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
edge-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
⇒ small size

found in clusters of galaxies
fuzz has galaxy-like spectra

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

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