

AGNAGN seminar

Sec.13-13.3

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13.1 Introduction

- HII region, planetary nebulae: first identified in Milky Way(MW), and studied in MW and in other galaxies
- Starburst galaxies: different structures from MW(have ionized gas and O/B type stars in their nuclei), and discussed in Sec.9

Active Galactic Nuclei(AGN): Galactic nuclei with ionized gas that is not associated with O/B type stars

- Seyfert galaxies,
- Radio galaxies,
- Quasars/QSOs,...

**AGN is rare in space, hence on average they are distant and faint
=Studied only in recent decades**

13.2 Historical Sketch

① Seyfert galaxies

1908: First observation in Lick Observatory(understood as the integrated light from large numbers of bright stars)

- 1926: NGC1068, 4051 and 4151 were observed
- $H\beta$, [OII], [NeIII] and [OIII] lines were detected

1943: Carl K. Seyfert advocated “Seyfert galaxy”, that has bright nuclei whose spectra show many high-ionization emission lines

② Radio galaxies

- Optical identification of the strong radio sources
⇒ **some faint galaxies are identified (like Cyg A)**
- **Rarer in space than Seyfert**

③ Quasar/QSO

- Strong radio source whose spectra were continuous, with no absorption lines, and with broad lines
- Understood as white dwarfs without heavy element
⇒ **Some nebular emission lines were detected, and reinterpreted as bright, distant galaxies (Quasar)**
- **QSO is similar, but radio-quiet objects** (also interpreted as radio-quiet quasar)

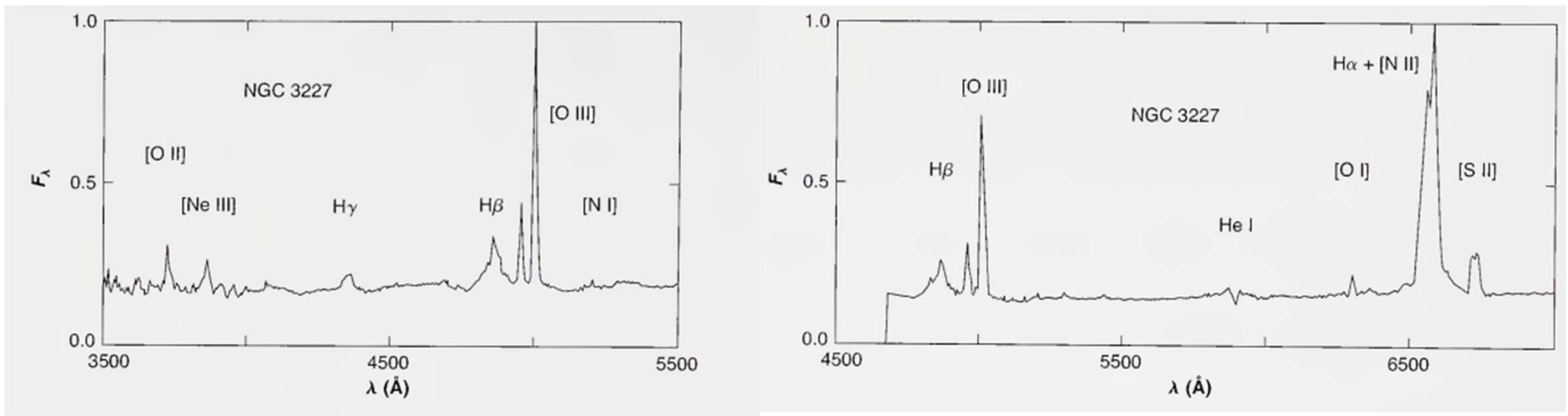
13.3 Observational Classification of AGNs

