ASTR 112

Stars & Galaxies

Clicker question solutions

CLICKER: In which topic are you ***most*** interested?

(a) the Sun

(b) telescopes

(c) stars

(d) galaxies

CLICKER: How many stars are in ***our*** solar system?

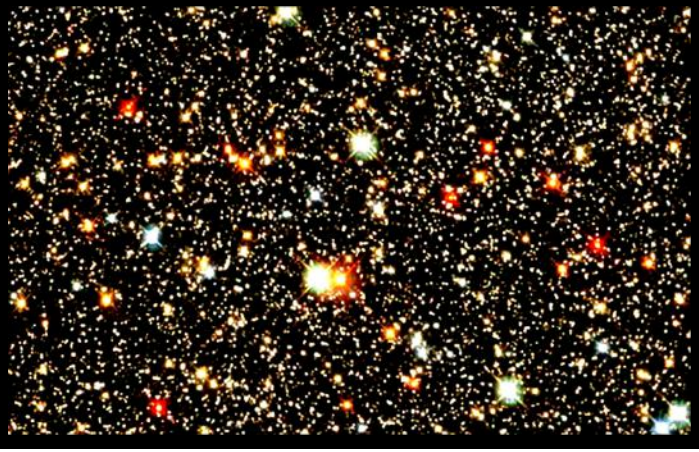
(a) one

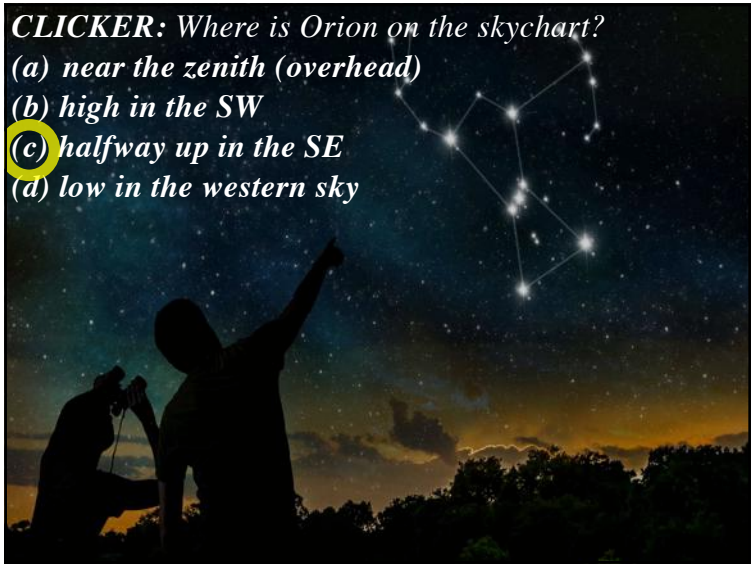
(b) thousands

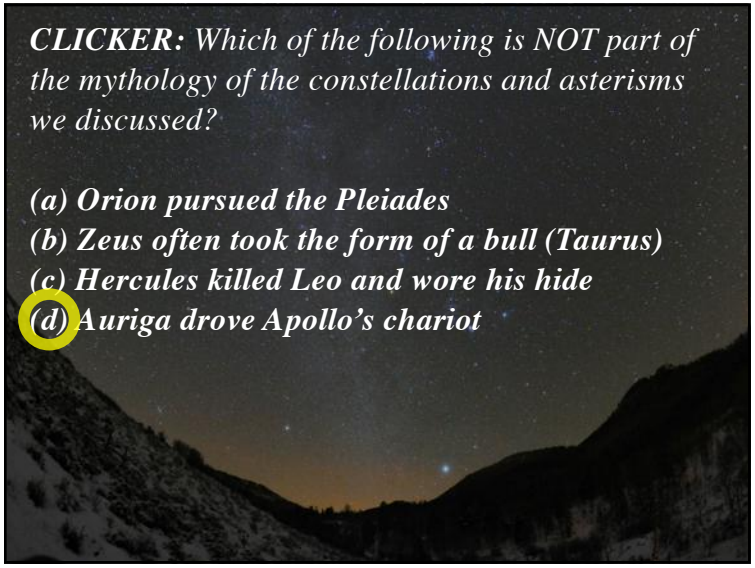
(c) millions

(d) billions and billions…

Navigating the Sky

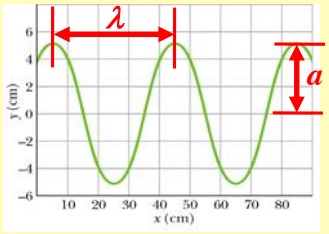






Light

- ***wavelength*** **(λ)**: distance from one peak to the next
- ***amplitude*** **(a)**: *"height"* of the *peaks* of a wave

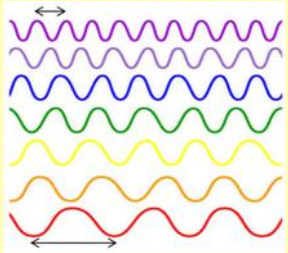


CLICKER: *λ for the wave shown above is:*
(a) 10cm (b) 20cm (c) 30cm (d) 40cm (e) 50cm

(eg) *wavelengths* vary ***tremendously***:
- **radio** waves: λ ~ *km*
- waves on pond: λ ~ *cm*
- **visible light**: λ ~ *nm*

• ***frequency*** *(f):* how *often* wave peaks pass by
(eg) *number of wavelengths per second*

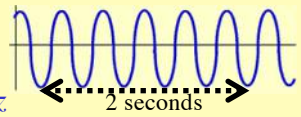
