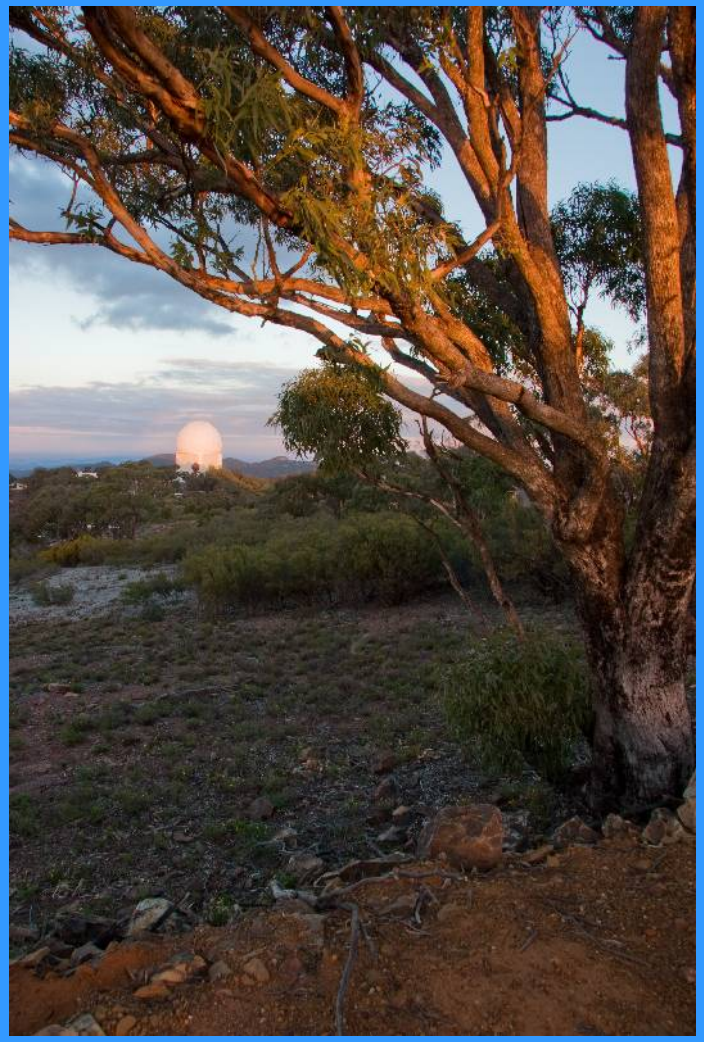
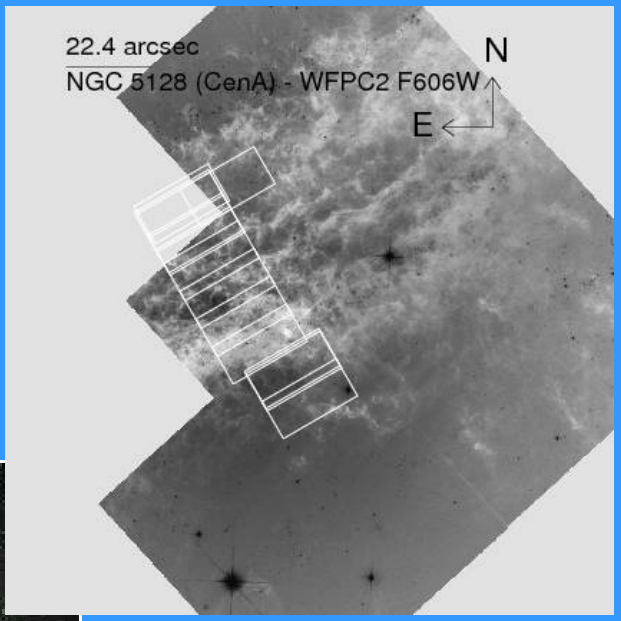


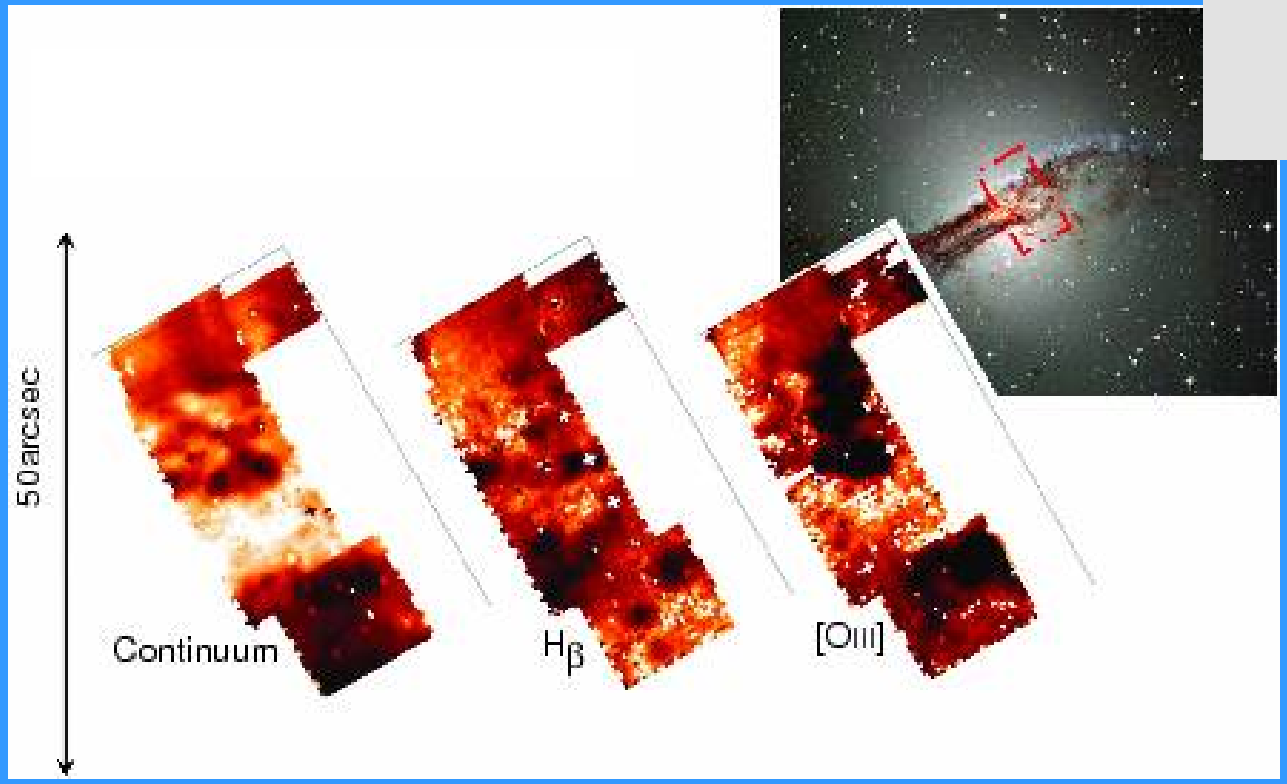
Rob Sharp

2dF Fellow, Anglo-Australian Observatory

Rob Sharp, AAO, rgs@aao.gov.au

Integral field spectroscopy of the inner arcminute





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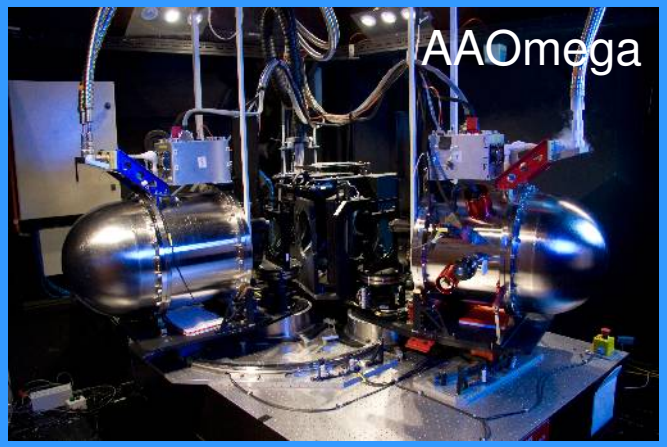
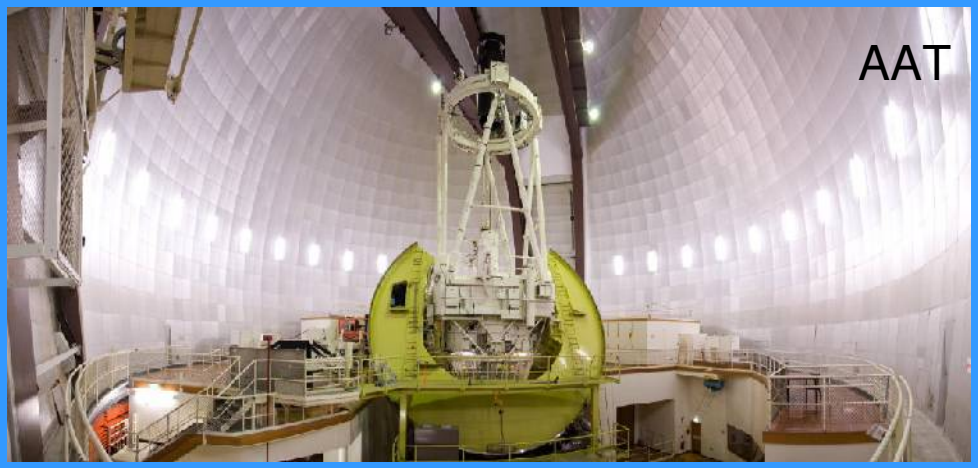
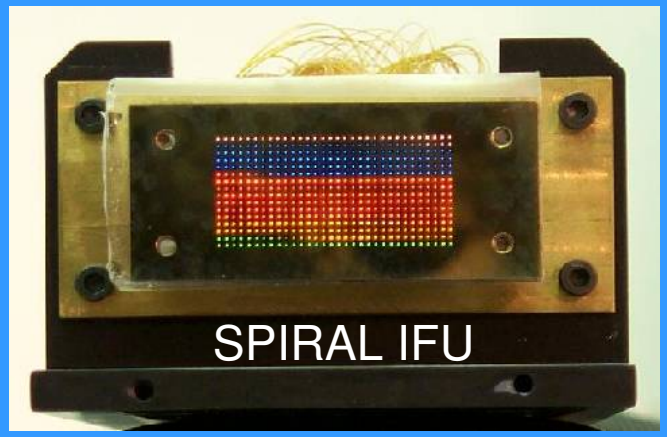
SPIRAL Integral Field Unit

and the AAOmega spectrograph

at the Anglo-Australian Telescope







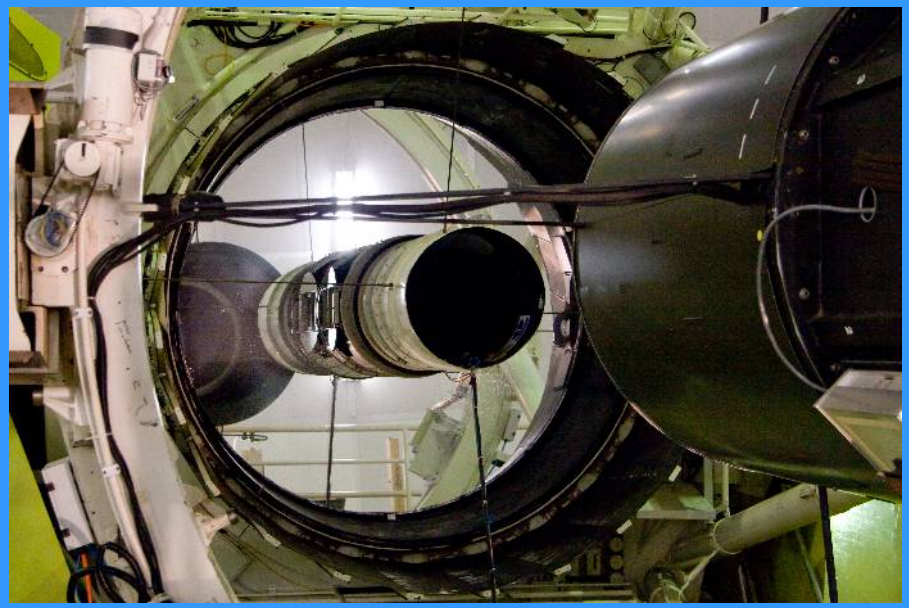
Co-conspirator(s):

