

# Orientation and optical spectral properties in a new sample of quasars

PENNSYLVANIA STATE UNIVERSITY



Jessie Runnoe

The Univ. of Texas at Austin, September 12, 2014

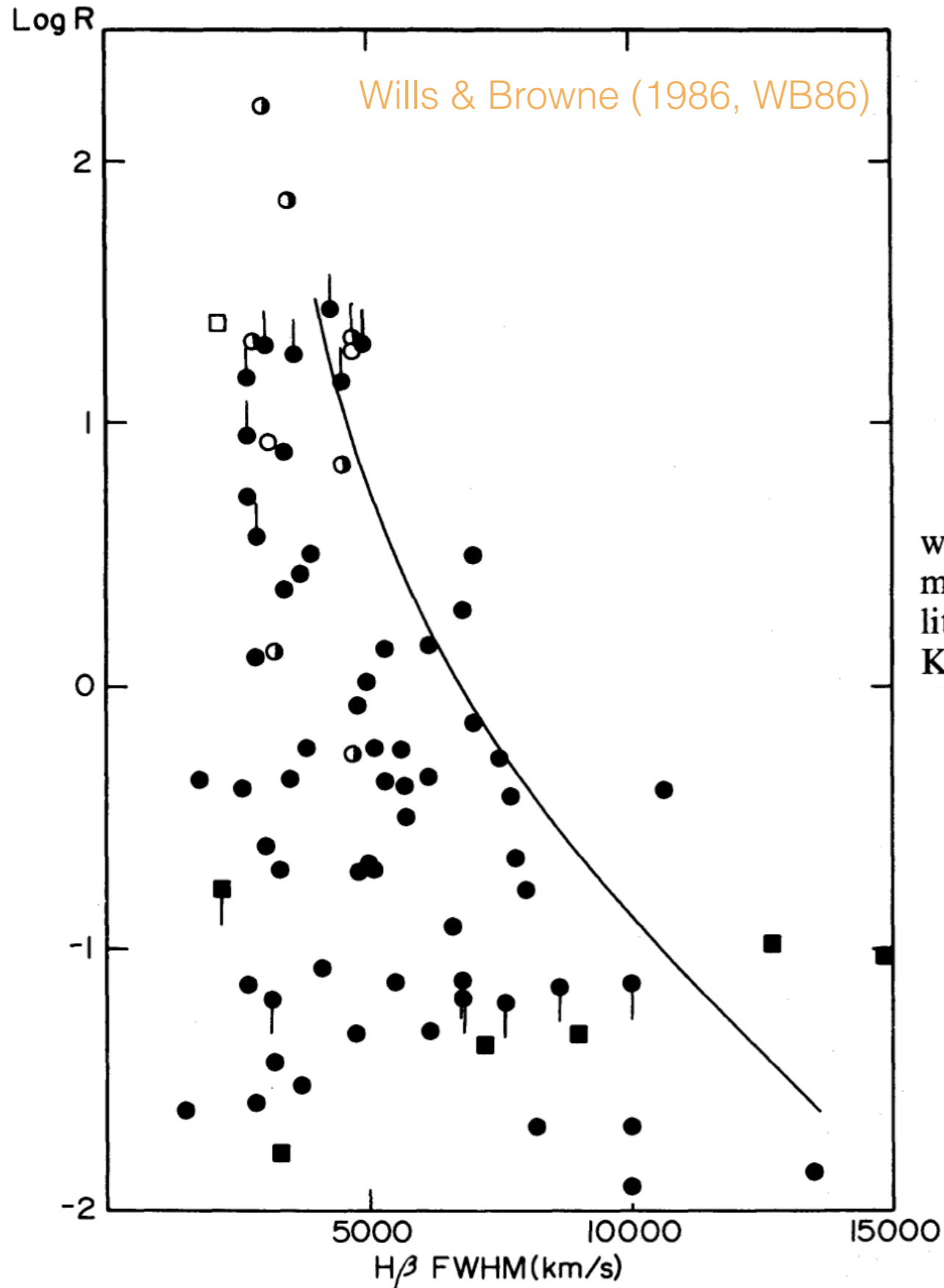


PENNSYLVANIA  
**SPACE GRANT**  
CONSORTIUM

Collaborators: Todd Boroson

Thanks to: Mike Brotherton, Mike Eracleous, Mike DiPompeo, Bev Wills, and Zhaohui Shang

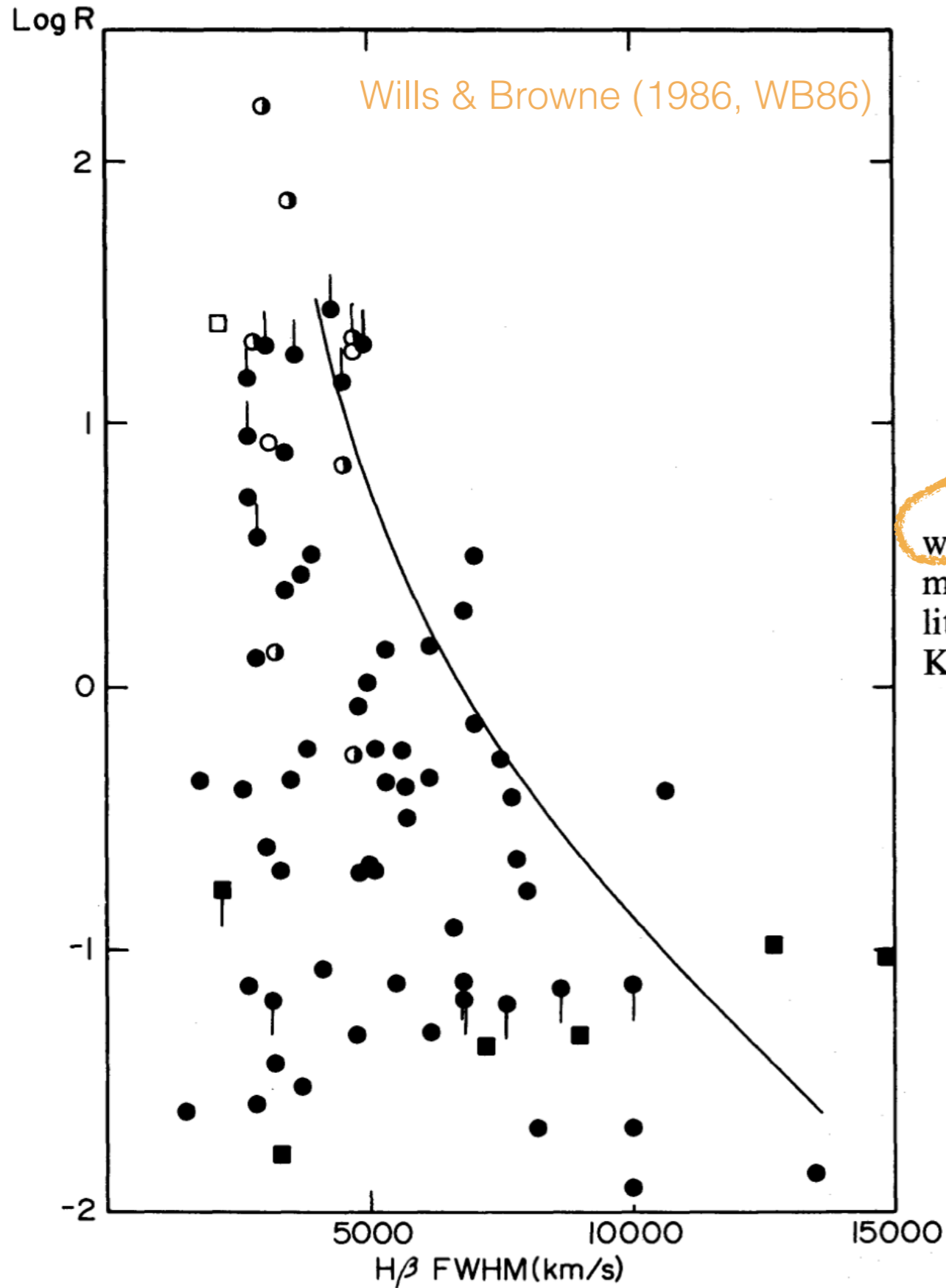
# Motivation and goals



## I. INTRODUCTION

Are core-dominated radio sources end-on extended doubles with their cores Doppler-boosted? The idea that they are has many attractive features and has been widely discussed in the literature (e.g., Scheuer and Readhead 1979; Blandford and Königl 1979). Consideration of the radio data alone shows that

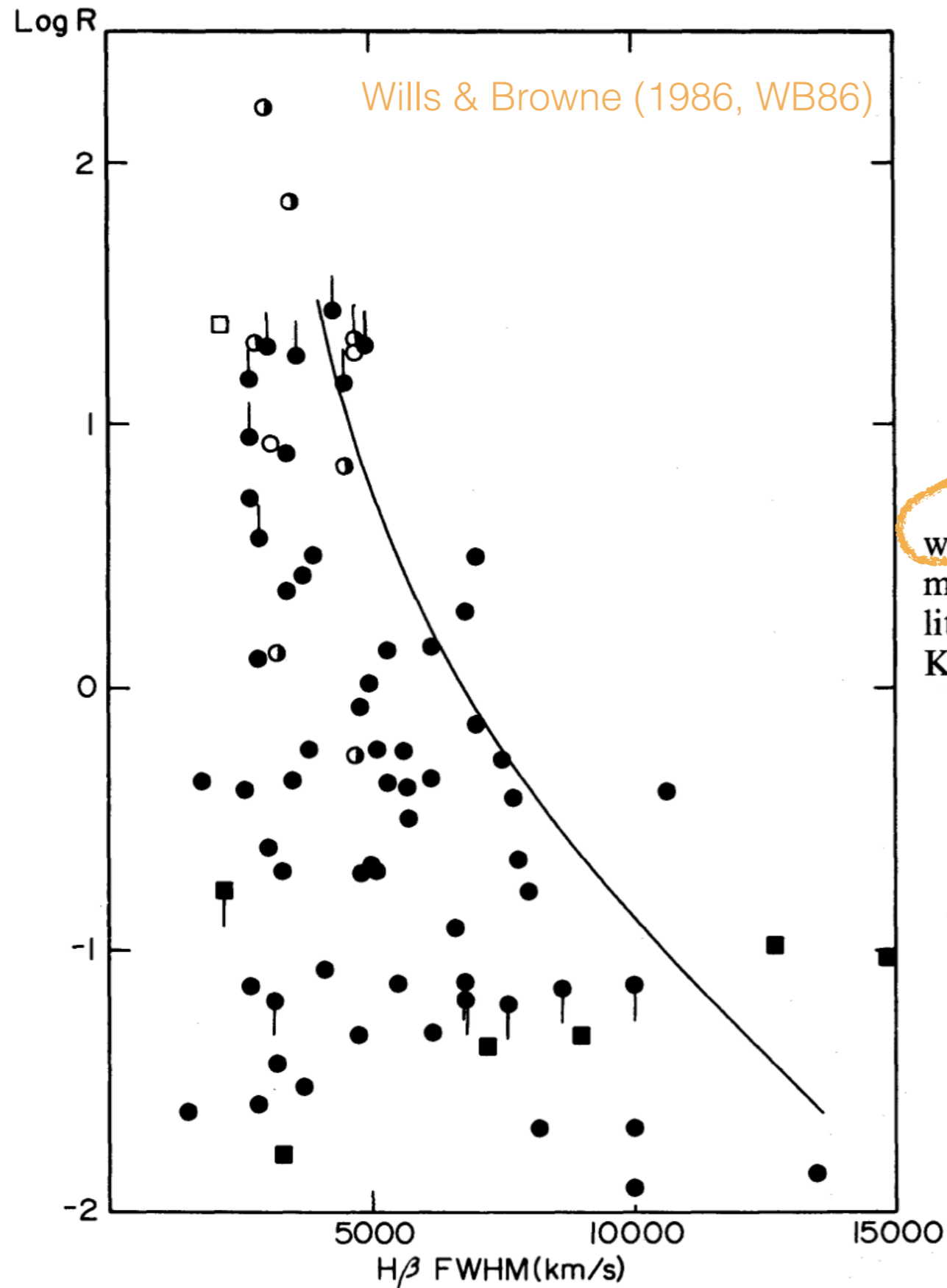
# Motivation and goals



## I. INTRODUCTION

Are core-dominated radio sources end-on extended doubles with their cores Doppler-boosted? The idea that they are has many attractive features and has been widely discussed in the literature (e.g., Scheuer and Readhead 1979; Blandford and Königl 1979). Consideration of the radio data alone shows that

# Motivation and goals

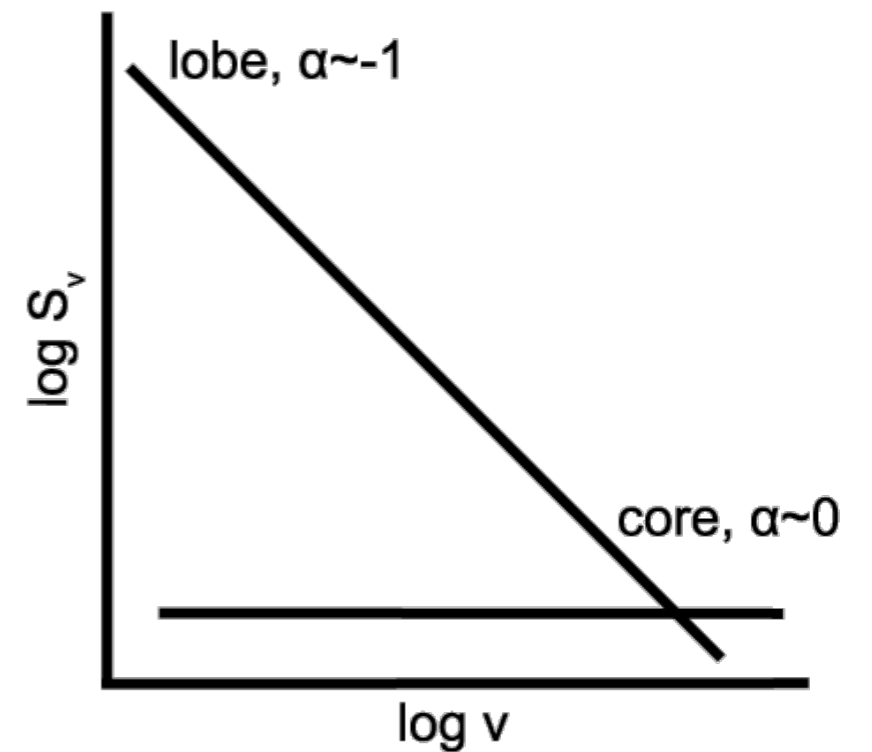
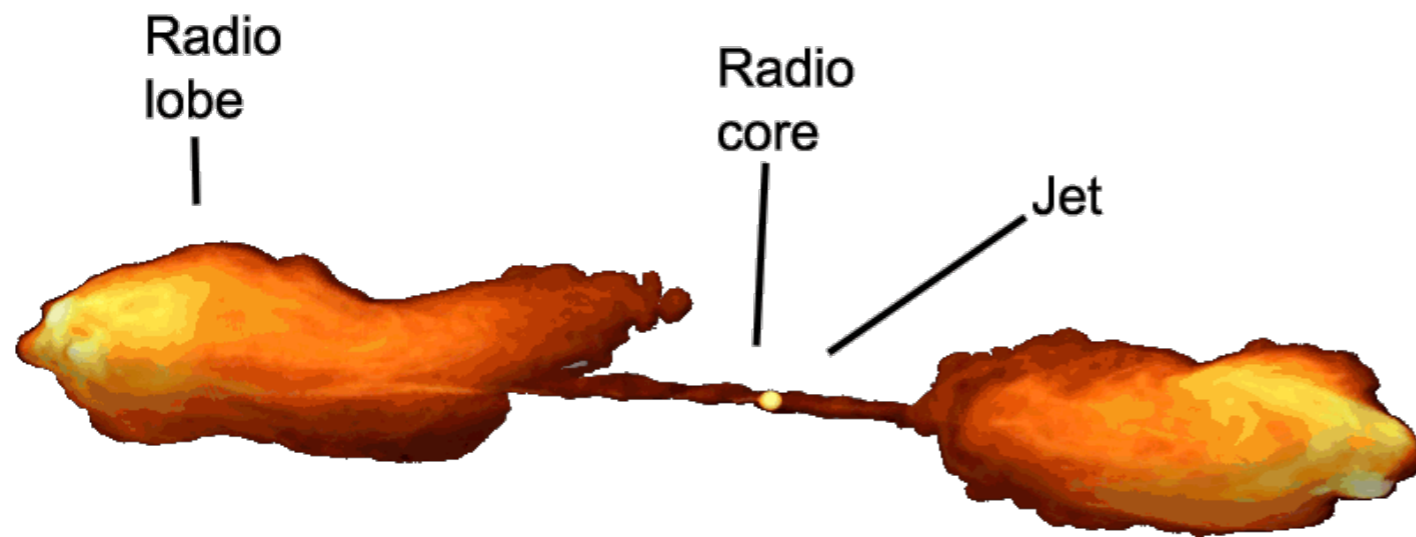


## I. INTRODUCTION

Are core-dominated radio sources end-on extended doubles with their cores Doppler-boosted? The idea that they are has many attractive features and has been widely discussed in the literature (e.g., Scheuer and Readhead 1979; Blandford and Königl 1979). Consideration of the radio data alone shows that

- Our goal: define a set of objects for studying orientation effects whose properties are representative.

