HI absorption in AGN: The ASKAP view

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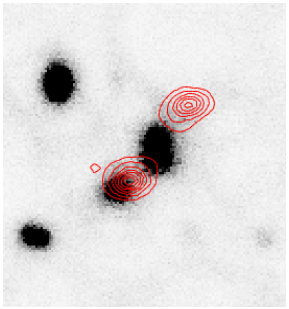
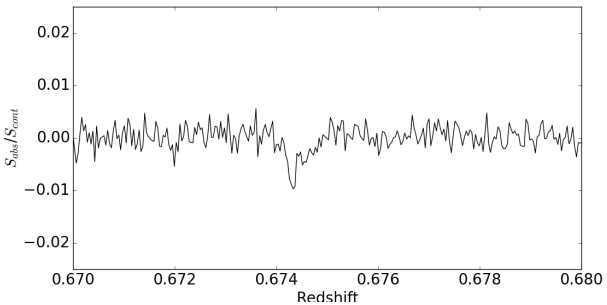
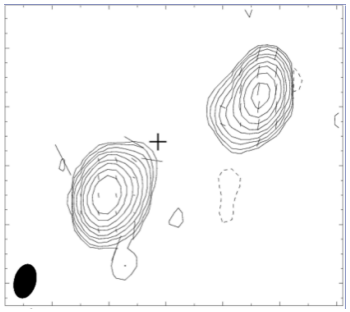
ASKAP-FLASH



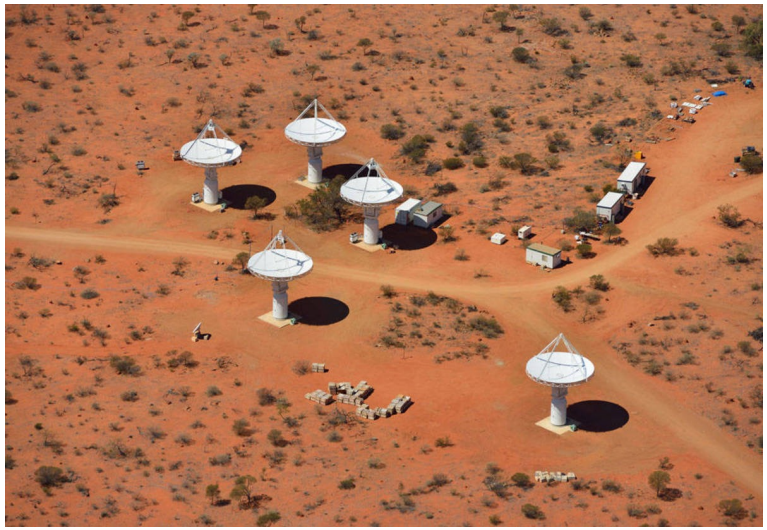




The FLASH survey

The First Large Absorption Survey in HI:

- Search ~150,000 sightlines for HI in absorption
- Blind approach: No pre-selection on background target sources
- HI-selected galaxy sample at 0.4<z<1.0.

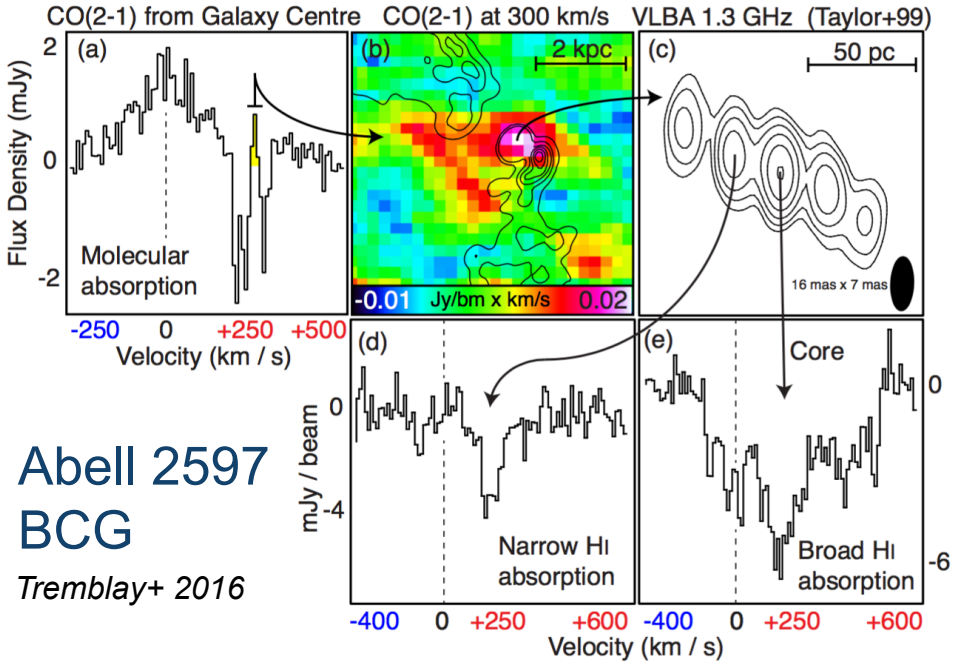


Detections can be split into two categories:

- **Intervening absorbers:** Study the *cosmic evolution of HI*, testing current galaxy evolution and mass assembly models
- **Associated absorbers:** Study *AGN fuelling and feedback* processes in powerful radio galaxies

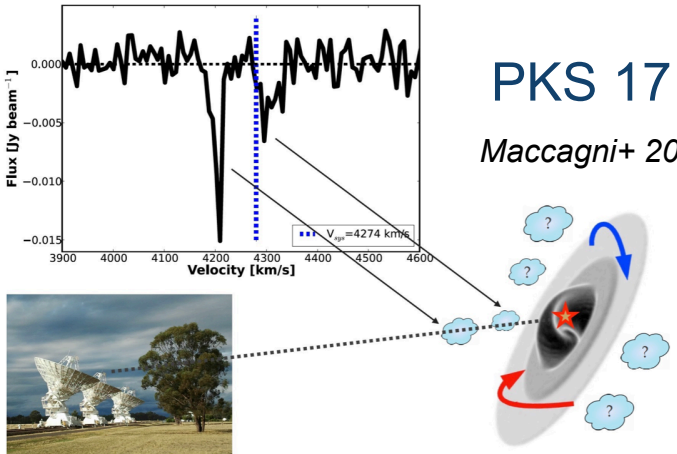
Image credit: CSIRO

AGN fuelling



Abell 2597 BCG

Tremblay+ 2016



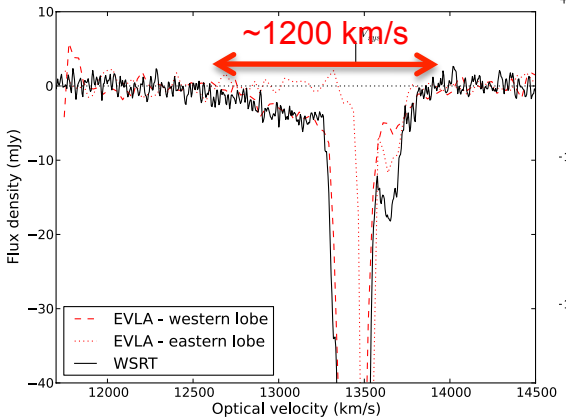
PKS 1718-649

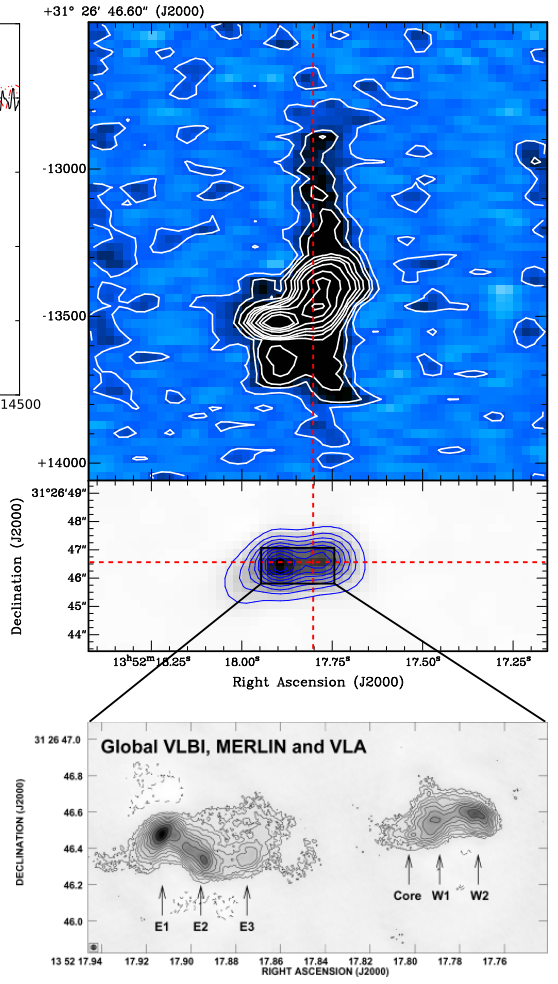
Maccagni+ 2014

- HI absorption probes cold gas close to the core
  - Can provide direct observations of AGN fuelling (see e.g. Tremblay+ 2016, Maccagni+ 2014)
- Radio galaxies often split into two separate populations according to accretion mode (High Excitation vs. Low Excitation Radio Galaxies)
  - Can observations of the cold gas provide insight into this dichotomy?