Joss Bland-Hawthorn *(et al.)*

Rob Sharp, AAO, rgs@aao.gov.au

The AAT

Coonabarabran
NSW



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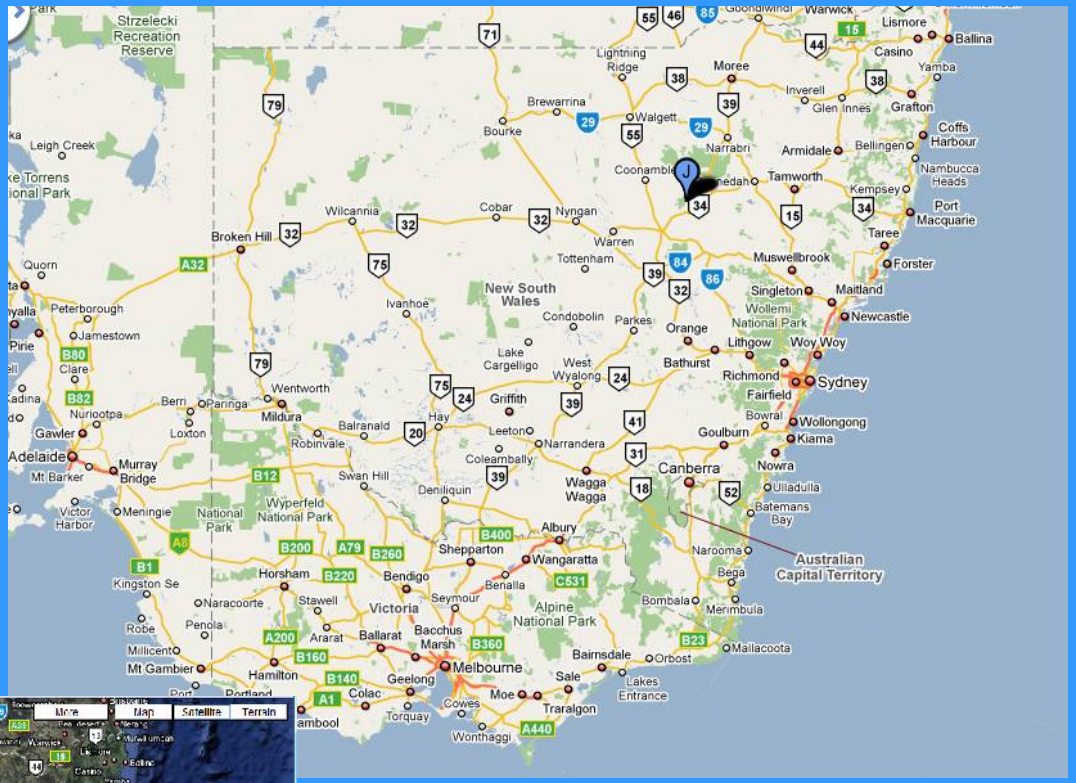

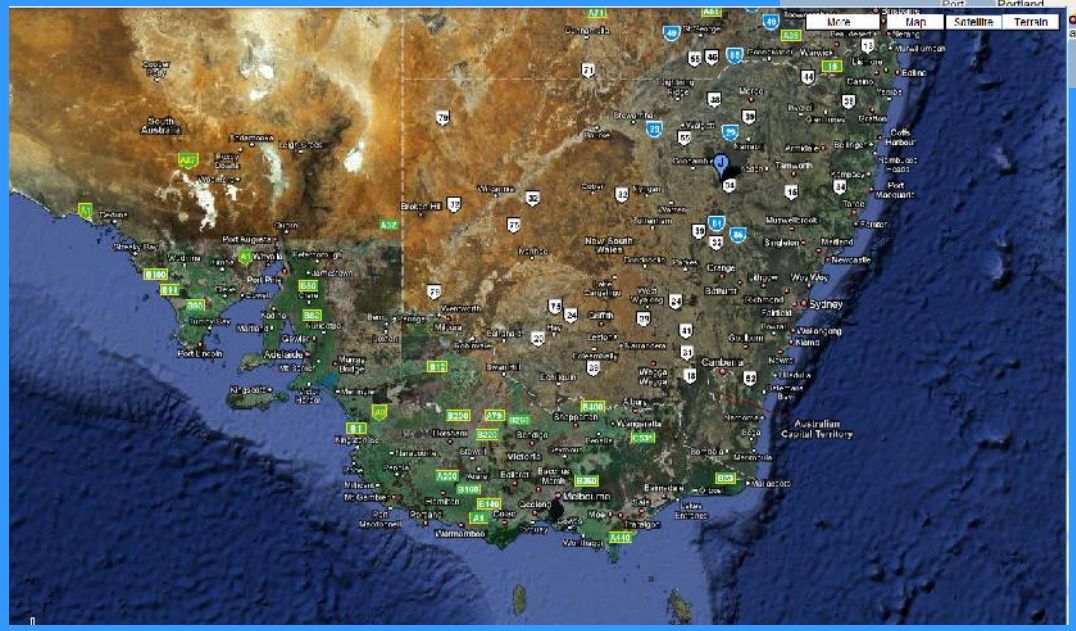

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AAOmega+SPIRAL

- **Dual beam spectrograph**
- 512 element fibre feed
- 32x16 rectangular array
- **0.7 arcsec** square pixels
- 11.2x22.4 arcsec FoV
- **Full range of AAOmega gratings**
- Real time data reduction with *2dfdr*

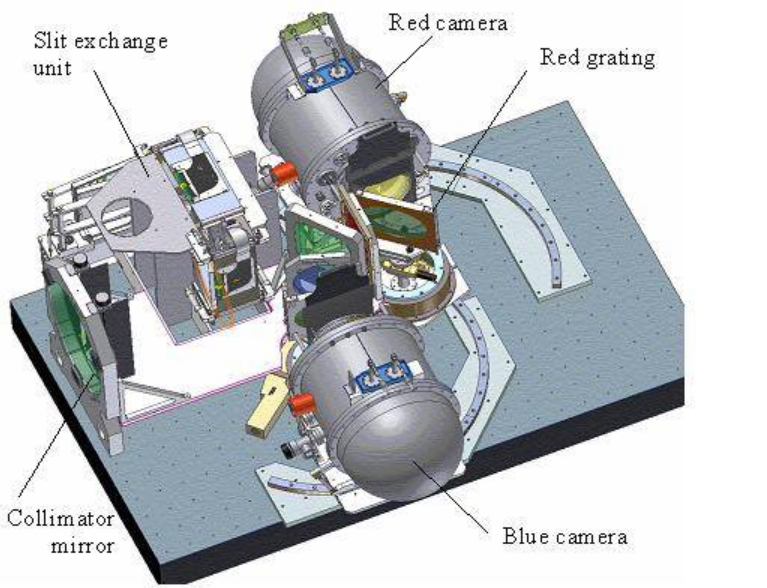
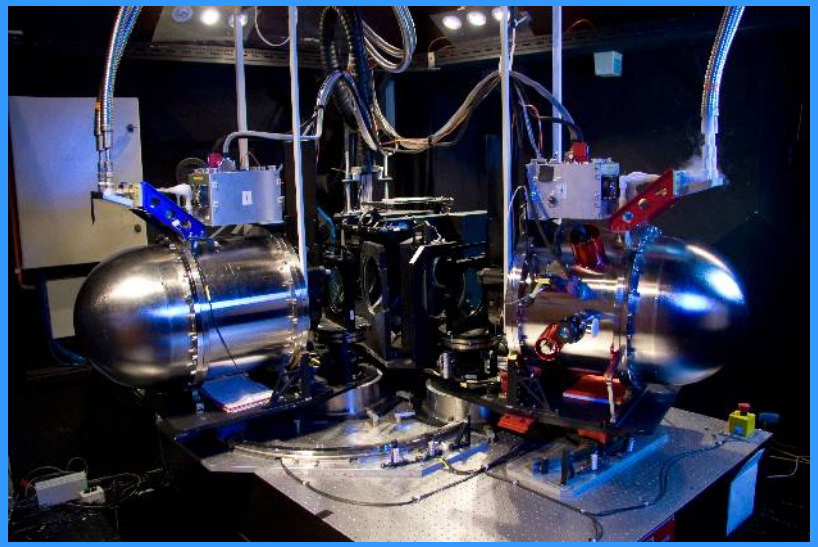
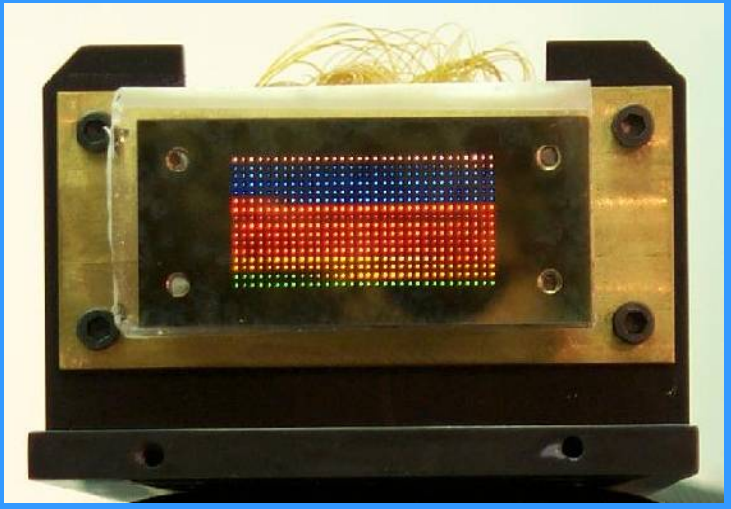


Figure 1. Physical layout of AAOmega, layout, showing the red camera in high dispersion mode, and blue camera in low dispersion mode.





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Survey setup

Instrument setup

1500V and 1000R gratings, 5700A dichroic
R~5000-6000 ~50km/s resolution element

Key spectral features

HeII / Hβ / [OIII] + Mg*b* in the blue arm
NaD + [OI] / Hα / [NII] / [SII] in the red
[OII]+ Neon UV lines not accessible

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ANU 2.3m – new IFS system

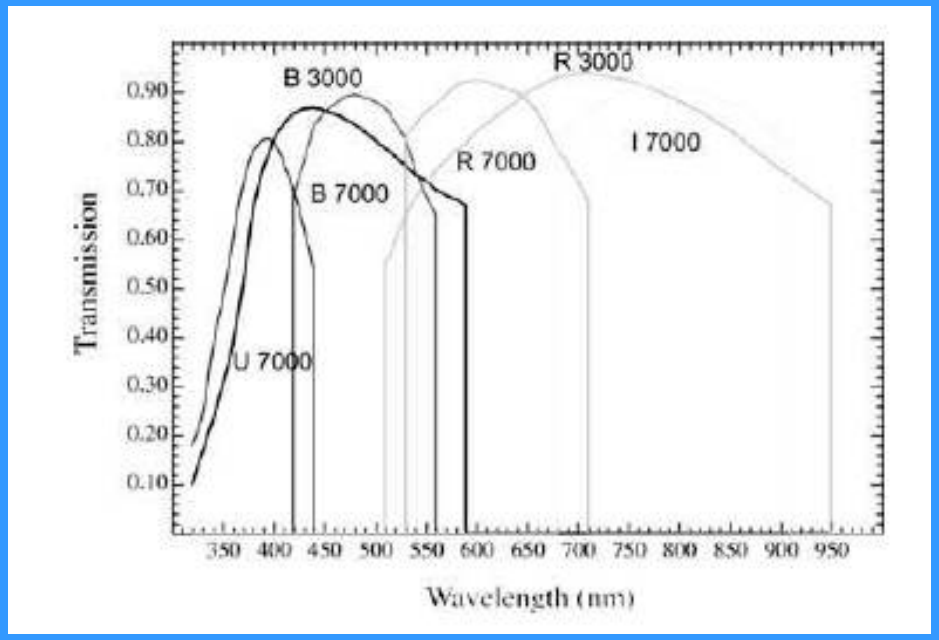
Commissioned 2009

FoV – 25x38arcsec

High transmission

Dopita *et al.* 2004 (SPIE)

Dopita et al. 2007 (Ap&SS)



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Choose the right tool for the job
(Part 1)

Optical	**Instrument**	**Telescope**	**FoV**	**Resolution**
	VIMOS	VLT	40”x40”	Low
	WiFeS	ANU 2.3m	30”x25”	Medium
	SPIRAL	AAT	22”x11”	Medium-*High*
	GMOS	Gemini	7”x5”	Low
IR	SINFONI	VLT	8”x8” - 2”x2”	Low-Medium
	GNIRS	Gemini	Defunct	---
	NIFS	Gemini	3”x3”	Medium

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Choose the right tool for the job
(Part 2)

