Extragalactic Astronomy II

Lecture 5

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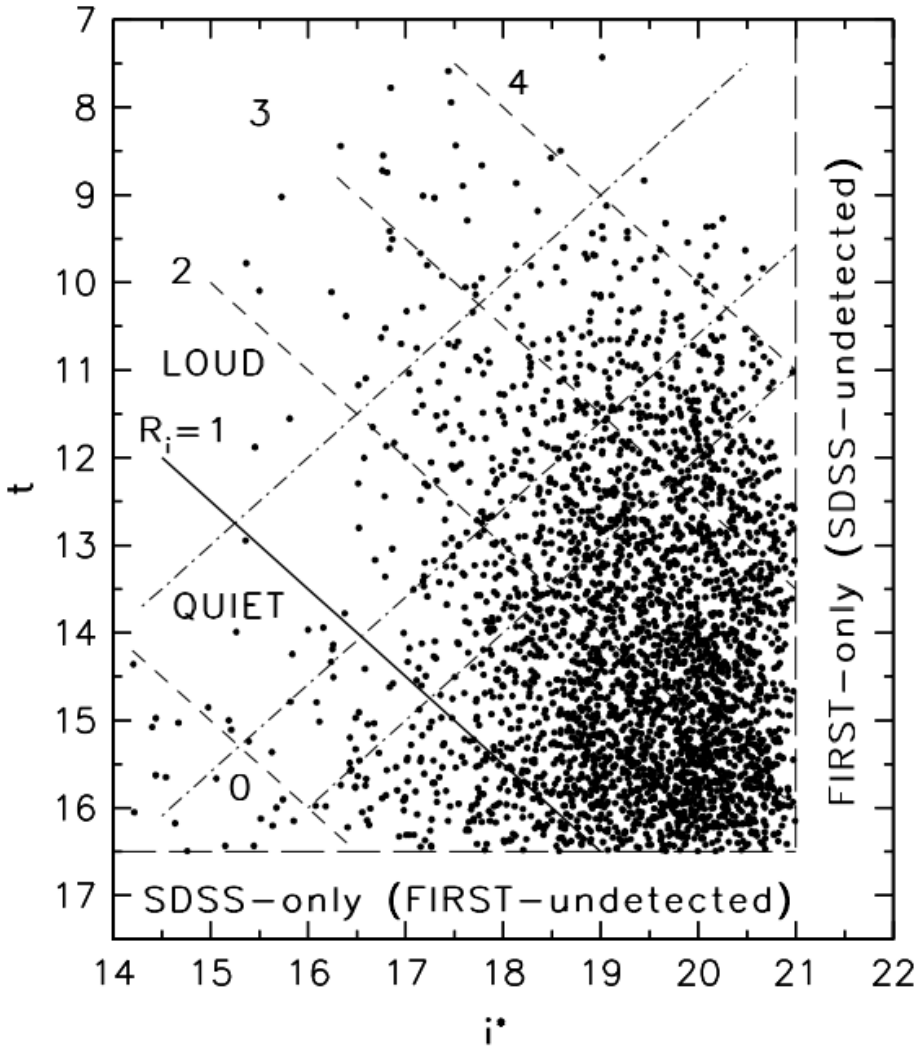
Apr-June 2021

The radio quiet and radio loud quasar populations

Are these fundamentally different or is this there a sample selection effect? This question was endlessly debated in the literature from about 1980-2010.
Radio loud is often defined as a quasar with 1.4 GHz rest-frame luminosity as $> 10^{25}$ W Hz^{-1} or $R_i > 1$, where R_i is the ratio of radio-to-optical flux.

