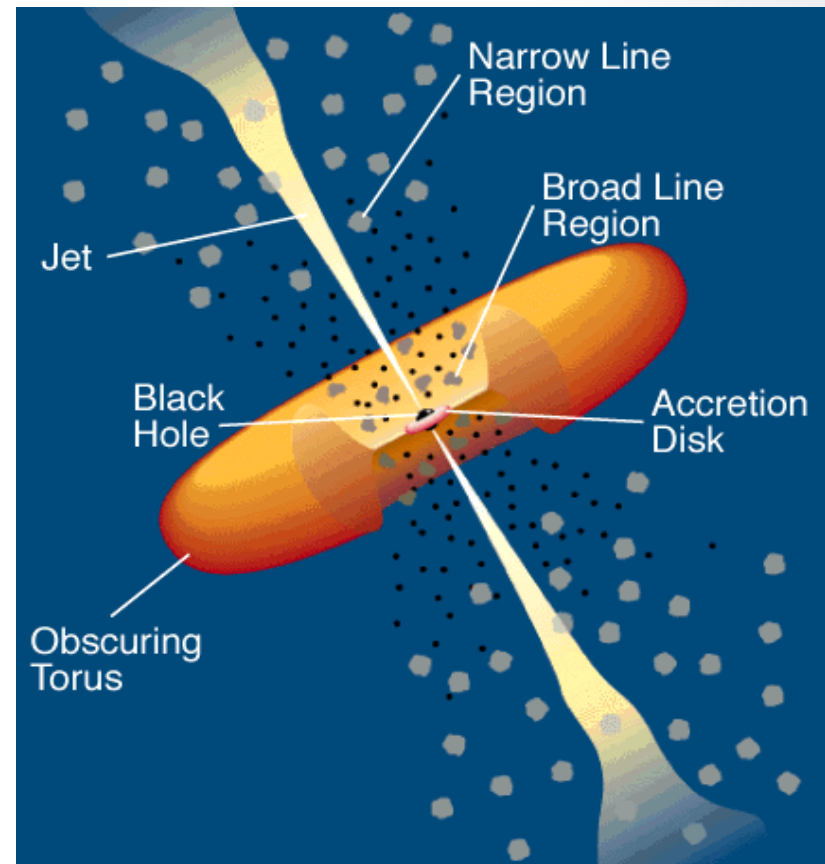


The Decade-long Variability of Broad Emission in Nearby Galaxy Centers

Robert Roten

Motivation

- Active galactic nuclei (AGN) accretion onto supermassive black hole
- Broad-line region (BLR)
 - Gas moving 1000s of km/s
 - Emission lines Doppler broadened
- Narrow-line region (NLR)
 - 100s of km/s
- BLR present – Type I AGN
- No BLR present – Type II AGN
- If not detected:
 - Pure type II
 - Obscured by circumnuclear dust
 - Buried in host galaxy light
 - Variability? →



Studies into variability

- Reverberation mapping
- Constrain models of accretion
- Most on QSO (distant luminous)
- Studies into nearby objects are scarce
- None for decade long scales

Can Variability be studied over decades? Is there data available?

- Constantin et al. (2014) found hints for decade scale variability in nearby low luminosity AGN for ~ 20 objects
- Need more galaxies and more measurements for each
- Scoured publicly available data sets

Palomar

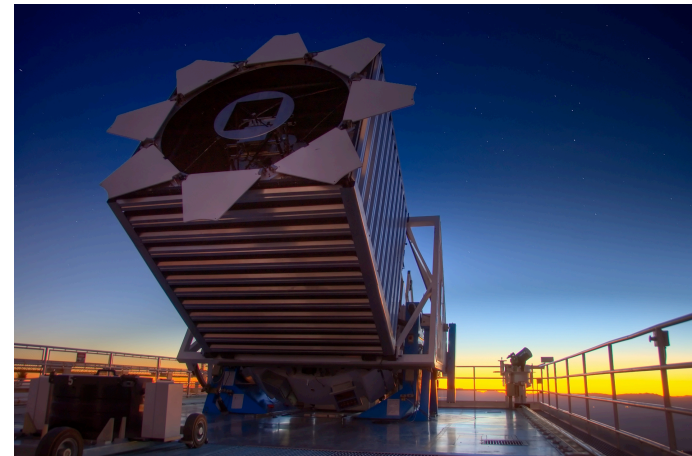
- Optical Spectroscopic survey of 486 low- luminosity AGN
- 2"x4" aperture
- 46 showed definite or probable evidence broad $H\alpha$ emission

