Optical Cerenkov Line-like Radiation in Active Galatic Nuclei

Shanghai Astronomical Observatory
Chen, Lei

Cooperators: **You, Junhan; Liu Dangbo**
Shanghai Jiaotong University

September 25, 2006

1. What is Cerenkov line-like radiation?

2. Does CLLR create Hydrogrn lines in AGNs?

    1. An line redshift test

    2. An Balmer decrement test

    3. What does the CLLR need?

3. Summary

Introduction

When a charged particle move in a medium, with a speed greater then speed of light in the medium

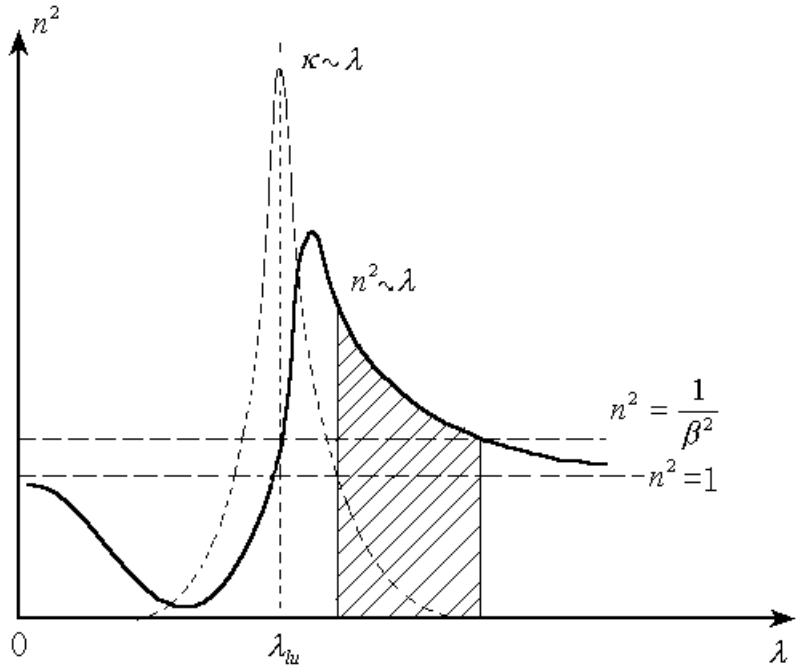
$$v > \frac{c}{n}$$

Cerenkov radiation is emitted, with the power

$$P_\nu d\nu = (4\pi^2 e^2 \beta\nu/c)(1 - \frac{1}{n_\nu^2 \beta^2})d\nu$$

Cerenkov spectrum $P_\nu \sim \nu \Longleftrightarrow n \sim \lambda$ Dispersion curve

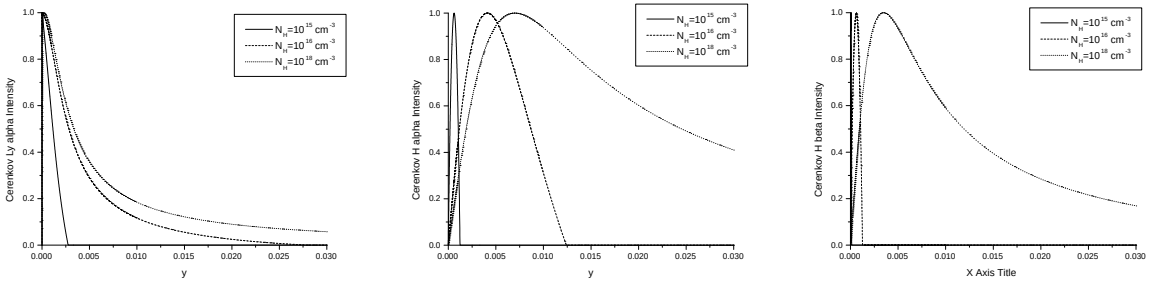
Introduction



Dispersion curve of dense gas
(near the wavelength of atom(ion) line)

Introduction

—— Cerenkov radiation of a hydrogen gas



Introduction

$$\Delta Z^{c}_{H\alpha} = 2.60 \times 10^{-4} \sqrt{\frac{N_2}{N_3}}$$

$$\Delta Z^{c}_{H\beta} = 1.34 \times 10^{-4} \sqrt{\frac{N_2}{N_3}}$$

$$\Delta Z^{c}_{Ly\alpha} = 0$$

Introduction

—— Something special about Cerenkov line-like radiation

- Concentrate nearby λ_{lu}
  $\Longrightarrow$ Cerenkov line-like radiation, or Cerenkov line

- Still much wider than the normal line created by energy level transition.