• ***frequency*** has units of
cycles/sec or ***hertz*** (*Hz*)
(eg) *1 Hz = 1 wave*
(peak-to-peak) per second



Q: Have you heard of ***hertz***?

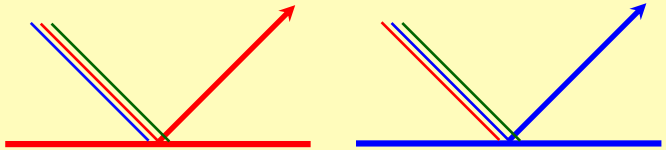
DEMO: *wave generator & speaker*

CLICKER: *What is the **f***
of the wave to the right?
(a) 1Hz (b) 2Hz (c) 2.5Hz (d) 5Hz



Colour

• see *colour* due to *reflected wavelengths*
• other *wavelengths* are *absorbed*



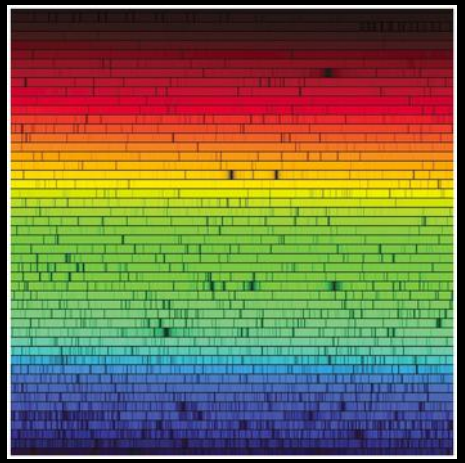
DEMO: laser pointer & coloured plastic

CLICKER: *An object appears **black** if it*
(a) absorbs all wavelengths (b) reflects all wavelengths

CLICKER: *Which of the following is correct?*

(a) radio waves have the lowest frequency
(b) reflection of sunlight causes our blue skies
(c) visible light, radio and X-rays readily pass through Earth's atmosphere
(d) visible light is a large part of the EM spectrum

Atoms & Spectra



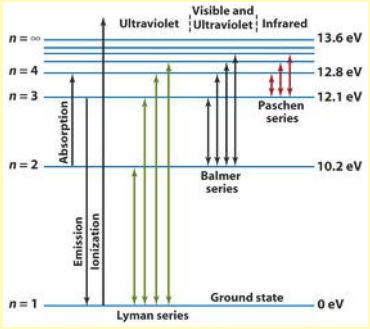
• atoms typically ***neutral*** (# protons **=** # electrons)

