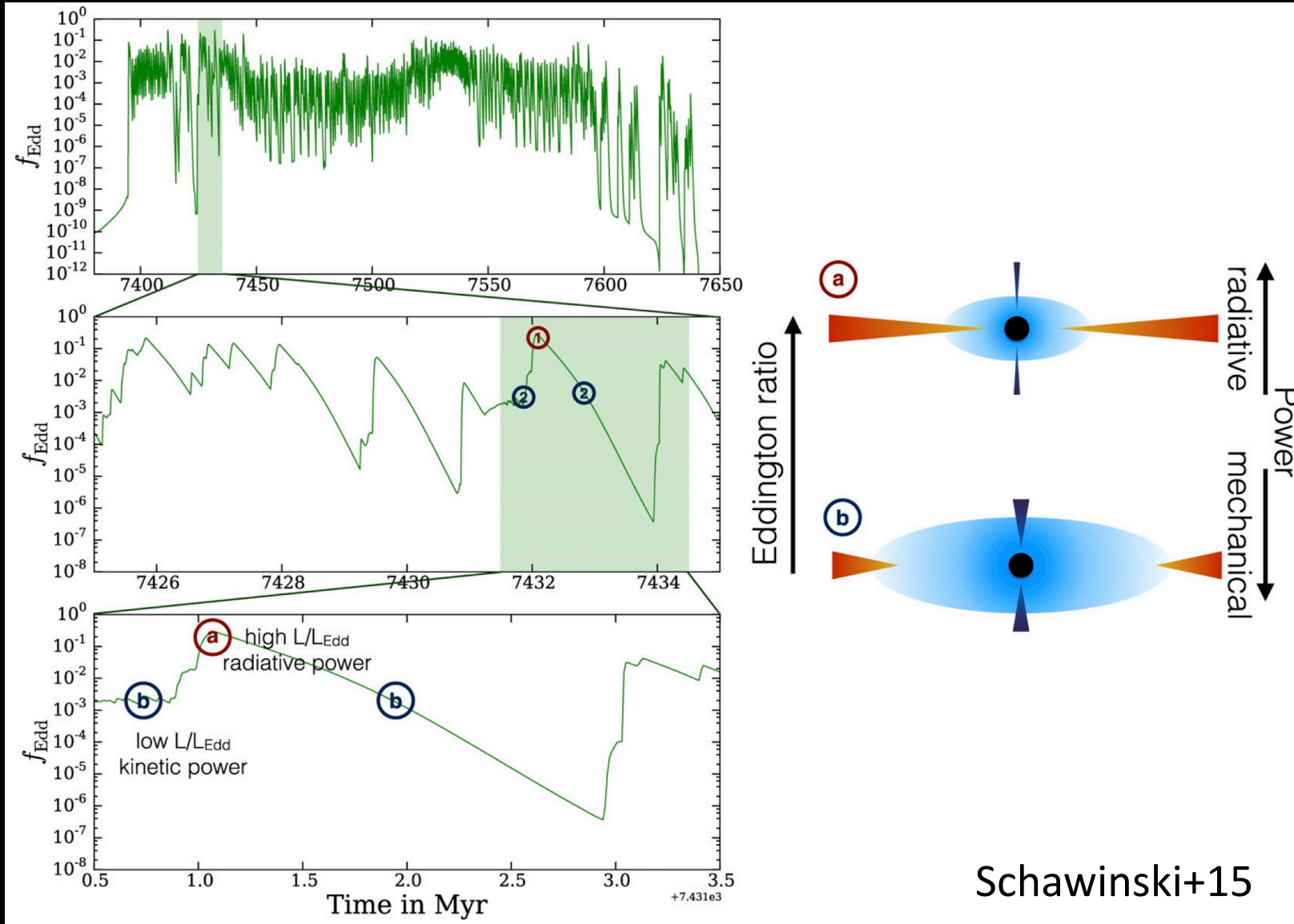


# The Origin and Utility of Changing-Look Quasars

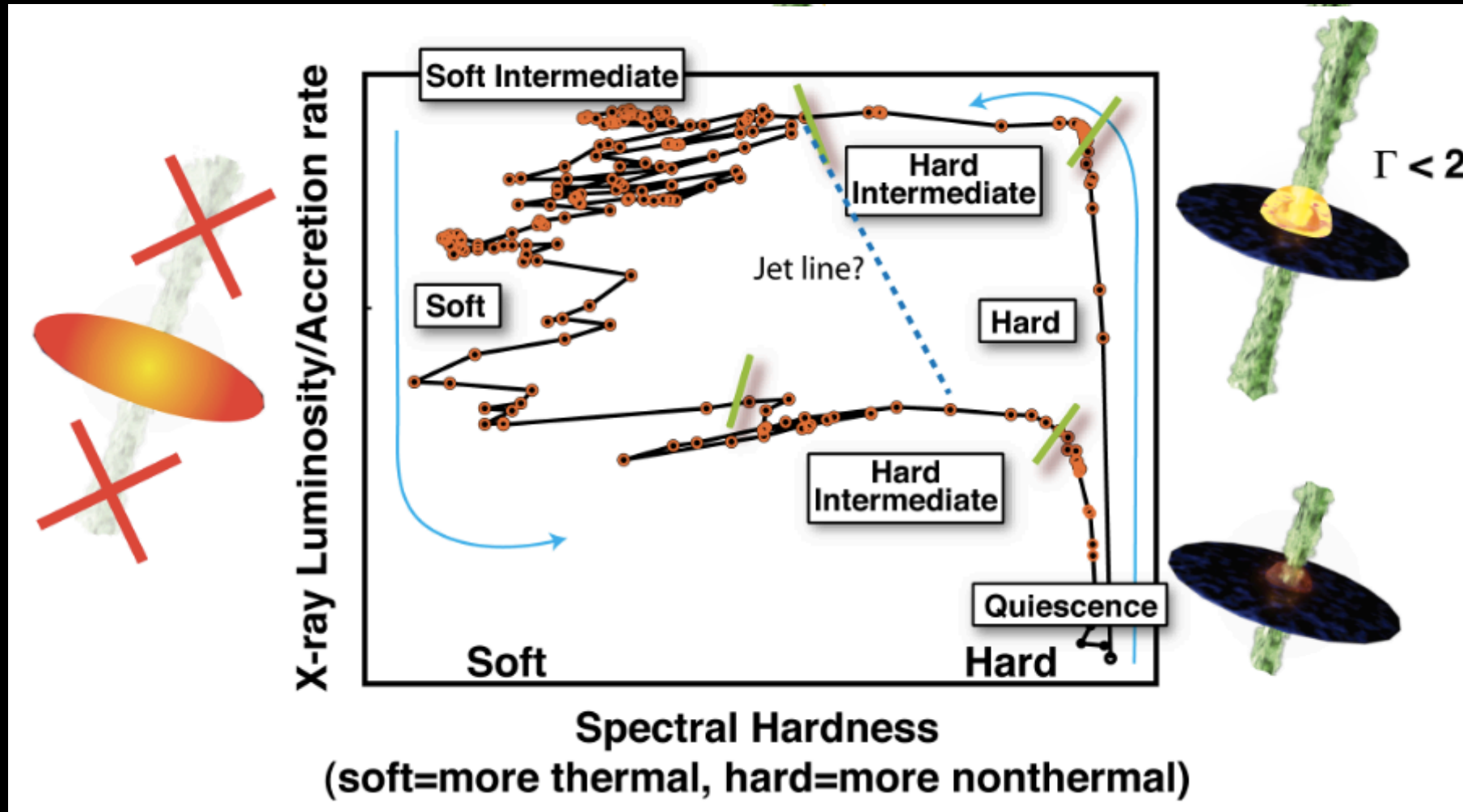
**John Ruan (U. of Washington)**

**In collaboration with: Jessie Runnoe, Chelsea MacLeod,  
Scott Anderson, Michael Eracleous, Paul Green**

# AGN vary strongly over cosmic time



# Accretion state transitions are commonly observed in X-ray binaries



Credit: Sera Markoff



# Hanny's Voorwerp

- Previous evidence for AGN accretion state transition in quasars, see talk by L. Sartori