I. Seyfert galaxies

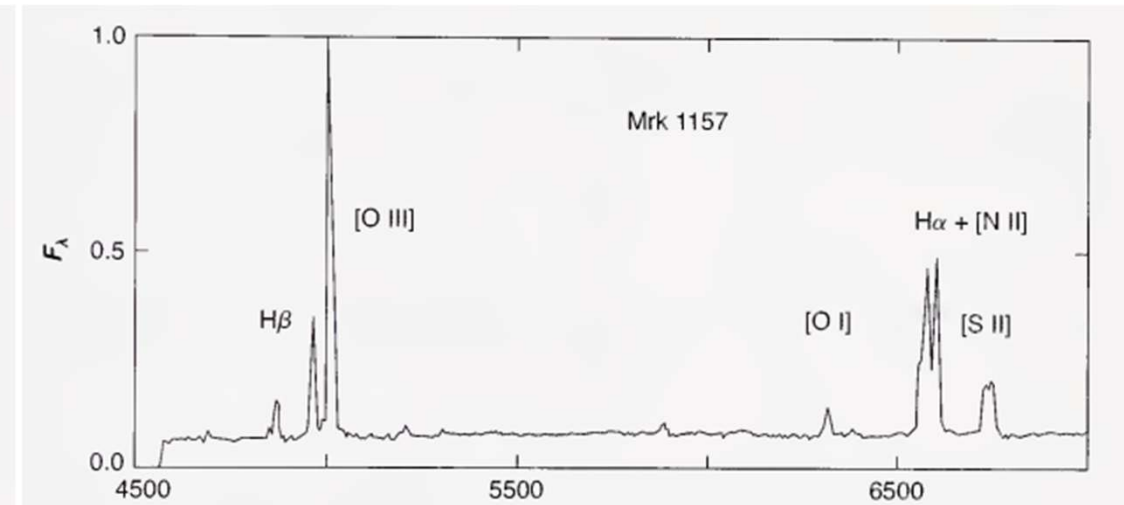
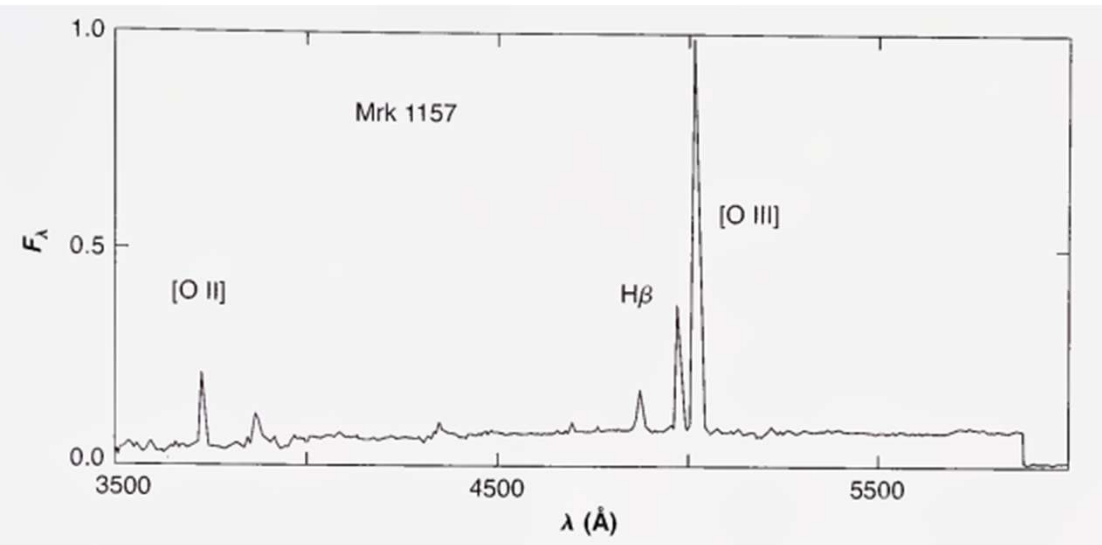
Survey: Schmidt telescope & objective-prism $\Rightarrow$ **SDSS**