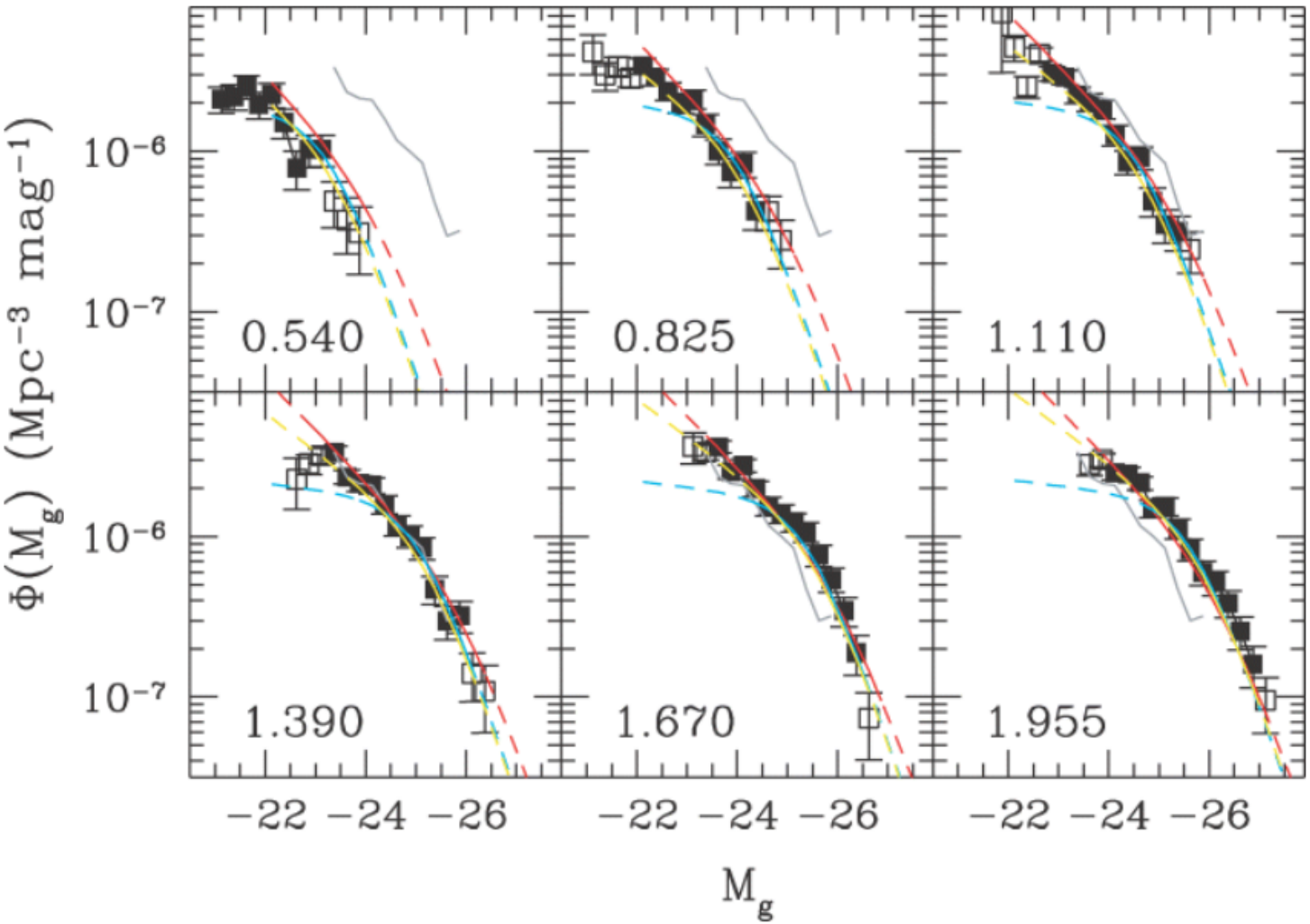
Ivezic et al. (2007), quasar radio bimodality



Ivezic et al. (2007) - more data leads to the right answer

The radio-loud quasars have a redder median color by 0.08 mag, and show a 3 times larger fraction of objects with extremely red colors.

