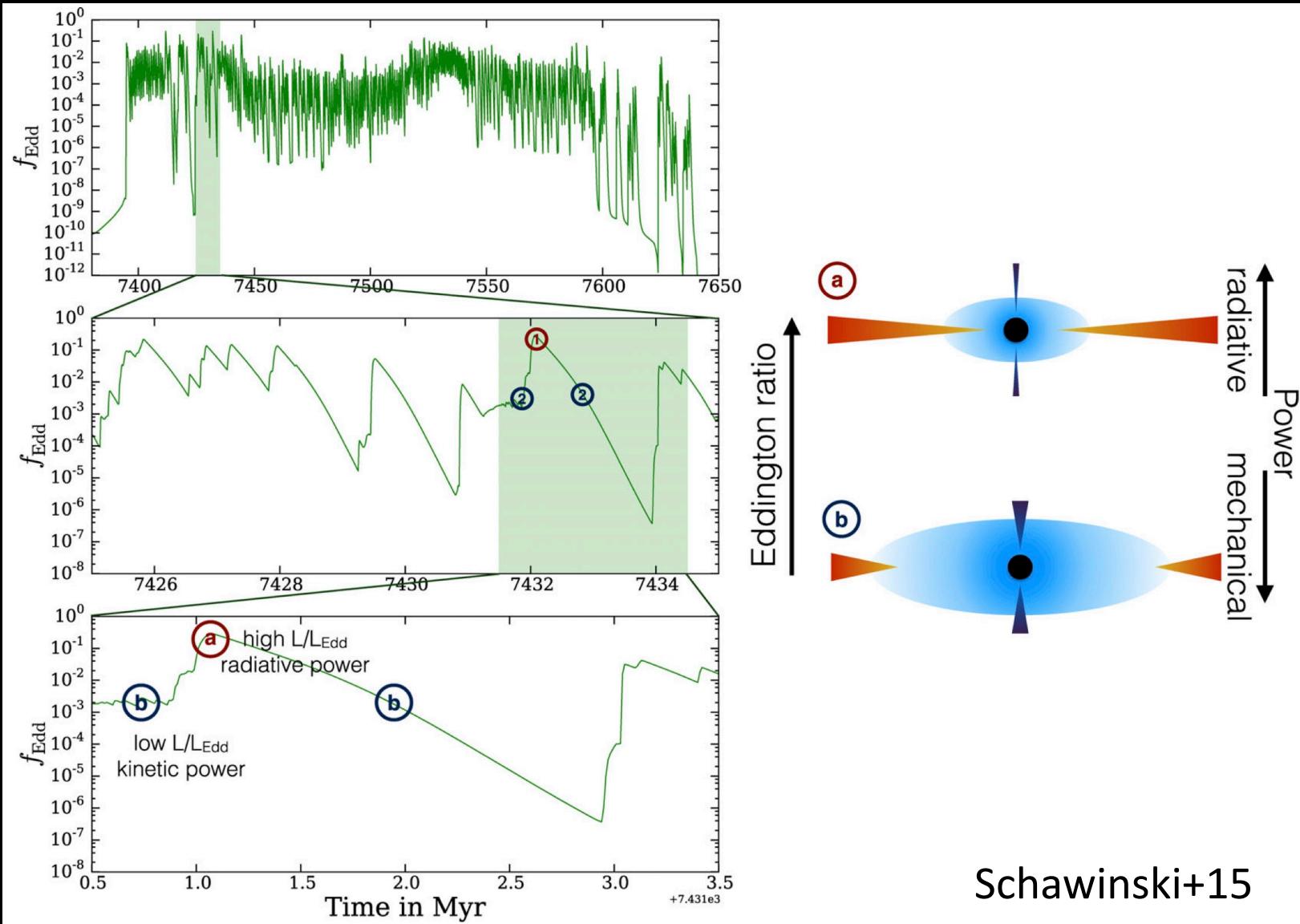


The Origin and Utility of Changing-Look Quasars

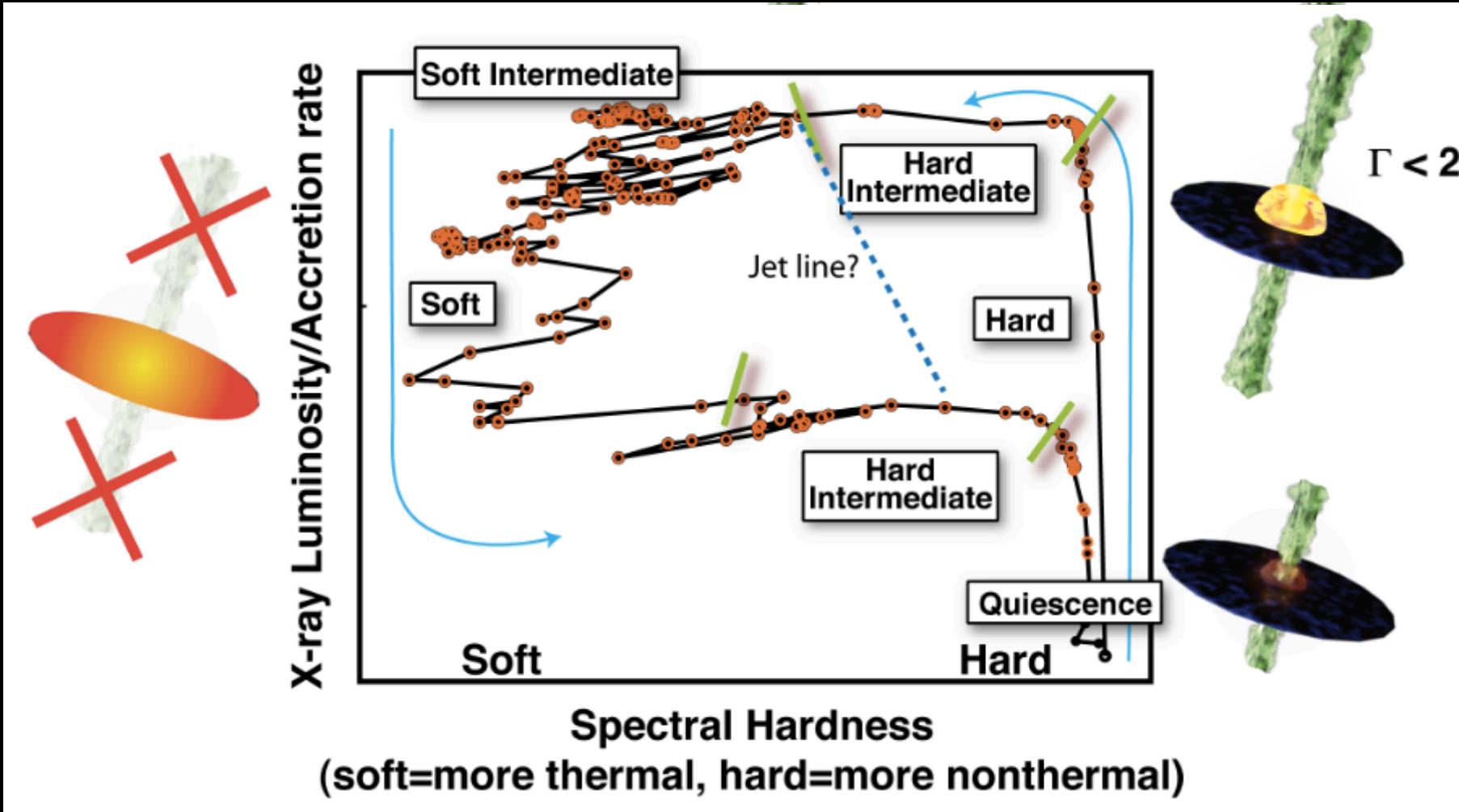
John Ruan (U. of Washington)