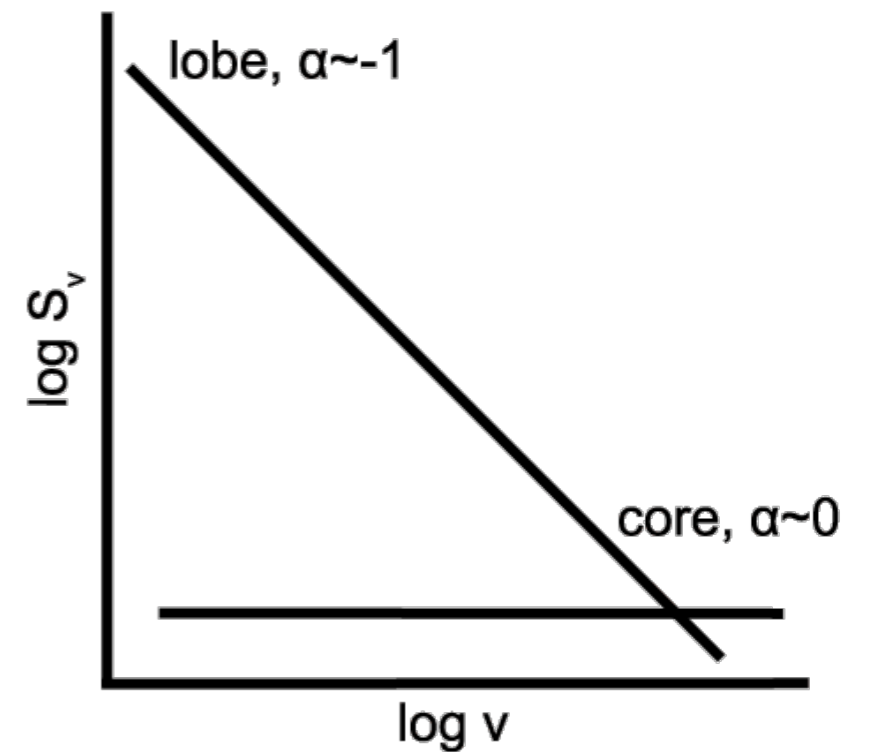
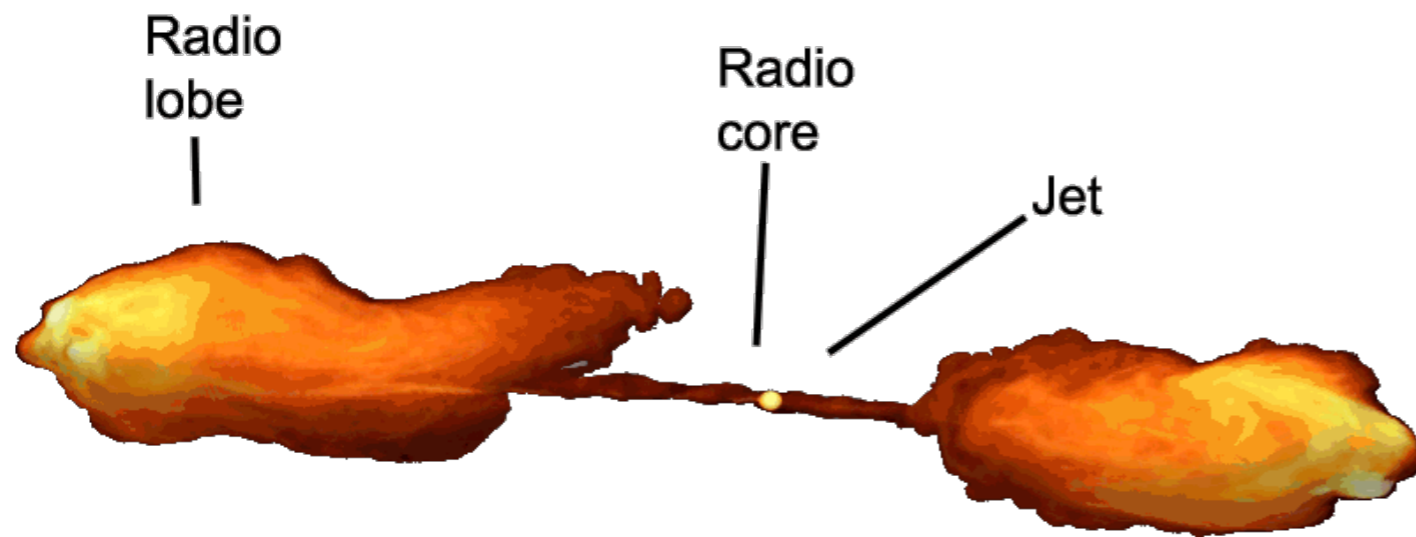
# Radio orientation indicators



Radio spectral index:

$$S_\nu \propto \nu^\alpha$$

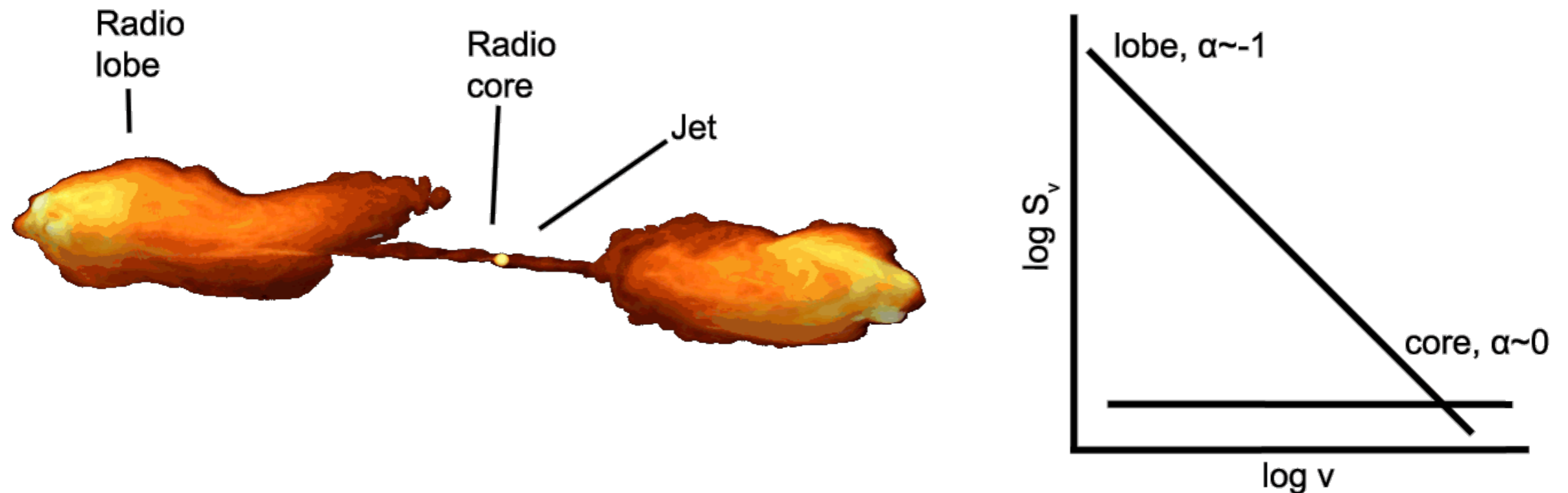
# Radio orientation indicators



Radio spectral index:

$$S_\nu \propto \nu^\alpha$$

# Radio orientation indicators

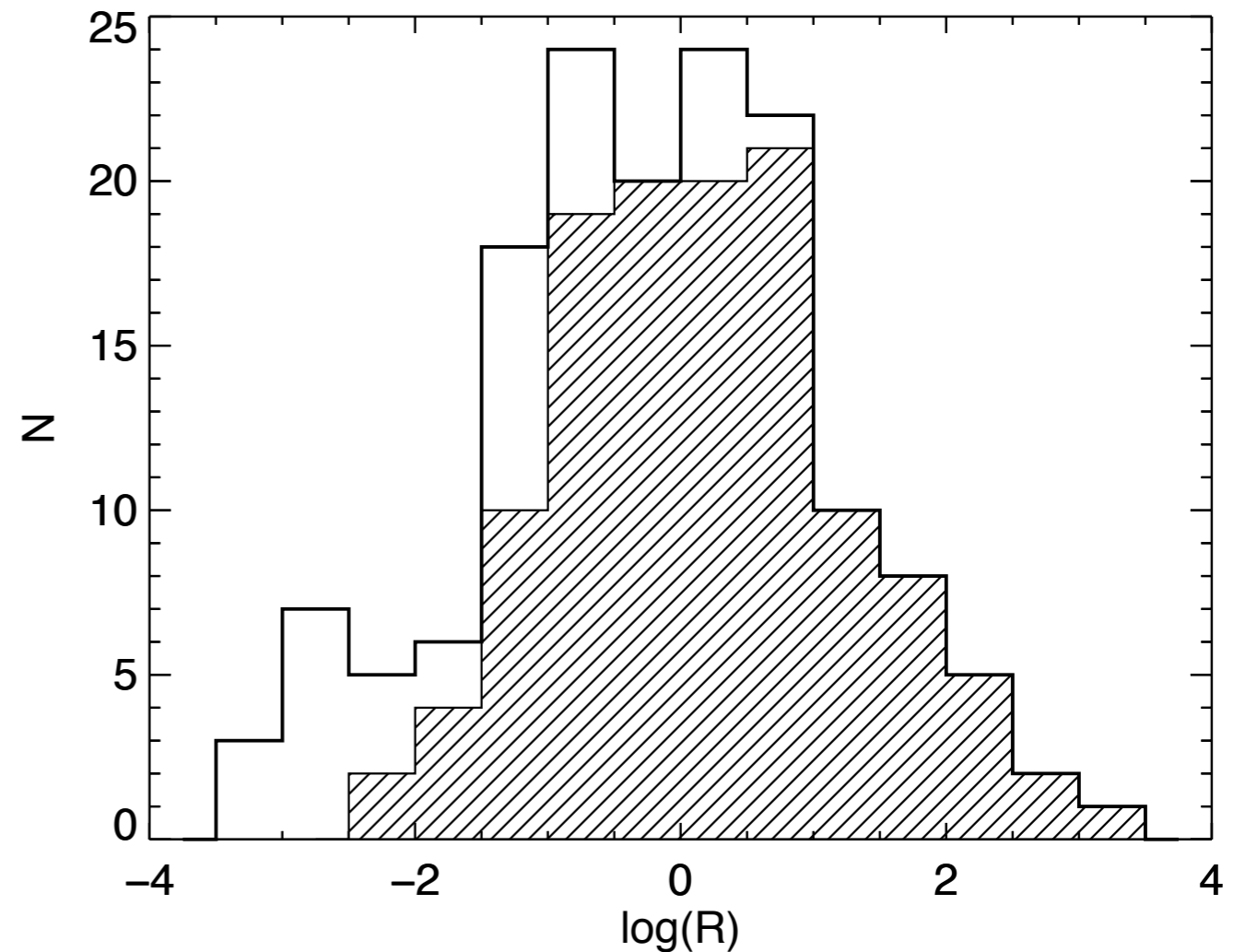


Radio core dominance:

$$\log R = \log(L_{\text{core}}/L_{\text{ext}})$$

# Sample selection

- SDSS DR7 quasar catalog
- $0.1 < z < 0.6$
- Match to WENSS (325 MHz)
  - Core within 30''
  - Lobes within 1100'' and:
    - Flux ratio of lobes  $< 2$ .
    - Within 30 degrees of being opposite each other.
- $\log L(325 \text{ MHz}) > 26.0 \text{ W Hz}^{-1}$
- Visual inspection (FIRST, NVSS, WENSS, SDSS).
- Complete sample of 156 objects.