AGN feedback

- Broad, shallow HI absorption lines indicate fast outflows of cold gas (e.g. Morganti+2005, Morganti+2013, Mahony+2013)
- Neutral + molecular gas make up the bulk of these outflows (e.g. Dasyra & Combes 2012, Mahony+2016)

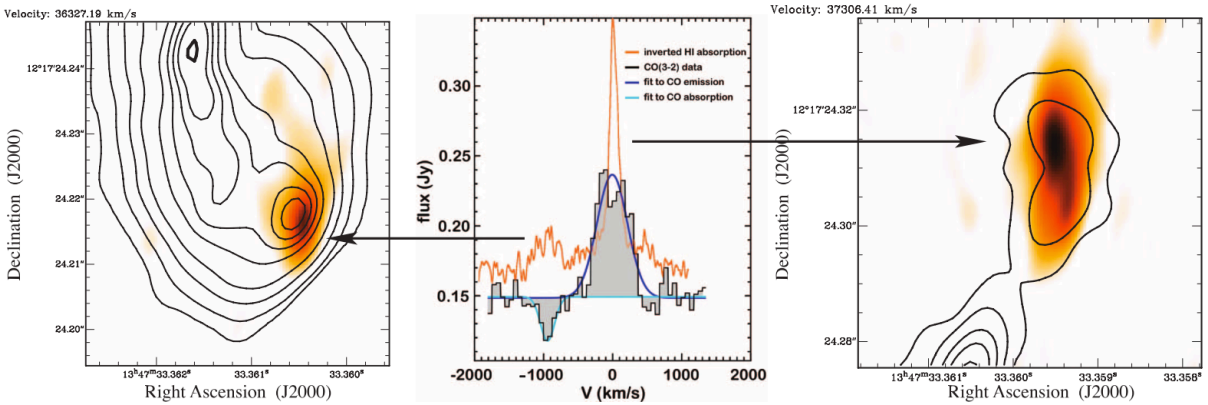




3C 293

Mahony+ 2013

4C 12.50



Morganti+ 2013

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ARC CENTRE OF EXCELLENCE FOR ALL-SKY ASTROPHYSICS

New detections with ASKAP

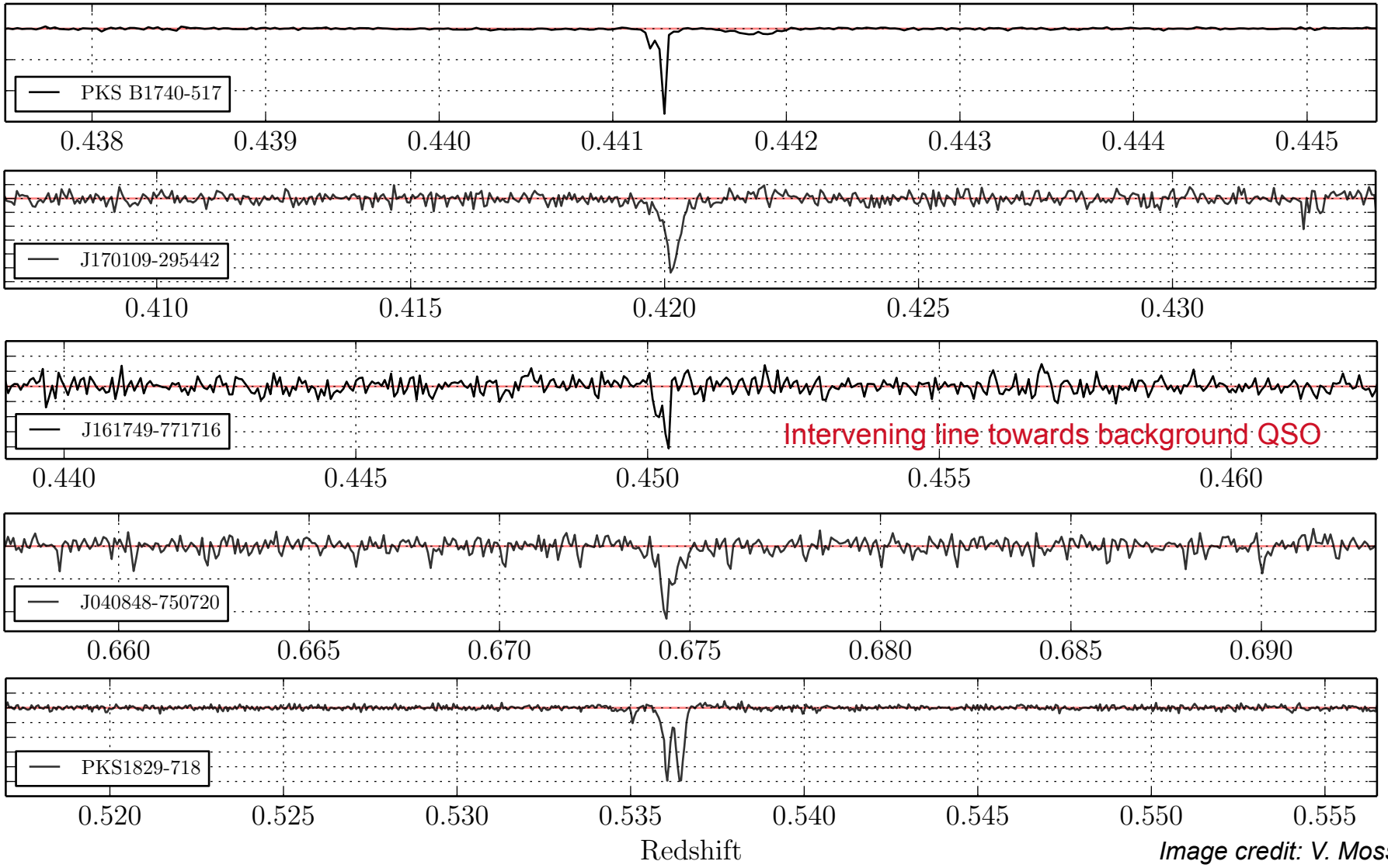

Image credit: V. Moss

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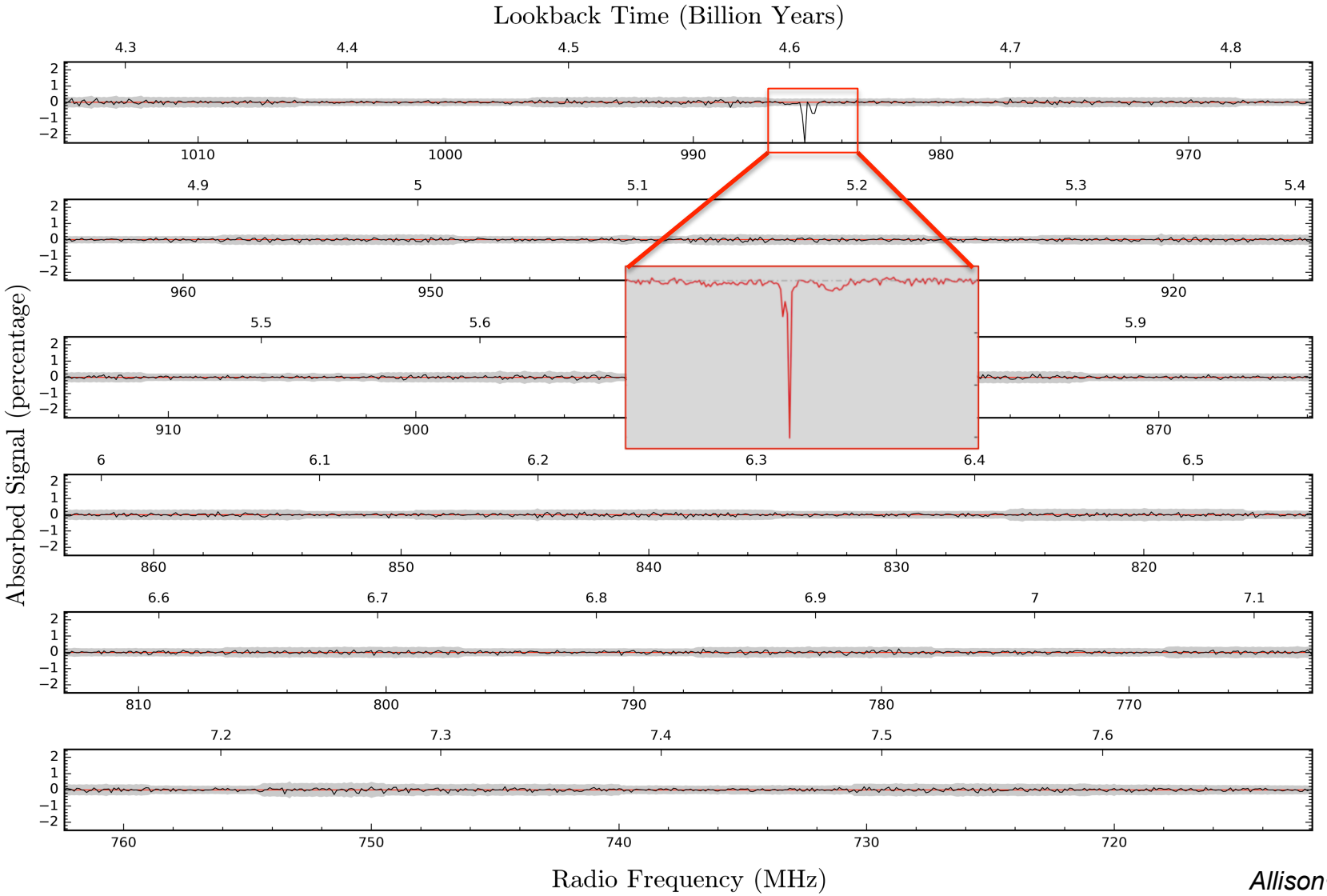
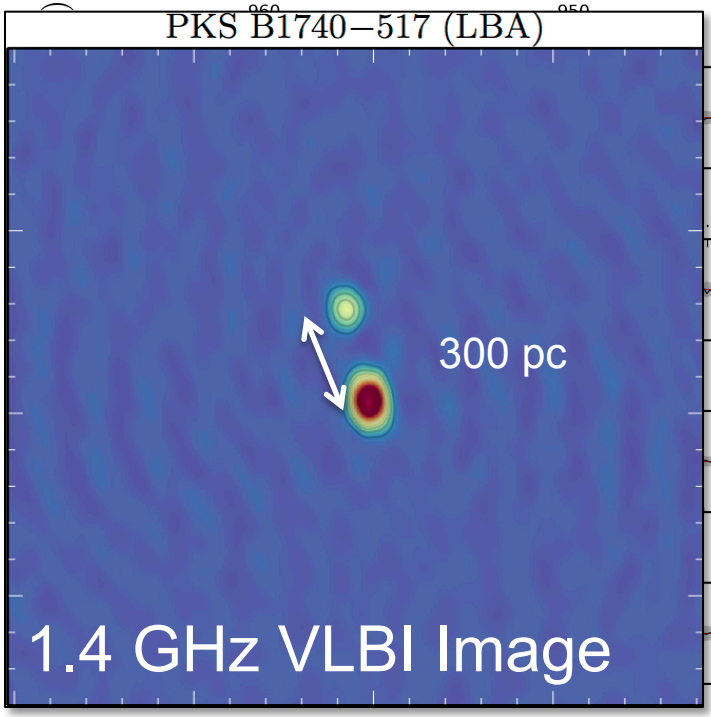
PKS1740-517: First new detection with ASKAP