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

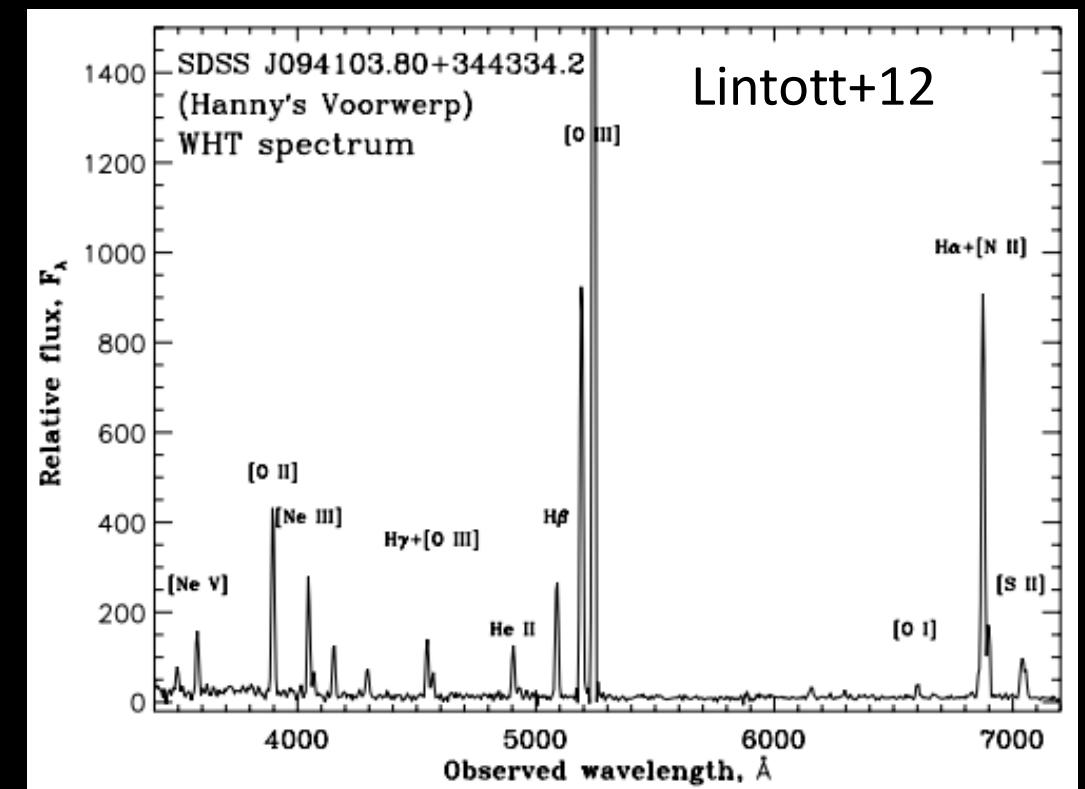
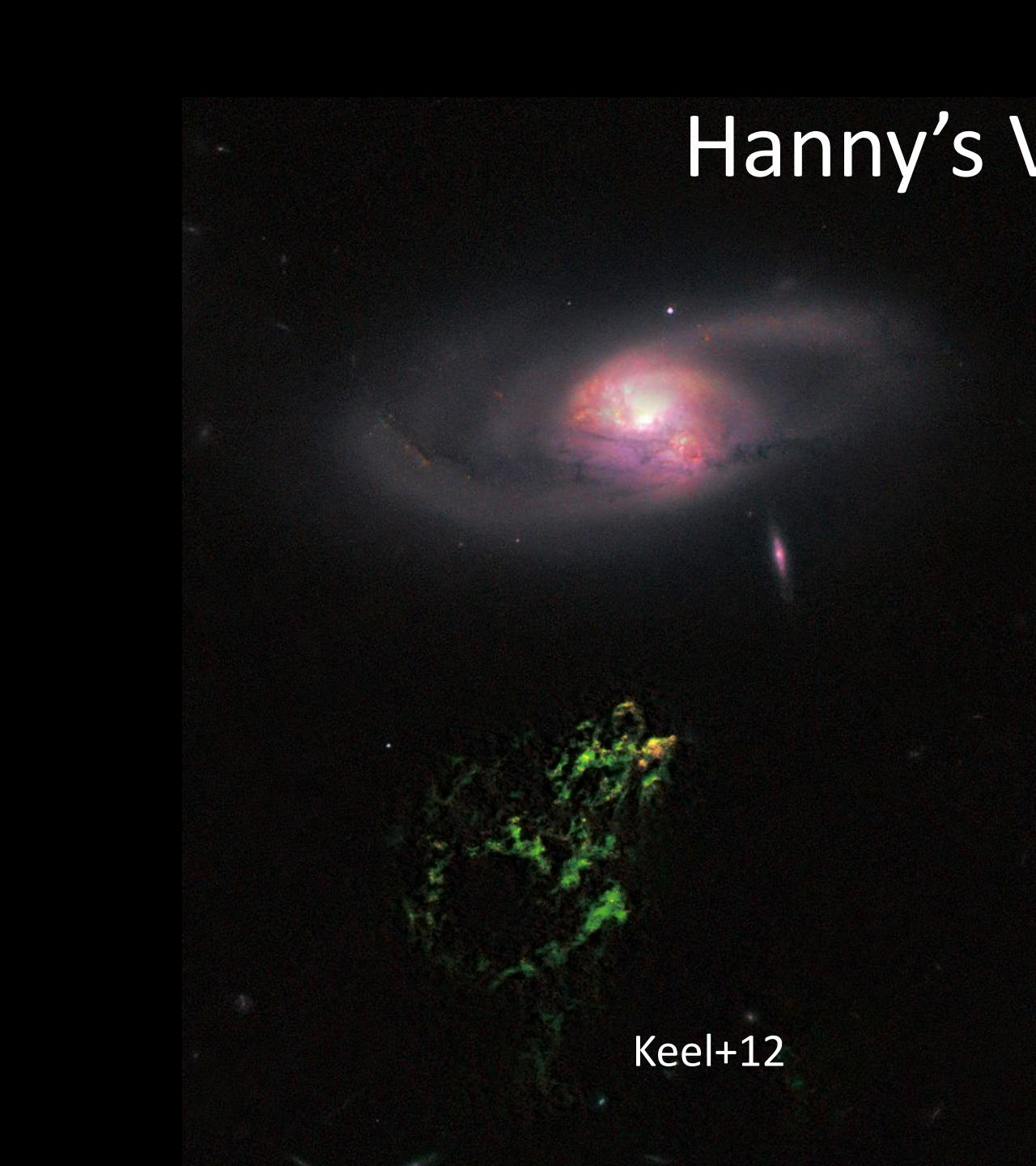
- Previous evidence for AGN accretion state transition in quasars, see talk by L. Sartori



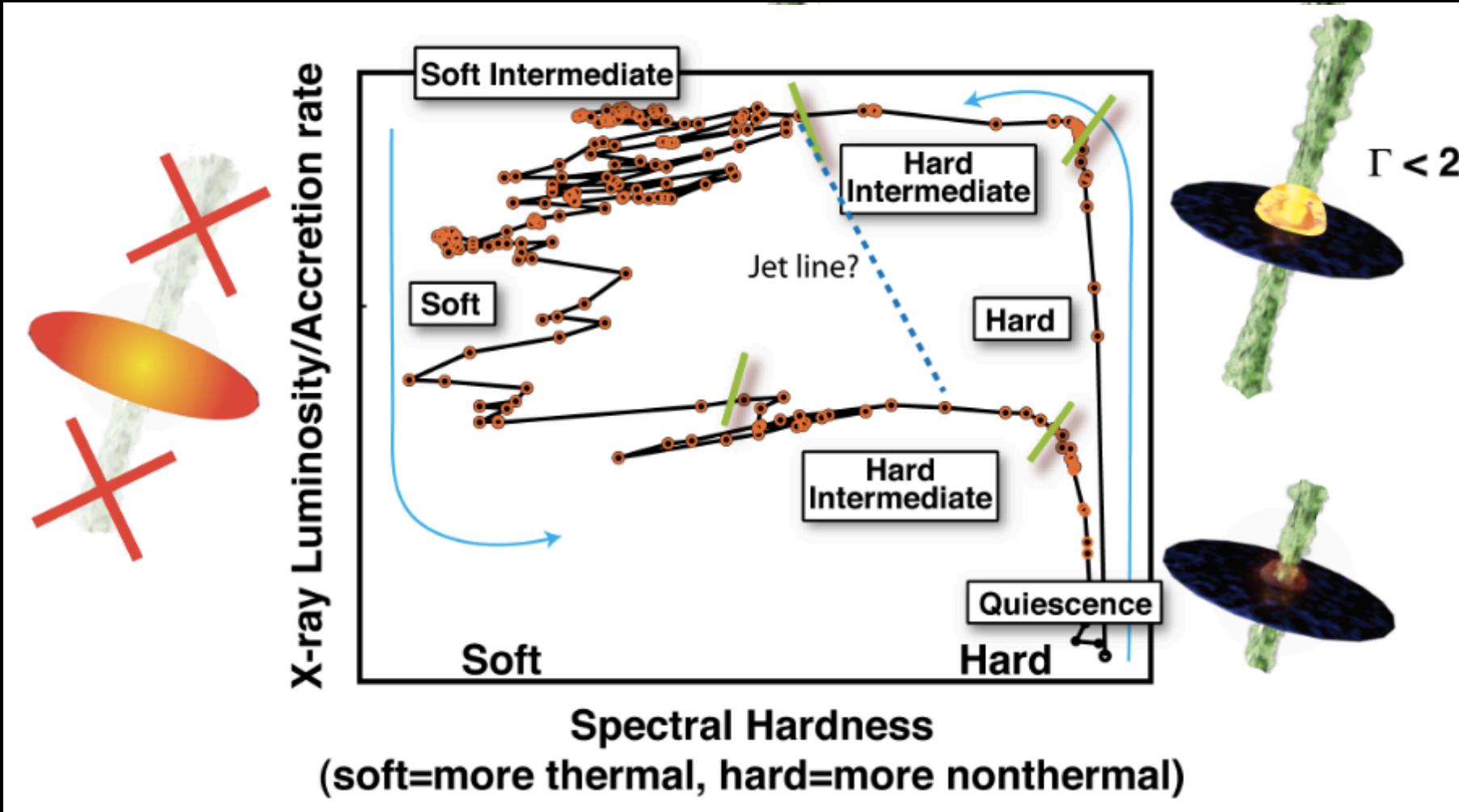
Keel+12

Hanny's Voorwerp

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Accretion state transitions are commonly observed in X-ray binaries



Credit: Sera Markoff

Accretion state transitions are commonly observed in X-ray binaries

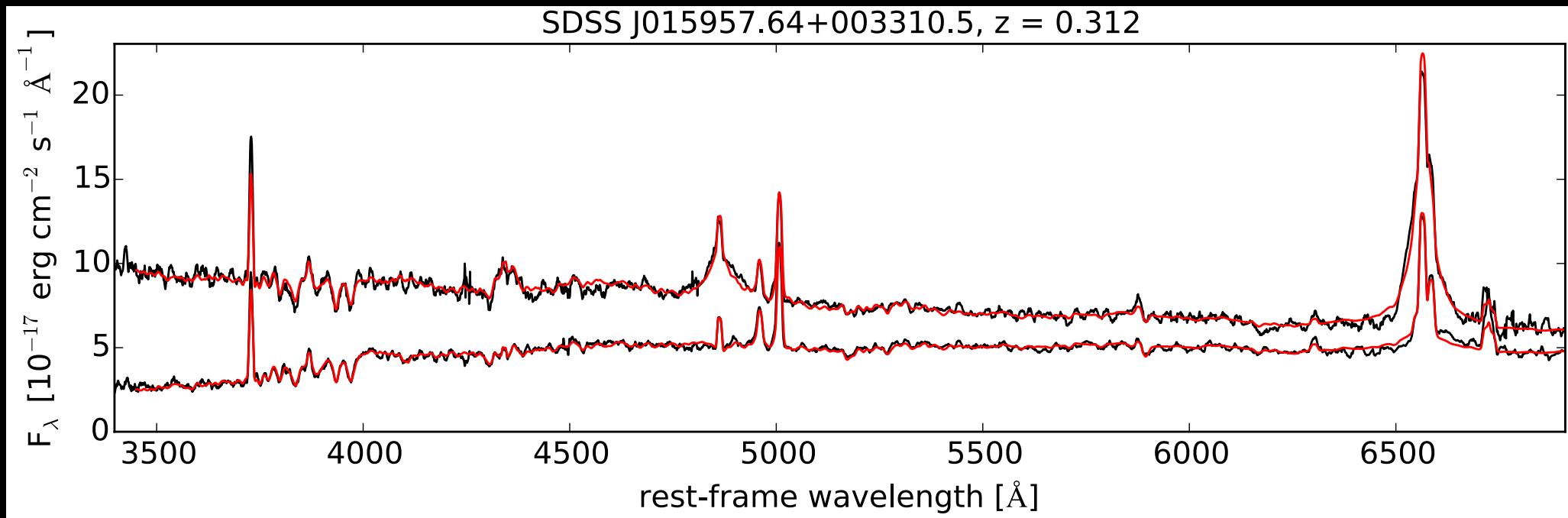
Does accretion around SMBHs directly scale from X-ray binaries?

