QUASARS AND PULSARS

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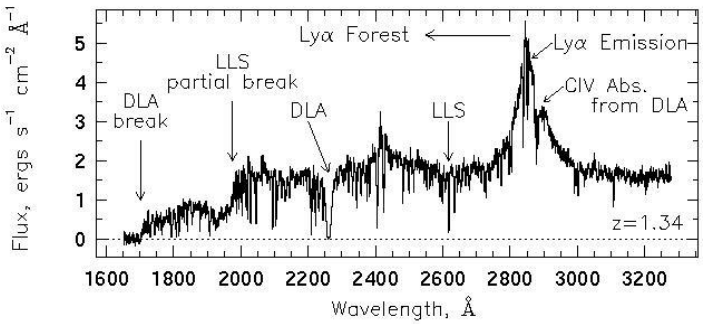
QUASARS.

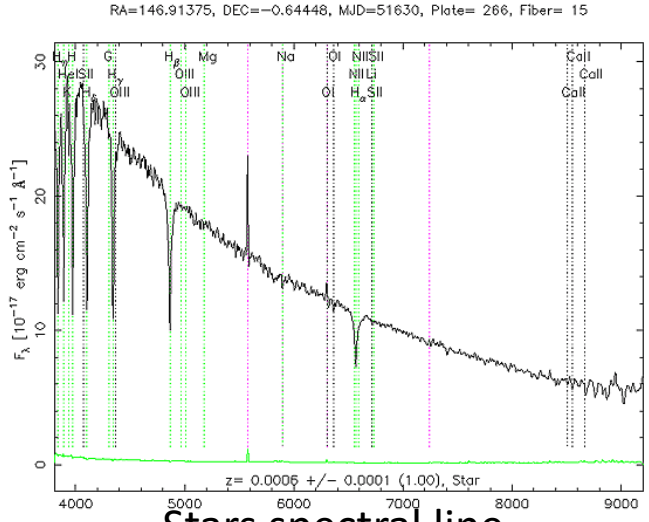
- quasi-stellar radio source.
- First discovered in the 1960s.
- Early radio telescope found radio emission from stars, nebulae and galaxy.
- There were also point like radio signals which were changing rapidally
- Detected radio sources without optical counterparts appearing as unresolved point sources.

Early Background of quasars

- a small number of anomalous objects with properties that defied explanation.
- Only radio signals were received but no source was optically observed.
- Extremely strange spectral line.
- Luminosity changing very rapidly in optical range.



