

DARK ENERGY  
SPECTROSCOPIC  
INSTRUMENT

U.S. Department of Energy Office of Science

# Changing-look AGNs in DESI

Wei-Jian Guo 郭威坚

2024/10/16

Tsung-Dao Lee Institute



# Contents of Talk



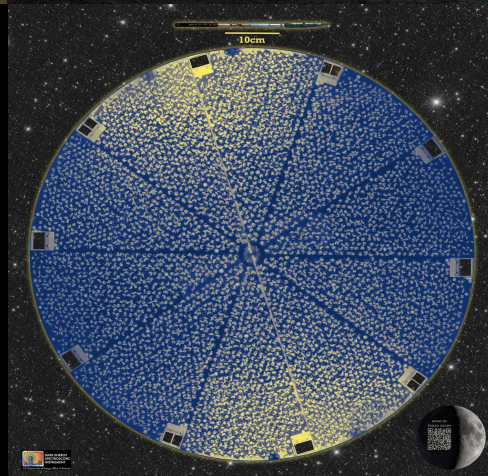
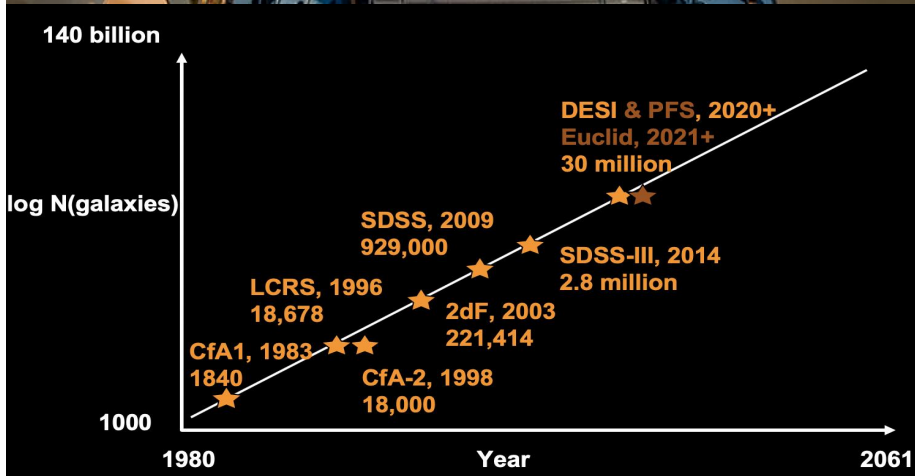
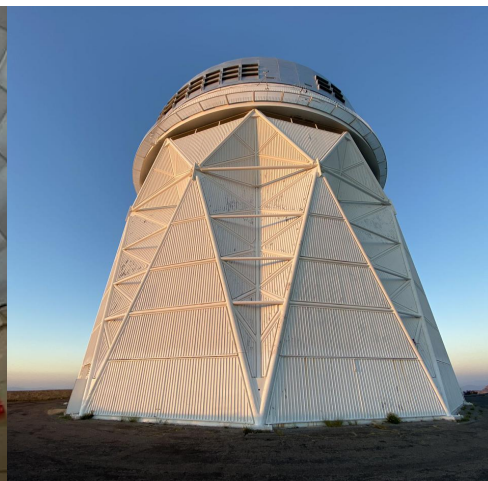
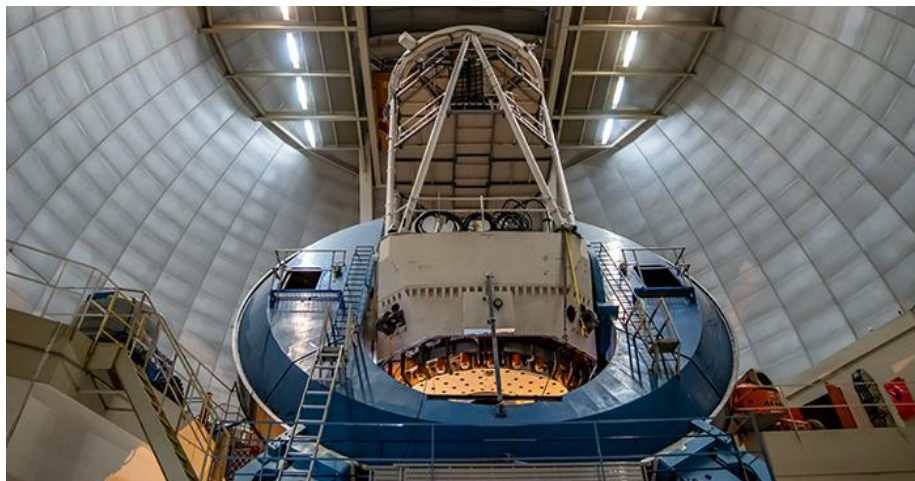
▶ DESI Survey and First Data Release

▶ CL-AGNs Research

▶ The CL-AGNs work in DESI

▶ Summary

# Dark Energy Spectroscopic Instrument (DESI)



Stage IV dark energy measurement

Supported by the Department of Energy  
Office of Science

Mayall 4-meter telescope at Kitt Peak  
National Observatory

5000 Eyes: Mapping the Universe

Tens of millions optical spectra of  
galaxies and quasars

Wavelength: Blue  $360 < \lambda \leq 555$  nm  
Resolution : Blue  $R = 2,000 \sim 3,200$

Red  $555 < \lambda \leq 656$  nm  
Red  $R = 3,200 \sim 4,100$

Infrared  $656 < \lambda \leq 980$  nm  
Infrared  $R = 4,100 \sim 5,000$



# Contents of Talk



▶ DESI Survey and First Data Release

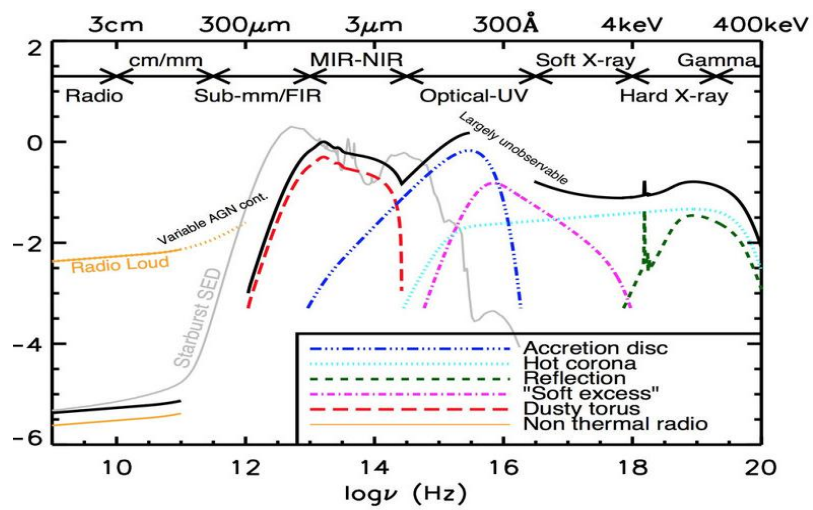
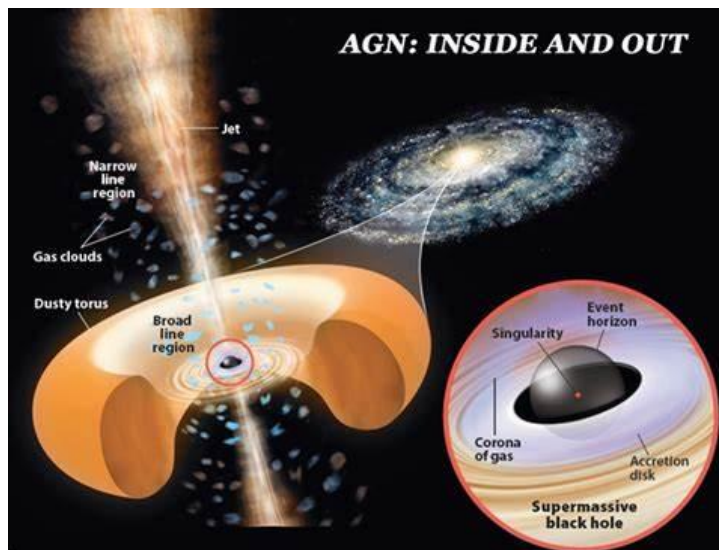
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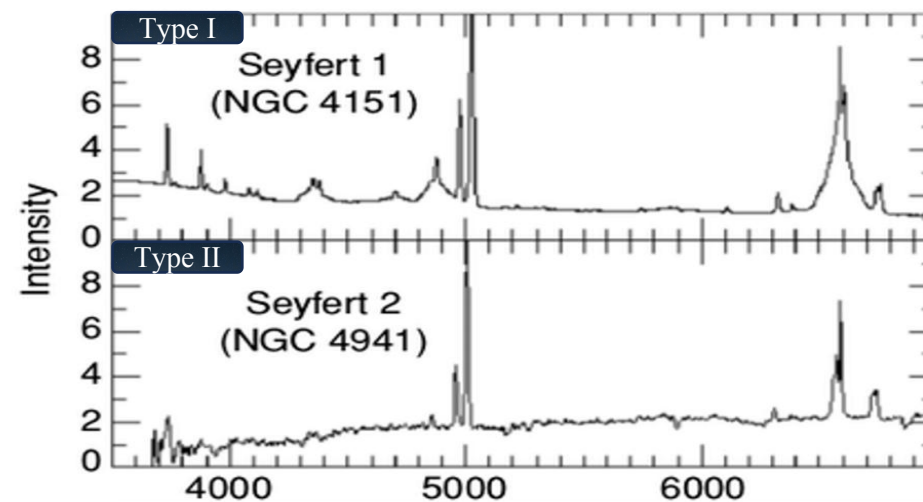
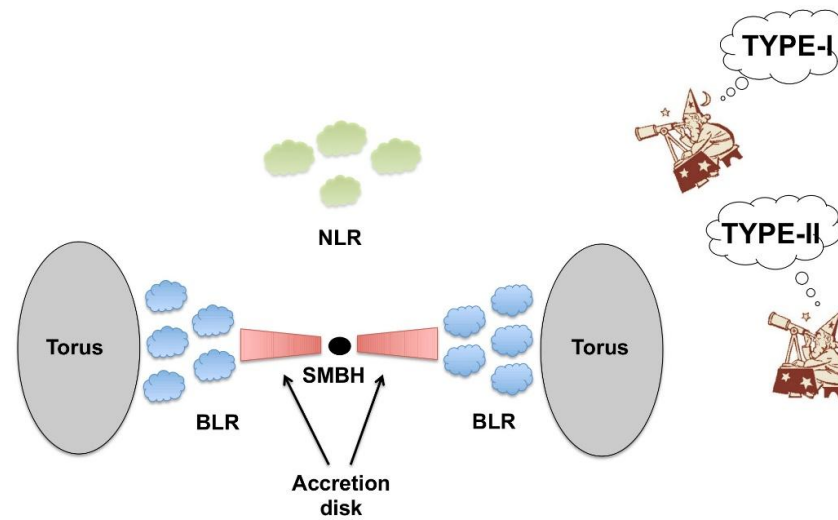
▶ Summary