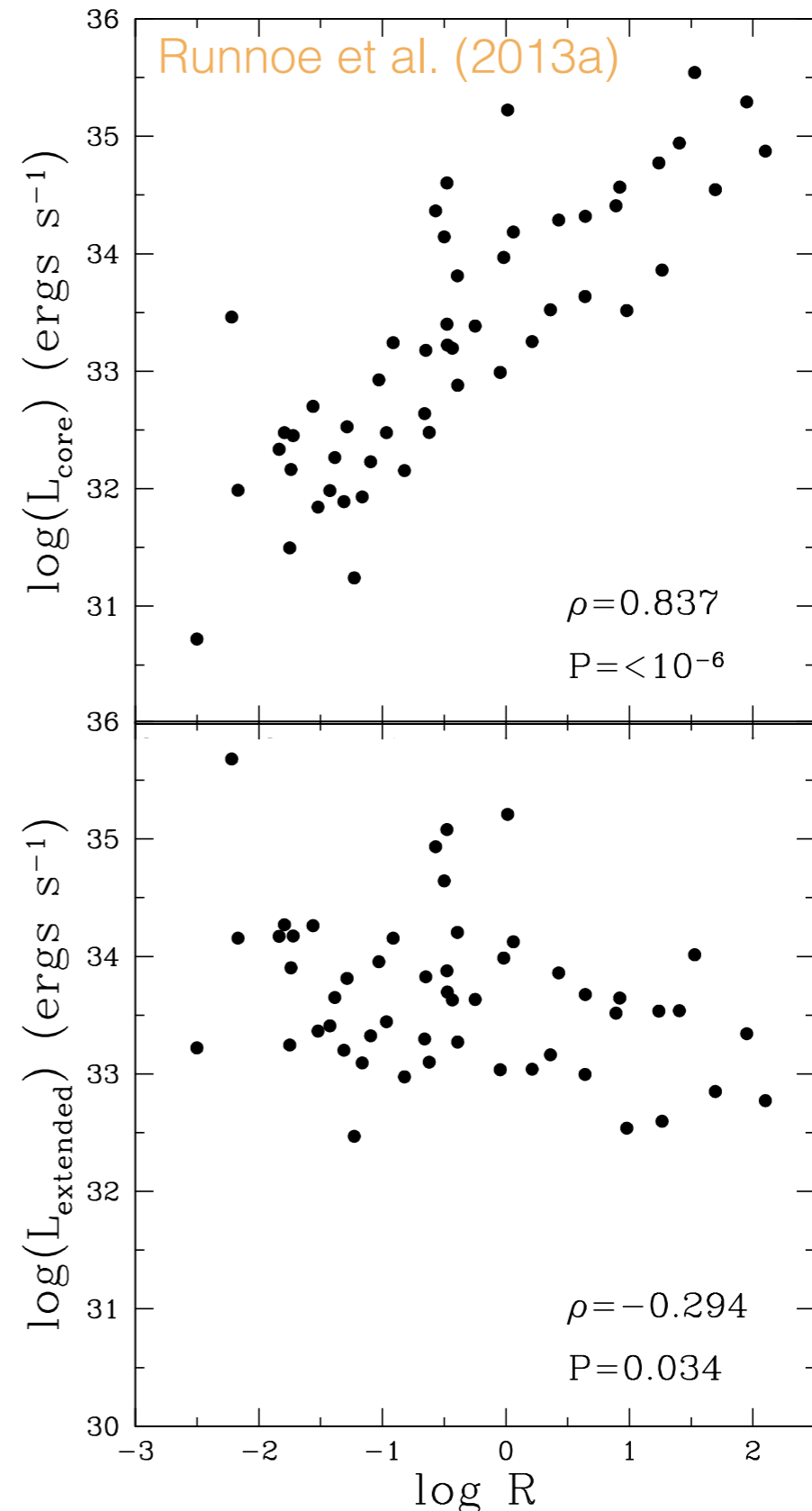




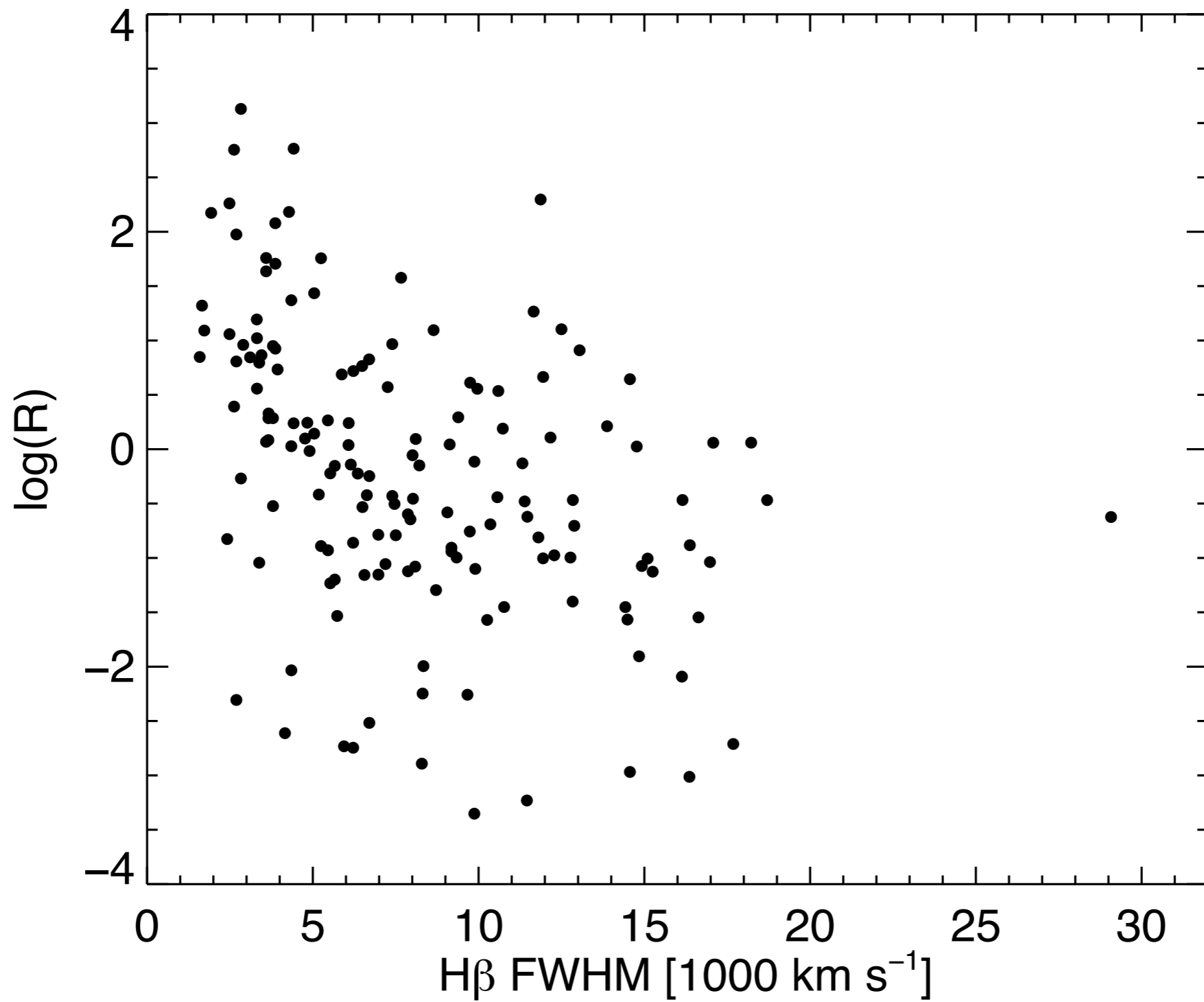
# The RL SED sample

- Selected from 3CR to have similar extended radio luminosities.
- $0.16 < z < 1.4$
- Had to substitute some bright objects for some faint ones.
- Blazars excluded from sample.
- Sample of 52 objects designed to isolate orientation effects.

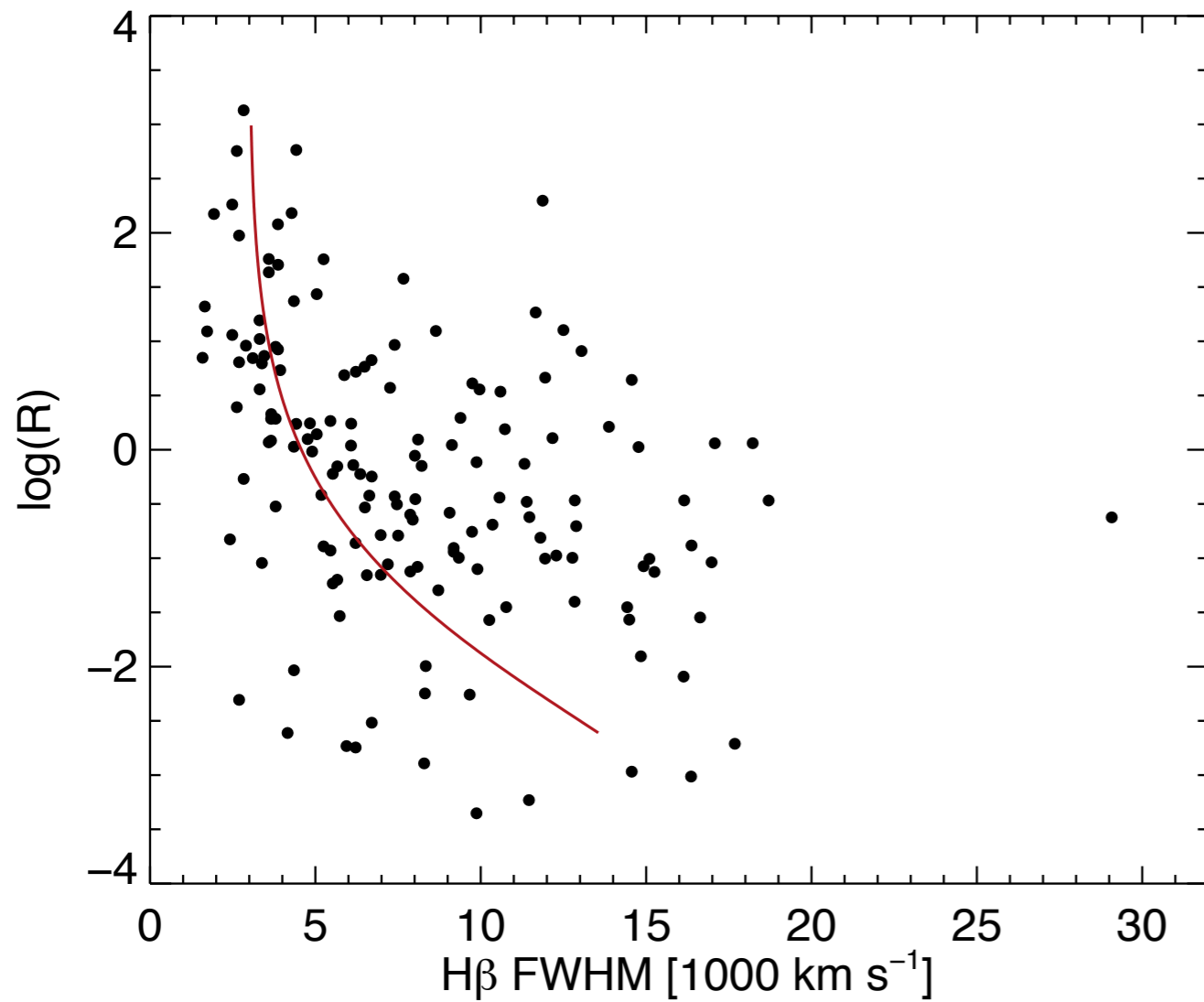
Wills et al. (1995), Shang et al. (2011)



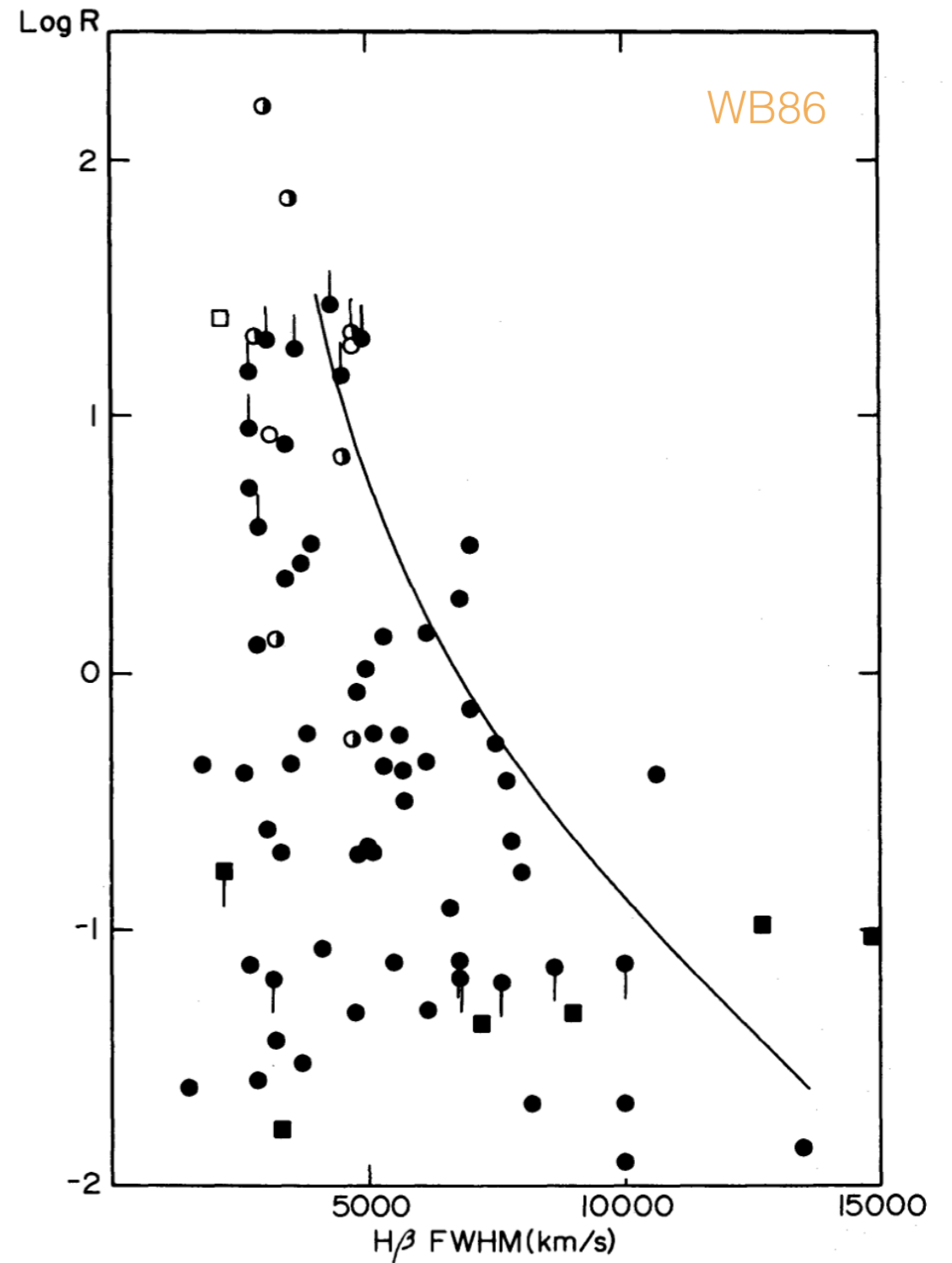
# Results



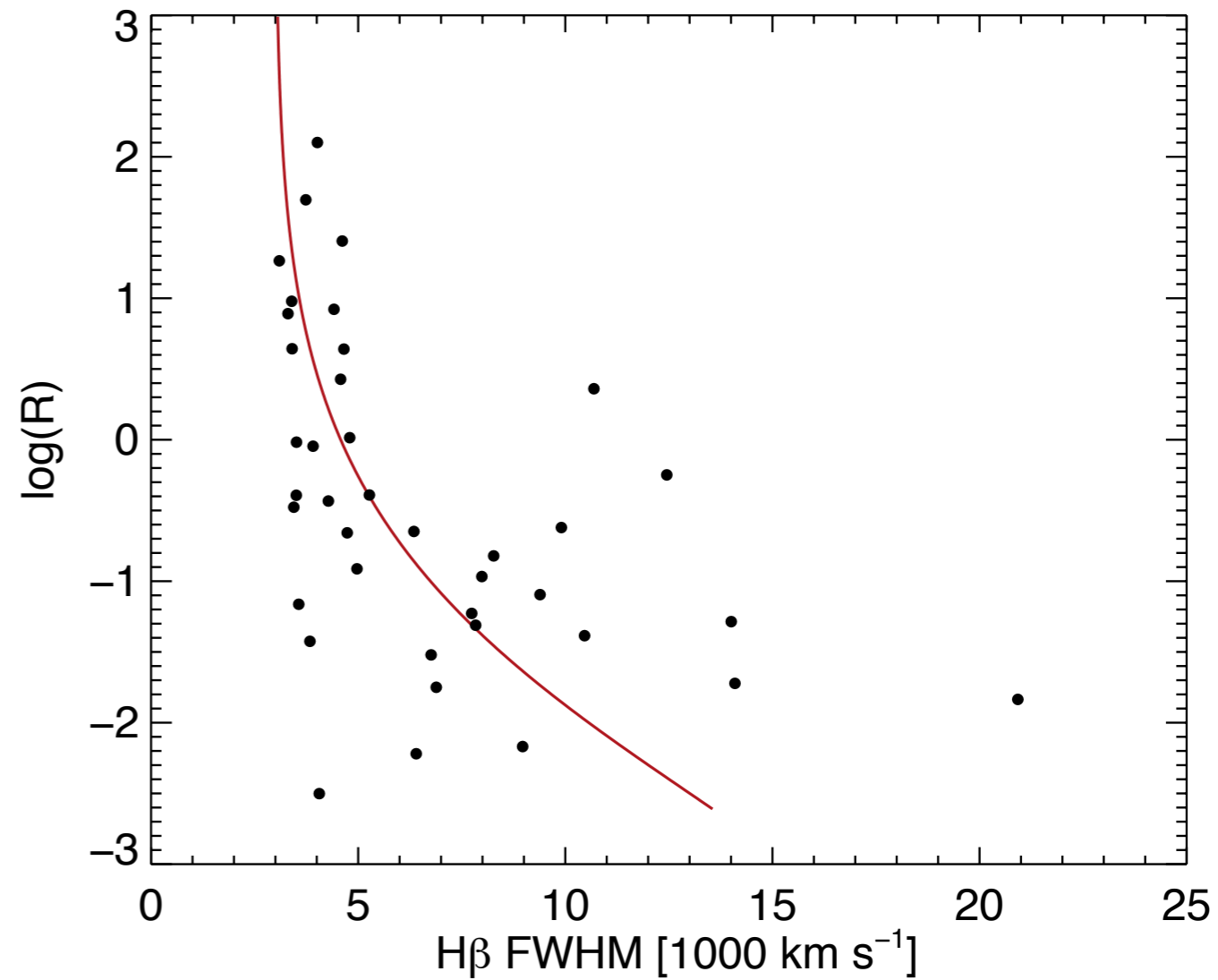
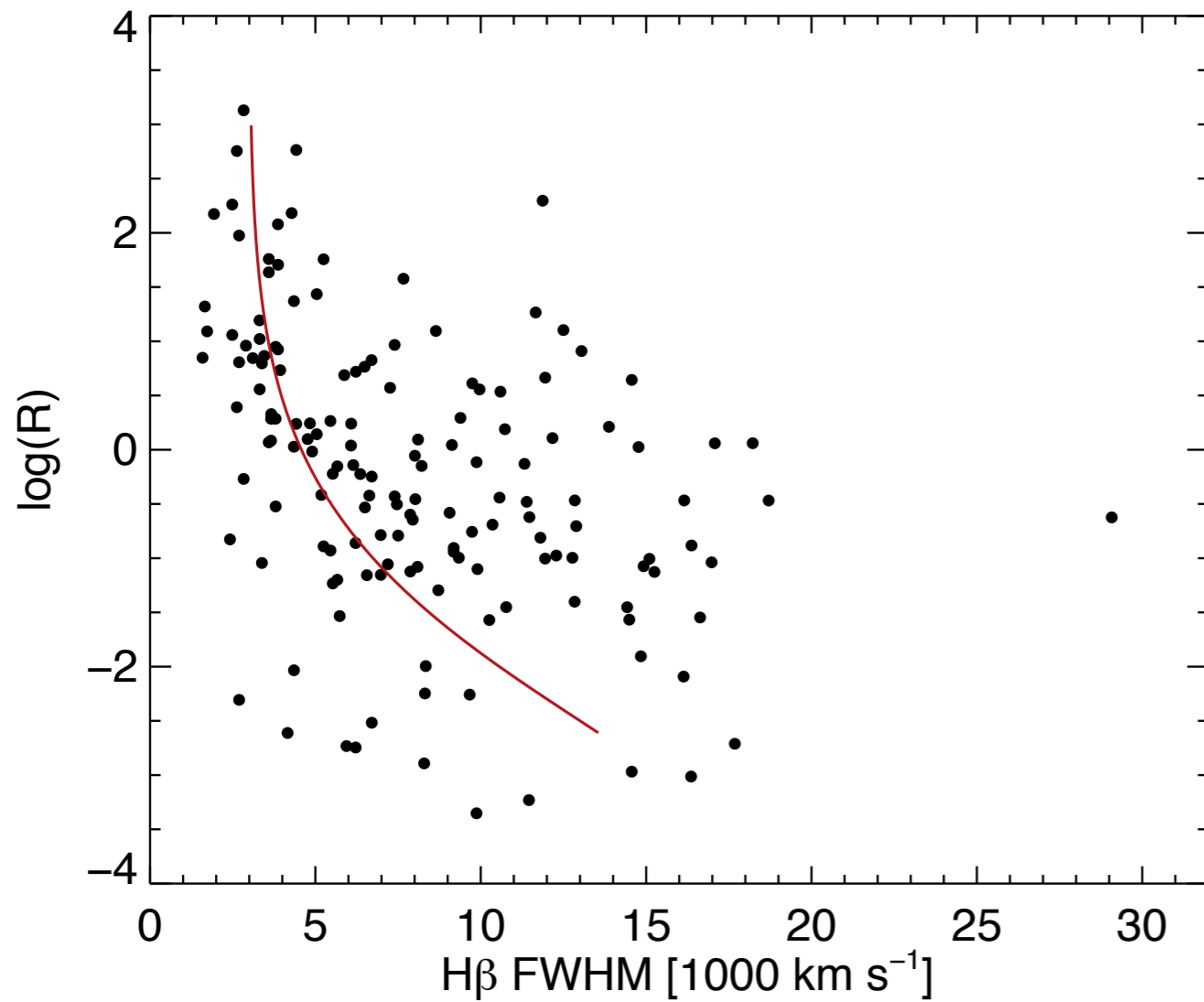
# How does this compare?



