Alvl P2: Telescopes (optional) Cheat Sheet
by MostAncientDream via cheatography.com/168994/cs/42317/

Overview

Convex Lens	() - *focuses incident light
Concave Lens	)(- spreads out* incident light
Principle Axis	the line passing through the centra of the lens, 90' to its surface
Real Image	formed when light rays **cross** after refraction
Virtual Image	formed on the same side of the lens, where the rays **dont cross**
Power of a lens	a measure of how closely a lens can focus a beam that is parallel to the princple axis

Equations

Lens formula- 1/f	1/u +1/v ---(where u is the d from object to centre of lens, v is image for centre and f is focal length)
Power (dioptres/D)	1/f
normal adjustment	fo + fe (focal length till focal point + distance between focal point and distance to eyepiece))
Anglar Magnication	angle subtended by image at the eye/ angle subtended by the object at the unaided eye
"	fo / fe (where angles are less than 10')

Equations (cont)

minimum angular resolution	lambda / D (diameter of objective lens/mirror)
angle subtened	diameter x distance

with reference to minimum angular resolution --> the smaller the angle the better the quality/resolution

Adv of large diameter telescopes

collecting power- a measure of the ability of a lens/mirror to collect incident em radiation (proportional to the area of the objective lens)
resolving power- ability of a telescope to produce separate images of close together objects
-for this to happen the angle between striaght lines from earth to object must be at least the minimum angular resolution 0 = lambda/D
-this is also known as the **Rayleigh Critierion** which states:
two objects will not be resolved if any part of the central maximum of either image falls within the first minimum diffraction ring of the other
CCD (charged couple device)- array of light-sensitive pixels, which become charged when they are exposed to light via photoelectric effect
quantum efficiency-percentage of incident photons which cause an electron to be released
spectral range- detectable rang eof wavlengths of light
pixel resolution- total number of pixels used to form an image
spatial resolution- minimum distance two objects must be apart to be distinguishable

comparing CCD and human eye

quantum eff	~80%	4-5%
spectral range	IF,UV,visible	visible
Pixel res	varies but ~50 megapixels	~500 megapixels
spatial res	10 micrometers	100 micrometers

CCD are more useful for detecting finer details and producing images which can be shared and stored

Astronomical Telescopes

tba

Ray diagram for a refracting telescope in normal adjustment (c-PMT)

Normal adjustment- when the distance between the lenses is the sum of their focal lengths
this means the principle focus for these two lenses is in the same place

More Telescopes

Refracting telescopes have two converging lenses
- **objective lens** used to collect light and create a real image of a distant object
> should have long focal length, large area to collect as much light as possible
-**eyepiece lens** used to magnify the image produced. it produces a virtual image at infinity since the light rays are parallel reducing eye strain.
collecting power is directly proportional to the square of the radius of the objective lens

Reflecting telescopes

Cassegrain Reflecting Telescope:
- involves a primary concave mirror and secondary convex mirror

Mirrors in relfecting telescopes are a thin coating of aluminium/silver atoms that are deposited onto a backing material
- this allows the mirrors to be smooth and minimises distortion

need to know how to draw a diagram of cassegrain.
points to note:
- mirror curves are clearly shown
- add the eye piece at the end
- rays have arrows and start parallel

Comparing refracting/reflecting telescopes

disadv of refracting	adv of reflecting
glass must be pure, free from defects (hard for large diameters)	mirrors are unaffected by chromatic aberr, spherical can be avoided using parabolic mirrors
Large lens can bend/distort under their own weight	mirrors are not as heavy as lenses therefore easier to handle and manoeuvre
affects by both chromatic and spherical aberration	though chromatic aberr can affect eyepiece, it can be solved using achromatic doublet
large magnifications require very large diameter obj lens with very long focal lengths	mirrors that are a few nm thick can be made and give esxcellent image quality

Comparing refracting/reflecting telescopes (cont)

lenses can only be supported from the edges which is difficoult as they are heavy and large	large primary mirrors are easy to support from behind as you dont need to see through them

Aberration

Chromatic-	Spherical-
for a given lens the focal length of the red light is greater than the blue light meaning the y are focused at different points	the curvature of a lens/mirror can cause rays of light at the edge to be focused in a different position to those near the centre (outside has shorter focal legnth)
this can cause a white object to produce an image with coloured fringing	this leads to image blurring and distortion
as its caused by refraction it has little effect on relfecting telescopes and only occurs in the eyepiece lens	as its most pronounced in lenses with a large diameter it can be avoided completely by using parabolic objective mirrors

Achromatic doublet- a way of minimising spherical and chromatic aberration in lenses

- consists of a convex lens made of crown glass and a concave lens made of flint glass cemented together to bring all rays of light into focus at the same position

(imagine convex next to concave)

Telescope types-

radio
- lowest energy,longest wavelength, can travel through dense interstellar clouds and allow to see motion of cold gas

infrared
- used to see through cold dust in order to study warm gas/dust and relatively cool stars as well as molecular absorptions

visible
- most stars emit the bulk of their em energy as, hotter-blue, colder- red

UV
- emitted by the hot glow of the stellar nurseries and indentifies hottest/most energetic stars

X-ray
- come from hottest gases that contain atoms, emitted from neutron stars or clouds of gas heated to millions of degrees including superheated material around a blackhole

gamma
- highest energy, smallest wavelength, come from free electrons and stripped atomic nuclei accelerated by powerful magnetic fields in exploding stars, colliding neutron stars and supermassive black holes
- also used to observe gamma ray bursts, quasars and black holes

types of GRB:
-**short lived** > last between 0.01 and 1 second (associated with merging neutron stars/neutron str falling into a black hole)
-**long lived** > last between 10 and 1000 seconds (associated with a type 2 supernova-death of a massive star)

Telescope types- Radio and optical

similarities	differences
function in the same way- intercept and focus incoming radiation to detect its intensity	as radio is larger than visible, radio telescopes have to be larger in diameter to achieve the same quality/resolving power (as they have larger diameter they will have larger collecting power)
both can be moved to focus on different sources of radiation/to track a moving source	construction of radio is cheaper and simpler as a wire mesh is used instead of a mirror (mesh size must be less than lambda/20 to avoid refraction and reflect)
parabolic dish of radio is similar to objective mirror of reflecting optical	a radio must move across an area to build up an image unlike optical
both can be built on the ground since both waves can pass through the atmosphere	radio experiences large interferance from man-made sources, optical is only natural sources eg weather, light pollution