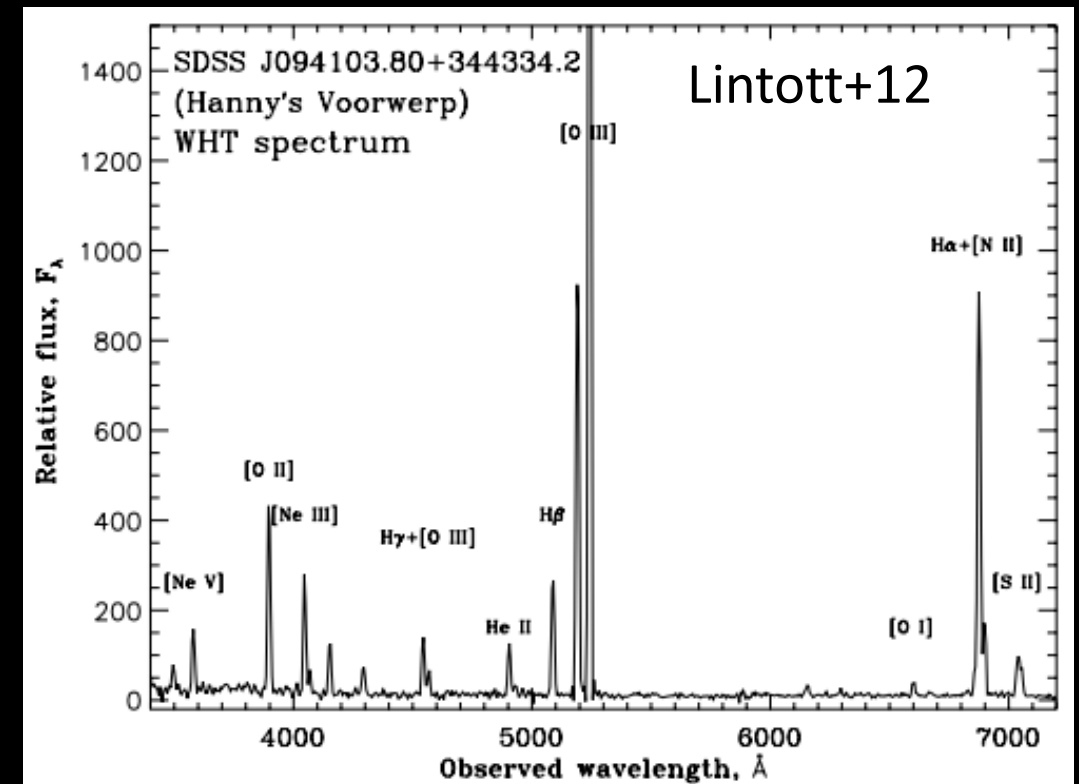
Keel+12



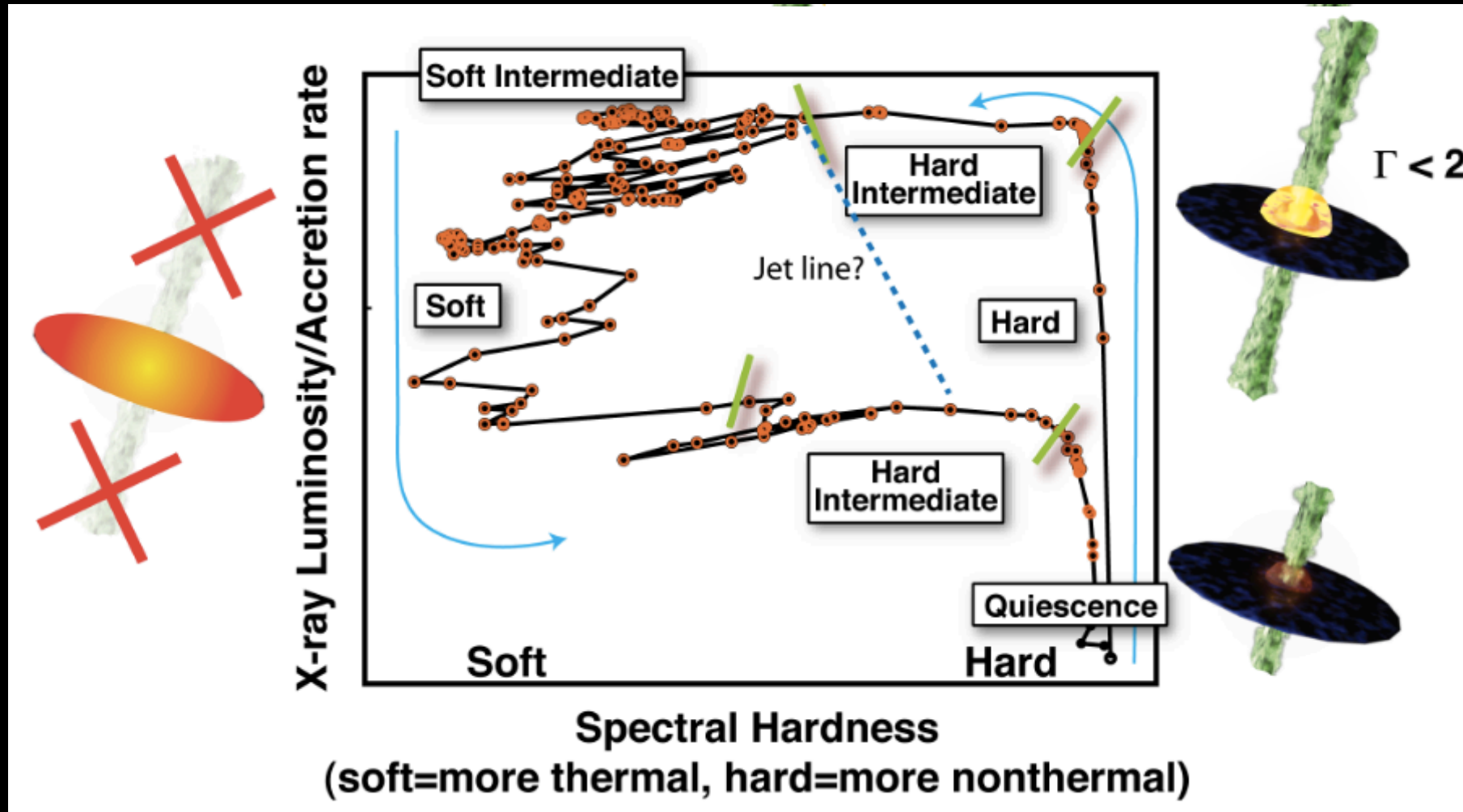
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Keel+12



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Credit: Sera Markoff



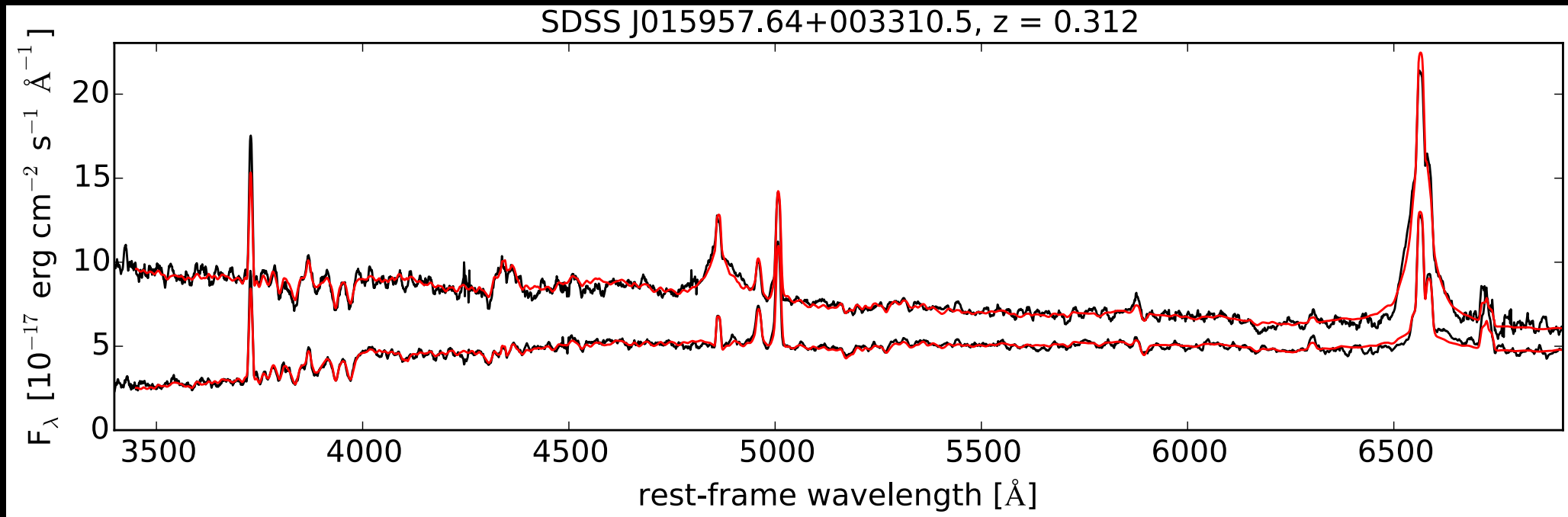
# Accretion state transitions are commonly observed in X-ray binaries

Does accretion around SMBHs directly scale from X-ray binaries?

- need to directly observe AGN accretion state transitions

# Discovery of changing-look quasars

- Lamassa et al. (2015) reported the serendipitous discovery of a quasar that ‘disappeared’