SDSS(Sloan Digital Sky Survey)

- Ground based all sky survey
- 3" fiber



Cross-matched with 5" angular separation

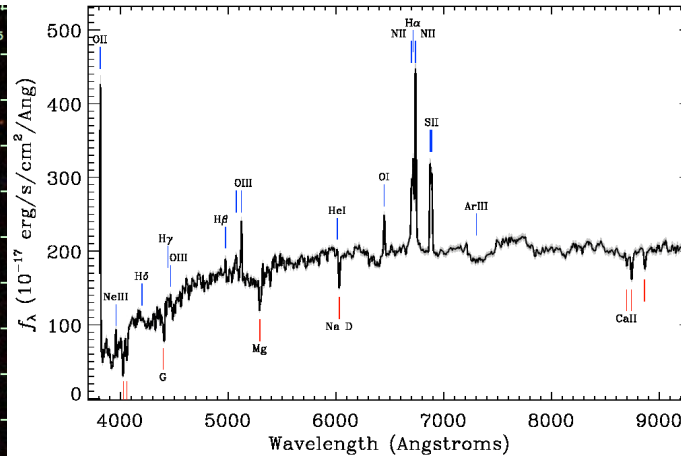
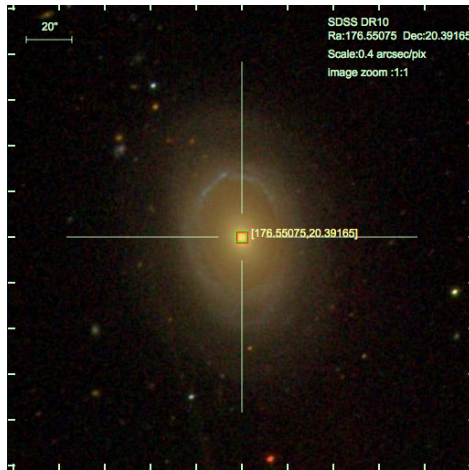


sample of 9 objects with spectra in SDSS



Cross-matching process

NGC 3884

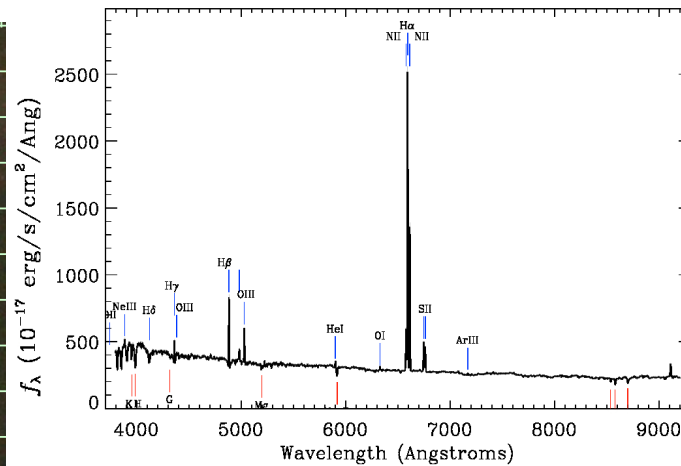
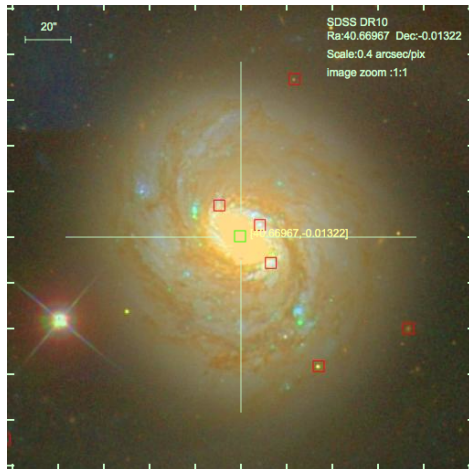