Quasar luminosity function



Richards et al. (2005)

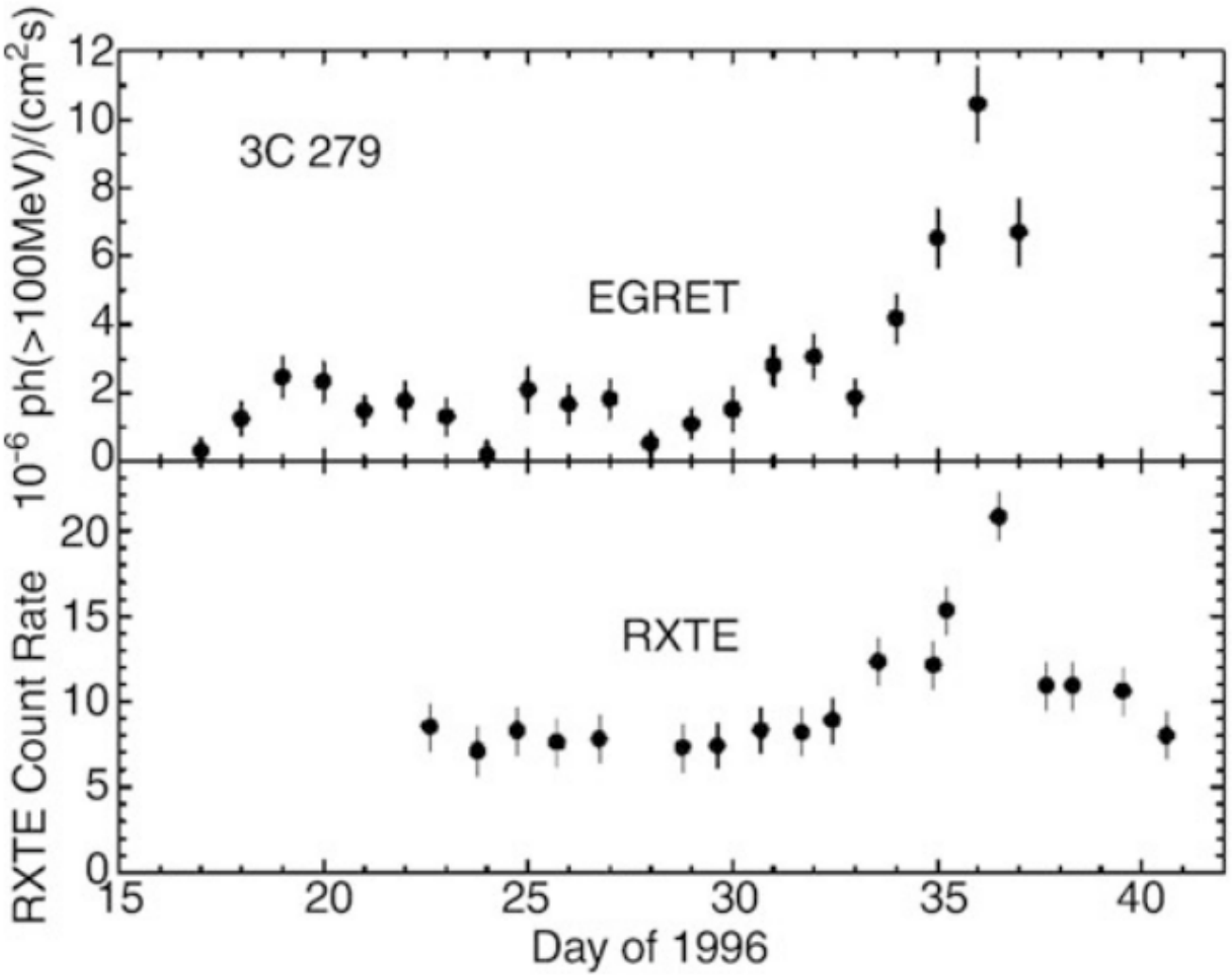
Optically Violently Variable (OVV)

- characterized by the very strong and rapid variability of its optical radiation on time scale of days
- more polarised optical emission (few percent). Normal quasars have polarisation below 1 percent.
- flux variable at other bands too, with shorter timescales and higher amplitudes at X-ray and gamma rays

BL Lac Objects

- strong variability like OVVs
- polarised like OVVs
- usually no emission or absorption lines seen, unlike OVVs
- when flux is low, emission lines are sometimes seen making it look like an OVV. So collectively called *blazars*.

