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ISTITUTO NAZIONALE
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NATIONAL INSTITUTE
FOR ASTROPHYSICS



UNIVERSITÀ
DEGLI STUDI
DI PADOVA

GTC optical spectroscopy of TeV blazars

Speaker: S. Paiano – (INAF–OAPD)

Collaborators: R. Falomo, A. Treves,
M. Landoni, R. Scarpa,
C. Righi

AGN12 meeting – Napoli – 29 Settembre 2016

Aim of the work

Blazars represent the most abundant extragalactic population at GeV–TeV energies

Contrary to most AGNs with prominent emission features,

Blazars/BL Lacs often lack its redshift

(or it is very uncertain)

[see Landoni's talk]



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[see Landoni's talk]

- For the interpretation
of emission models

- To study the EBL

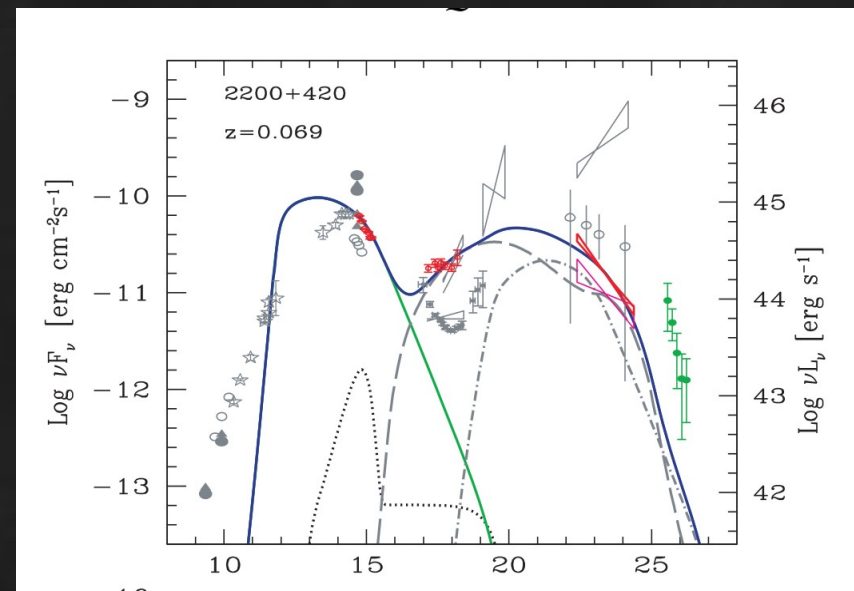
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Contrary to most AGNs with prominent emission features, Blazars/BL Lacs often lack its redshift (or it is very uncertain)
[see Landoni's talk]

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Ghisellini+2011

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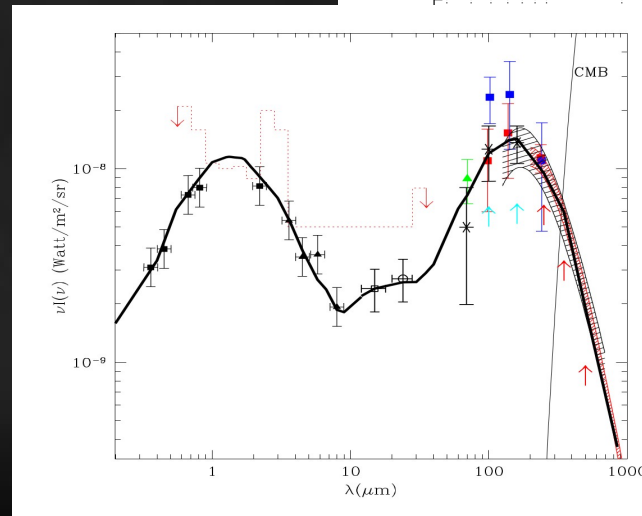
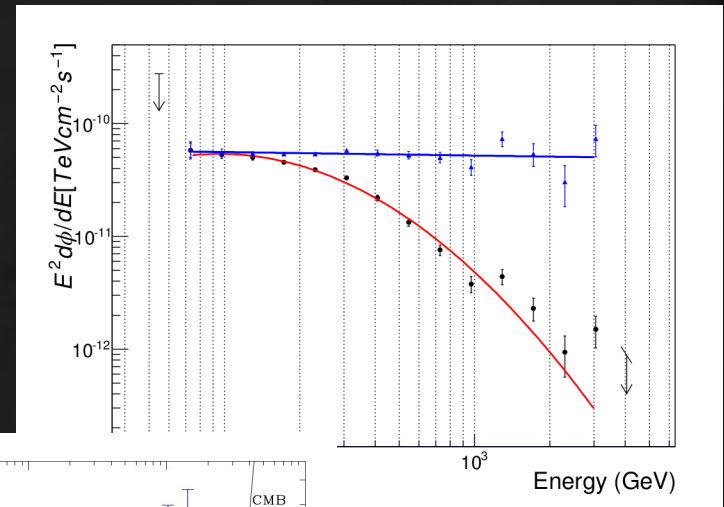
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(or it is very uncertain)

[see Landoni's talk]

• For the interpretation of emission models

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Ahnen+2016
(MAGIC coll.)

Franceschini+2016

Aim of the work

Blazars represent the most abundant extragalactic population at GeV–TeV energies

Contrary to most
with prominent
Blazars/BL Lacs
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• For the intensity
of emission