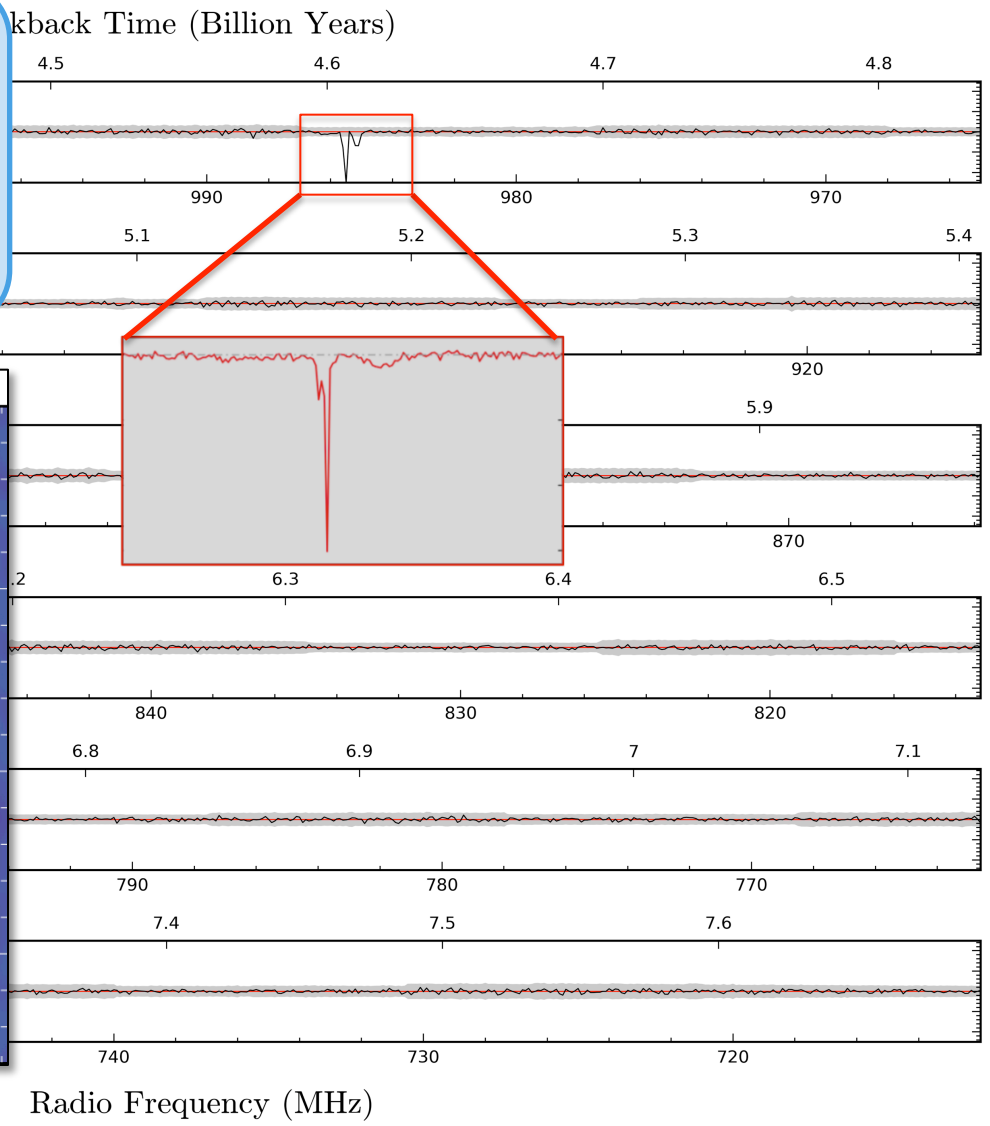


Allison+ 2015

PKS1740-517: First new detection with ASKAP

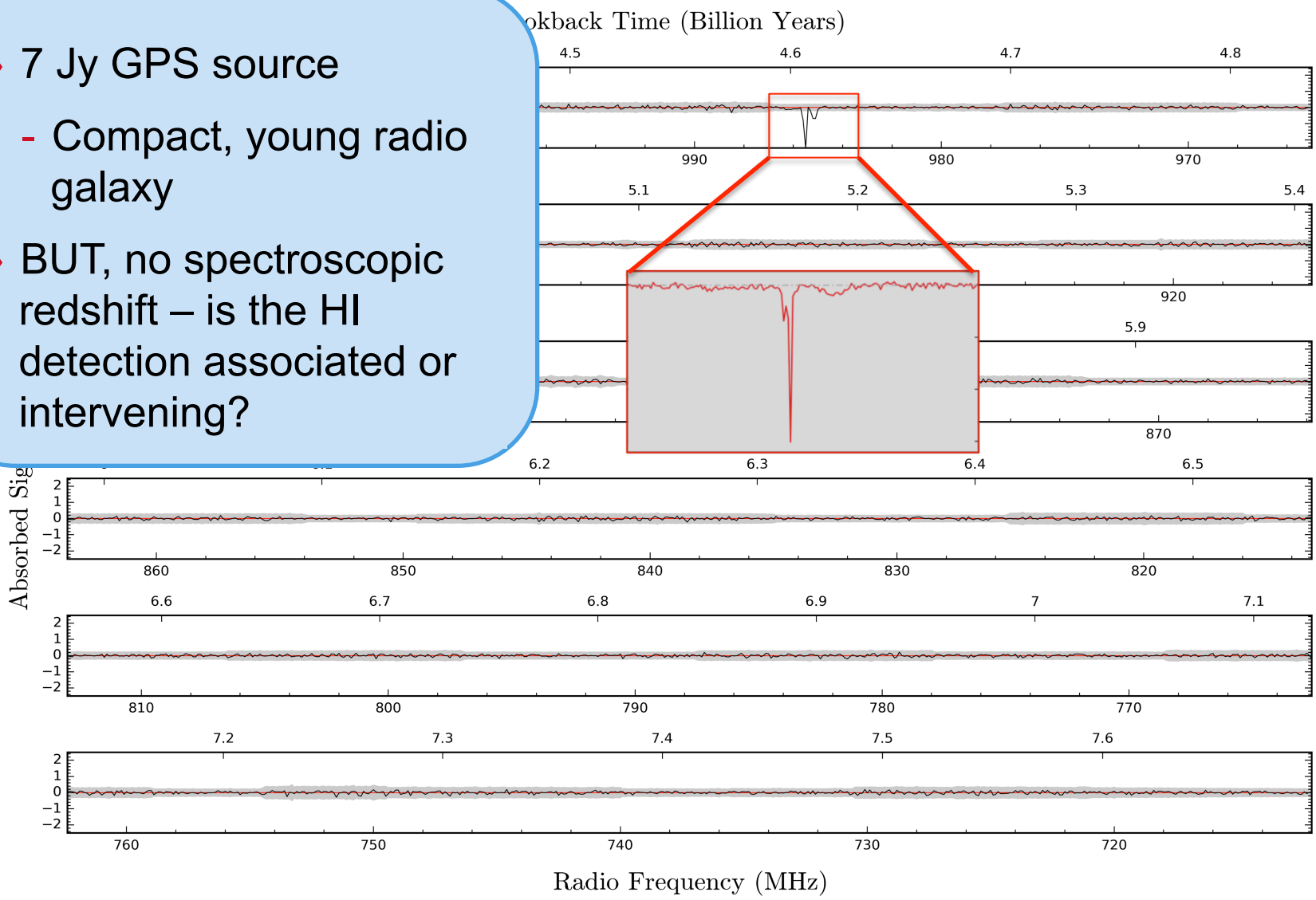
- 7 Jy GPS source
  - Compact, young radio galaxy





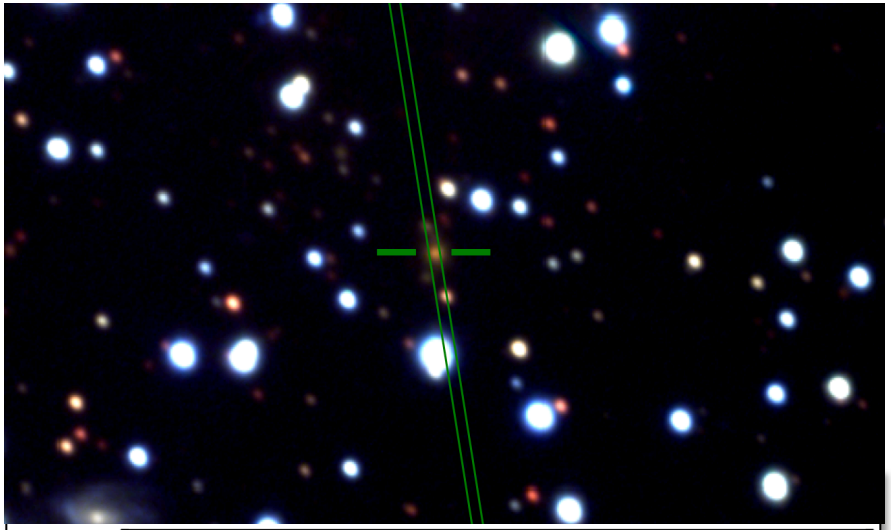
PKS1740-517: First new detection with ASKAP

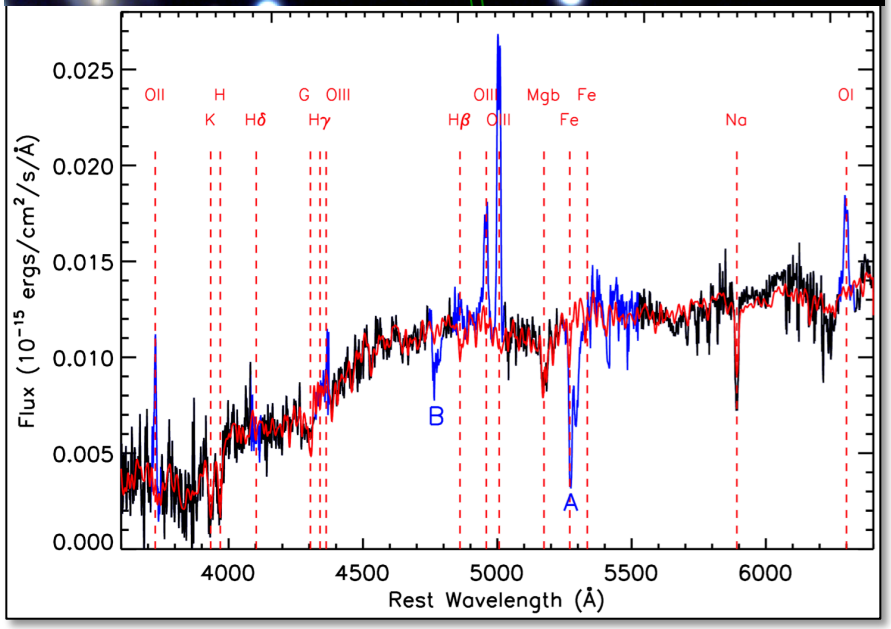
- 7 Jy GPS source
  - Compact, young radio galaxy
- BUT, no spectroscopic redshift – is the HI detection associated or intervening?



PKS1740-517: Optical follow-up

- Spectroscopic follow-up on Gemini-South (PI: Matt Whiting)
- Confirmed redshift of radio source at z=0.44
  - Associated system
- Strong [OIII] emission lines -> HERG
  - Also detect strong [OI] emission, indicating possible jet-ISM interaction?





