September 3

Damon's Office Hours: Tuesdays, 4-6 in Thaw 210

Group contracts and 2nd homework due Friday

Unit Vectors

Direction and magnitude

$\vec{a} = |\vec{a}|\hat{a} \Rightarrow \hat{a} = \frac{\vec{a}}{|\vec{a}|}$

magnitude: $\sqrt{x^2+y^2+z^2}$; direction (unit vector)

a: unit vector in direction of $\langle 1,1,1 \rangle$ m

b: ——— , ——— $\langle 2,2,2 \rangle$ m

c: ——— , ——— $\langle 3,3,3 \rangle$ m

$\hat{a} = \langle 0.577, 0.577, 0.577 \rangle$

It's in the stars

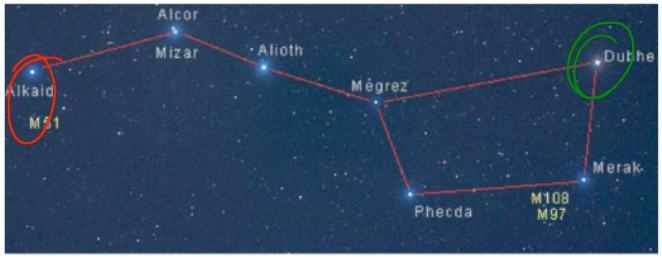
X	y	z
12.2	92.5	-48.2
11.2	66.6	-42.8
1.5	72.5	-53.3
-2.3	54.5	-35.3
-9.1	58.0	-38.1
-18.0	72.0	-47.2
-61.6	159.3	-122.2

from visual import *

sphere(pos=vector(12.2, 92.5, -48.2))

.
.
.

scene.forward = (0, 0.8, -0.5)
scene.range = 1



Name	x (lyr)	y (lyr)	z (lyr)
Dubhe	12.1	92.5	-48.2
Merak	11.1	66.6	-42.9
Phecda	1.4	72.5	-53.3
Megrez	-2.4	54.5	-35.3
Alioth	-9.1	58.0	-38.1
Mizar	-18.1	72.0	-47.2
Alkaid	-61.8	159.2	-122.2

Dubhe to Earth distance? 105 lyr

How long does it take light to travel from Alkaid to Dubhe?

What is distance of Alkaid from Earth? 210 lyr

What is unit vector from Alkaid to Earth?

Δ Symbolizes change

final - initial

$\Delta\vec{r}$ = relative position vector

$= \vec{r}_f - \vec{r}_i = \vec{r}_D - \vec{r}_A$

Motion in 3D

$$\vec{v}_{ave} = \frac{\vec{r}_f - \vec{r}_i}{t_f - t_i} = \frac{\Delta \vec{r}}{\Delta t}$$

$\Delta \vec{r}$: change in position

Δt: change in time

$$\vec{r}_f = \vec{r}_i + \vec{v}_{ave}\,\Delta t$$

Position update formula

$$x_f = x_i + v_{ave_x}\,\Delta t$$

$$y_f = y_i + v_{ave_y}\,\Delta t$$

$$z_f = z_i + v_{ave_z}\,\Delta t$$

Traveling in the Big Dipper

What is average speed of Spaceship that flies from Alkaid to Dubhe in 372 yrs?

$C = 3 \times 10^8 \text{ m/s}$

$1 \text{ lyr} = 3 \times 10^8 \text{ m/s yr}$

$\frac{1}{3} \frac{\text{lyr}}{\text{yr}} = \frac{1}{3} \frac{3 \times 10^8 \text{ m/s yrs}}{\text{yrs}} = 1 \times 10^8 \text{ m/s}$

You are the helmsperson. Which way do you head?

$$\Delta\vec{r} = \vec{r}_D - \vec{r}_A = \langle 12.2 - (-61.8),\ 92.5 - 159.2,\ -48.2 - (-122.2) \rangle \text{ lyrs}$$

$$= \langle 73.9,\ -66.7,\ 74.0 \rangle \text{ lyr}$$

$$|\Delta\vec{r}| = 124 \text{ lyrs}$$

$$\hat{\Delta r} = \frac{\Delta\vec{r}}{|\Delta\vec{r}|} = \langle 0.596,\ -0.538,\ 0.597 \rangle$$

On 100 anniversary of launch, where are you?

On 100yr anniversary, where are you?

$$\vec{r}_f = \vec{r}_i + \vec{v}_{ave}\,\Delta t$$

$$= \vec{r}_A + |\vec{v}_{ave}|\,\hat{v}_{ave}\,\Delta t$$

$$= \langle -61.8, 159.2, -122.2 \rangle \text{ lyrs} + \frac{1 \text{ lyr}}{3} \langle 0.596, -0.538, 0.597 \rangle 100 \text{ yr}$$

$$= \langle -419, 141.3, -102.3 \rangle \text{ lyrs}$$

Momentum

Must be interaction with one or more objects to cause a change in motion

Momentum combines mass m and velocity

$$\vec{p} = \gamma m \vec{v}$$

$$\gamma = \frac{1}{\sqrt{1 - \frac{|\vec{v}|^2}{c^2}}}$$

$\vec{p}$ is always in the same direction as $\vec{v}$.