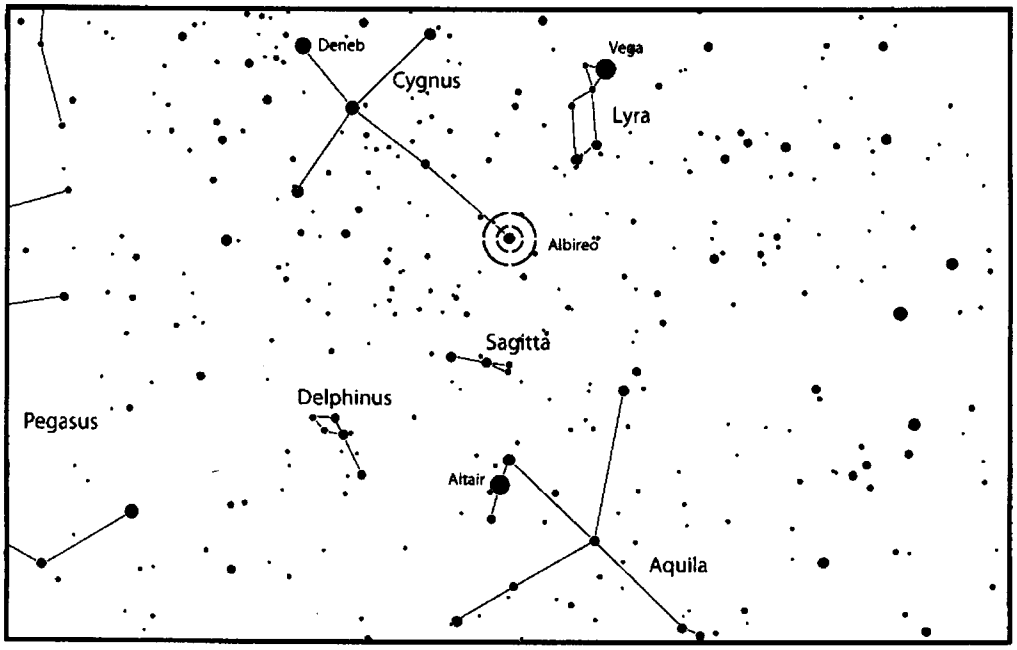
ϕ1040 - ASTRONOMY
MIDTERM 2

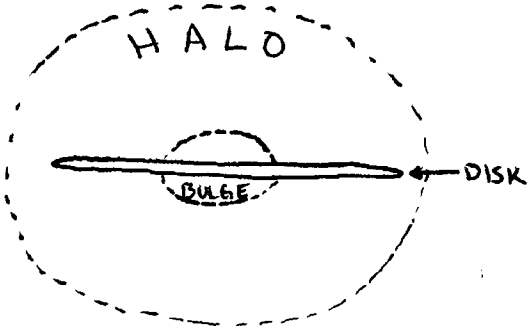
① WHAT CAN WE SAY ABOUT ALBIRED FROM BRIGHTNESS AND COLOR?

(a) The bluer star is likely the hotter star, and the redder star is cooler

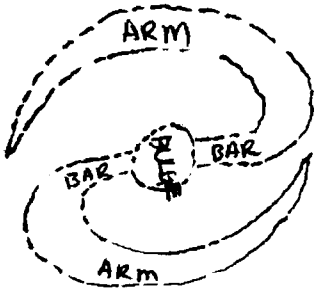
(b) Even though the golden star is cooler, it is possible for it to be brighter than the blue star if it is LARGER. The larger surface area radiates more light than a smaller area.



② SKETCH A TYPICAL BARRED SPIRAL GALAXY



EDGE ON VIEW



FACE-ON VIEW

→

③ Evidence for Supermassive Black Holes

(a) In the Milky Way we can see stars orbiting Sgr A* a bright radio source at the center of the galaxy. From the observed orbits we determine Sgr A* is very compact and a mass of ~ 4 million solar masses.