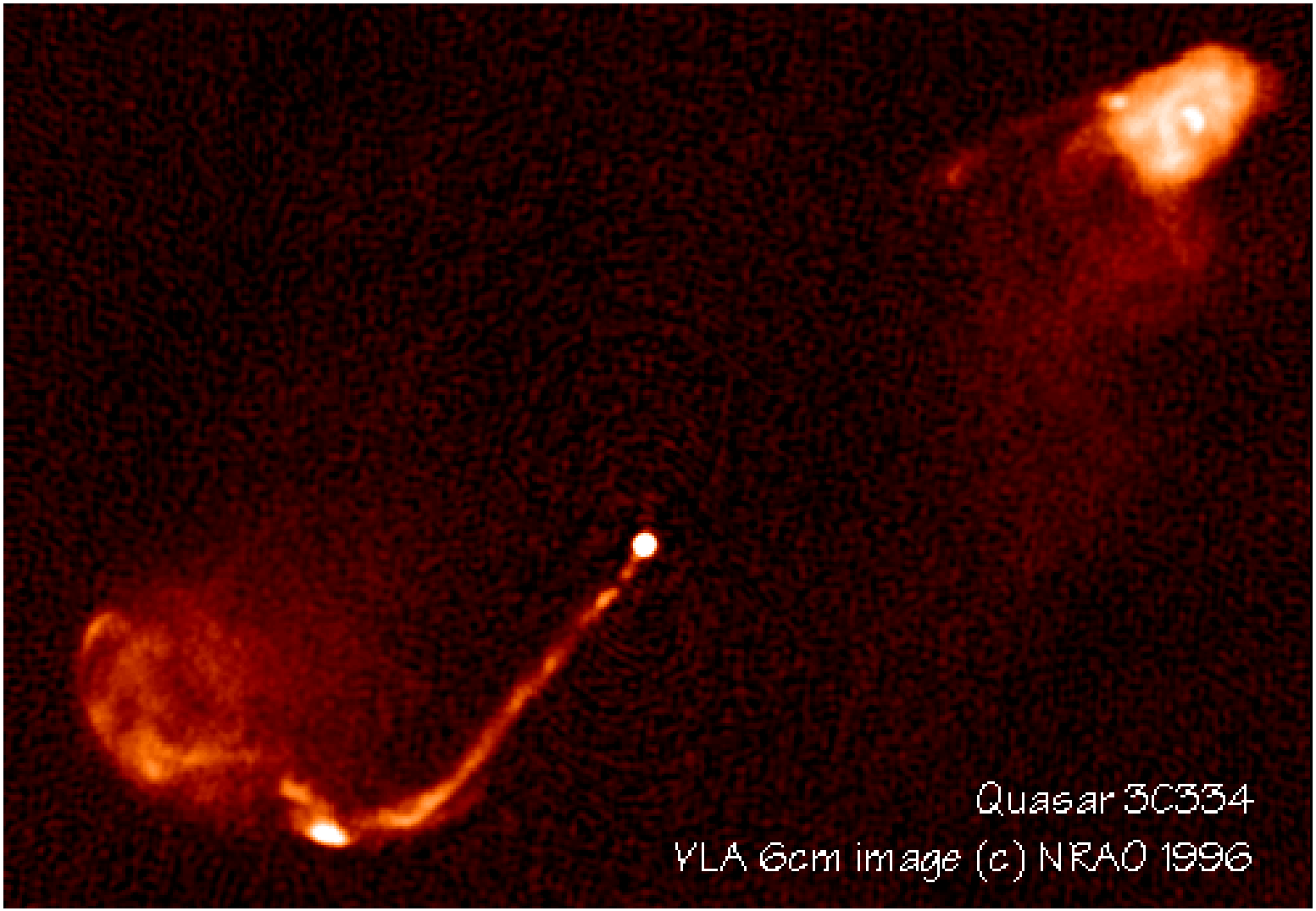
Light curve of Blazar 3C 279 - Hartman et al. (2001)



On time-scales of a few days, the luminosity varies by a factor ~ 10

Where must this emission originate?