Narrow band and tuneable filters

- Excellent surface brightness sensitivity
- Wide field of view

But…

- Limited kinematic information
- Limited spectral line coverage

See Simon Ellis' talk on Thursday

for wide field emission line coverage

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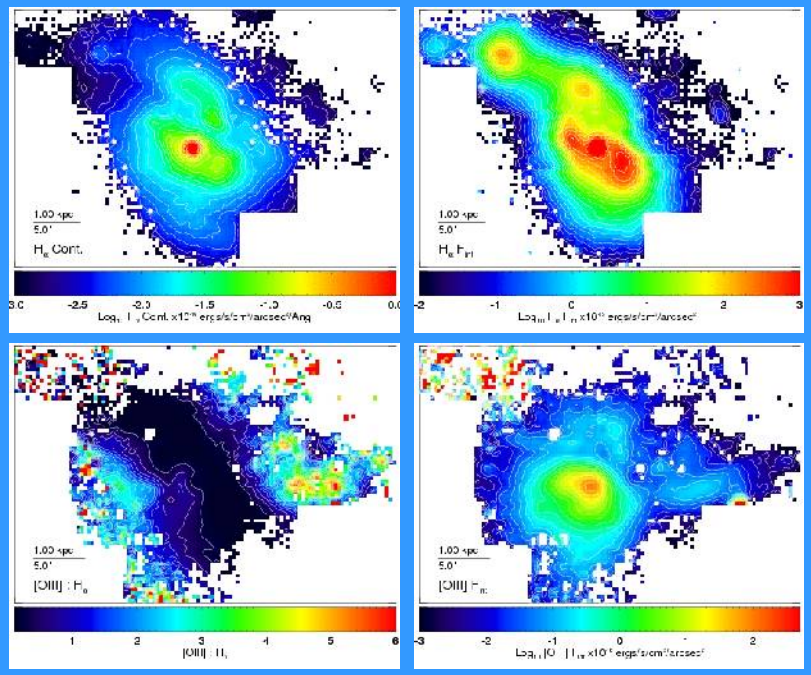
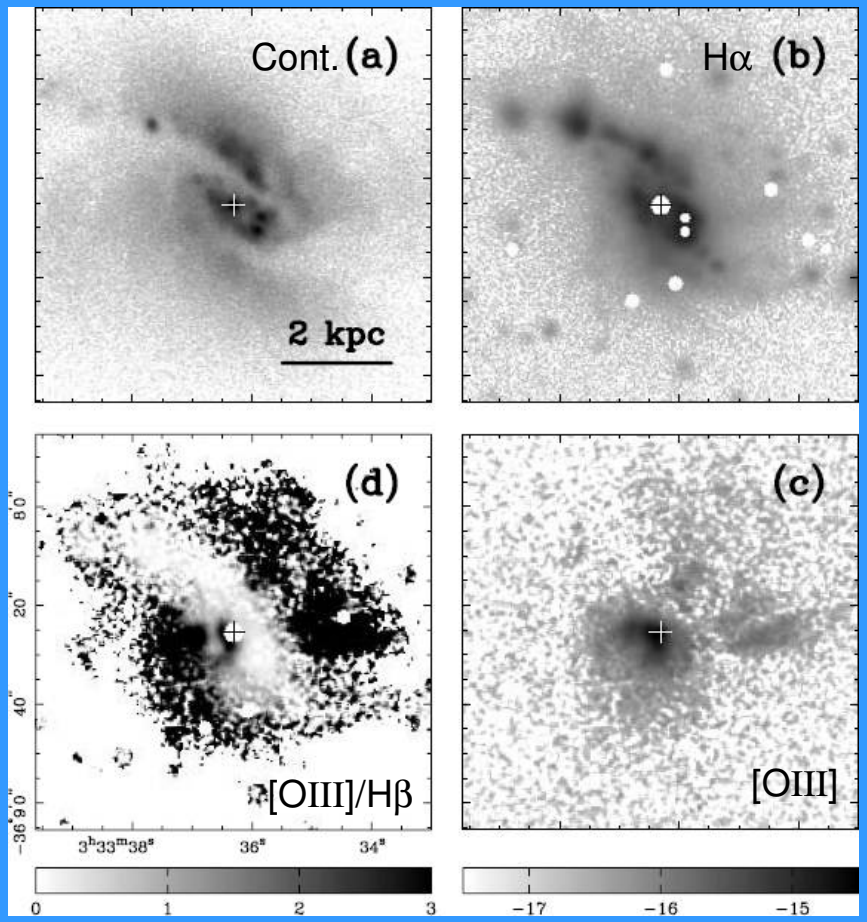
A quick comparison



NGC 1365

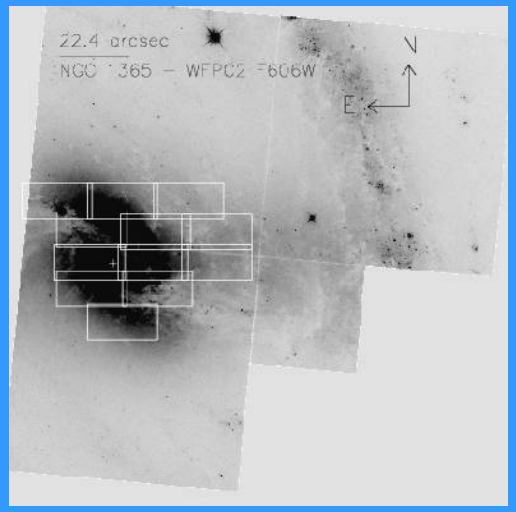
AAT/TTF

Veilleux *et al.* 2003



AAT/SPIRAL
IFS maps

SPIRAL IFU
22.4x11.2 arcsec



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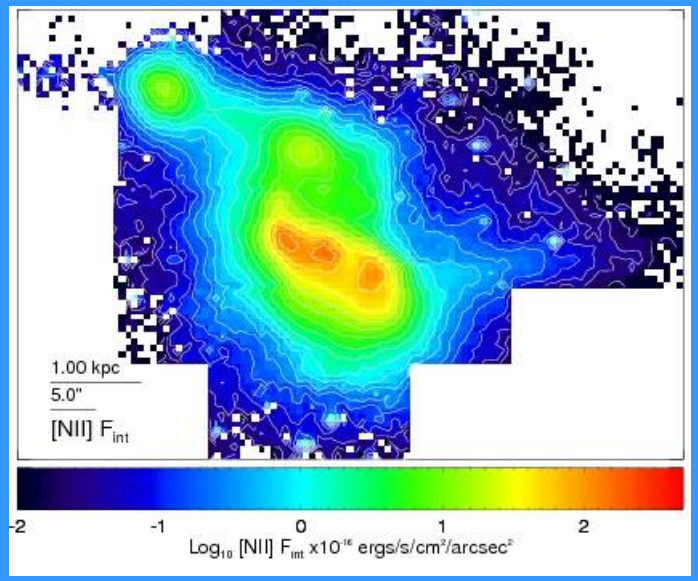
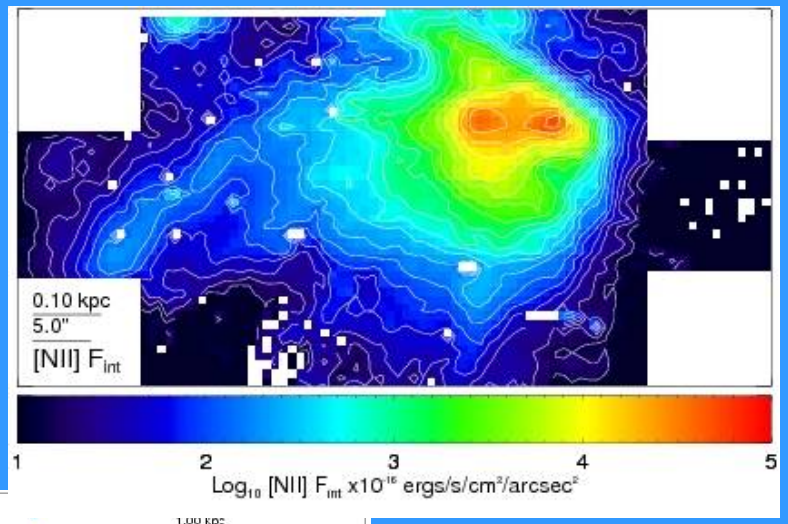
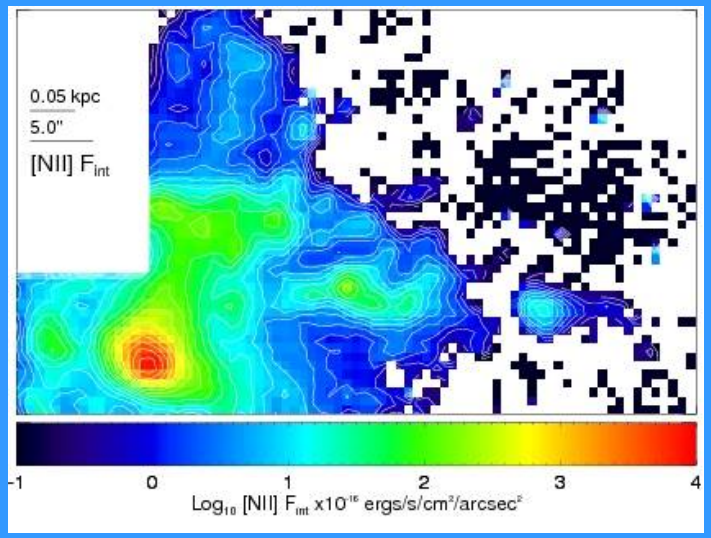
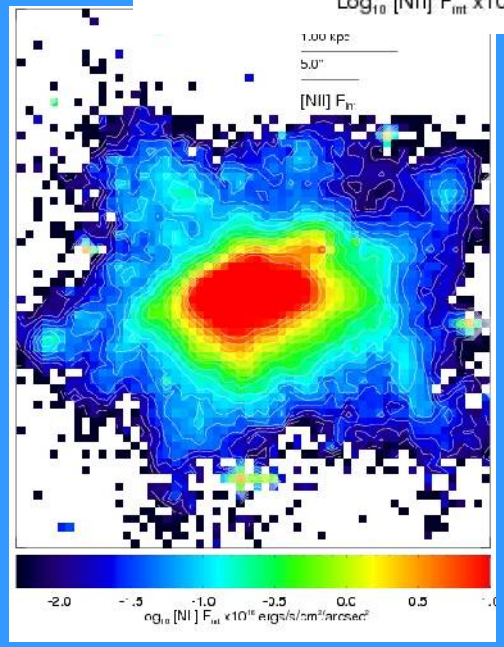
Gratuitous plug…









"A survey of nearby starbursts with starburst-driven and AGN-driven winds"

Sharp & Bland-Hawthorn in prep.

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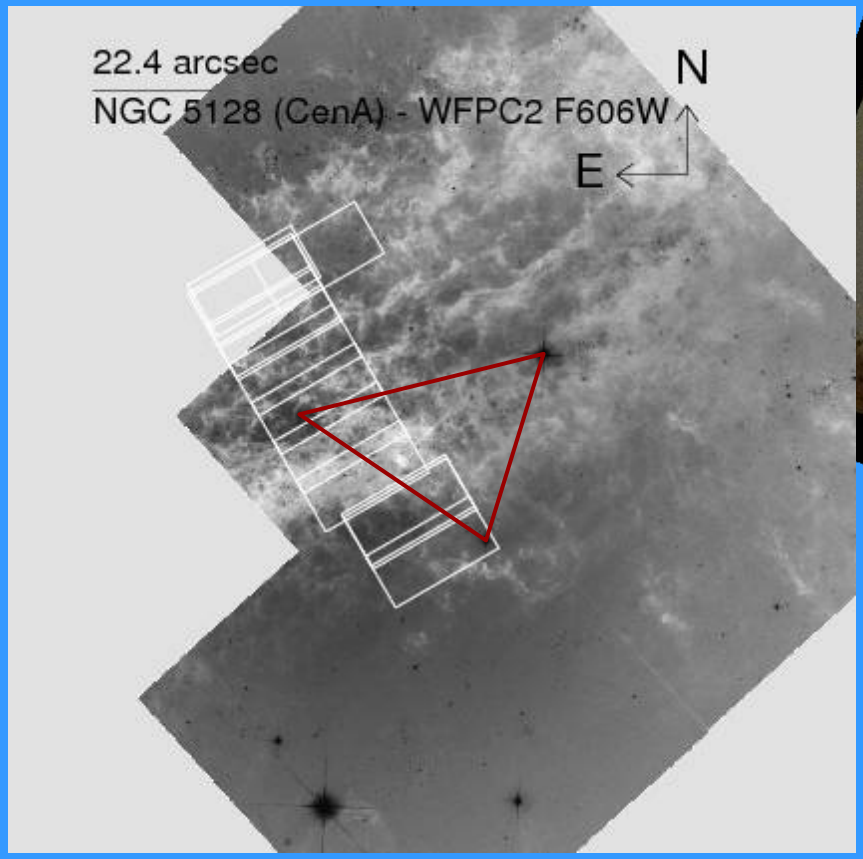
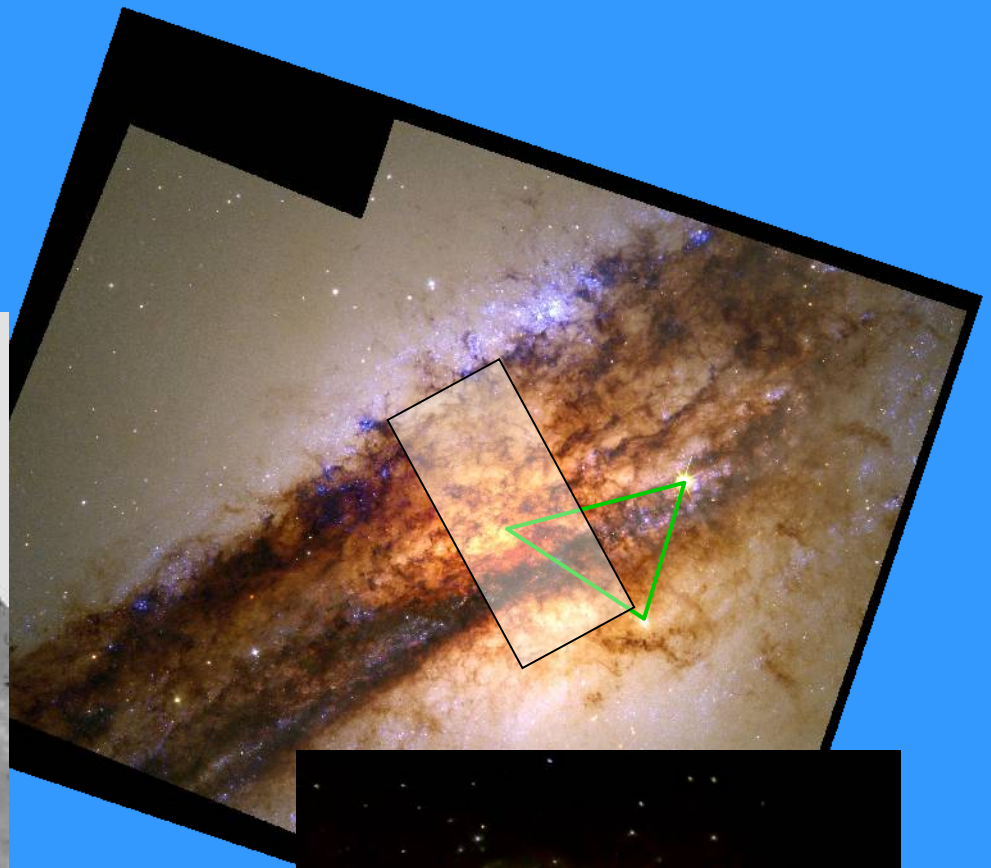
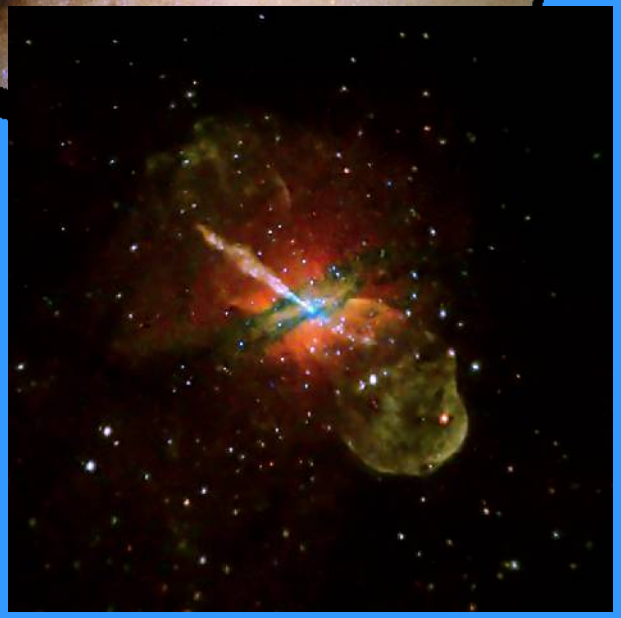
Novel orientation