• if an atom *gains/loses electron(s)* becomes an ***ion***

Q: *electron in H atom absorbs >13.6 eV & escapes, resulting in… ?*

Q: *Which* ***Balmer*** *transition is most likely to emit UV? Why?*

CLICKER: electrons moving from n=3 to n=2 …



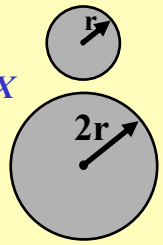
(a) absorb UV (b) absorb visible (c) absorb infrared
(d) emit UV (e) emit visible (f) emit infrared (g) are ionized

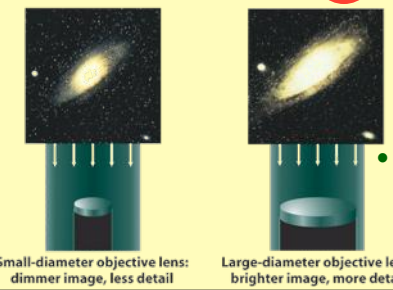
Telescopes

• ***light gathering ability*** depends on ***area*** of mirror or lens ($A = \pi r^2$); related to ***aperture***

CLICKER: *a 6m scope collects how much more light than a 2m scope?*

(a) 2X (b) 3X (c) 6X (d) 9X (e) 12X

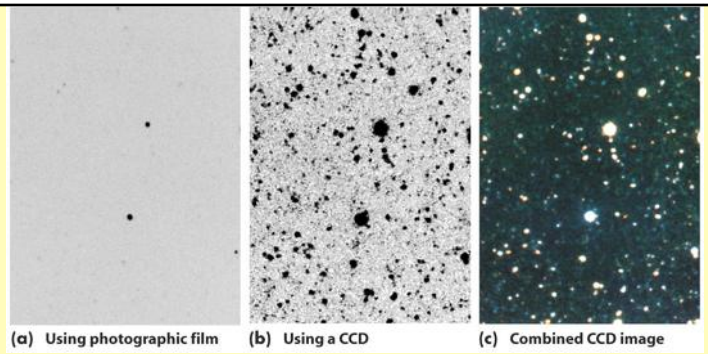




• ***larger scopes*** collect ***more light*** & see ***dimmer objects***

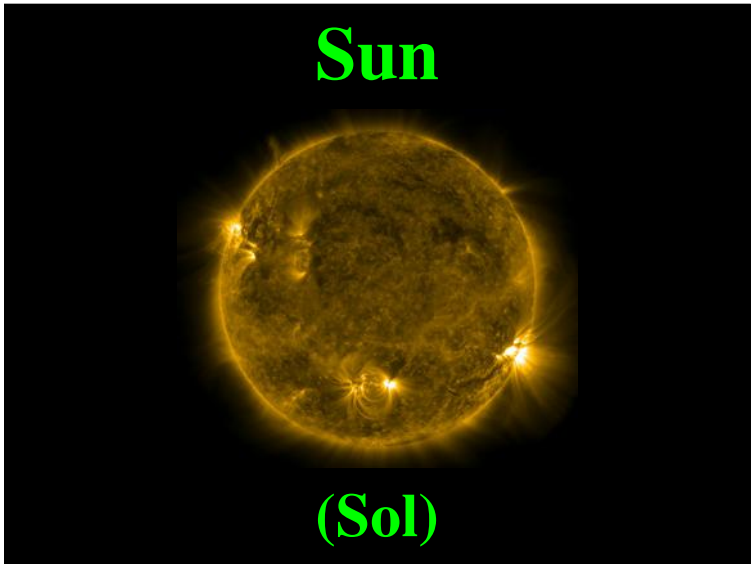
CLICKER: *Which one does NOT affect reflectors?*

(a) spherical aberration
(b) chromatic aberration
(c) lens sag
(d) high cost per inch of aperture



• ***CCD***'s ~ **50x** more sensitive than film

CLICKER: *Astronomers take advantage by….*
(a) taking shorter exposures to get same detail
(b) taking exposures of same length but more faint detail
(c) imaging the entire sky in reasonable time periods