Interpreting the gas kinematics

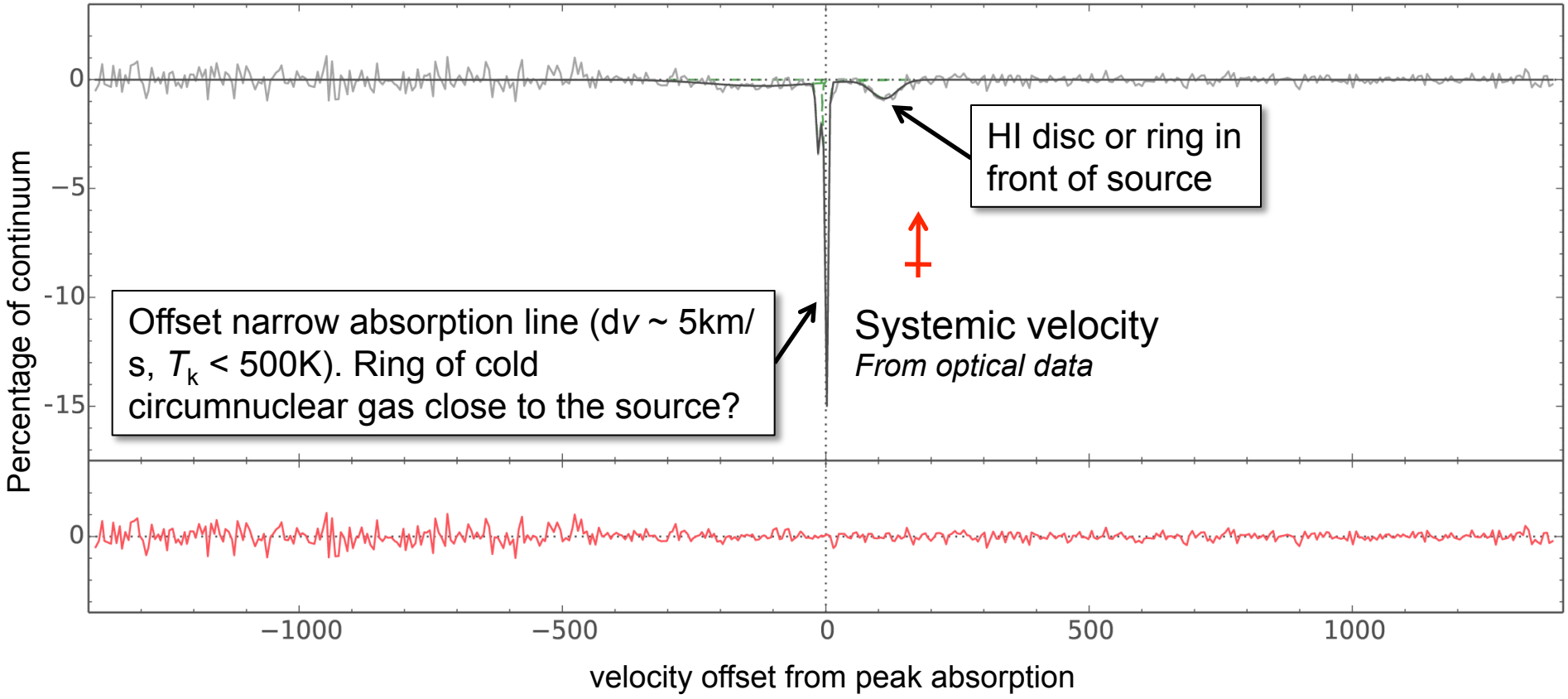


Image credit: J. Allison

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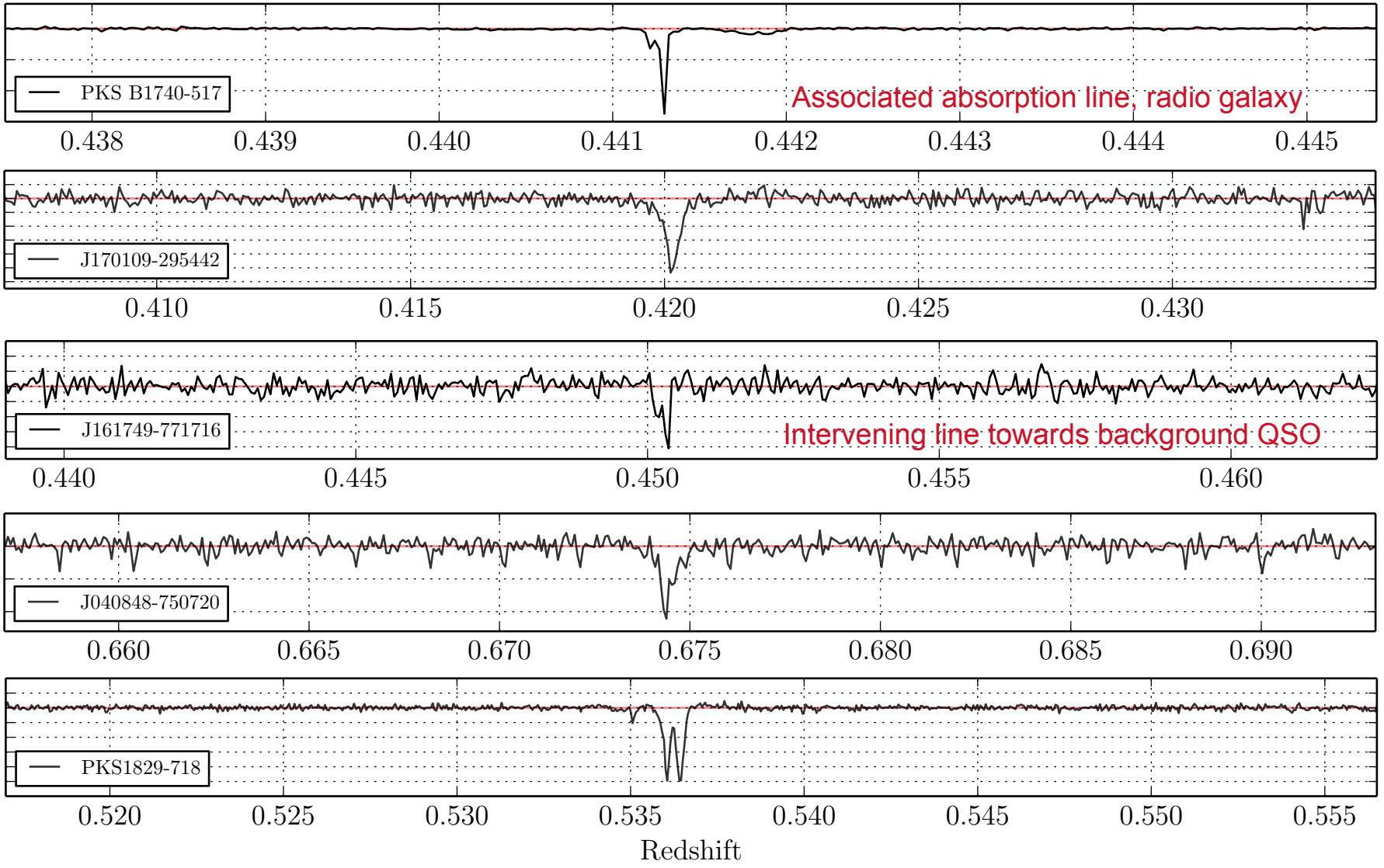
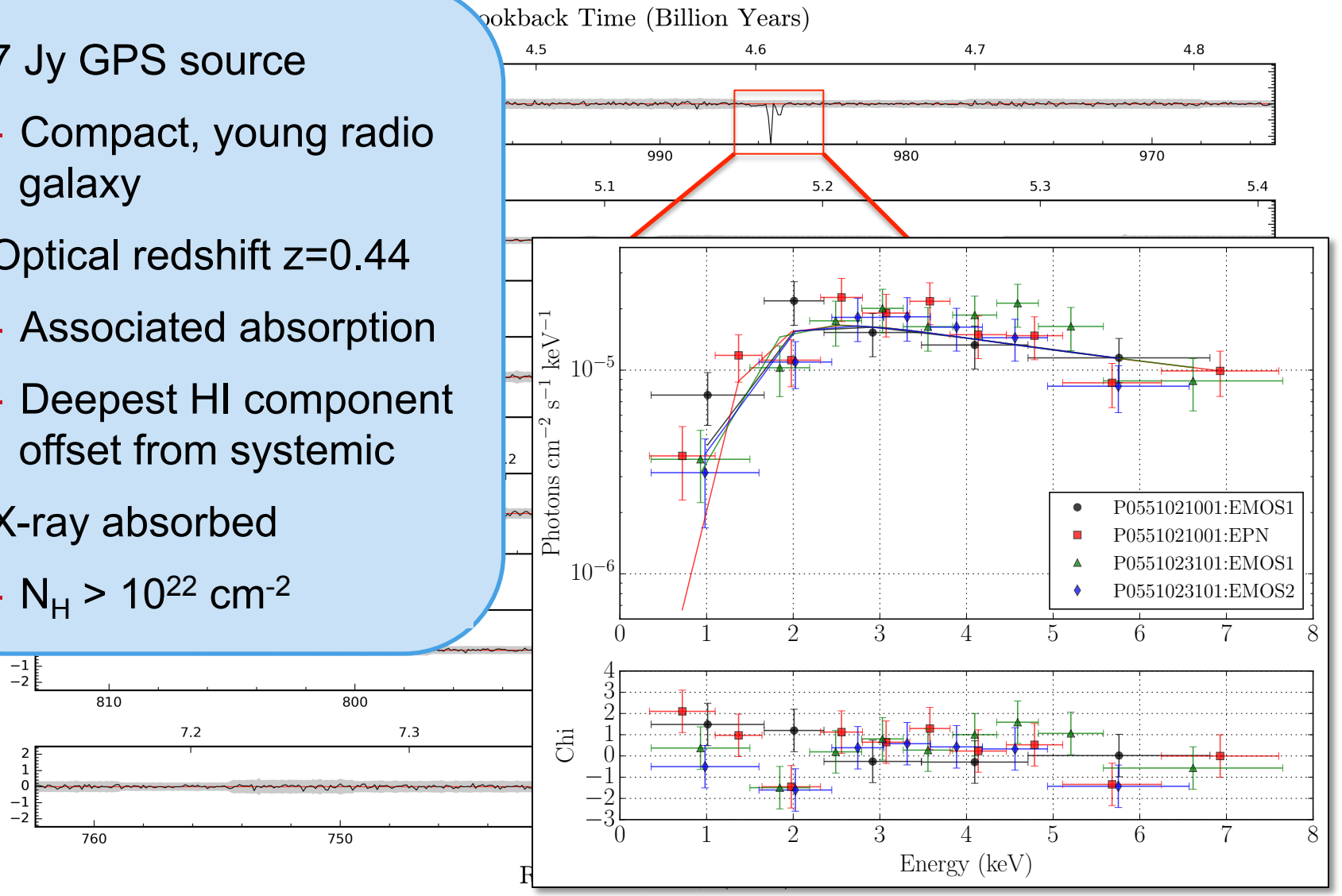