WB86 sample.

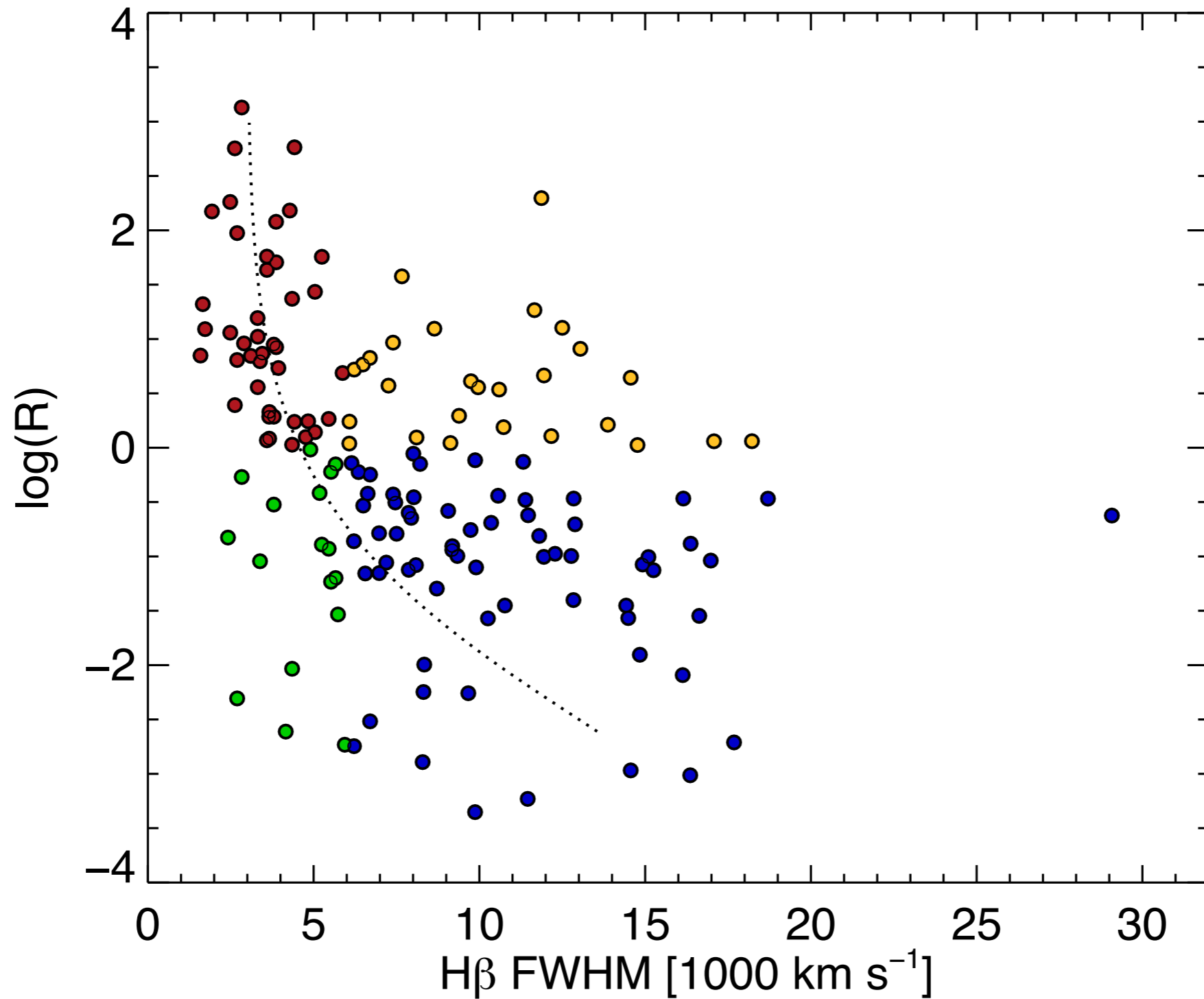


# How does this compare?

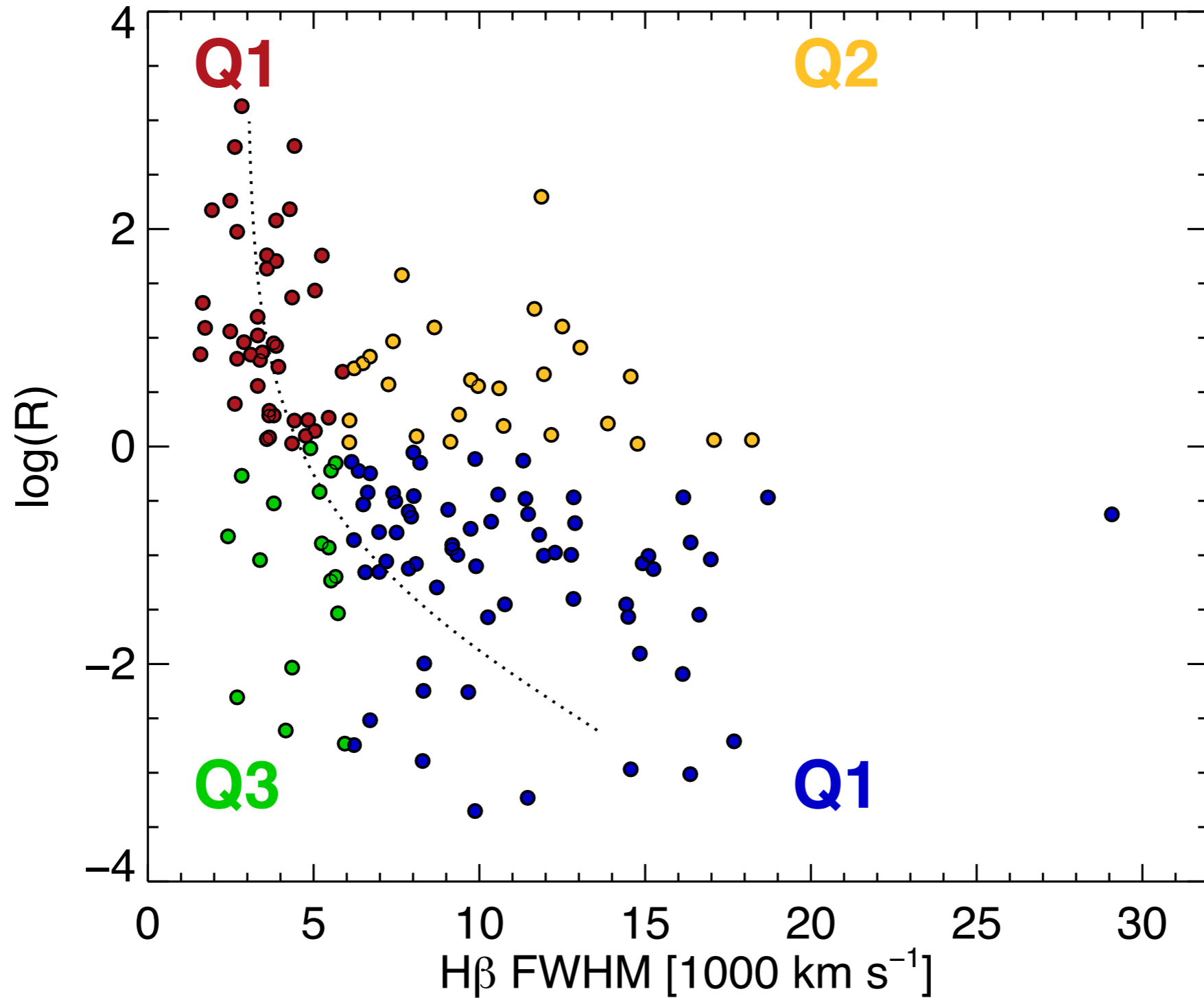


RL SED sample.

What's populating  $\log R$  - FWHM( $H\beta$ ) space?

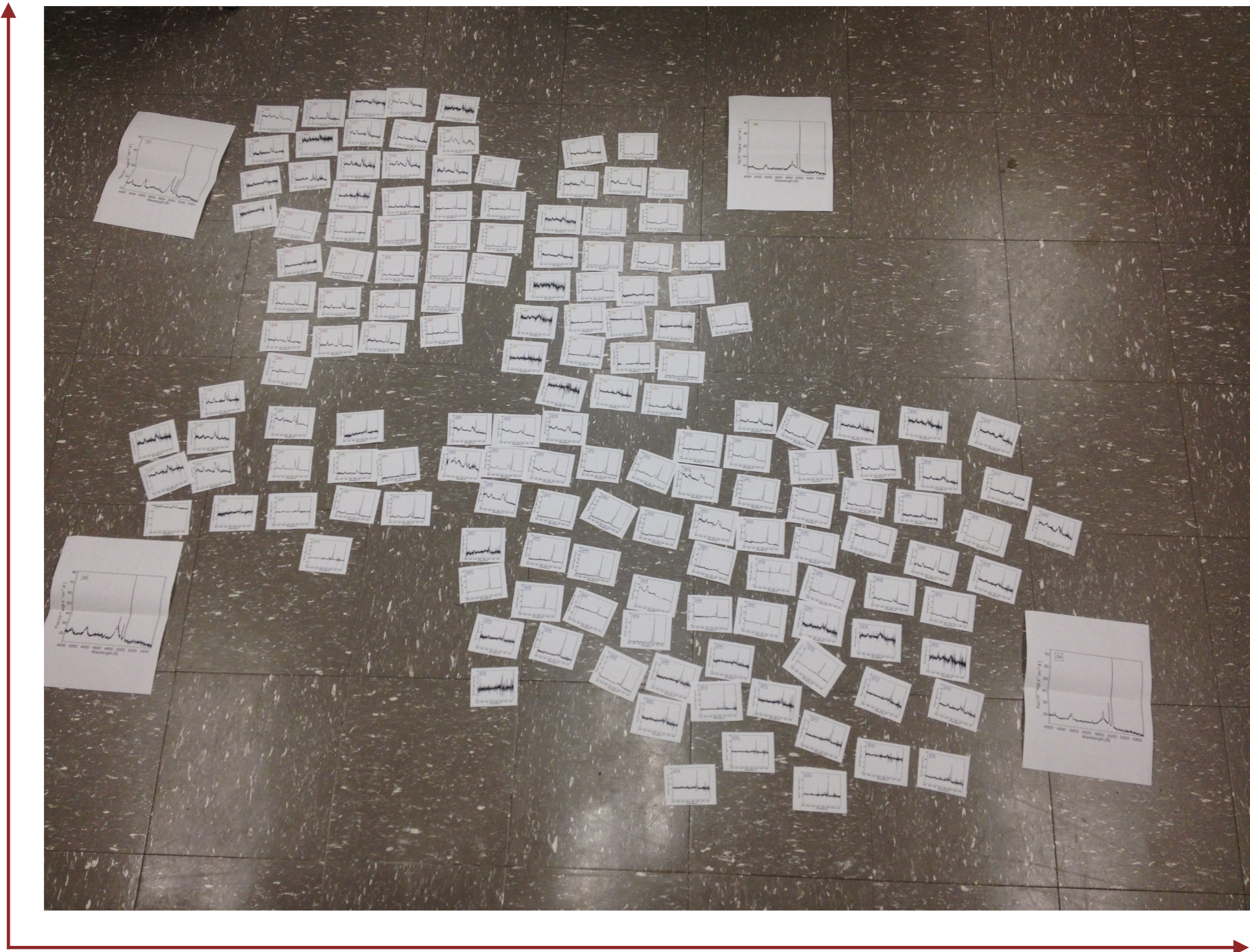


What's populating  $\log R$  - FWHM( $H\beta$ ) space?