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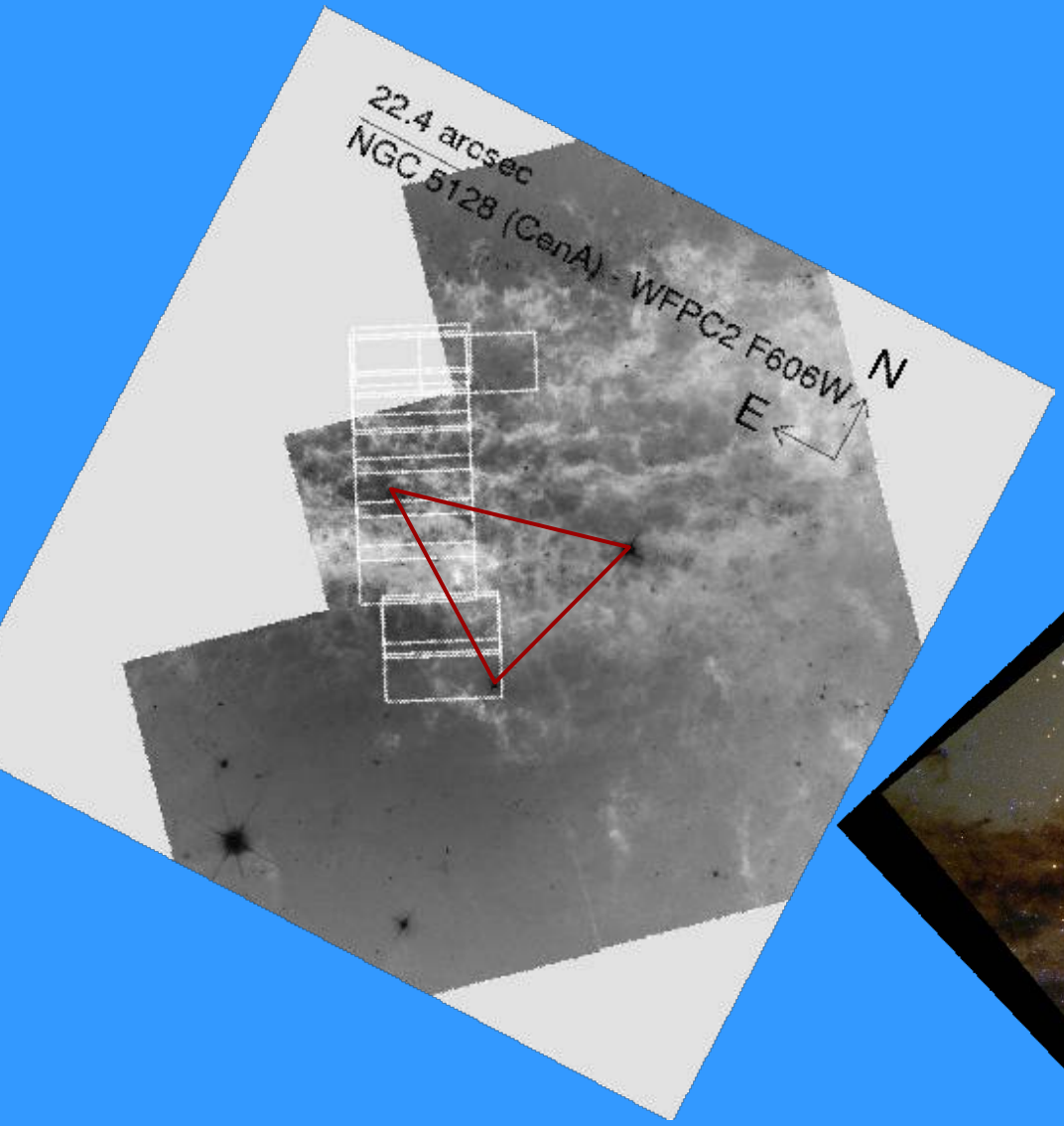

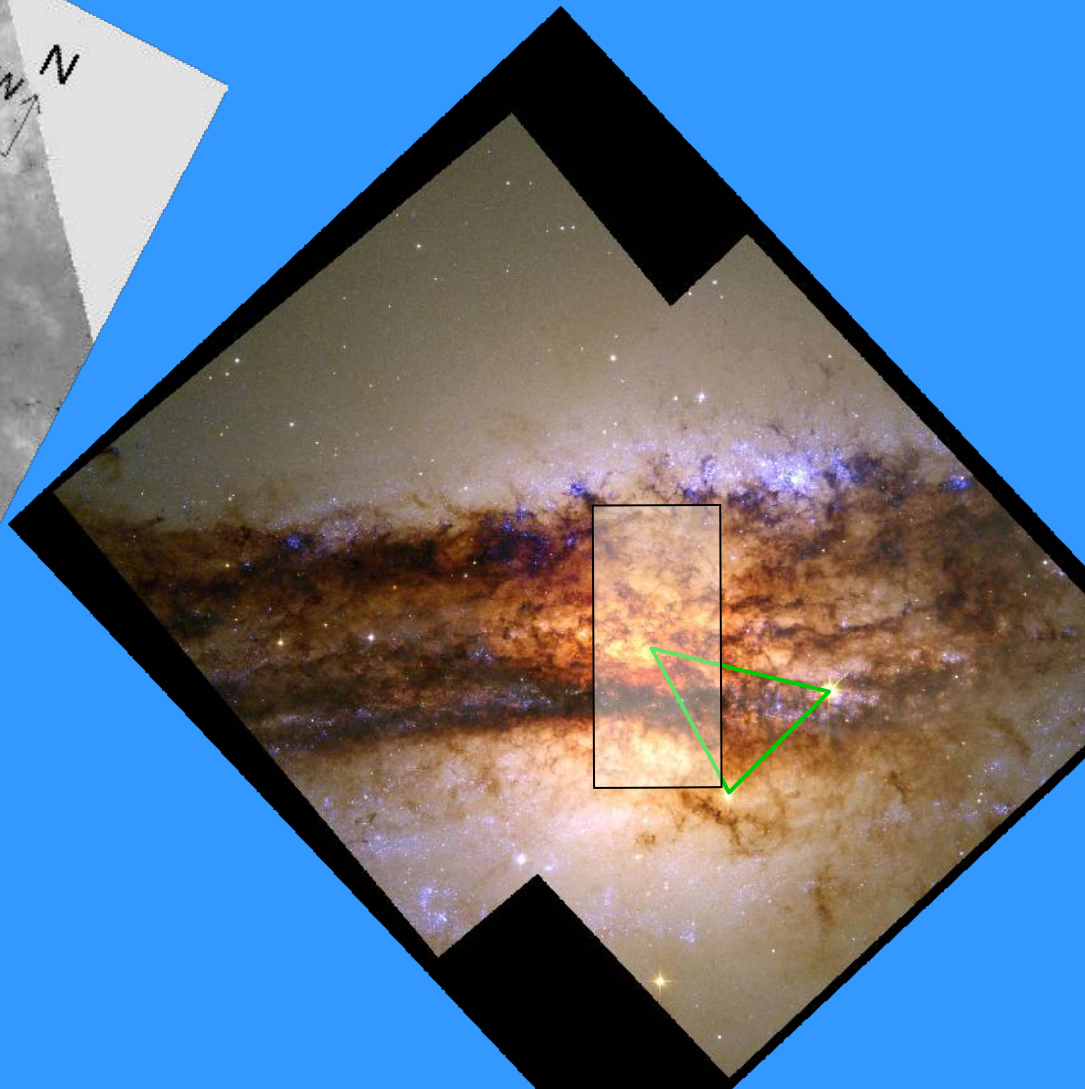

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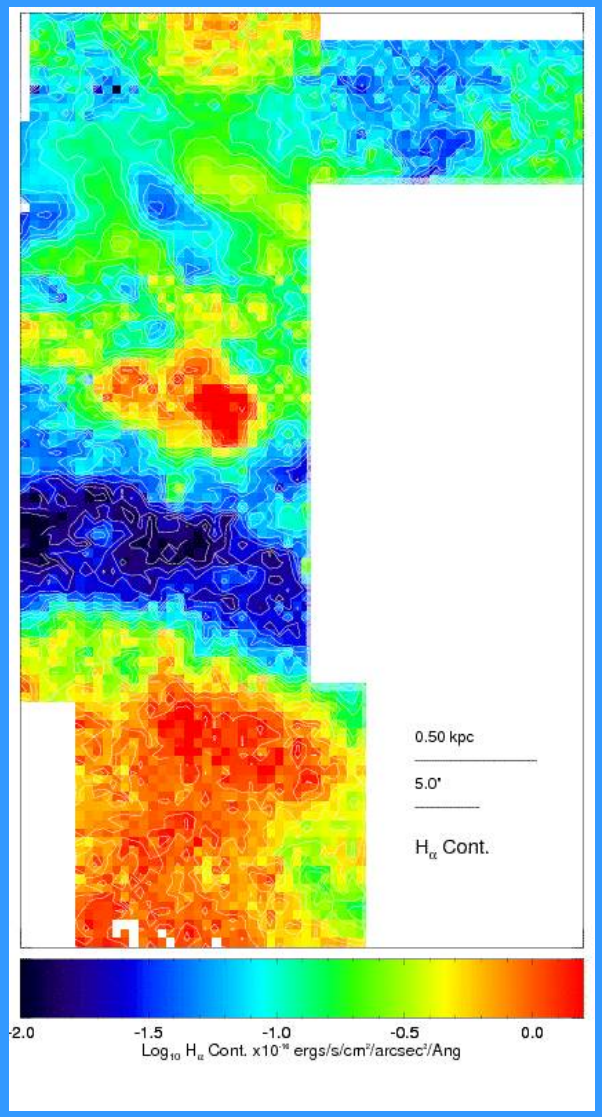
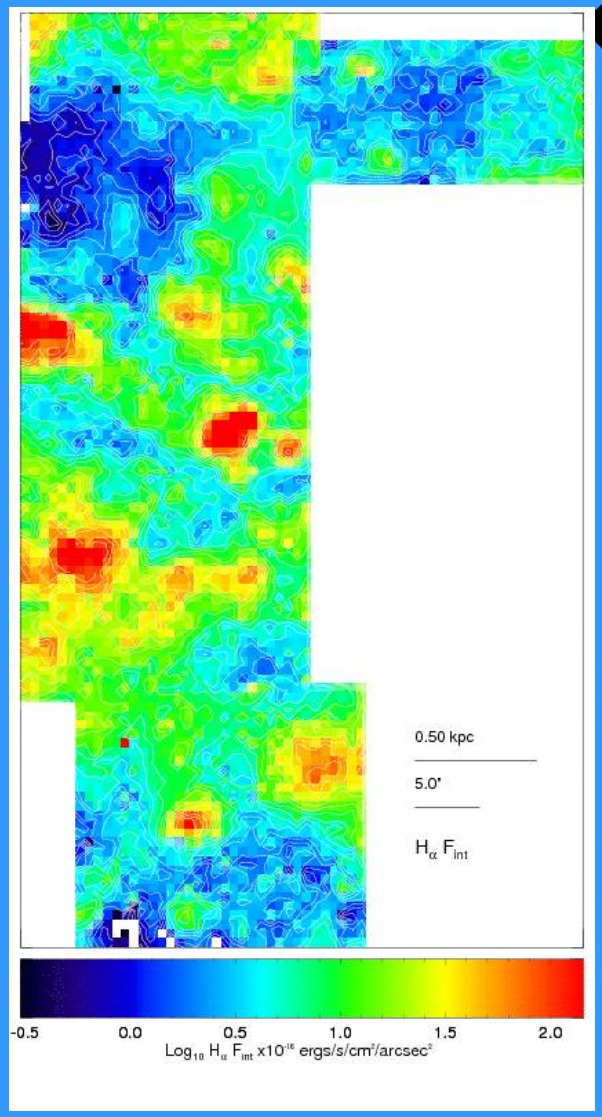
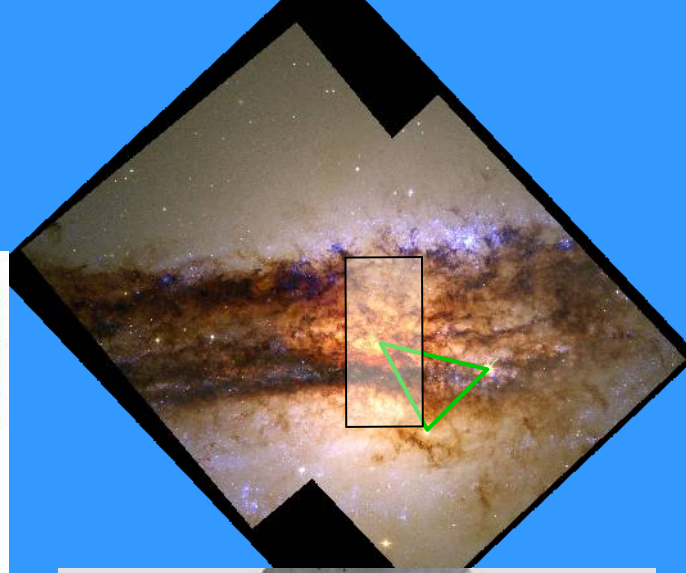
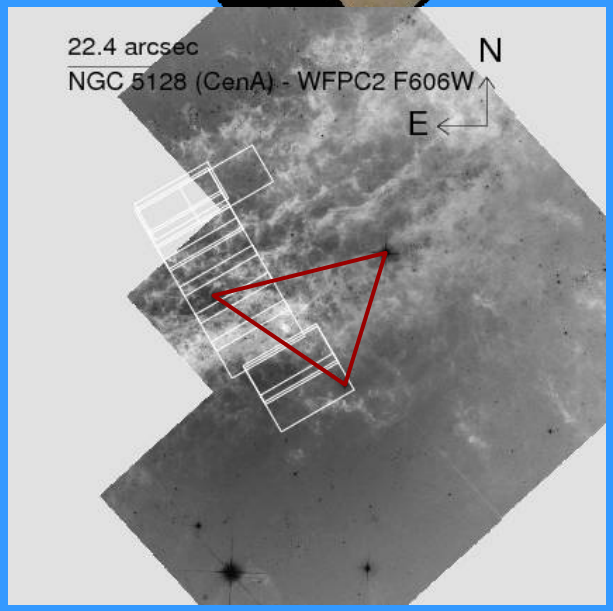
25 *(clear)* hours