• *energy* is *transported* **outward** from ***core***

• ***conduction****: energy* transfer via *atomic collisions*

(eg) *iron frying pan on the stove*

• ***convection****: energy* carried by *fluid motion*

(eg) *water on the stove; thunderheads*

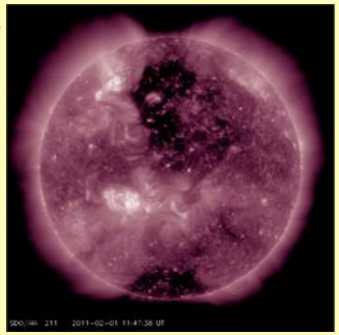
• ***radiation****: energy* radiated via *EM waves*

(eg) *a nice fire;* ***you****!*

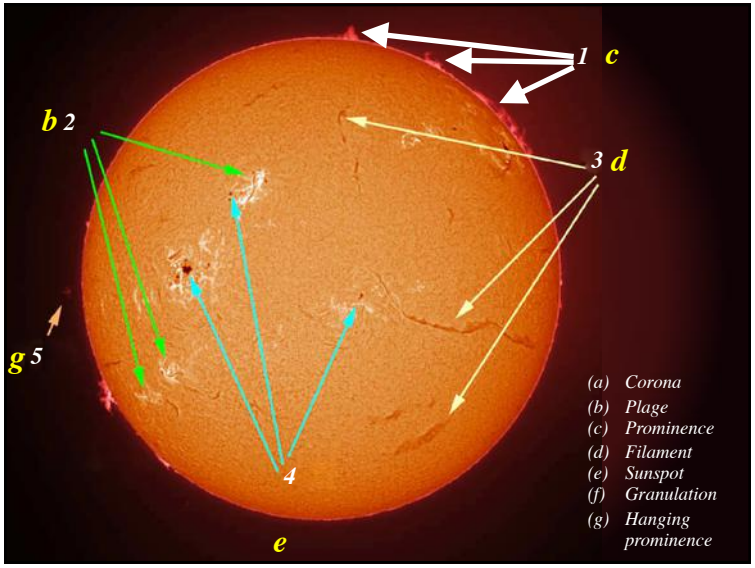
CLICKER: *sunshine warms you mainly due to…*
(a) conduction (b) convection (c) radiation

• corona *emits* ***UV & X-rays***

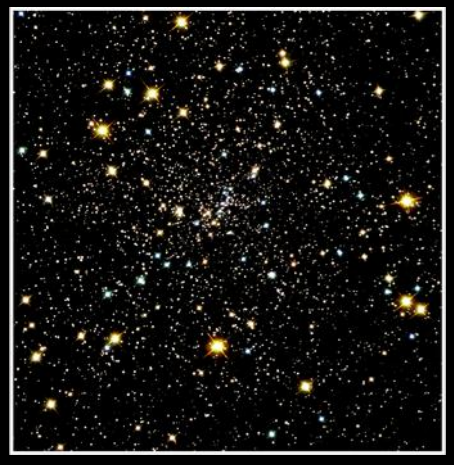
• *only one millionth* as bright as ***photosphere***
• "like" *full moon*



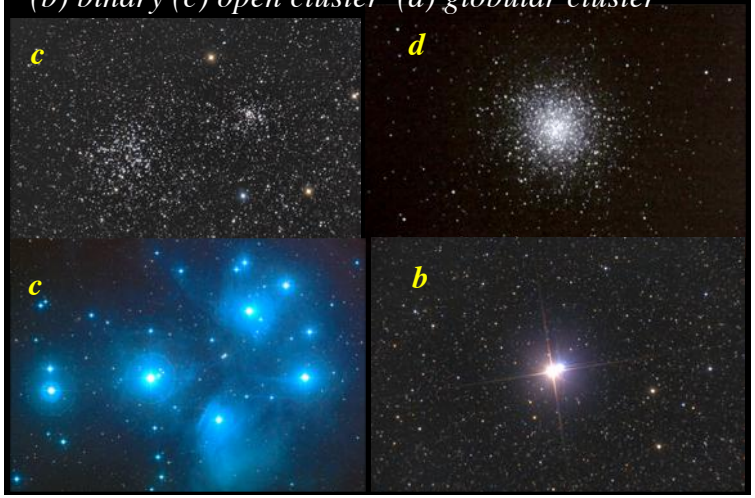
CLICKER: *The corona is very dim relative to the photosphere because…?*
(a) most of the emission is not in visible light
(b) the density is very low
(c) it contains colder gas than the photosphere
(d) magnetic field lines are unable to trap hot gas
(e) both a & b (f) both b & c (g) both c & d