(b) In other galaxies we sometimes see highly collimated jets which could be powered by massive black holes. Additionally there is a known relationship between the size of a galaxy's central bulge and the mass of the black hole at its center — big bulge means big black hole.

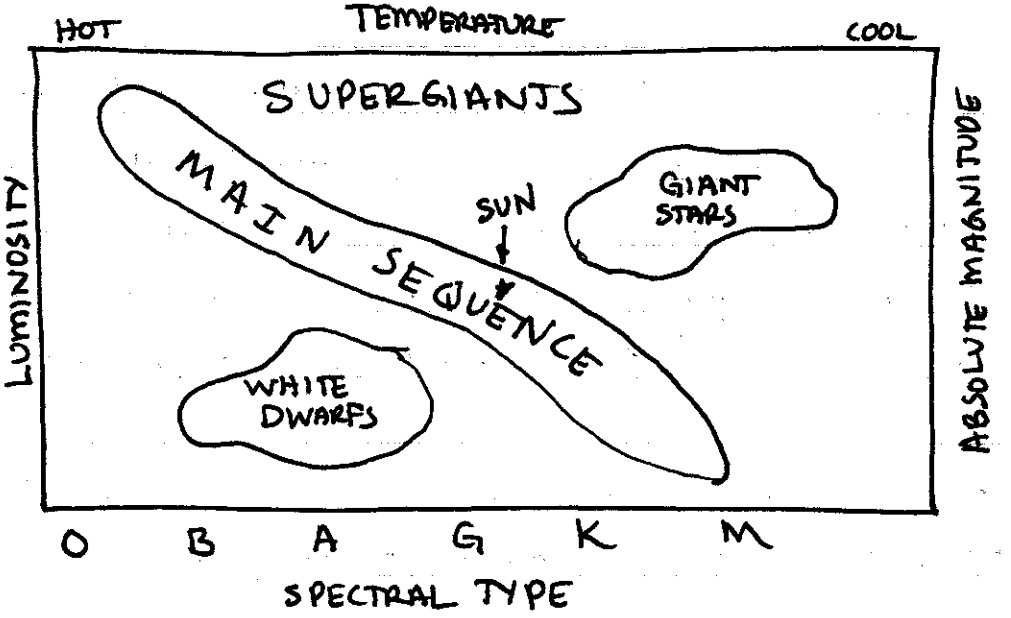
(c) The primary evidence for black holes in QSOs is the enormous energy output — black holes are one of the few possible explanations. Additionally QSOs also show highly collimated jets, like some galaxies.

④ How do Supernovae Affect Metallicity?

Supernovae explosions generally enrich the galactic medium by explosively sending out heavy elements that were made during a star's life or during the SN event itself.

After the SN explosion the gas has <u>HIGHER METALLICITY</u> because some nucleosynthesis occurs during the explosion (particularly elements beyond <u>IRON</u>.

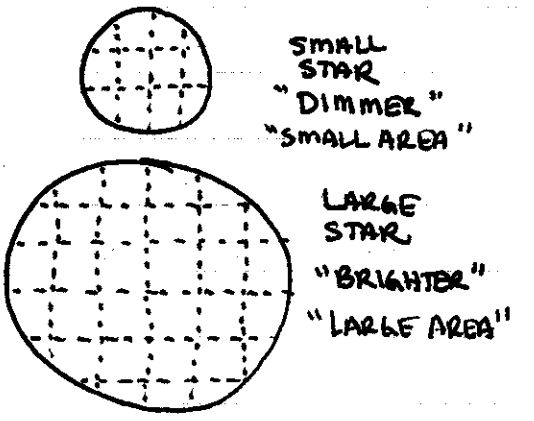
⑤



The HR Diagram is extraordinary useful for mapping and understanding the evolution of stars, determining the kind of star (dwarf, main sequence, giant) from easily measurable properties (color and brightness), and for determining the ages of stellar clusters.

⑥ HOW CAN TWO STARS HAVE SAME TEMPERATURE BUT DIFFERENT BRIGHTNESS?

