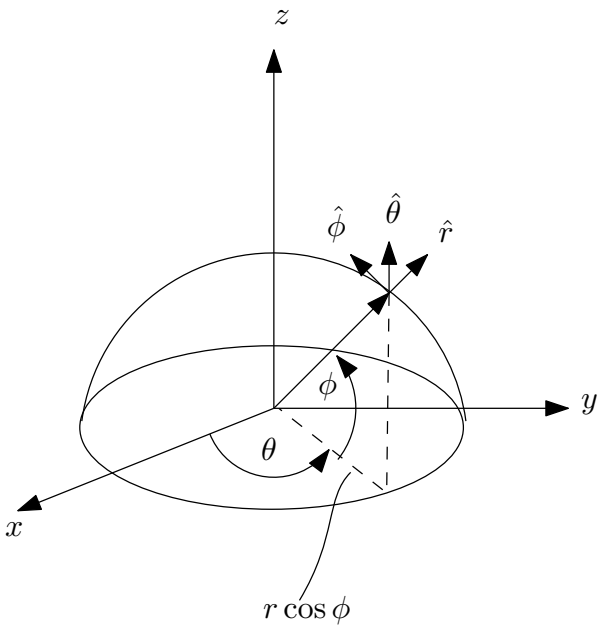

$$x = r\cos\phi\cos\theta$$

$$y = r\cos\phi\sin\theta$$

$$z = r\sin\phi$$

$$r = \sqrt{x^2+y^2+z^2}$$

$$\theta = \tan^{-1}\frac{y}{x}$$

$$\phi = \tan^{-1}\frac{z}{\sqrt{x^2+y^2}}$$

Particle Kinematics in Spherical Coordinates

$$\hat{r} = \cos\theta\cos\phi\hat{i} + \sin\theta\cos\phi\hat{j} + \sin\phi\hat{k}$$
$$\hat{\theta} = -\sin\theta\hat{i} + \cos\theta\hat{j}$$
$$\hat{\phi} = -\cos\theta\sin\phi\hat{i} - \sin\theta\sin\phi\hat{j} + \cos\phi\hat{k}$$

Angular velocity of the coordinates system:

$$\bar{\omega} = \dot{\theta}\sin\phi\hat{r} - \dot{\phi}\hat{\theta} + \dot{\theta}\cos\phi\hat{\phi} \tag{1}$$

Position:

$$\bar{r} = r\hat{r} \tag{2}$$

Velocity:

$$\bar{v} = \dot{\bar{r}} = \frac{\partial\bar{r}}{\partial t} + \bar{\omega}\times\bar{r} = \dot{r}\hat{r} + r\dot{\theta}\cos\phi\hat{\theta} + r\dot{\phi}\hat{\phi} \tag{3}$$

Acceleration:

$$\bar{a} = \dot{\bar{v}} = \ddot{\bar{r}} = \left(\frac{\partial}{\partial t} + \bar{\omega}\times\right)\left(\frac{\partial\bar{r}}{\partial t} + \bar{\omega}\times\bar{r}\right) = (\ddot{r} - r\dot{\theta}^2\cos^2\phi - r\dot{\phi}^2)\hat{r}$$
$$+ (2\dot{r}\dot{\theta}\cos\phi - 2r\dot{\theta}\dot{\phi}\sin\phi + r\ddot{\theta}\cos\phi)\hat{\theta} + (2\dot{r}\dot{\phi} + r\dot{\phi}^2\sin\phi\cos\phi + r\ddot{\phi})\hat{\phi} \tag{4}$$