Quasar extended emission in radio



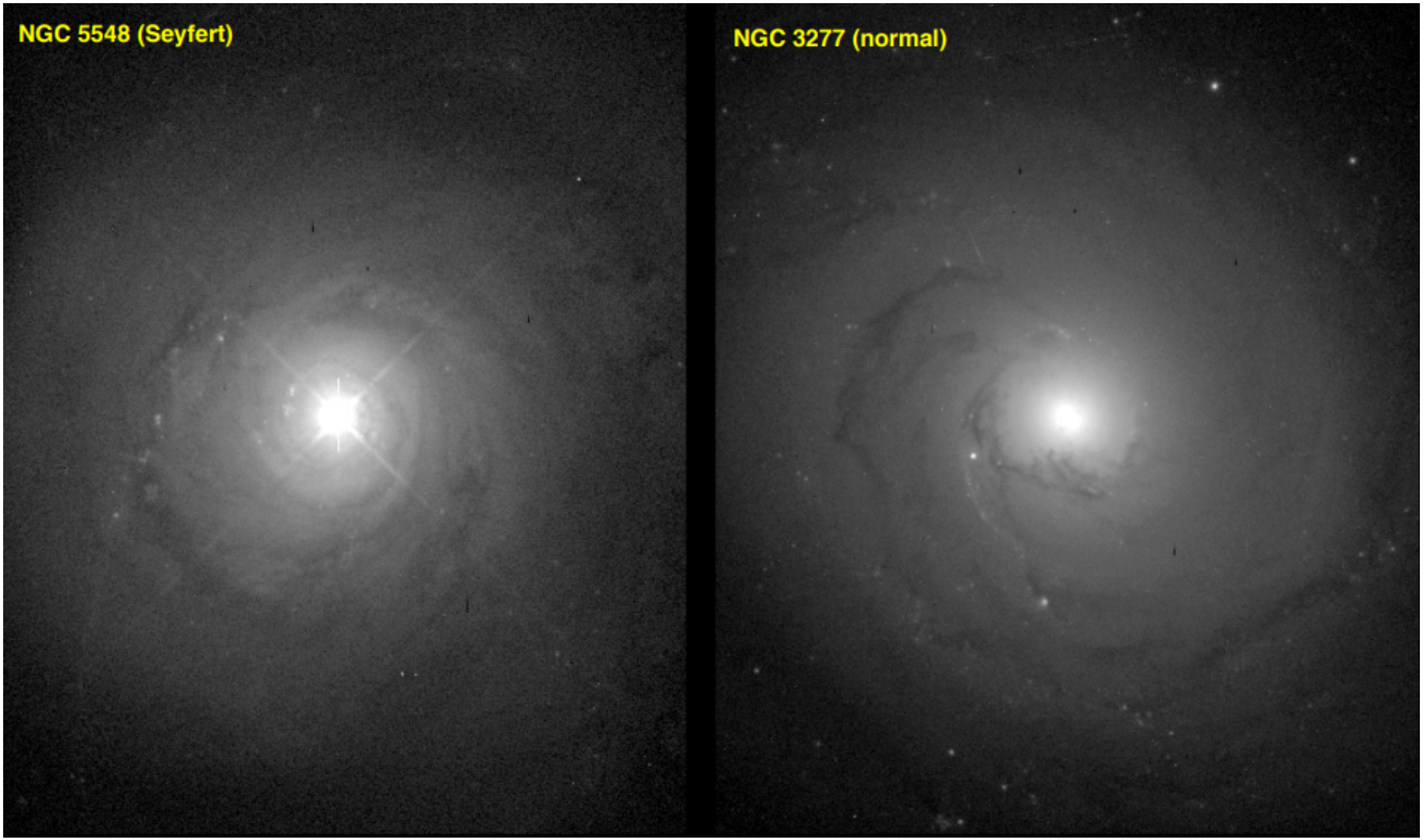
Confusing quasar nomenclature in the literature

- Quasars without extended structure are often called quasars
- Quasars without radio emission are often called QSOs, quasi-stellar objects, but sometimes called quasars.

