$\vec{a} = \langle a_1, a_2, a_3 \rangle$

$\|\vec{a}\| = \sqrt{a_1^2 + a_2^2 + a_3^2}$

From the graphs we see

$$\frac{a_1}{\sqrt{a_1^2+a_2^2+a_3^2}} = \cos(\alpha) \rightarrow a_1 = \sqrt{a_1^2+a_2^2+a_3^2}\ \cos\alpha$$

$$\frac{a_2}{\sqrt{a_1^2+a_2^2+a_3^2}} = \cos(\beta) \rightarrow a_2 = \sqrt{a_1^2+a_2^2+a_3^2}\ \cos\beta$$

$$\frac{a_3}{\sqrt{a_1^2+a_2^2+a_3^2}} = \cos(\gamma) \rightarrow a_3 = \sqrt{a_1^2+a_2^2+a_3^2}\ \cos\gamma$$

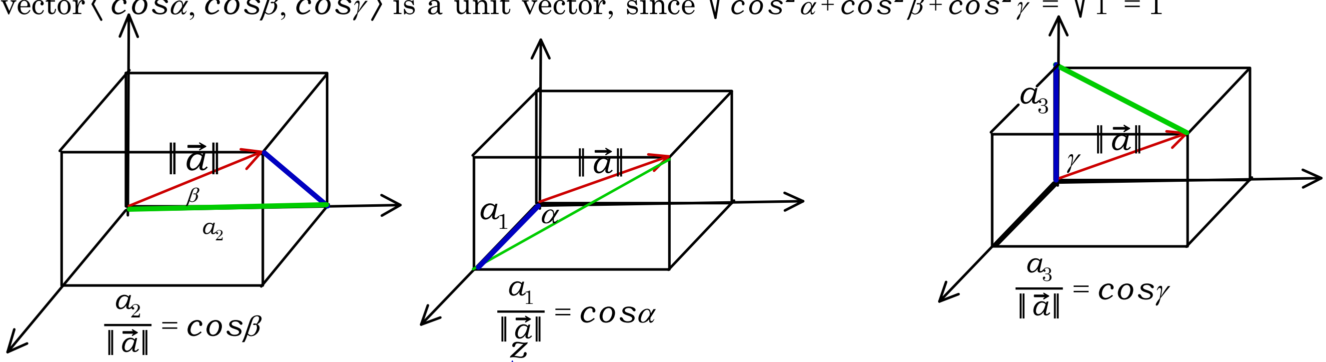
So squaring and adding gives us

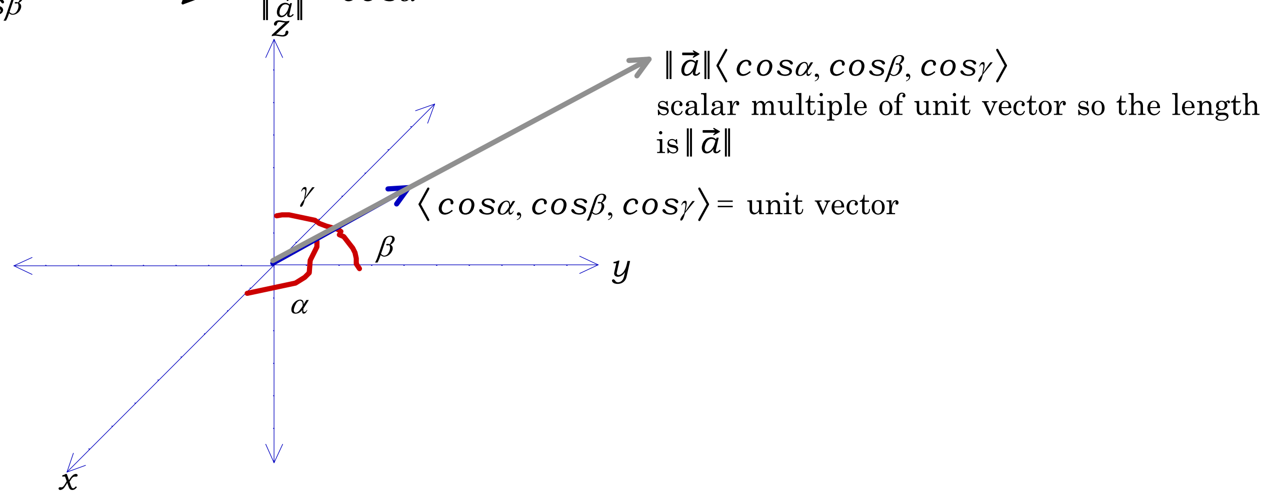
$$\cos^2\alpha + \cos^2\beta + \cos^2\gamma$$
$$= \left(\frac{a_1}{\sqrt{a_1^2+a_2^2+a_3^2}}\right)^2 + \left(\frac{a_2}{\sqrt{a_1^2+a_2^2+a_3^2}}\right)^2 + \left(\frac{a_3}{\sqrt{a_1^2+a_2^2+a_3^2}}\right)^2$$
$$= \frac{a_1^2}{a_1^2+a_2^2+a_3^2} + \frac{a_2^2}{a_1^2+a_2^2+a_3^2} + \frac{a_3^2}{a_1^2+a_2^2+a_3^2}$$
$$= \frac{a_1^2+a_2^2+a_3^2}{a_1^2+a_2^2+a_3^2} = 1$$

So we can write , using the red parts:

$$\langle a_1, a_2, a_3 \rangle = \left\langle \sqrt{a_1^2+a_2^2+a_3^2}\ \cos\alpha\ ,\ \sqrt{a_1^2+a_2^2+a_3^2}\ \cos\beta,\ \sqrt{a_1^2+a_2^2+a_3^2}\ \cos\gamma \right\rangle$$

$= \langle \|\vec{a}\|\cos\alpha, \|\vec{a}\|\cos\beta, \|\vec{a}\|\cos\gamma \rangle = \|\vec{a}\| \langle \cos\alpha, \cos\beta, \cos\gamma \rangle$ but above we see the vector $\langle \cos\alpha, \cos\beta, \cos\gamma \rangle$ is a unit vector, since $\sqrt{\cos^2\alpha + \cos^2\beta + \cos^2\gamma} = \sqrt{1} = 1$





If we let the angles range over 0 to π,