**Seyfert 1: broad permitted lines(FWHM: 1000~5000km/s),
narrow forbidden lines(500km/s)**

Spectrum of NGC3227



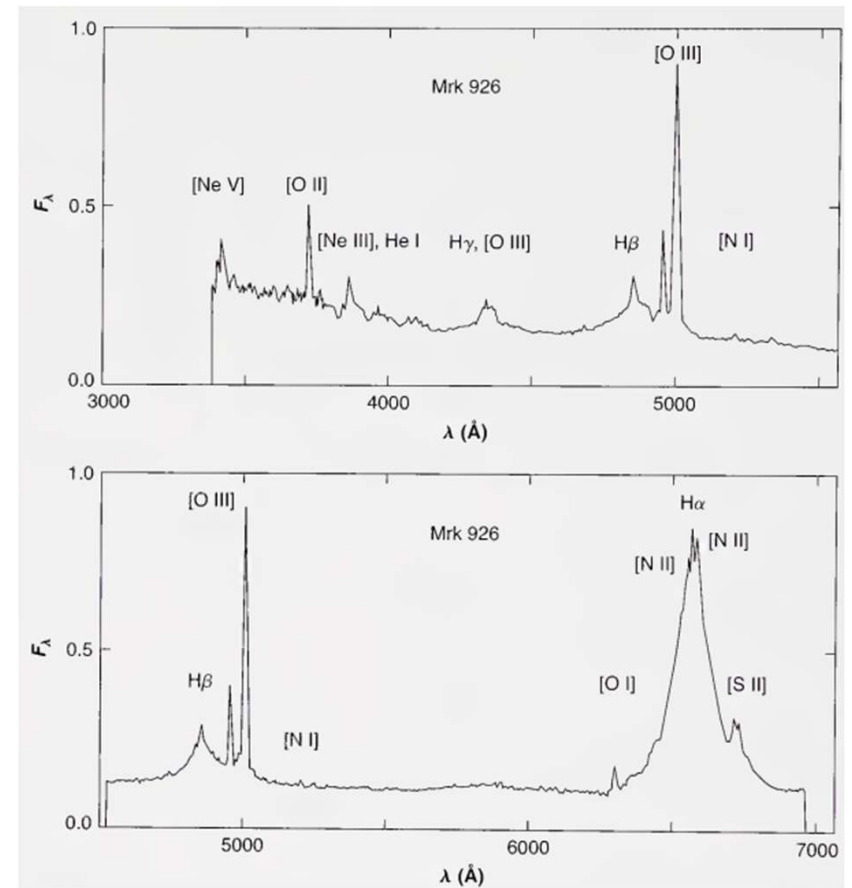
Seyfert 2: narrow permitted lines(FWHM: 500km/s), narrow forbidden lines(500km/s)



Subdivided classification:

Some Seyfert galaxies have composite H I emission lines, consisting of a broad component and a narrow component

- **Seyfert 1.5:**
Galaxies with intermediate-type H I profiles
- **Seyfert 1.8:**
Galaxies with strong narrow & weak broad components of H α and H β
- **Seyfert 1.9:**
Galaxies with strong narrow & weak broad components of H α



Spectrum of Mrk926, Seyfert 1.5

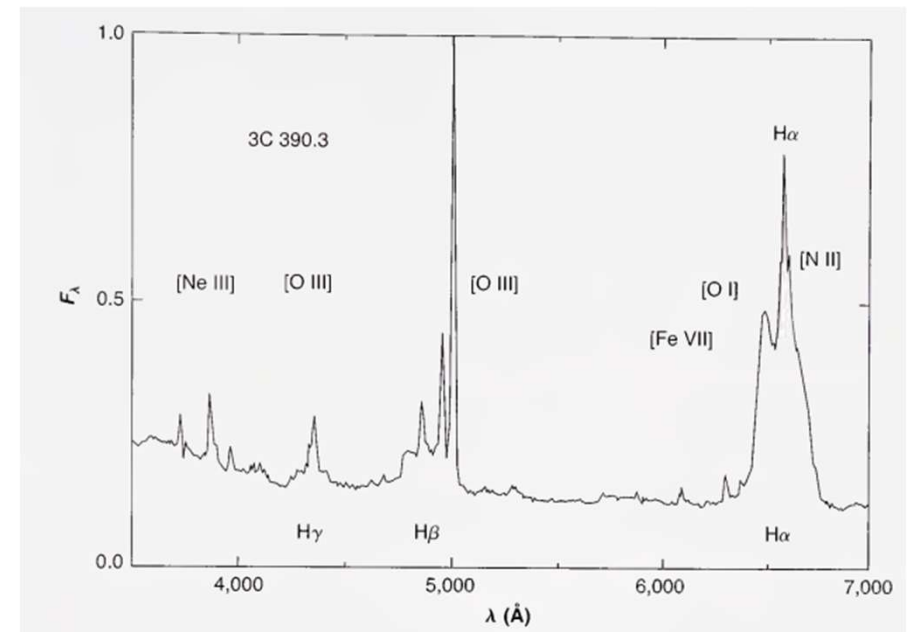
II. Radio galaxies

- Synchrotron radio-frequency emission from two large, diametrically opposite lobes, far outside the limits of the galaxy
- Nucleus of galaxy emits strong optical emission lines, but radio emission is not so strong