and 9000 spectra later…









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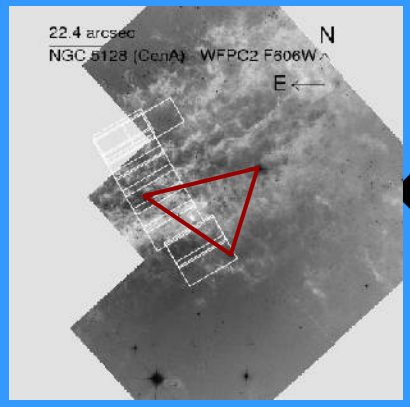
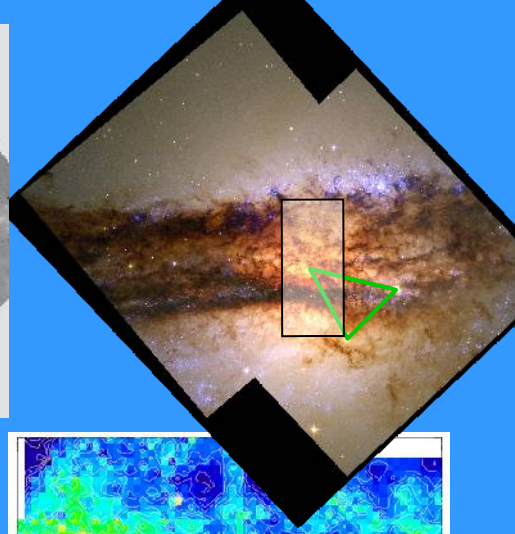
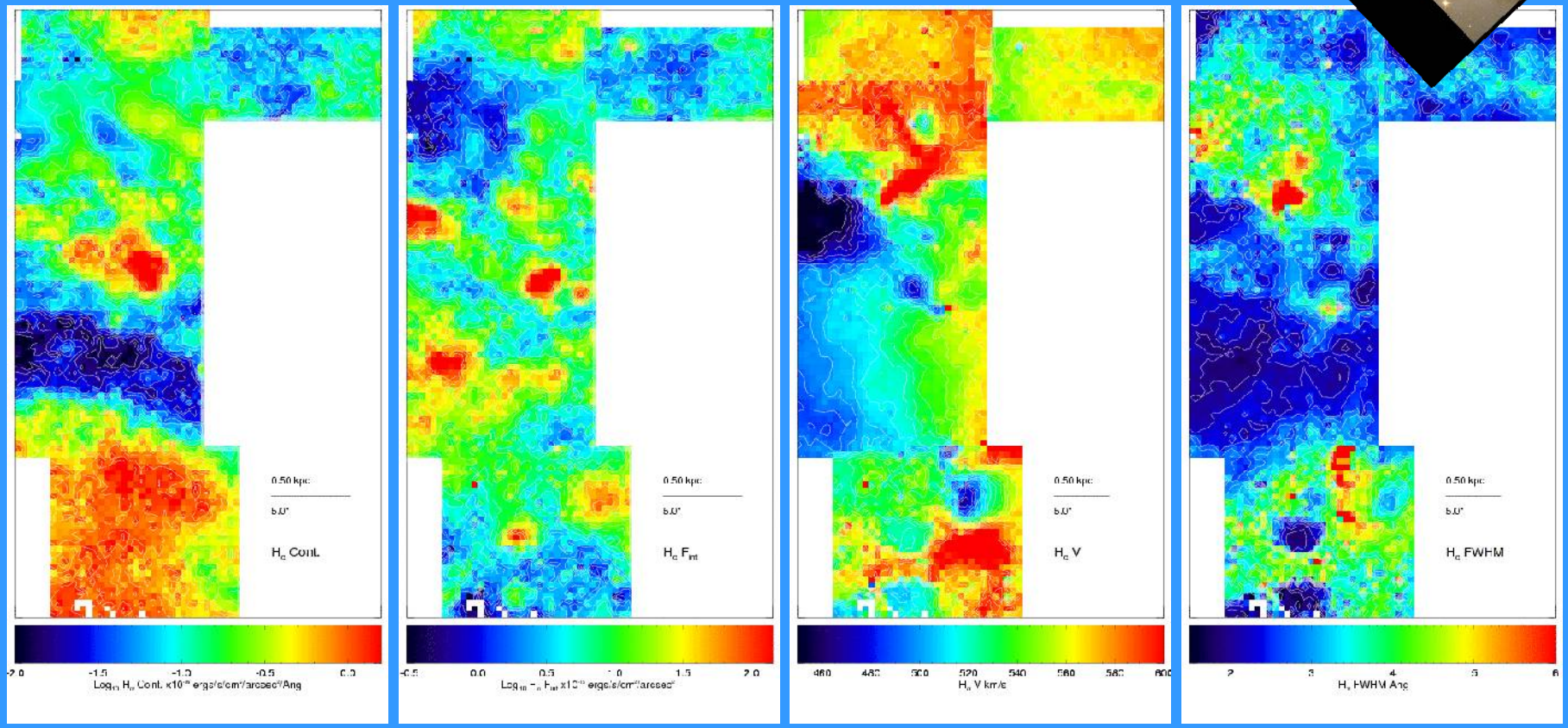
Hα properties







Velocity field needs a little work still

IFS reduction is difficult!

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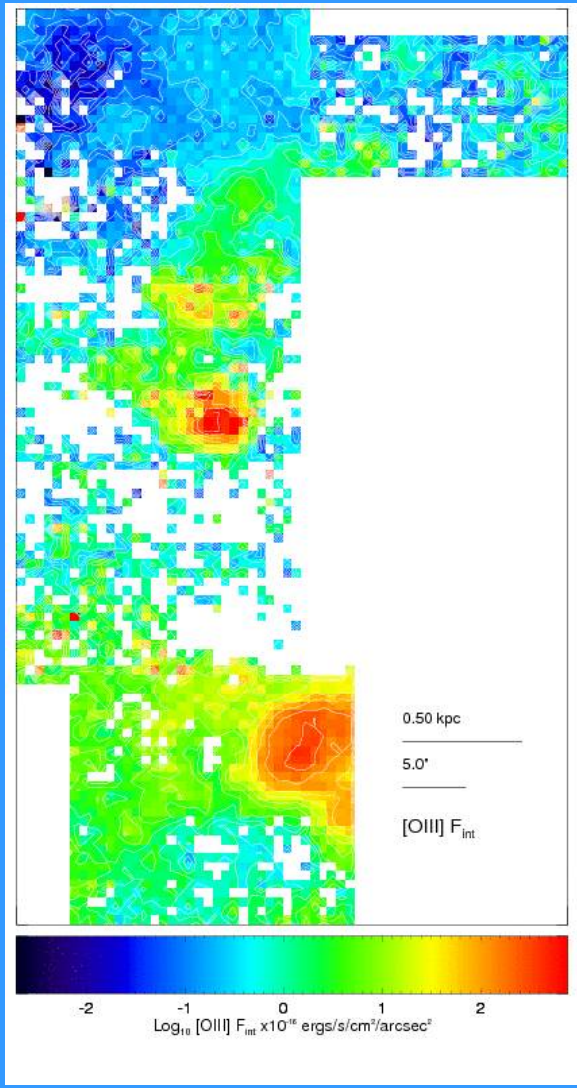
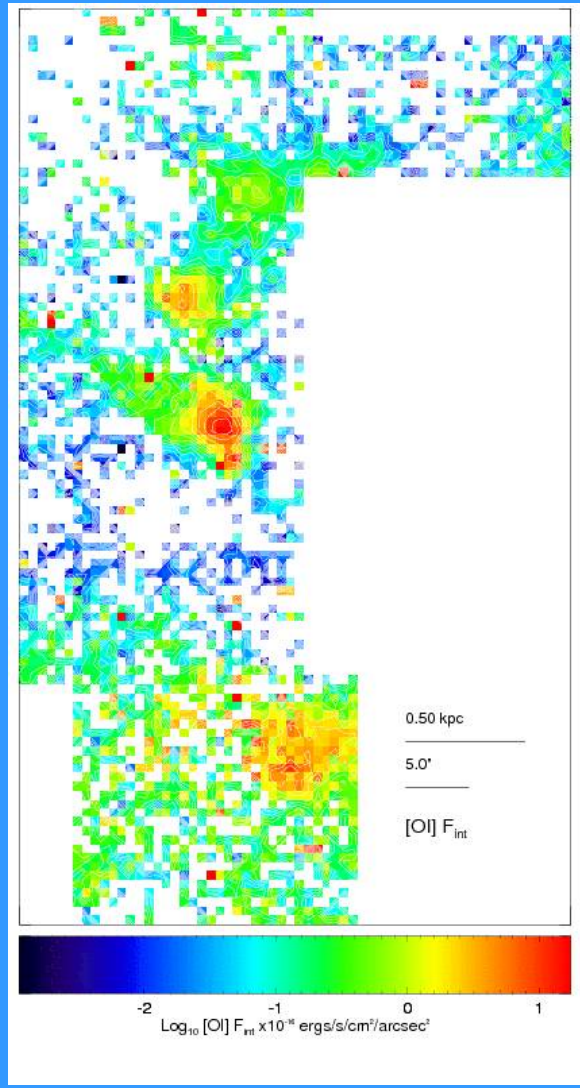
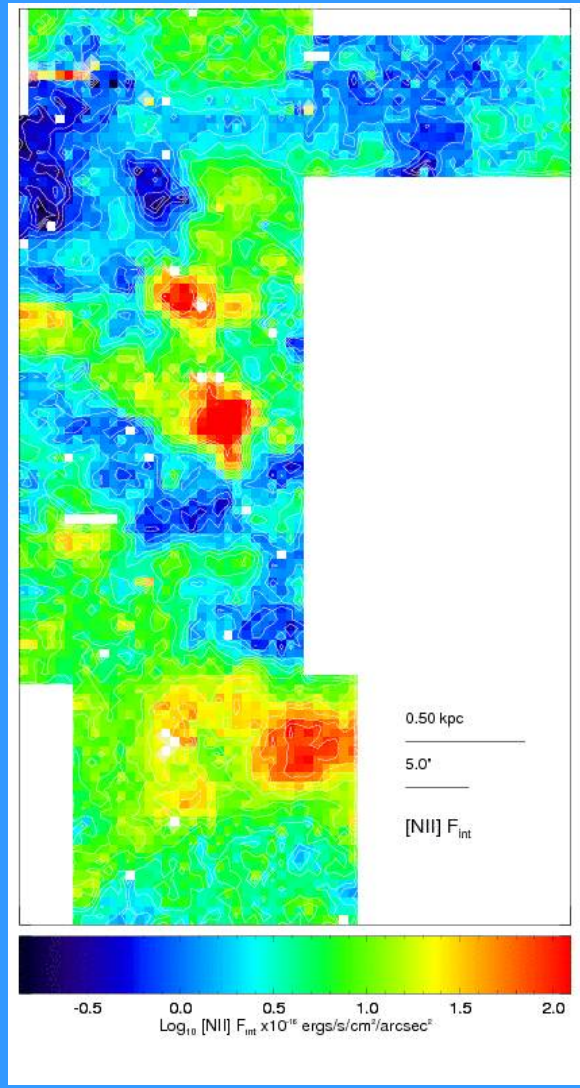






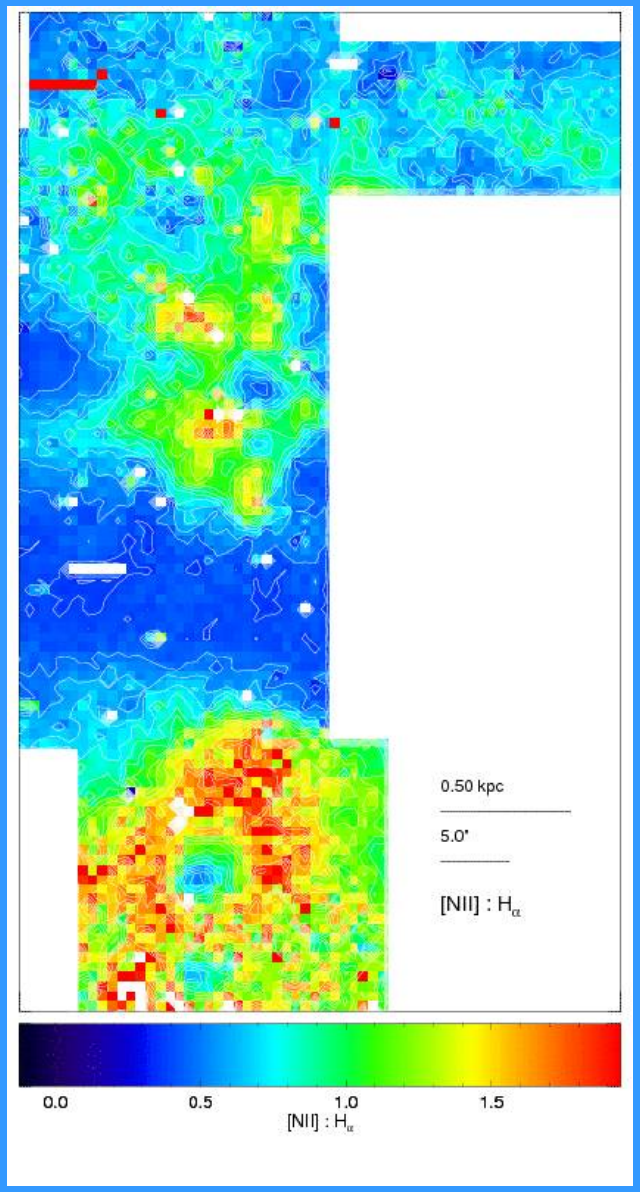
But what does it all mean?

