Planet Formation - Summary

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This summary is based on the book Chapter 28 from Carroll, Bradley W., and Dale A. Ostlie. An Introduction to Modern Astrophysics

1 Active Galaxy (AGN) classification

- **Seyferts:** spiral galaxies with unusually bright emission lines from their cores. Several indications of galaxy interactions which may cause the activity.
  - Type I - very broad emission lines → Doppler broadening → high velocities
  - Type II - narrow emission lines
- **Quasars** - Quasi stellar radio Objects → very far away (high redshift) and very bright → 10^5 times more energetic than a normal galaxy like our own Milky Way.
  - radio loud - more energetic than the radio quite version
  - radio quite - sometimes also called QSO - quasi stellar object. typically less energetic as the radio loud versions
- **radio galaxies** - typically elliptical galaxies at large distances. → several million times more radio energy than is produced by a normal galaxy. Components: core, jets, radio lobes, radio halo. Often associated with galaxy clusters → interactions and mergers. Often also bright in the X-ray, e.g. X-ray halos and jets.
  - BLRG - broad-line radio galaxies
  - NLRG - narrow-line radio galaxies
- **Blazars** - very bright compact objects that occur when the jet is pointing directly towards us, rapid variability and a high degree of linear polarization at visible wavelengths
  - BL Lacs - spectrum shows only a featureless continuum with very weak emission and absorption lines.
  - OVV quasars - optically violently variable quasars, similar to the BL Lacs except that they are typically much more luminous, and their spectra may display broad emission lines
- **ULIRGs** - ultraluminous infrared galaxies → very bright in the infrared → most likely due to a large amount of dust + possible contribution of star formation → indicates galaxy mergers as the origin
- **LINERs** - Low Ionization Nuclear Emission-line Regions, low luminosities in their nuclei, but with strong emission lines of low-ionization species,

1.1 The spectra

The spectral energy distribution (SED) is bright over 10 orders of magnitude in frequency. This wide spectrum is markedly different from the thermal (blackbody) spectrum. Common features: infrared bump → from warm dust, big blue bump → from the accretion disk

spectral index: describes the slope of the low frequency end (radio) of the spectra.

a **synchrotron spectrum** is produced by the combined radiation emitted by individual electrons as they spiral around magnetic field lines. At a transition frequency, the spectrum turns over because the plasma of spiraling electrons becomes opaque to its own synchrotron radiation, known as **synchrotron self-absorption**.

Synchrotron radiation is the electromagnetic radiation emitted when relativistic charged particles are subject to an acceleration perpendicular to their velocity.

1.2 Evidence for AGN evolution

Bright quasars were more common at earlier epochs than they are now. Both the total number of quasars and their luminosities may have been different. A well-defined relationship exists between the mass of a supermassive black hole and the velocity dispersion of the spheroid of a galaxy, suggesting that as the mass of the galaxy grows and the velocity dispersion of its spheroid increases, so does the mass of the central supermassive black hole.

There is evidence, including interactions in observed quasars, suggesting that an individual quasar "event" lasts only for a galactic dynamical timescale → indicates short periods of AGN activity → these are most likely triggered by mergers and interaction.

Short time scale variation → small physical size of the source of the radiation.

2 The Unified model of AGN

3 Radio galaxies

Doppler boosting → an effect of special relativity when the jet is propagating at relativistic speeds at relatively small angles compared to the line of sight towards our direction → one sided jets

Fanaroff-Riley Luminosity classes:

- Class I: distance between the brightest spots of radio emission on either side of the centre (excluding the central source) to the full extent of the radio source is less than 0.5; "core brightened" the inner bit of the jet is the brightest, often curved jets
- Class II: have a ratio greater than 0.5. "edge brightened" with hot spots and straight jets, the overall luminsoty tends to be brighter compared to the class Is

4 Related phenomena

4.1 Gravitational lensing

4.2 Lyman-alpha forrest

In astronomical spectroscopy, the Lyman-alpha forest is a series of absorption lines in the spectra of distant galaxies and quasars ari sing from the Lyman-alpha electron transition of the neutral hydrogen atom. As the light travels through multiple gas clouds with different redshifts, multiple absorption lines are formed.