## Extragalactic Astronomy II Lecture 4

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- The quasar outshines the galaxy by a factor of 100 or more.
- The FWHM of the PSF of ground based optical telescopes is typically 1 arcsecond. At z = 2, the angular scale is about 8.5 kpc/arcsec.

In such a situation can we ever hope to detect a quasar host galaxy directly?

#### Host galaxies of nearby quasars (z < 0.3)



Bahcall et al. (1997)

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Active galaxies require fuel to stay active. Merging galaxies channel gas (and sometimes stars) towards the centre. Galaxy mergers were more common at earlier epochs.

#### How the bulge of a galaxy grows

#### The Growth of Bulges in Spiral Galaxies Three evolutionary scenarios

Rapid Collapse







I. Primordial hydrogen cloud.

Environmental Effects

2. Cloud collapses under gravity. 3. Large bulge of ancient stars dominates galaxy.



I. Disk galaxy and companion.



I. Disk galaxy forms around small bulge.



2. Smaller galaxy falls into

disk galaxy.

2. Disk perturbations form a bar-like structure which shovels stars the bar is disrupted fresh gas into the center.



3.As bulge grows with new and dissipates.



3. Bulge inflates with addition

of young stars and gas.

Will this mean that the black hole mass grows too?

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orbit around it 30e3\*\*2\*150e9/6.67e-11 = 2.0239880059970016e+30 How was it done for the SMBH in M87 recently? GRMHD How would you measure the total mass (including dark matter) of a galaxy? How would you measure only the stellar mass?



#### Bulge mass - SMBH mass correlation



Suggests that growth of bulge and SMBH growth occurs through similar processes.

### Is Quasar luminosity correlated with SMBH mass?

# If not, why not? Variation of which parameter is responsible for large scatter in this relation?

- for nuclear luminosities  $M_V < -23.5$ , the hosts of both radio–loud and radio–quiet AGN are virtually all massive ellipticals.
- properties of these hosts are indistinguishable from those of quiescent, evolved, low-redshift ellipticals of comparable mass. So, radio loudness does not correlate with radio morphology.
- the fraction of massive spheroids/black holes that produce quasar-level activity. This fraction is ~ 0.1 per cent at the present day, rising to > 10 per cent at z ~ 2 - 3.



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Type 2 quasars (optically obscured quasars)

- optically faint, so flux limited samples miss them
- absence of broad emission lines means that grism based samples miss them
- weak in soft X-rays, which are absorbed by dust, hence X-ray selected samples miss them.

We will talk a bit more about obscured quasars after we introduce the AGN unification model.

#### Gravitationally lensed quasars



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### Quasar pair 1343+266 - gravitationally lensed or not?



#### Wadadekar and Kembhavi (1999)

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