Good match

Spectra taken from nucleus

Spectrum shows broad component

NGC 1068



Bad match

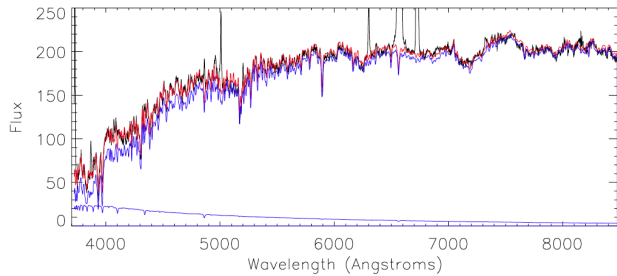
No spectra taken from nucleus

Angular separation $>5''$

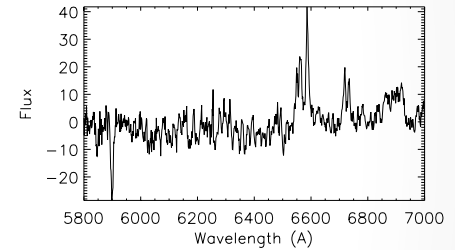
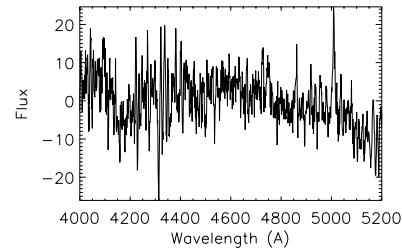
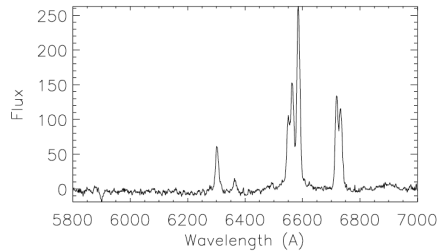
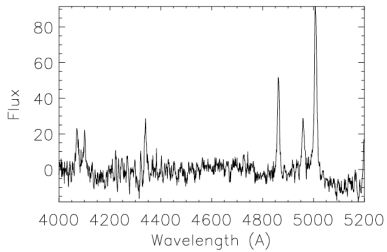
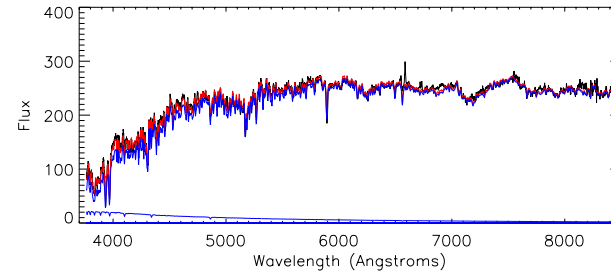
Spectrum shows no broad component