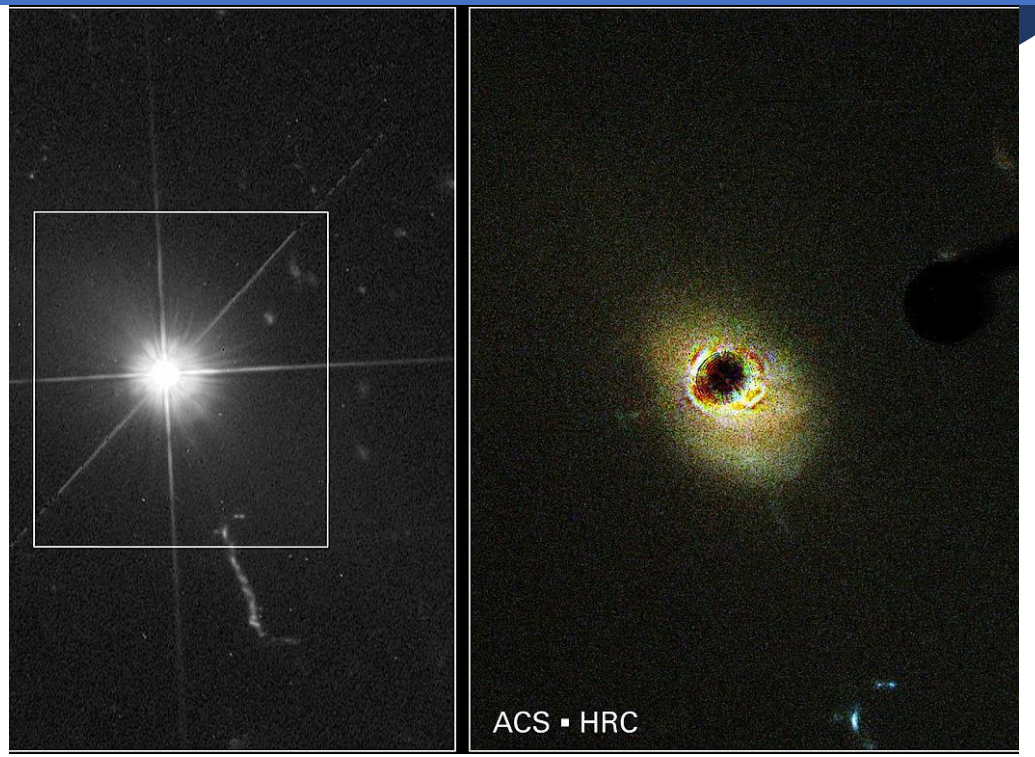
Quasars's spectral line



Stars spectral line

Early observation

- Optical counterpart appeared to be a faint blue star at the location of the radio source
- Schmidt was able to demonstrate that these were likely to be the ordinary spectral lines of hydrogen redshifted by 15.8%.
- They were comparatively of very small size.



Hubble images of quasar 3C 273. At right, a coronagraph is used to block the quasar's light, making it easier to detect the surrounding host galaxy

Implication of early observation

- Reason for red shift could be-:

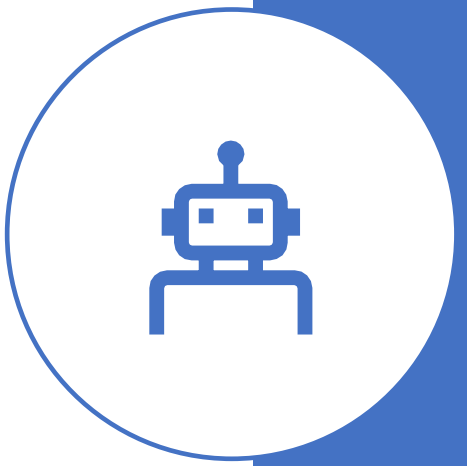
  1) due to the physical motion

  - 3C 273 was receding at an enormous velocity, around 47000 km/s, far beyond the speed of any known star and defying any obvious explanation

  2)due to cosmological reason

  - was far more luminous than any galaxy, but much more compact.

- Applying this to 3C48 meant that, rather than being a star in our galaxy, the quasar was 4 billion light-years away. The astronomers' concept of the size of the universe increased suddenly and dramatically.



Development of physical understanding

- If red shift is caused by first reason then

  1) very distant objects with extraordinarily high luminosity in order to explain large radio signal.

  2) immense power output, far beyond any object seen to date in order to explain extreme brightness.

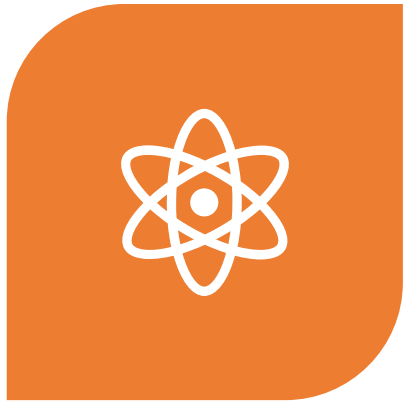
- explanation for the high redshift because of physical motion was not widely accepted at the time.

- if they were very small and much closer to our galaxy, it would be easy to explain their apparent power output, but less easy to explain their redshifts and lack of detectable movement against the background of the universe.

- So we need some new mechanism….!

Quasar engine.

Quasars' extraordinary energy output demanded an extraordinary source: black hole.

