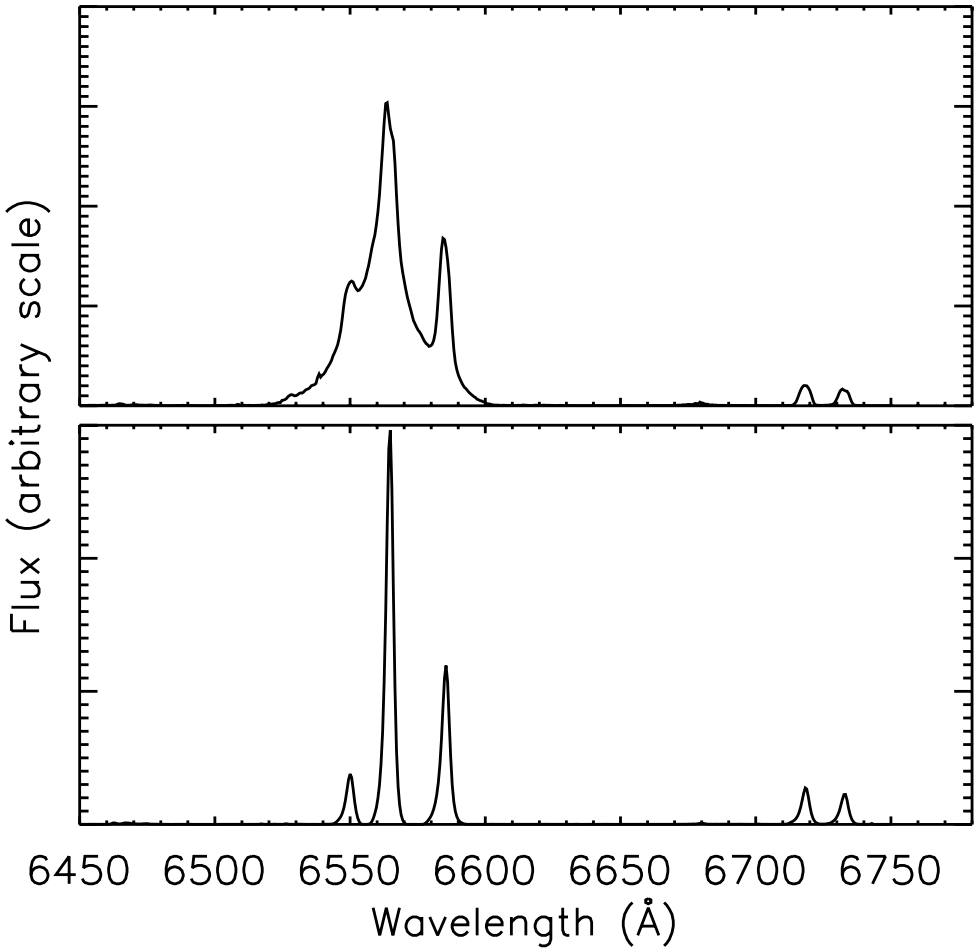
NGC 1365 - Data

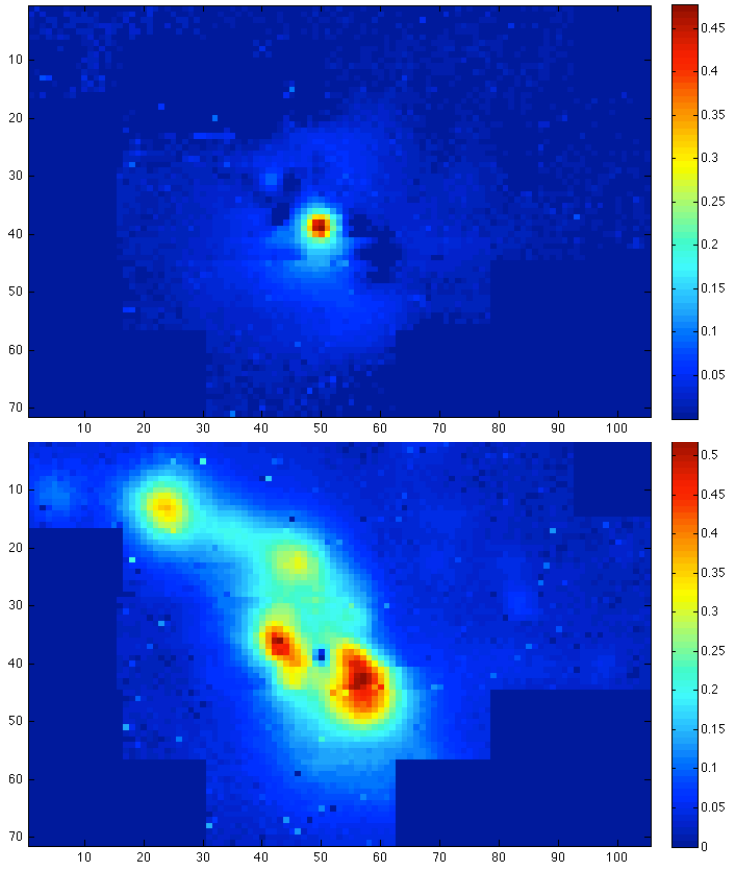
- Seyfert at z=0.00546
- Observed with SPIRAL IFU
- 1 spaxel = 0.7” = 70 pc
- 30 X 30 spaxel region analysed using MFICA