# Active Galactic Nuclei

## Observation

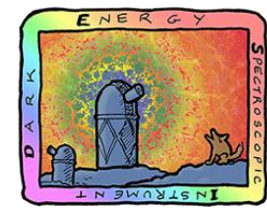


## Unification Paradigm





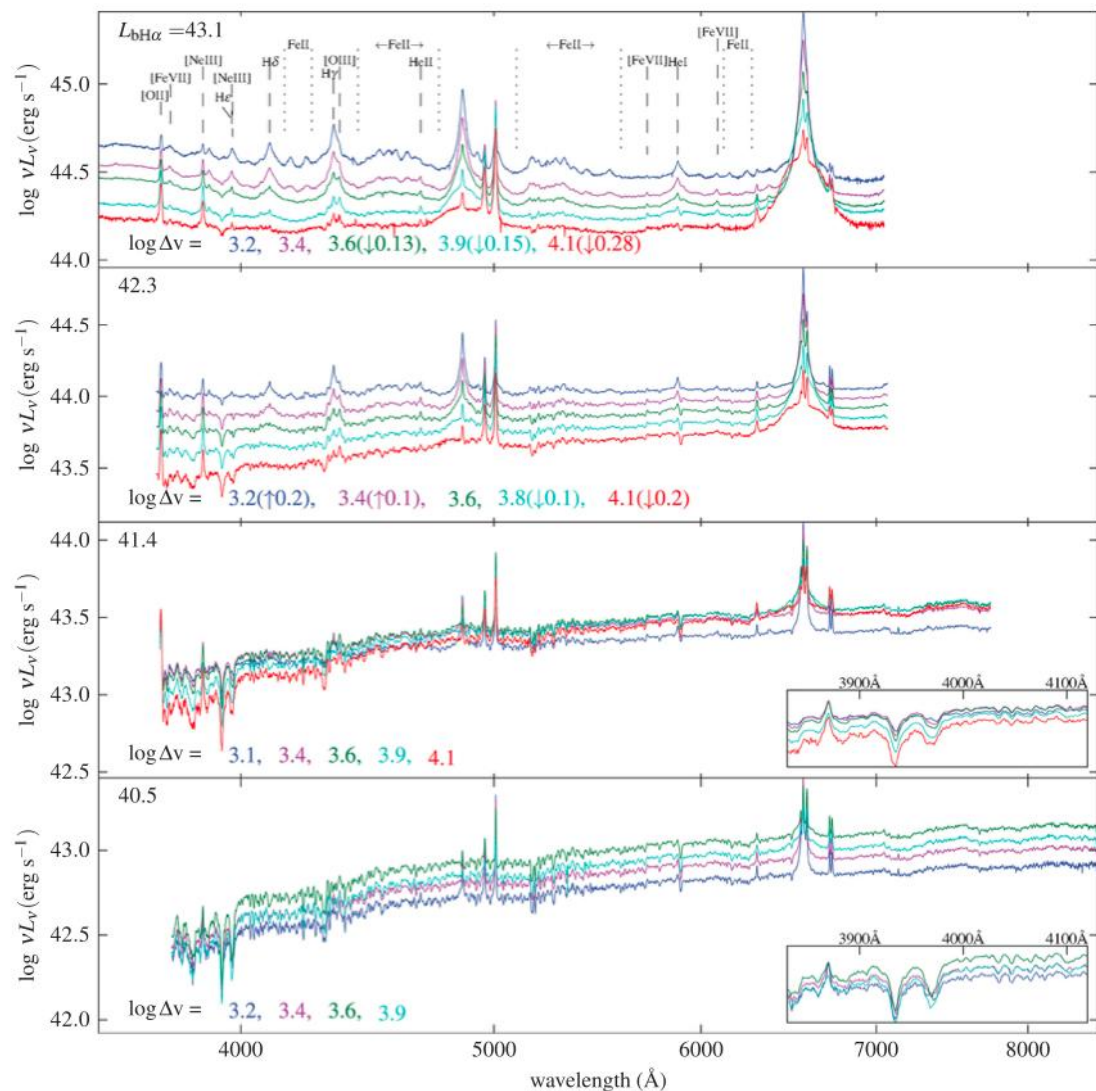
# AGN Evolution



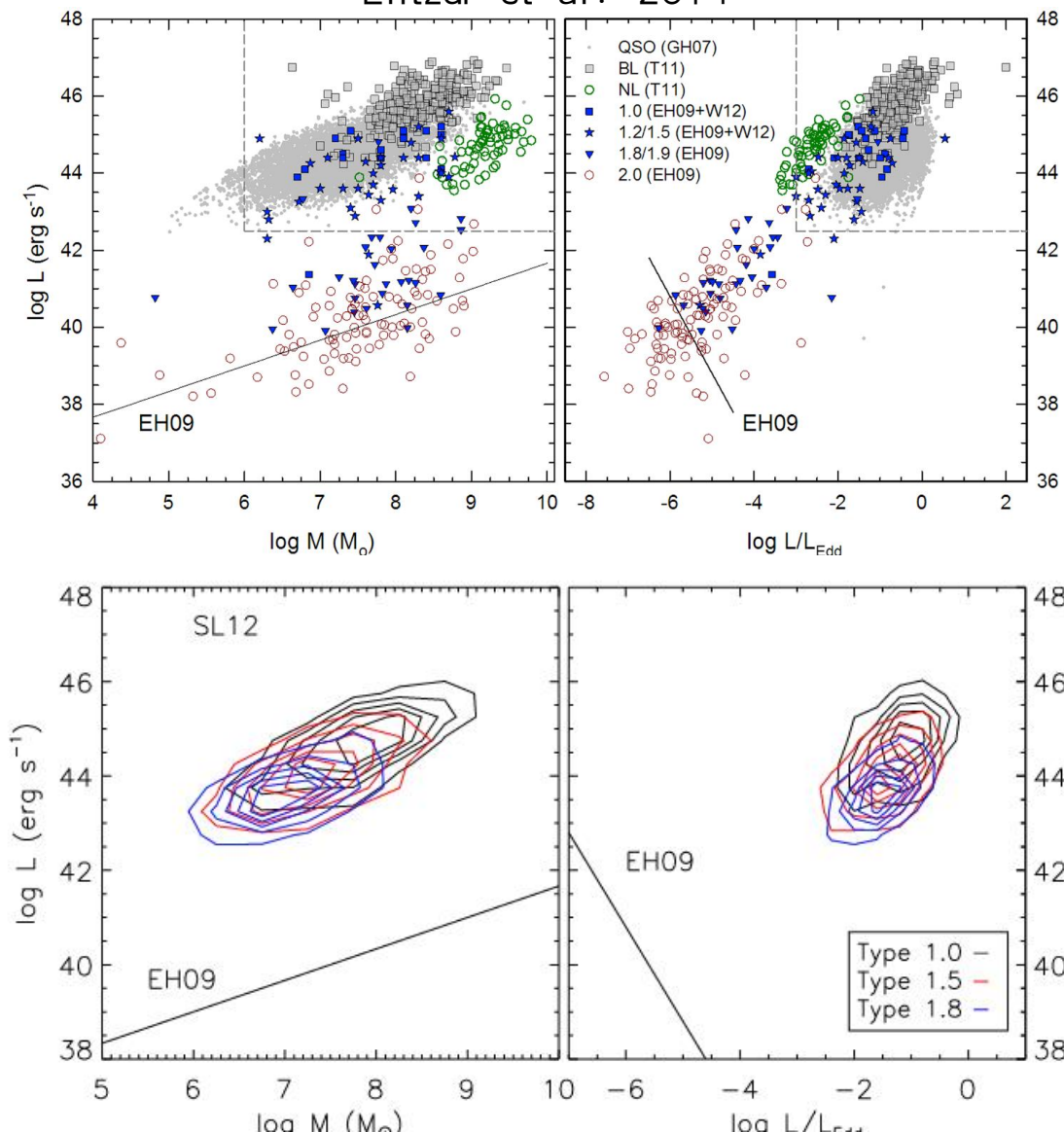
# Dark Energy Spectroscopic Instrument

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Stern &amp; Laor 2012



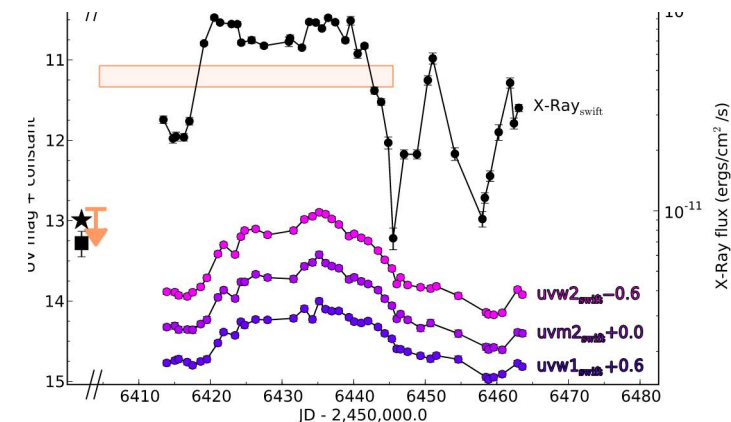
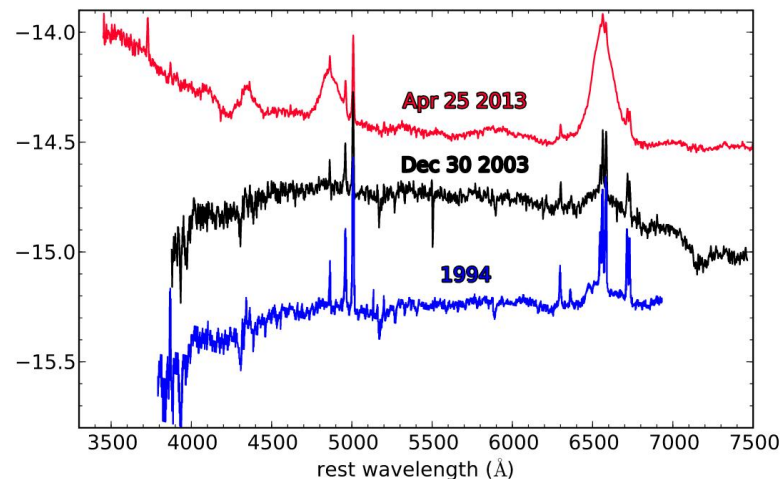
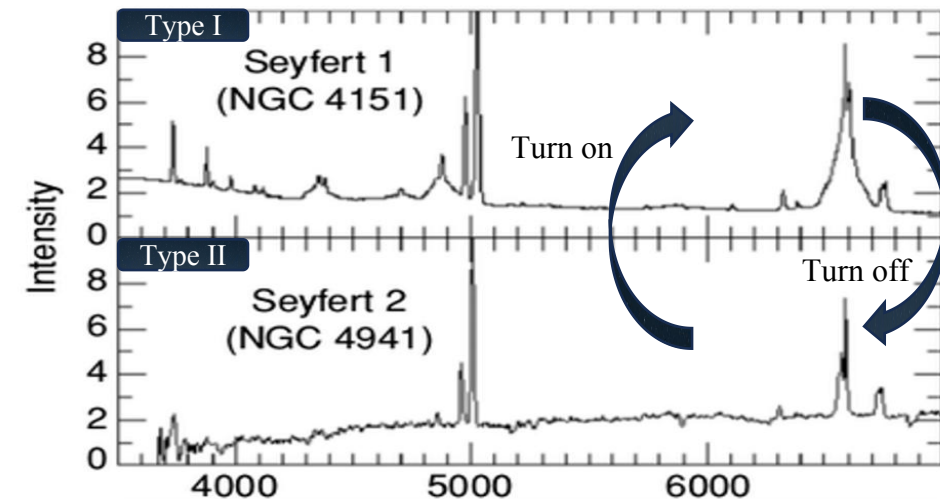
Elitzur et al. 2014