Host galaxy light subtraction

NGC 3884



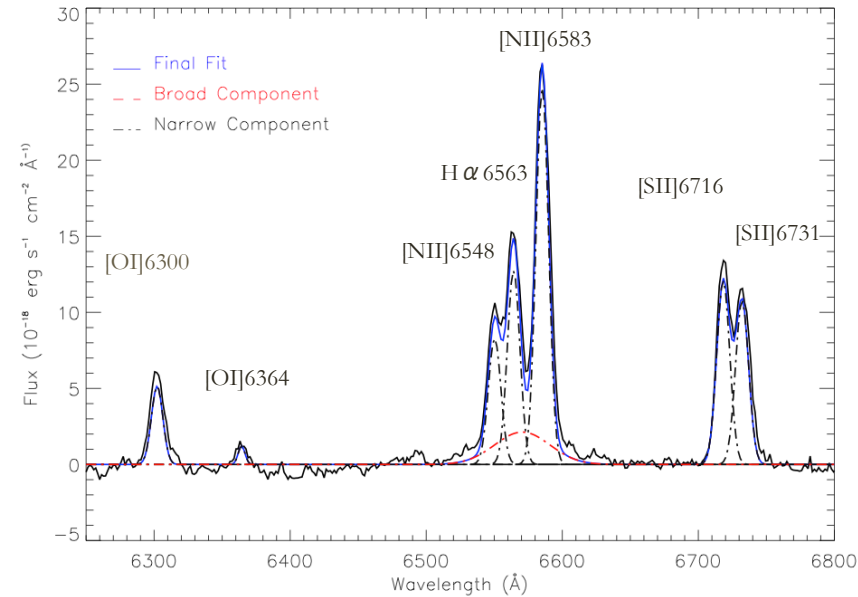
NGC 4168



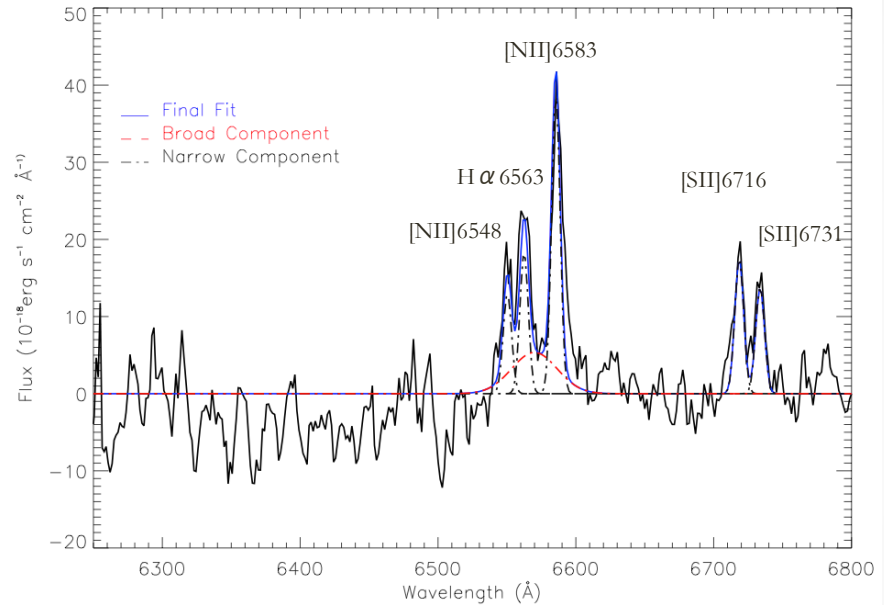
- Fit data with a continuum produced by a linear combination of synthetic models of stellar populations of various ages and metallicity
- Subtracted continuum to produce pure emission line spectra