Stars



CLICKER: *Classify the images using(a) single star (b) binary (c) open cluster (d) globular cluster*



Q: *Why* might a star appear *bright* to us on Earth?

- ***apparent magnitude*** **(m)***:*
how bright a star *looks from Earth*

- ***absolute magnitude*** **(M)***:*
how bright a star *would look* **if** it were located *10 parsecs from the Earth*

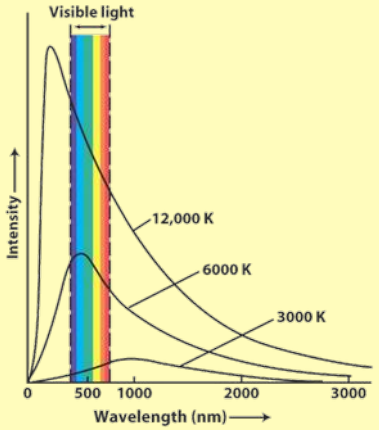
(eg) Sun: m = -26.7; M = +4.8

CLICKER: *A star has m = +6.7; M = +1.2. Is it* ***(a)*** *closer or* ***(b)*** *further than 10 parsecs away?*

- since star appears **dimmer** from Earth (+6.7) than it would if *at 10 parsecs* (+1.2) it must be **further**

• as *temperature* changes, *location of peak* & ***intensity*** *of* ***spectrum*** *changes*

CLICKER: *What colour would a star with a* ***surface temperature*** *of 3000 K appear to be?*
(a) blue (b) yellow
(c) green (d) red



Luminosity

• ***luminosity*** is ***total energy emitted per second***:

$$L = F \times \text{area}$$

• ***L*** has units of ***watts, W***

• ***absolute magnitude*** is *related* to ***luminosity***

Q: Do two stars with ***same F*** but ***different sizes*** emit the ***same total energy***? Can objects with ***different F***'s emit the ***same total energy***?

CLICKER: *L* if Sun had ***same size*** but ***twice as hot…*** ?
(a) *unchanged* (b) 2x (c) 4x (d) 8x (e) 16x

CLICKER: *Why do the hottest spectral types (O and B stars) show so few absorption lines?*

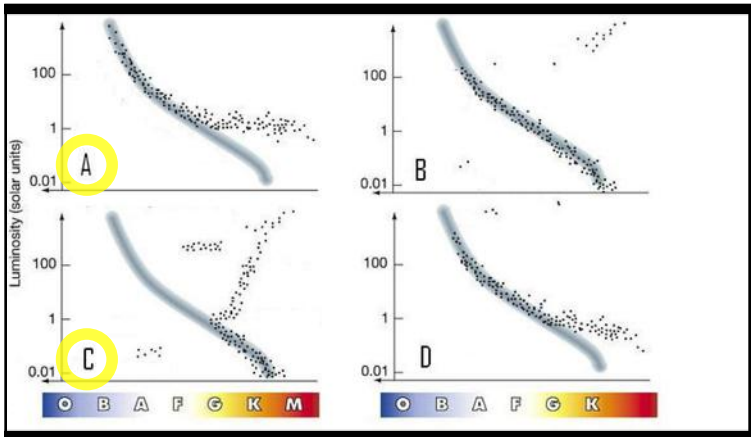
(a) these stars have used up most of their elements
(b) these stars are old & formed before heavy elements were available
(c) O & B stars only produce continuous spectra
(d) most atoms in these stars are ionized and do not readily absorb photons

CLICKER: *In a random sample stars, you would expect most to belong to which group?*

(a) main sequence
(b) giants
(c) super giants
(d) white dwarfs

CLICKER: *The most common type of star is a…*

(a) red dwarf star
(b) yellow (Sun-like) star
(c) blue-white high mass star
(d) blue super-massive star



CLICKER: *Which of the above is the OLDEST?*

CLICKER: *Which of the above is the YOUNGEST?*

Stellar Evolution: Low & Intermediate Mass Stars

CLICKER: What ***stops*** a star's grav collapse?