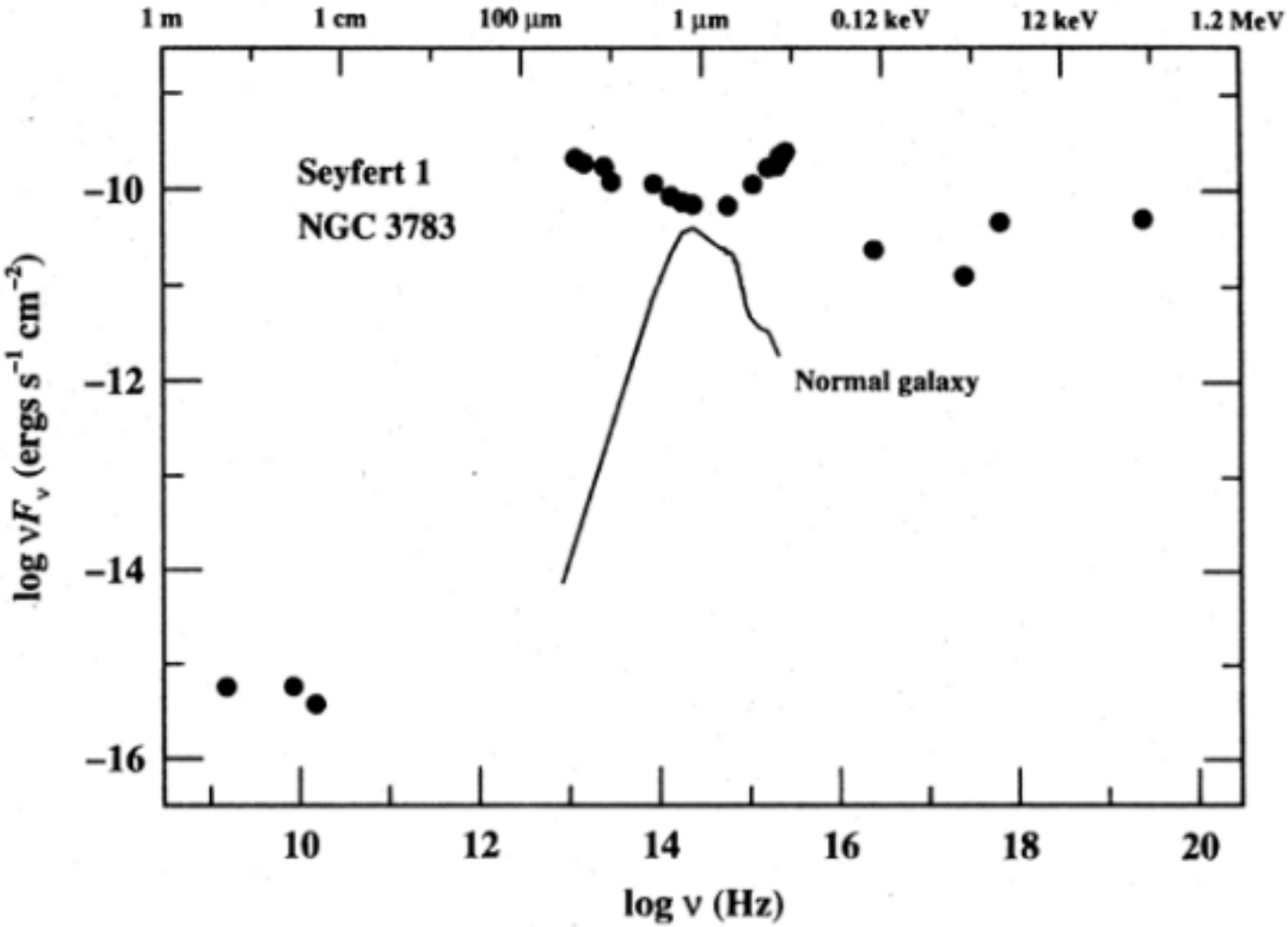
Seyfert 1 AGN

- first studied systematically by C. Seyfert (1943)
- invariably hosted by spiral galaxies in the nearby Universe
- may or may not have strong radio emission
- spectrum shows UV excess and strong broad and narrow emission lines.