Fitting Emission line Components

NGC 3884

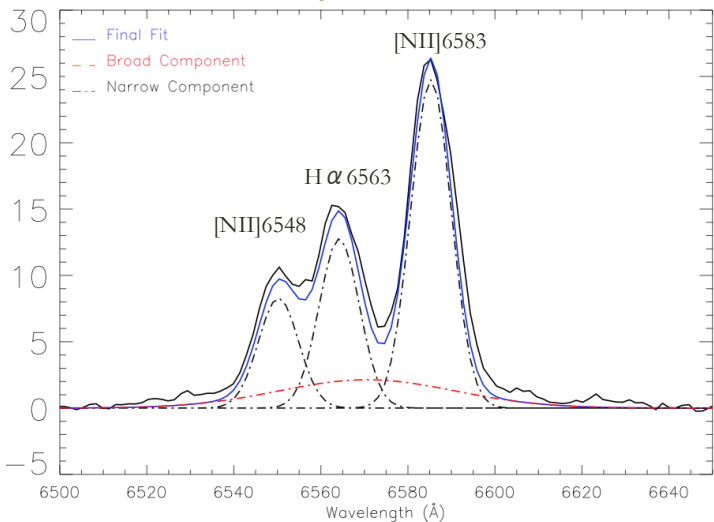


NGC 4168



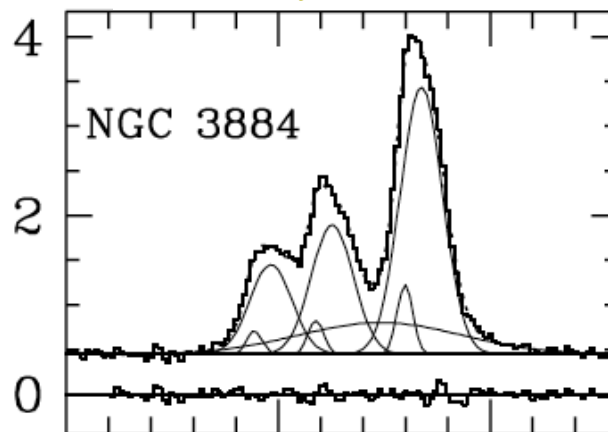
- Model used a priori conditions of the physics which produces emission lines
- Obtained emission line ratios, flux, and widths via chi-square minimization

SDSS year: 2007.3

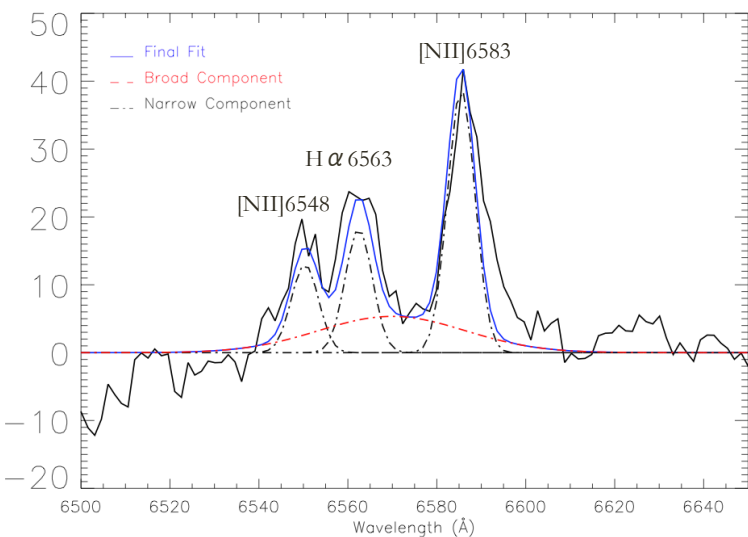


FWHM	
2170	2100
$f_{\text{blend}}[\text{H } \alpha + \text{NII}]$	
0.16	0.19
$f_{\text{H } \alpha}$	
0.42	0.47

Palomar year: 1984.2

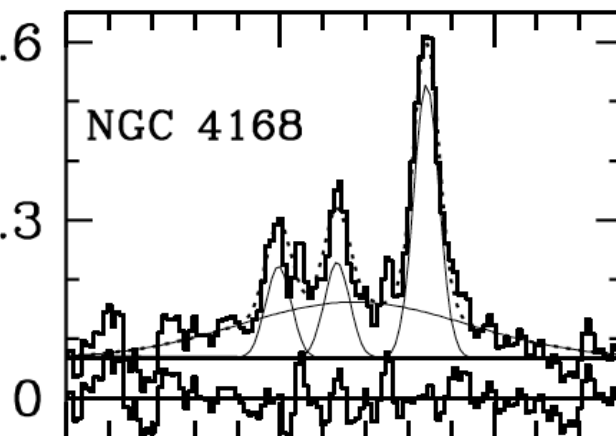


SDSS year: 2004.4



FWHM	
1770	2150
$f_{\text{blend}}[\text{H } \alpha + \text{NII}]$	
0.29	0.52
$f_{\text{H } \alpha}$	
0.61	0.84

