Detection of emission gas located between the broad and narrow emission line region in active galactic nuclei

Zhenzhen Li (李臻臻)
Shanghai Astronomical Observatory

Collaborators: Lei Hao (SHAO)，Hongyan Zhou (USTC)

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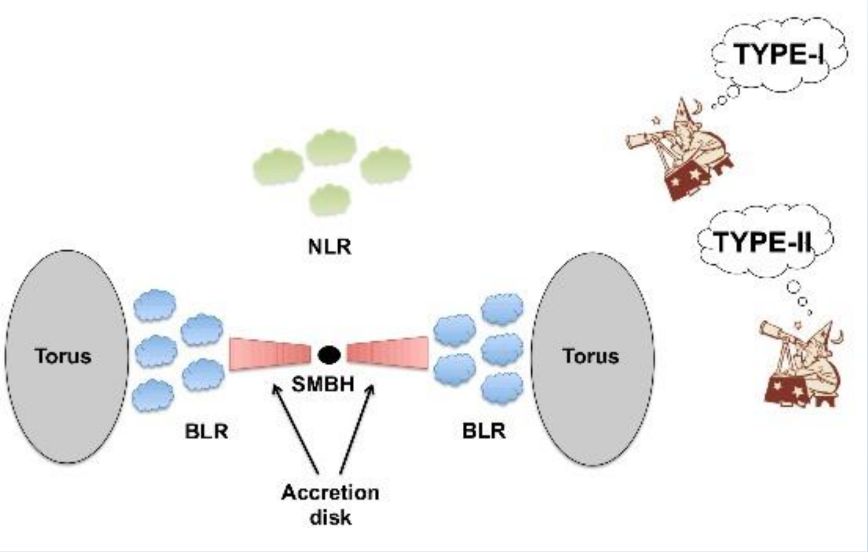
Emission line regions in AGNs



Broad emission lines Region (BELR)

Small size : ~0.1 pc

High velocity : ~5000 km/s

High density : ~10^9-10^{13} cm^{-3}

Narrow emission lines region (NELR)

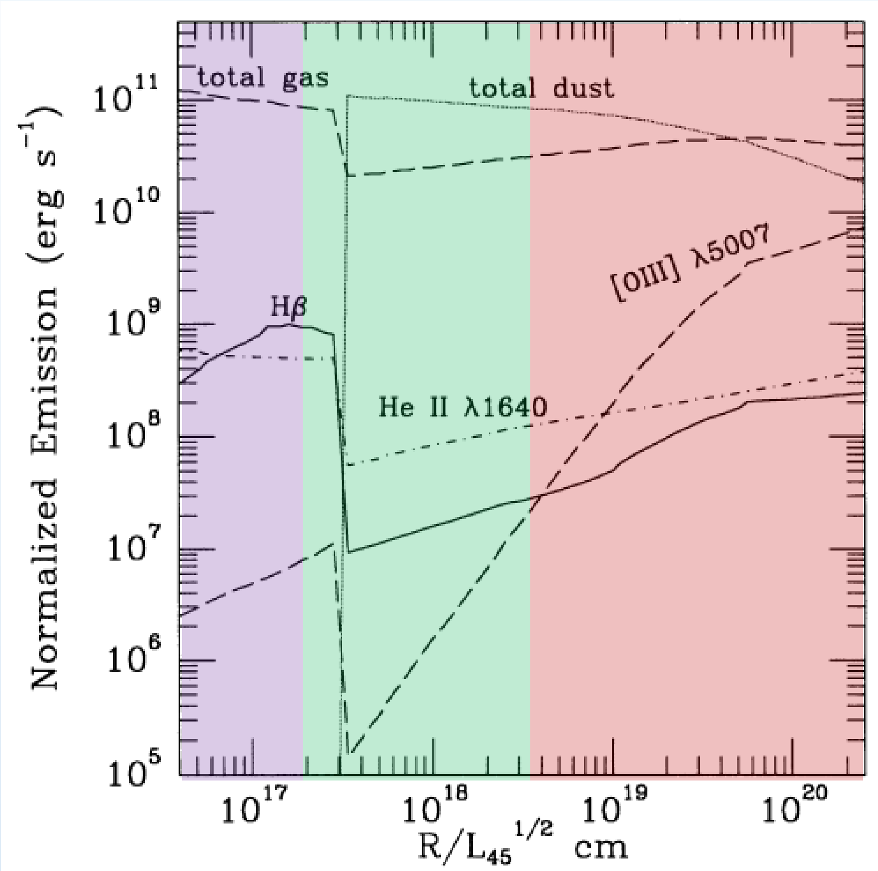
Large size : ~ kpc

Low velocity: ~500 km/s

Low density :~10^3-10^6 cm^{-3}

There is an apparent emission **gap** in a large range of $\sim 10^{-1} - 10^3 pc$.