PKS1740-517: X-ray spectrum

- 7 Jy GPS source
  - Compact, young radio galaxy
- Optical redshift z=0.44
  - Associated absorption
  - Deepest HI component offset from systemic
- X-ray absorbed
  - $N_H > 10^{22}$ cm^{-2}



The BETA X-ray sample

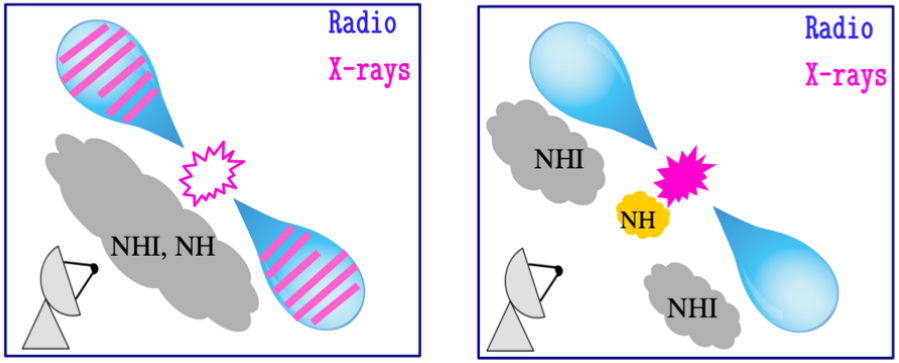
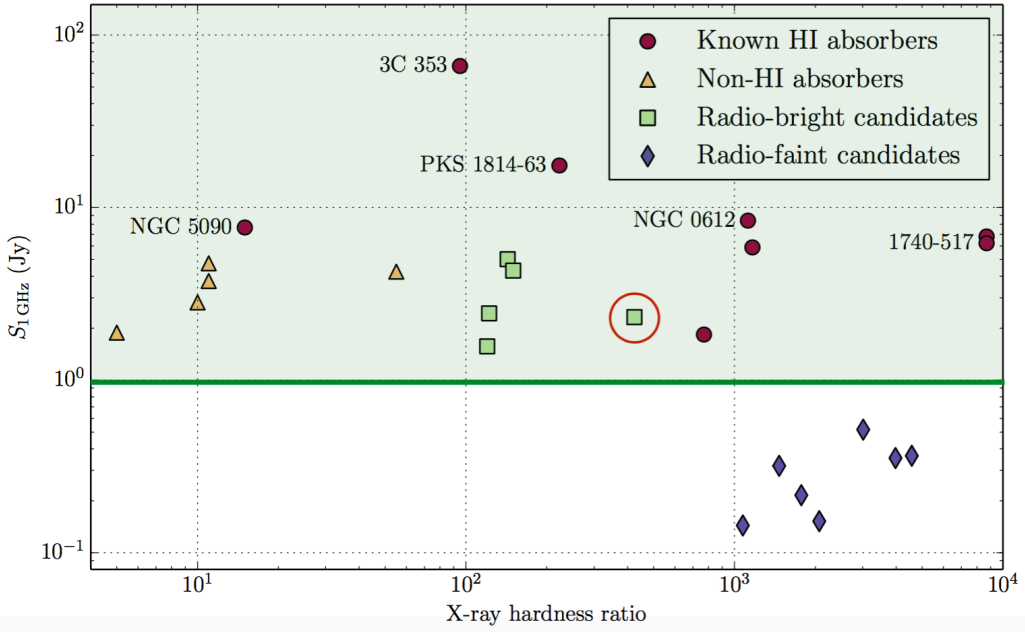
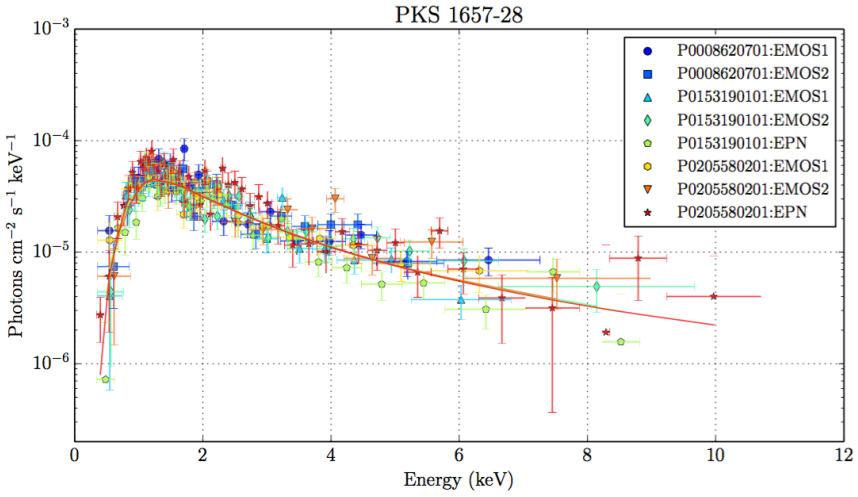


Image credit: L. Ostorero

- Correlation between HI absorption and X-rays in GPS sources (Ostorero+ 2010, 2016)
- Observed pilot sample of 5 sources showing X-ray absorbed spectrum





Moss+ in prep

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PKS1657-298

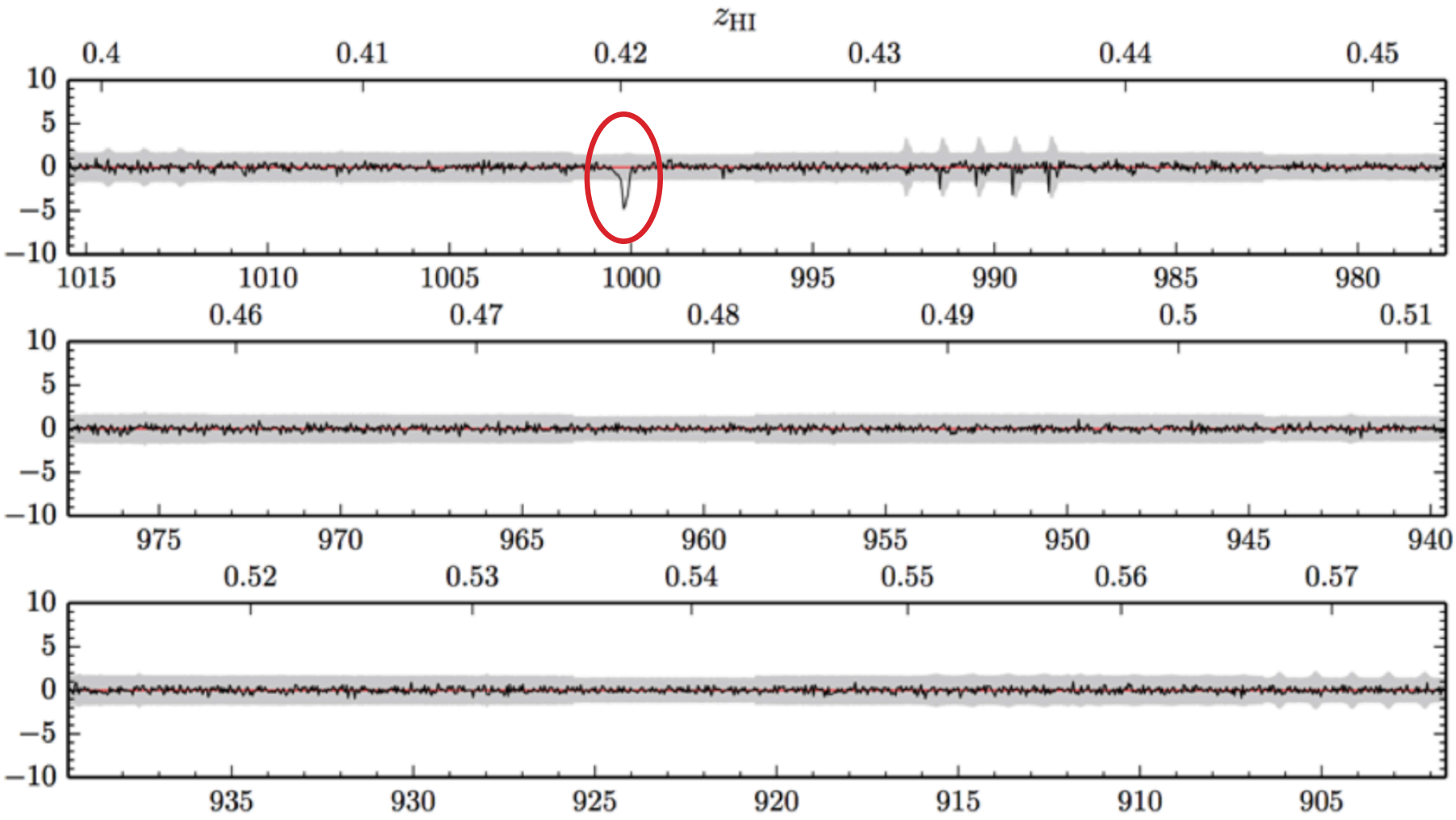
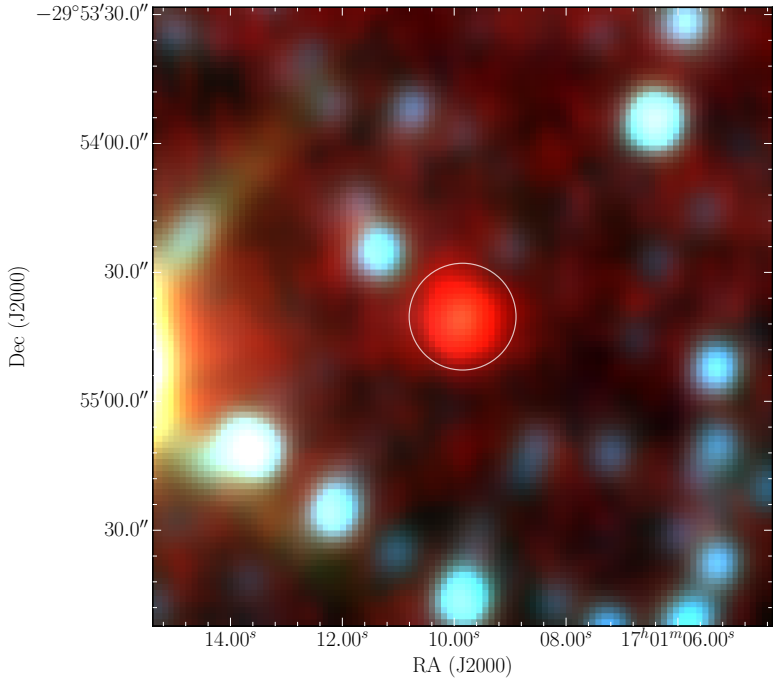