- need to directly observe AGN accretion state transitions

Credit: Sera Markoff

Discovery of changing-look quasars

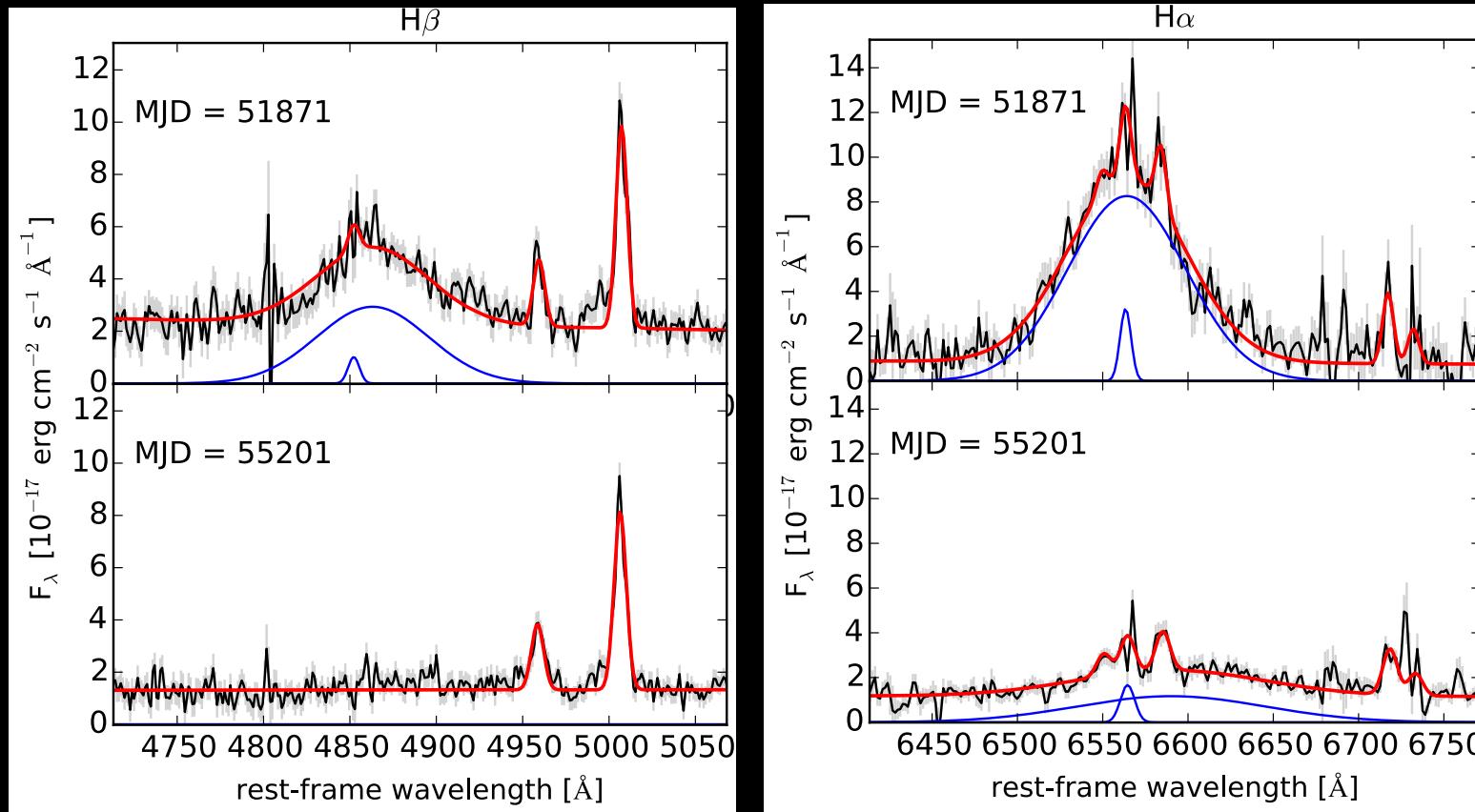
- Lamassa et al. (2015) reported the serendipitous discovery of a quasar that ‘disappeared’



Adapted from Lamassa+15

Discovery of changing-look quasars

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



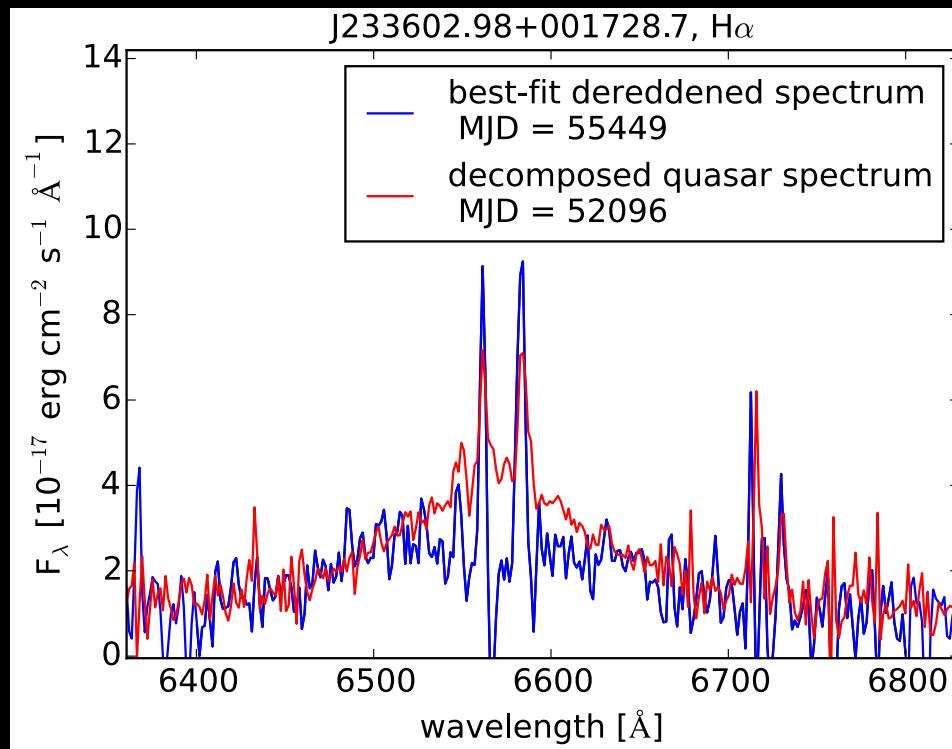
What is the origin of changing-look quasars?

1. Dust obscuration?

What is the origin of changing-look quasars?

1. Dust obscuration? No

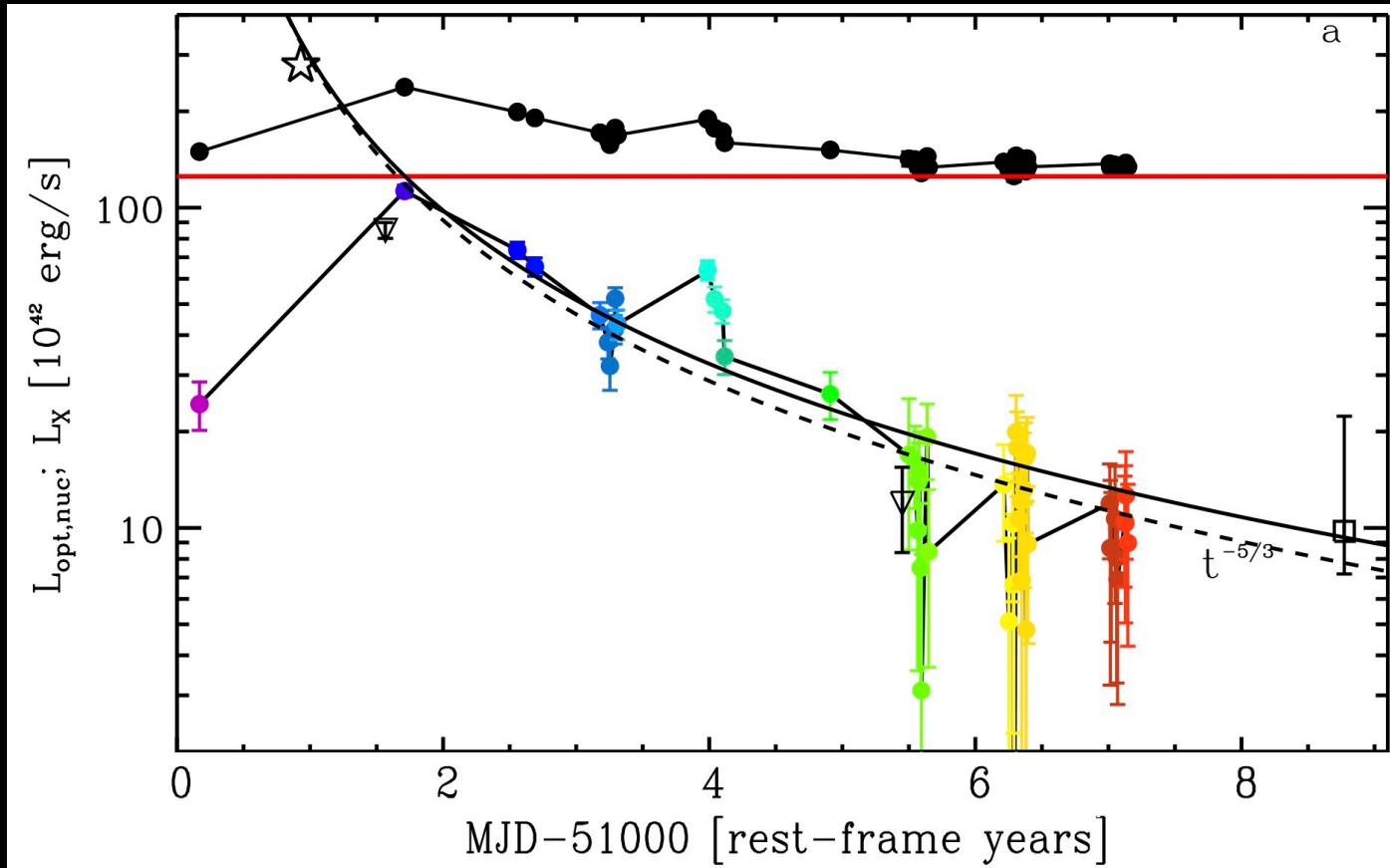
- Inconsistent with broad line dimming and timescales