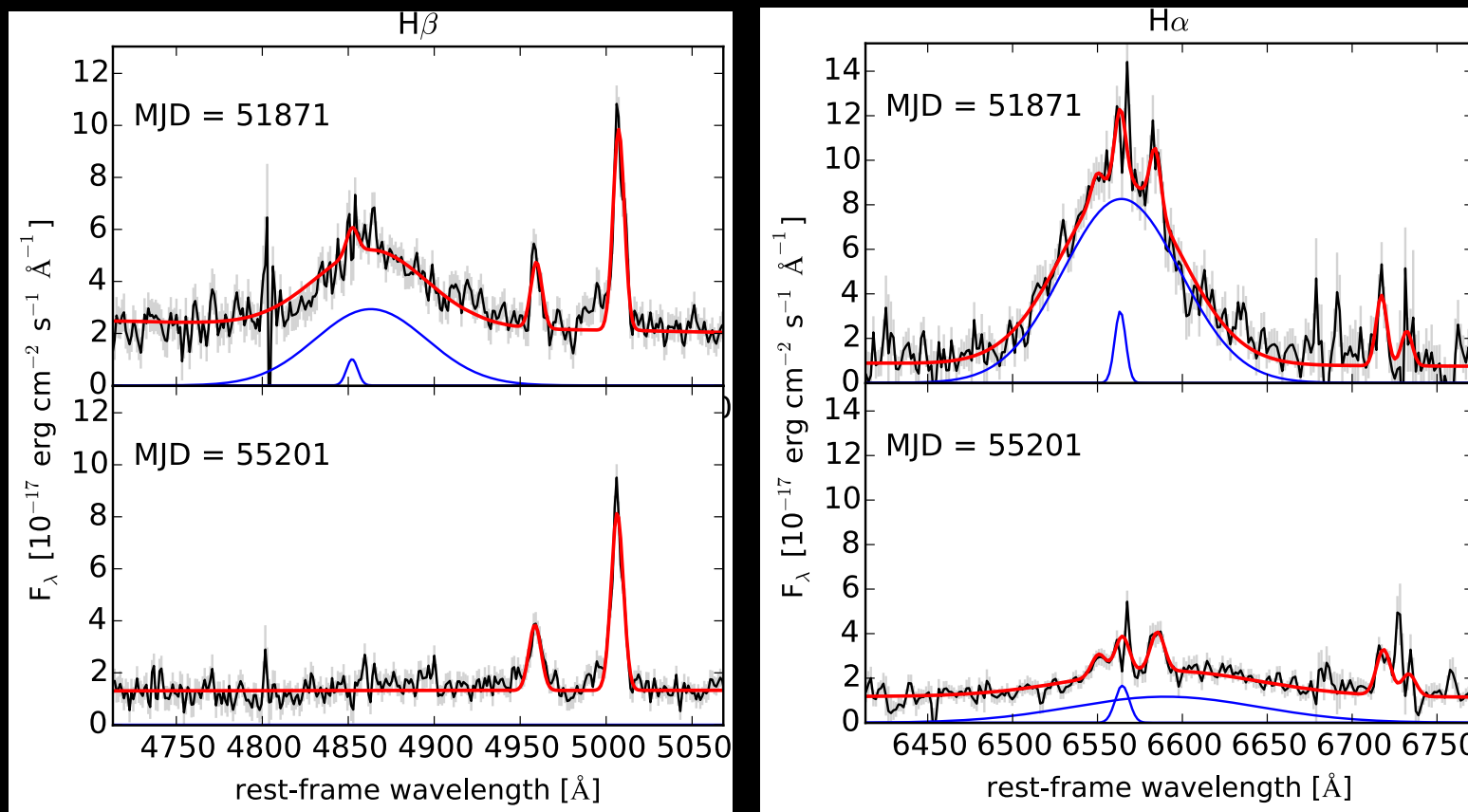


Adapted from Lamassa+15



# Discovery of changing-look quasars

- Broad emission lines and continuum fade in repeat spectroscopy over  $\sim$ few years



Ruan+16

# What is the origin of changing-look quasars?

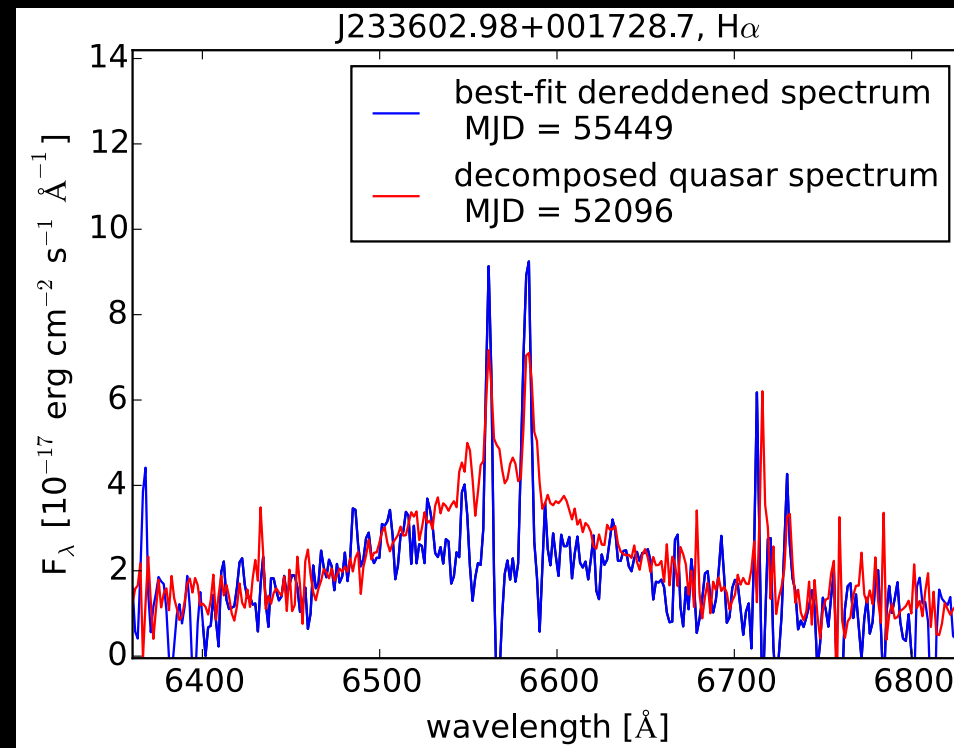
1. Dust obscuration?



# What is the origin of changing-look quasars?

## 1. Dust obscuration? No

- Inconsistent with broad line dimming and timescales



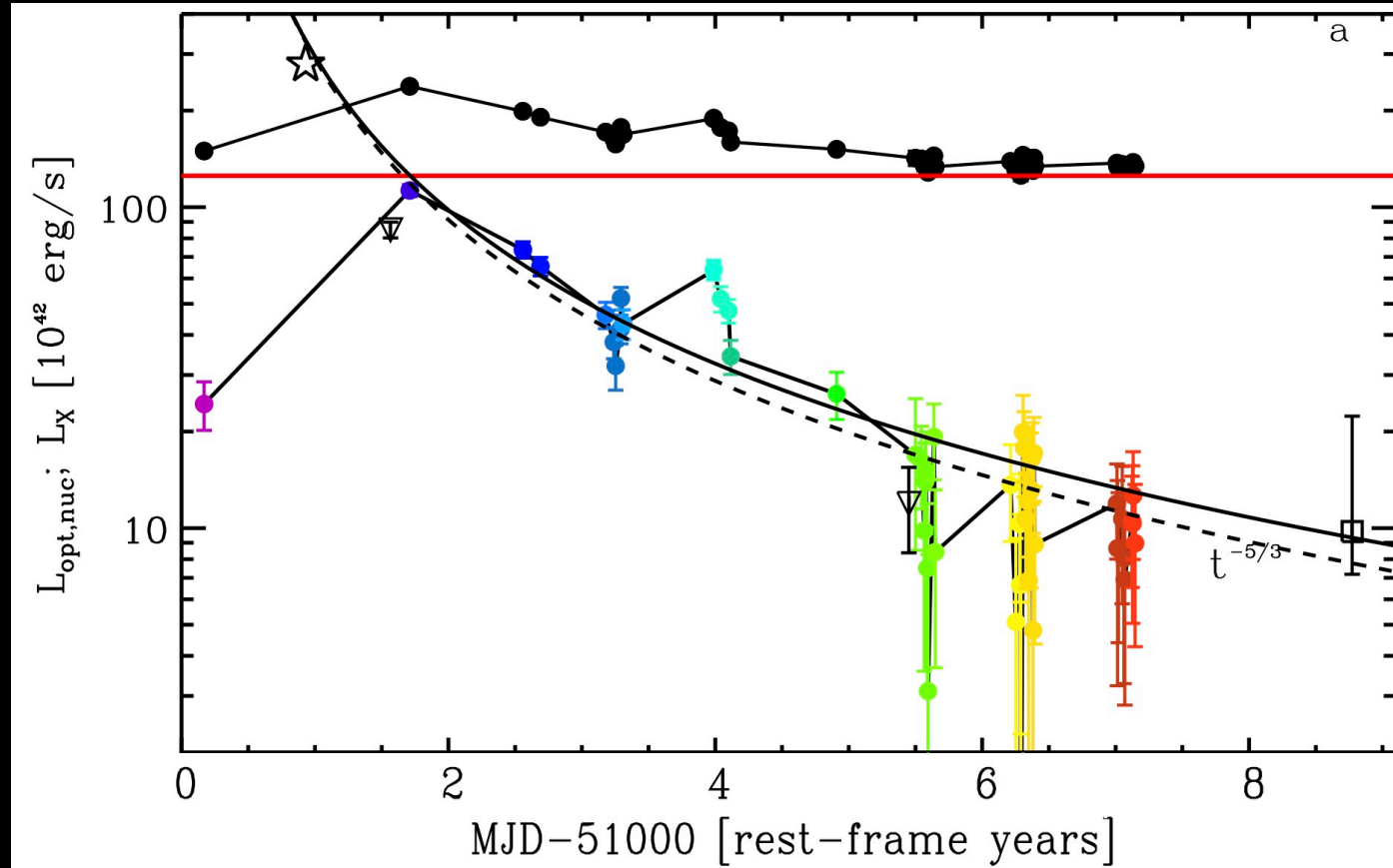
Ruan+16

# What is the origin of changing-look quasars?

1. Dust obscuration? **No**
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2. Tidal disruption events? (Merloni+15)