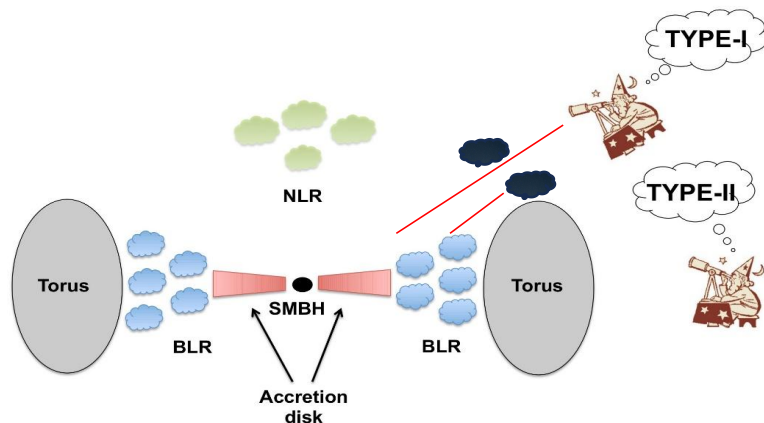
# Discover of the Changing-look AGN

View Angle

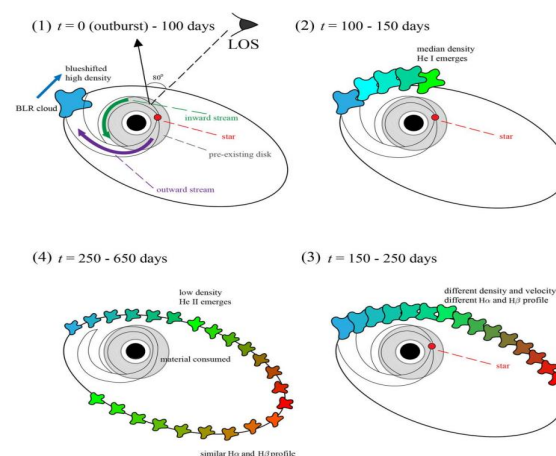
NGC 2617



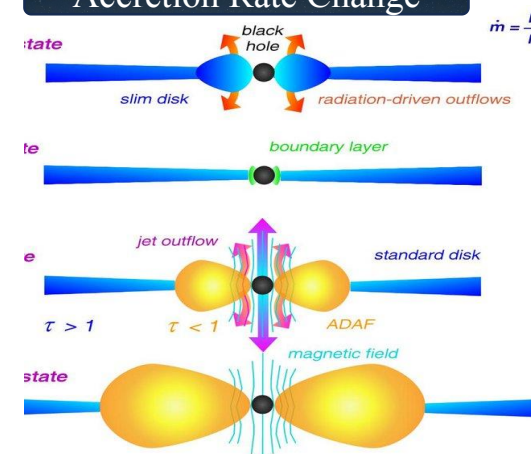
Obscured by Clouds



Tidal Disruption Event

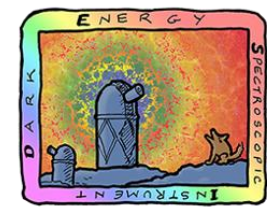


Accretion Rate Change





# DESI CL-AGN project (PI: Wei-Jian Guo)



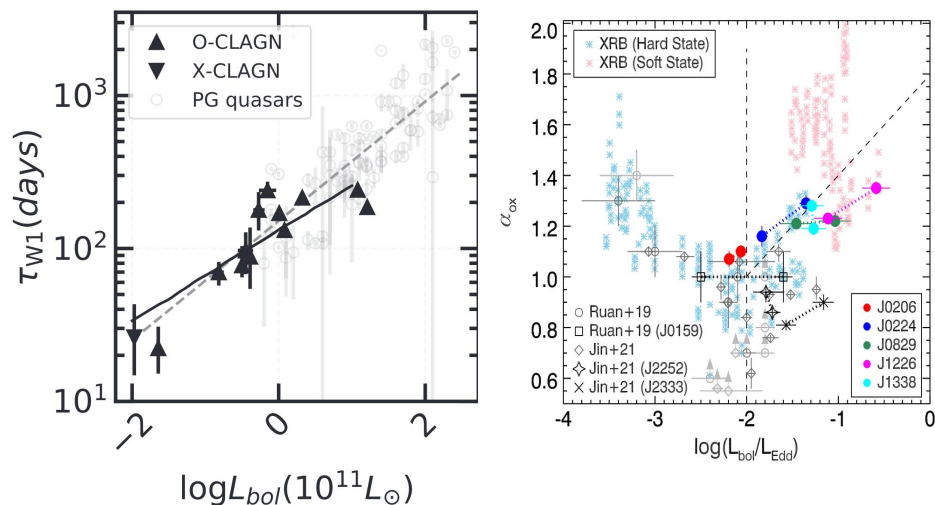
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Mid-Infrared characteristic and torus properties

Data: WISE

Leader: GREENWELL, CLAIRE L. (Durham)



Search for the CL-AGN,  
statistical analysis, SED for  
CL-AGN

DESI collaboration:

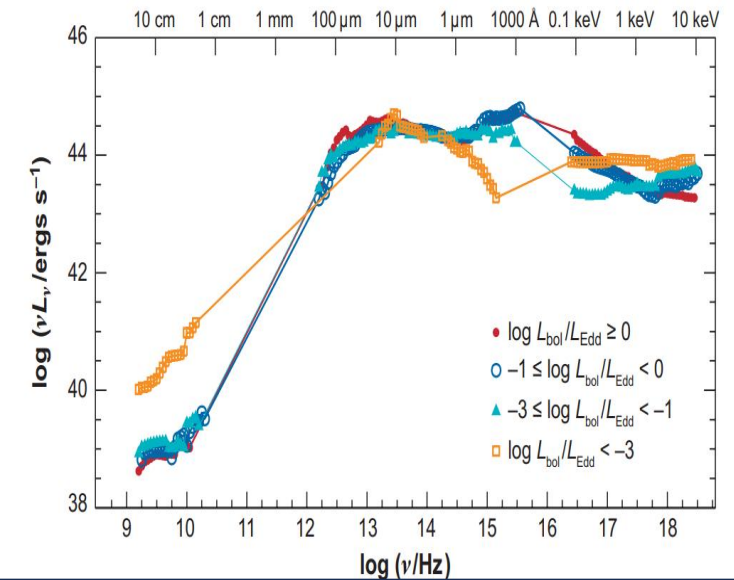
Wei-Jian Guo, David Alexander,  
Rahma Alfarsy, Rebecca Canning,  
Tamara Davis, Vicky Fawcett,  
Linhua Jiang, Claire Greenwell,  
Stephanie Juneau, John Moustakas,  
Zhiwei Pan, Ragadeepika Pucha,  
Małgorzata Siudek, Hu Zo

Radio characteristic

Data: FIRST and VLASS

Leader: Victoria Fawcett (Newcastle)

Zhi-qiang Cheng (NNU)



X-Ray characteristic

Data: eROSA and Einstein Probe

Leader: Huaqing Cheng (EP) Stephanie Juneau  
(Noirlab) Wei-Jian

Host galaxy characteristic

Data: DESI SDSS WISE

Leader: Junjie Jin (NAOC) Shengxiu Sun (PKU)  
Małgorzata Siudek (IFAS)



# Contents of Talk



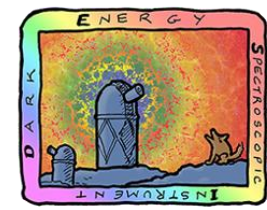
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# CL-AGN Selection

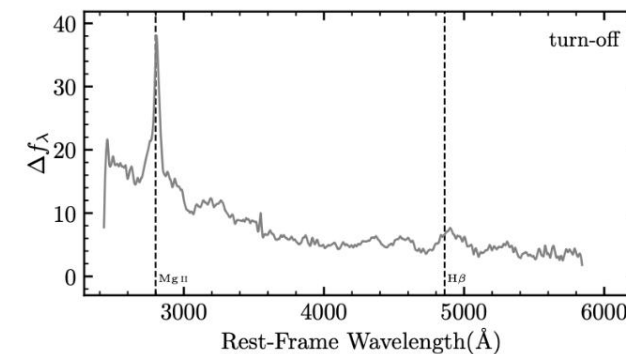
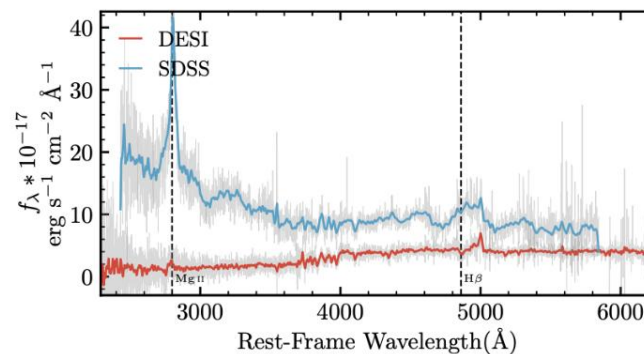
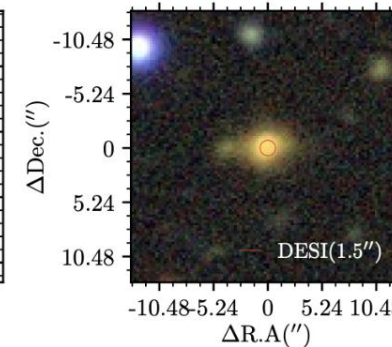
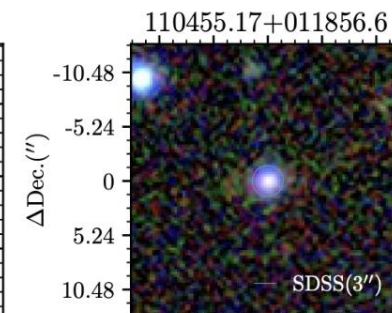
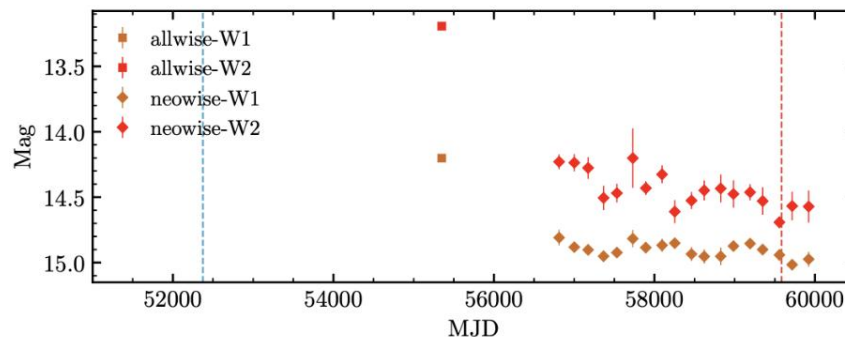
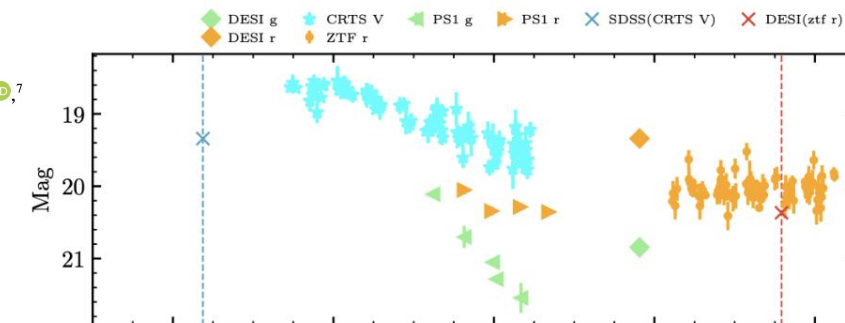
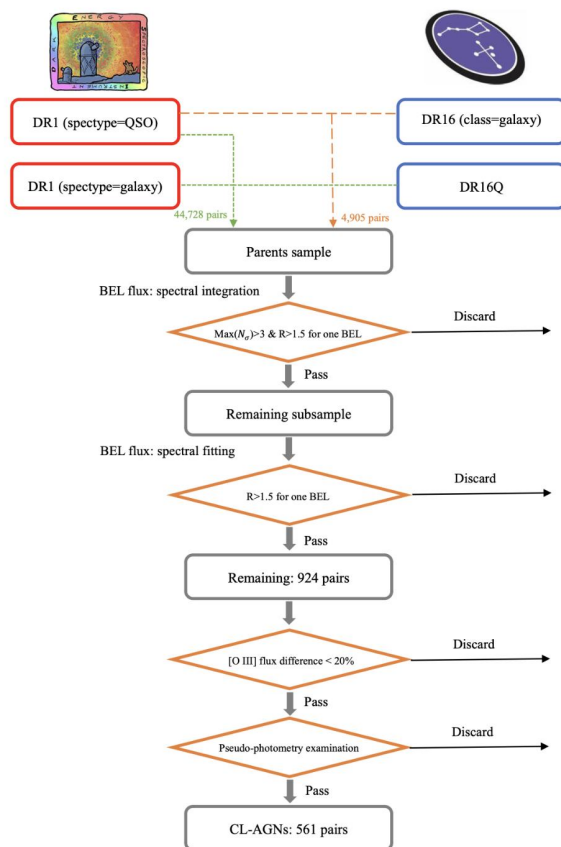