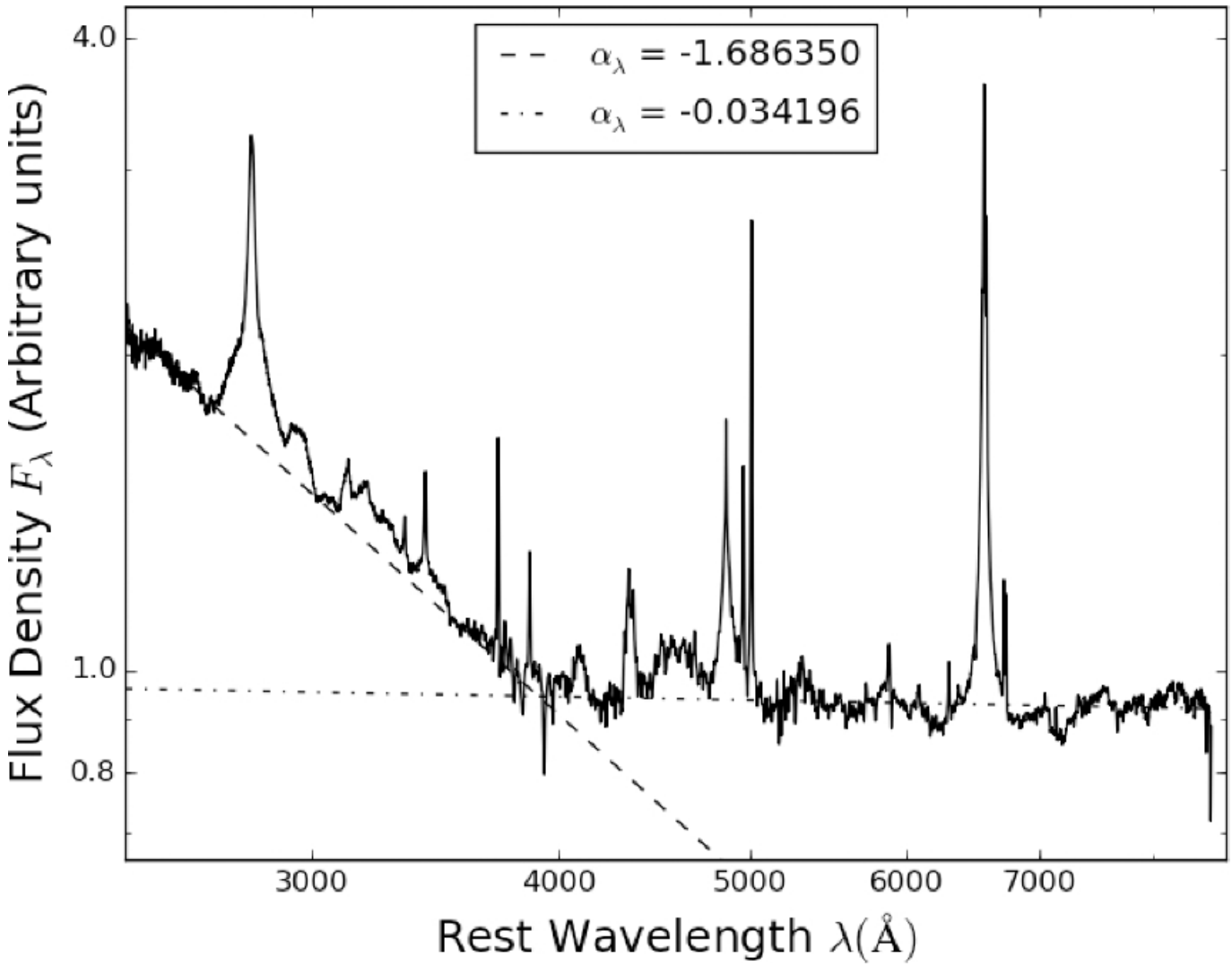
Seyfert appearance in optical



Seyfert 1 SED

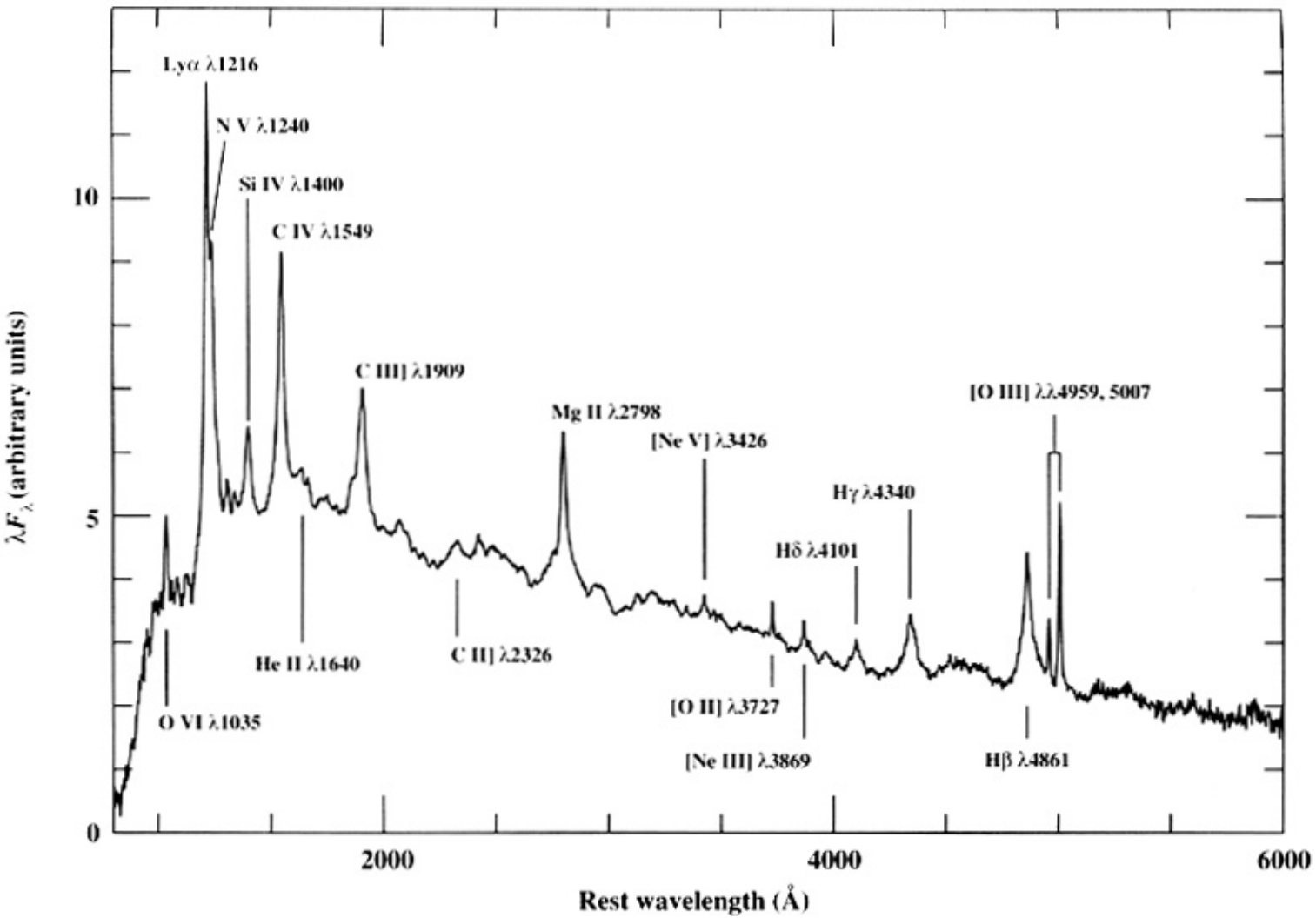


Seyfert 1 composite spectrum



Pol & Wadadekar (2017)

Composite quasar spectrum



Vanden Berk et al (2001)

Seyfert 1 properties

- both broad and narrow lines seen like quasars.
- clearly much less luminous than quasars; host galaxy easily seen.

How will you find new Seyfert 1 galaxies?

Seyfert 2 galaxies

are a lot like Seyfert 1 galaxies, except that they lack broad emission lines in their spectrum. The flux in the narrow line does not change with time.

Emission lines from AGN or from non-AGN source?

Can normal galaxies also show emission lines in their spectrum?

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Massive stars have a clear cut-off in their ionizing spectrum, at the Lyman-limit of helium (corresponding to 228 Angstrom), whereas the non- thermal radiation from AGNs extends to much higher photon energies. As a consequence, the ratio of collisionally excited lines to that of lines which are produced in the course of recombination is larger in the case of an AGN–like ionizing radiation field.