- Components fit to all spaxels



Sharp & Bland-Hawthorn 2010

Results - 2 Components





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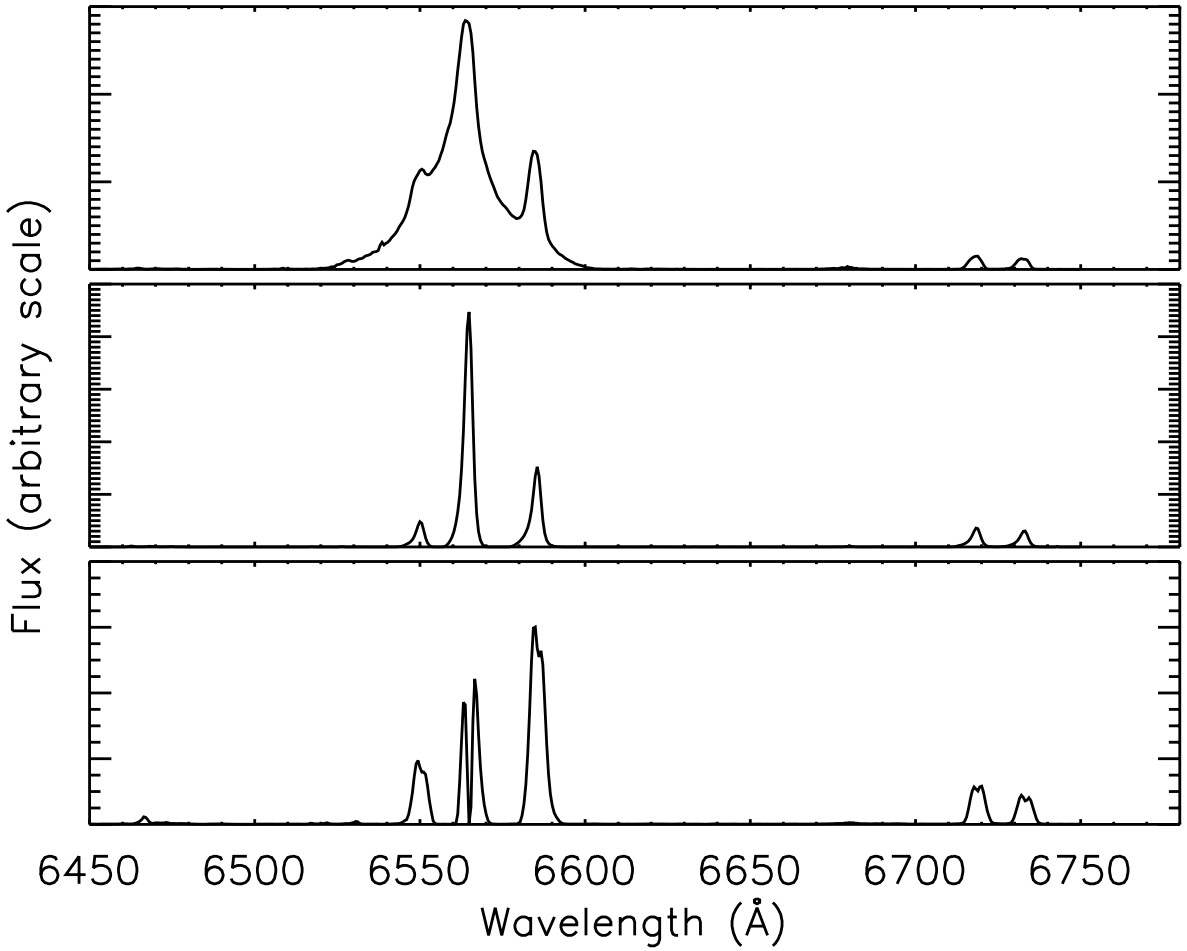
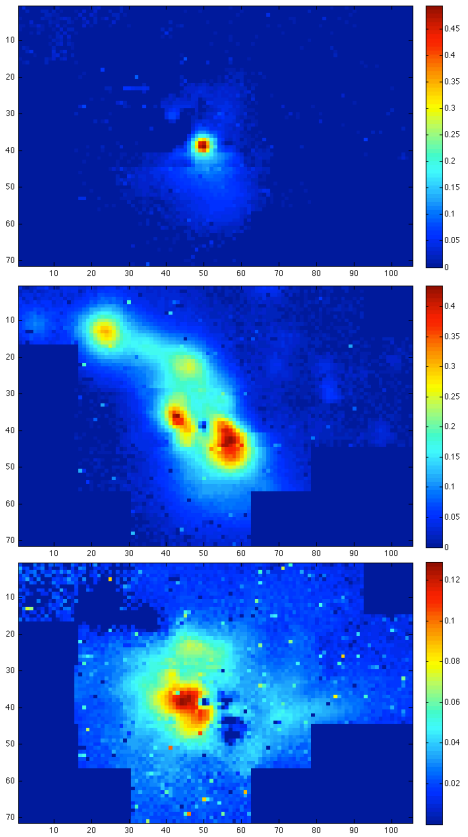
Results - 3 Components





