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Progress in Changing-look AGNs

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In coll. with

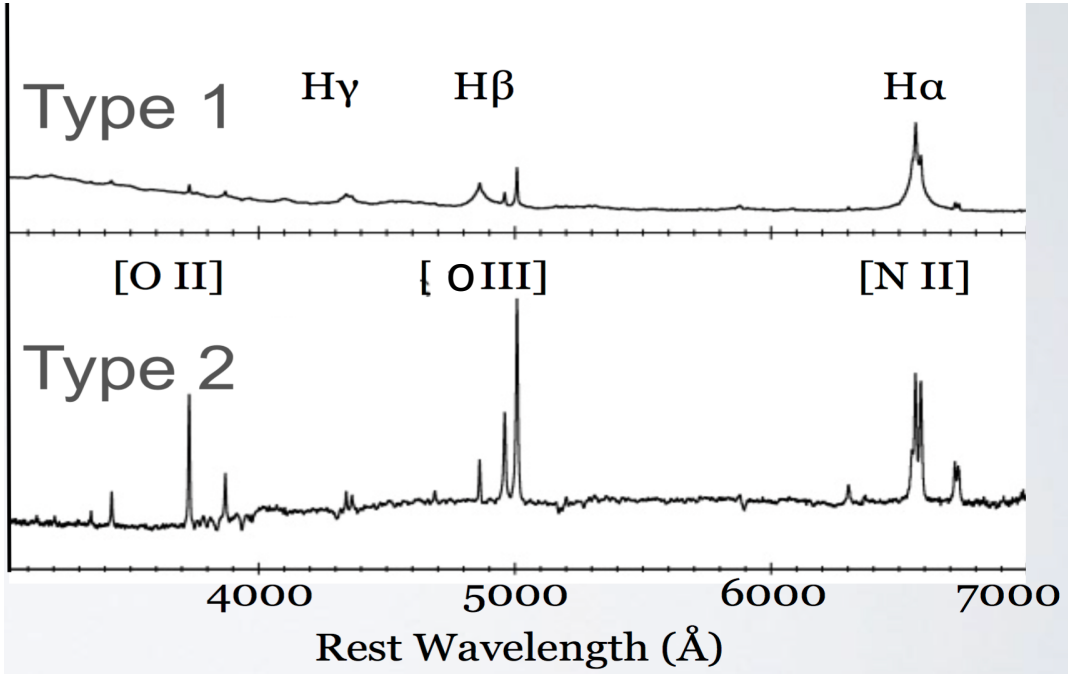
Jing Wang, **Jianyan Wei** and colleagues from NAOC

- Why do we study Changing-look (CL) AGNs?
- Two new "turn-off" CL-AGNs and implication on "partially-obscured" AGNs
- A new repeat CL-AGN: deep breathing of the BLR
- Ongoing and future projects

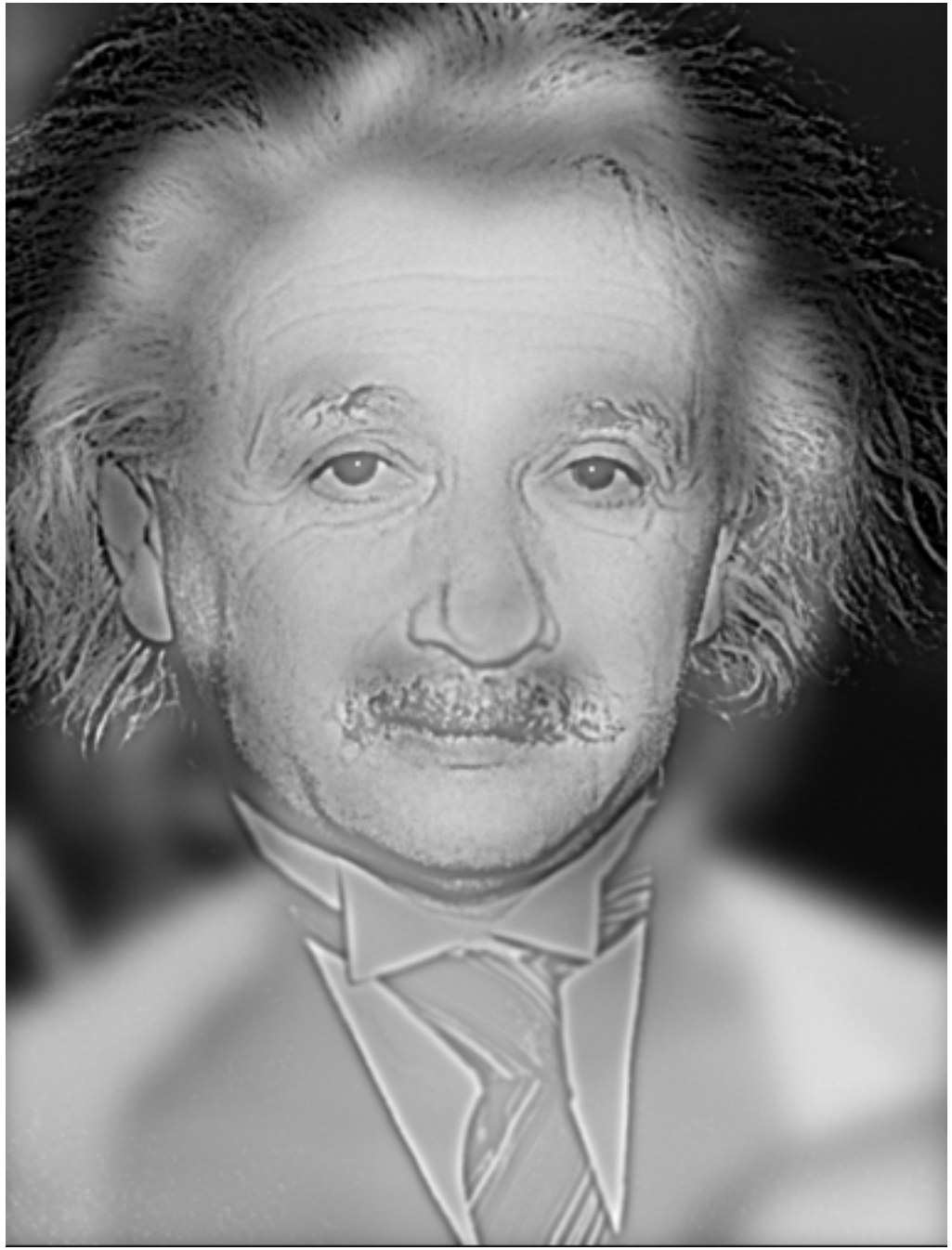
AGN Paradigm

- Unified model (Antonucci 93 & Urry & Padovani 95)
  - Obscured vs. unobscured AGNs (opt & X-ray)

AGNs are super-massive black-holes accreting gas from a disk in the center of a galaxy.