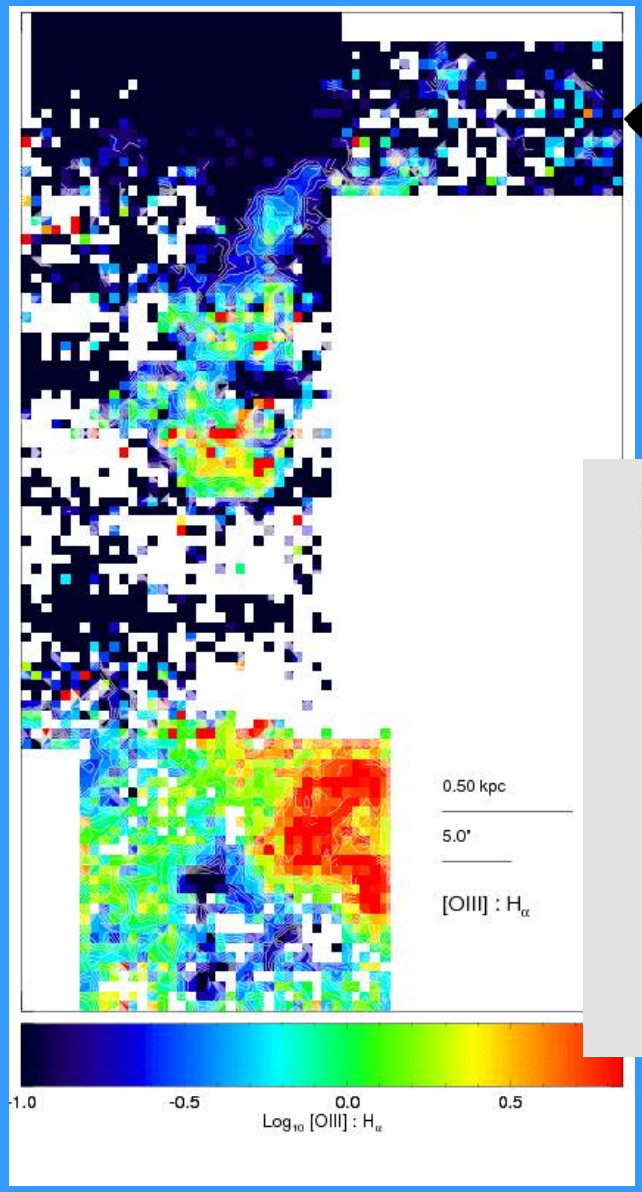
Rob Sharp, AAO, rgs@aao.gov.au

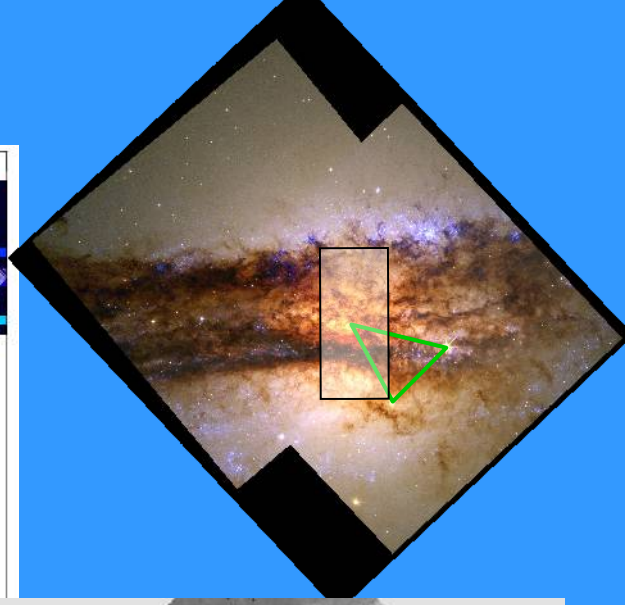
What do we learn?

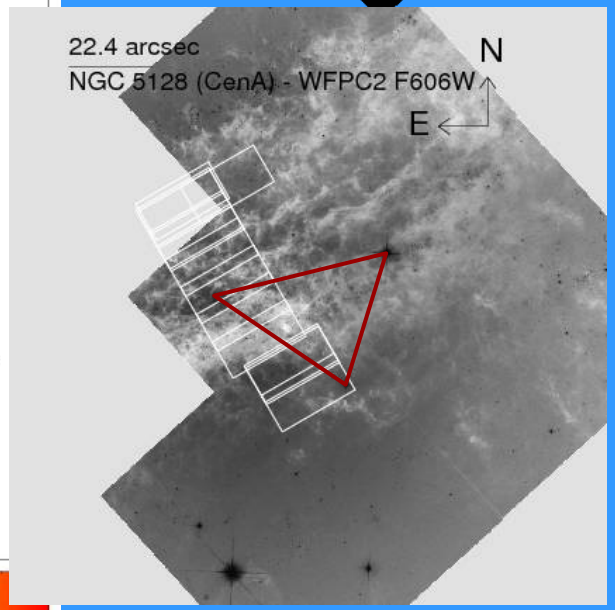
- Line intensity maps are great fun
- but line ratios are the key to understanding the physics

Coherent ionisation structures









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Ionisation Diagnostic Diagrams

Baldwin, Phillips & Terlevich 1981

Veilleux & Osterbrock 1987

Kewley *et al.* 2001

Shull & McKee 1979

And many others…

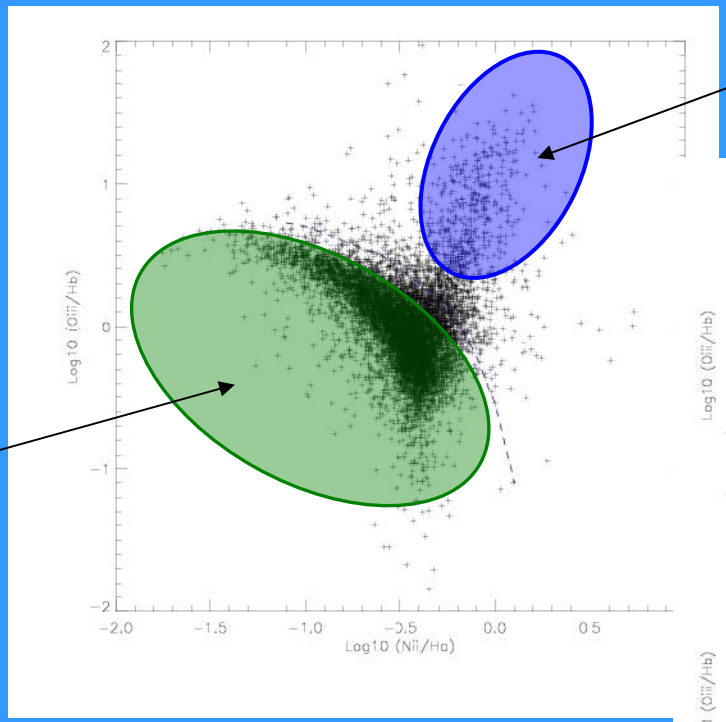
Hard UV

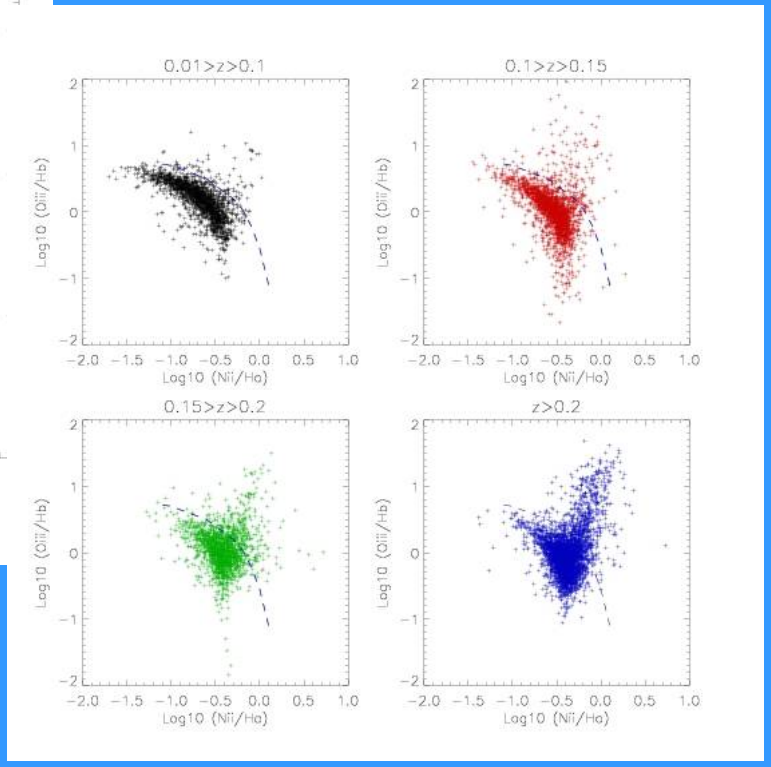
spectrum

AGN

Star formation

HII regions





GAMA project: *Galaxies and Mass Assembly*

http://www.eso.org/~jliske/gama/

Driver *et al.* in press

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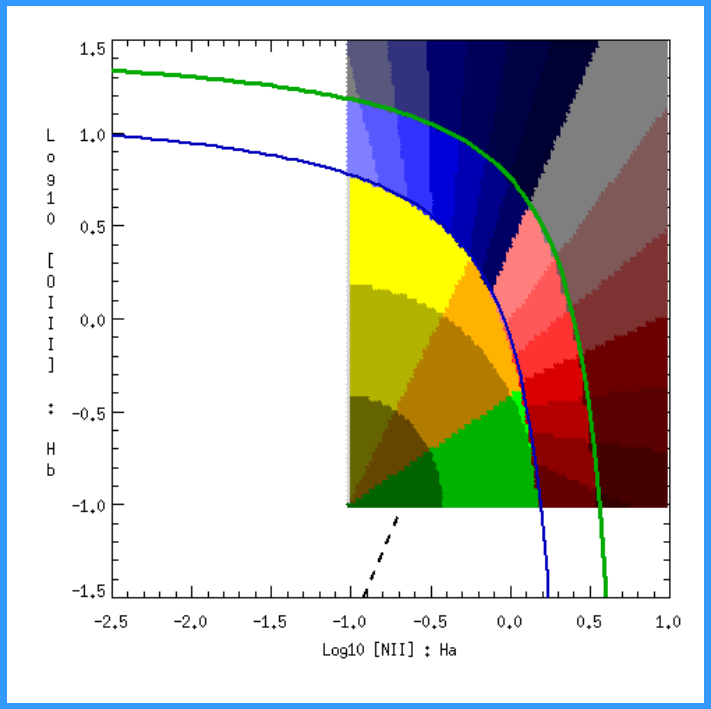
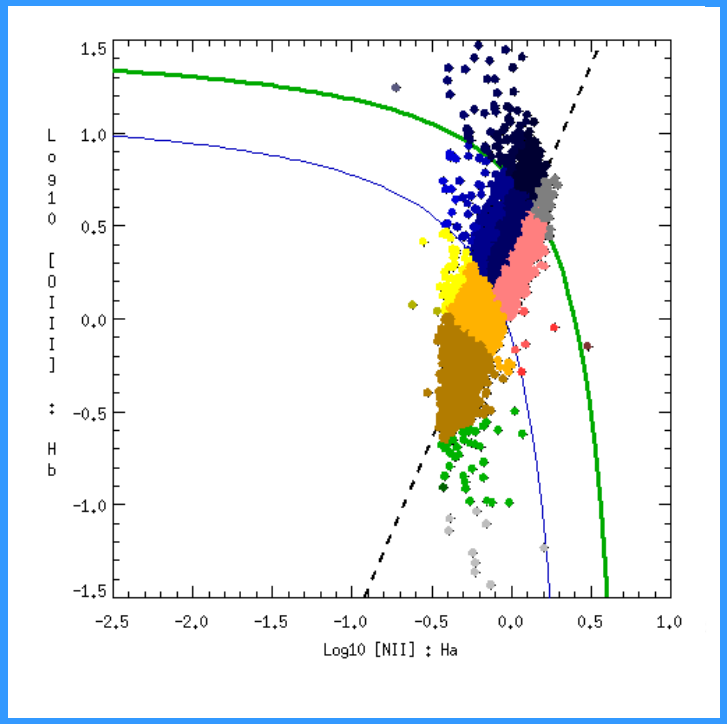
Classic BPT diagram for CenA