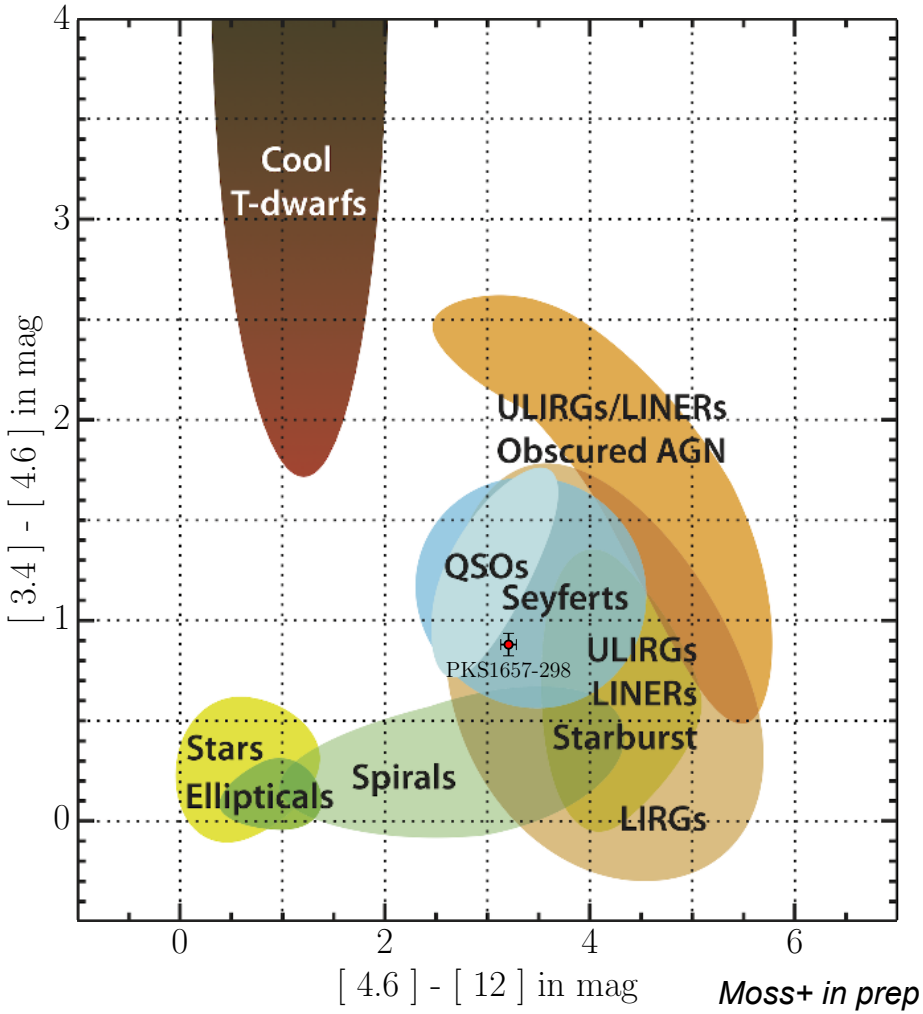
Image credit: V. Moss

Characterising the host

- No known spectroscopic redshift
- WISE colours suggest QSO or Seyfert host
- IR and optical follow-up planned



WISE 3 colour image – 3.4, 4.6, 12um



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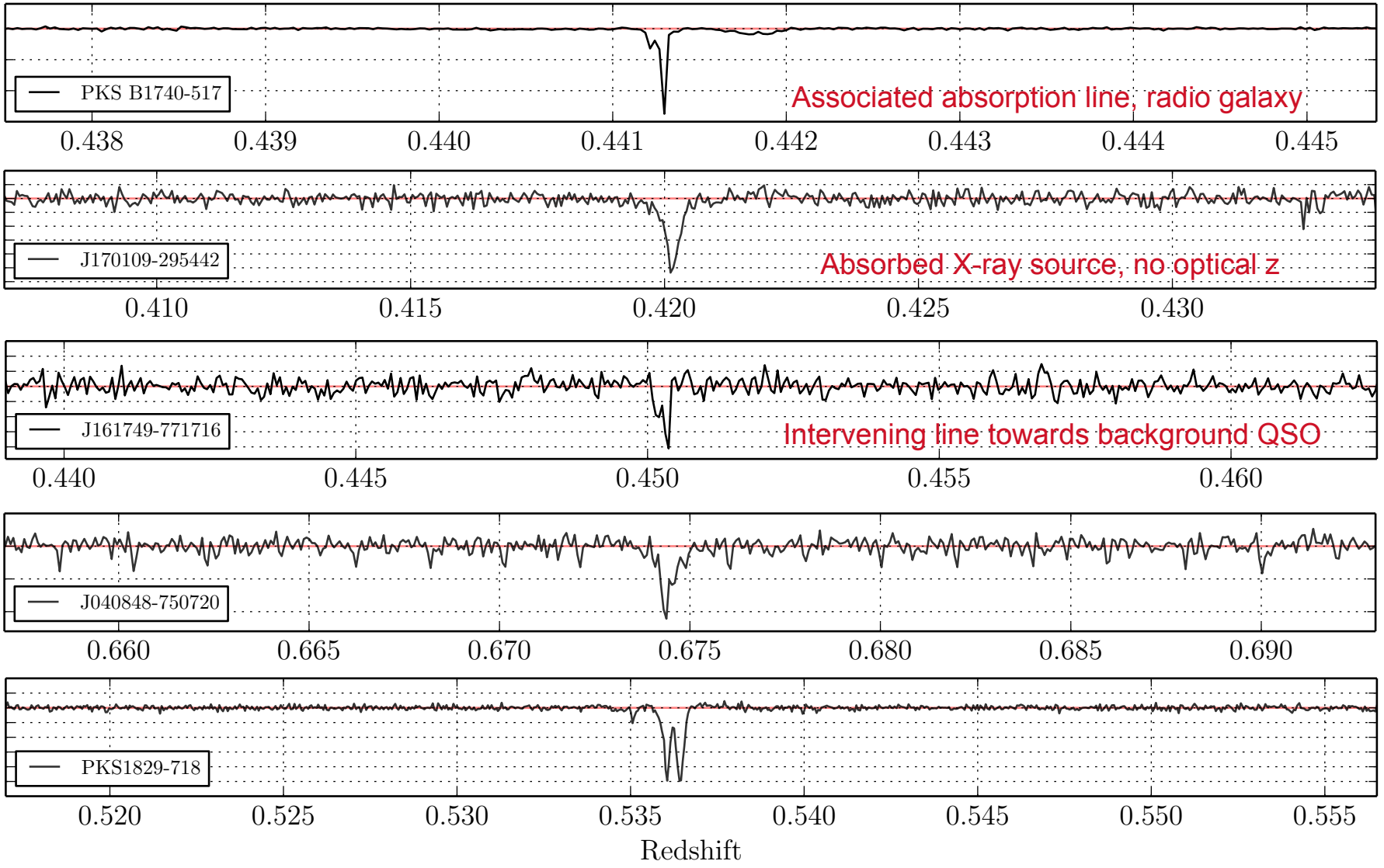
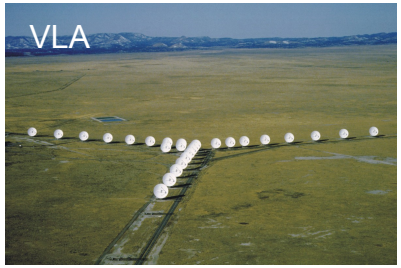


The 2-Jy sample

- Observed 10 sources selected from the 2-Jy sample with BETA
  - Sample of the brightest southern radio sources selected to be brighter than 2 Jy at 2.7 GHz (Wall+ Peacock 1985)
  - Redshift range 0.4<z<0.7
- Pilot for FLASH survey – sources selected based on flux density only
- Comprehensive multi-wavelength follow-up (Morganti+93, Tadhunter+93)



Multi-frequency radio imaging

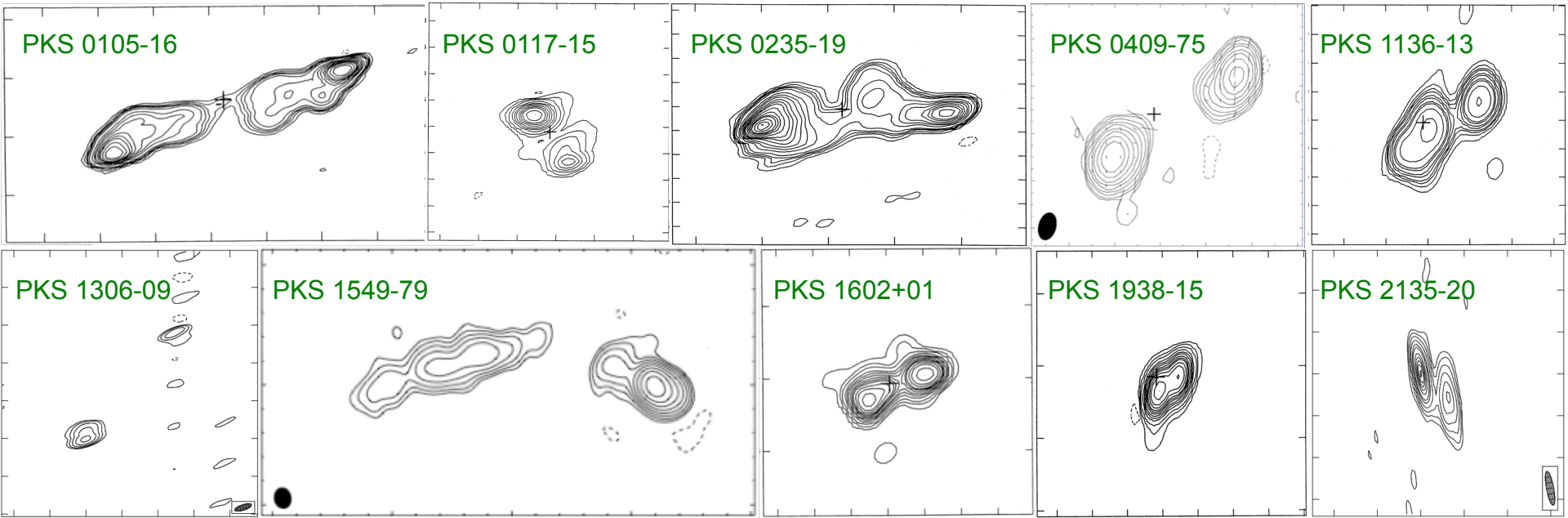
Deep optical imaging and spectroscopy

Near, mid and far-IR data

X-ray imaging

The 2-Jy sample

- Observed each source for 3-7 hrs per source, aim to reach optical depth of ~few per cent.
- Forms a high-z comparison to Morganti+2001
  - Searched for HI absorption in 2-Jy sources in the redshift range 0.1<z<0.2
  - Detected 5/23 sources – 22% detection rate