Albert Einstein



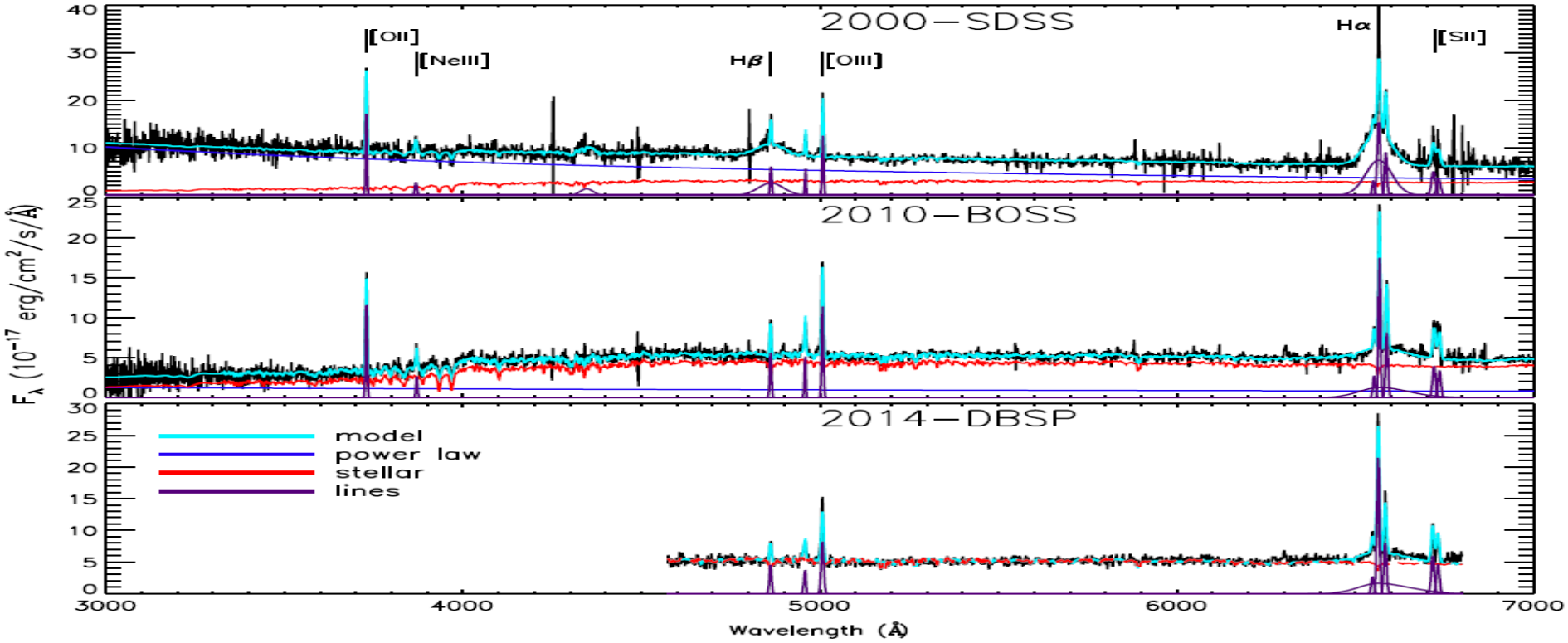
Marilyn Monroe?

Changing-look AGNs

- rare events with extreme (opt) spectral type change within years.
- Type 2 ⟷ Type 1.8/1.9 ⟷ Type 1.5 ⟷ Type 1

  (**turn-off ⟷ turn-on**)

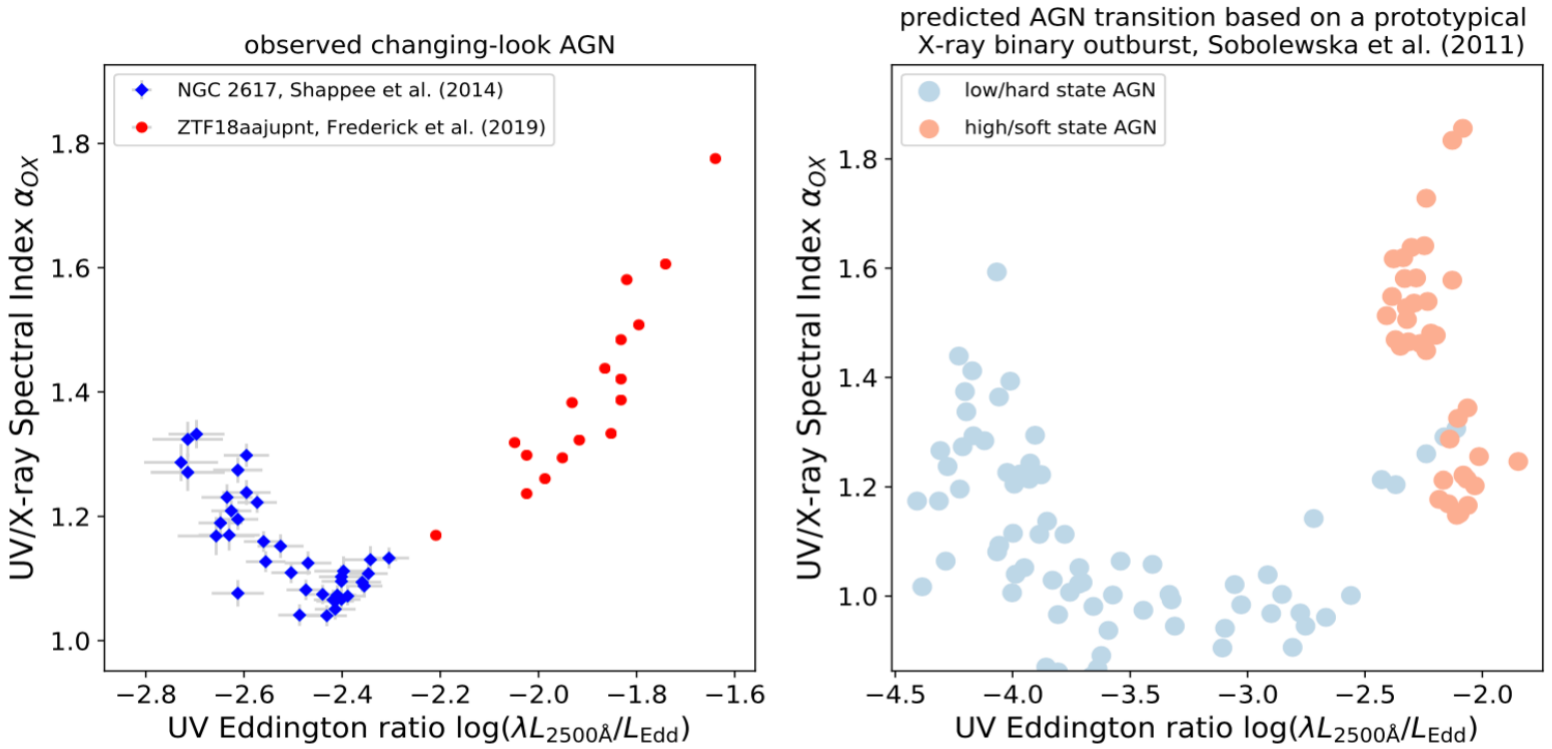
1st CL QSO: SDSSJ0159+0033 (LaMassa+15)