Horrid colour scheme is a work in progress

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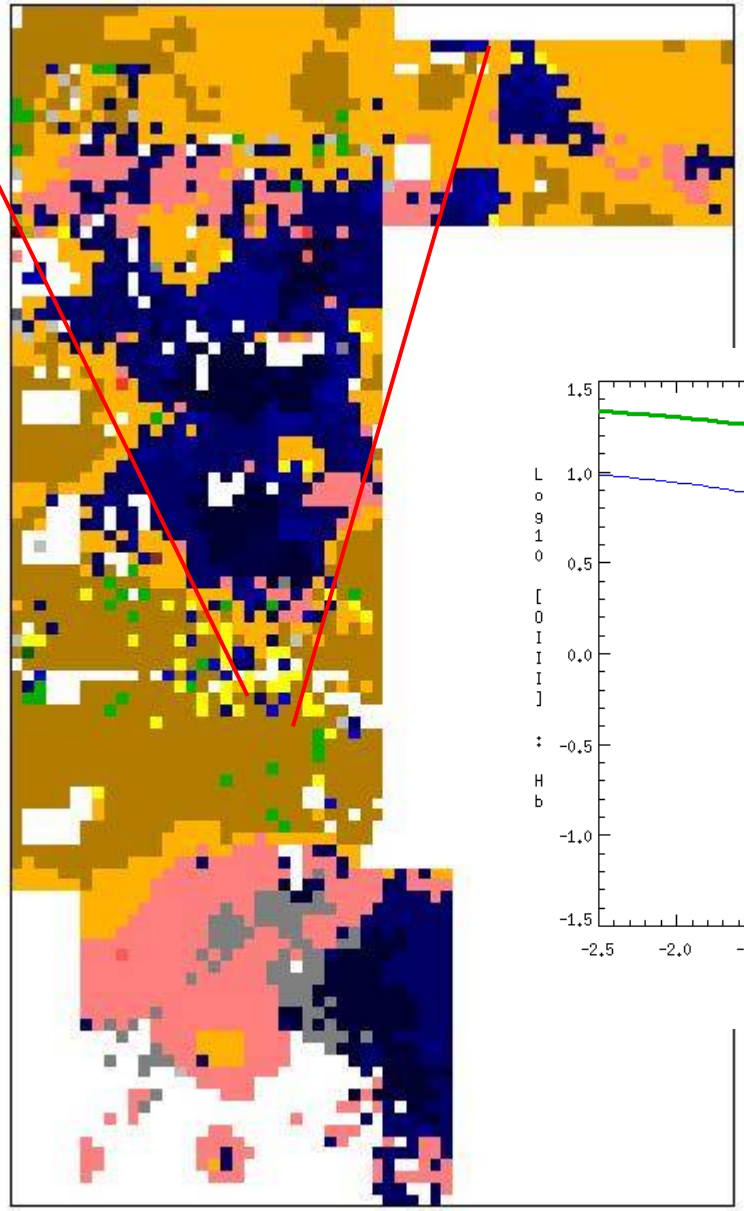
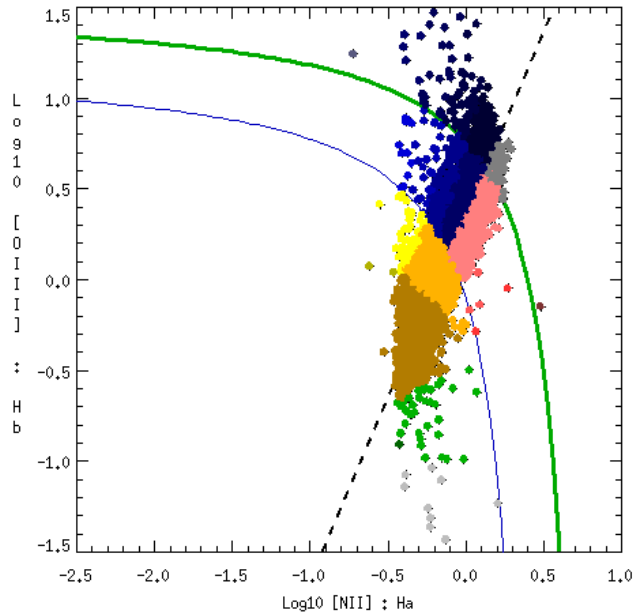
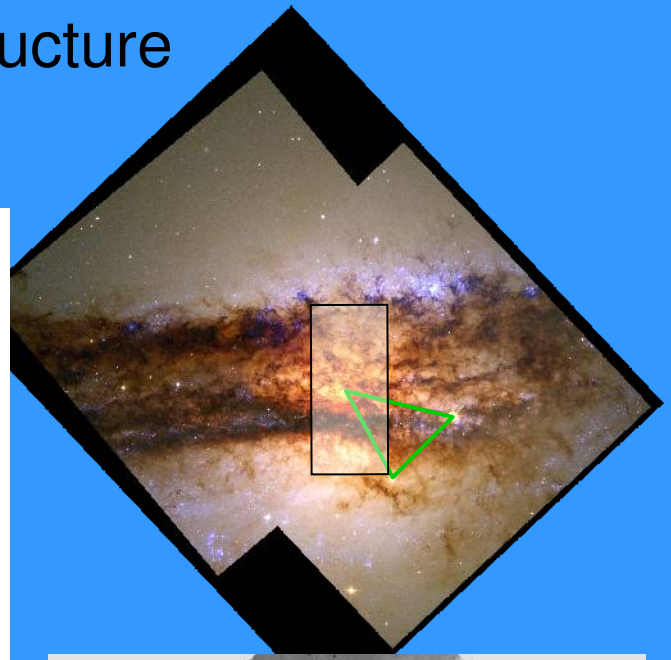
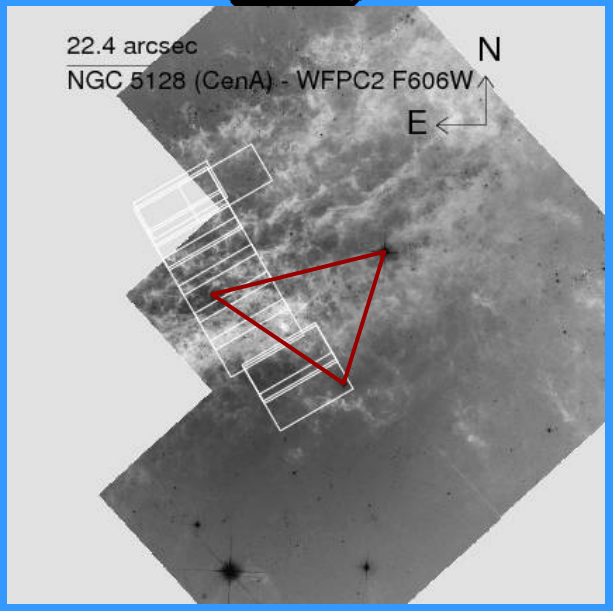
Strong Coherent ionisation structure









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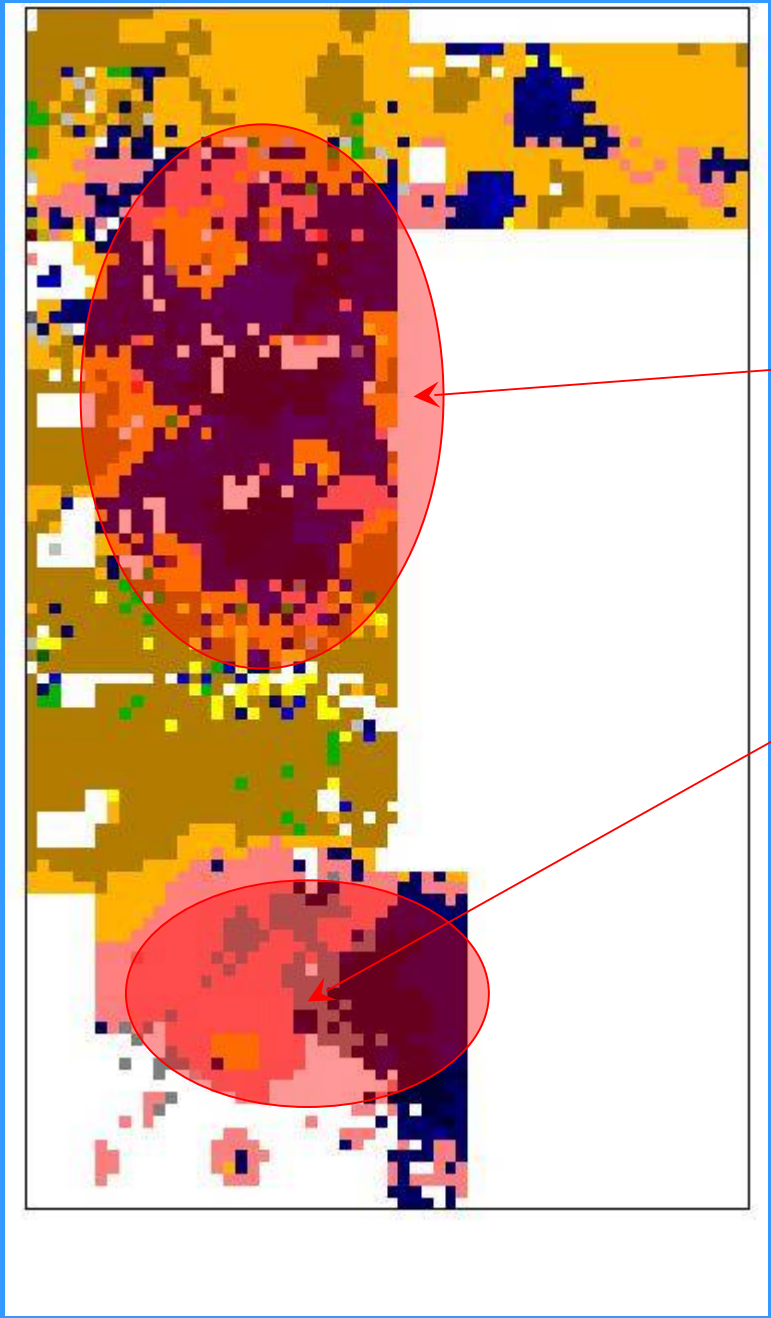
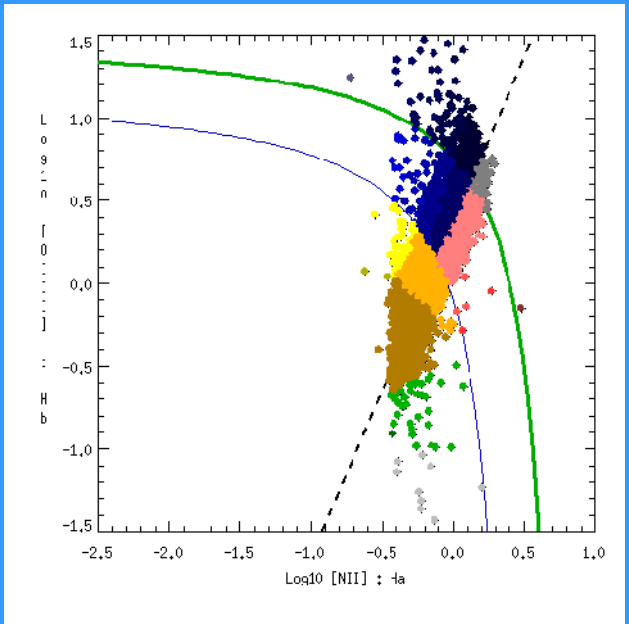