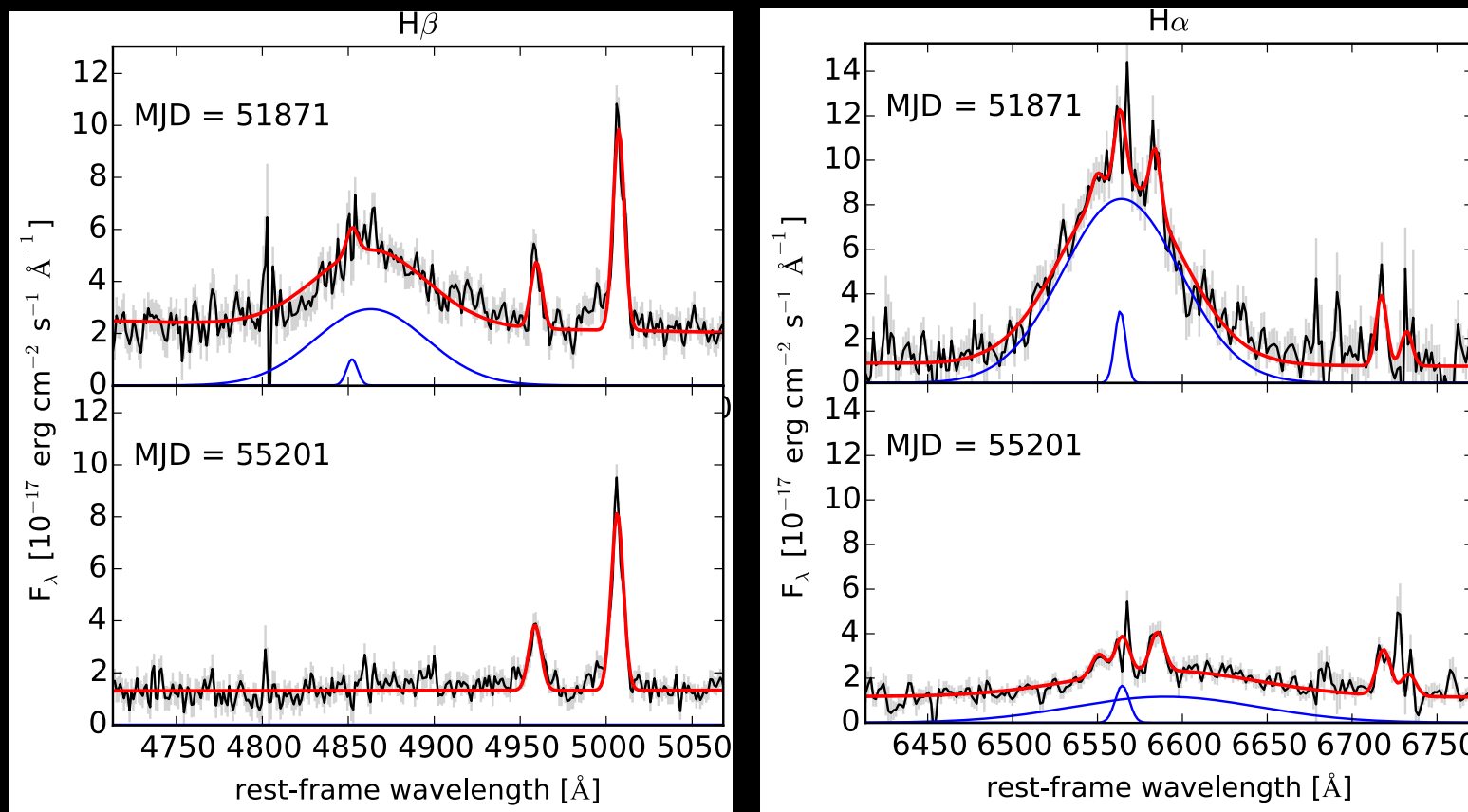
# Optical light curve suggests changing-look quasars may be TDEs



Merloni+15

# Discovery of changing-look quasars

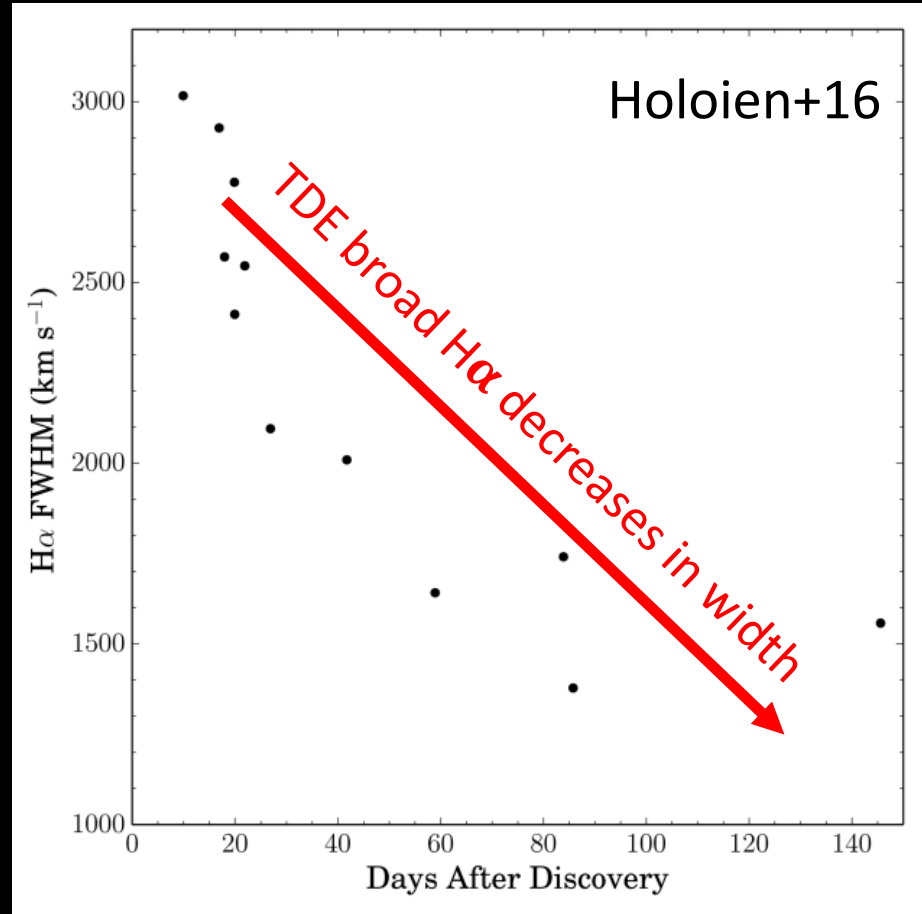
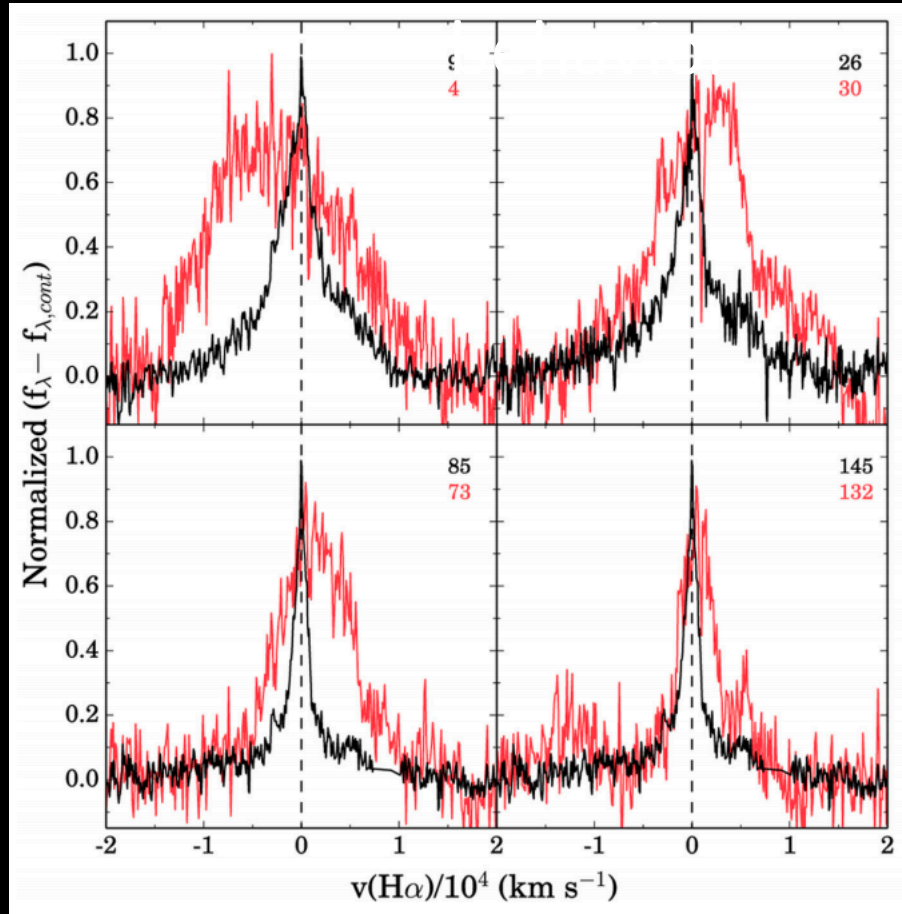
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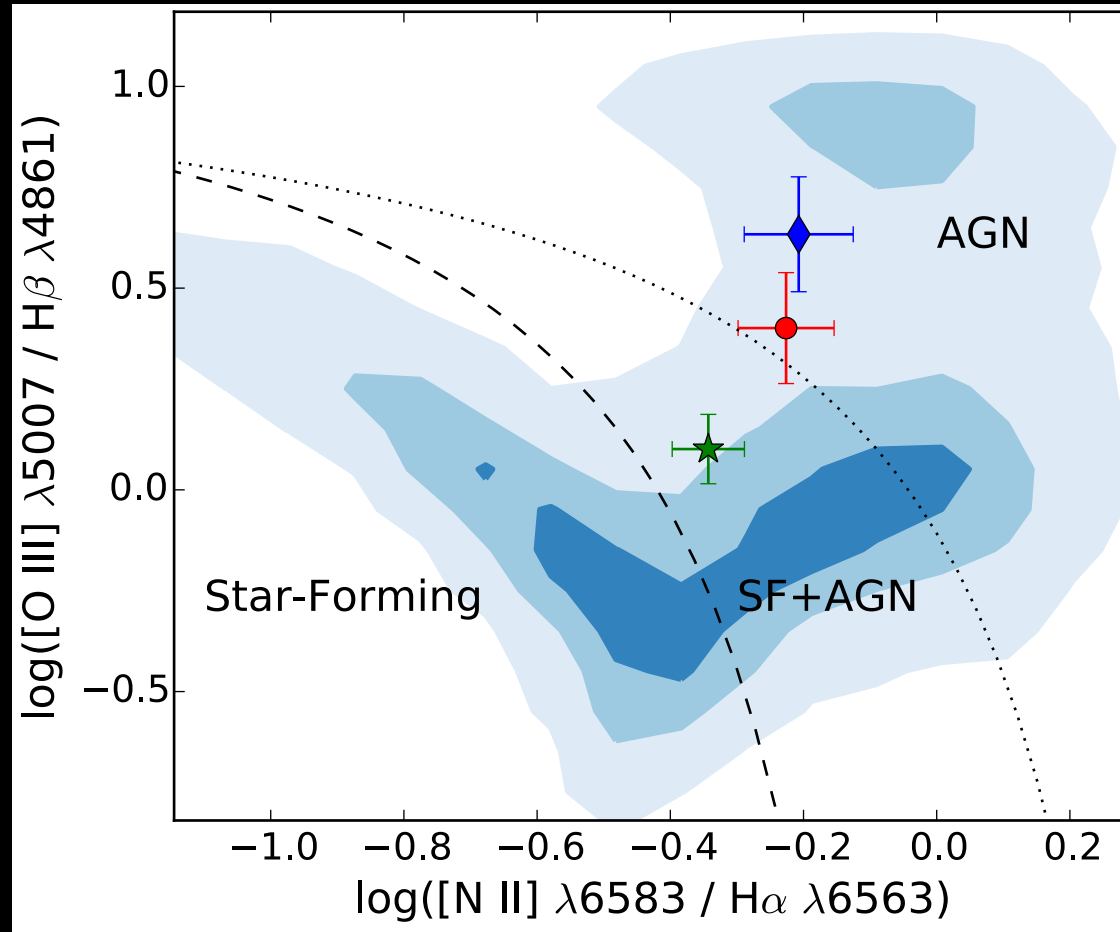
Ruan+16