CL AGN phenomenon : Challenges and opportunities

- **physical driver is still an open issue.**
- **a challenge to the unified model:** changes in accretion rate or obscuration?
- **a timescale crisis:** expected viscous time scale of optical emission lines from outer accretion disk is larger than the observed time scale by an order of magnitude.

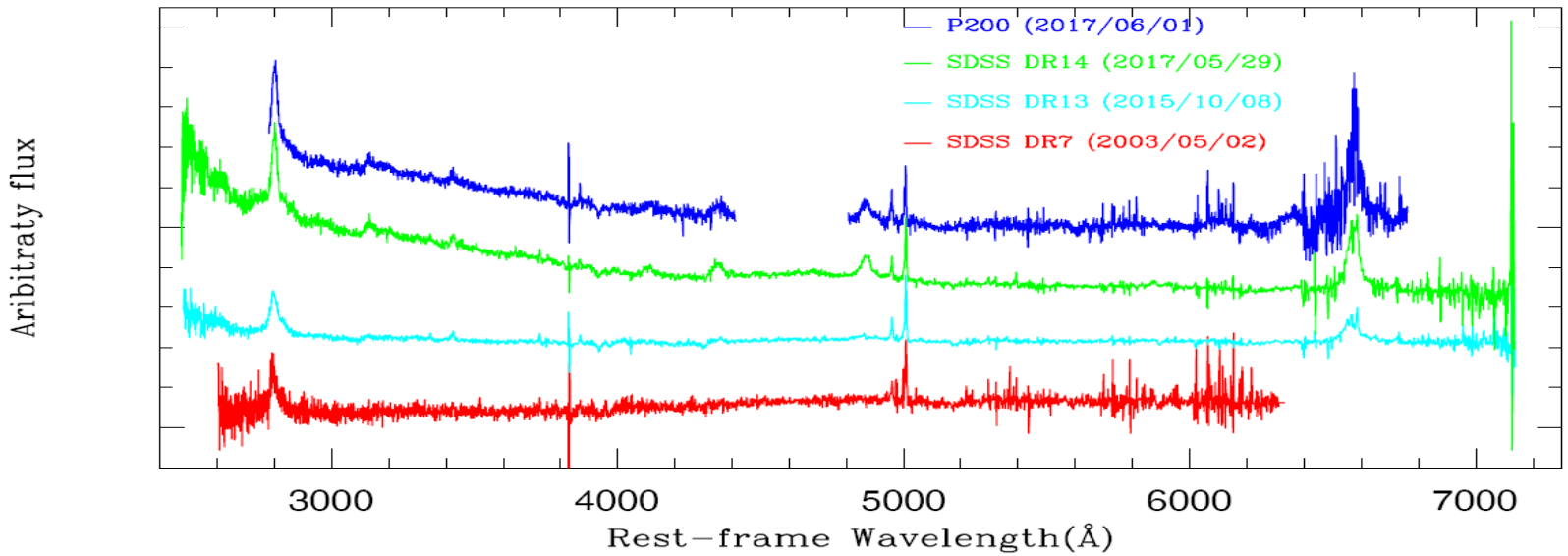
- **an ideal testbed for studying the co-evolution of SMBH & its host**
- **a robust probe of the AGN/X-ray binary analogy**



Ruan et al. (2019)

Previous Discoveries

- ~ 80 CL-AGNs discovered by repeated but sparse spectroscopic observations
- Case studies: e.g., Mark 1018, Mark 590, 3C390.3, NGC2617, NGC4151, NGC 7582, SDSS J015957.64+003310.5, SDSSJ101152.98+544206.4, SDSS J155440.25+362952.0, HE1136-2304, 1ES1927+654, NGC1566, PS1-13cbe (e.g., Penston & Perze 1984; Cohen et al. 1986 ; Goodrich 1995; Aretxaga et al. 1999; Shapovalova et al. 2010; Shappee et al. 2014; LaMassa et al. 2015; McElroy et al. 2016; Parker et al. 2016; Runco et al. 2016; Runnoe et al. 2016; Gezari et al. 2017; **Wang, Xu & Wei 2018** (A new CL quasar with a "turn-on" type transition from Type-2/1.9 into Type-1 within a rest frame time scale of 1-10 years.); Stern et al. 2018; Reza et al. 2019 Trakhtenbrot et al. 2019)



- Repeat CL-AGNs: e.g., Even though most of the identified CL-AGNs are observed to have changed just once, repeat transitions have been identified in a few nearby Seyfert galaxies: Mrk1018, Mrk590, NGC2617, NGC 4151, NGC 7603 and NGC 1566.