(a) *solidification of its core*
(b) *an intense stellar wind*
(c) *the rapid rotation of the protostar*
(d) *nuclear reactions in its core*

CLICKER: *Why are Red Giants "red"?*

(a) ***decreased*** energy flux at the star's surface
(b) ***scattering of blue light*** by enhanced envelope
(c) ***increased*** surface temperature
(d) ***contraction*** & ***cooling*** of the star's envelope

Stellar Evolution: High Mass Stars

CLICKER: *Why do we think stars cannot form** with masses greater than ~200 $M_\odot$?*

(a) fusion pressure exceeds gravity in outer layers
(b) rapid rotation at that mass rips the star apart
(c) >200 $M_\odot$ stars immediately become black holes
(d) molecular clouds never contain that much mass

CLICKER: A neutron star is

(a) left behind after a Type Ia supernovae explosion
(b) created immediately after fusion of H ceases
(c) one possible remnant of Type II supernovae
(d) at the center of a planetary nebulae

CLICKER: What is the origin of X-rays often used to identify Black Hole candidates?

(a) the hot, high temperature collapsing core
(b) frictional heating within an accretion disk
(c) cosmic rays due to the intense gravity
(d) neutrons accelerated by intense magnetic fields

The Milky Way

CLICKER: How are globular clusters distributed in the Milky Way?

(a) about the center, within the disk
(b) spherically about the core, in the galactic halo
(c) only in the spiral arms
(d) only in the core/nucleus

CLICKER: The main observable effect of dark matter on galaxies is:

(a) stars near the edges move faster than expected
(b) central supermassive black holes are larger
(c) galactic disks are thicker
(d) much higher rate of star formation in spiral arms

CLICKER: If the spiral arms were "solid", like rotating blades of a fan, then

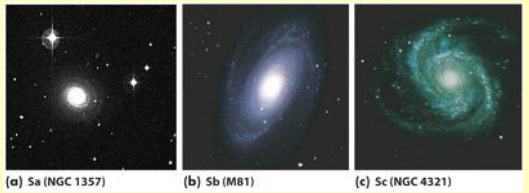
(a) orbital speeds of all stars would be the same
(b) stars closer to edge would move slower
(c) stars closer to the edge would move faster
(d) spiral arms would become "tighter" over time

Galaxies

• ***spiral galaxies*** have *new, hot stars* in spiral arms (“***Population I***” or *metal-rich*) and *older, cooler stars* in core (“***Population II***” or *metal-poor*)

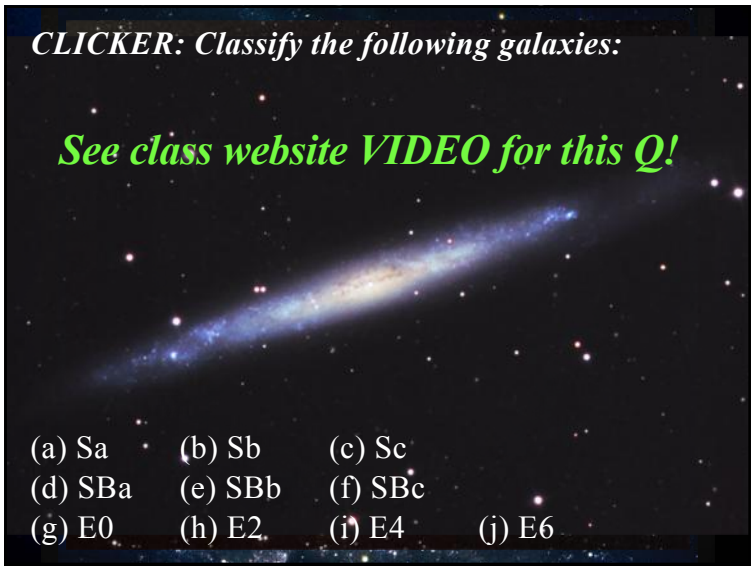
CLICKER: *Which spectra below is Population I?*