# TDEs and changing-look quasars display opposite broad emission line behavior

## TDE ASSASN-14li: broad H $\alpha$



# Narrow line diagnostics show AGN in changing-look quasars



Ruan+16

Although see talk  
by P. Blanchard  
on TDEs in AGN



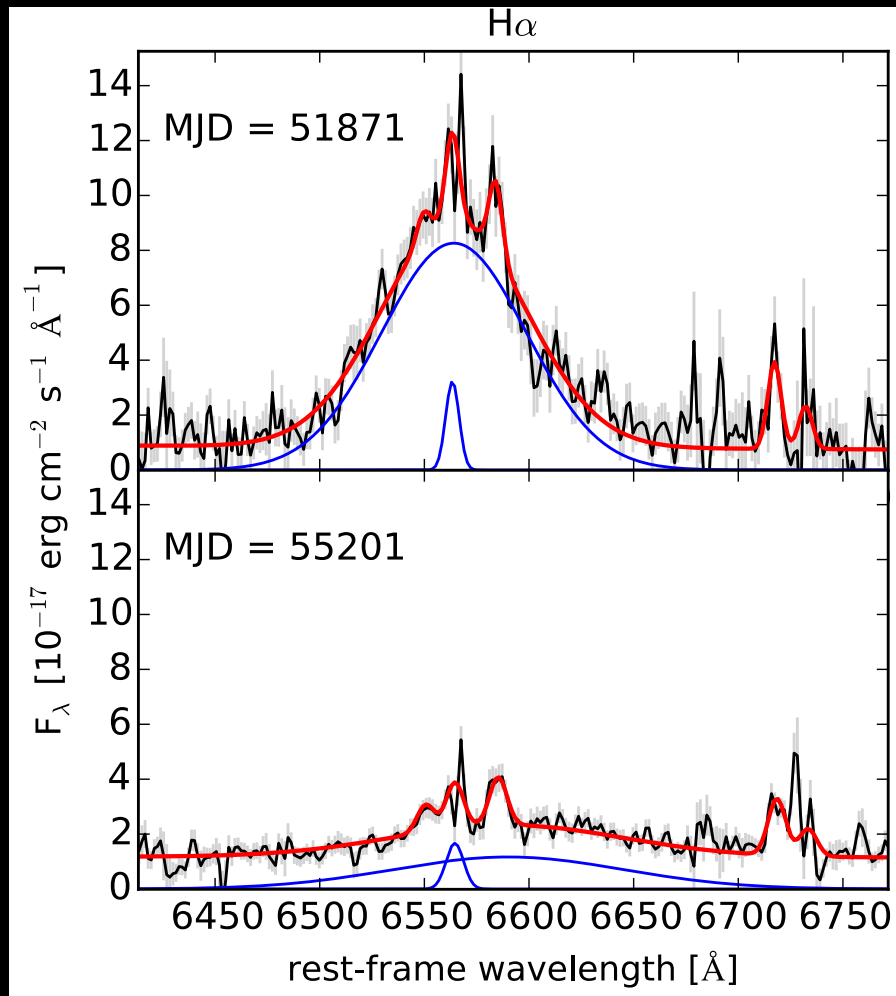
# What is the origin of changing-look quasars?

1. Dust obscuration? **No**
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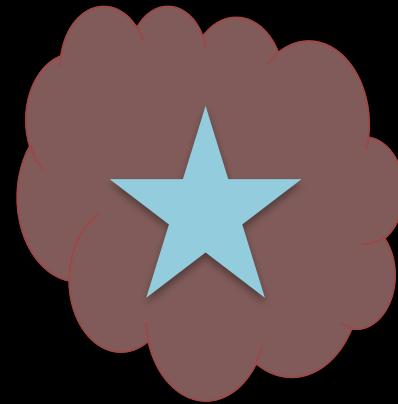
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3. Changes in accretion rate?

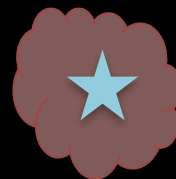
# CL quasars: changes in accretion rate



Ruan+16



Lower gas velocities,  
Narrower lines



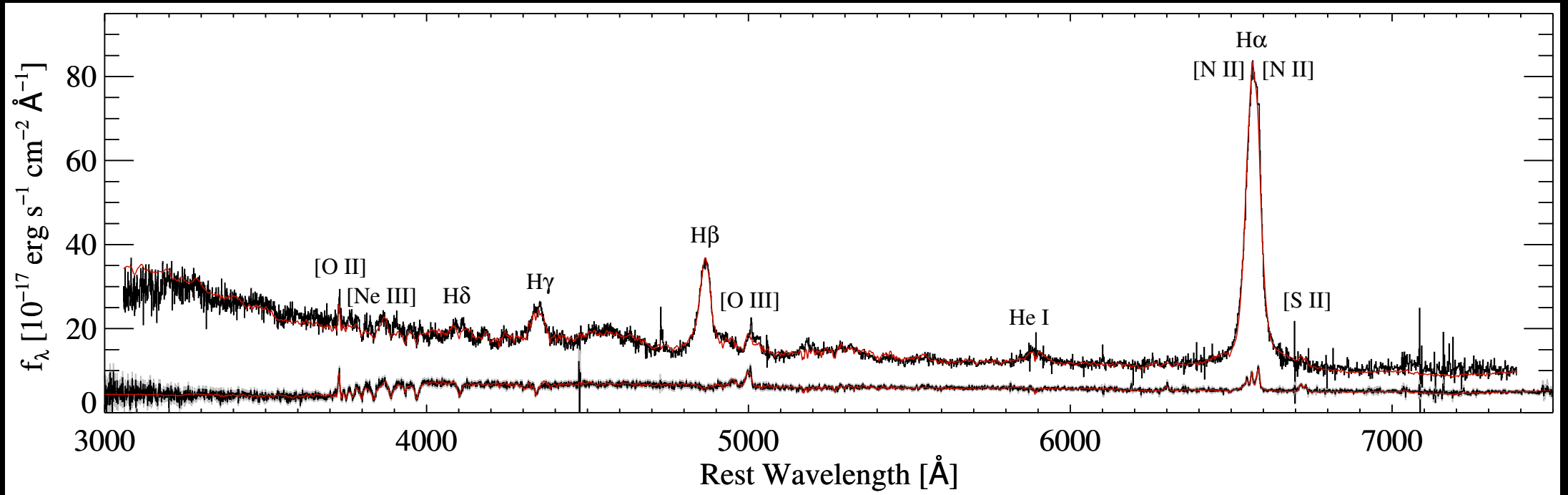
Higher gas velocities,  
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# What is the origin of changing-look quasars?