AGN ionisation cone

Counter jet region seems confused



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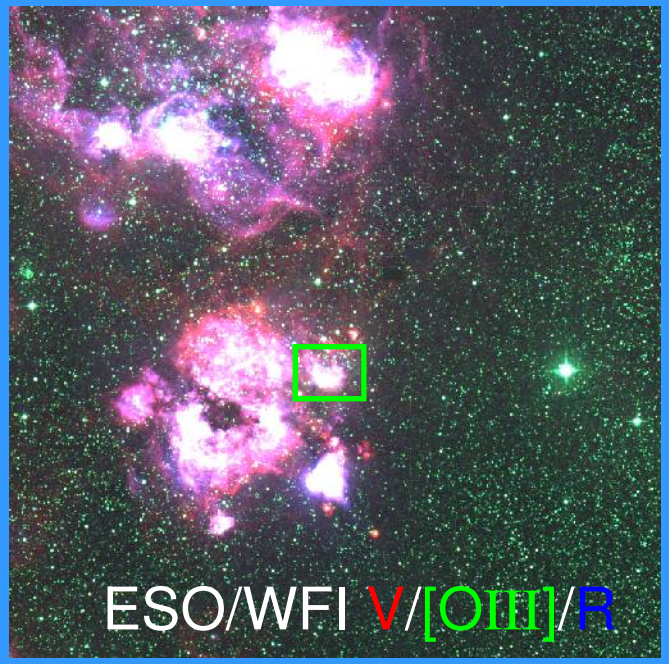
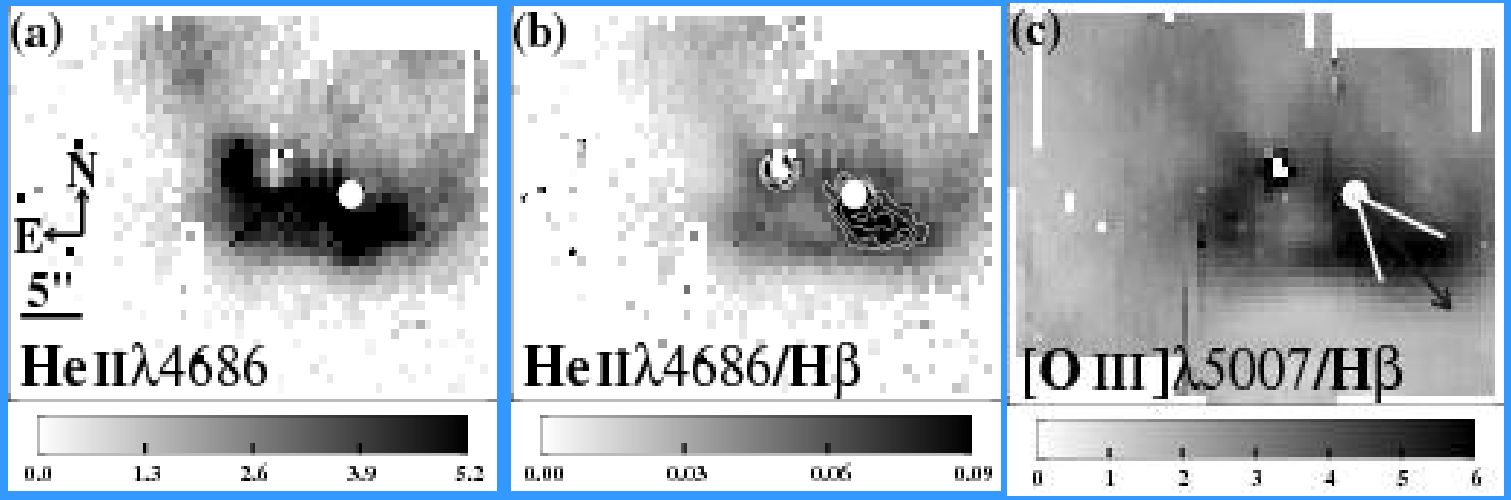
AGN Ionisation cones

Reconstructing the invisible nuclear source spectrum

Ryan Cooke,
PhD Cambridge IoA

VIMOS IFU observations of LMC-x1





Cooke, Kuncic, Sharp & Bland-Hawthorn 2007
Cooke, Bland-Hawthorn, Sharp & Kuncic 2008

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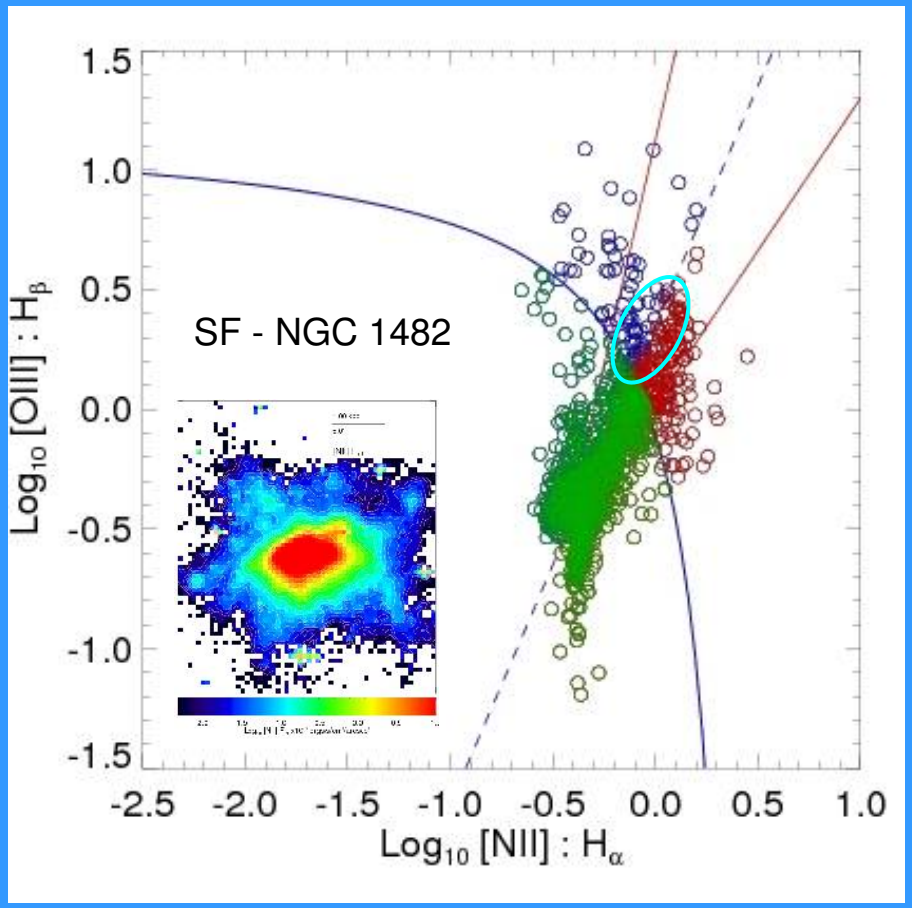
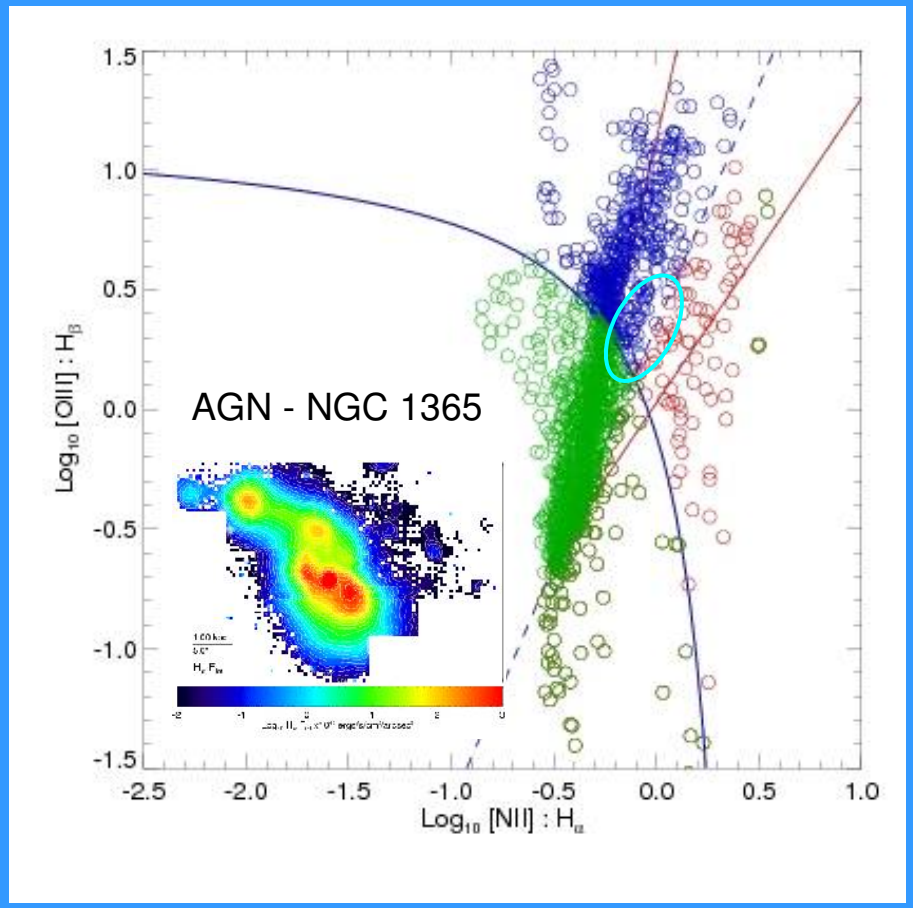
A complication

Dilute power-law or fast shock?





Even with ideal data (no beam smearing, no line blending) diagnostics are ambiguous **in this region**

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Conclusions

- Detection of an optical ionisation cone
- Likely ionised by a dilute power-law radiation field from the AGN
- Ionised medium is patch
- Less ordered ionisation structure to the south, perhaps due to counter jet interactions with a denser medium?
- Further analysis of the radiation field should reveal more of the central source intrinsic spectrum

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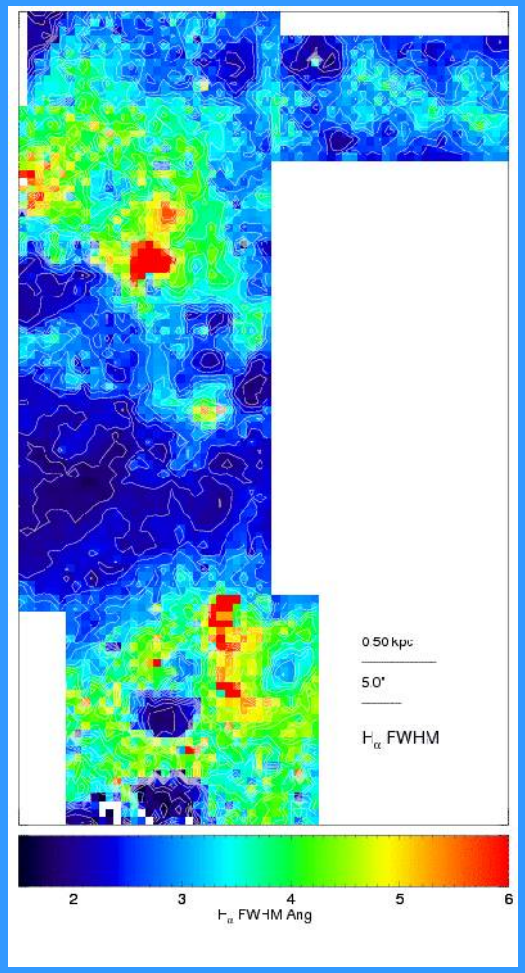

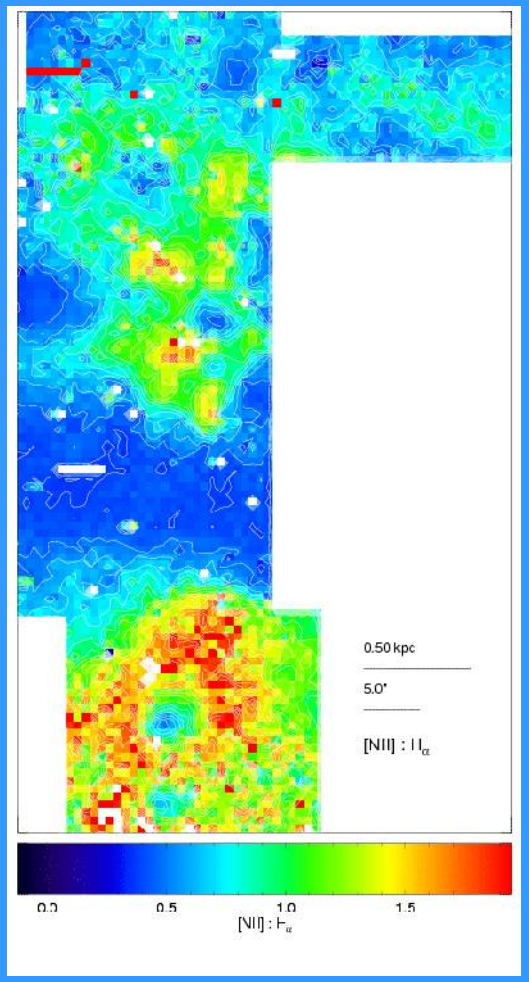

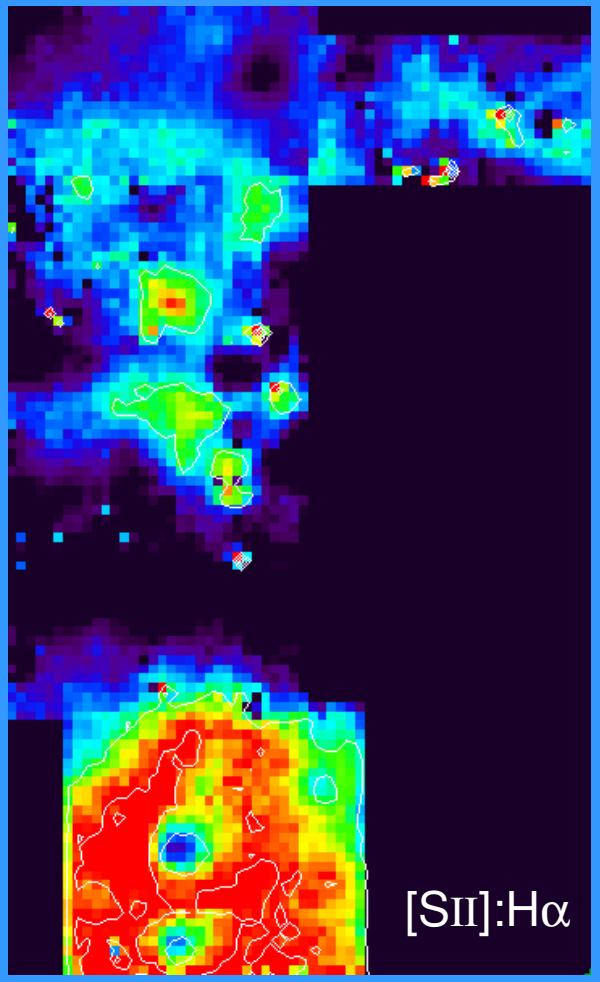

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