• *subdivided* by *spiral arm tightness, dust, core size*



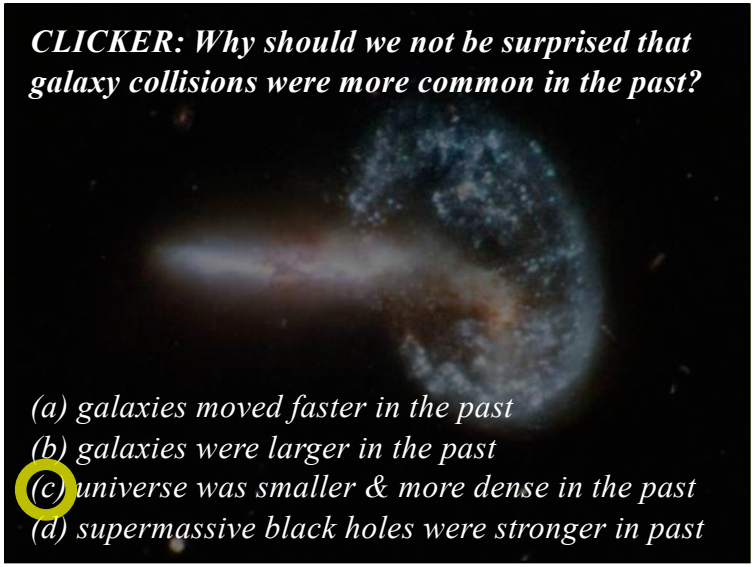
CLICKER: Classify the following galaxies:

See class website VIDEO for this Q!

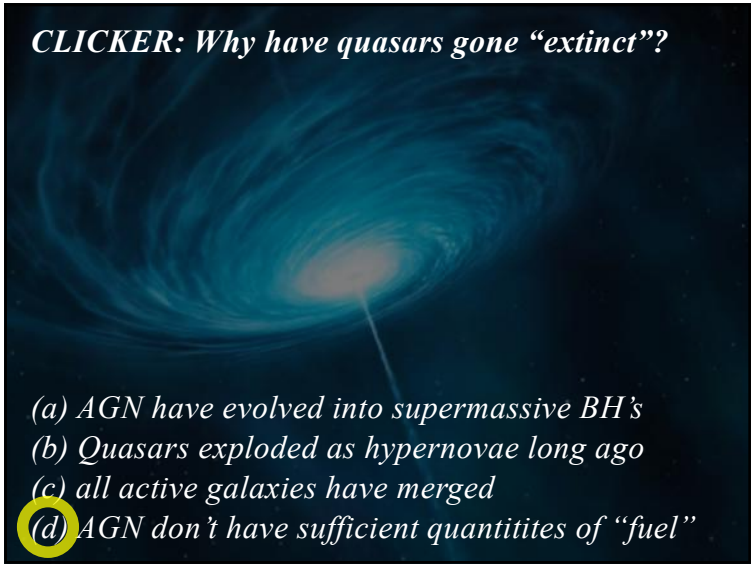


(a) Sa (b) Sb (c) Sc
(d) SBa (e) SBb (f) SBc
(g) E0 (h) E2 (i) E4 (j) E6

CLICKER: Why should we not be surprised that galaxy collisions were more common in the past?



(a) galaxies moved faster in the past
(b) galaxies were larger in the past
(c) universe was smaller & more dense in the past
(d) supermassive black holes were stronger in past


CLICKER: Why have quasars gone "extinct"?
(a) AGN have evolved into supermassive BH's
(b) Quasars exploded as hypernovae long ago
(c) all active galaxies have merged
(d) AGN don't have sufficient quantitites of "fuel"