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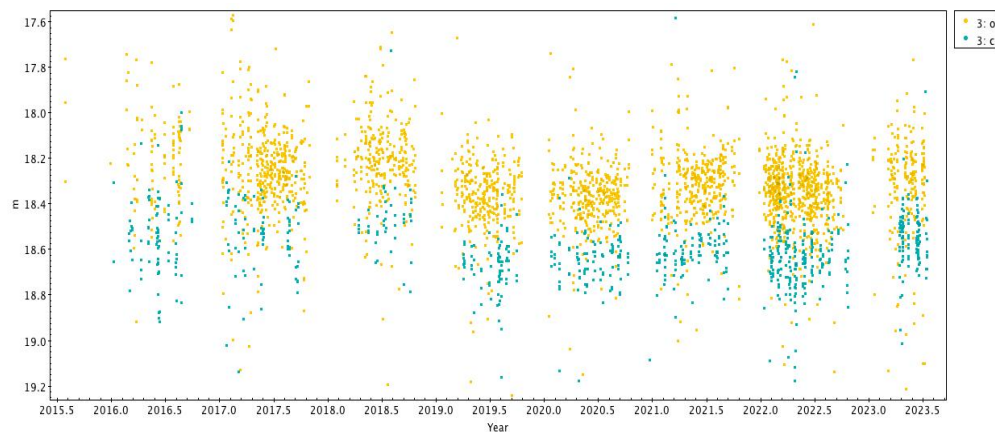
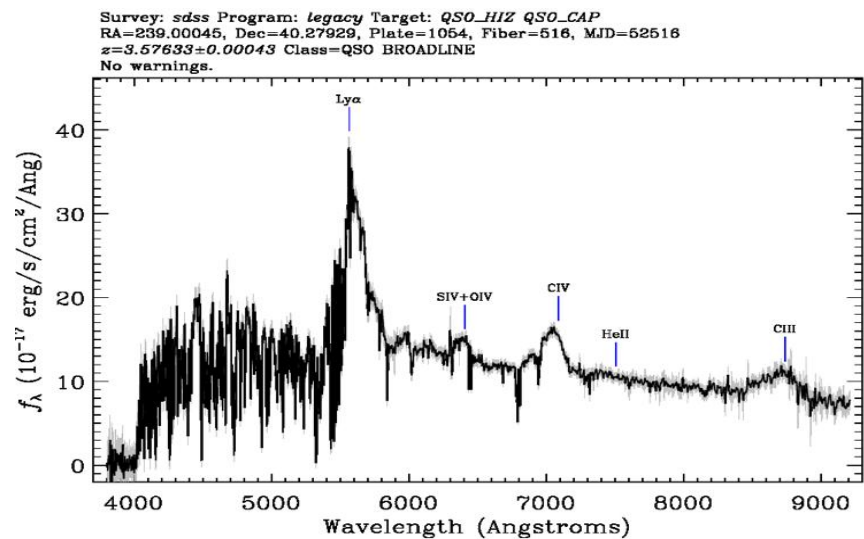
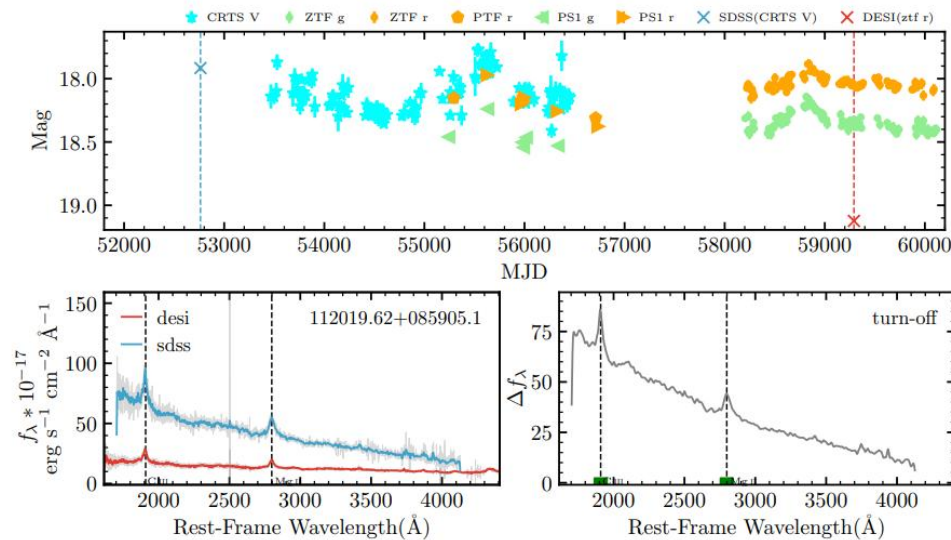
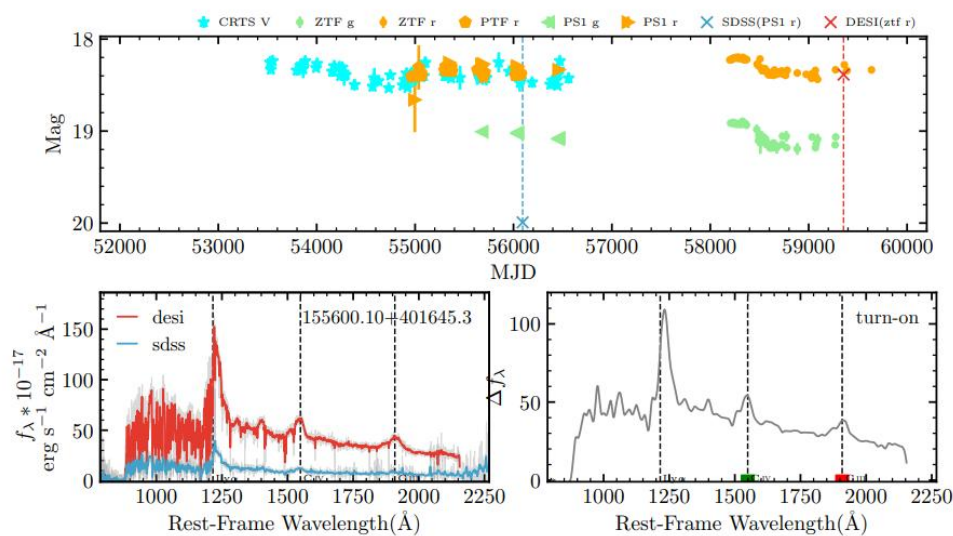
## Changing-look Active Galactic Nuclei from the Dark Energy Spectroscopic Instrument. II. Statistical Properties from the First Data Release

WEI-JIAN GUO<sup>1</sup>, HU ZOU<sup>1</sup>, CLAIRE L. GREENWELL<sup>2</sup>, DAVID M. ALEXANDER<sup>3,2</sup>, VICTORIA A. FAWCETT<sup>4</sup>,  
ZHIWEI PAN<sup>5</sup>, MAŁGORZATA SIUDEK<sup>6</sup>, JESSICA NICOLE AGUILAR<sup>7</sup>, STEVEN AHLEN<sup>8</sup>, DAVID BROOKS<sup>9</sup>,  
TODD CLAYBAUGH<sup>7</sup>, KYLE DAWSON<sup>10</sup>, AXEL DE LA MACORRA<sup>11</sup>, PETER DOEL<sup>9</sup>, ANDREU FONT-RIBERA<sup>9,12</sup>,  
ENRIQUE GAZTAÑAGA<sup>13,14,6</sup>, SATYA GONTCHO A GONTCHO<sup>15</sup>, GASTON GUTIERREZ<sup>15</sup>, ROBERT KEHOE<sup>16</sup>, THEODORE KISNER<sup>17</sup>,  
MARTIN LANDRIAU<sup>18,12</sup>, LAURENT LE GUILLOU<sup>17</sup>, MARC MANERA<sup>18,12</sup>, AARON MEISNER<sup>19</sup>, RAMON MIQUEL<sup>20,12</sup>,  
JOHN MOUSTAKAS<sup>21</sup>, FRANCISCO PRADA<sup>22</sup>, GRAZIANO ROSSI<sup>23</sup>, EUSEBIO SANCHEZ<sup>24</sup>, MICHAEL SCHUBNEL<sup>25,26</sup>,  
DAVID SPRAYBERRY<sup>19</sup>, JIPENG SUI<sup>27</sup>, GREGORY TARLÉ<sup>26</sup>, BENJAMIN ALAN WEAVER<sup>19</sup>, YUN-AO XIAO<sup>27</sup> AND  
SIWEI ZOU<sup>28,29</sup>

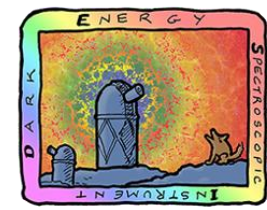




# Data:SDSS Fiber Drop!

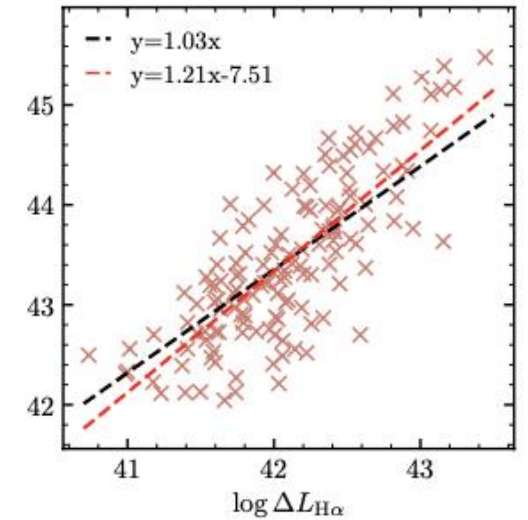
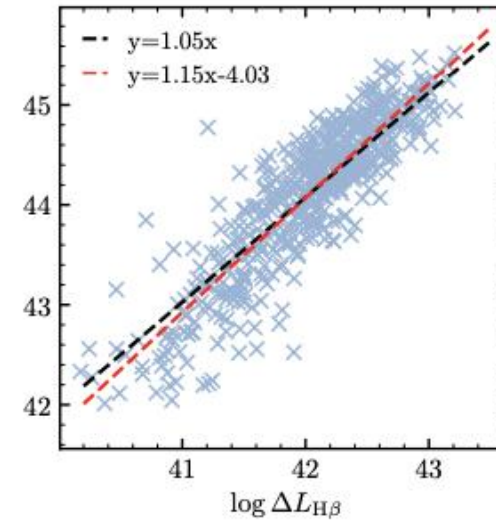
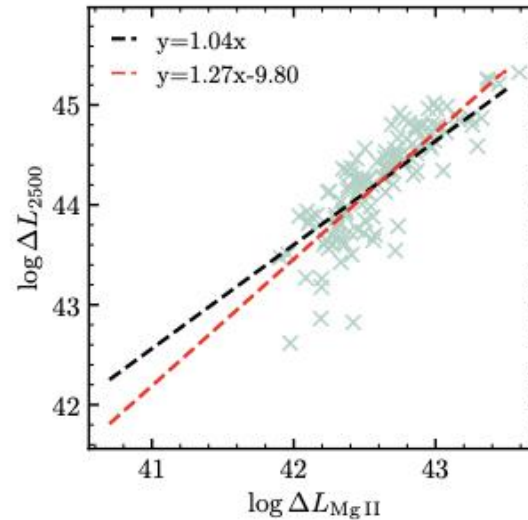
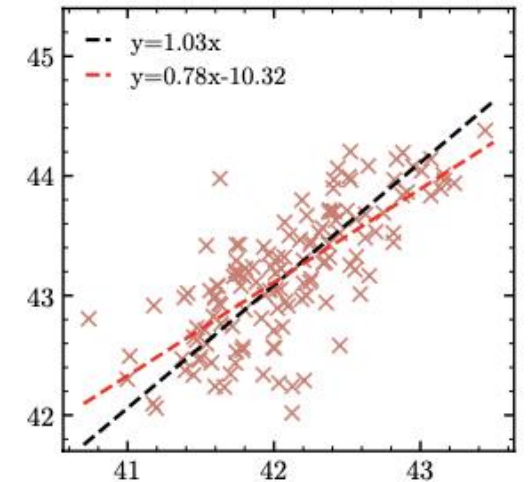
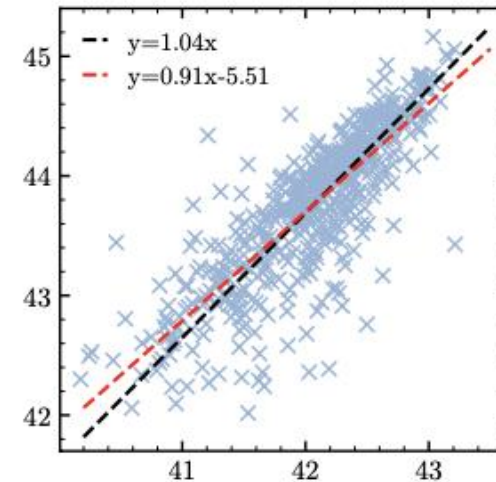
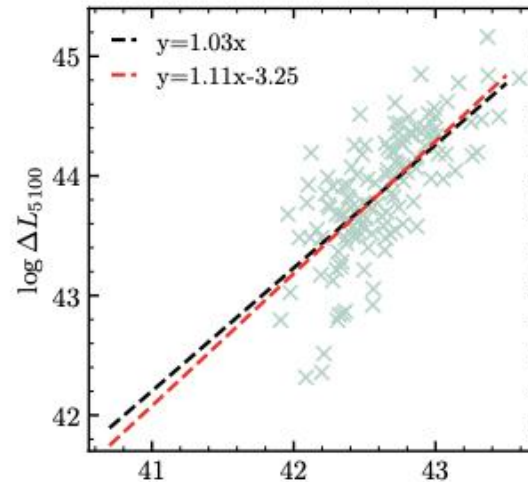
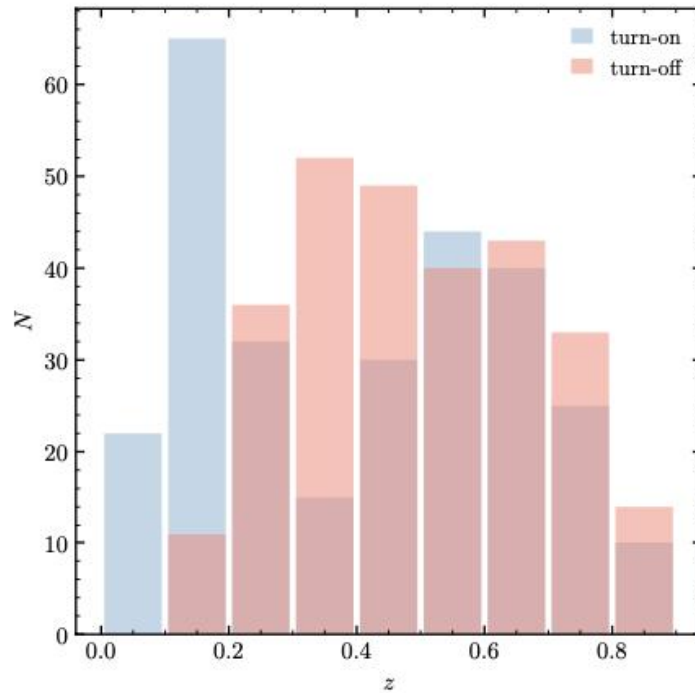