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The 2-Jy sample

Source	z	Radio class	Optical class	Cont. flux (Jy)	Hrs obs.	5σ op. depth
PKS 0105-16	0.400	FRII	NLRG	8.6	2.5	2%
PKS 0117-15	0.565	FRII	NLRG	9.1	2.5	2%
PKS 0235-19	0.620	FRII	BLRG	6.5	3	3%
PKS 0409-75	0.693	FRII	NLRG	21.1	4	0.5%
PKS 1136-13	0.554	FRII	QSO	8.0	4	4%
PKS 1306-09	0.464	CSS	NLRG	7.0	7	1.5%
PKS 1547-79	0.483	FRII	BLRG	6.0	3	2%
PKS 1602+01	0.462	FRII	BLRG	7.7	7.5	1.5%
PKS 1938-15	0.452	FRII	BLRG	12.3	3	2%
PKS 2135-20	0.635	CSS	BLRG	3.8	4	5%

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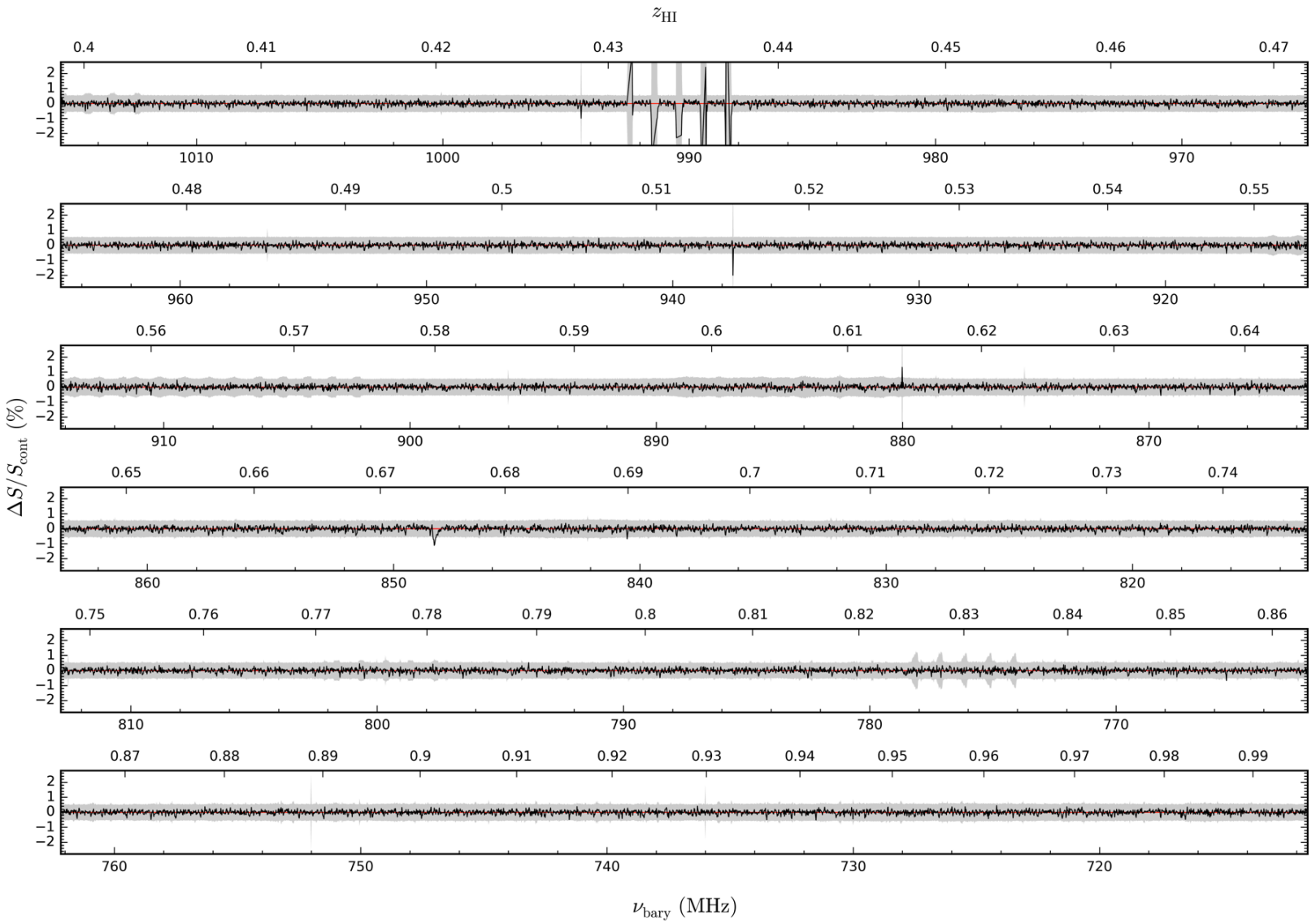
BETA spectrum



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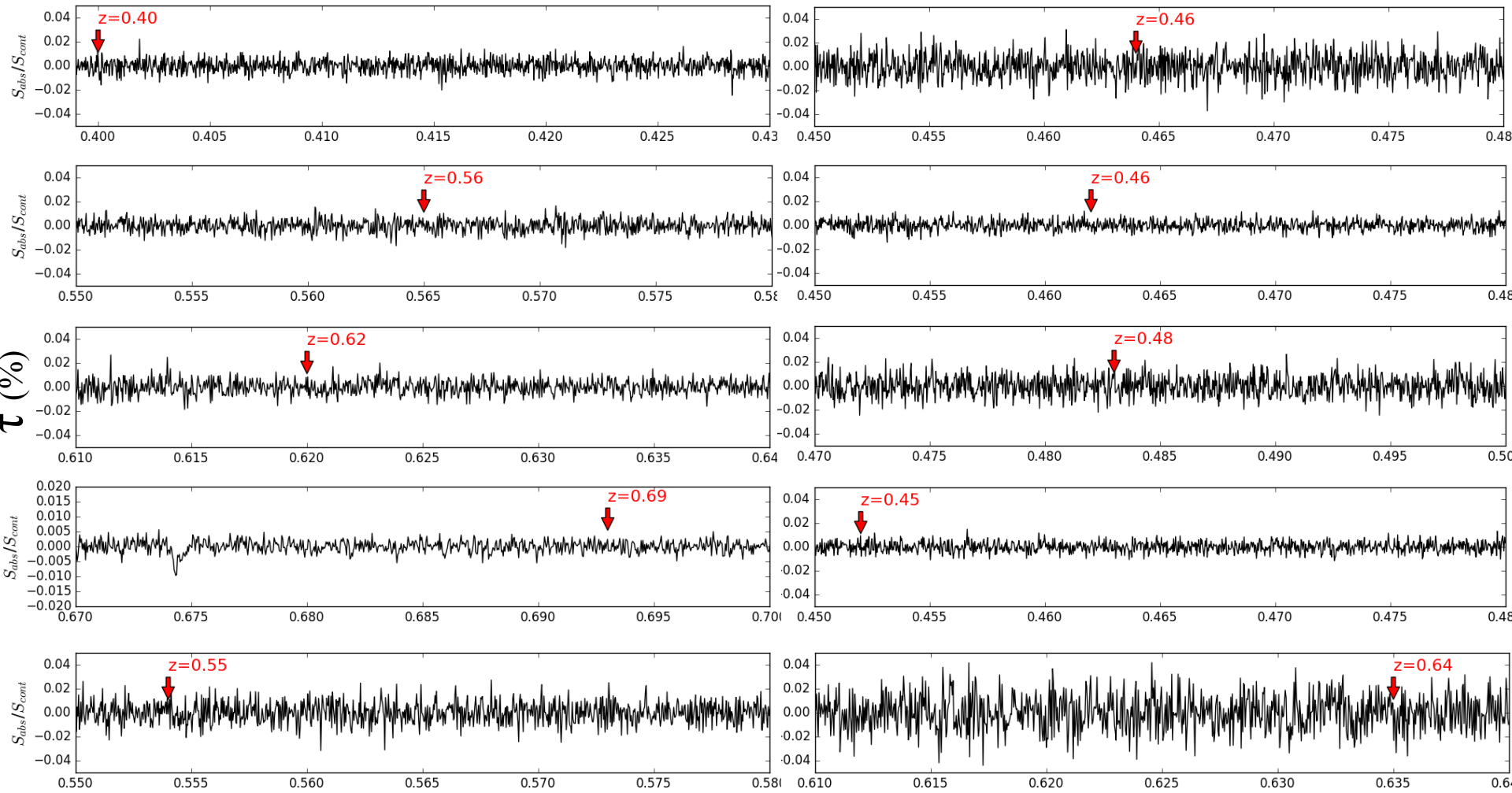
BETA spectra