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- Small samples: e.g. 13 CLQs from systematic archival searches in SDSS with repeat spectroscopy (Ruan et al. 2016; MacLeod et al. 2016), 21 CLQs based on optical/MIR variability (Yang et al. 2018) and 17 CLQs based on large optical amplitude variability and **a catalog of more than 200 highly variable candidates for future CLQ searches** (Macleod et al. 2019).

Searching for new CL AGNs

- The sample is selected from the CLQs candidates with large amplitude variability recently released by Macleod et al. (2019).
  - $|\Delta g| > 1$mag and $|\Delta r| > 0.5$mag
    (by comparing the photometric measurements between SDSS DR10 and Pan-STARRS)

- $z < 0.83$: in order to ensure the Hβ in observer frame is within optical wavelength range

- $g < 19$ mag

→ 48 candidates are selected for follow-up spectroscopic observations.

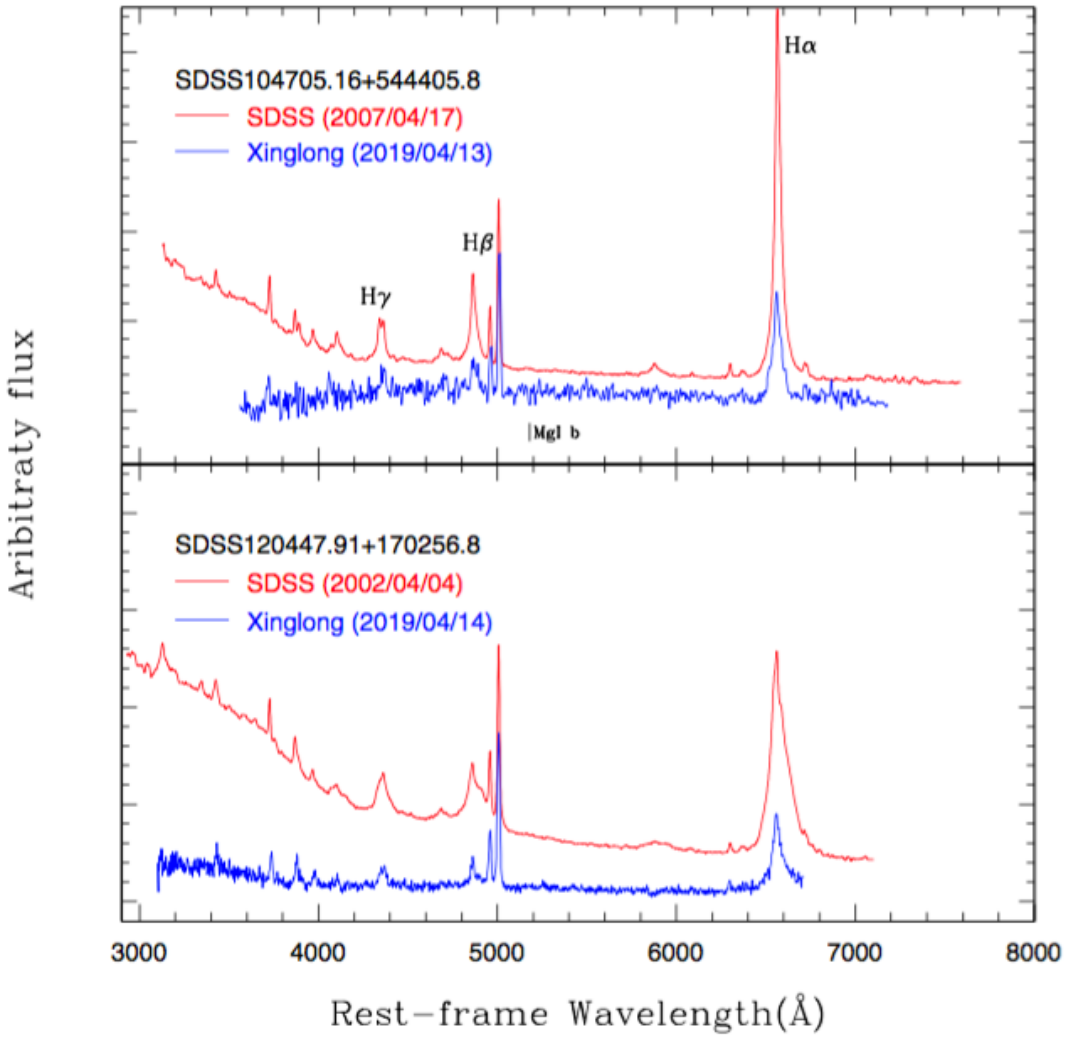
Optical spectroscopy: the first observing run