• To study

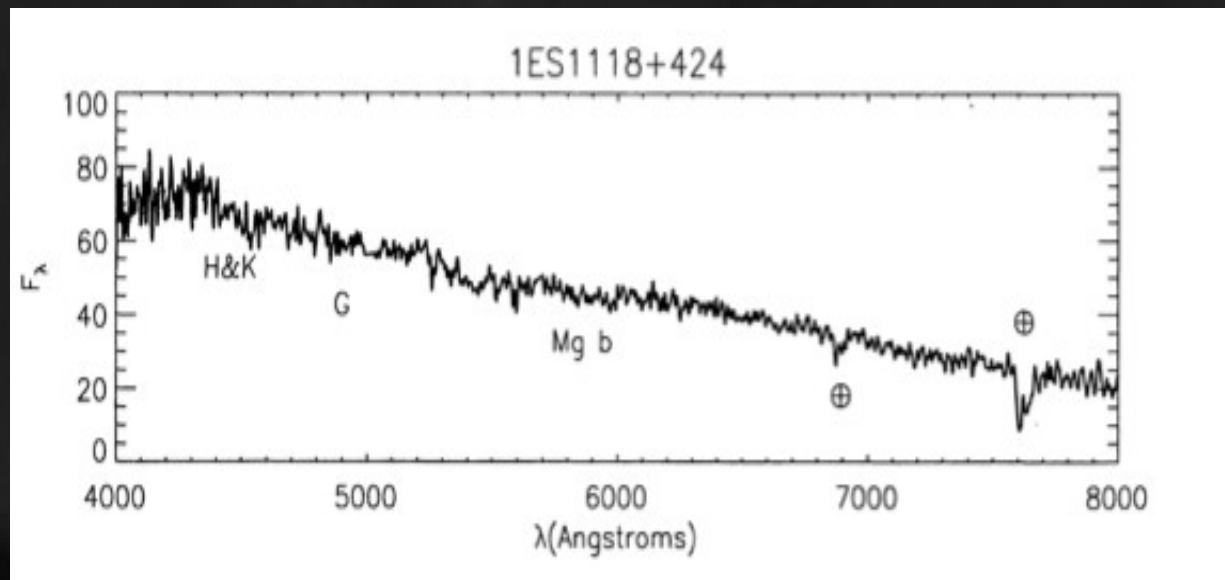


We present the results of a
spectroscopical campaign
carried out
at the GTC for a sample of
21 TeV
(or candidate TeV) blazars
with
unknown/uncertain redshift

The Sample

14 TeV blazars and 7 TeV candidates of BZCAT
With unknown or uncertain redshift

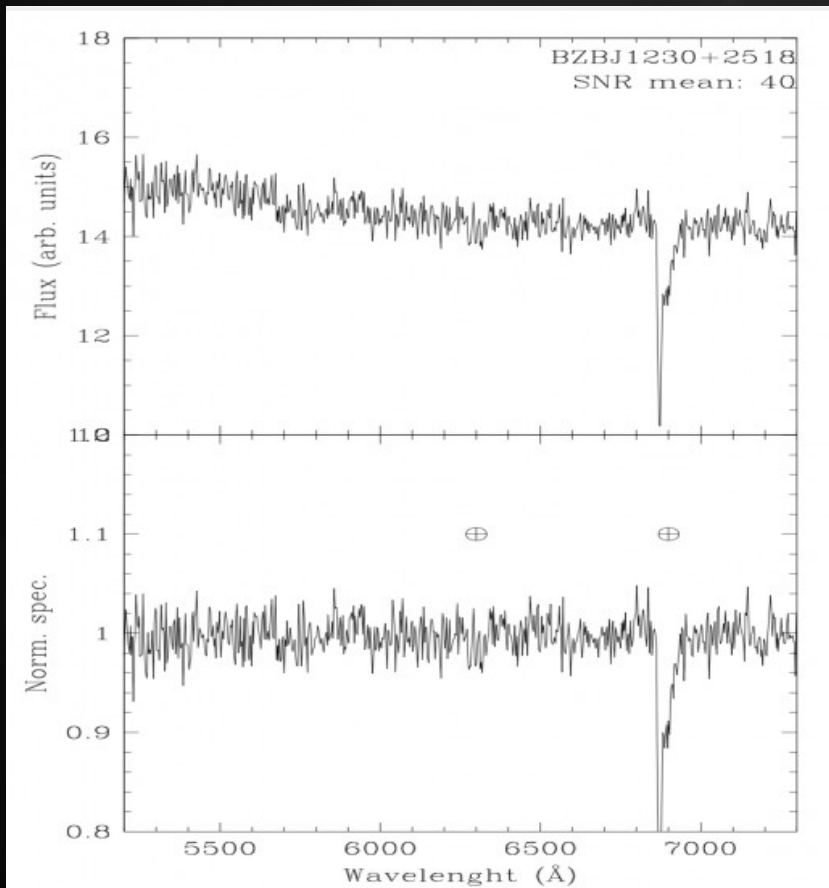
BZB J1120+4212 (RBS0970) $\rightarrow z=0.124$ (?)



Perlman+1996

The Sample

14 TeV blazars and 7 TeV candidates of BZCAT
With unknown or uncertain redshift



Massaro+2015

S3 1227+255

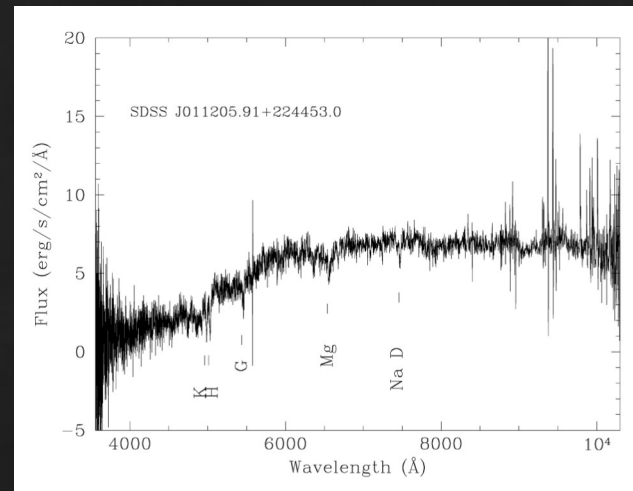
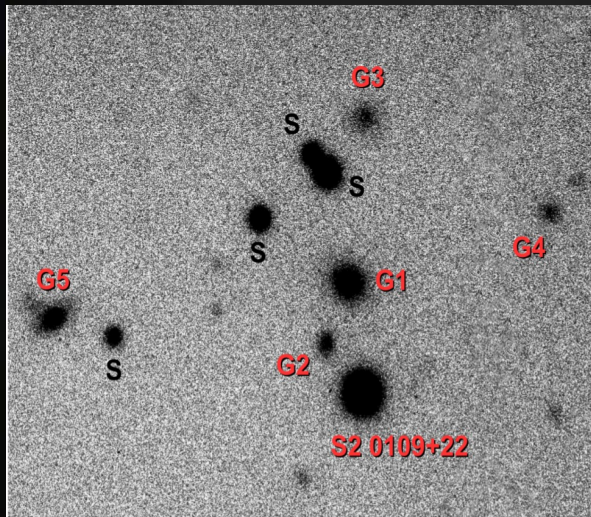
$Z=0.135$ (?)