Stars with the same surface temperature emit the same amount of light from each small part of their surface. What we think of as a star's brightness is all of these small bits of light added together. A star can appear BRIGHTER if it is LARGER because there are more little bits of surface sending out light.



⑦ DESCRIBE WHY SOME REGIONS OF THE GALAXY LOOK BLUER OR REDDER.

The color of different regions of a galaxy are created by the stars that live in those regions. Hot young stars are usually very blue (high energy) while cooler older stars are usually redder (lower energy). As a general rule then the bluest regions of an observed galaxy have younger stars and are typically STAR FORMING REGIONS. Star formation is often triggered by strong perturbing events such as galaxy collisions, so colliding galaxies often show a strong red/blue contrast between different regions.

⑧ AN OBJECT SHOWS 2640 SECOND VARIABILITY. WHAT IS ITS MAX SIZE?

The maximum size is given by the distance light can travel in the variability time. Nothing can travel FASTER than light, so this is the maximum size.

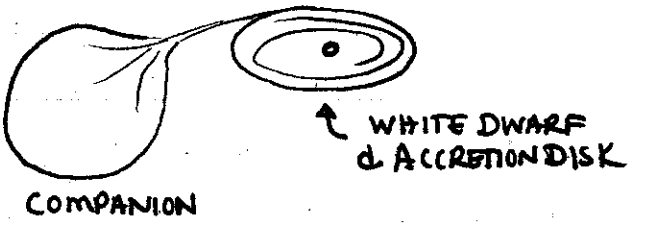
$$R = c \cdot \Delta t = \left(3.0 \times 10^8 \tfrac{m}{s}\right)(2640s) = 7.92 \times 10^{11} m$$

$$= 792{,}000{,}000{,}000 m = 5.3 \text{ AU}$$

This is a method by which the size of BLAZARS is estimated.

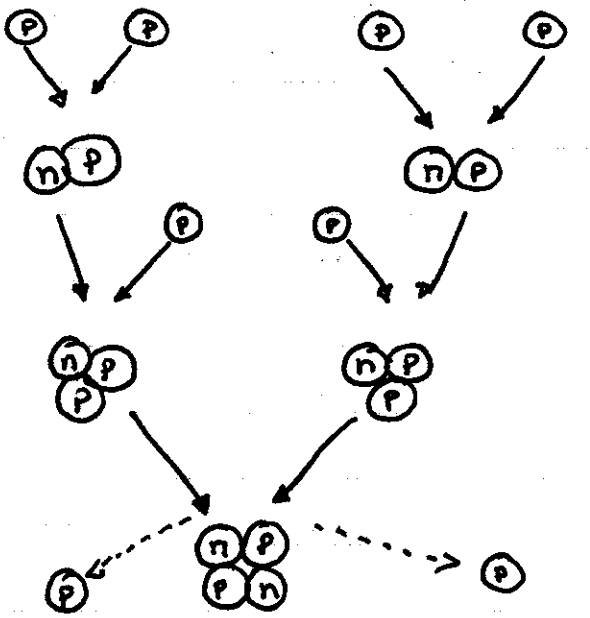
⑨ WHY MIGHT NOVA BE CALLED NOVA WHEN THEY ARE OLD STARS?

Nova are (sometimes) recurrent explosions caused by accretion onto the surface of a white dwarf (an OLD EVOLVED STAR) from a companion star. When enough material is on the surface of the white dwarf, a themonuclear explosion can occur. This explosion greatly increases the brightness of the star for a time. Often the star was NOT visible in the night sky, but during the explosion it IS bright enough to be seen — it is a "new star"!



⑩ EXPLAIN THE PROTON-PROTON CHAIN.

The proton proton chain converts six protons into two free protons and a helium atom. Several other particles are given off in the process, which I ignore here. The 3 basic steps are:



① $p + p \rightarrow$ DEUTERIUM (pn)

② $pn + p \rightarrow$ HELIUM 3 (ppn)

③ $He^3 + He^3 \rightarrow$ HELIUM (ppnn) + p + p