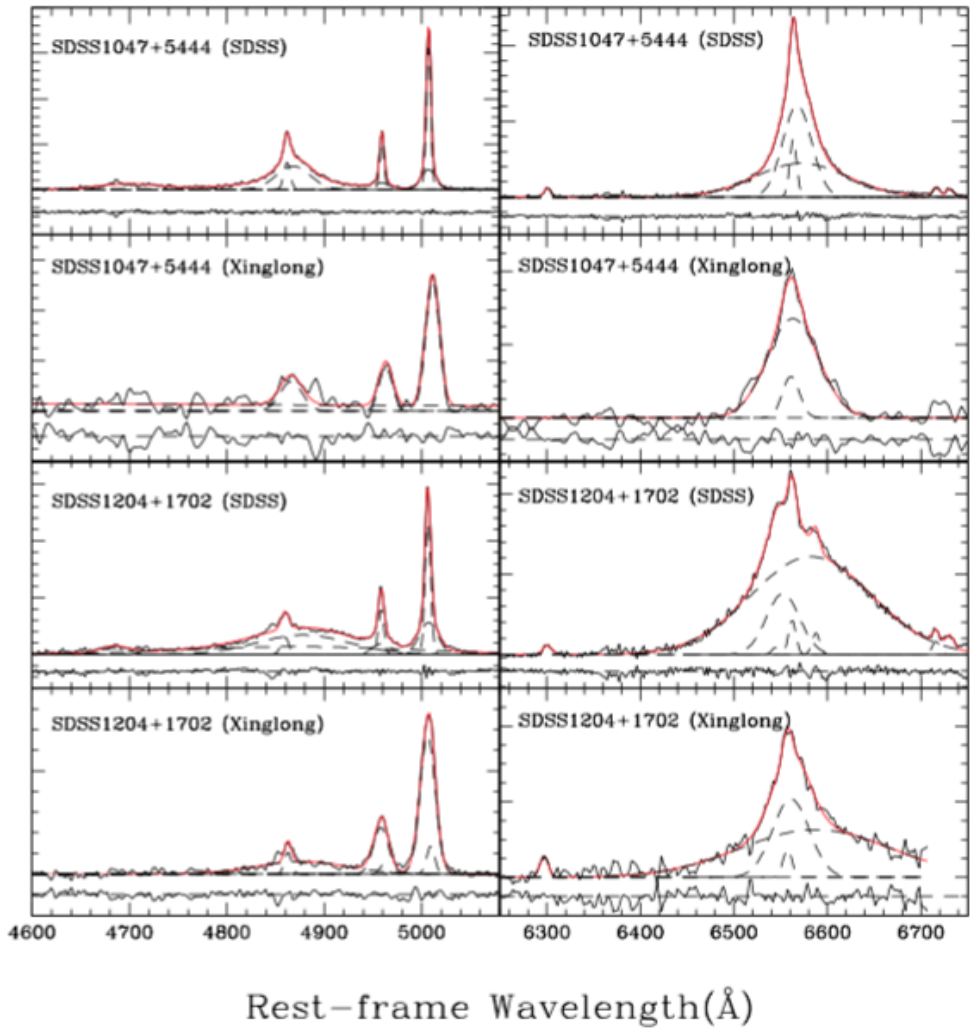
Table 1. Log of Spectroscopic Observation

SDSS ID	z	g-band mag	Date	Exposure seconds
(1)	(2)	(3)	(4)	(5)
J085259.22+031320.6	0.297	16.19	March 30	2400
			March 31	2400
J094443.08+580953.2	0.562	17.90	March 23	2400
			March 24	2400
			March 25	2400
J104705.16+544405.8	0.215	17.56	April 09	2400
			April 14	4800
J105125.58+105621.5	0.602	18.07	April 21	7200
J120447.91+170256.8	0.298	16.69	March 29	2400
			April 03	4800
			April 07	2400
			April 13	4800

Xinglong, NAOC

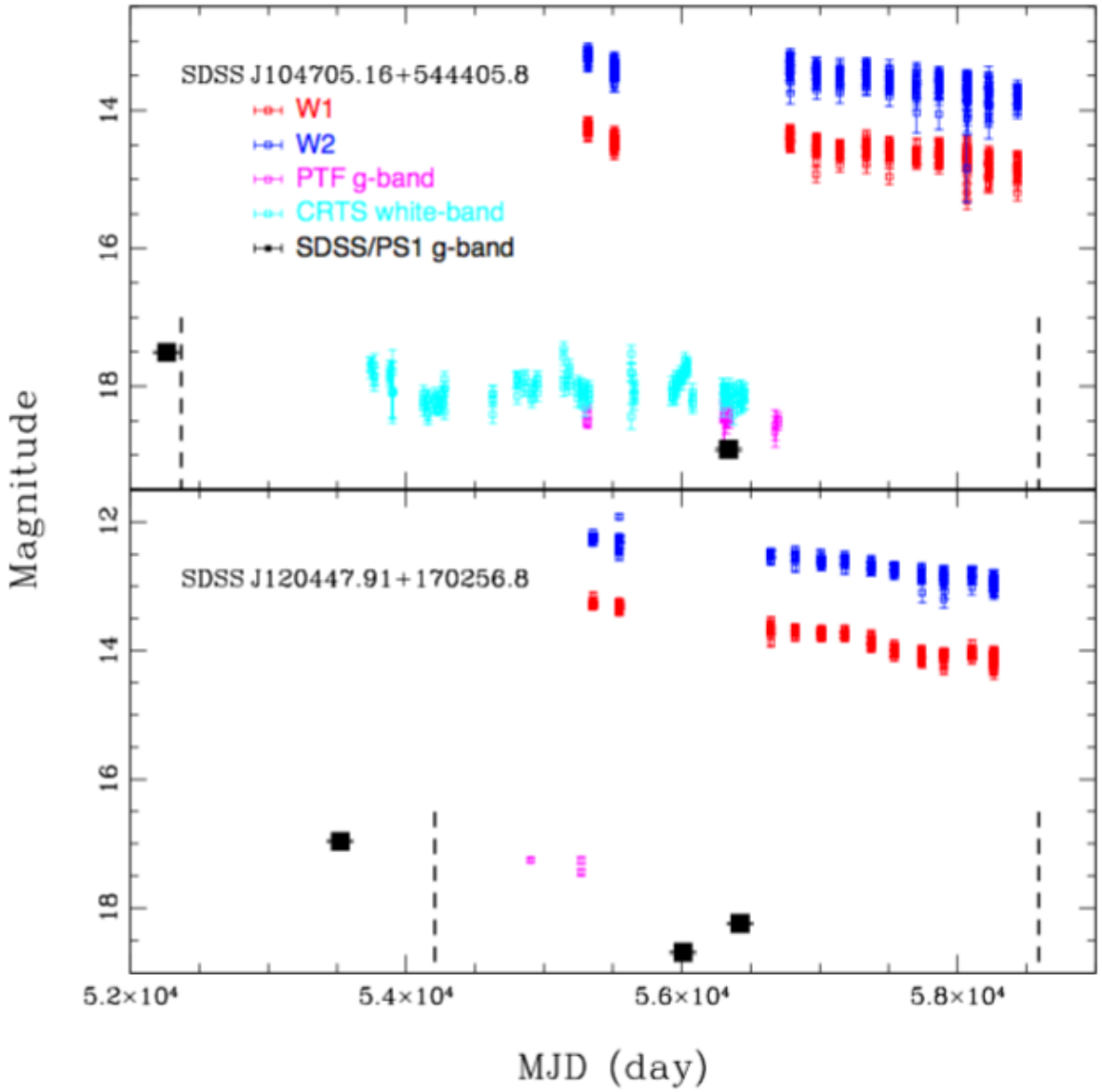
Two new "turn-off" CL AGNs: from Type-1 into Type-1.9