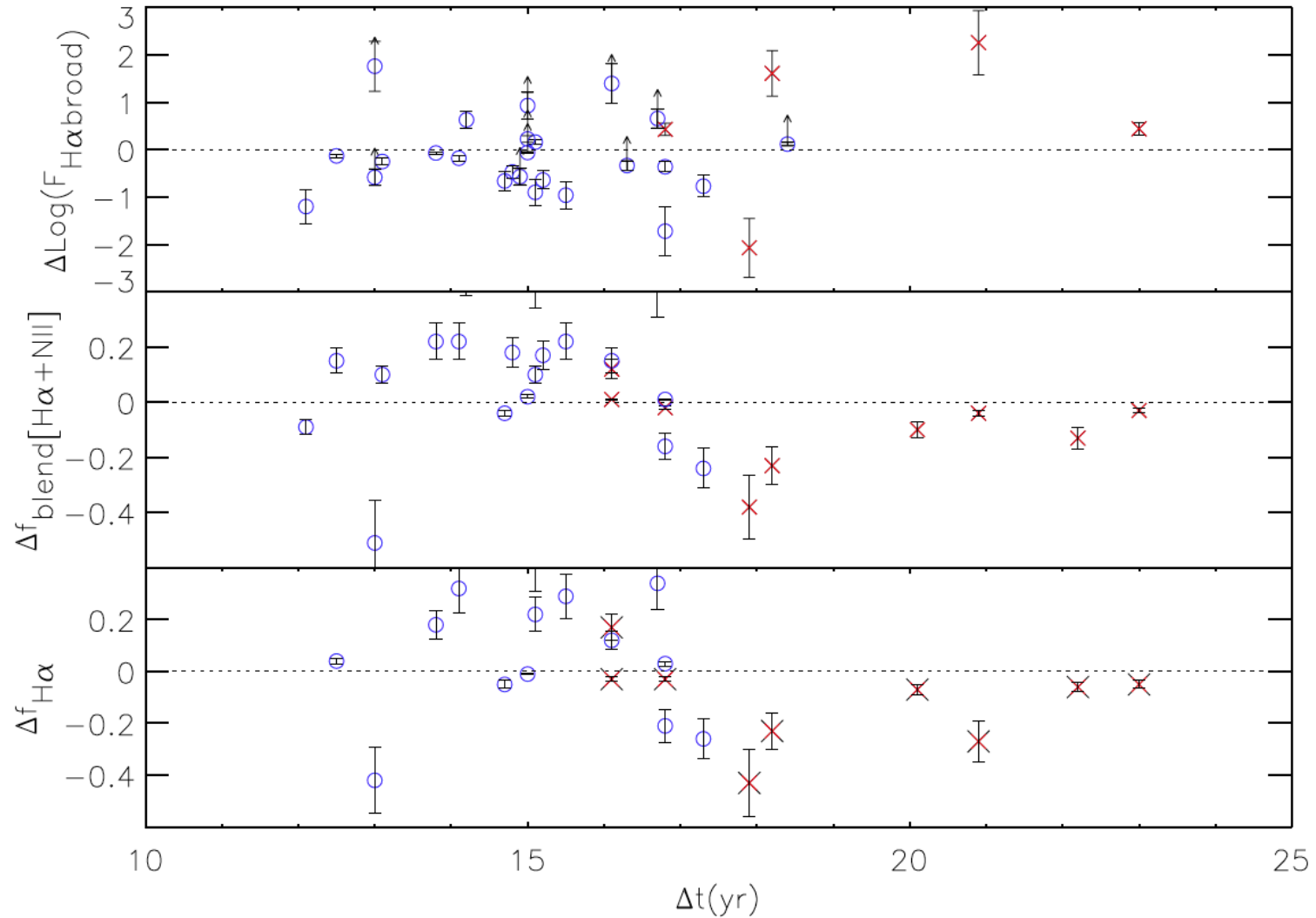
Palomar year: 1986.2



Variability

○ HST Data

× SDSS data



Further Directions

- Structure function analysis
- Monte Carlo simulations of the variability process
 - Hope to obtain constraints on period/amplitude of variability
- Correlation of change in flux with a variety of physical parameters of both nuclear region and host galaxy