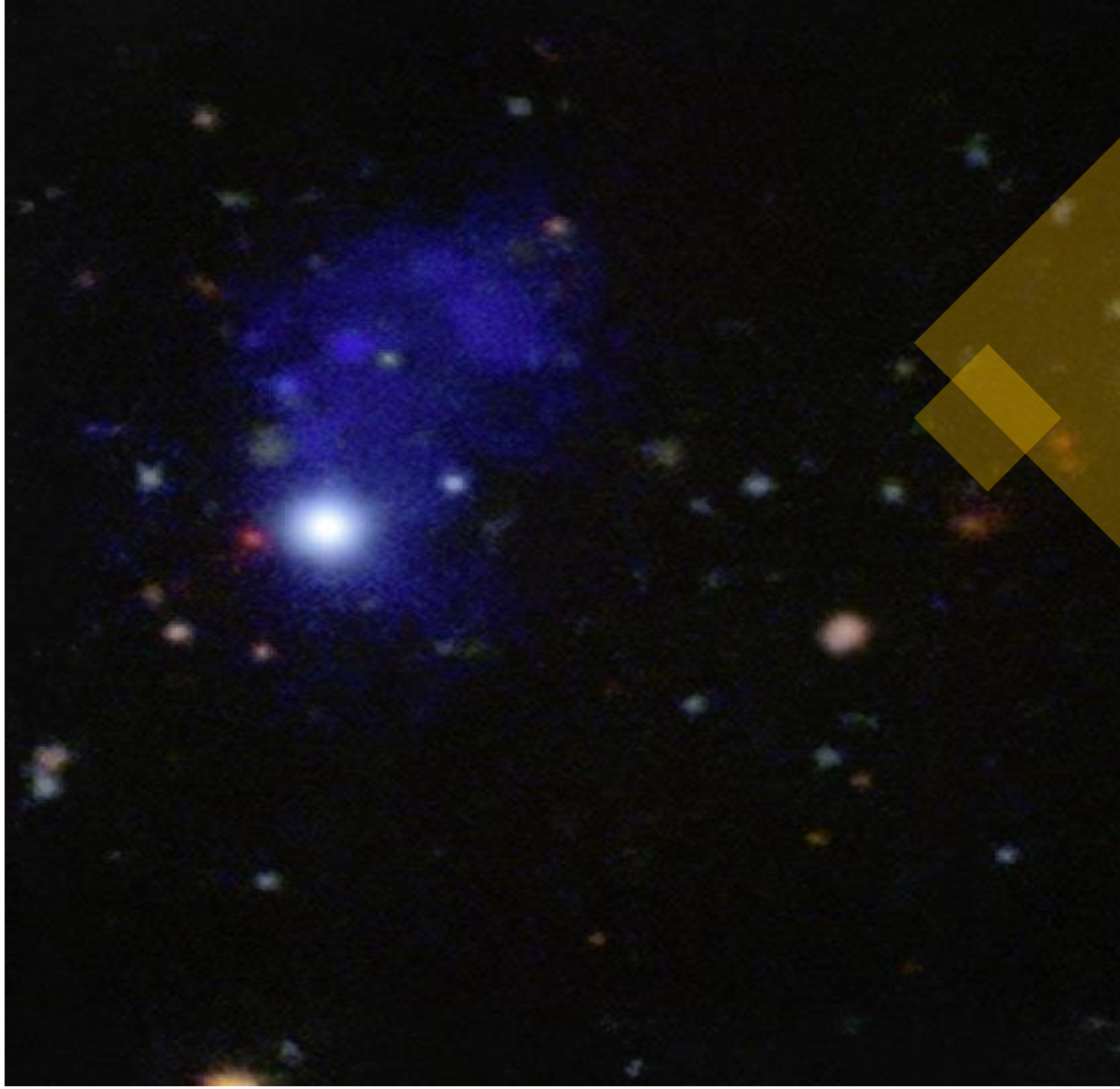


IT WAS PROPOSED PROPOSED THAT A BLACK HOLE COULD BE A POWERFUL ENERGY SOURCE BY ACCRETING GAS FROM NEARBY STARS.

BECAUSE THE GAS WOULD SPIN AROUND THE BLACK HOLE IN A HIGH-VELOCITY ORBIT, IT WOULD BE HEATED TO HIGH TEMPERATURES, CAUSING IT TO RADIATE.

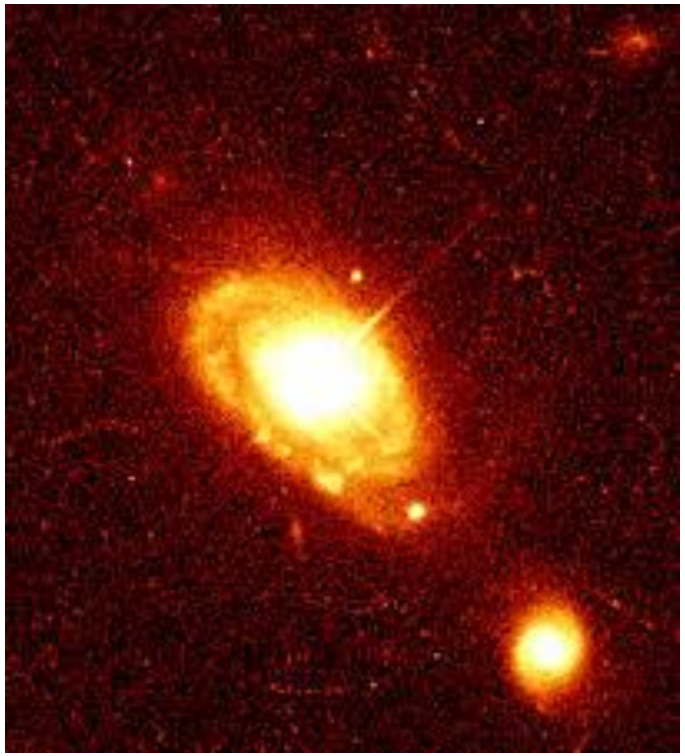
FRICTION WOULD CAUSE SOME OF THE GAS TO FALL INTO THE BLACK HOLE, EMITTING HIGH-ENERGY RADIATION BEFORE IT DISAPPEARED.