So far no spectrum
published

The Sample

14 TeV blazars and 7 TeV candidates of BZCAT
With unknown or uncertain redshift

S2 0109+22 $z=0.26$

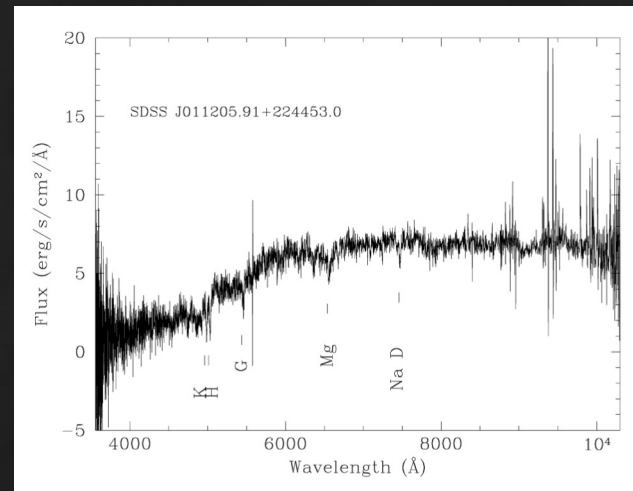
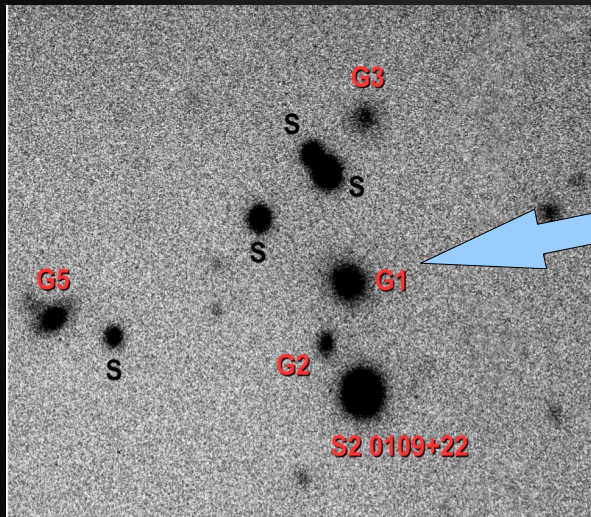


SDSS spectrum,
Healey+2008, Shaw+2012

The Sample

14 TeV blazars and 7 TeV candidates of BZCAT
With unknown or uncertain redshift

S2 0109+22 $z=0.26$

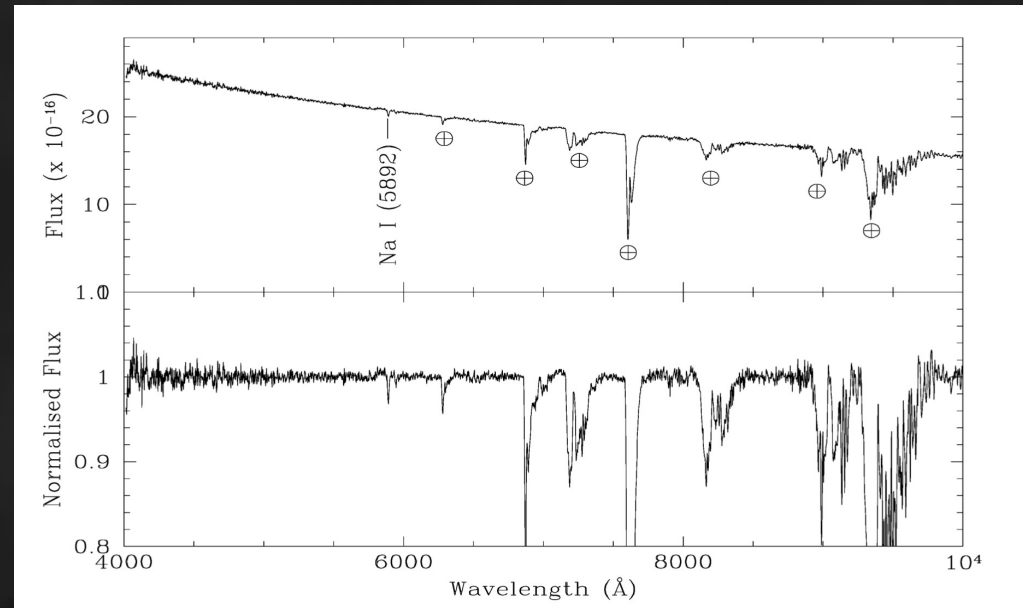
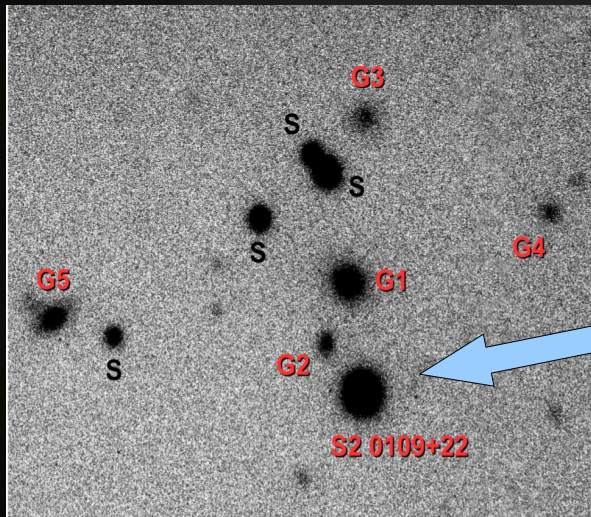