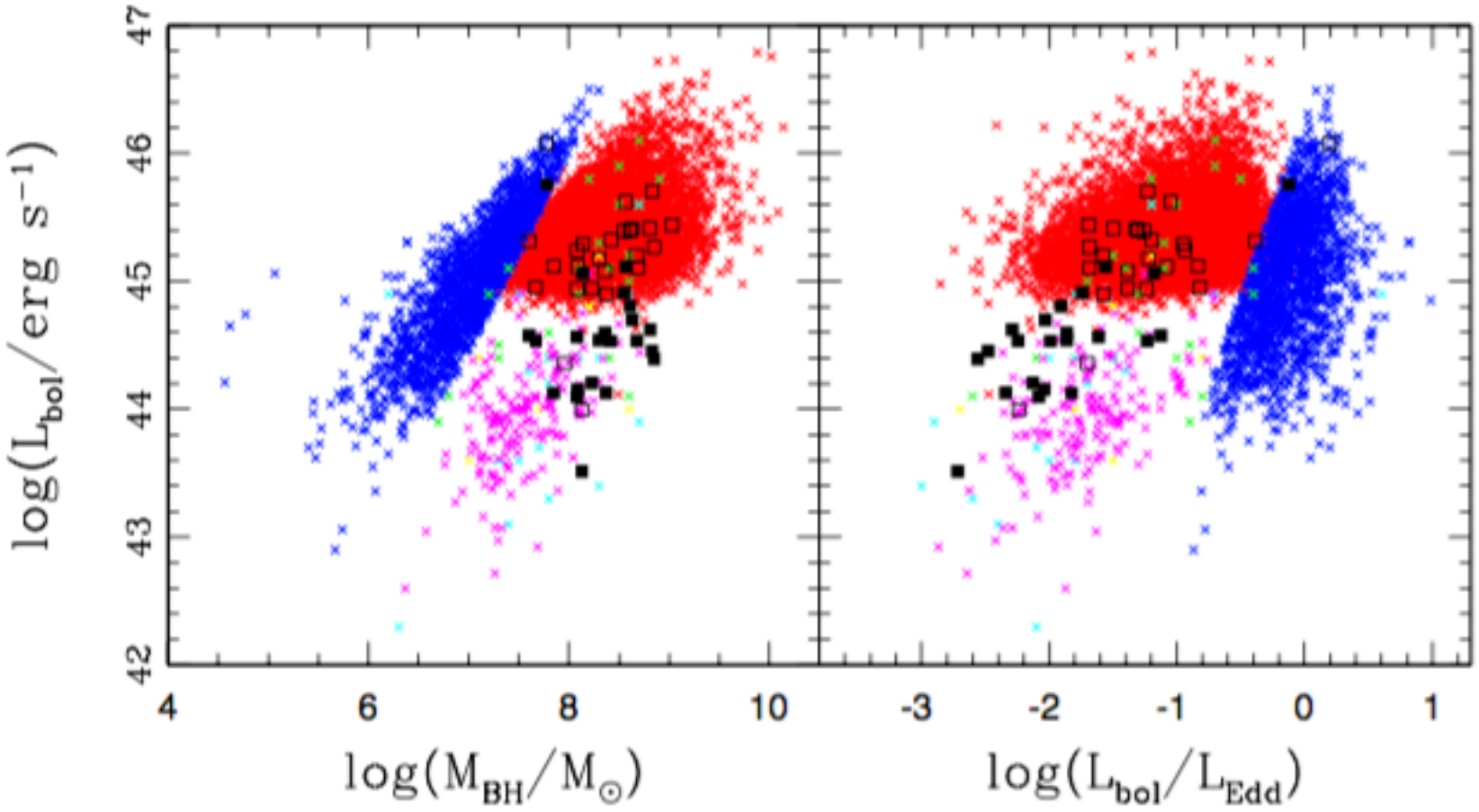


Wang, Xu, Wang et al. 2019

Multi-wavelength light curves



Implication on “Partially Obscured” AGNS

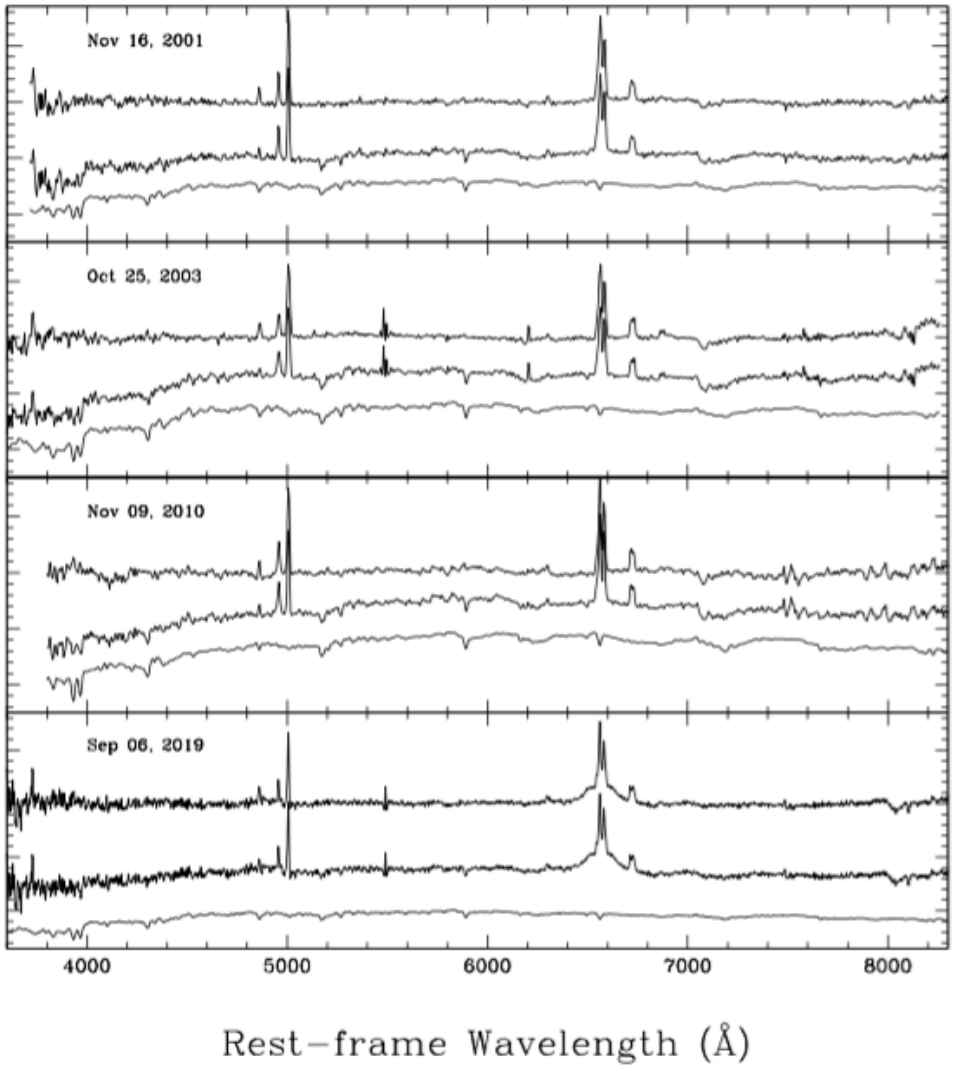


A new repeat CL-AGN

Repeat Spectroscopy:

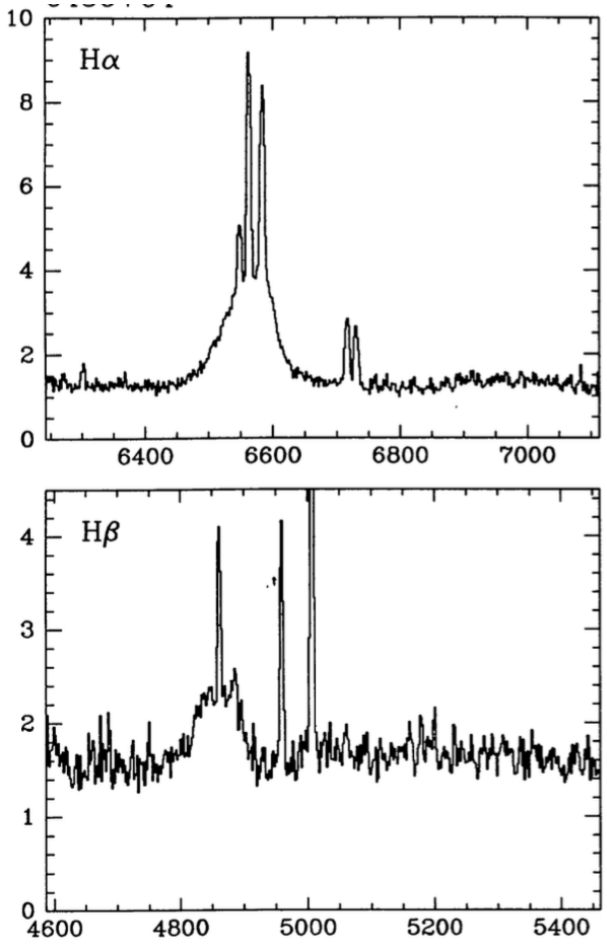
2.16m telescope at Xinglong, NAOC

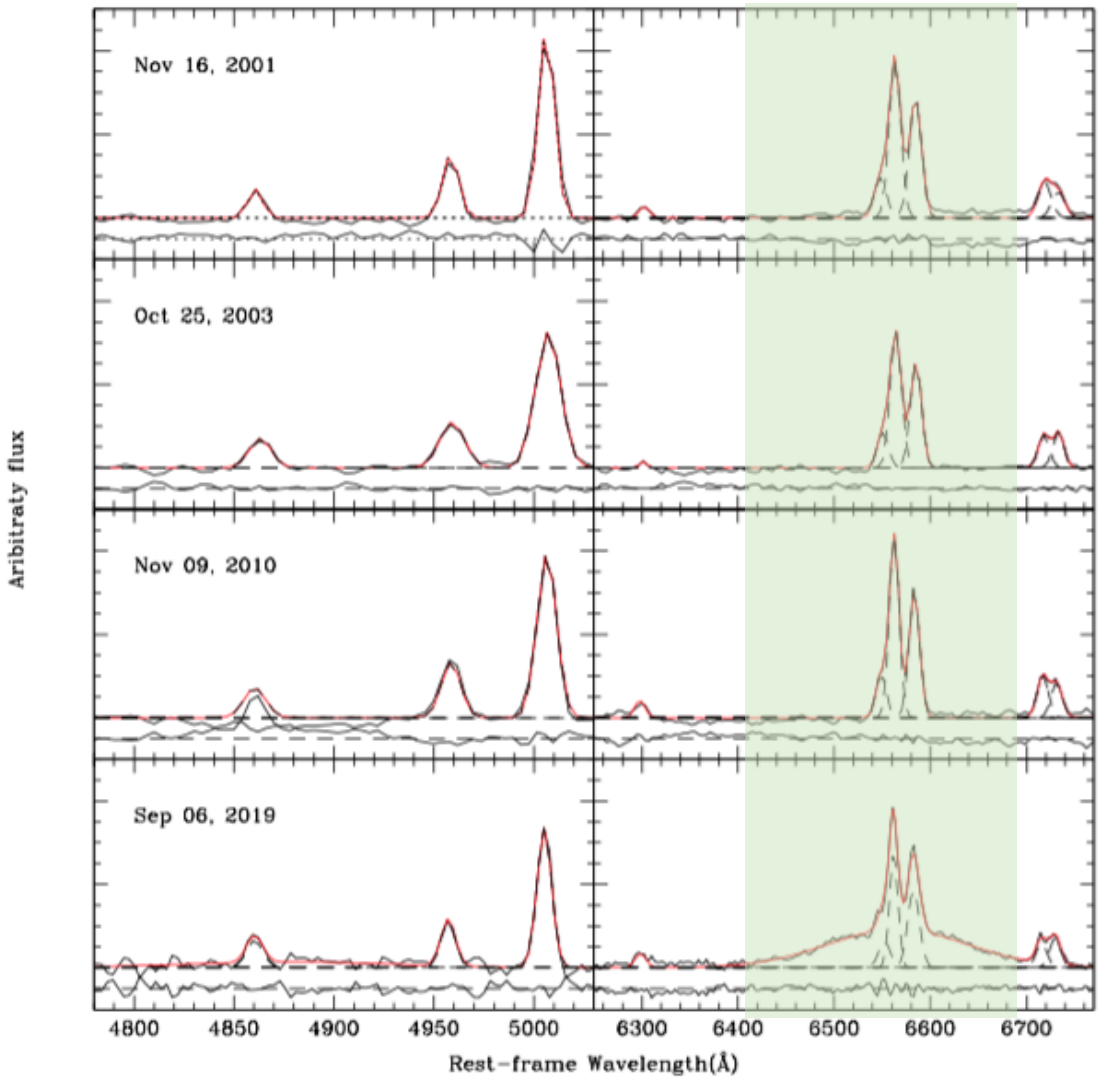
Date	Exposure time seconds	S.p. type
(1)	(2)	(3)
2001/11/16	1500×2	S2
2003/10/25	3600×2	S2
2010/11/09	3600×2	S2
2019/09/06	1800×2	S1.8