# Statistical Results: basic behaviours



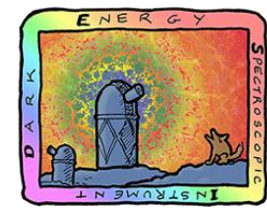
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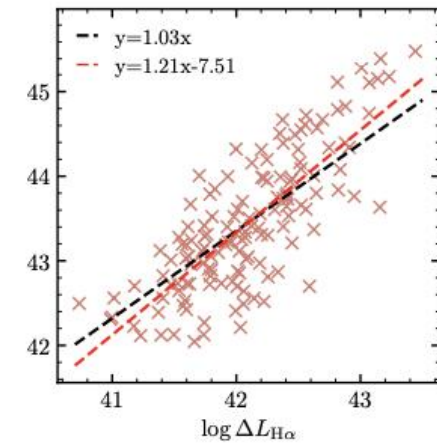
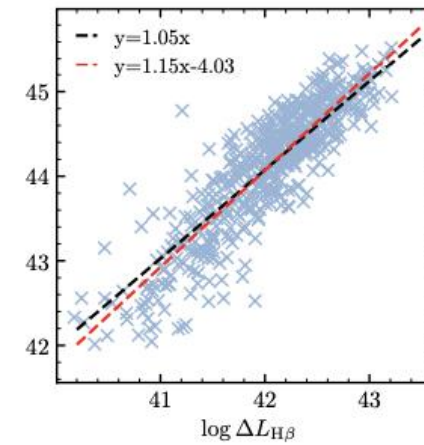
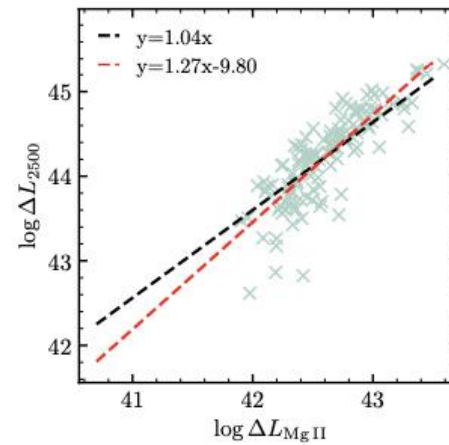
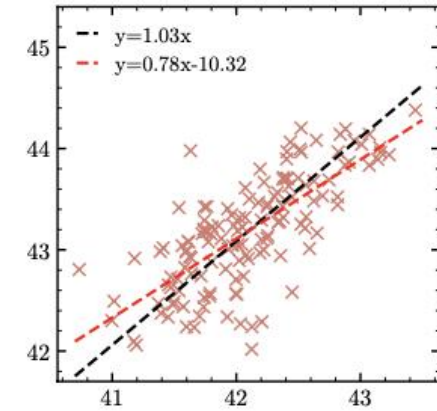
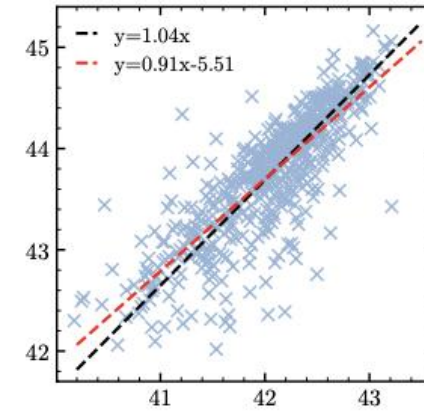
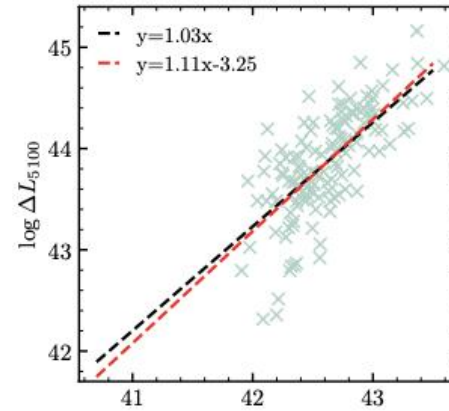
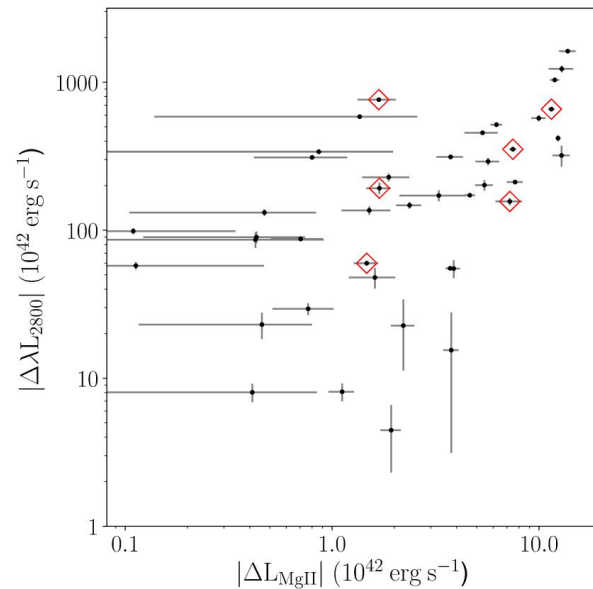
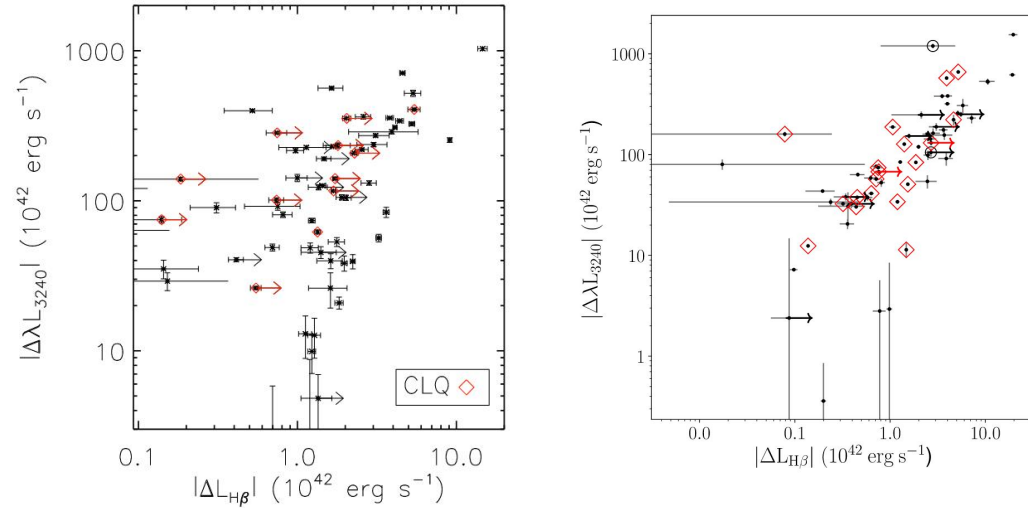


# Statistical Results: Broad Emission lines

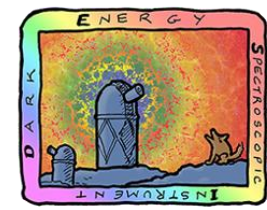


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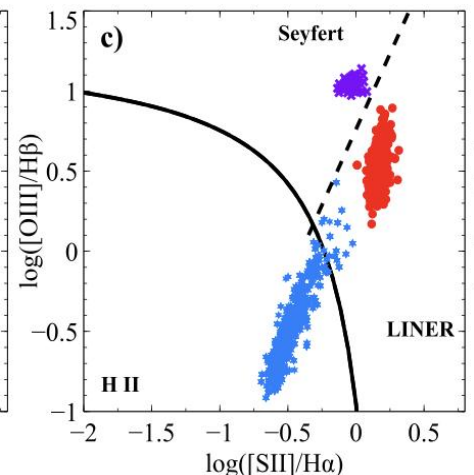
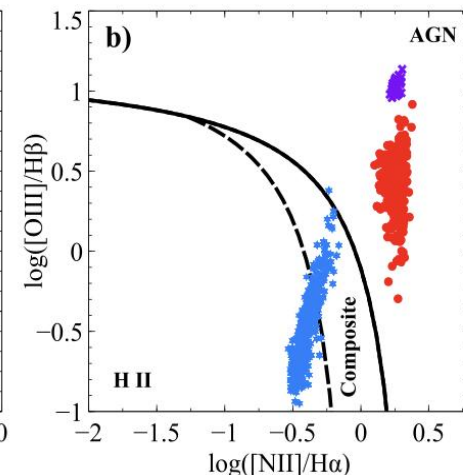
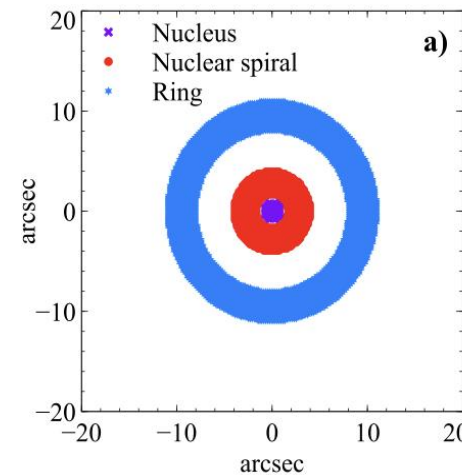
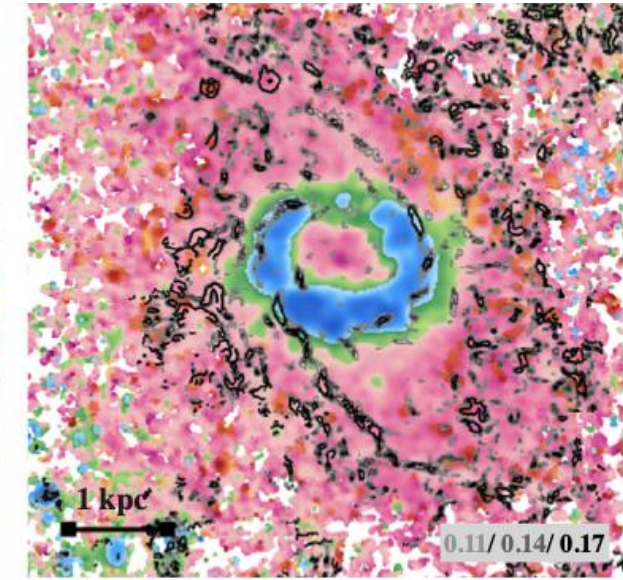
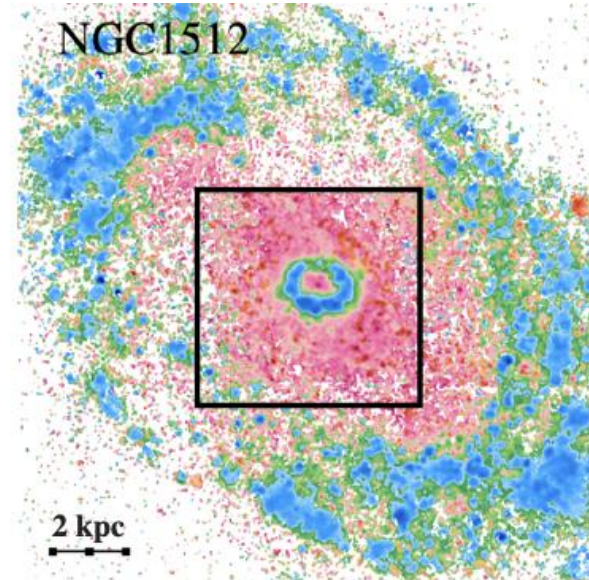
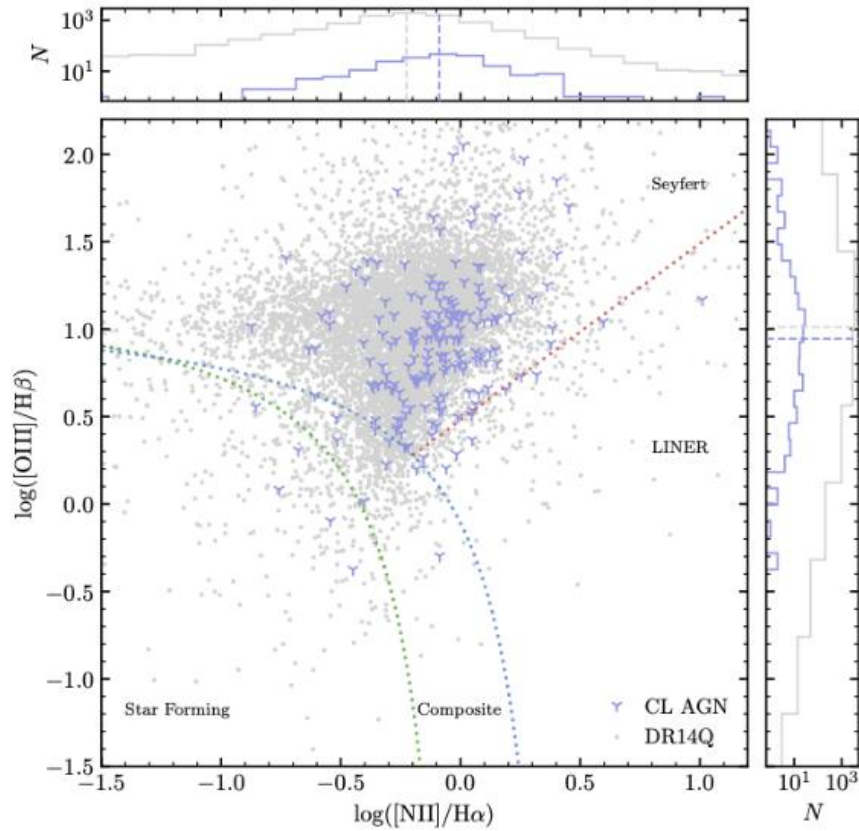