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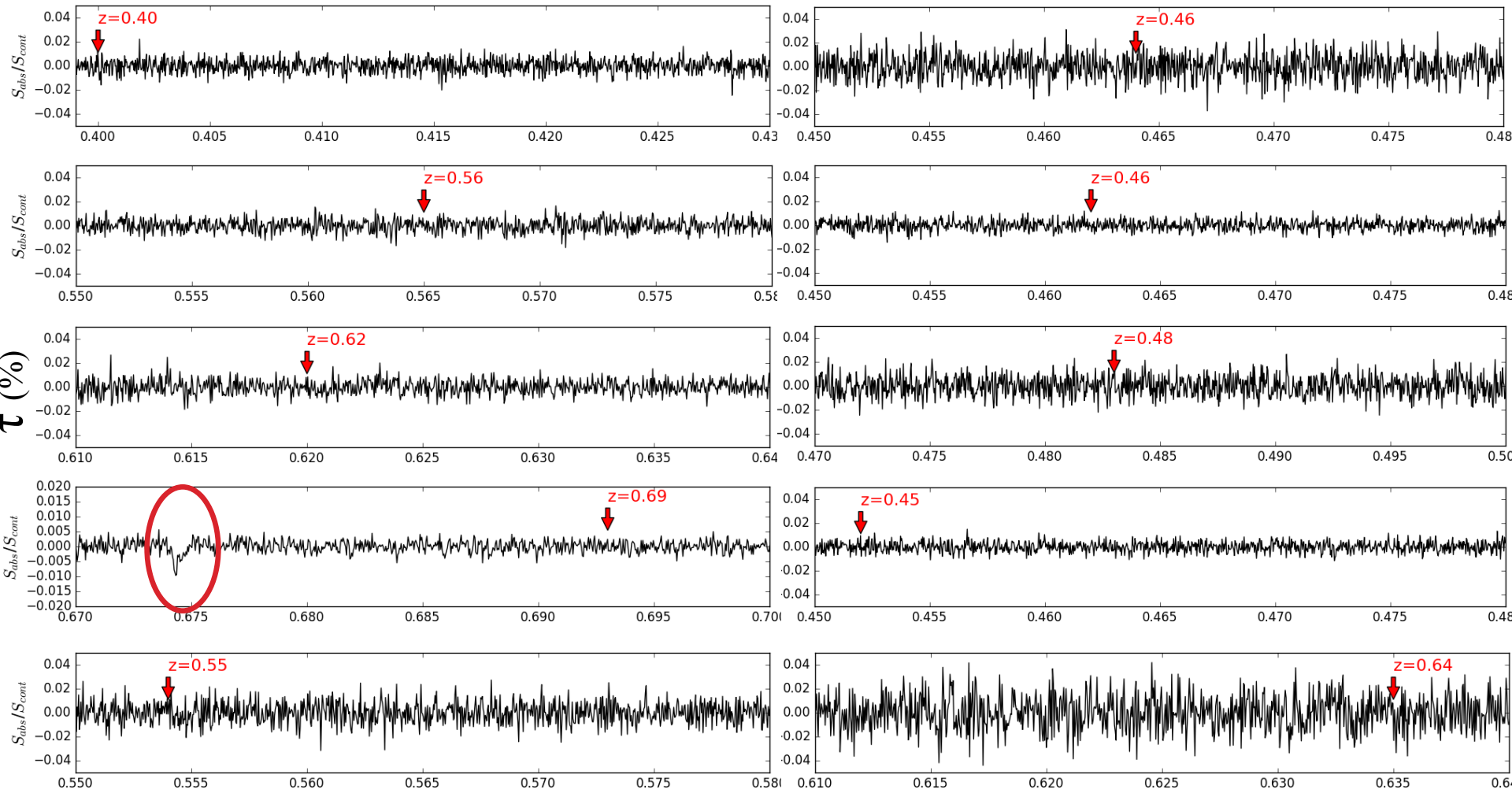
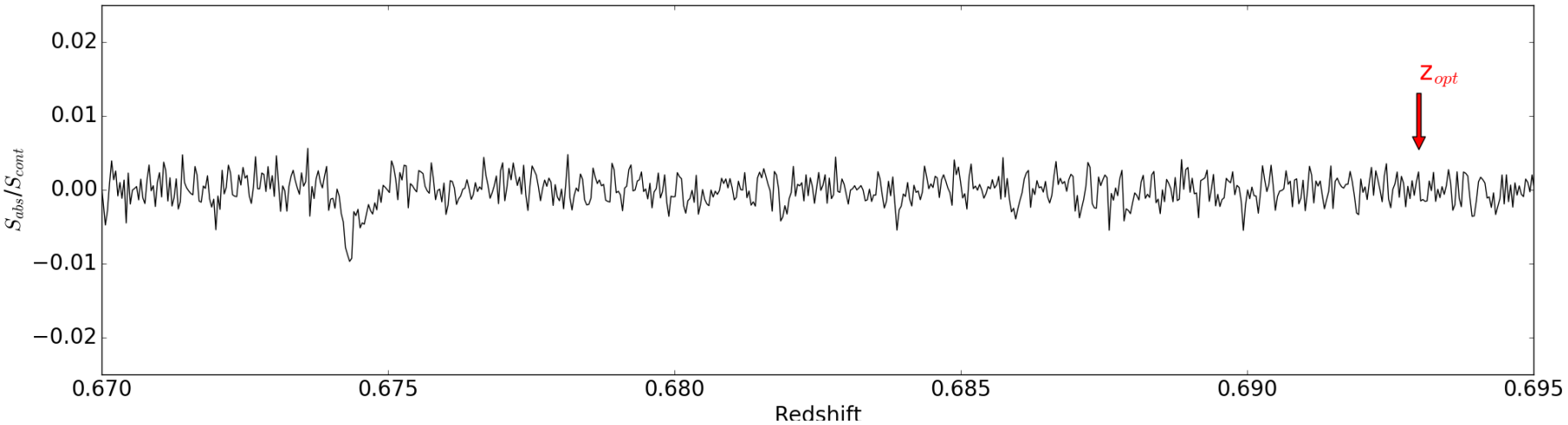
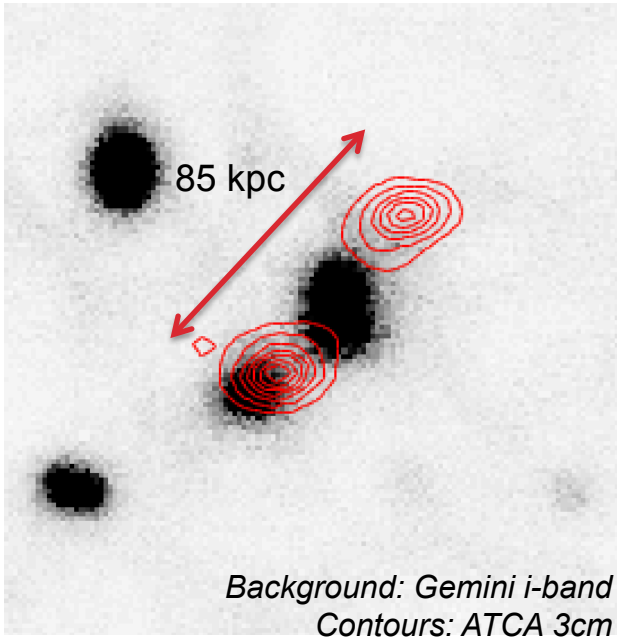


PKS0409-75



- z_{HI} = 0.674, but z_{opt}=0.693 -> HI blueshifted by 3000 km/s
  - Is this absorption associated with the host galaxy?
  - Or associated with another galaxy in the group?
    - Need follow-up observations for confirmation: optical spectroscopy of nearby source, ALMA
  - A chance alignment?
- Submitted follow-up proposals – obtained WIFES IFU data last week!



Background: Gemini i-band
Contours: ATCA 3cm

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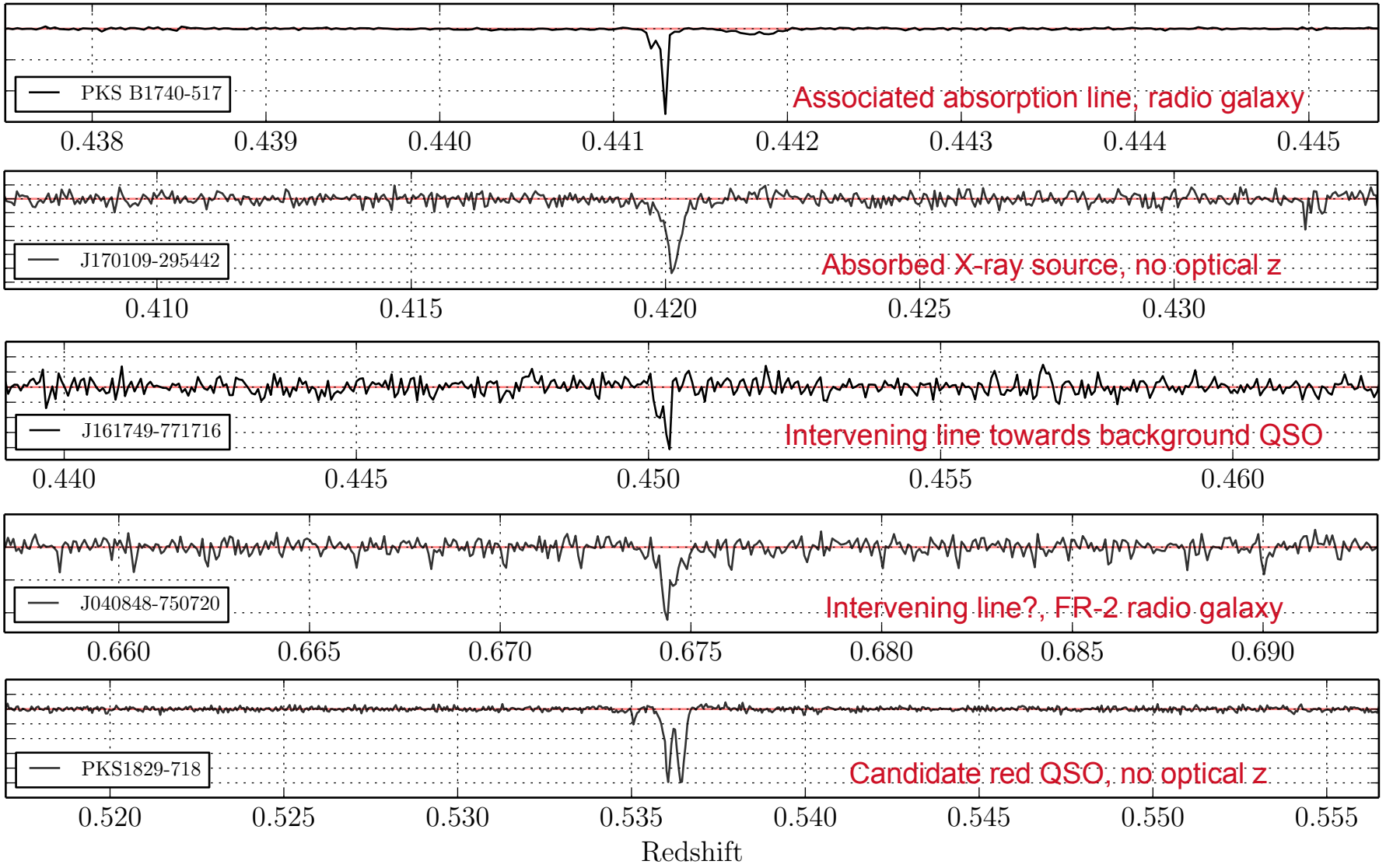
New detections with ASKAP



Summary

- The FLASH survey will provide an **HI-selected galaxy sample** at 0.4<z<1.0
  - Complementary to other HI absorption surveys (e.g. MALS on MeerKAT, Sharp on AperTIF), in redshift range, target selection and radio power.
- Commissioning results using the BETA array resulted in 5 new detections
  - BUT, need multi-wavelength follow-up to characterise these sources