SDSS spectrum,
Healey+2008, Shaw+2012

The Sample

14 TeV blazars and 7 TeV candidates of BZCAT
With unknown or uncertain redshift

S2 0109+22 ~~$z=0.26$~~ = still unknown



Paiano+2016

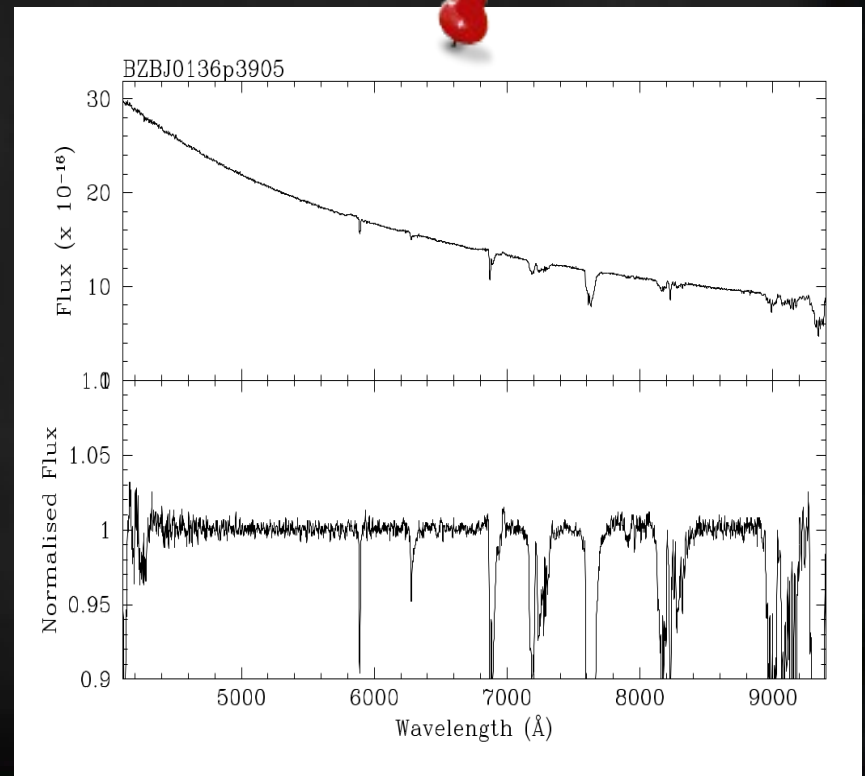
GTC observations

Spectra (4000–10000 Å)
obtained with
OSIRIS@GTC

Details in Landoni's talk

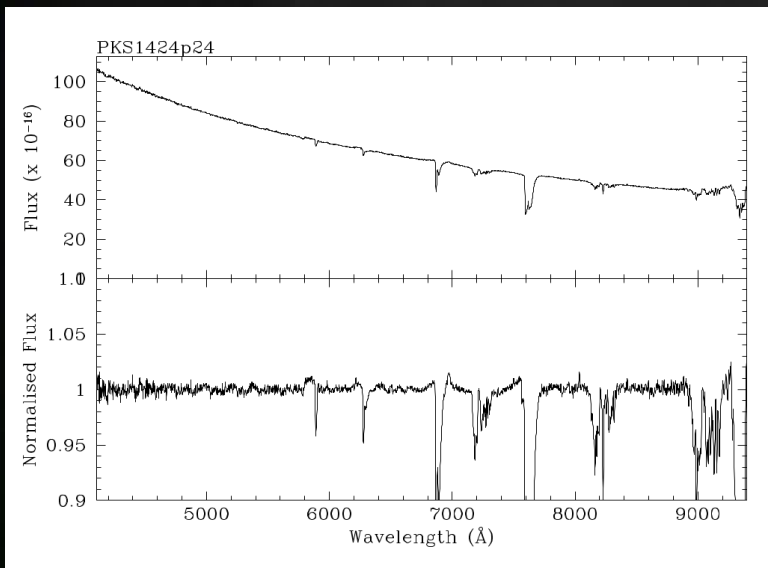


Spectra with
high SNR $\rightarrow \sim 100-500$



Results: search for em/abs features

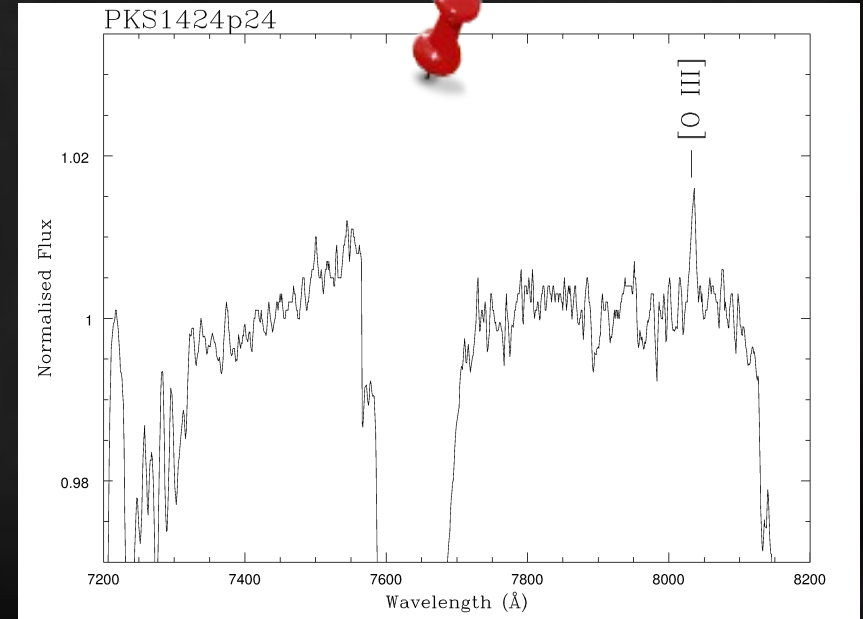
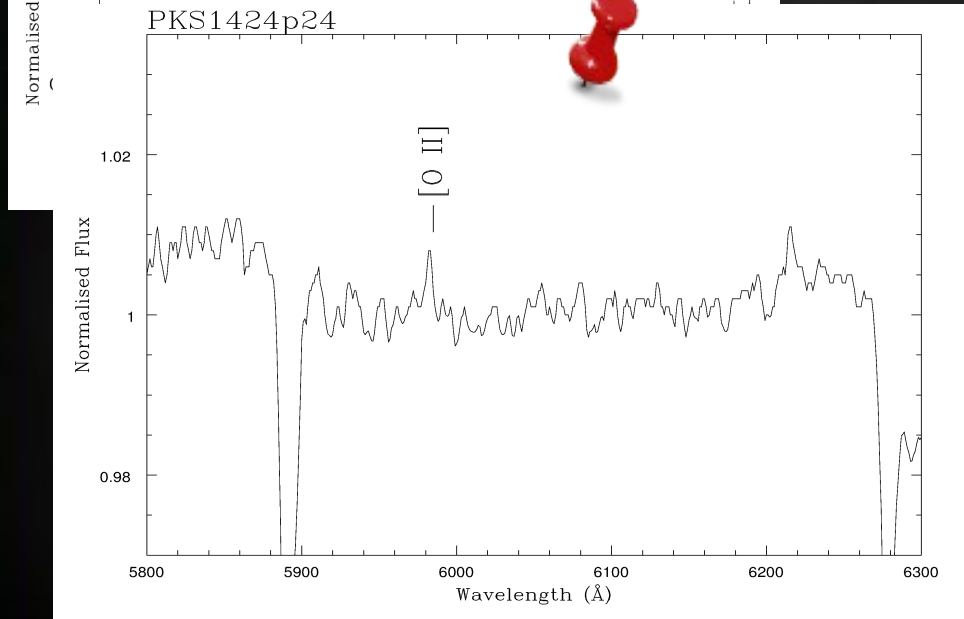
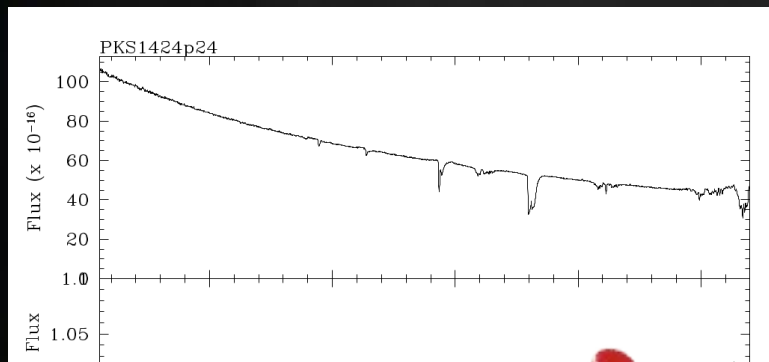
New Redshift for PKS 1424+240



