Galaxies with Active Cores

most of the energy comes from the center
  sun - solar system - galaxy

Double-lobed Radio Galaxies

$10^7 \times E$ of normal galaxy
discovered in 1950’s
emit radio waves from lobes
  much larger than galaxy
most at outer edges
sometimes jets
  leading to lobes
double-exhaust model
eruption at core
drives jets of high energy
gas in opposite directions
  push against intergalactic gas
ionized
drags magnetic field
movement may drag tails

NGC5128
collision between
giant elliptical
  and small spiral
new stars
may have triggered
  eruption

Seyfert Galaxies

lack radio lobes
spiral galaxies
unusually bright, tiny cores
fluctuate in brightness
powerful IR sources
narrow or broad
  emission lines

BL Lac objects

elliptical galaxies
  no lines in spectrum

M87 elliptical
active core
no radio lobes
but does have a jet

**Model**

mass flowing into accretion disk

about compact object

provides energy

pulsar

neutron star

galaxies

supermassive black hole

interaction with other galaxies

push matter into central region

trigger eruption

if viewed face-on:

BL Lac object

detergent-wise:

Seyfert galaxy

**Quasars**

Quasi-stellar objects
discovered in 1960's

radio sources

much smaller than

radio galaxies

looked more like stars

at visible $\lambda$

spectra

unlike stars

### 3C273

bright quasar at center

surrounded by faint fuzz

large red-shift

of spectral lines

indicates

most distant objects

superluminous

brightness fluctuations

as short as a week

$\Rightarrow$ small size
The telescope is a (one-way) time machine. Maximum density of quasars at a distance of 13 billion ly earlier than 14 BYA and later than 12 BYA ⇒ few quasars during the Age of Quasars 12-14 BYA galaxies were closer, more mass being fed to black holes.

HST pictures of quasar fuzz show surrounding galaxies often undergoing mergers.

Gravitational lens of distant galaxy in front of quasar creates double image when subtracted ⇒ faint galaxy

Quasars: active cores of distant galaxies triggered by collisions when universe was much younger

Image: quasar_hst
Image: 17-14a
Image: 17-14b
Image: 17-14c