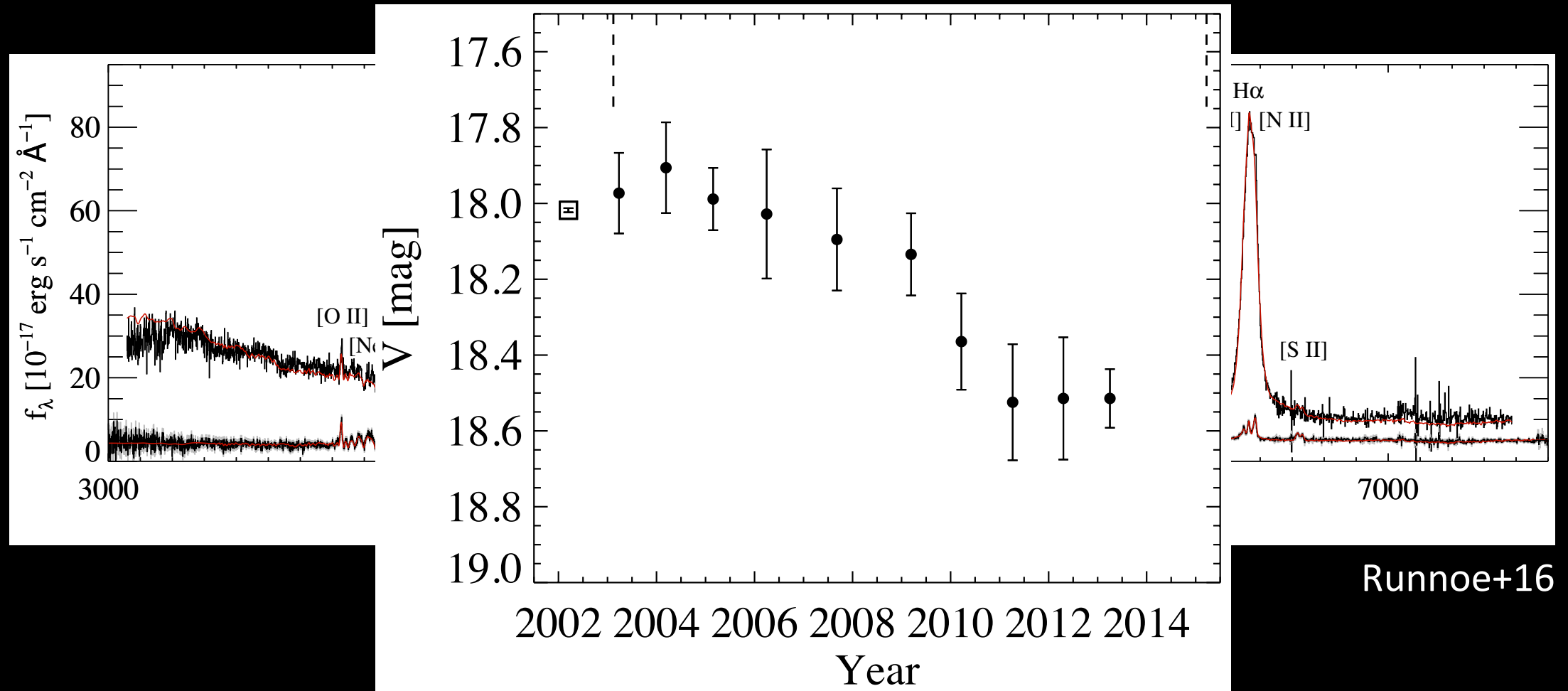
1. Dust obscuration? **No**
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3. Changes in accretion rate? **Yes**
  - Broad lines broaden as continuum dims
  - Accretion rate decreases by factor of 2.5-4