Results: search for em/abs features

New Redshift for PKS 1424+240

[OII] 3727 Å ; [OIII] 5007 Å
@ $z = 0.604$

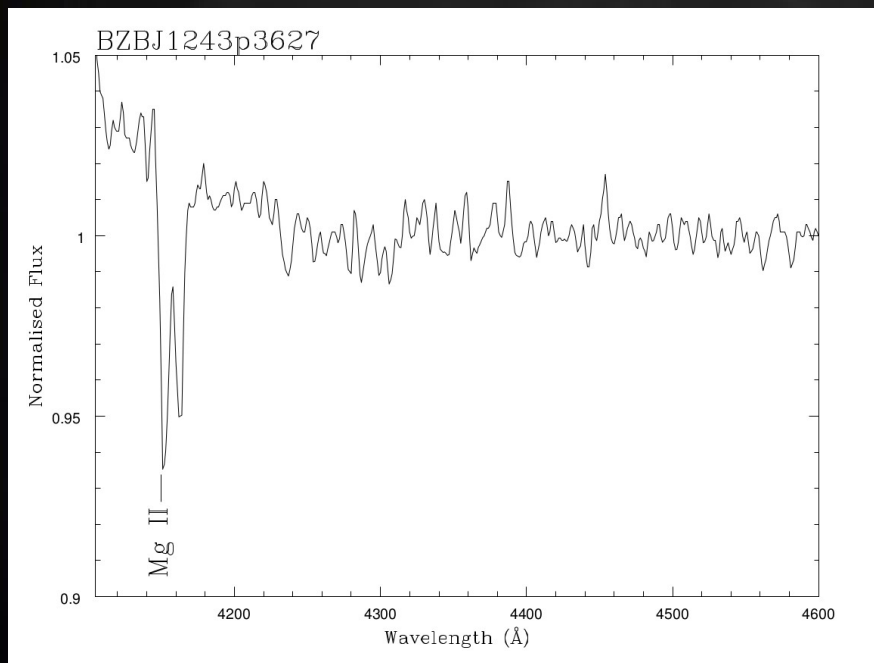


Results: search for em/abs features

MgII abs lines for BZB1243 & BZB1540

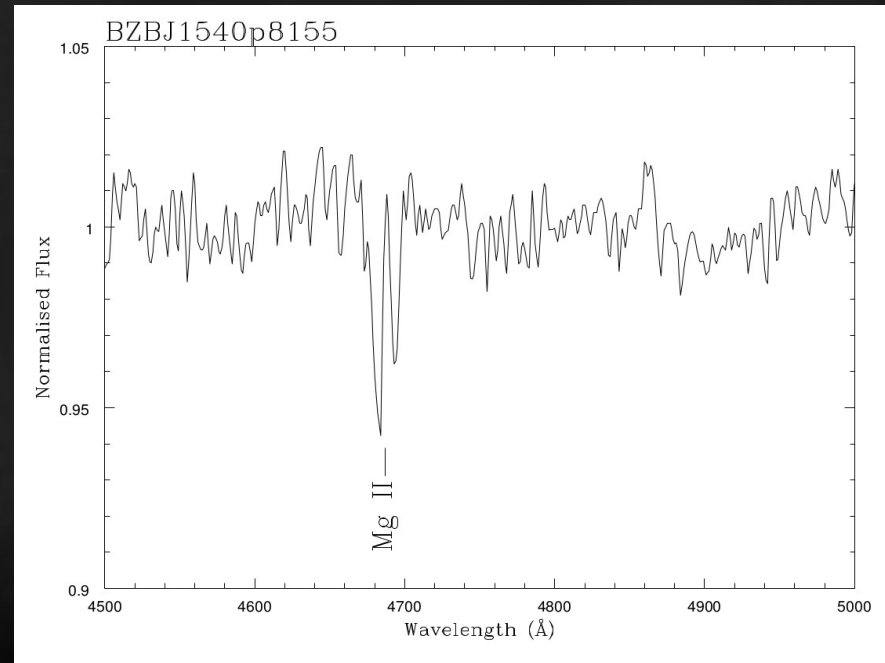
BZBJ1243+3627

MgII 2800A @ $z > 0.48$



BZBJ1540+8155

MgII 2800A @ $z > 0.67$

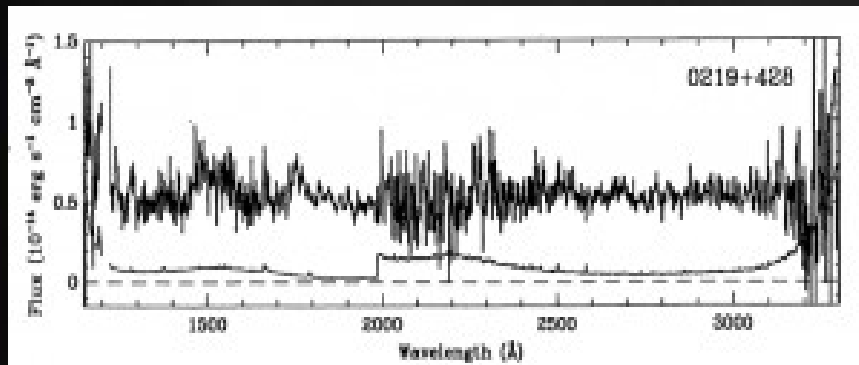


Results: search for em/abs features

4 targets with confirmed redshift

6 targets with no-confirmed redshift and still unknown

3C 66A $\rightarrow z=0.444(?)$



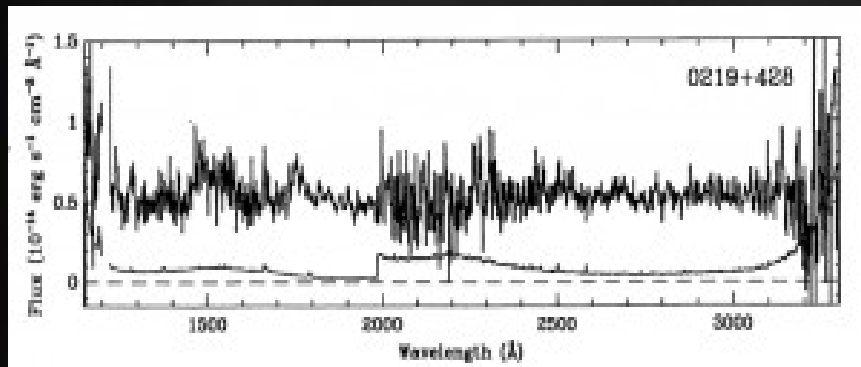
Miller+78 (MgII ?),
Spectrum above from
Lanzetta+1993