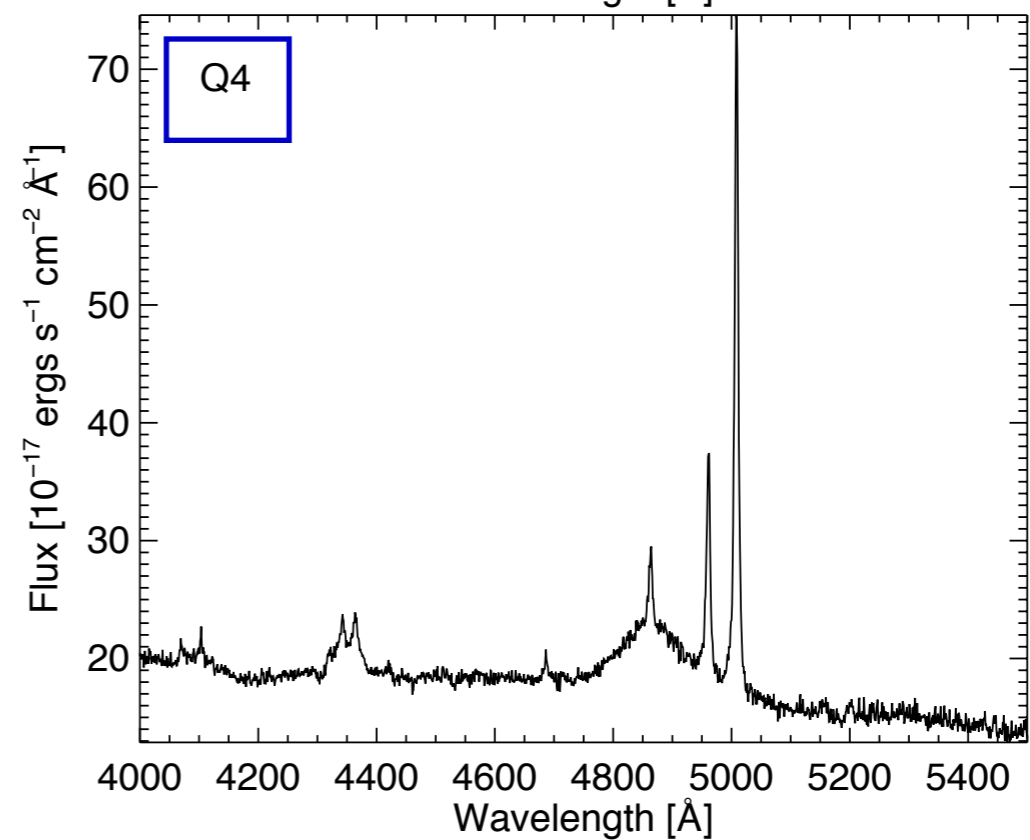
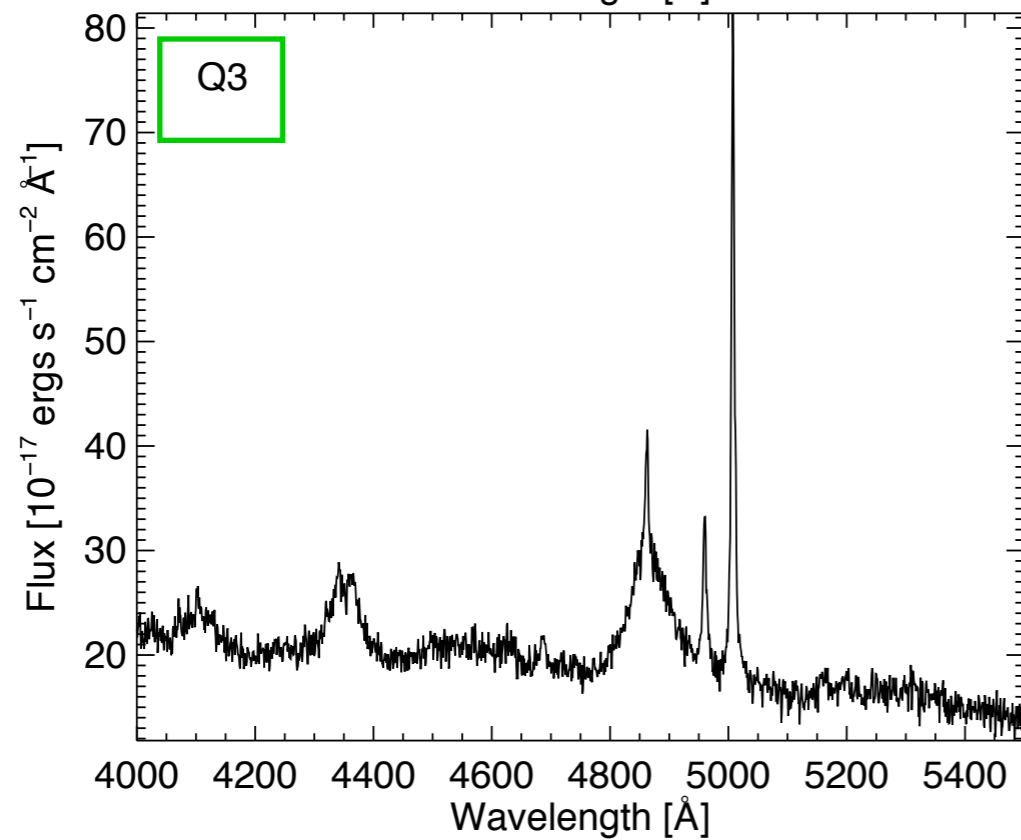
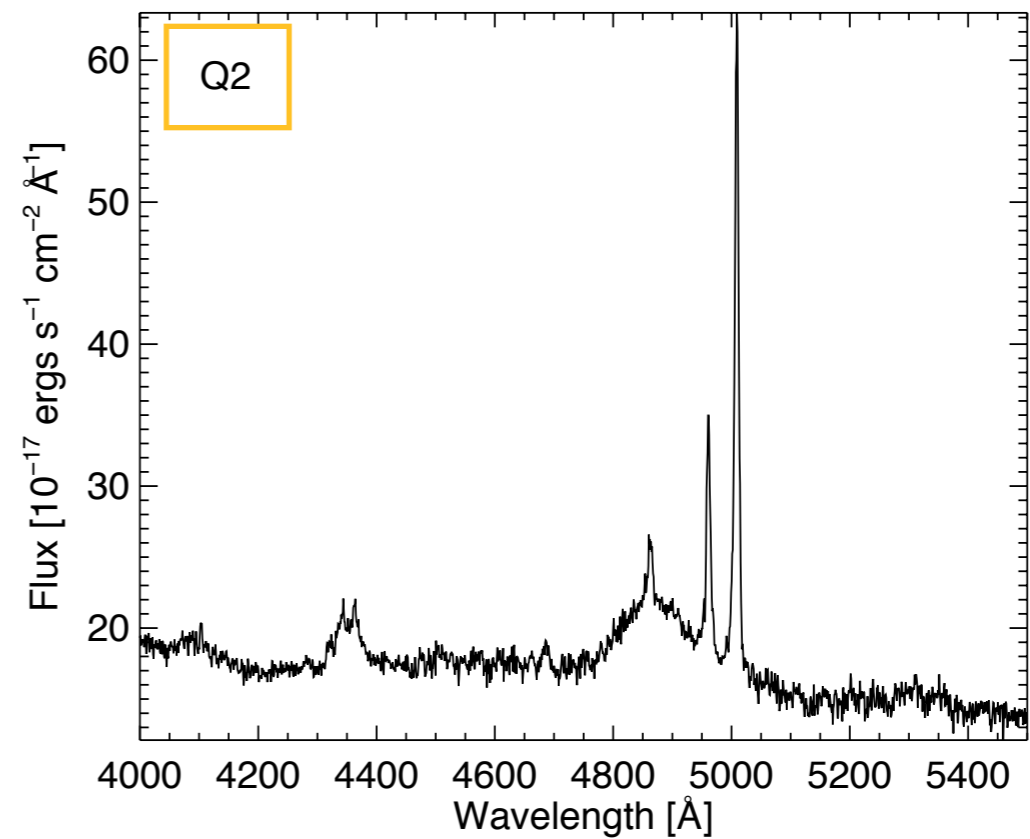
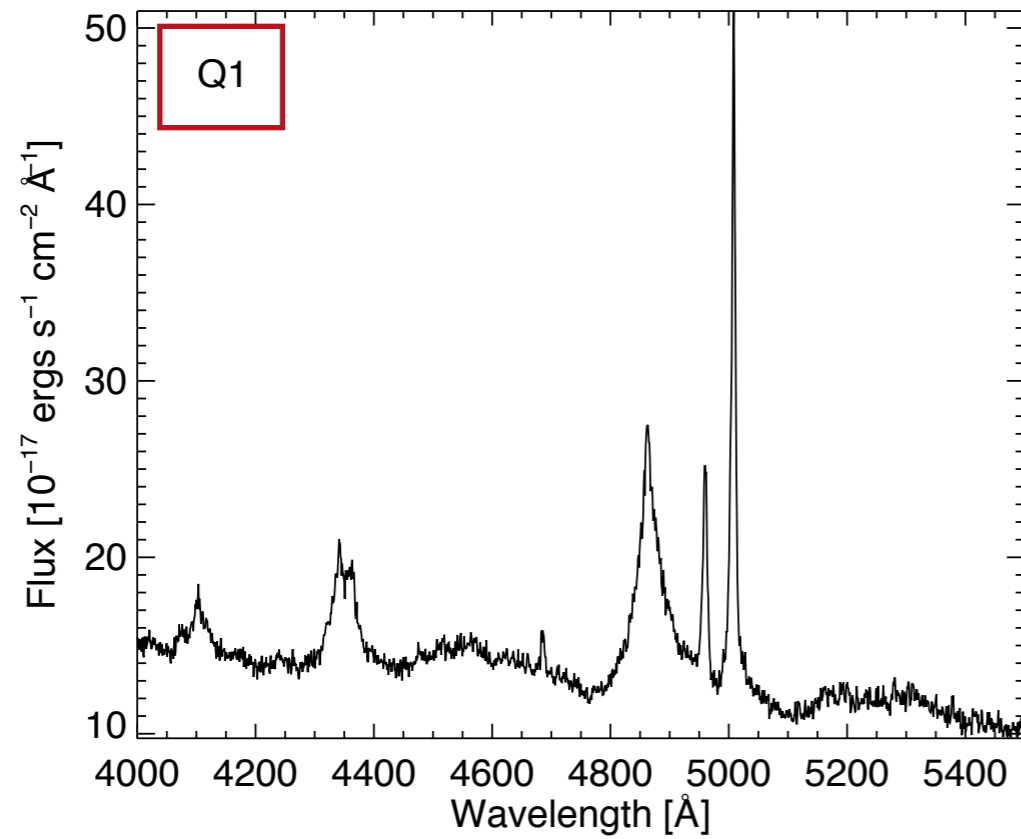
# “Floor” plot

log R



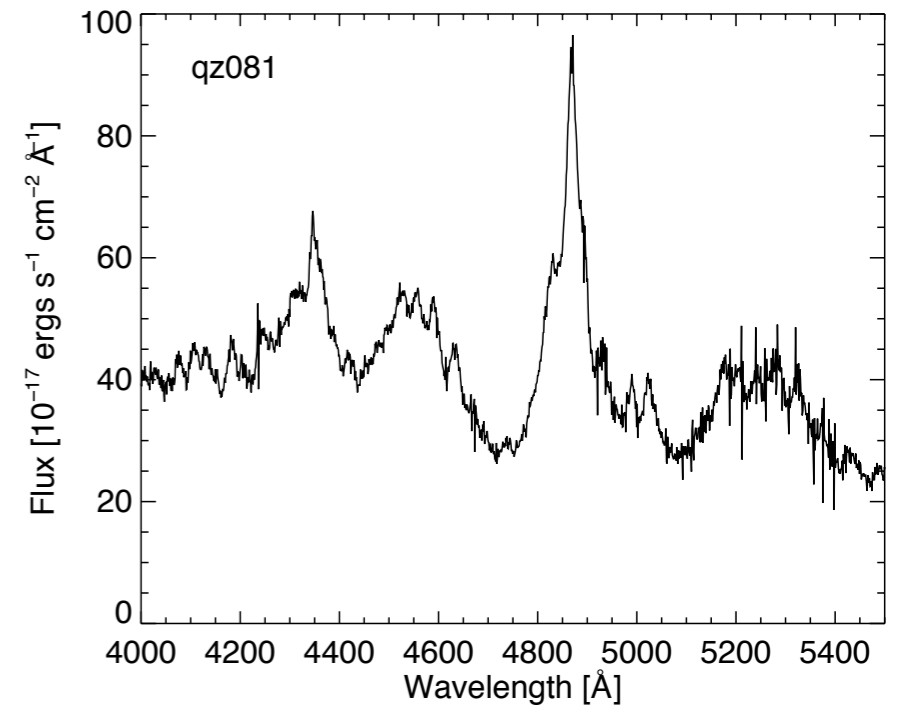
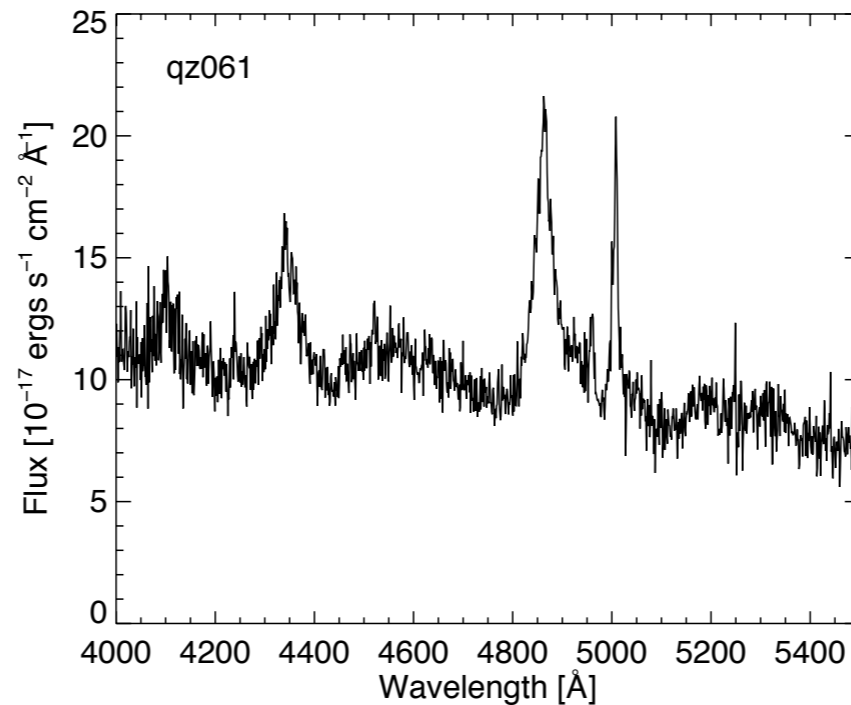
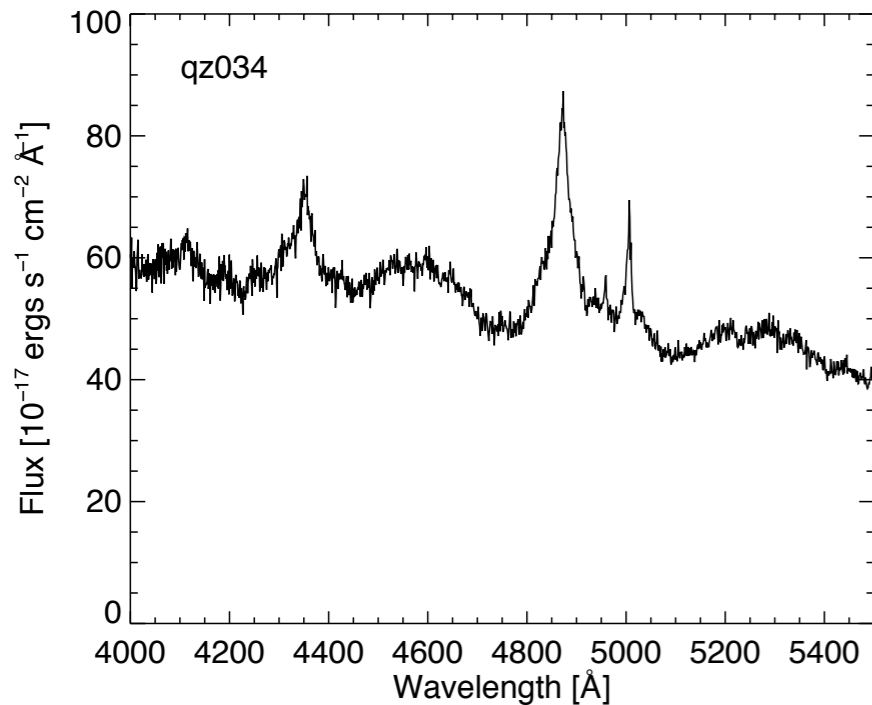
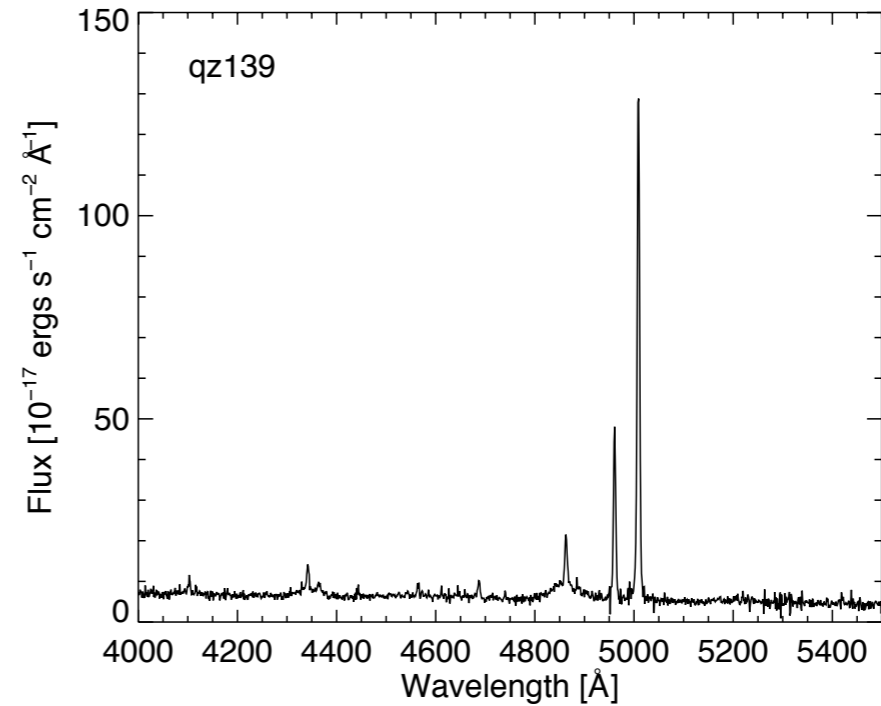
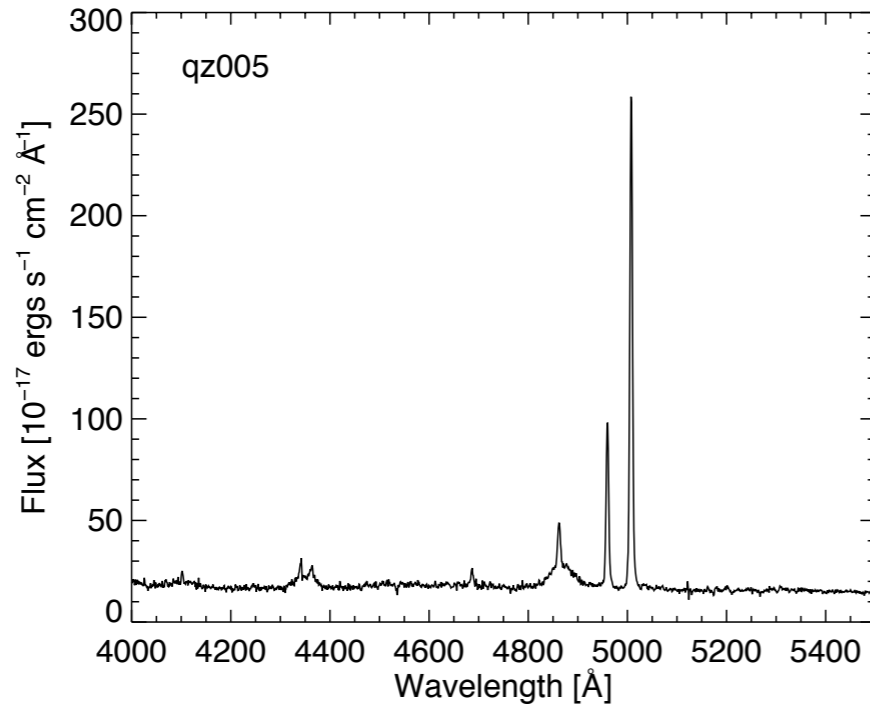
FWHM H $\beta$