What is the origin of changing-look quasars?

1. Dust obscuration? **No**
 - Inconsistent with broad line dimming and timescales
2. Tidal disruption events? (Merloni+15)

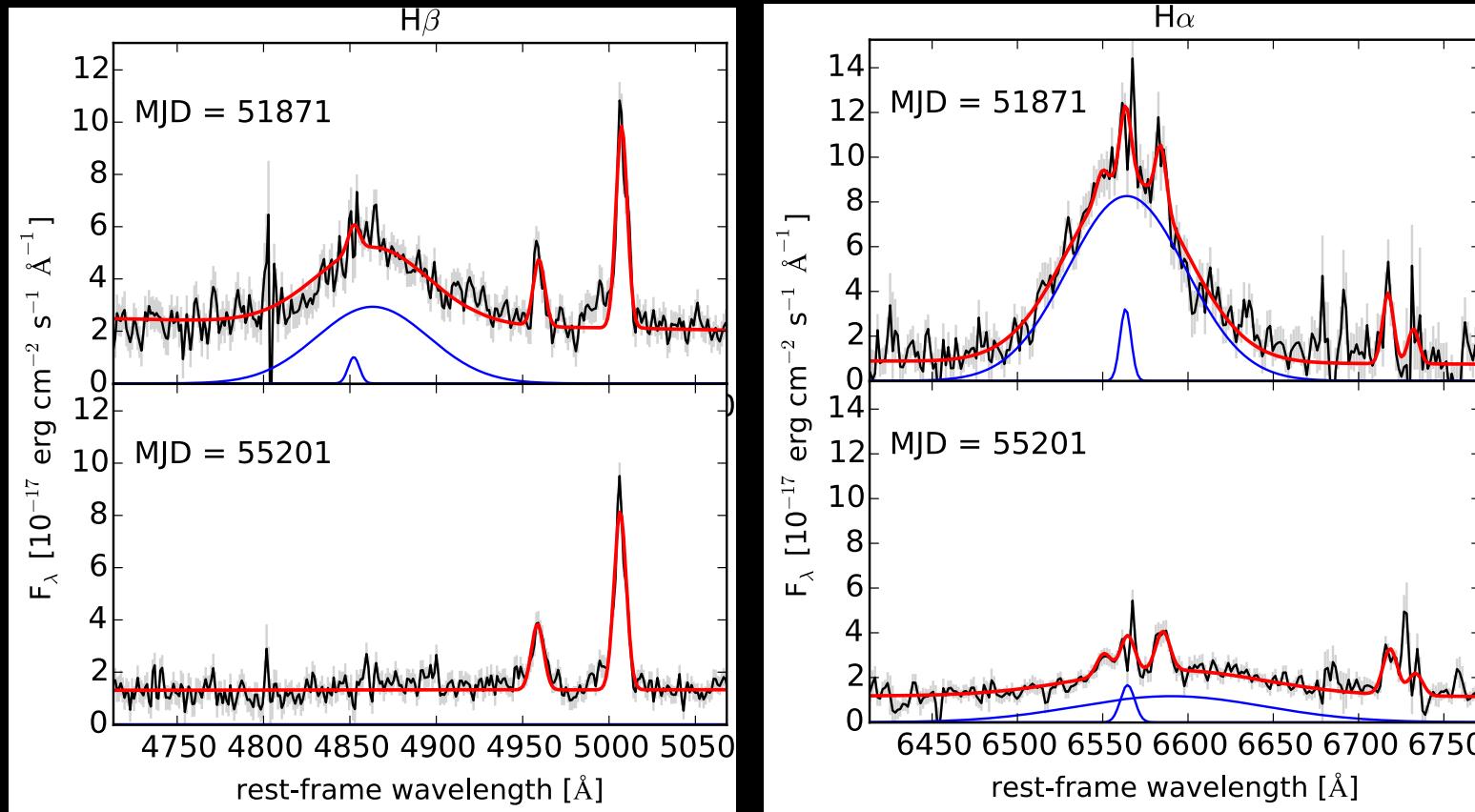
Optical light curve suggests changing-look quasars may be TDEs