Results: search for em/abs features

4 targets with confirmed redshift

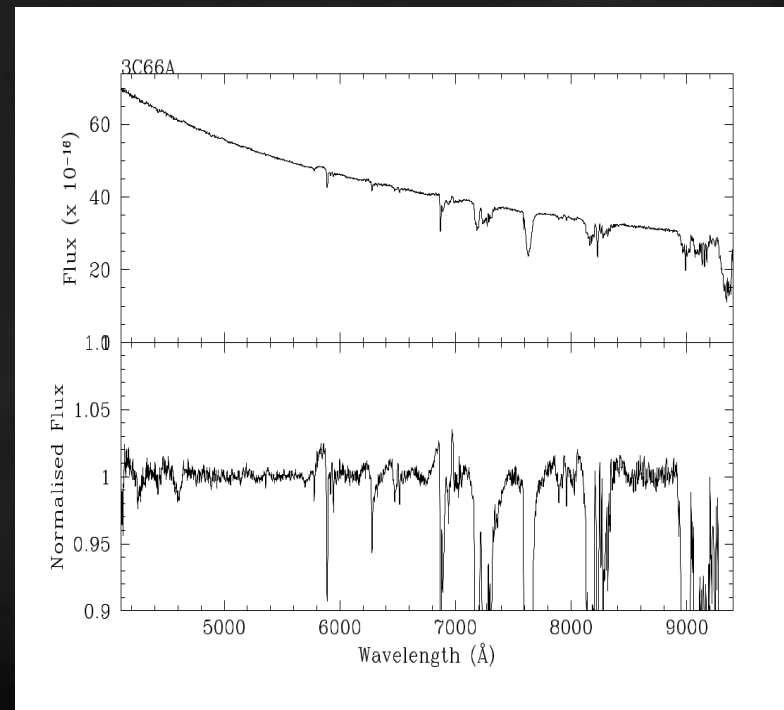
6 targets with no-confirmed redshift and still unknown

3C 66A → ~~$z=0.44(?)$~~ → not confirmed



Miller+78 (MgII ?),
Spectrum above from
Lanzetta+1993

SNR=300 — $E_{\text{Wmin}}=0,1$ A — $z>0.1$



Results: search for em/abs features

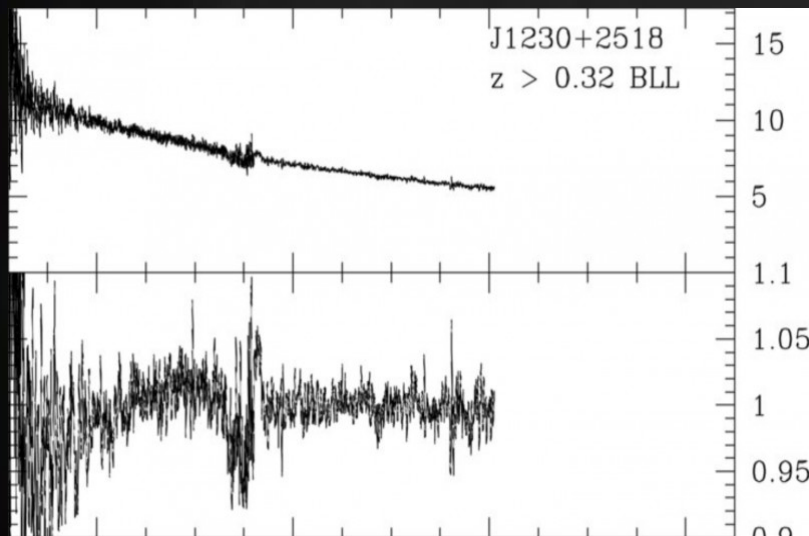
4 targets with confirmed redshift

6 targets with no-confirmed redshift and still unknown

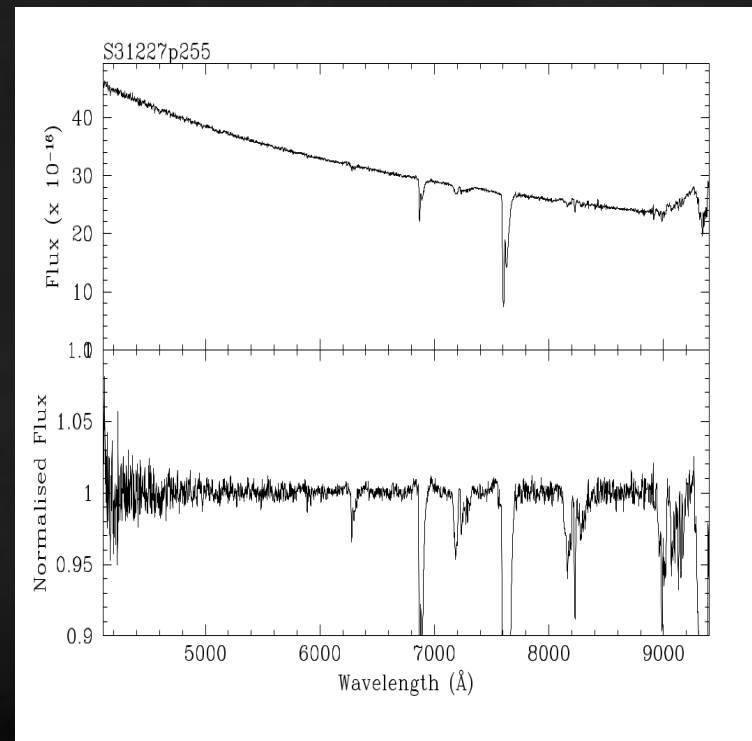
S3 1227+255 $\rightarrow z=0.135(?) \rightarrow$ not confirmed