Deep breathing of the BLR:
a journey from Type-1.5 → Type-2 → Type-1.8 over 30 years

Jan 1987





Wang+ 2019, in preparation

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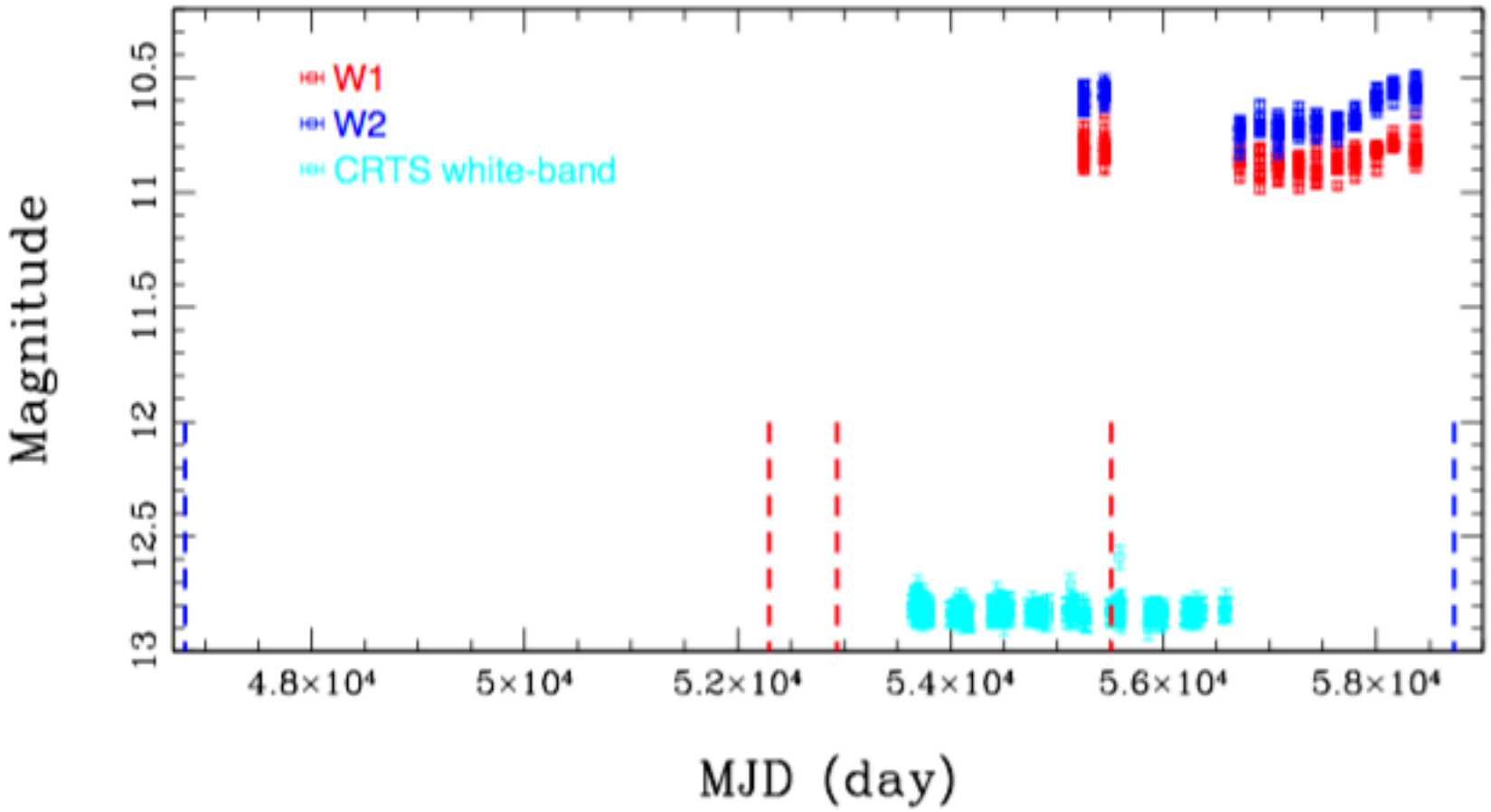

Ongoing and Future projects

- **Searching for new CL-AGNs with large optical amplitude variability and near-UV (NUV) selected candidates, using the Xinglong 2m telescope at NAOC and the Shane 3m telescope** (in coll. with W. Zheng and A. V. Filippenko @UC Berkeley) **at Lick Observatory**
- **Systematically searching for new CL-AGNs with the SDSS-V repeat spectroscopy**

- **Targeting the subsample of known CL-AGNs for the SVOM GP science (MXT/VT)**

- **Swift UVOT/XRT observations of the newly discovered repeat CL-AGN**

- **Catching CL-AGNs which are in the act of an apparent state transition by triggering the SVOM ToO observation (MXT/VT)**

Thank you!