# Composites



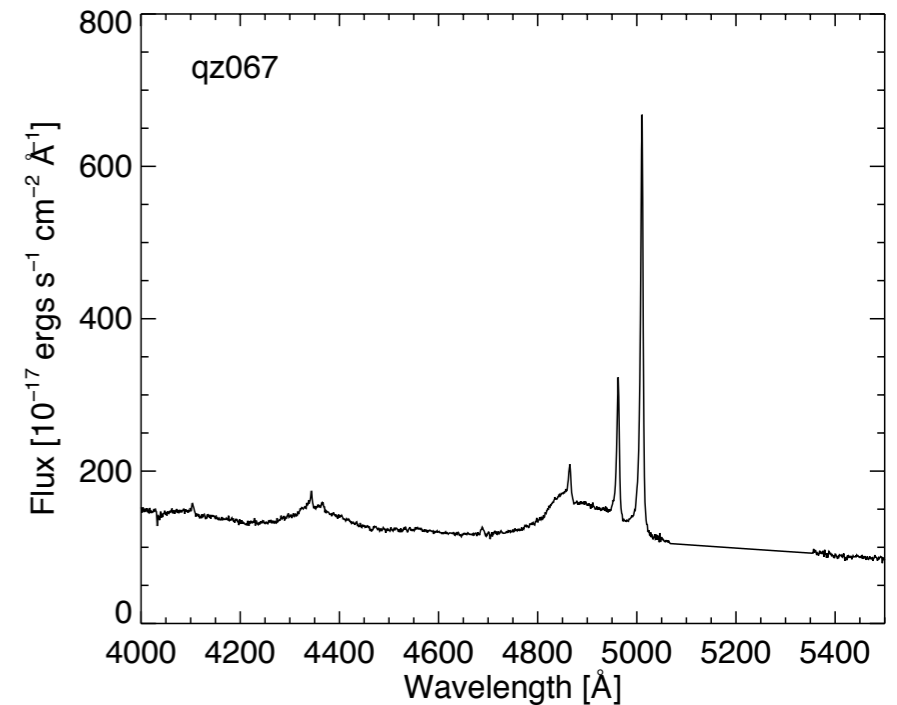
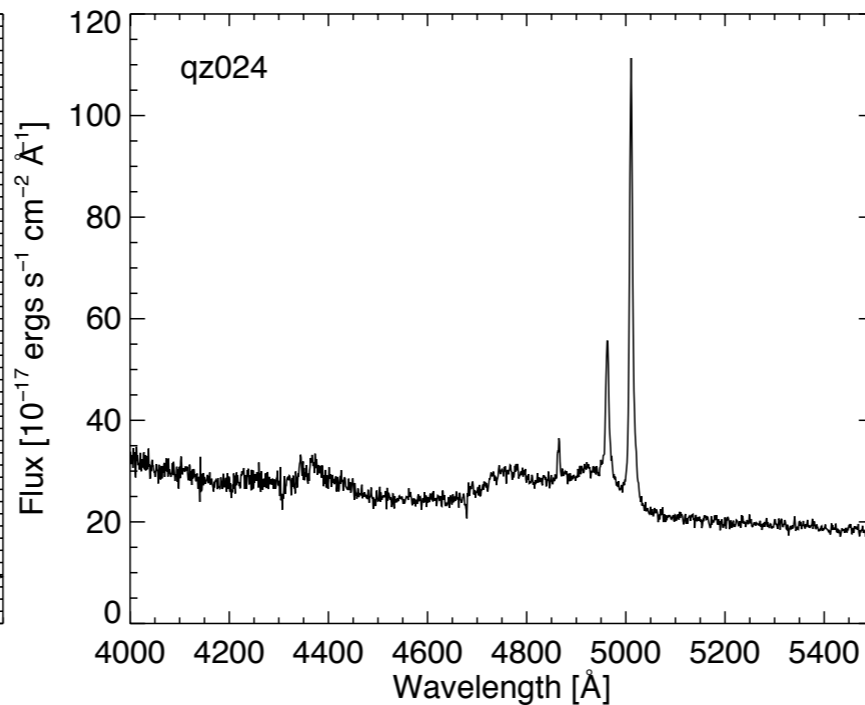
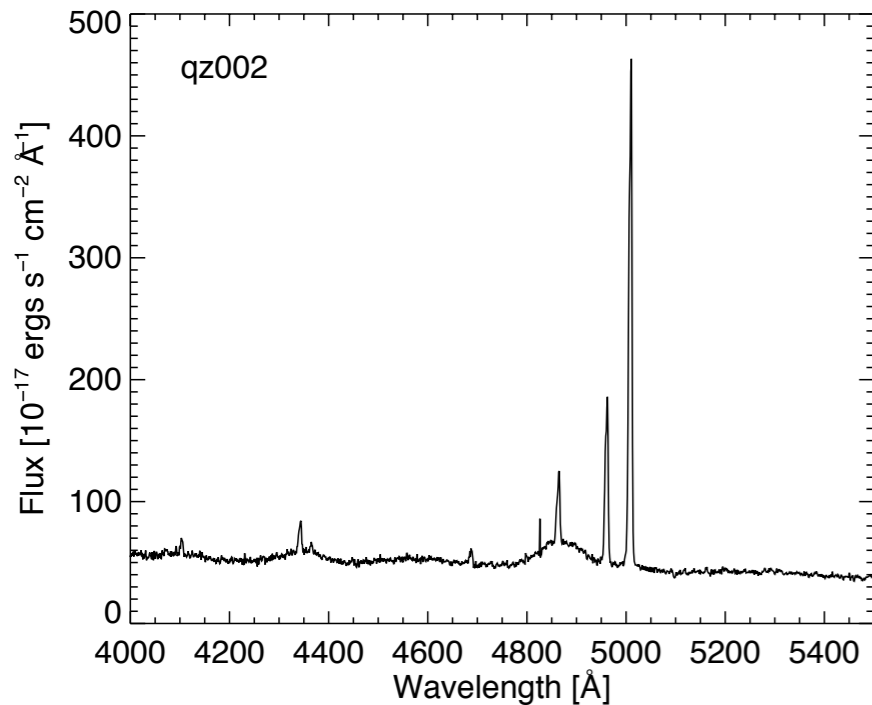
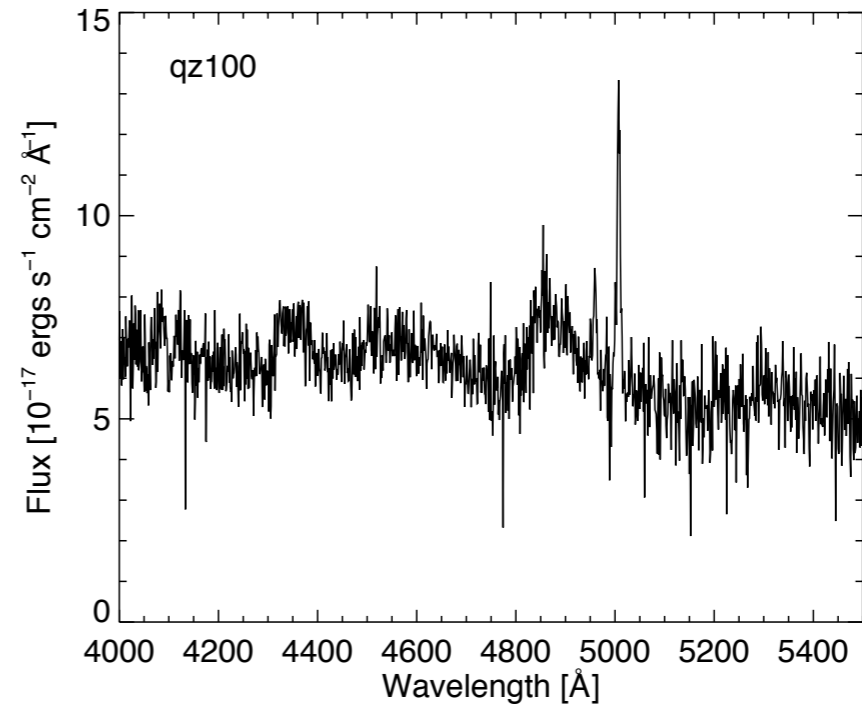
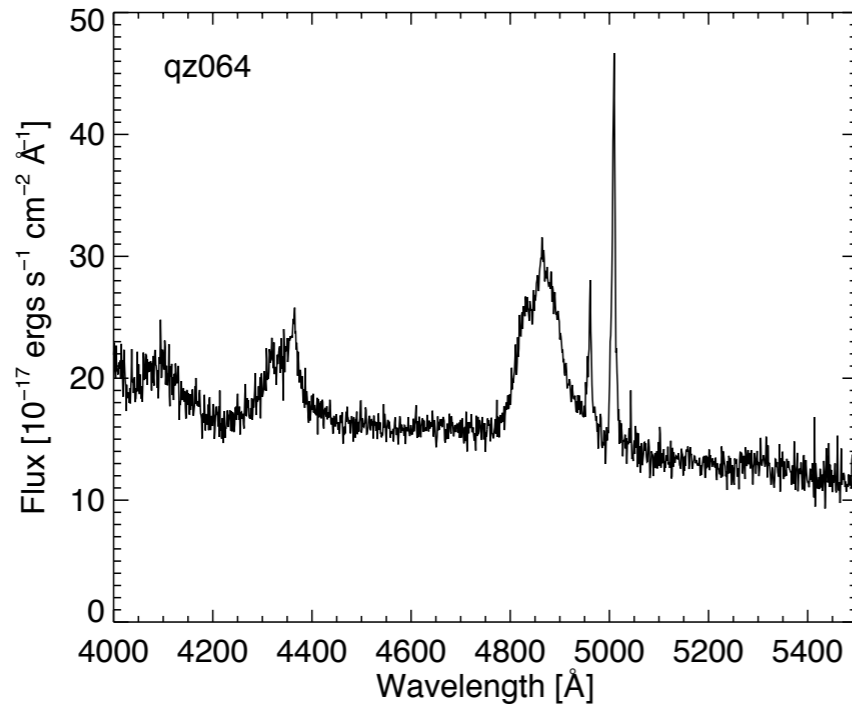


# Q1 Spectra



$\log R > 0$ ,  $FWHM(H\beta) < 6000$  km  $s^{-1}$

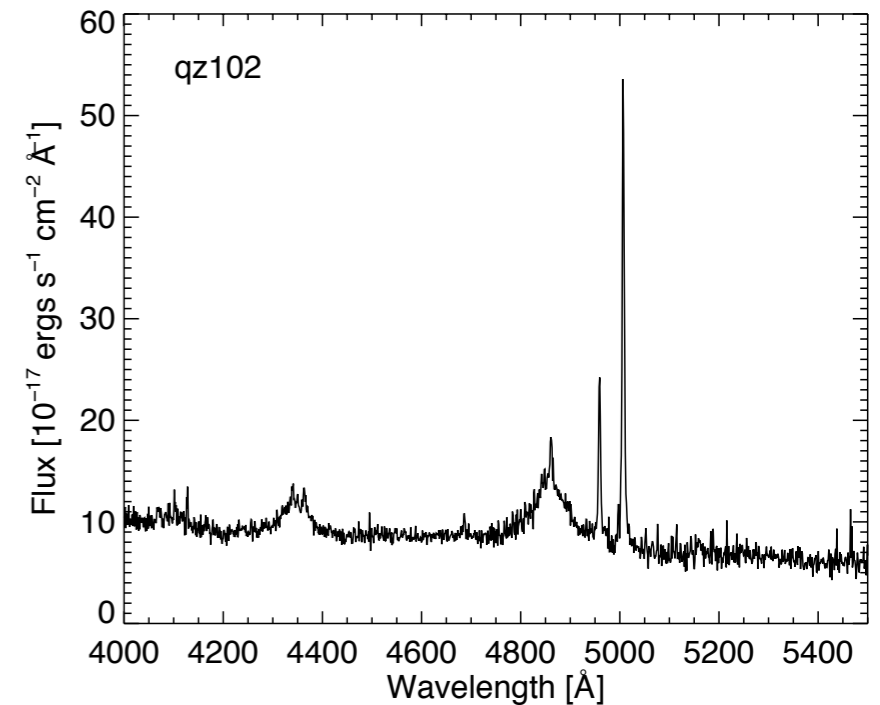
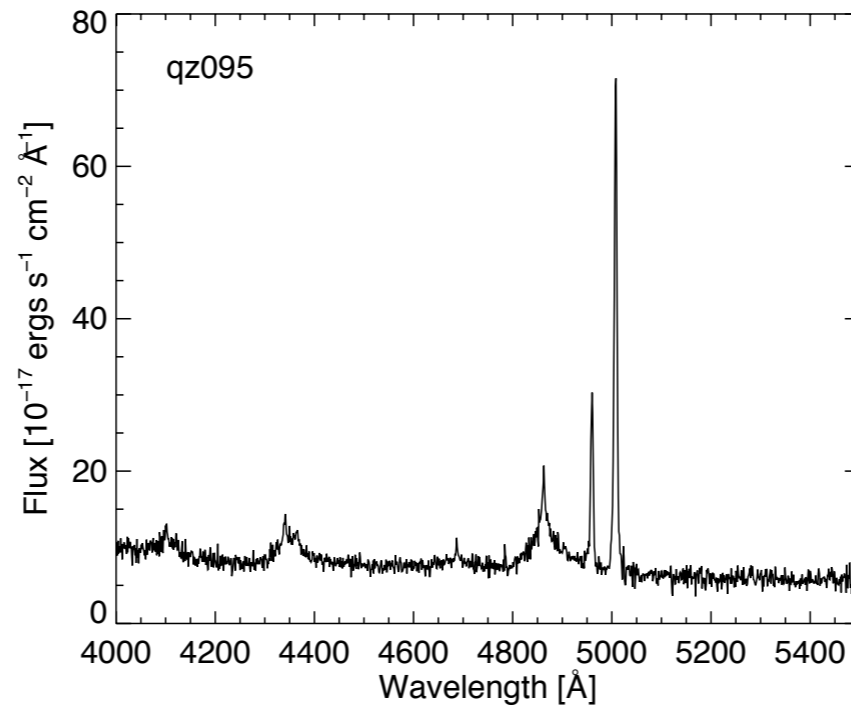
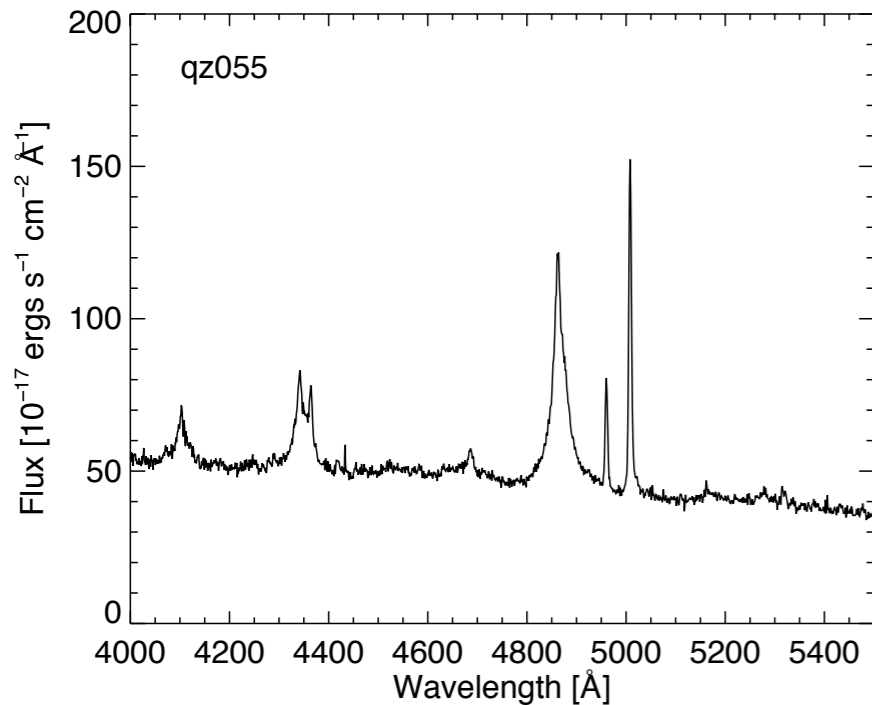
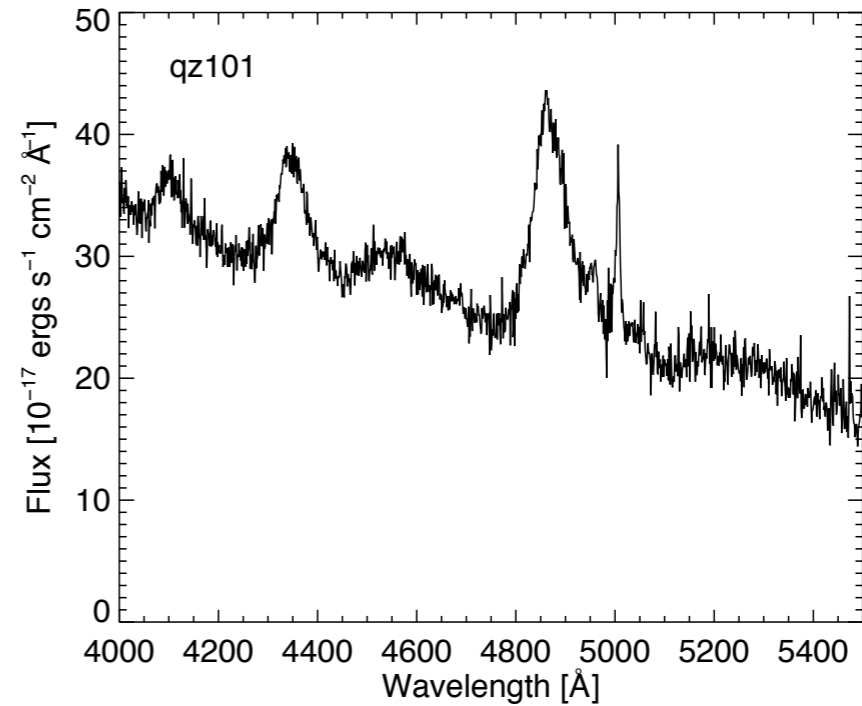
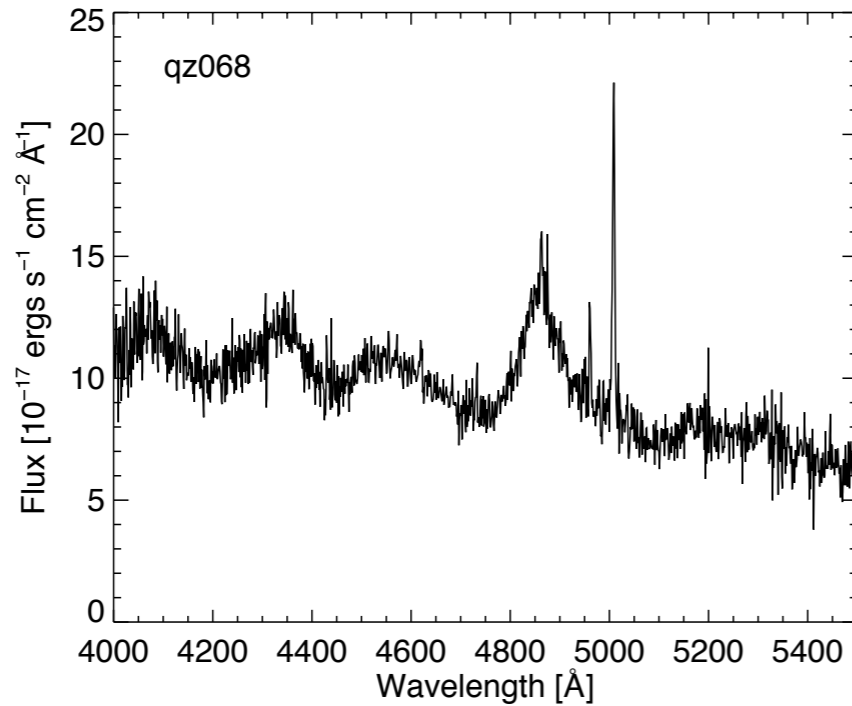
# Q2 Spectra