# Statistical Results: BPT



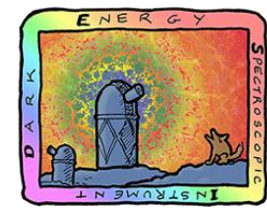
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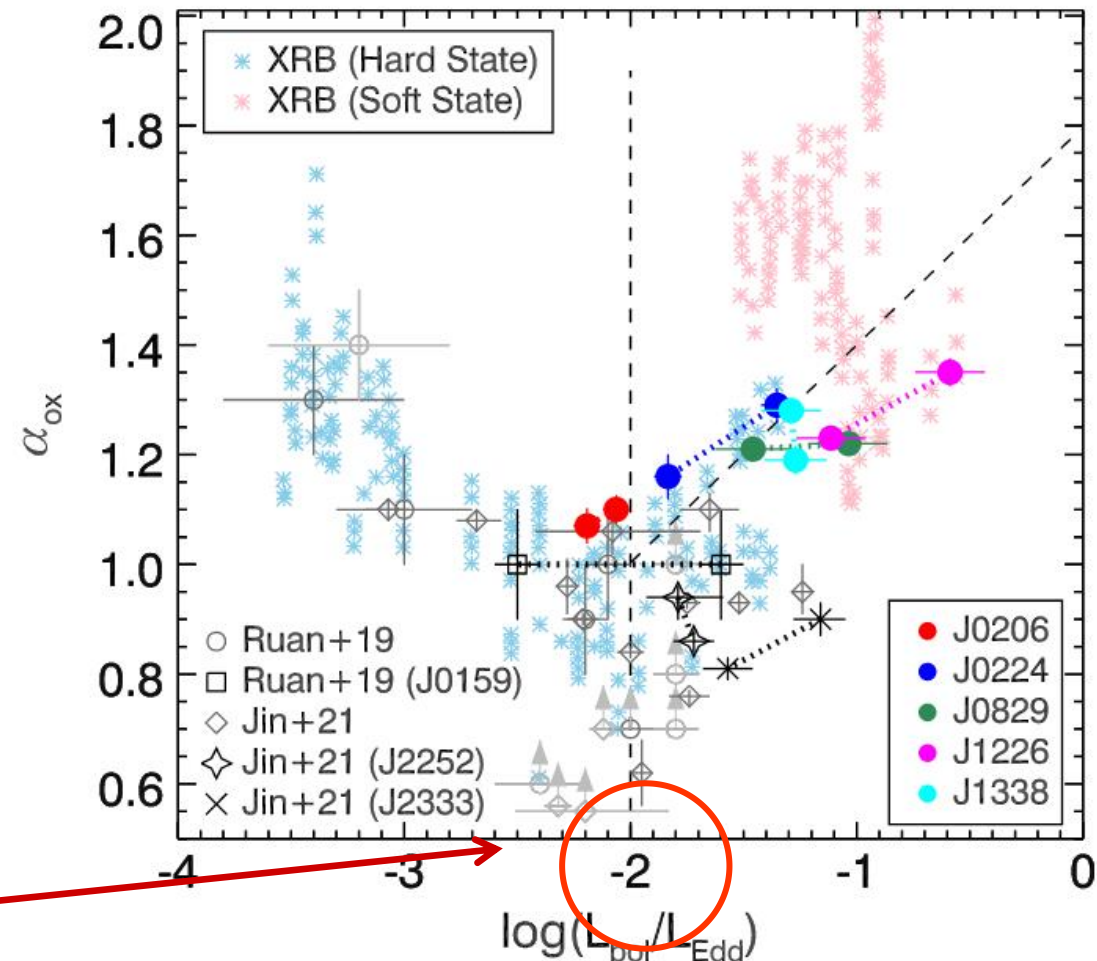
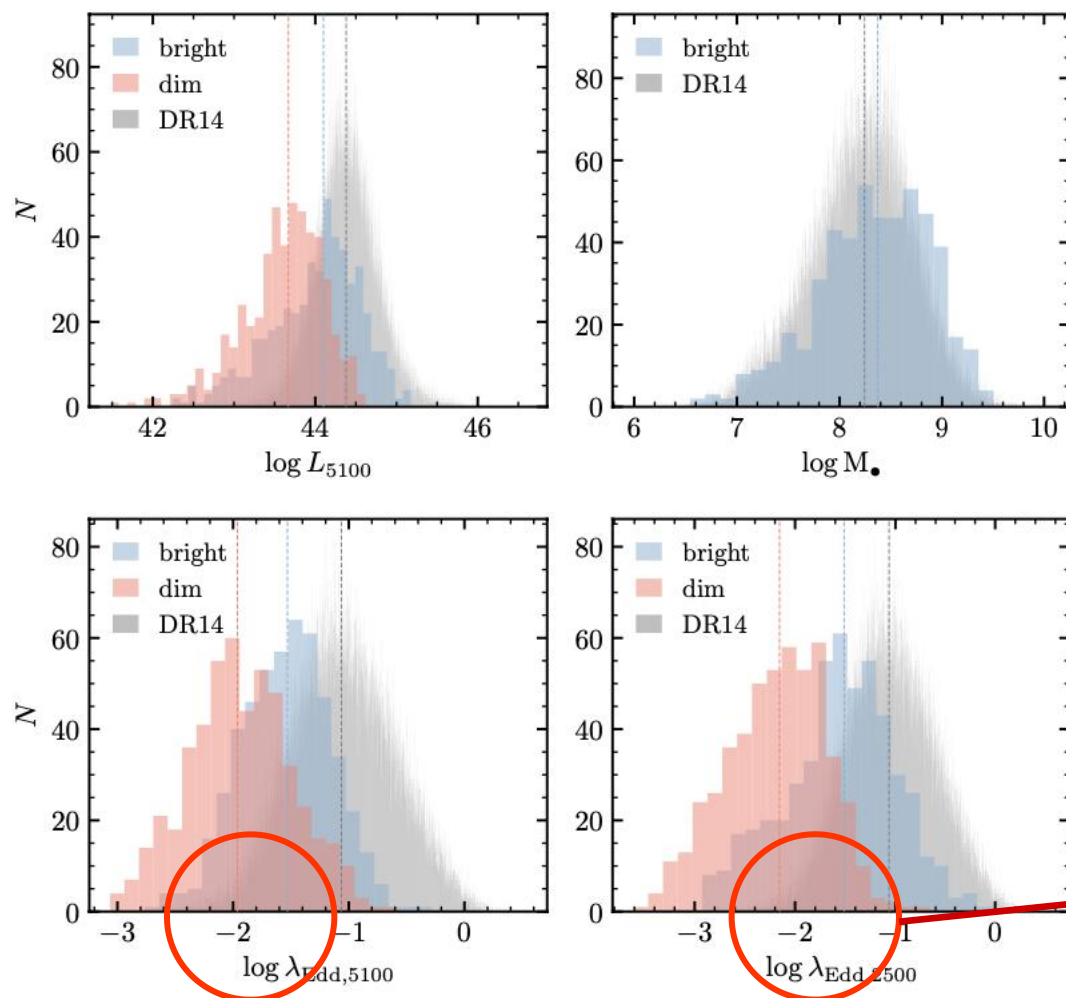