Nass+96 $\rightarrow$ No spectrum
No info

SNR=300 — $E_{wmin}=0,09 \text{ A}$ — $z>0.1$



Shaw+2013

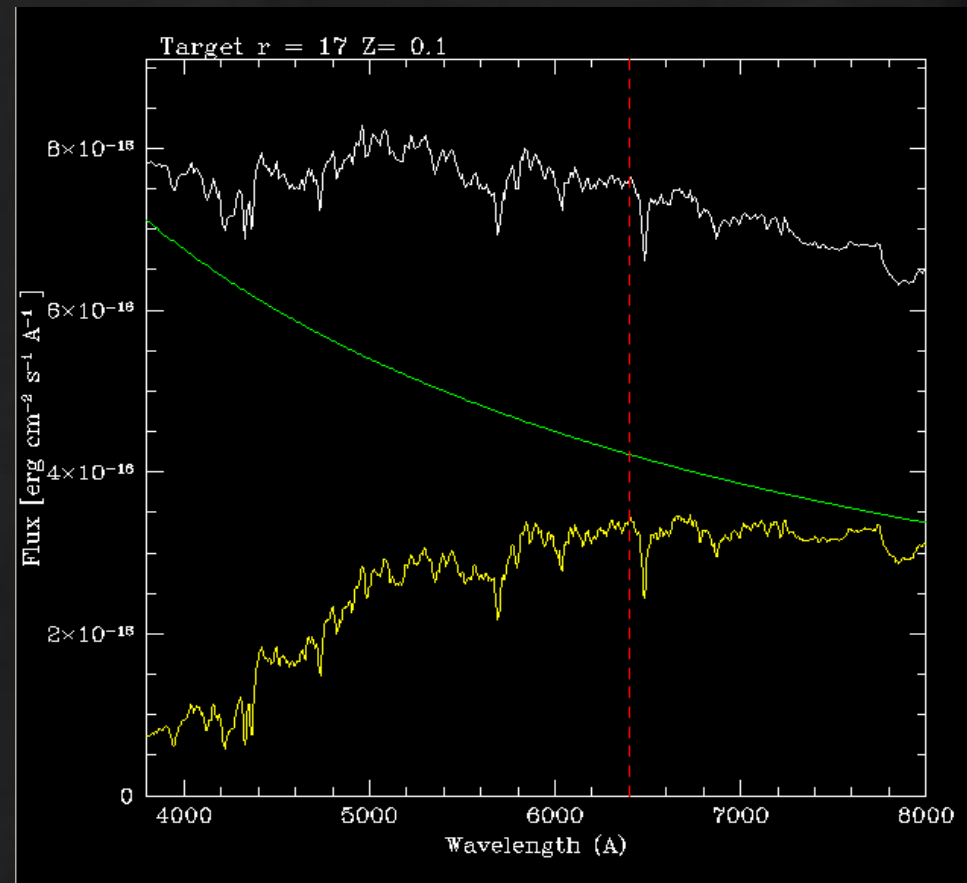


Results: Lower Limits on the redshift

Non-thermal Nucleus +
Elliptical host galaxy =

Spectrum observed !

Mag=17 $z=0.10$ Diluted EW=1,60Å

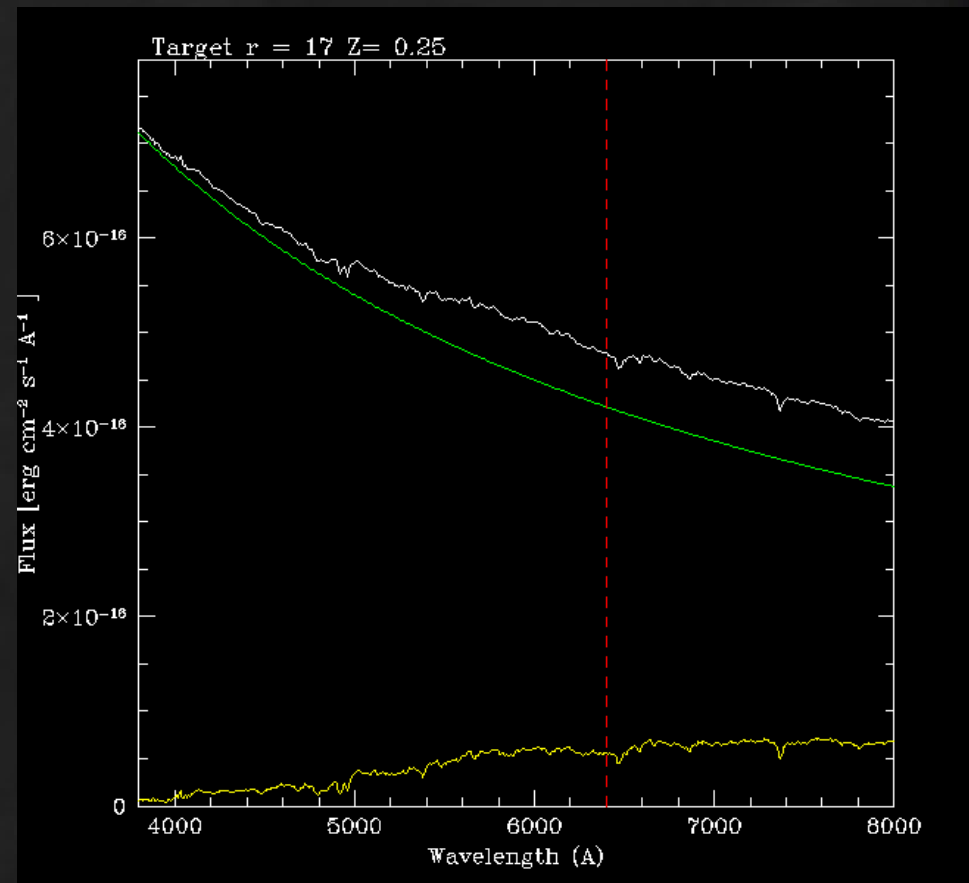


Results: Lower Limits on the redshift

Non-thermal Nucleus +
Elliptical host galaxy =

Mag=17 $z=0.25$ Diluted EW=0,49Å

Spectrum observed !