Broadline radio galaxies(BLRGs):

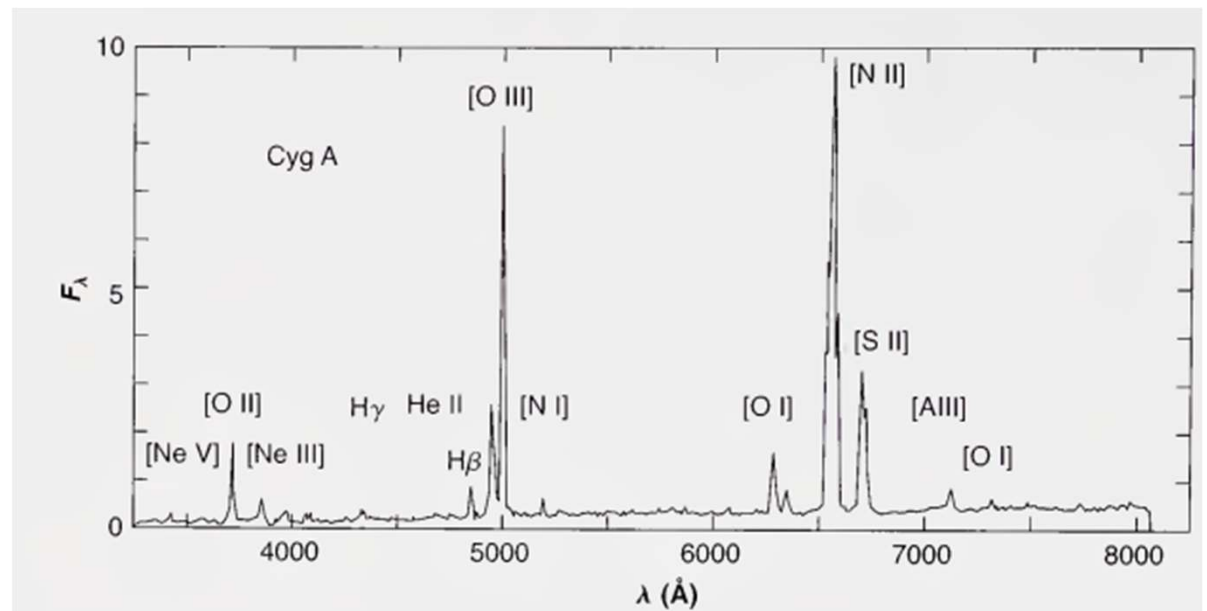
Galaxies with broad permitted lines, and narrow forbidden lines (analogues to Seyfert 1)

Spectrum of 3C 390.2,
typical BLRGs



Narrow radio galaxies(NLRGs):
Galaxies with narrow permitted lines, and narrow forbidden lines
(analogues to Seyfert 2)

**Spectrum of Cyg A,
typical NLRGs**



Differences between radio and Seyfert galaxies

- BLRGs is the counterpart of Seyfert 1, but it has composite H I profiles (like Seyfert 1.5)
- Seyfert emits strong Fe II permitted lines, but radio galaxies doesn't
- $H\alpha/H\beta$ ratio of BLRGs (6.0) is higher than Seyfert 1 (3.5)
(Caused by the difference of optical properties?)
- Morphological type of Seyfert is spiral (Sa, Sb or Sc), but that of radio galaxy is elliptical (cD, D or E) or type N (nearly quasars)

Featureless continuous spectrum from AGN

- Emitted from a tiny, unresolved object within the nucleus (energy generator of AGN)
- **Dominant emission in Seyfert 1**
(Contribution for Seyfert 2 is not so strong)
⇒ **Seyfert 1 is typically brighter than Seyfert 2** (by 1mag, average)

Quasar/QSO and Seyfert

- **Quasar/QSOs are bright AGN, and observational features are similar to Seyfert 1/BLRGs**
(few QSOs analogous to Seyfert 2)