- black holes wouldn't have an unlimited fuel supply and that dead quasars could be common in nearby galaxies.
- redshift was not due to the physical motion (special relativity) but rather to light escaping a deep gravitational well (gravitational lensing, general relativity).
- Observational evidence came from M87



This Picture of the Week shows a huge cloud of gas around the distant quasar SDSS J102009.99+104002.7, taken by the Multi Unit Spectroscopic Explorer (MUSE) instrument on ESO's Very Large Telescope (VLT) at the Paranal Observatory

Quasars role in star formation.



- influence the galaxy in which it residesin three ways:

  1)through its jets,

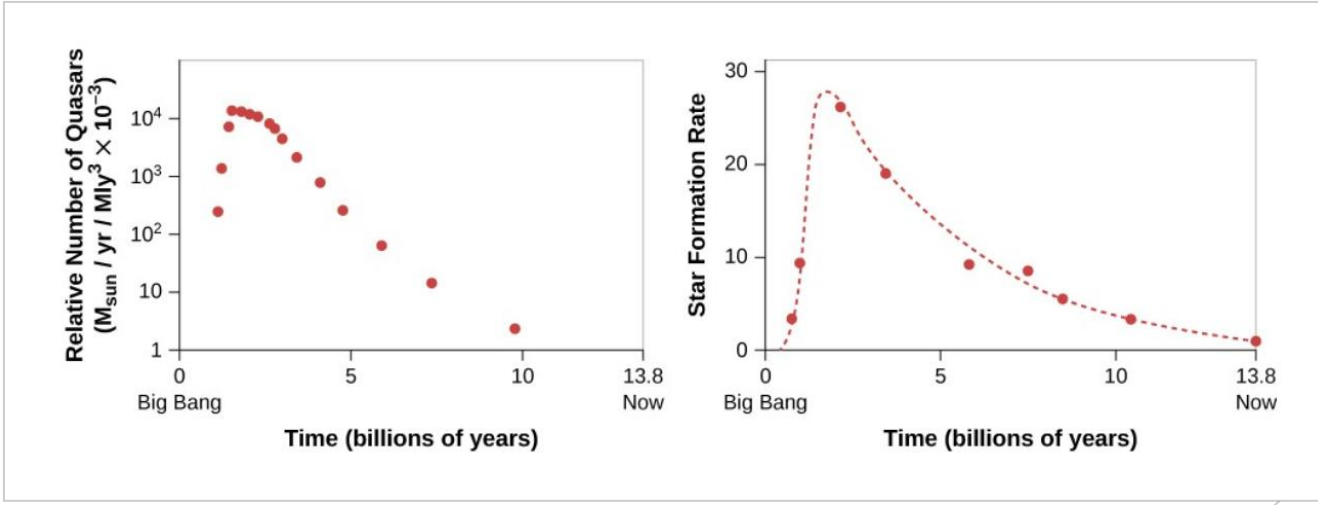
  2)through winds of particles that manage to stream away from the accretion disk,

  3)through radiation from the accretion disk.

- all three can either promote star formation by compressing the surrounding gas and dust—or instead suppress star formation by heating the surrounding gas and shredding molecular clouds,

Understanding the universe through quasars.

- there were more quasars long ago (far away) than there are today (nearby).
- matter in the accretion disk is continually being depleted by falling into the black hole or being blown out from the galaxy in the form of jets, then a quasar can continue to radiate only as long as new gas is available to replenish the accretion disk.



Puzzle ahead

What came first blackhole or galaxy?

Understanding the universe through quasars.

- quasars serve as distant flashlights revealing the properties of the early universe.
  - astronomers have learned that almost all of the hydrogen gas in the early universe was ionized into protons and free electrons within a billion years after the Big Bang
- mapping the filamentary matter structure of the universe.