$\log R > 0$ ,  $FWHM(H\beta) > 6000$  km  $s^{-1}$

# Q3 Spectra

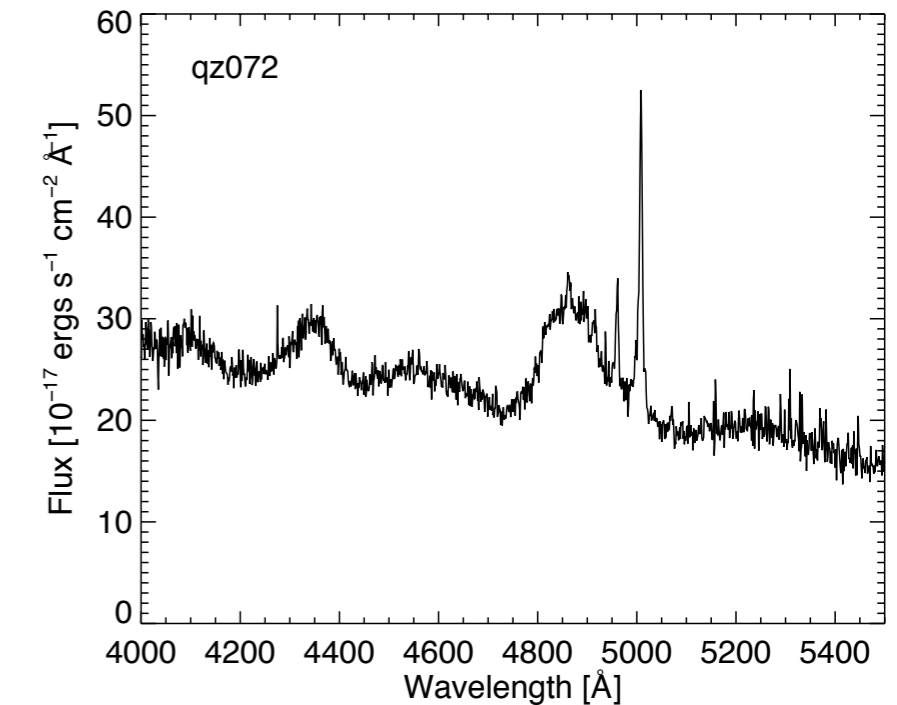
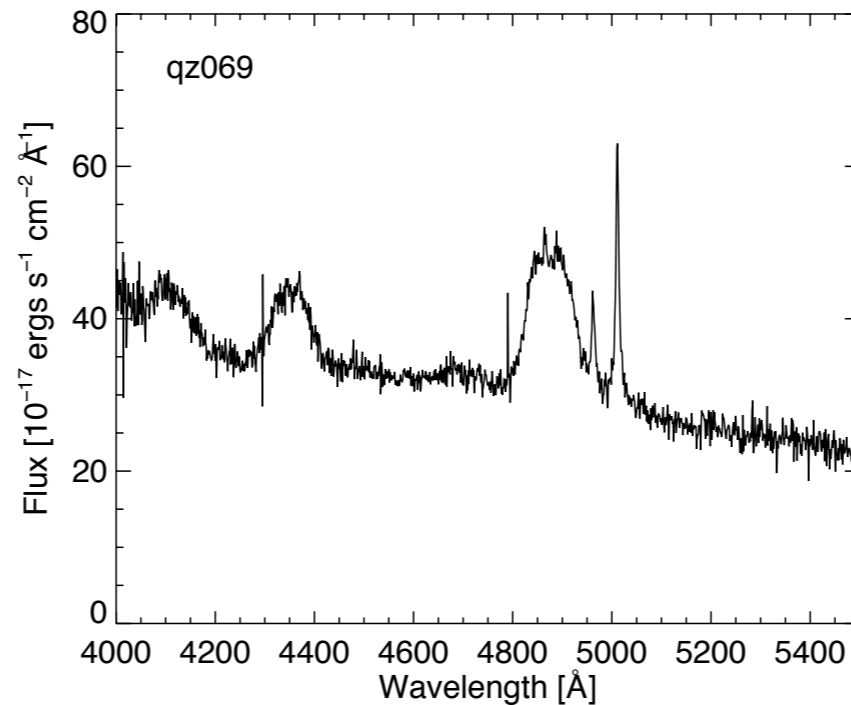
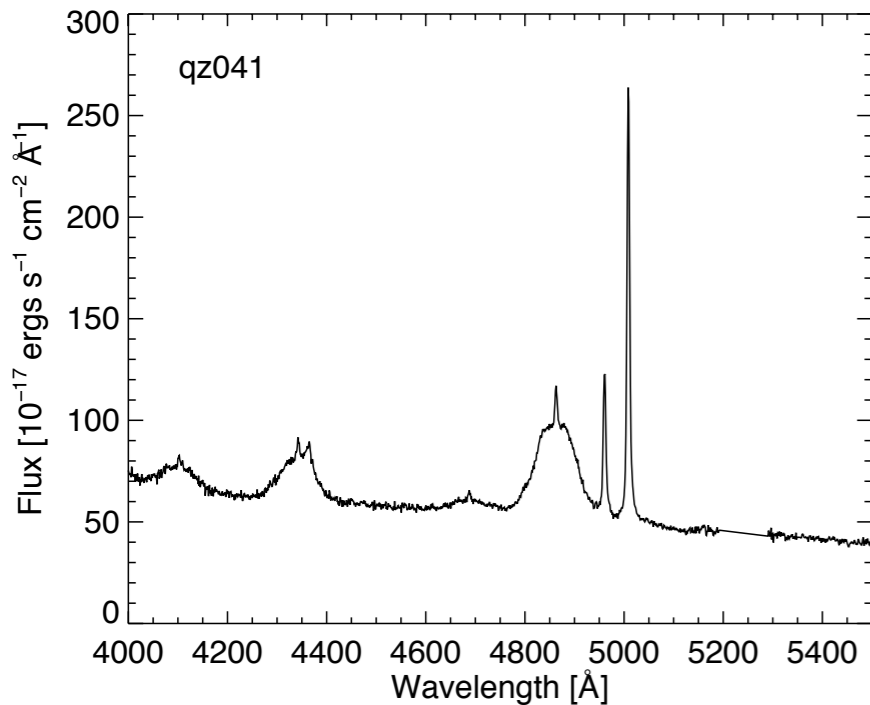
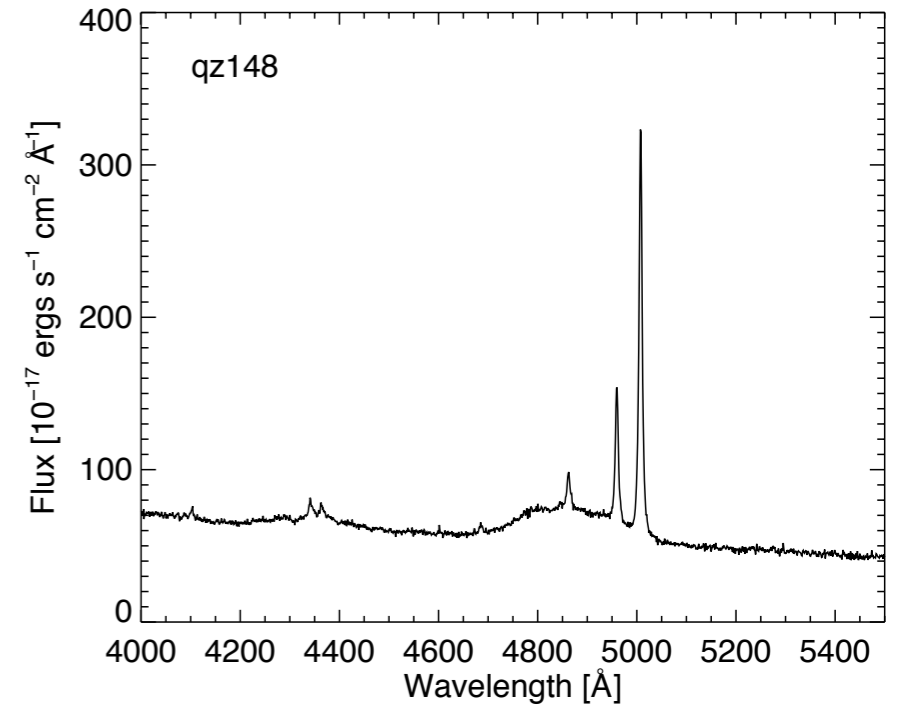
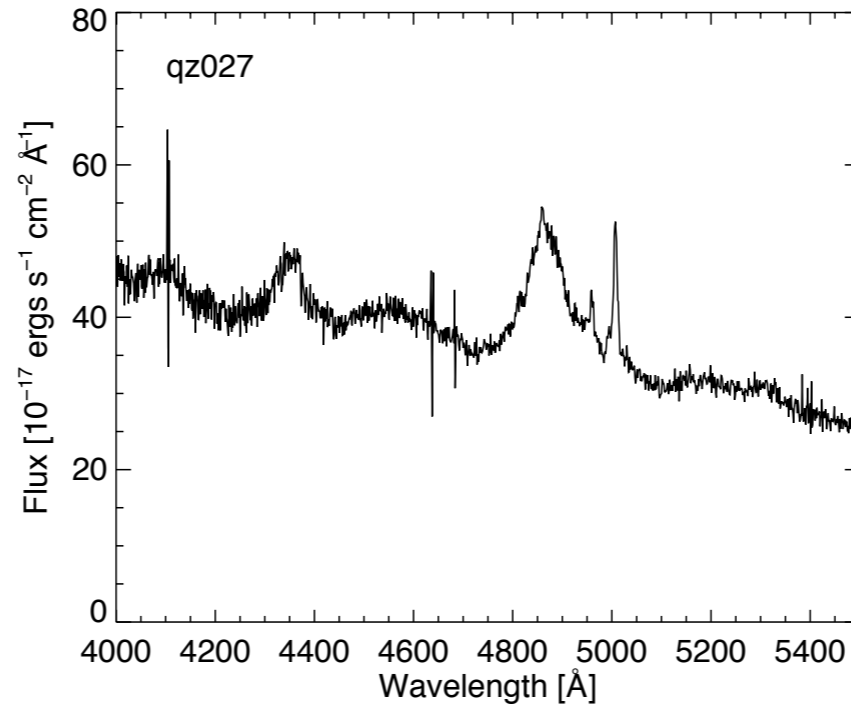
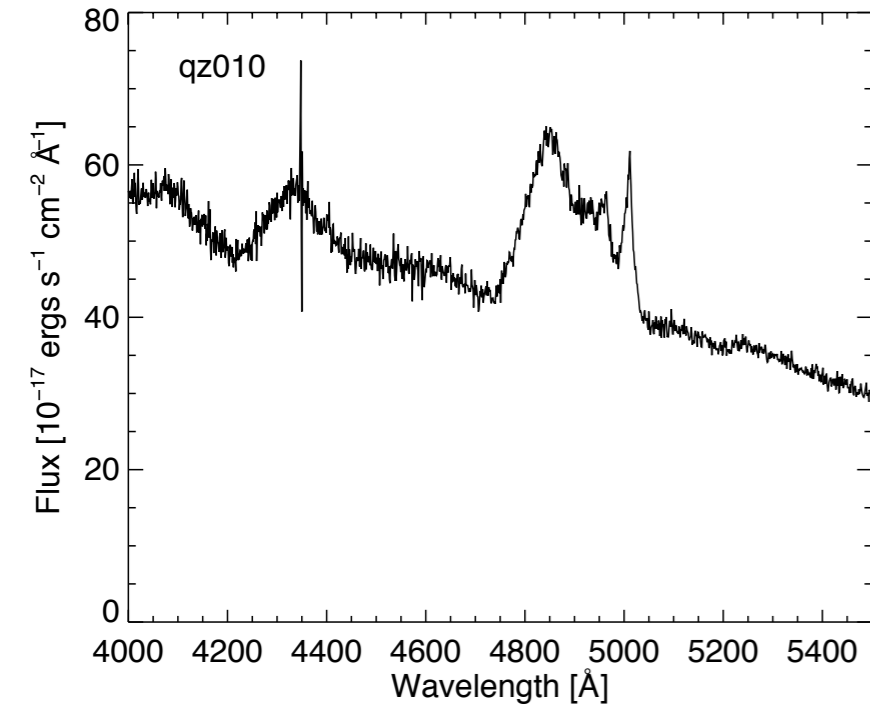
---