The emission gap between BELR and NELR



There is a jump of gas emission between the BELR and NELR.

Gas located between the BELR and NELR is hard to be detected.

Photo-ionization simulation (Netzer & Laor 1993)

- r <dust sublimation radius (i.e. BELR), Dust is sublimated; Emission lines are not affected by dust
- r ~dust sublimation radius (i.e. IELR), Dust exist; Ionizing photos are absorbed by dust; Emission lines are suppressed
- r>>dust sublimation radius (i.e. NELR), Dust exist; Ionization parameter decrease with increasing radius; The efficiency of dust absorbing ionizing photos decrease; Emission line intensity increase

Netzer & Laor , ApJ,1993, 448, 27

How to detect the emission of gas located in the intermediate region ?

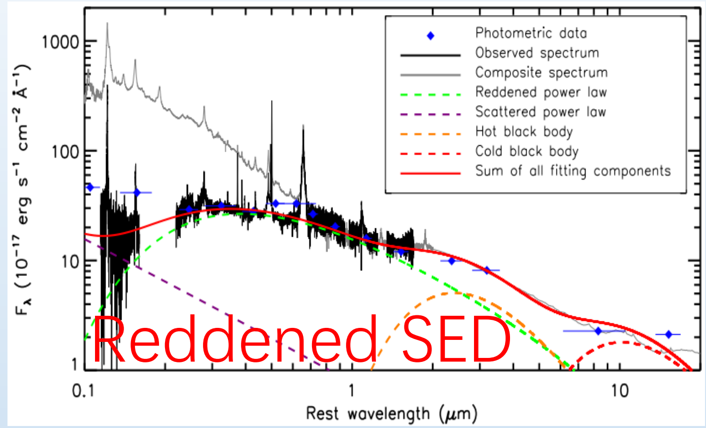
Partially obscured quasars may provide a chance.

A Case Study

Detecting Intermediate-width Emission Lines (IELs) in Partially Obscured Quasar OI 287 with Dusty Torus as ``Coronagraph''

Zhenzhen Li (SHAO)
Lei Hao (SHAO)
Hongyan Zhou (USTC)

Li et al. ApJ, 2015, 812, 99



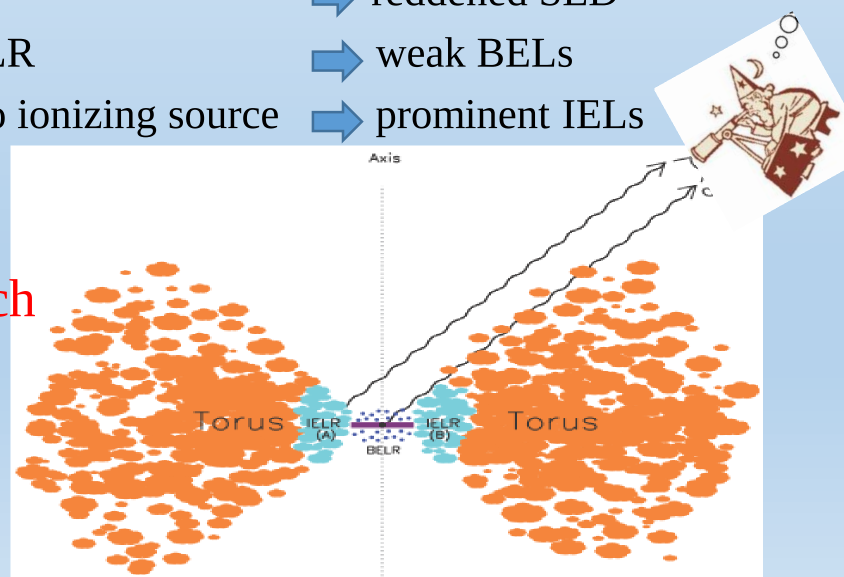
$$R_{\mathrm{IELR}} = GM_{\mathrm{BH}}/(f\,\mathrm{FWHM(IEL)})^2 \sim 2.9 \text{ pc}$$
$$R_{dust} = L_{uv,46}^{0.5} T_{1500}^{-2.8} \sim 1.3 \text{ pc}$$