# Serendipitous discovery of another CL quasar

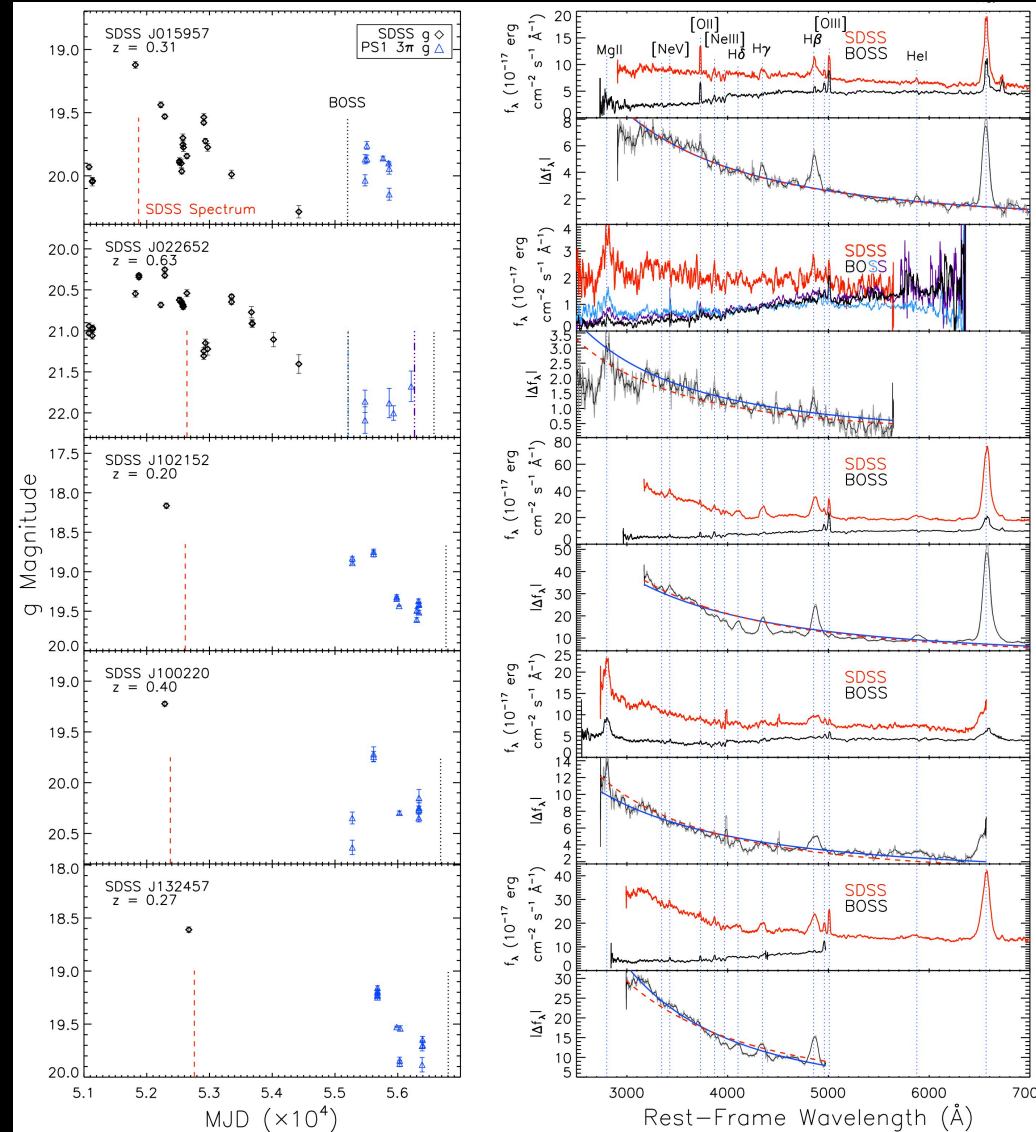


Runnoe+16

# Serendipitous discovery of another CL quasar



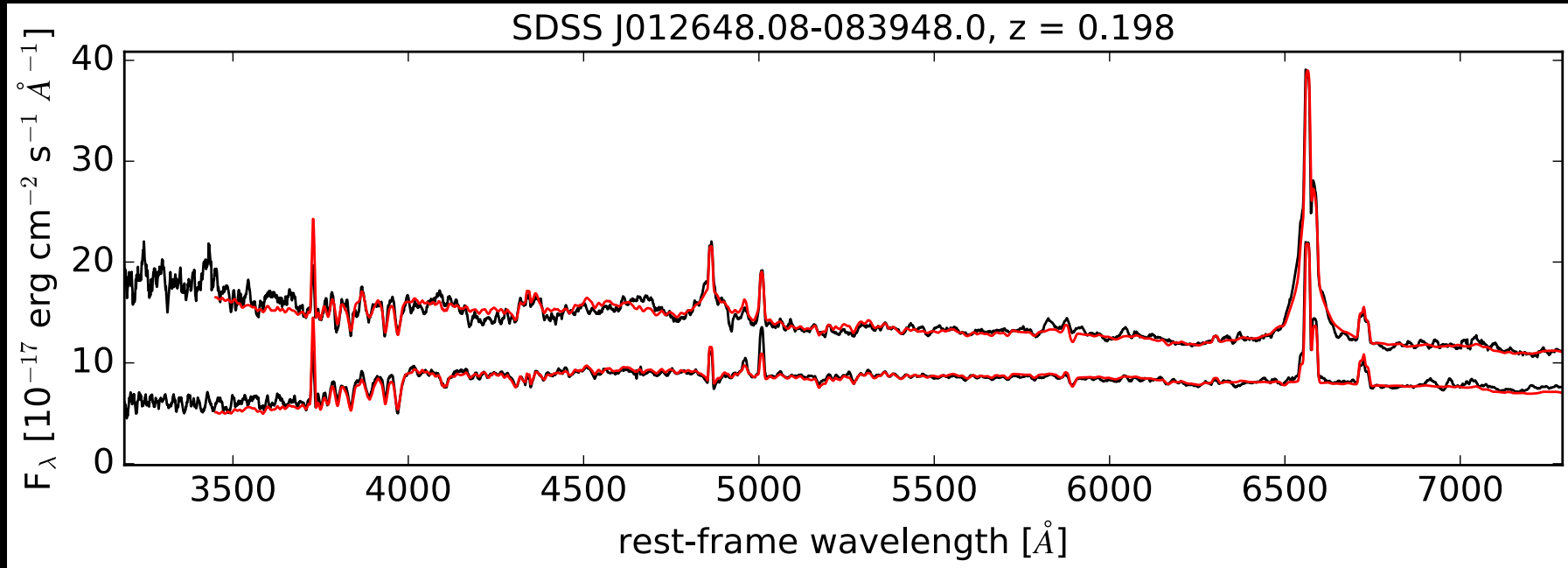
# Systematic Searches for CL quasars



see talk by  
C. MacLeod

MacLeod+16

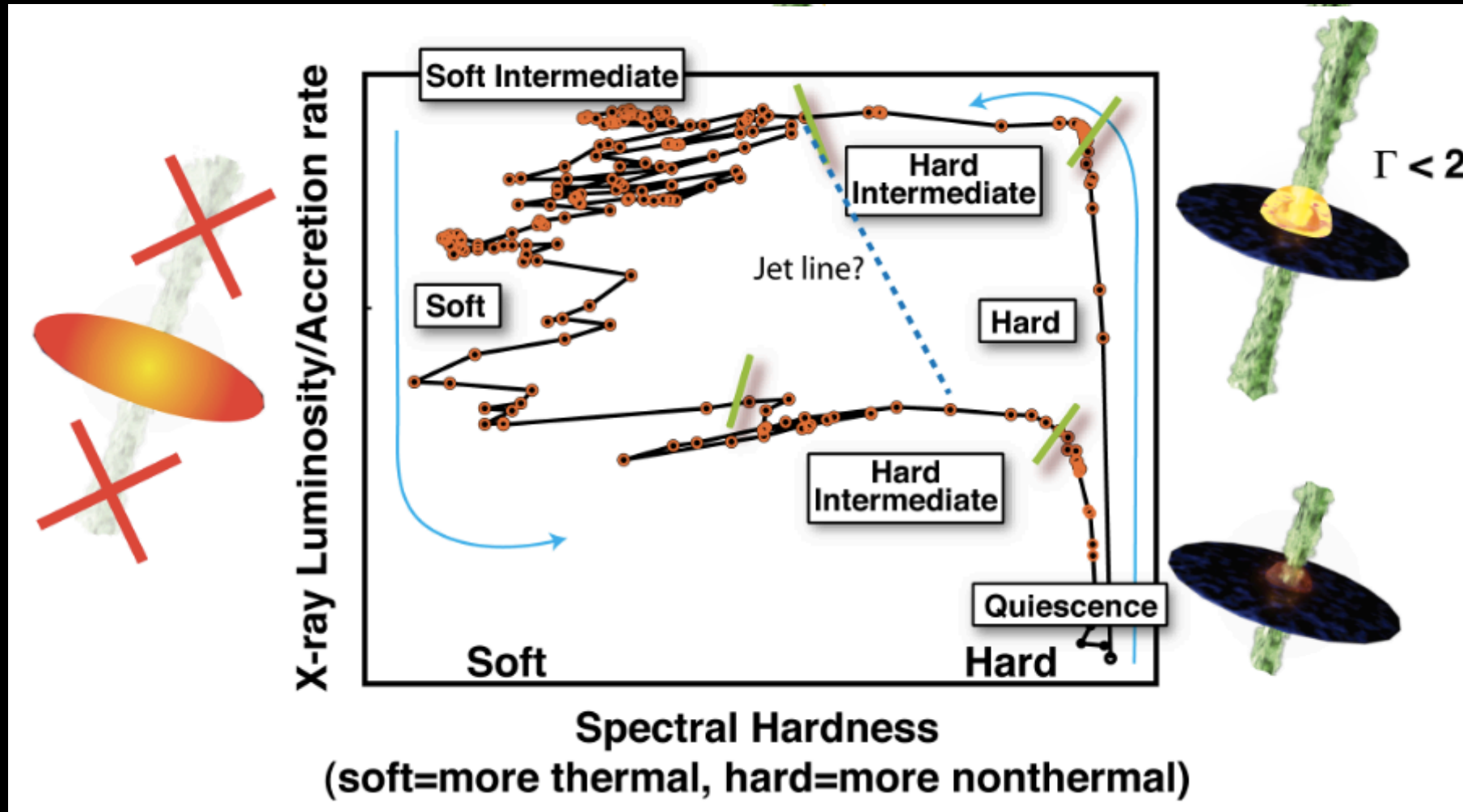
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Ruan+16



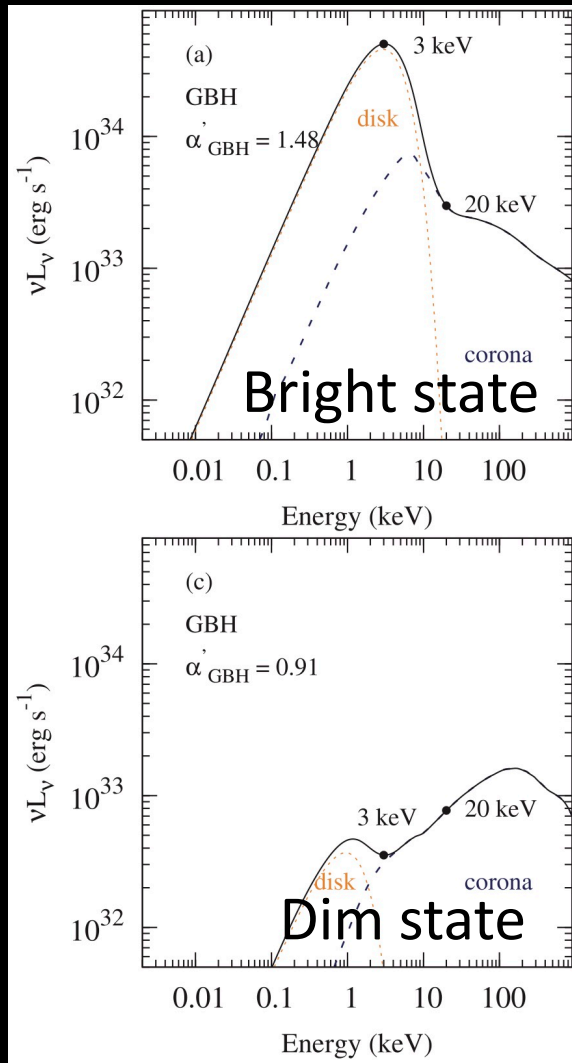
# Accretion state transitions are commonly observed in X-ray binaries