- Slightly Redshifted Peak, not exactly at $\lambda = \lambda_{lu}$.
  "Cerenkov Redshift"

Does CLLR create Hydrogen lines in AGNs?

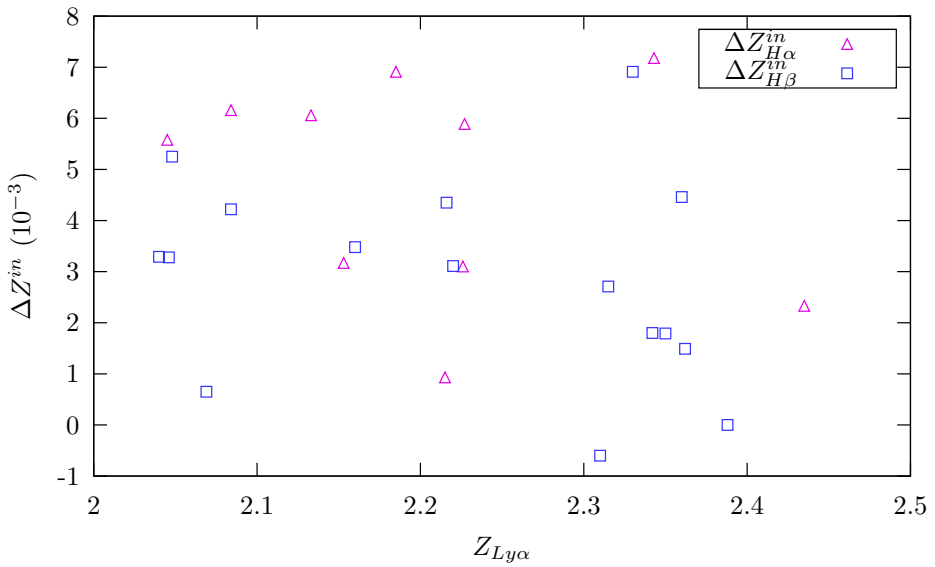
Now we have TWO radiation mechanisms to create atom lines.

- Energy Level Transition
  ——Had been thought to the only way

- CLLR
  ——An alternative?

Does CLLR create Hydrogen lines in AGNs?

—— A Line Redshift Test



$H\alpha$ and $H\beta$ redshifts, for a sample of high redshift QSOs.

Does CLLR create Hydrogen lines in AGNs?

—— A Line Redshift Test

Theory:

$$\Delta Z^{c}_{H\alpha} = 2.60 \times 10^{-4}\sqrt{\frac{N_2}{N_3}}, \quad \Delta Z^{c}_{H\beta} = 1.34 \times 10^{-4}\sqrt{\frac{N_2}{N_3}}$$

Observation:

$$\overline{\Delta Z^{in}_{H\alpha}} = 4.73 \times 10^{-3}, \quad \overline{\Delta Z^{in}_{H\beta}} = 2.89 \times 10^{-3}$$

Does CLLR create Hydrogen lines in AGNs?

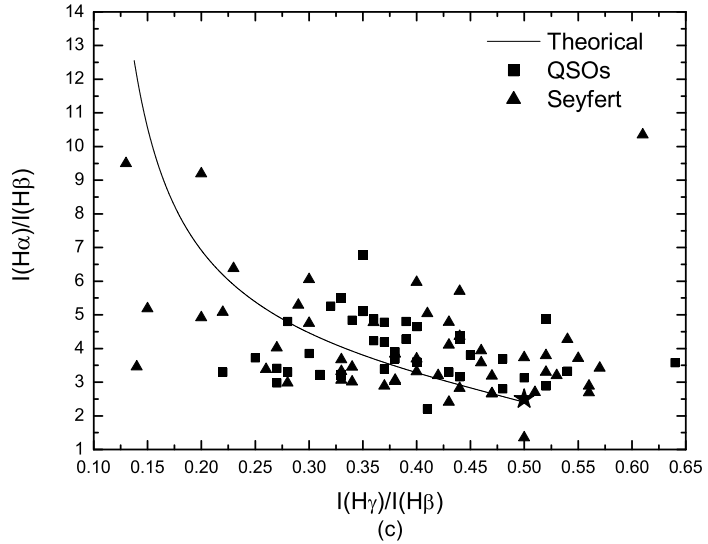
—— A Balmer Decrement Test

$$\frac{I^{\mathrm{C}}(\mathrm{H}\alpha)}{I^{\mathrm{C}}(\mathrm{H}\beta)} = 2.183 \frac{\ln\left(1+28.3X_\beta^2\right) - 2\left[1 - 0.188\frac{\arctan(5.32X_\beta)}{X_\beta}\right]}{\ln\left(1+1.18X_\beta^2\right) - 2\left[1 - 0.922\frac{\arctan(1.09X_\beta)}{X_\beta}\right]}$$