# Statistical Results: Physical Properties

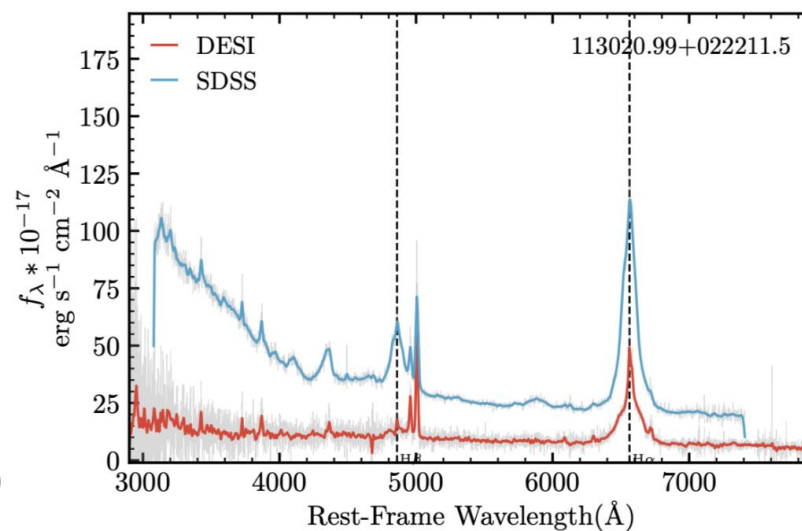
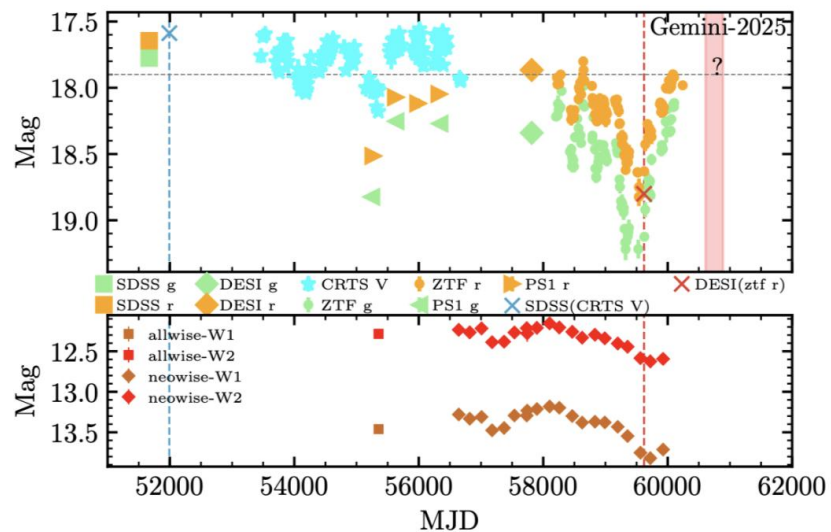
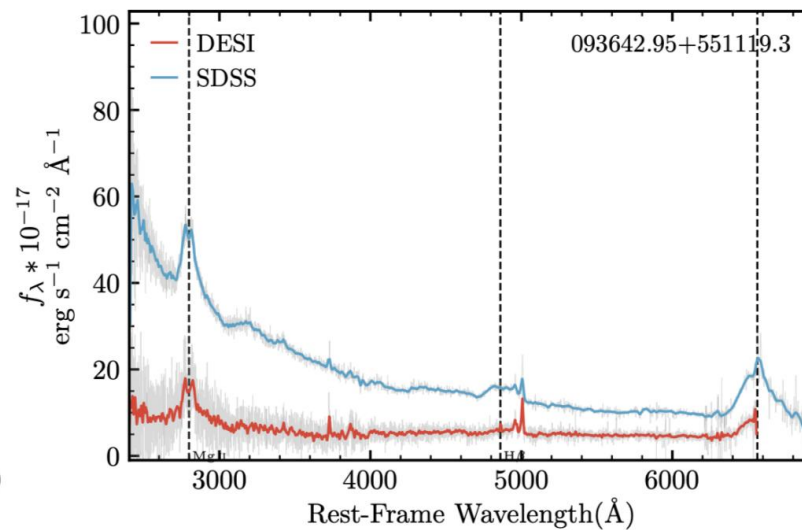
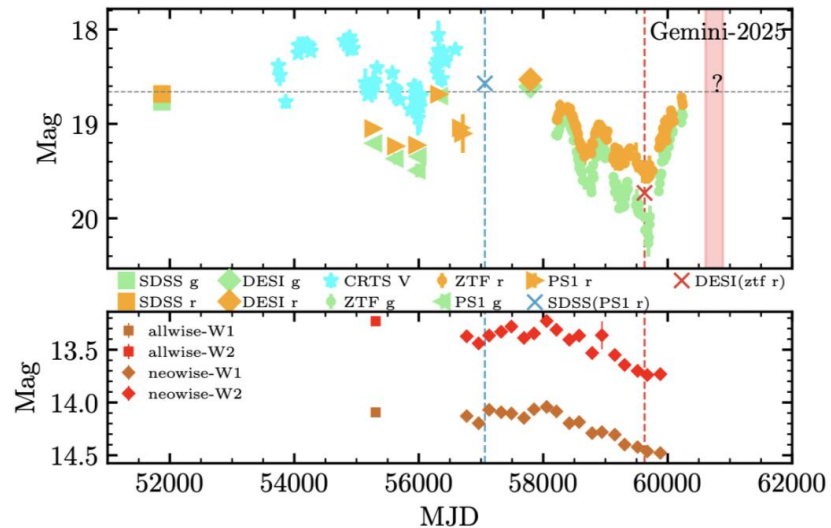


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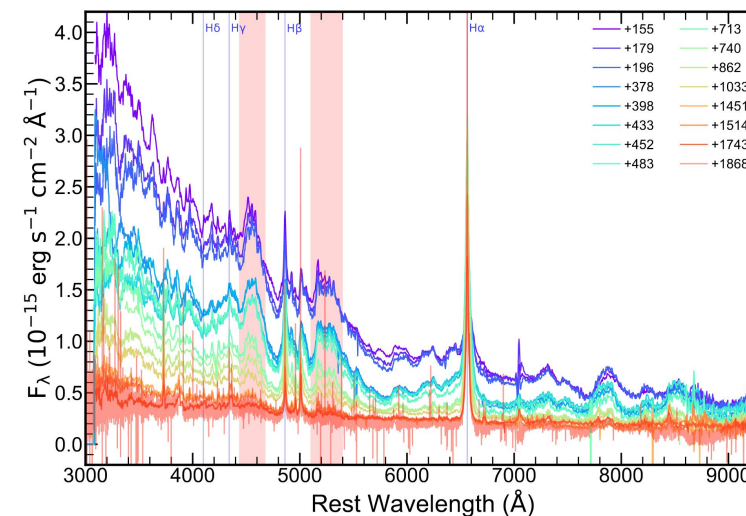
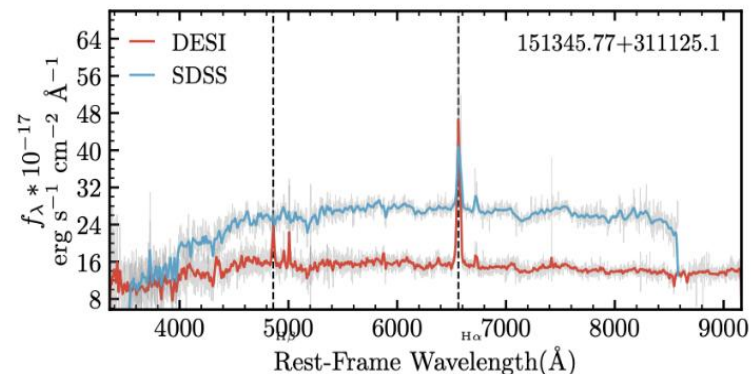
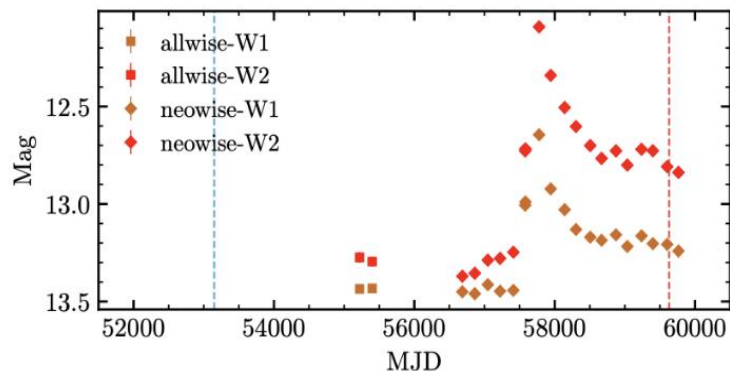
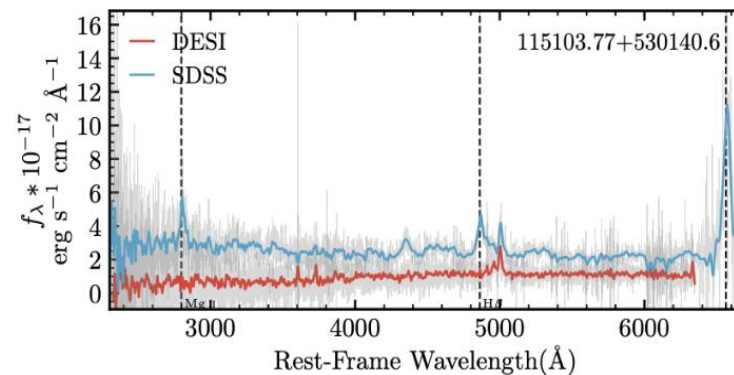
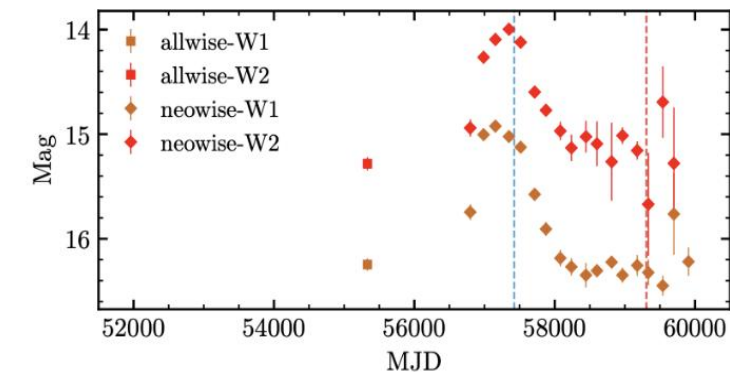
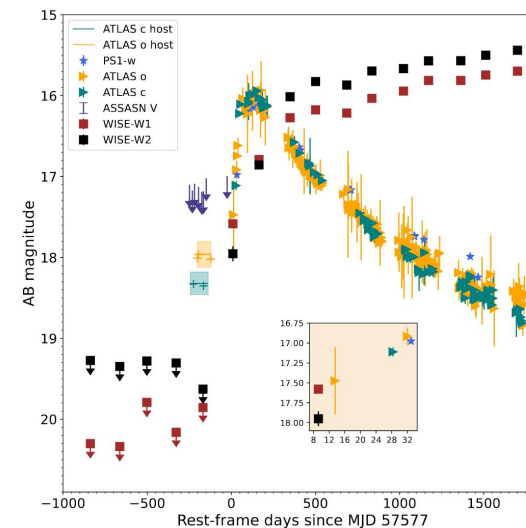
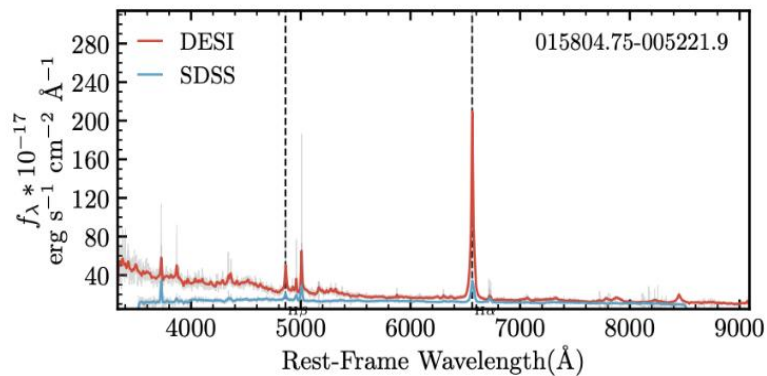
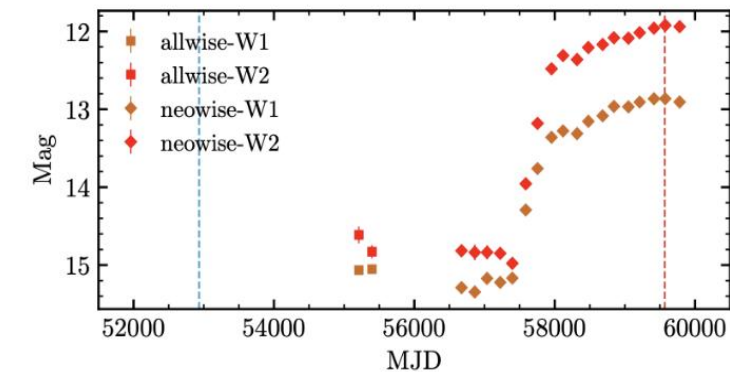