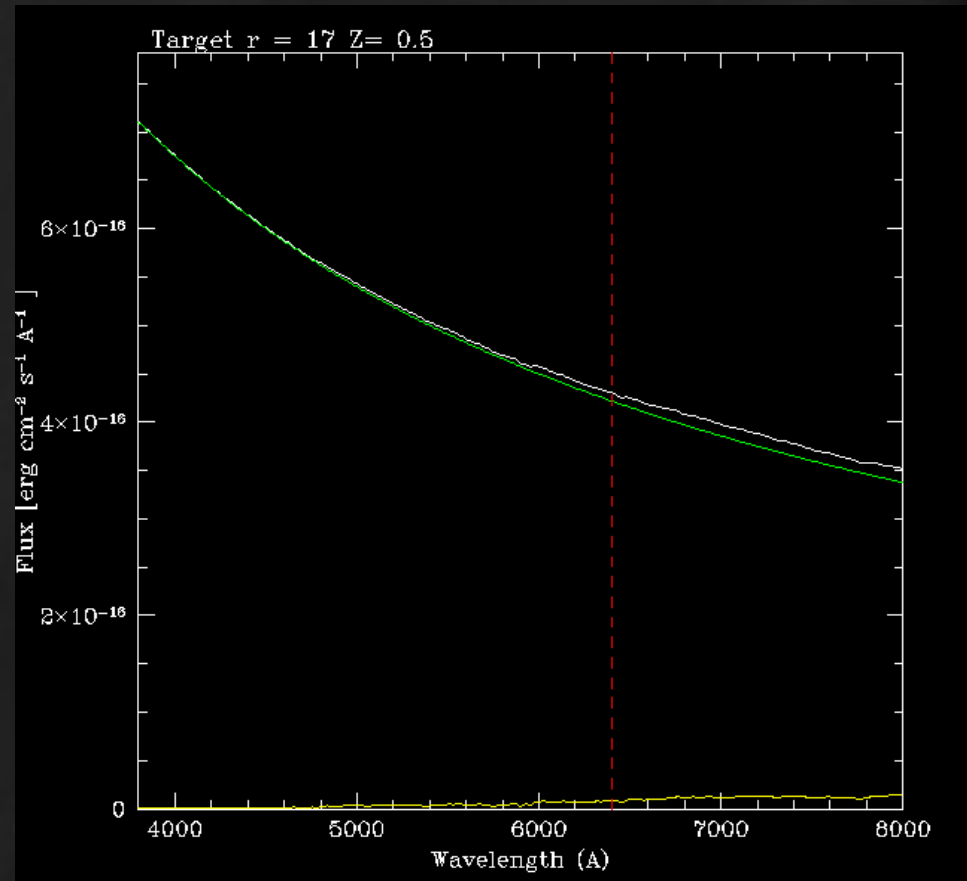


Results: Lower Limits on the redshift

Non-thermal Nucleus +
Elliptical host galaxy =

Mag=17 $z=0.50$ Diluted EW=0,15A

Spectrum observed !



Results: Lower Limits on the redshift

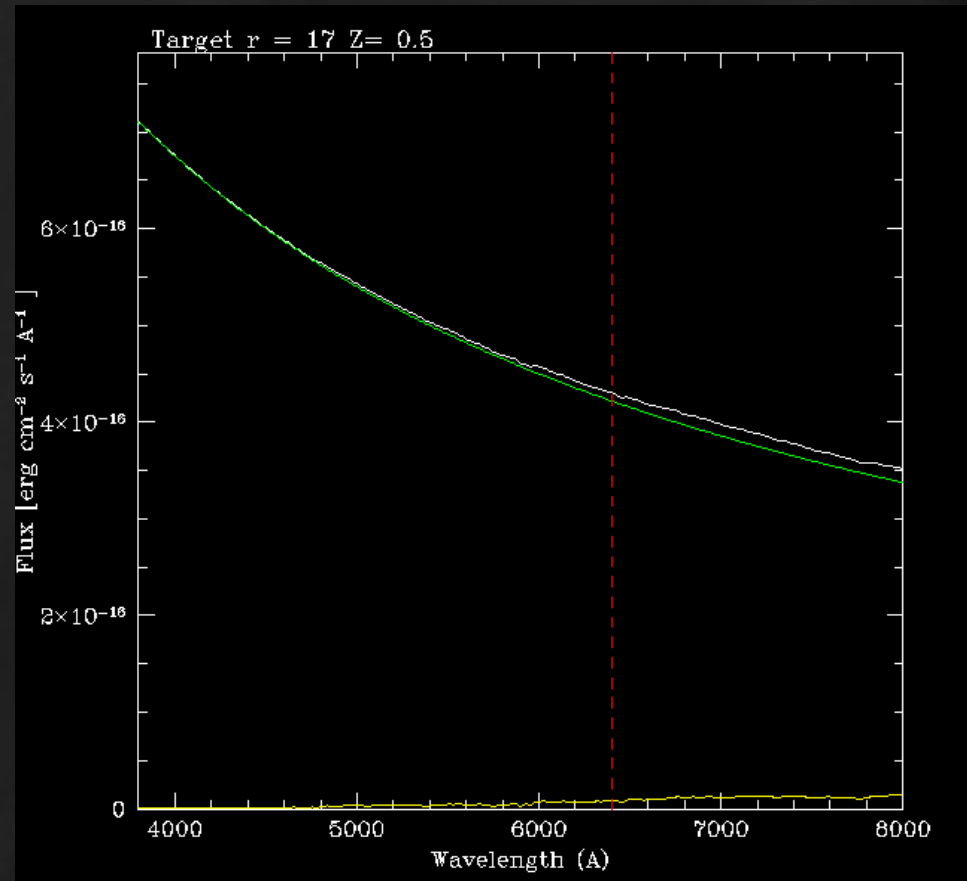
Non-thermal Nucleus +
Elliptical host galaxy =

Mag=17 $z=0.50$ Diluted EW=0,15A

Spectrum observed !



With wide range and
high SNR spectra,
we can derive EW upper limits
and Redshift lower limits



We derive redshift lower limits ($>0.1 - 0.90$)
for all of our targets with unknown redshift

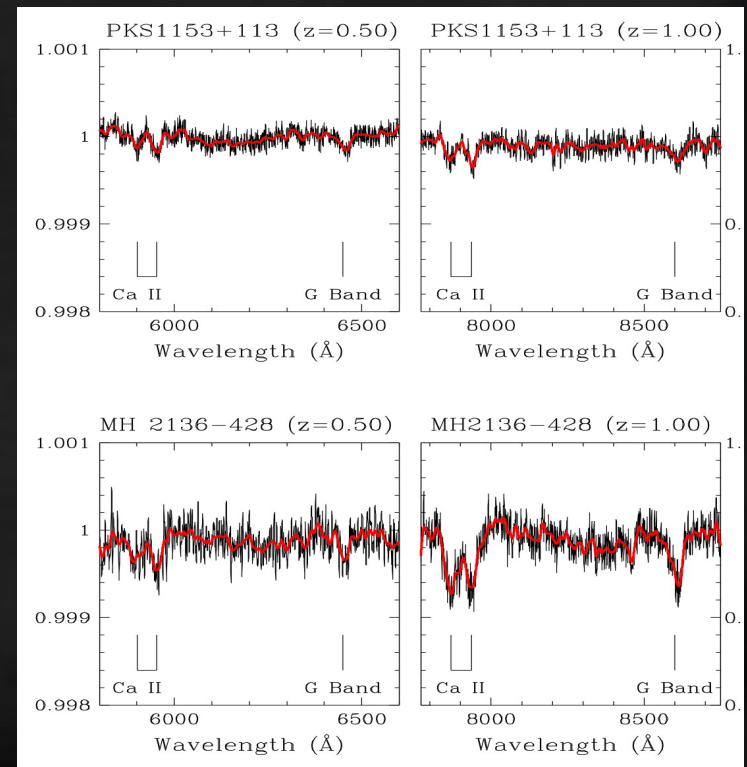
Towards the Future ..

For our sample we have new redshift,
but for many targets the previous values are not confirmed:
Several TeV blazars have still unknown redshift

..Waiting for the EELT(39m)
equipped with
a Xshooter-like (@VLT)
instrument



$T_{\text{exp}} = 3600 \text{ sec}$
 $N_{\text{uc}}/N_{\text{host}} = 2500$



Landoni+2014