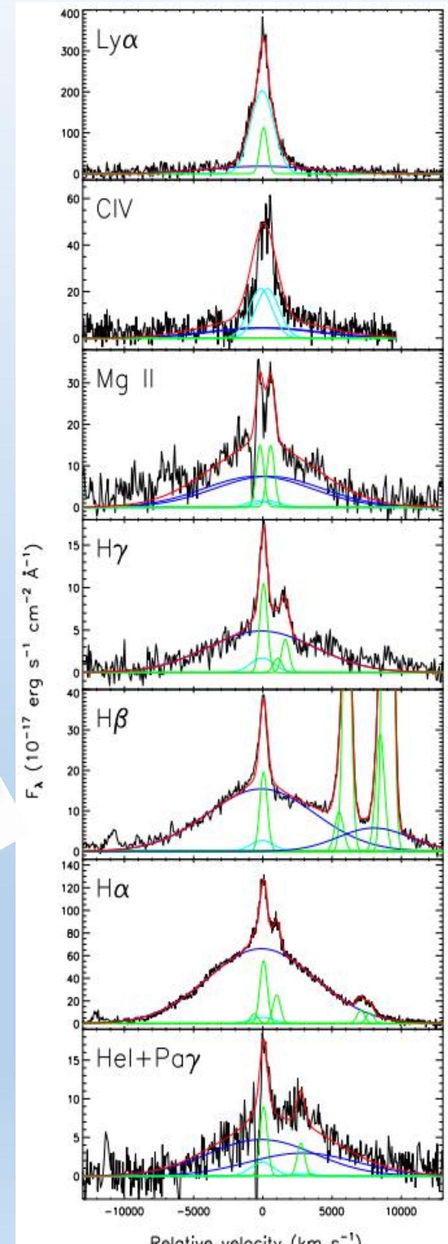
Outer part of torus obscure disk → reddened SED

Outer part of torus obscure BELR → weak BELs

Inner wall of torus is exposed to ionizing source → prominent IELs

The inner wall of dusty torus produce IELs, which would be prominent if BELs are suppressed.





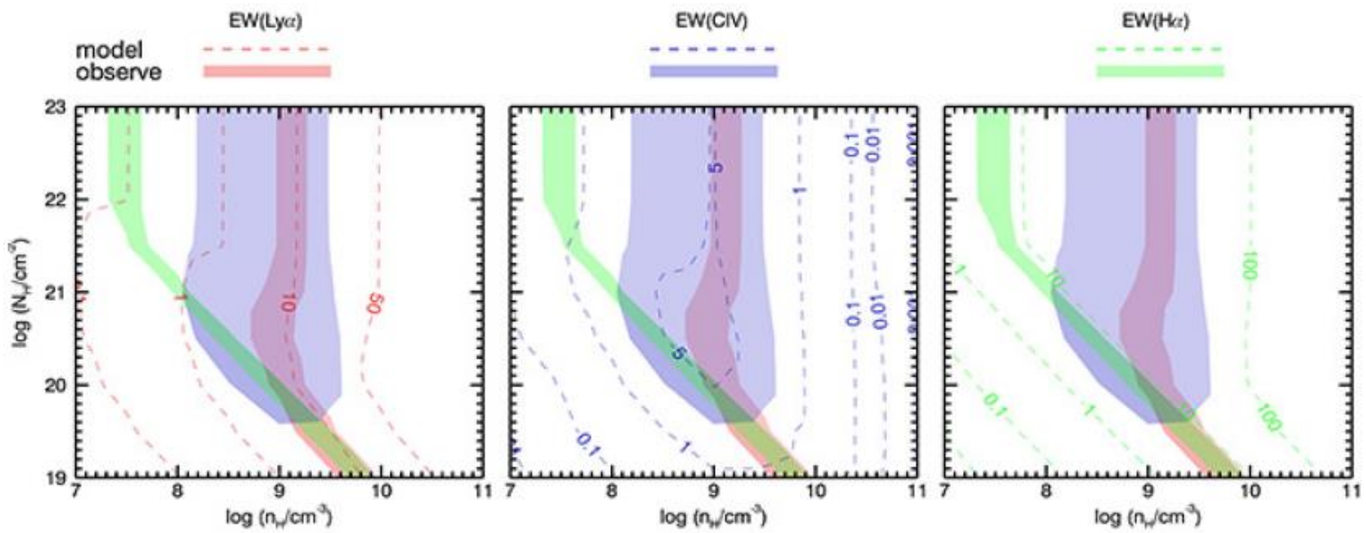
Toward UV, BELs become weak, while IELs become

What can IELs tell us ?