# New Class: Recurring CL

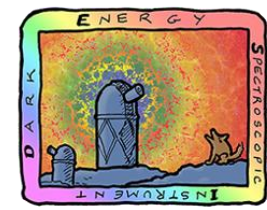




# New Class: TDE-like flare

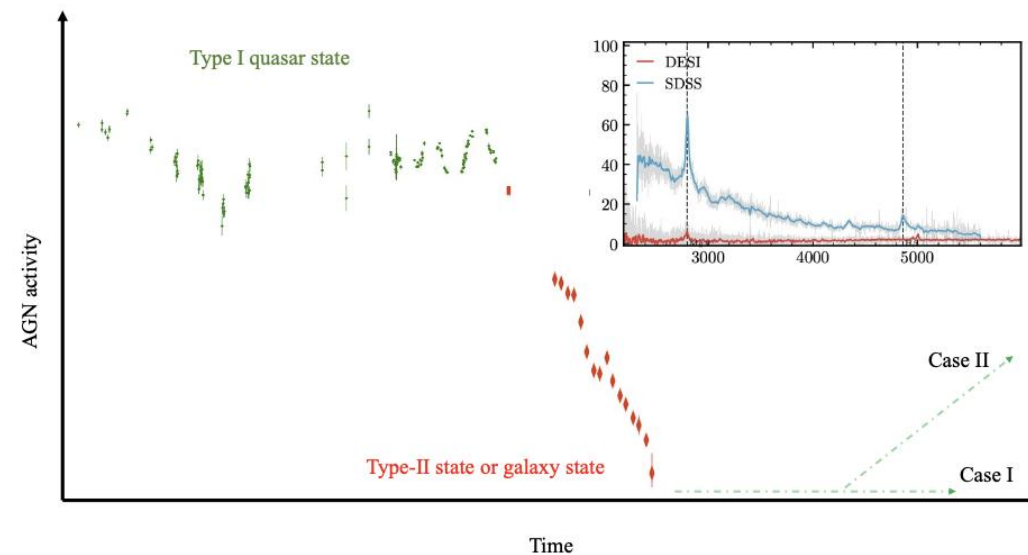
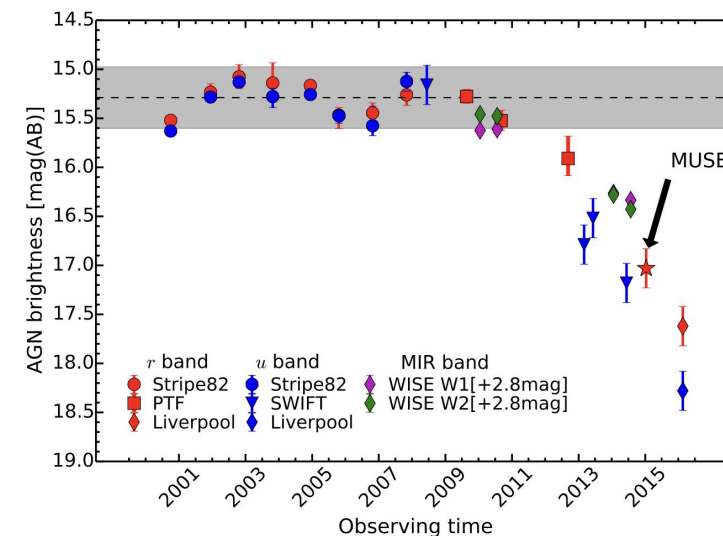
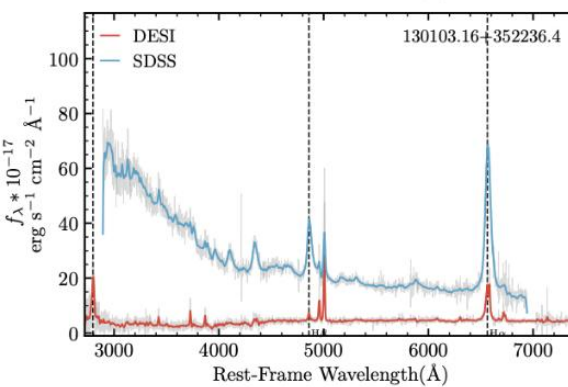
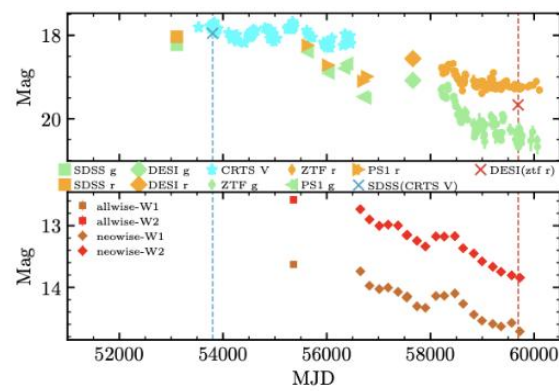
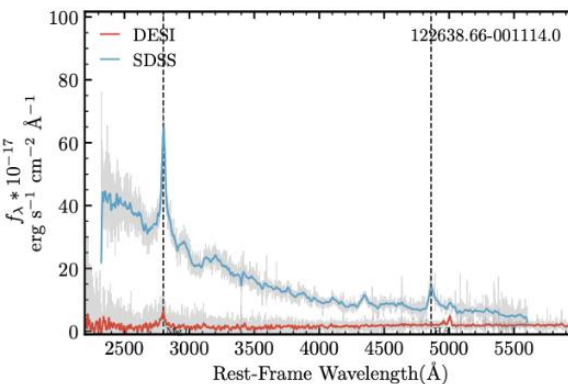
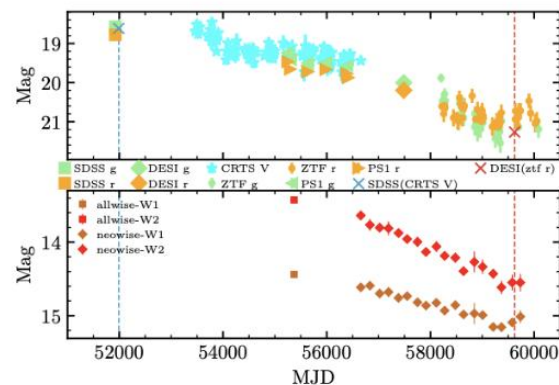
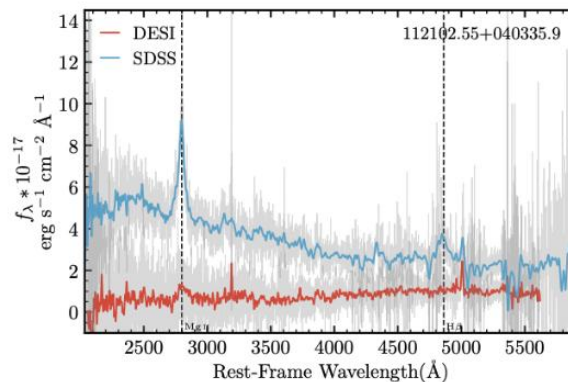
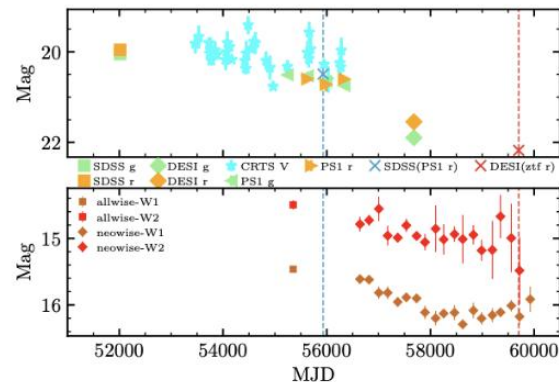


# New Class: Peculiar Changing-look



Dark Energy  
Spectroscopic  
Instrument

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# New Classification and physical mechanism

New classification (internal or external)

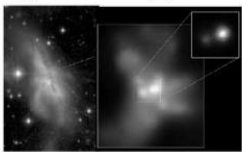
- 1) Intrinsic variability accretion change vs. obscuration
- 2) flare or temporary AGN
- 3) external physical mechanism (Tidal disrupt events, SMBH binary, stellar BH binary in the accretion disk etc.)

(c) Interaction/"Merger"



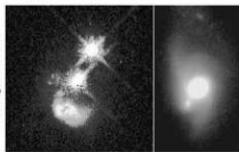
- now within one halo, galaxies interact & lose angular momentum
- SFR starts to increase
- stellar winds dominate feedback
- rarely excite QSOs (only special orbits)

(d) Coalescence/(U)LIRG



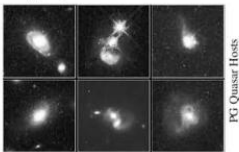
- galaxies coalesce: violent relaxation in core
- gas inflows to center: starburst & buried (X-ray) AGN
- starburst dominates luminosity/feedback, but, total stellar mass formed is small

(e) "Blowout"



- BH grows rapidly: briefly dominates luminosity/feedback
- remaining dust/gas expelled
- get reddened (but not Type II) QSO: recent/ongoing SF in host
- high Eddington ratios
- merger signatures still visible

(f) Quasar



- dust removed: now a "traditional" QSO
- host morphology difficult to observe: tidal features fade rapidly
- characteristically blue/young spheroid

(b) "Small Group"

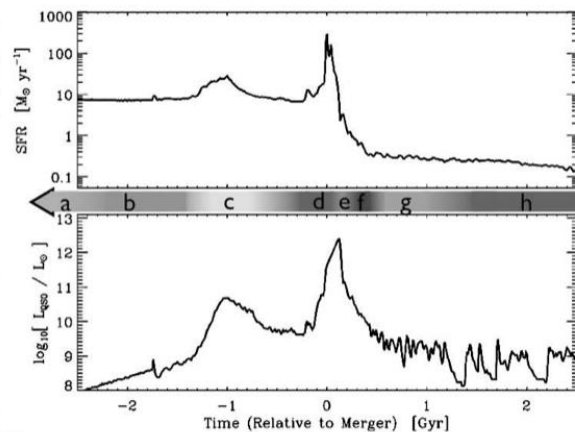


- halo accretes similar-mass companion(s)
- can occur over a wide mass range
- $M_{\text{halo}}$  still similar to before: dynamical friction merges the subhalos efficiently

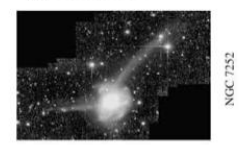
(a) Isolated Disk



- halo & disk grow, most stars formed
- secular growth builds bars & pseudobulges
- "Seyfert" fueling (AGN with  $M_{\text{BH}} > 23$ )
- cannot redden to the red sequence



(g) Decay/K+A

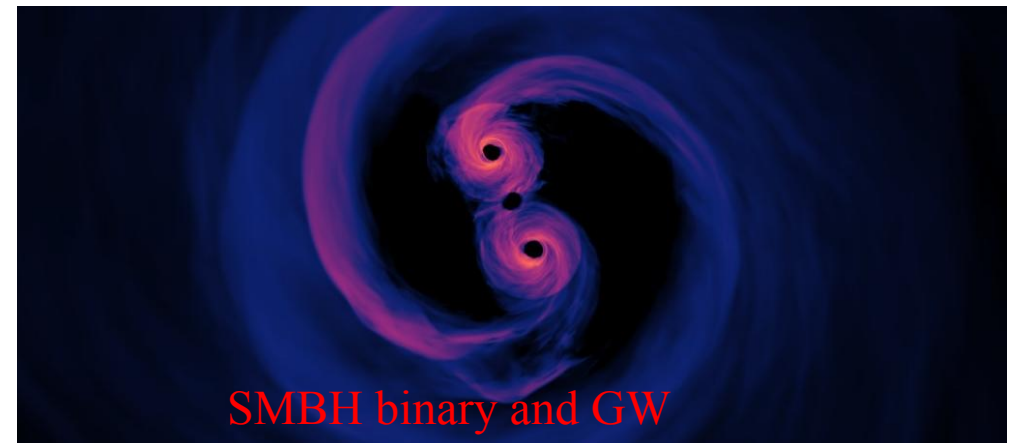
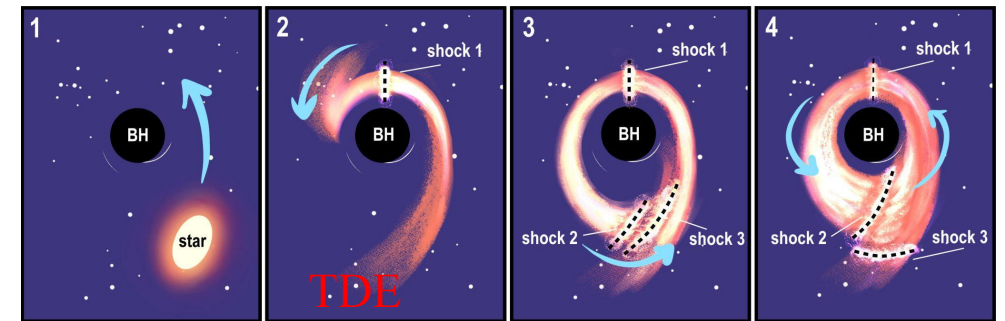


- QSO luminosity fades rapidly
- tidal features visible only with very deep observations
- remnant reddens rapidly (E+A/K+A)
- "hot halo" from feedback
- sets up quasi-static cooling

(h) "Dead" Elliptical



- star formation terminated
- large BH/spheroid - efficient feedback
- halo grows to "large group" scales: mergers become inefficient
- growth by "dry" mergers



SMBH binary and GW

# Contents of Talk

▶ DESI Survey and First Data Release

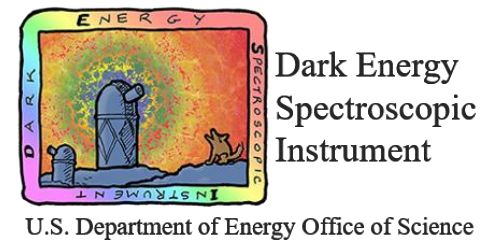
▶ CL-AGNs Research

▶ The CL-AGNs work in DESI

▶ Summary



# Summary



## Summary:

- 1: We build the largest CL-AGN sample with less bias (561 objects), and provide statistical results.**
- 2: We give a new classification on the CL-AGN (internal or external)**
- 3: There are too many peculiar objects worthy to studying in detail.**

## Prospect:

- 1: A special analysis would be conducted on CL-AGN with TDE-like flare**
- 2: The carried out work on multi-wavelength studies could uncover mistory of the physical mechnism**
- 3: We are looking forwad to find more CL-AGNs.**

Thank you!