Distance measurement of stars

Medium of Observation: Electromagnetic Radiation

} Elementary particles + Nuclei

Light:

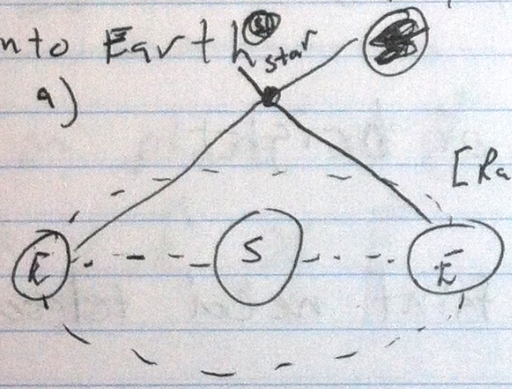
~~I)~~ Ray optics (pretending light travels in straight lines)

A) Deductions - ~~300 km~~

1) Radius of orbit 1.5×10^{11} m = 1 AV (average)

Sun to Earth

a)



$\theta = \frac{2AV}{D}$ [Radians]

$\rightarrow D = \frac{2AV}{\theta}$

~~close objects~~

$1\,ly \approx 10^{16}$ m

2π rad = 360°

$1^\circ = 60'$

$1' = 60''$

Measurement of θ requires very precise measuring equipment

$1\ parsec = \frac{1\,AV}{1''} = 3 \cdot 10^{16}$ m (roughly 3 ly)

$= 206,265\ AV$

II. How bright something appears with distance

$$\text{Intensity}(D_2) = I(D_1) \cdot \frac{D_1^2}{D_2^2}$$

On Earth, $I_\odot = 1.3 \ \frac{kW}{m^2}$

Measure of Brightness: Magnitude m (apparent)

- 1. Super Bright
- 0 → Really Bright
- 5 kind of bright
- 10 very faint need telescope

$M_\odot = -26.83$

Brightness is ~~togrit~~ log-scale

apparent mag:
$$m = -2.5 \lg\left(\frac{I[obj]}{I[m=0]}\right)$$

Logarithm to base 10

abs. Mag:
$$M = m + 2.5 \lg\left(\frac{10pc^2}{r^2}\right) = m + 5 \lg\left(\frac{10pc}{r}\right)$$

$$= m - 5 \lg\left(\frac{r}{10pc}\right)$$

Electromagnetic Waves

Light-Wave Approach

plane wave $\vec{E}(t, \vec{r}) = \vec{E}_0 \cos(\vec{k} \cdot \vec{r} - \omega t)$

($\vec{E}$: electric field)

$\vec{k}$: k = direction of propagation

$k = \frac{2\pi}{\lambda}$ $\quad \omega = 2\pi f = \frac{2\pi}{T}$

* in vacuum $\frac{\omega}{k} = c$

$\vec{E}_0 \perp \hat{k}$

$\vec{B}$ in phase w/ $\vec{E}$

$\vec{B} = \frac{1}{c} \hat{k} \times \vec{E}$

$\vec{\nabla} \cdot \vec{E} = \frac{\rho}{\varepsilon_0} = 0$

$\vec{\nabla} \cdot \vec{B} = 0$

$\vec{\nabla} \times \vec{E} = -\frac{\partial \vec{B}}{\partial t}$

$\vec{\nabla} \times \vec{B} = +\mu_0 \varepsilon_0 \frac{\partial \vec{E}}{\partial t}$

Maxwell's equations explain why electric and magnetic fields are transverse, their relationship to each other, and why the phase velocity is the speed of light.