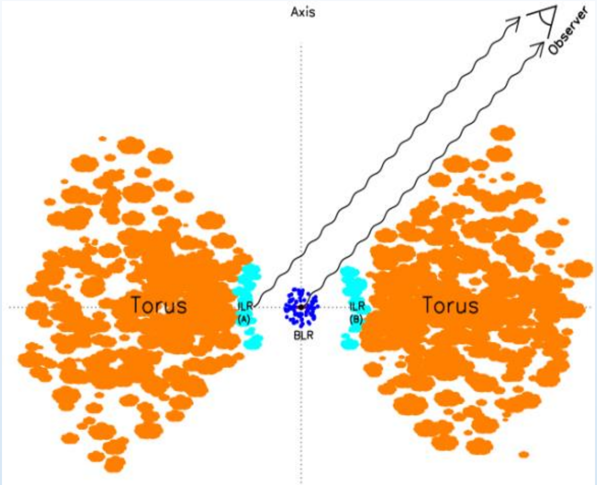
A way to understand the physical condition for the gas located between BELR and NELR.

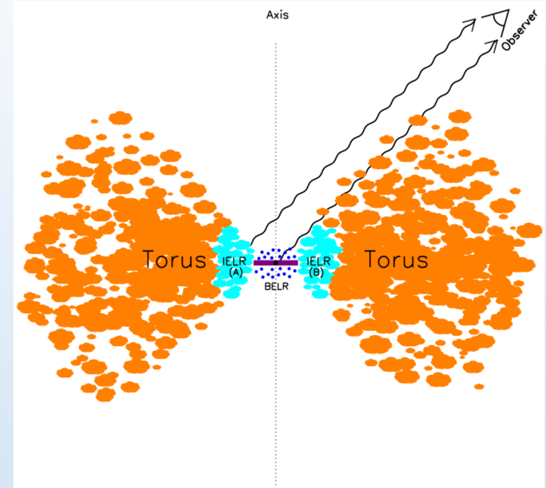
Example: Estimate the gas density

Observed IELS+CLOUDY simulation



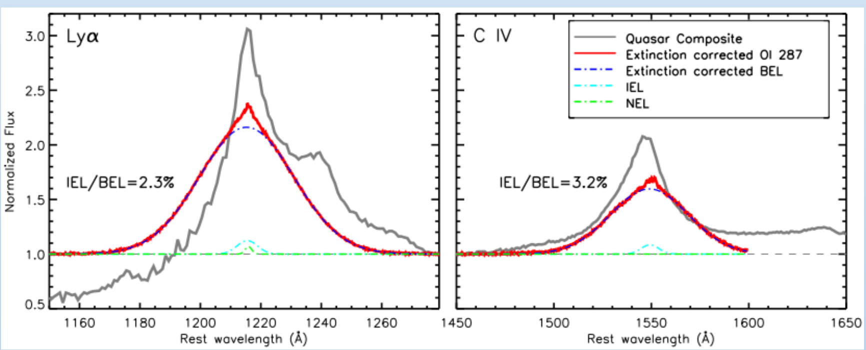
By combining the observed EW(IEL) and CLOUDY model, the gas density is constrained to be $n_H \sim 10^9 cm^3$.