$$\frac{I^{\mathrm{C}}(\mathrm{H}\gamma)}{I^{\mathrm{C}}(\mathrm{H}\beta)} = 0.526 \frac{\ln\left(1+0.250X_\beta^2\right) - 2\left[1 - 2.00\frac{\arctan(0.500X_\beta)}{X_\beta}\right]}{\ln\left(1+1.18X_\beta^2\right) - 2\left[1 - 0.922\frac{\arctan(1.09X_\beta)}{X_\beta}\right]}$$

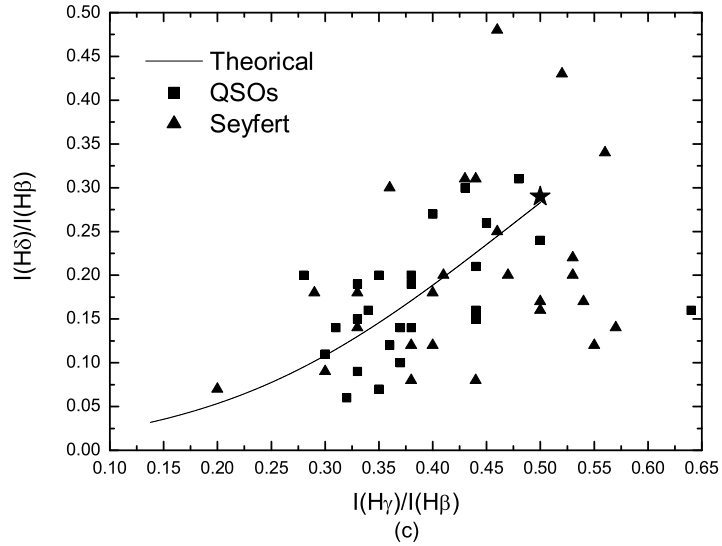
Does CLLR create Hydrogen lines in AGNs?

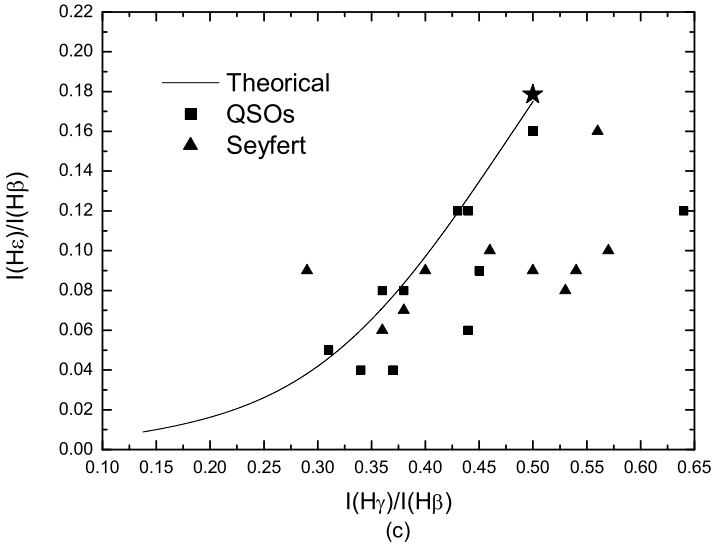
—— A Balmer Decrement Test



Does CLLR create Hydrogen lines in AGNs?

—— A Balmer Decrement Test





Does CLLR create Hydrogen lines in AGNs?

—— What does the CLLR need?

Tentative parameters sets (γ_c, N_2, N_3, N_e), for $H\beta$ line in NGC5548.

γ_c	$N_3(\text{cm}^{-3})$	$N_2(\text{cm}^{-3})$	$N_{H^0}(\text{cm}^{-3})$	$N_e(\text{cm}^{-3})$
10^2	2.9×10^{15}	1.4×10^{18}	5.9×10^{19}	3.7×10^{8}
10^3	2.9×10^{13}	1.4×10^{16}	5.9×10^{17}	3.7×10^{8}
10^4	2.9×10^{11}	1.4×10^{14}	5.9×10^{15}	3.7×10^{8}
10^5	2.9×10^{11}	1.4×10^{14}	5.9×10^{13}	3.7×10^{8}
10^6	2.9×10^{11}	1.4×10^{14}	5.9×10^{11}	3.7×10^{8}

Summary

- Some Observations Provide Evidence of CLLR
- Futher Observation Needed
- BLR physics

Thank You!