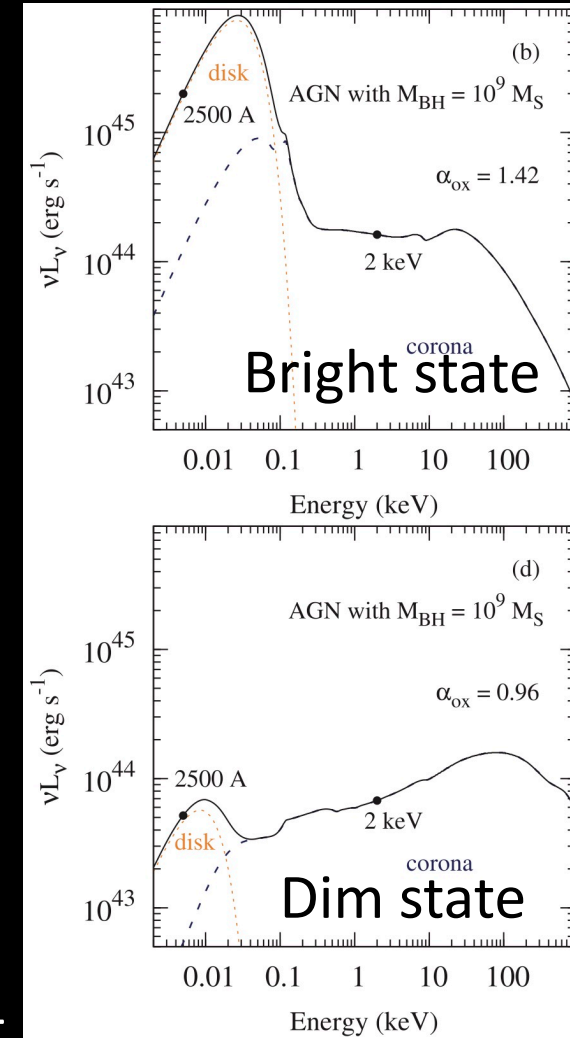
Credit: Sera Markoff

# Comparing transitions in XRB and AGN

## X-ray binaries



## AGN



Sobolewska+11

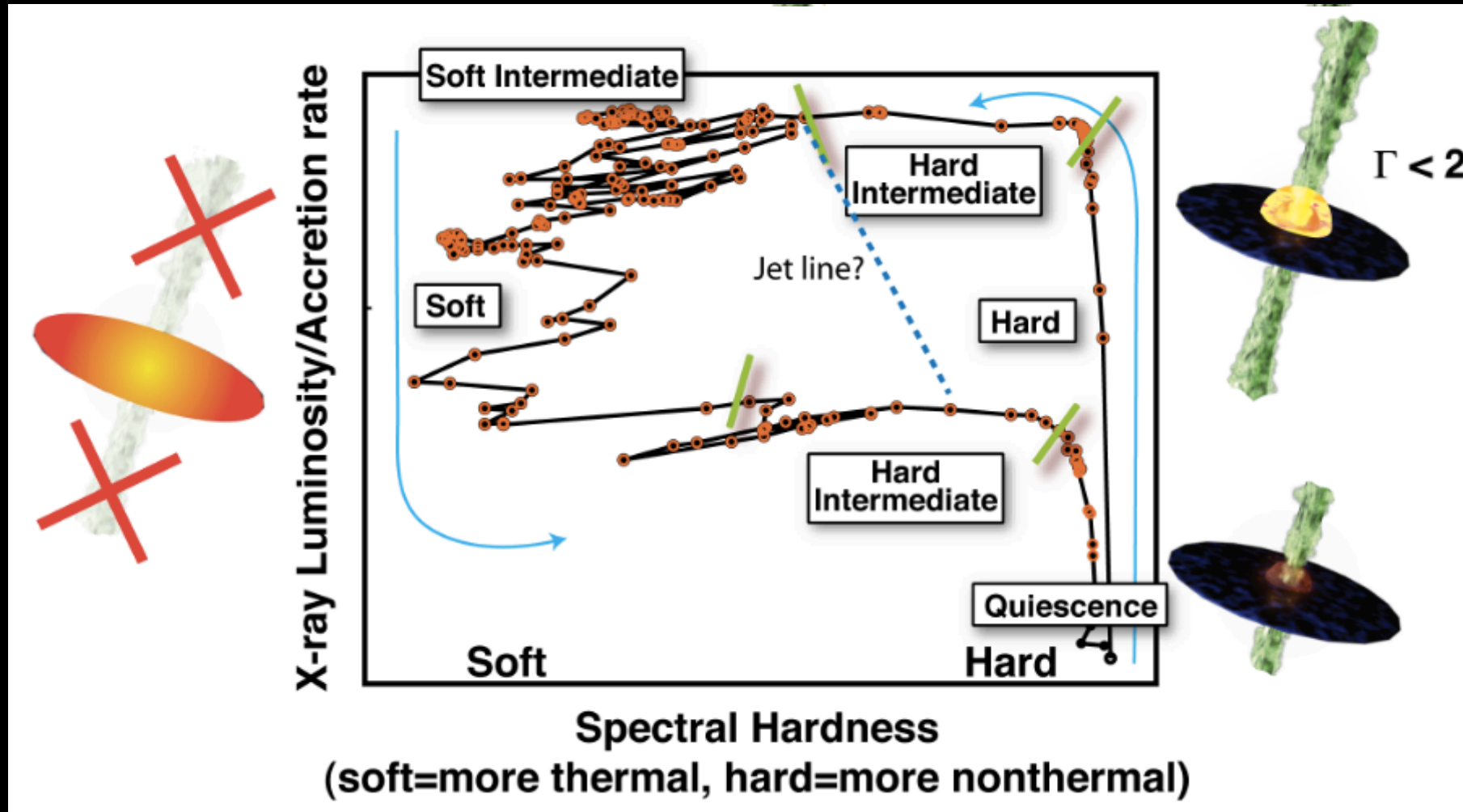
# Comparing transitions in XRB and AGN

- Chandra cycle 18 and 19 GO programs
  - Sample of 6 confirmed changing-look quasars
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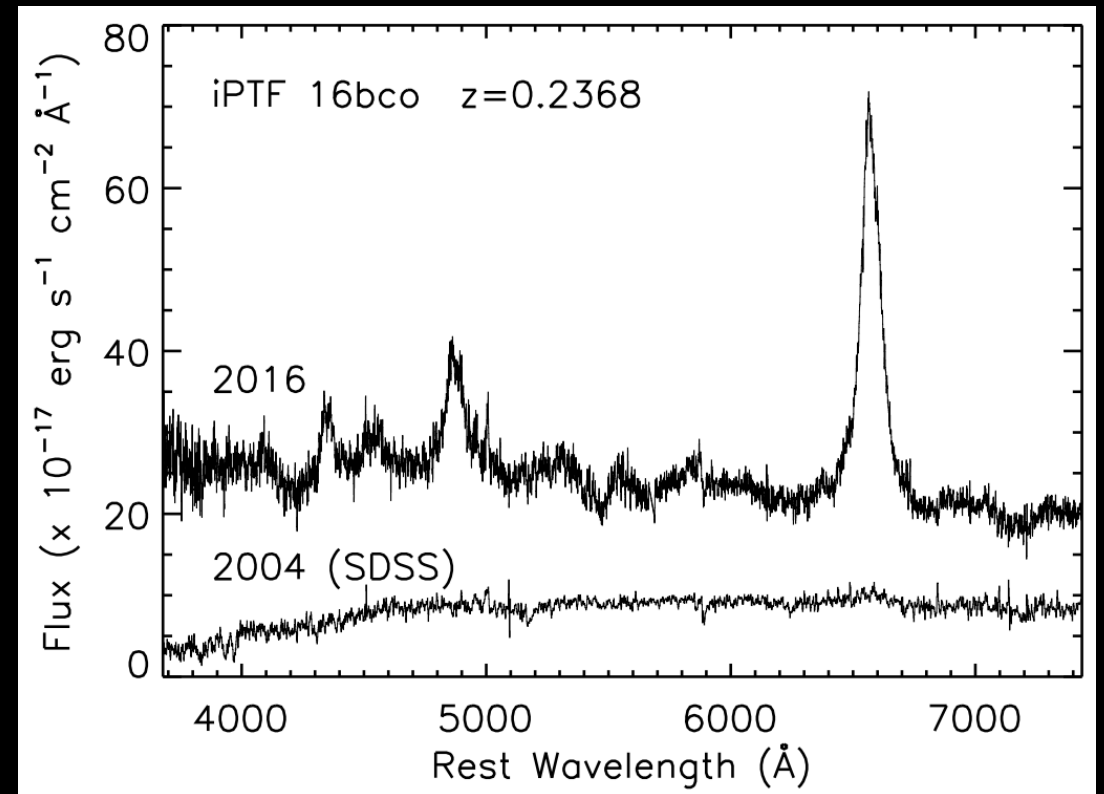
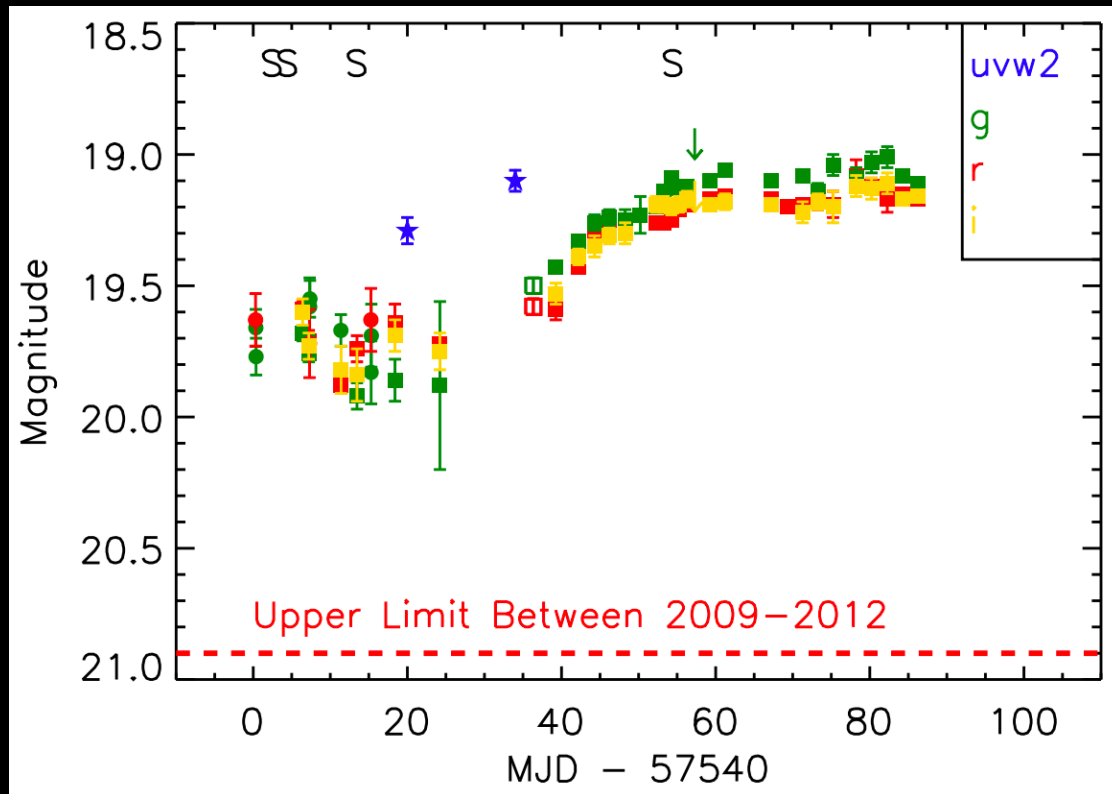
# Accretion state transitions are commonly observed in X-ray binaries



Credit: Sera Markoff



# Discovery of 'turn-on' changing-look quasars



Gezari+17

# Need larger samples of changing-look quasars!

- Various current approaches to searching for changing-look quasars:
  - Serendipitous discoveries (e.g. Lamassa+15, Merloni+15, Runnoe+16)
  - Searches through archival repeat spectra (e.g. Ruan+16)
  - Searches through archival light curves + follow-up spectra (e.g. MacLeod+16, see talk by C. MacLeod)
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- Proliferation of time-domain imaging/spectroscopic surveys bodes well for the future of changing-look quasar science

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# Conclusions

- Changing-look quasar phenomenon is the rapid shutdown of accretion in an AGN
- AGN accretion state transitions can provide new insights into AGN physics
  - directly test the AGN/X-ray binary connection
- Need larger samples!