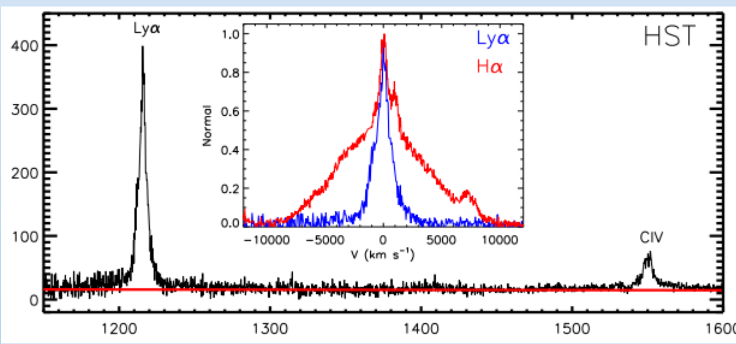




BELs are not suppressed

BELs are suppressed



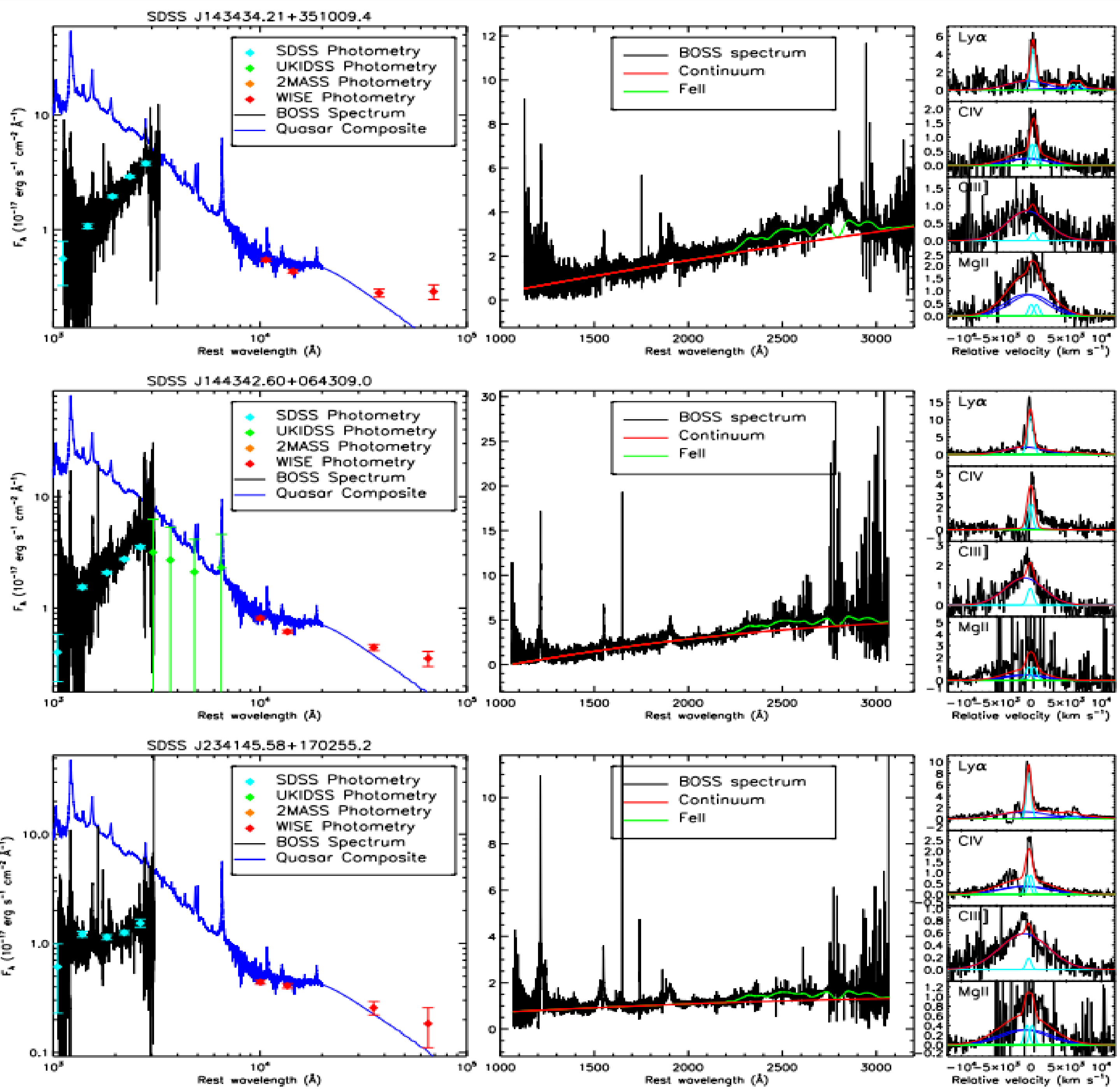


➢The emission line spectra of quasar are usually dominated by the BELs.

➢The IELs are much weaker than BELs, which become prominent when the BELs are suppressed.

➢It is a view effect that the IELs become prominent in the spectra of AGNs. We suggest that there maybe a popular of AGNs with prominent IELs.

More Similar Objects



More partially obscured AGNs with prominent IELs found from BOSS spectra.

Conclustion

- Between the BELR and NELR, there is a jump of gas emission, which cause gas in this region hard to detect.

- In the spectra of partially obscured quasars, there are prominent IELs, which maybe produced from gas located between the BELR and NELR.

- The observed IELs provide a way to understand the physical condition of gas located between the BELR and NELR.

See more details in Li et al. ApJ, 2015, 812, 99

Thank you!