Merloni+15

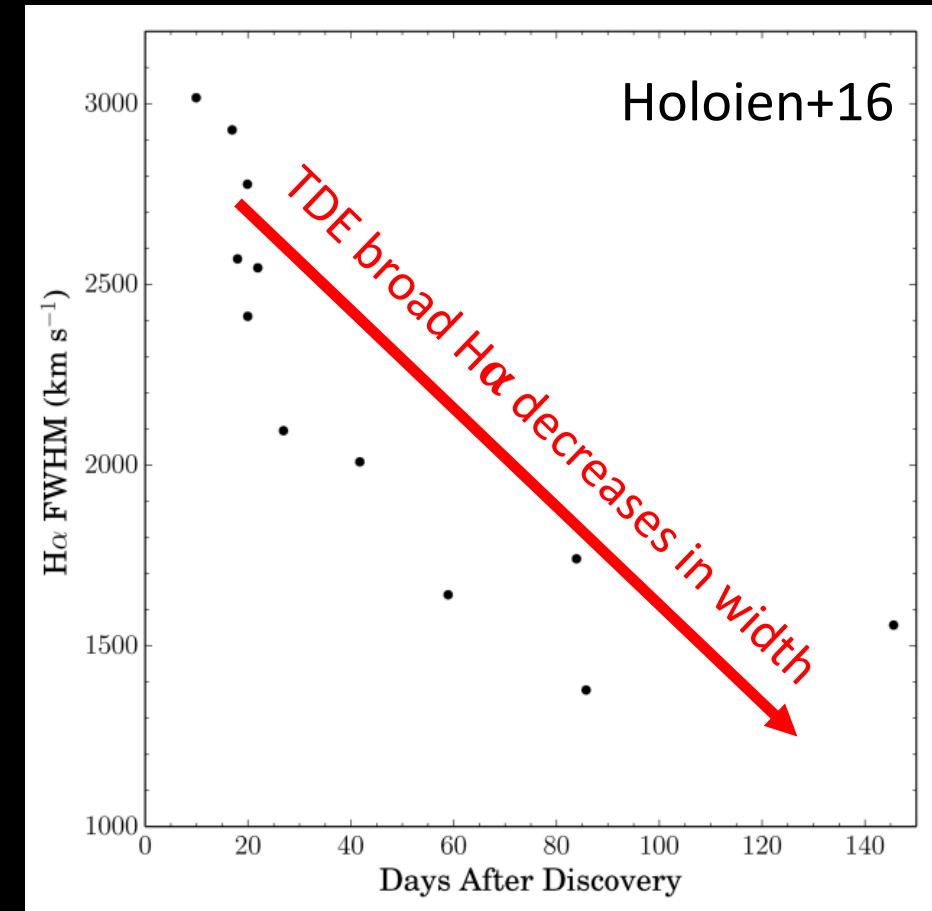
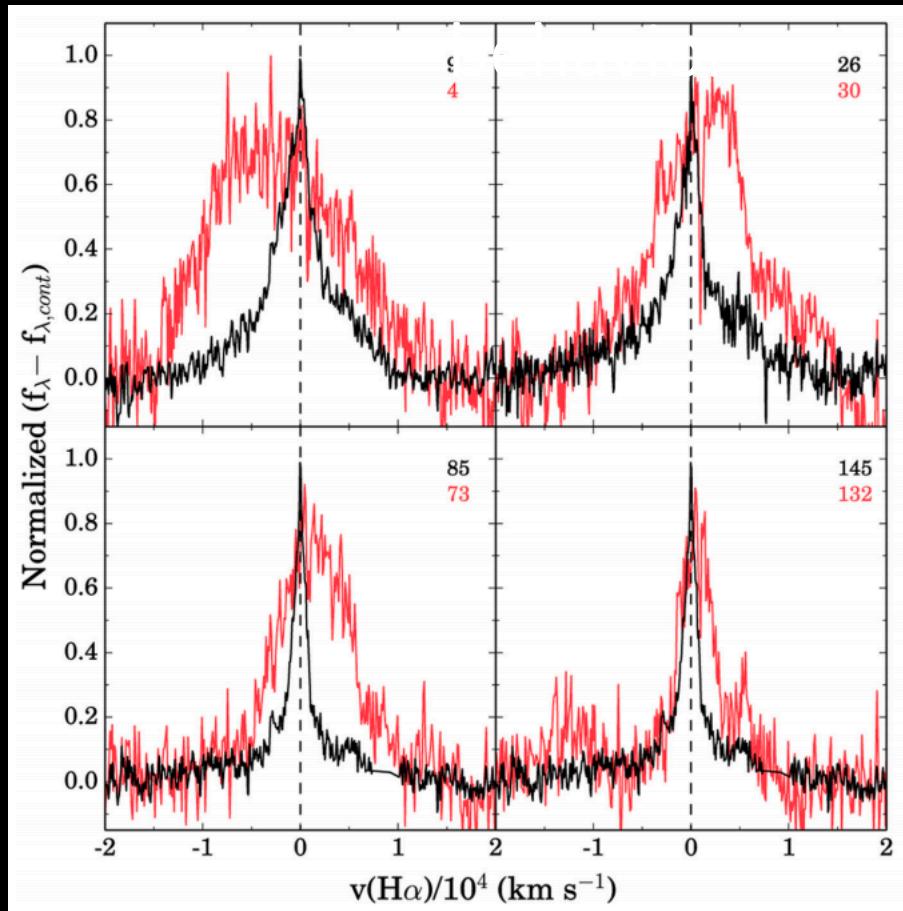
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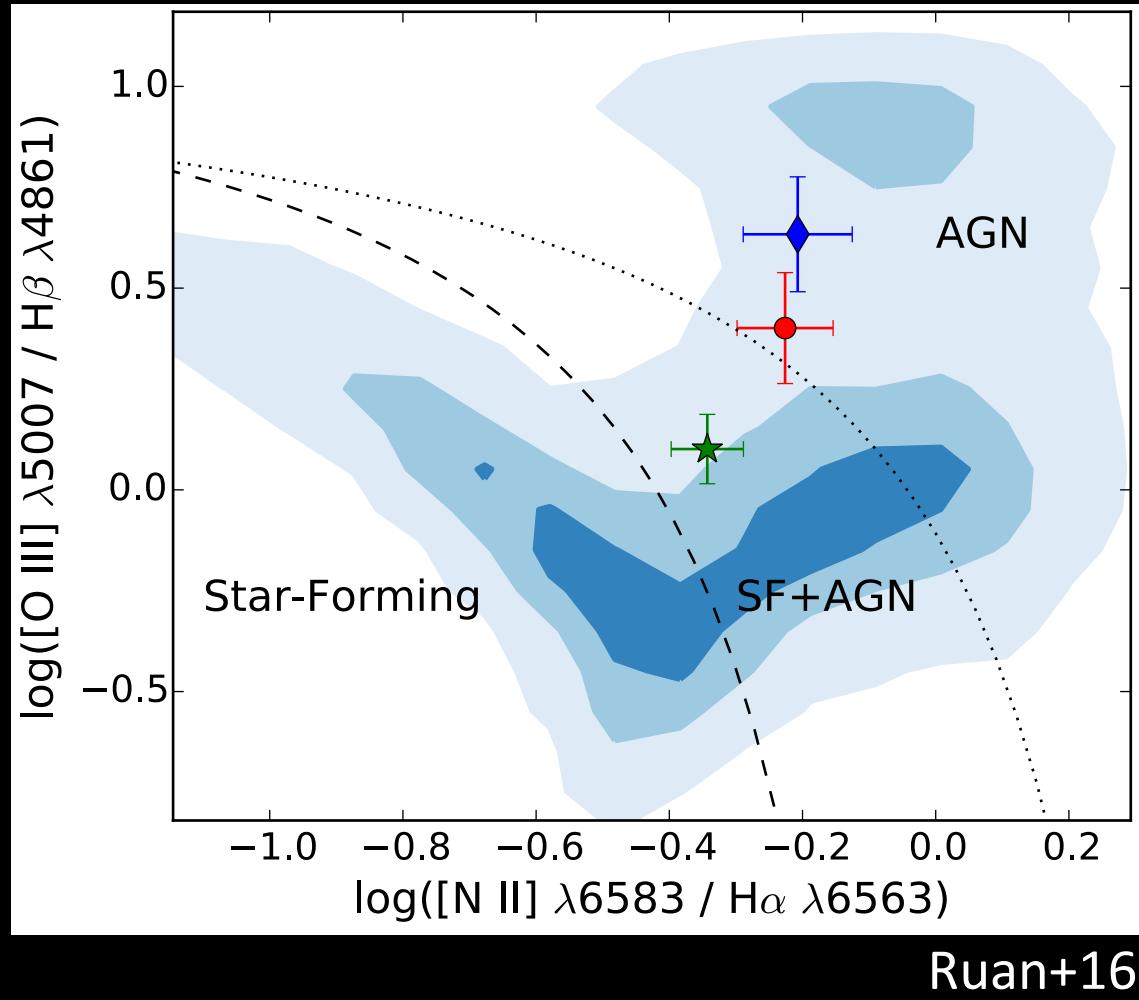


TDEs and changing-look quasars display opposite broad emission line behavior

TDE ASSASN-14li: broad H α



Narrow line diagnostics show AGN in changing-look quasars



Although see talk
by P. Blanchard
on TDEs in AGN

Ruan+16

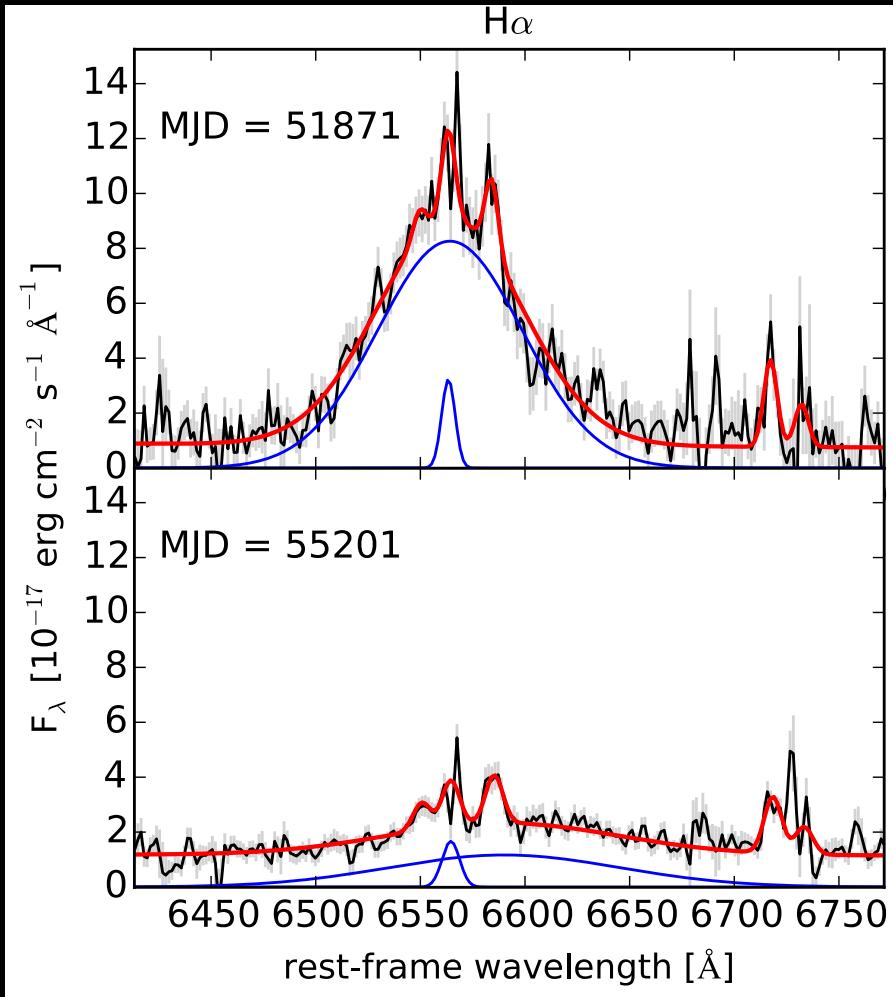
What is the origin of changing-look quasars?

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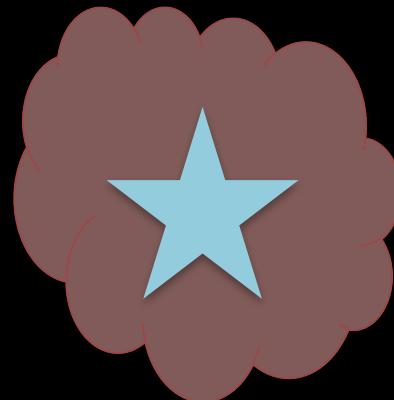
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3. Changes in accretion rate?

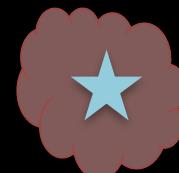
CL quasars: changes in accretion rate



Ruan+16



Lower gas velocities,
Narrower lines

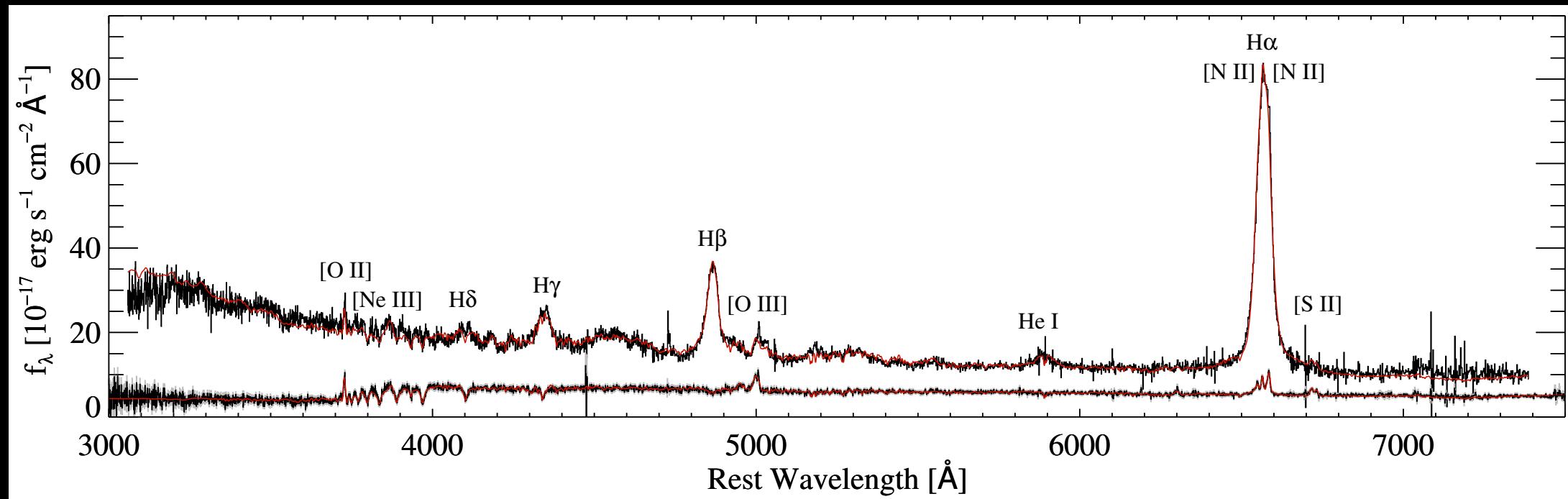


Higher gas velocities,
Broader lines

What is the origin of changing-look quasars?