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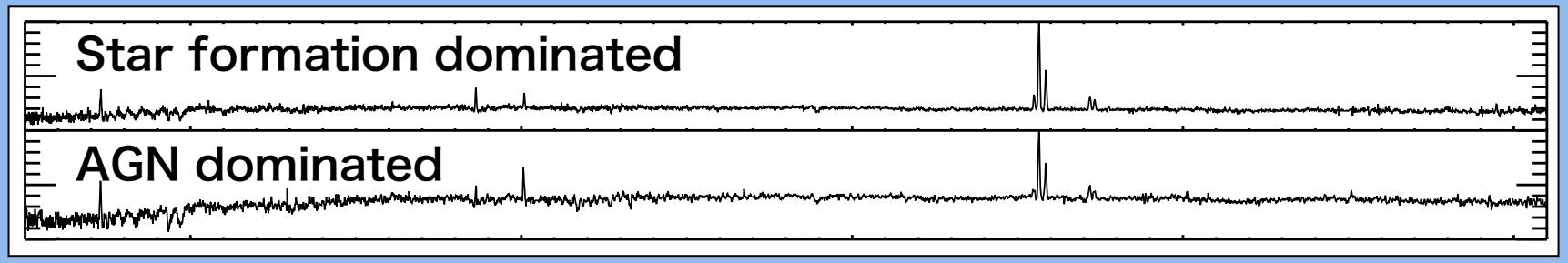
Outline

- The difficulties of identification and measurement of sources of ionising radiation



- Established methods - emission line diagnostics
- New methods - blind source separation
- Application to IFU surveys