$\log R < 0$ ,  $FWHM(H\beta) < 6000$  km  $s^{-1}$

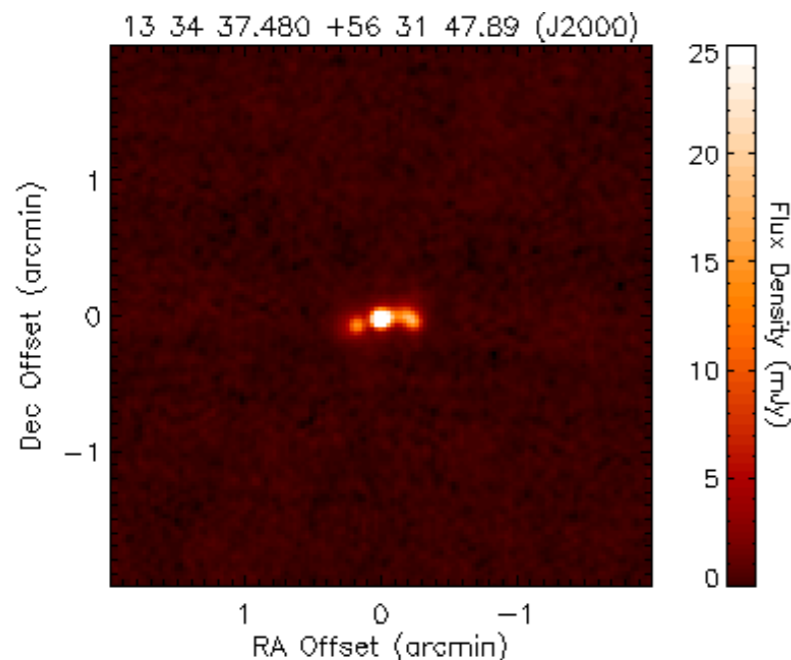
# Q4 Spectra

---

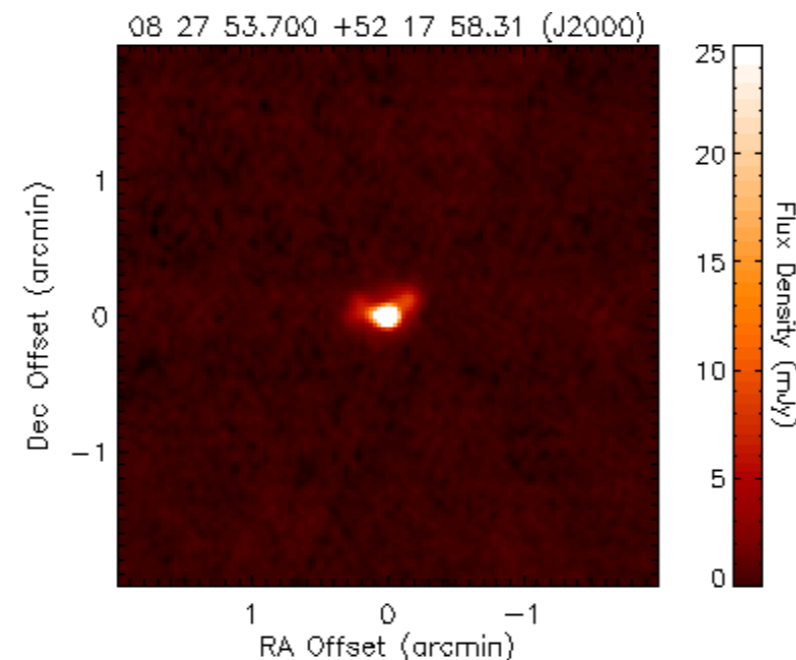


$\log R < 0$ ,  $FWHM(H\beta) > 6000$  km  $s^{-1}$

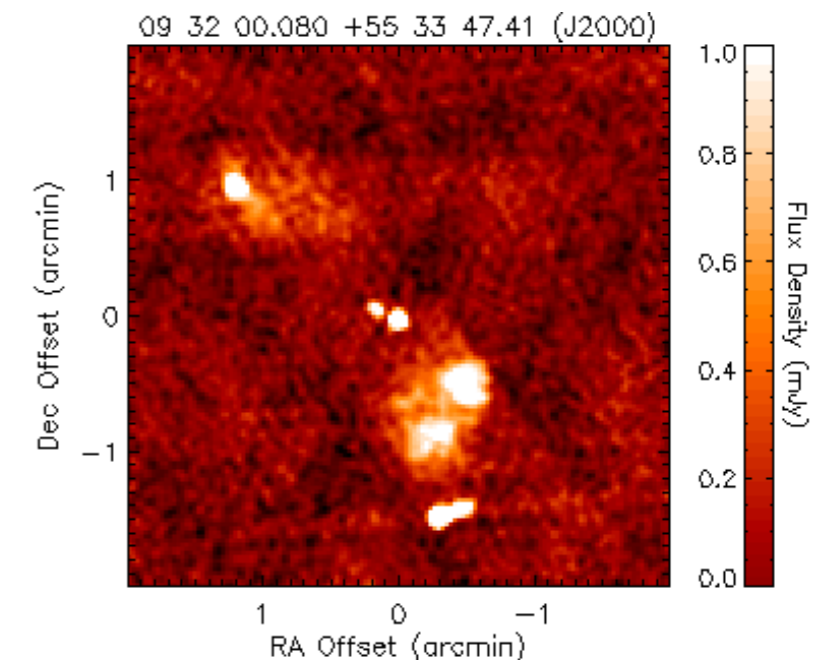
# Radio morphologies



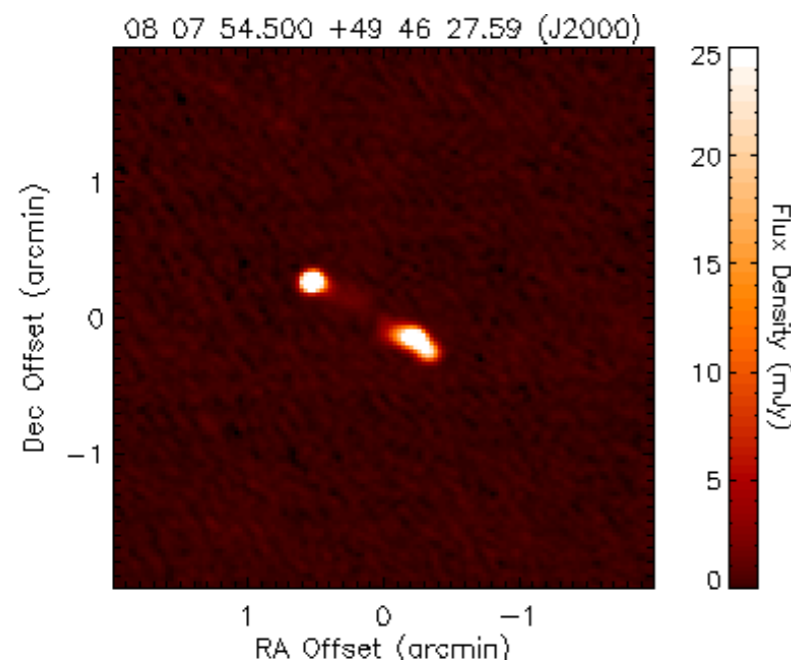
133 x 133 pixels extracted from FIRST image 13360+56415G  
 Brightest pixel is 65.36 mJy/beam at  
 X, Y = 67, 67 pixels  
 RA, Dec = 13 34 37.462 +56 31 48.65 (J2000)  
 RMS noise 0.177 mJy



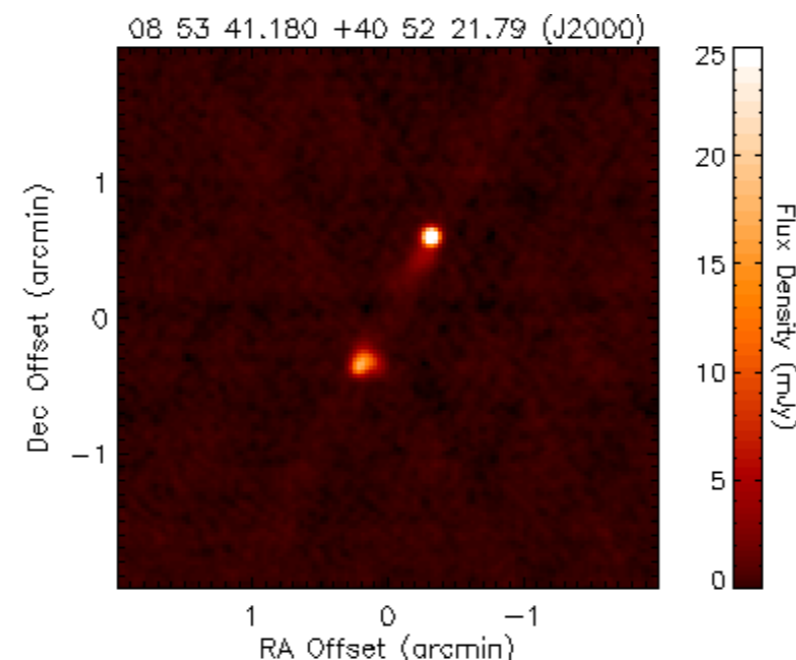
133 x 133 pixels extracted from FIRST image 08270+52196F  
 Brightest pixel is 145.24 mJy/beam at  
 X, Y = 67, 67 pixels  
 RA, Dec = 08 27 53.767 +52 17 58.04 (J2000)  
 RMS noise 0.177 mJy



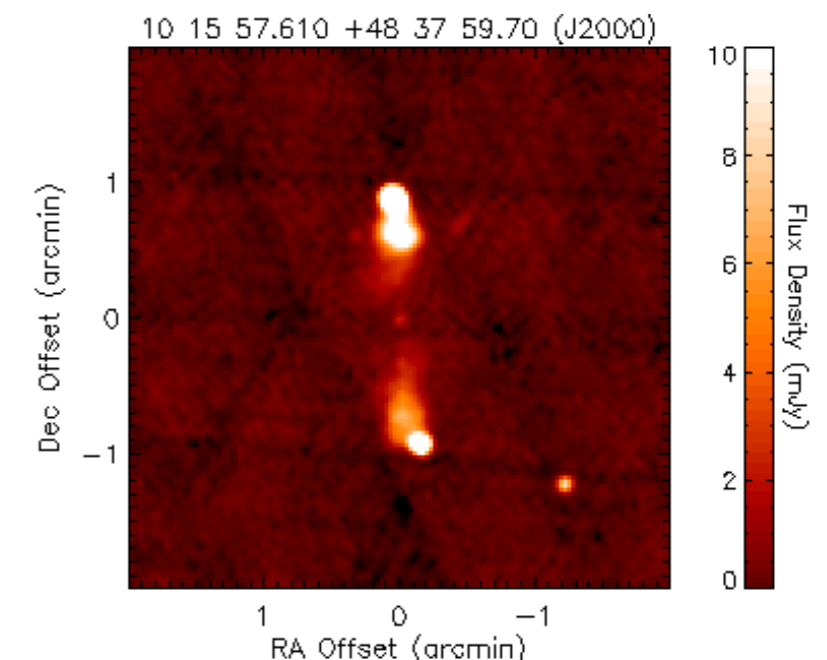
133 x 133 pixels extracted from FIRST image 09330+55553G  
 Brightest pixel is 7.10 mJy/beam at  
 X, Y = 77, 18 pixels  
 RA, Dec = 09 31 58.006 +55 32 19.96 (J2000)  
 RMS noise 0.112 mJy



133 x 133 pixels extracted from FIRST image 08090+49440F  
 Brightest pixel is 85.78 mJy/beam at  
 X, Y = 49, 76 pixels  
 RA, Dec = 08 07 57.865 +49 46 44.56 (J2000)  
 RMS noise 0.194 mJy

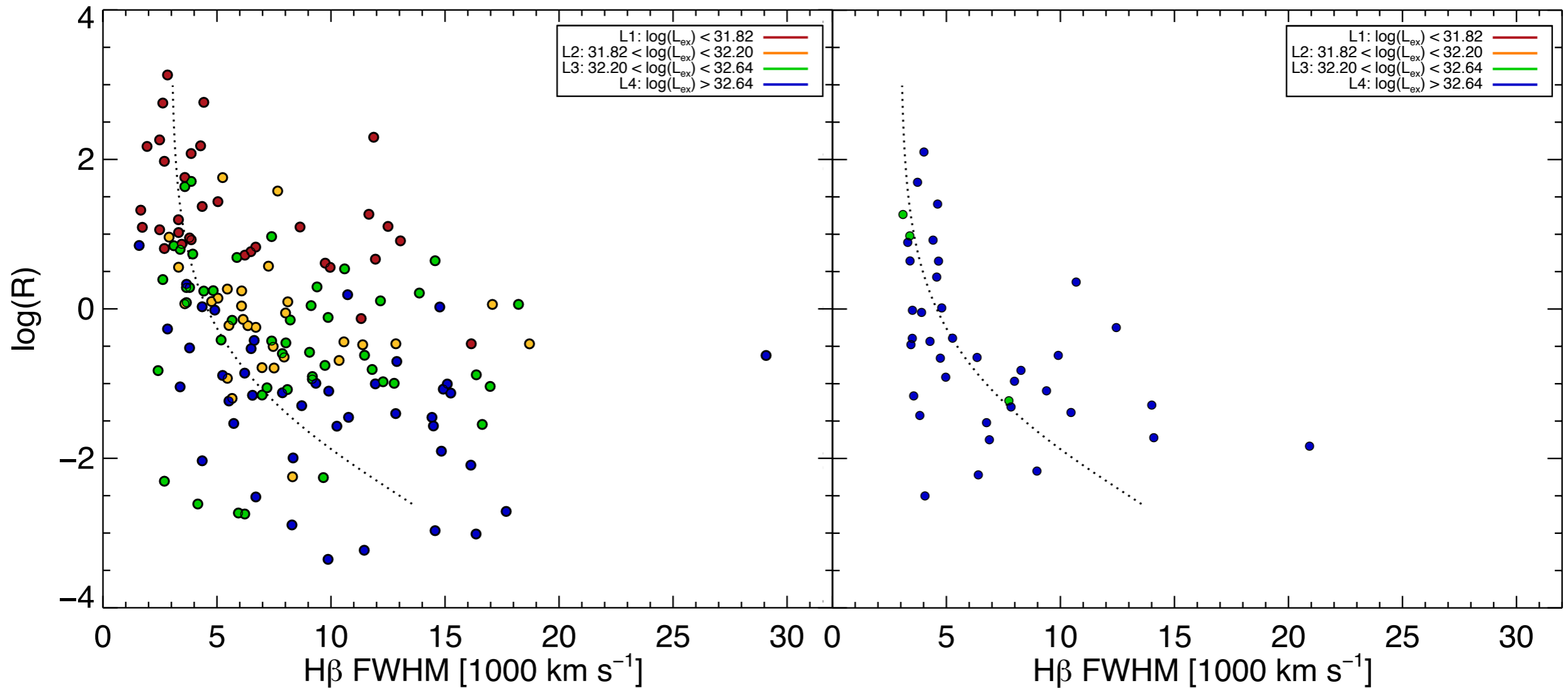


133 x 133 pixels extracted from FIRST image 08540+40417E  
 Brightest pixel is 46.52 mJy/beam at  
 X, Y = 78, 87 pixels  
 RA, Dec = 08 53 39.436 +40 52 57.55 (J2000)  
 RMS noise 0.194 mJy



133 x 133 pixels extracted from FIRST image 10150+48304F  
 Brightest pixel is 103.32 mJy/beam at  
 X, Y = 66, 97 pixels  
 RA, Dec = 10 15 57.874 +48 38 54.29 (J2000)  
 RMS noise 0.198 mJy

# Extended radio luminosity



- Why don't we find core-dominated, high  $L_{\text{ext}}$  objects?
- They're rare!

# Summary

- Complete sample of 156 DR7 SDSS quasars with  $0.1 < z < 0.6$  and  $\log L(325 \text{ MHz}) > 26 \text{ W Hz}^{-1}$ , including some with no radio cores.
- Objects are diverse in optical spectral properties and radio morphologies.
- Includes core-dominant population with broad FWHM( $H\beta$ ).
- Range in properties indicates importance of other physical parameters in addition to orientation.