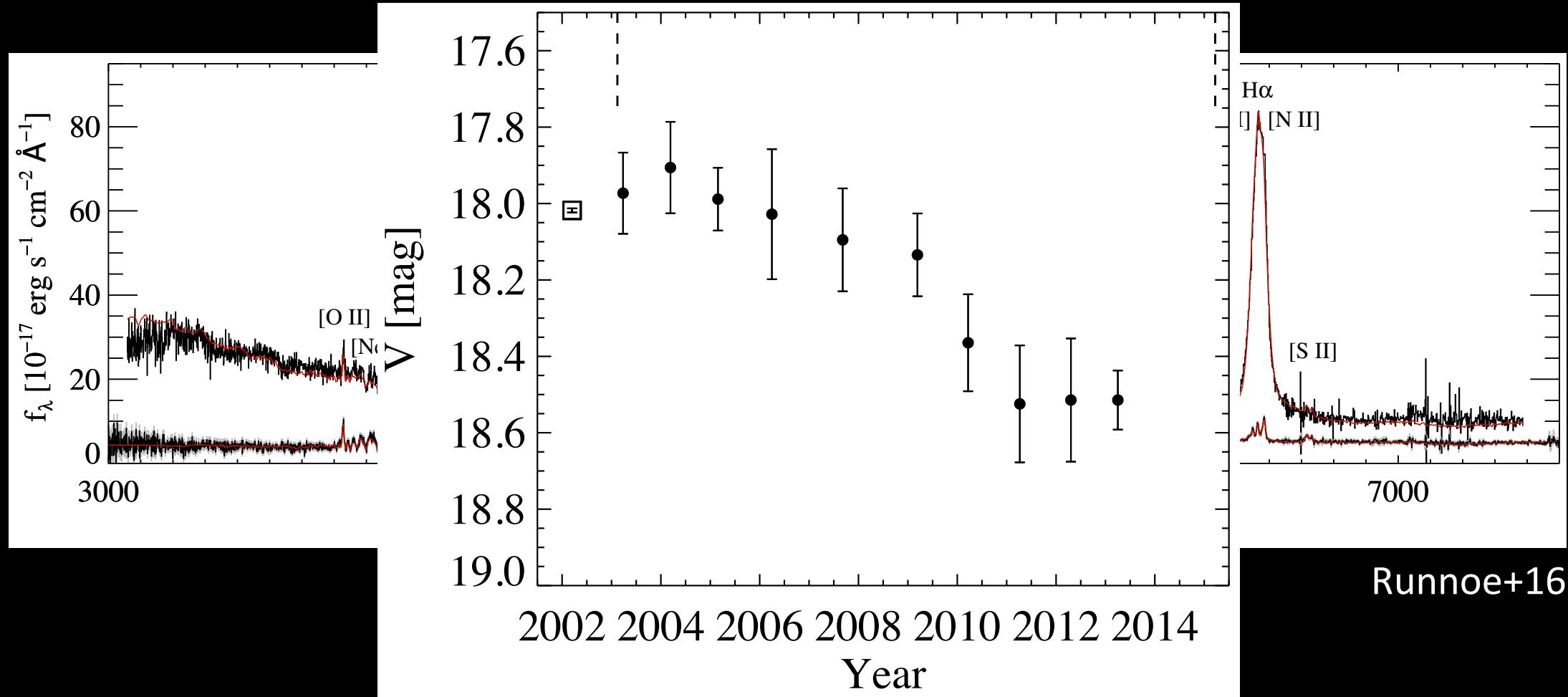
1. Dust obscuration? **No**
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2. Tidal disruption events? (Merloni+15) **Unlikely**
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3. Changes in accretion rate? **Yes**
 - Broad lines broaden as continuum dims
 - Accretion rate decreases by factor of 2.5-4

Serendipitous discovery of another CL quasar

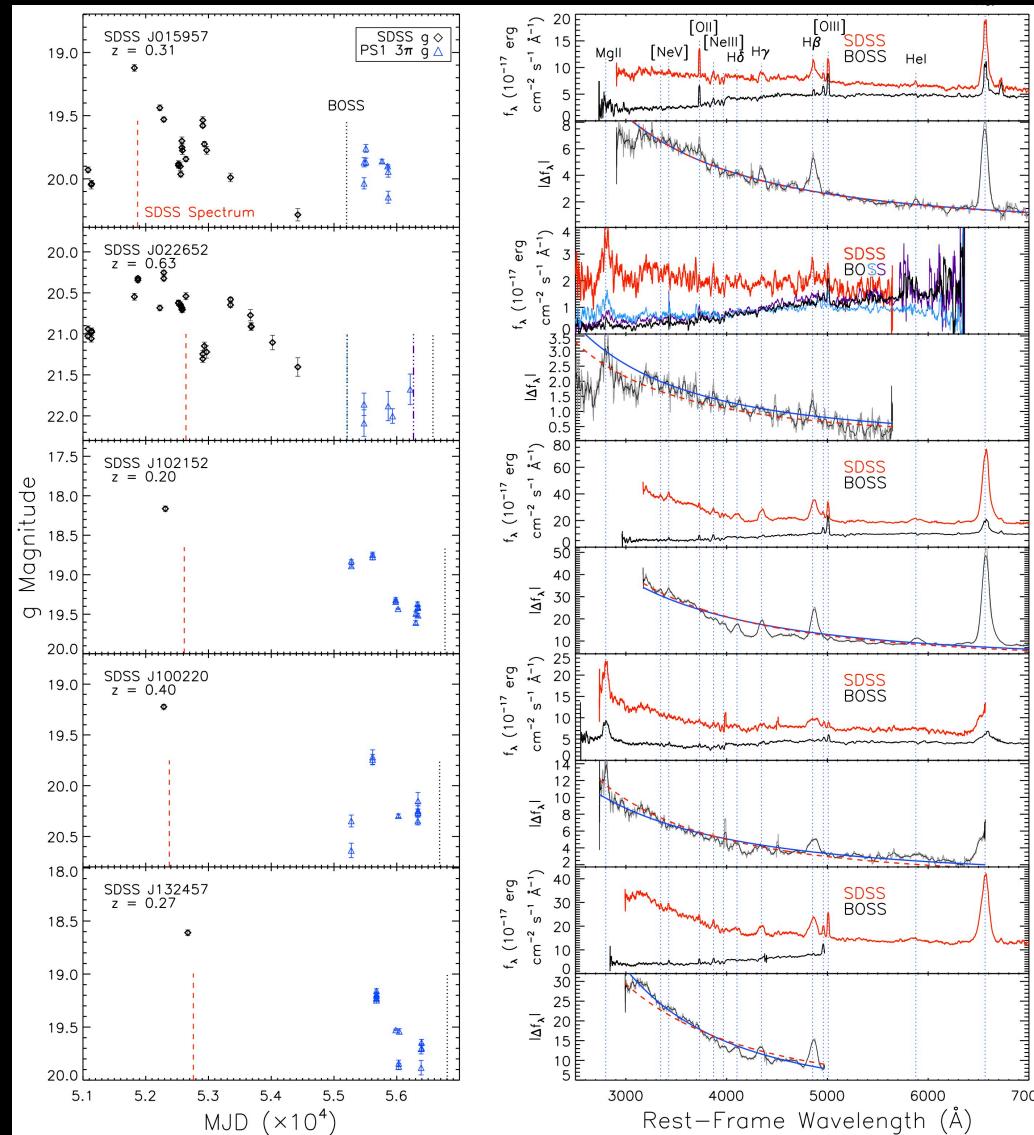


Runnoe+16

Serendipitous discovery of another CL quasar



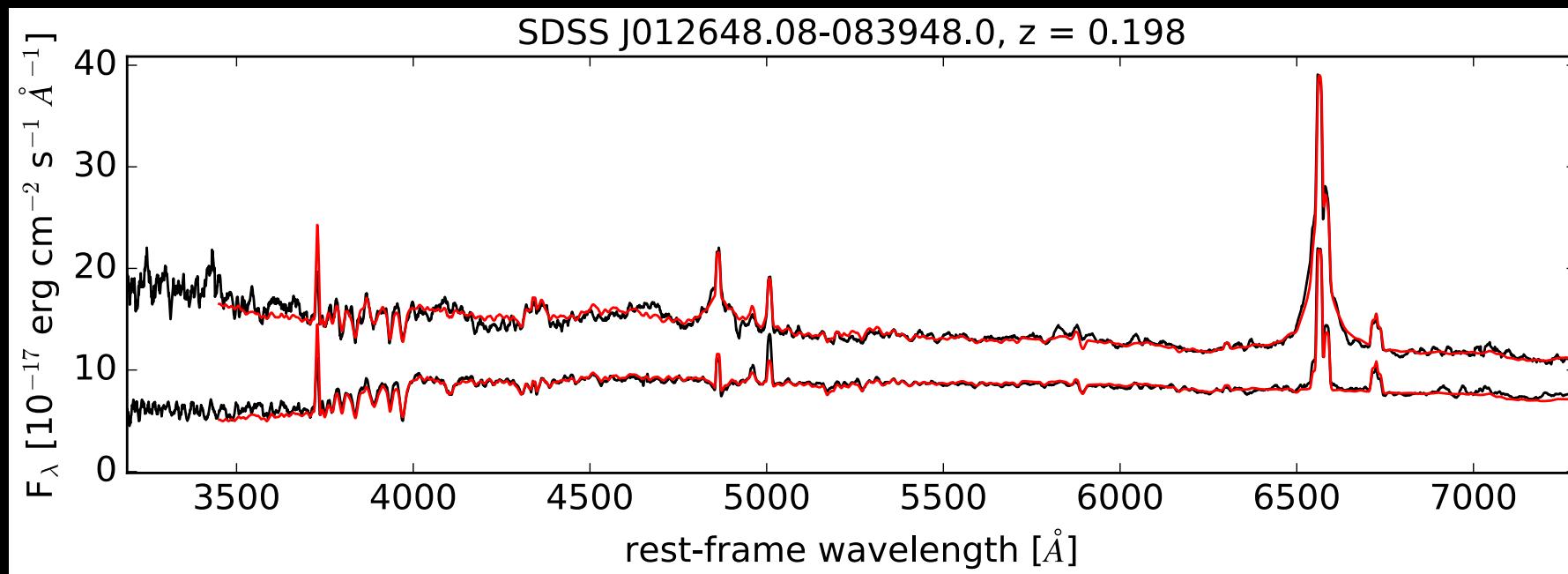
Systematic Searches for CL quasars



see talk by
C. MacLeod

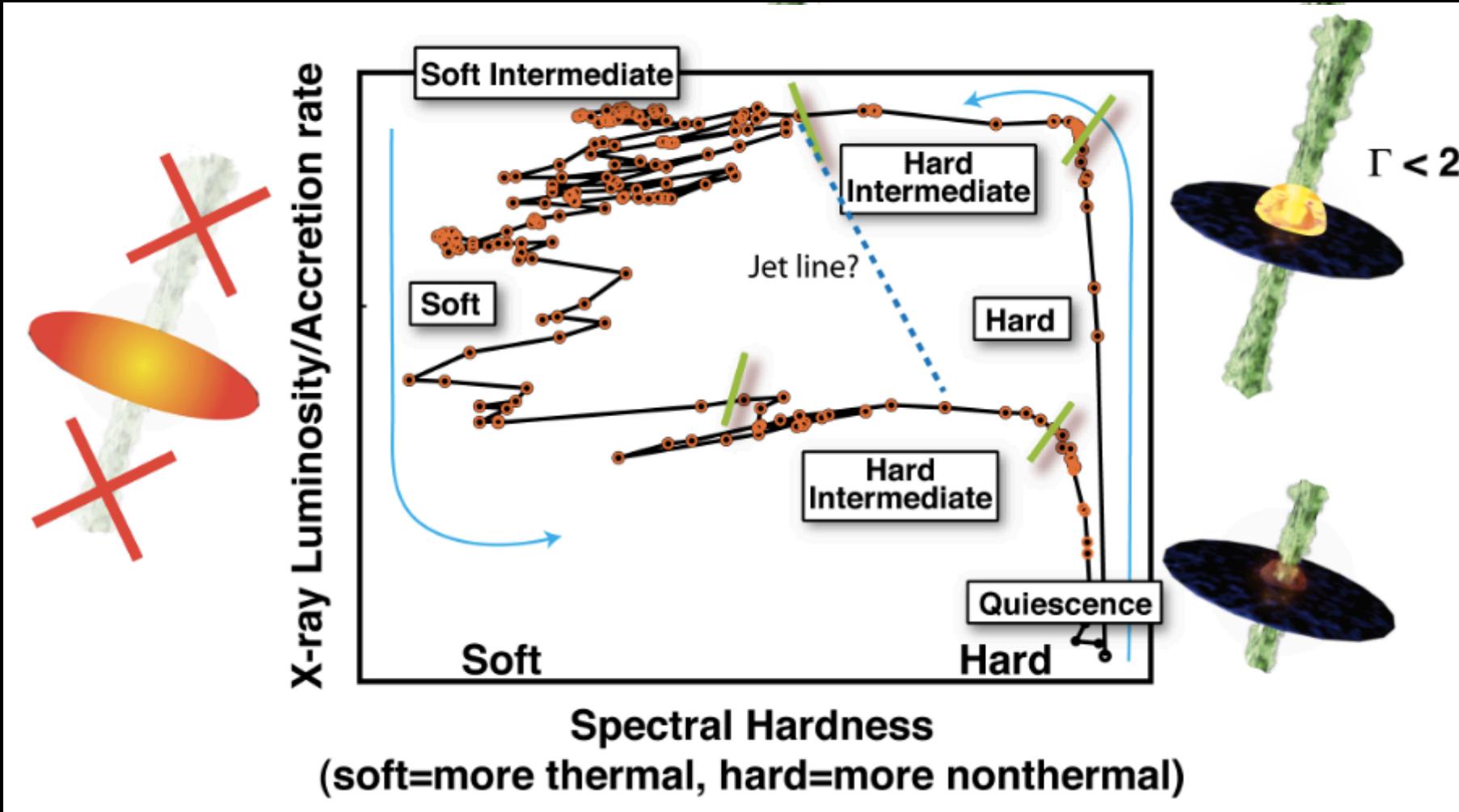
MacLeod+16

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Ruan+16

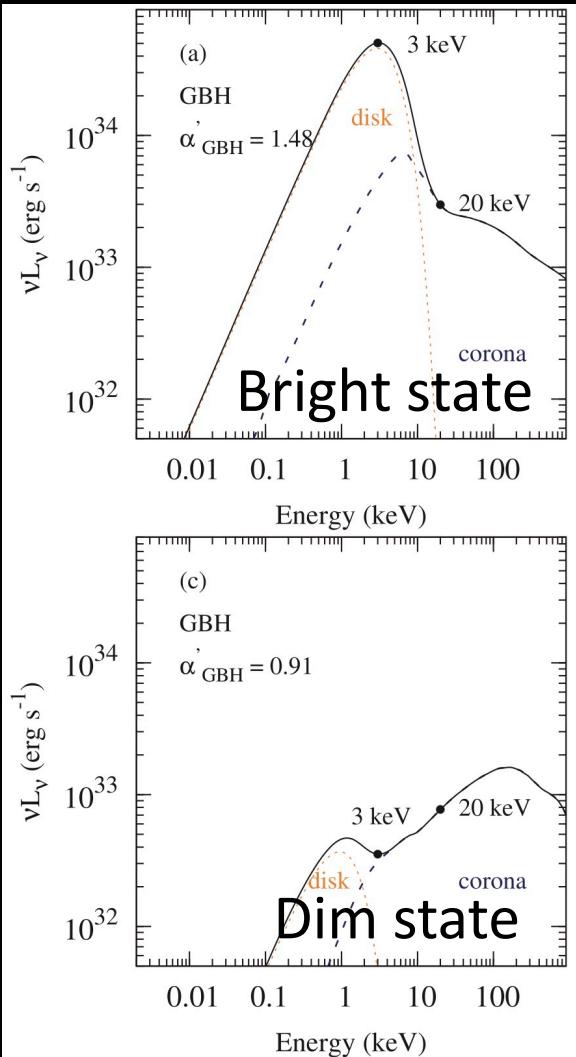
Accretion state transitions are commonly observed in X-ray binaries



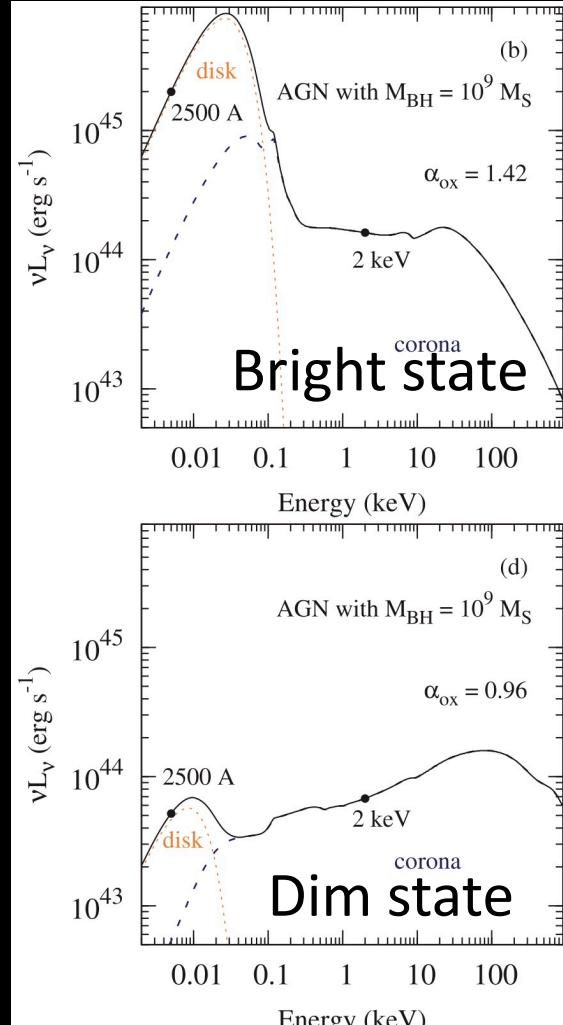
Credit: Sera Markoff

Comparing transitions in XRB and AGN

X-ray binaries



AGN



Sobolewska+11

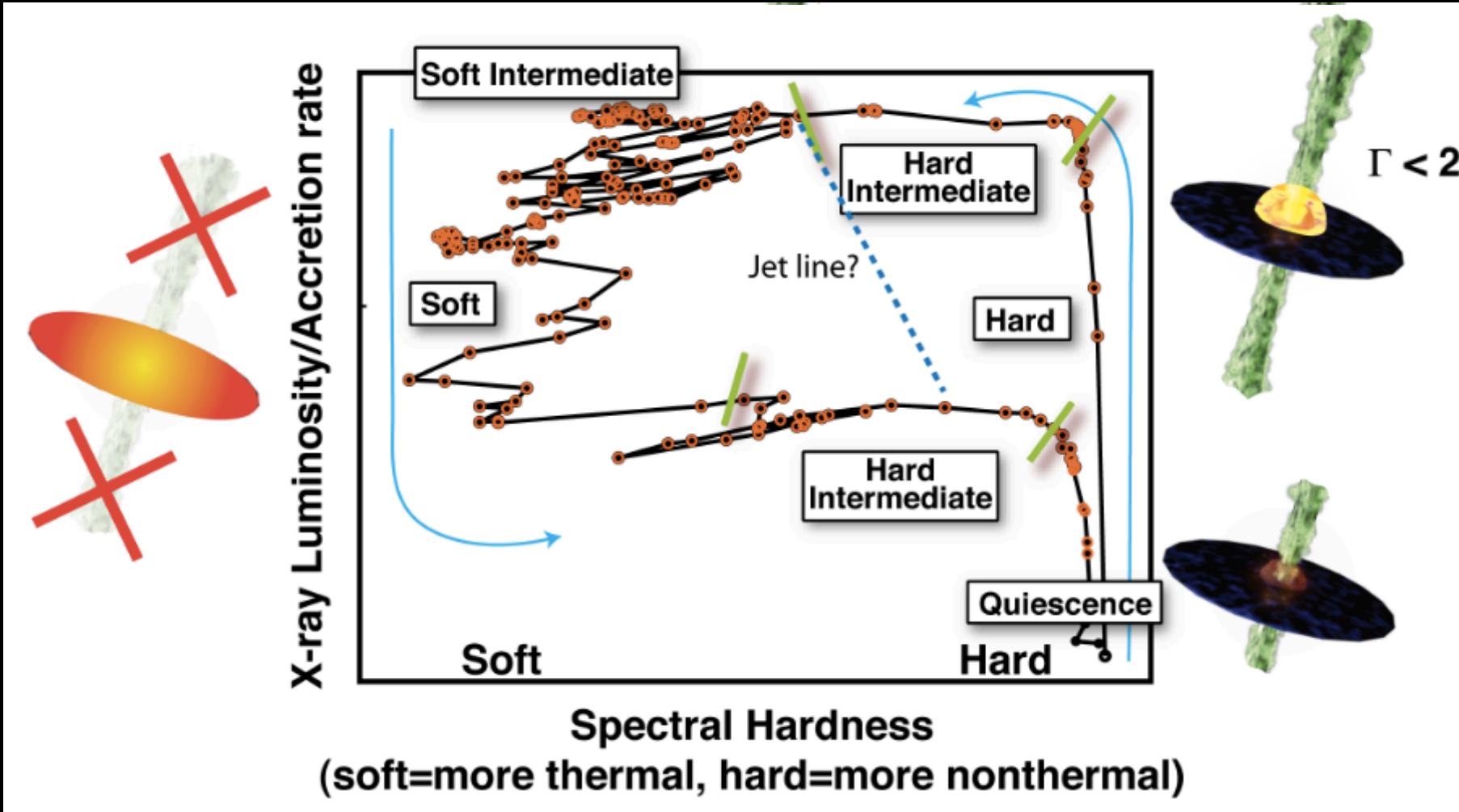
Comparing transitions in XRB and AGN

- Chandra cycle 18 and 19 GO programs
 - Sample of 6 confirmed changing-look quasars
 - X-ray/optical observations in both high- and low-accretion states
- Test our simple picture of AGN transitions based on XRBs

Comparing transitions in XRB and AGN

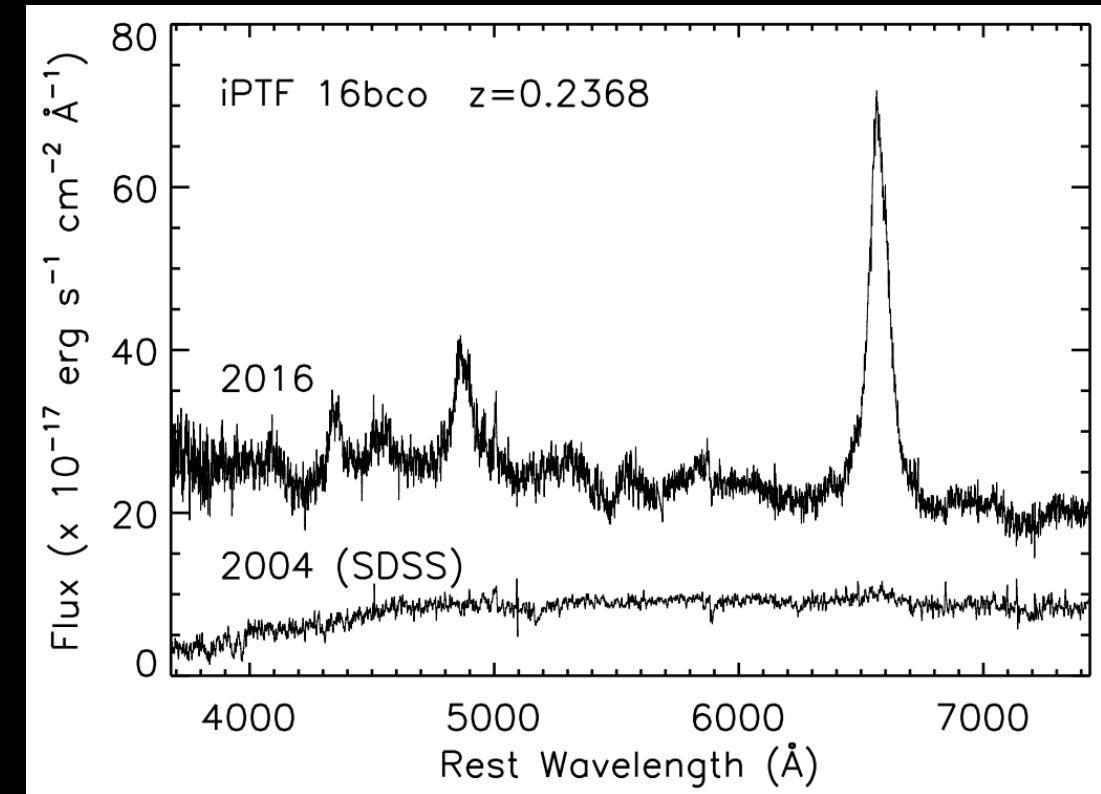
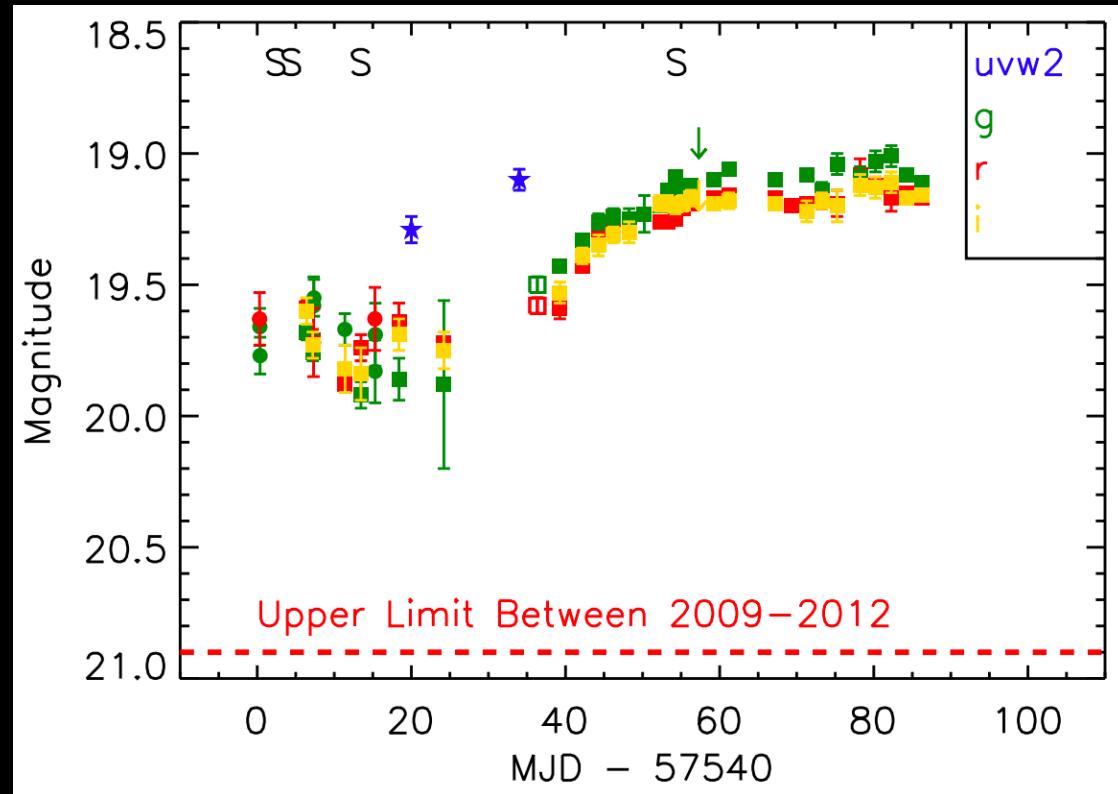
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Credit: Sera Markoff

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)
 - SDSS-IV Time-Domain Spectroscopic Survey repeat spectroscopy of 15,000 quasars (e.g. MacLeod+17)
- 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!