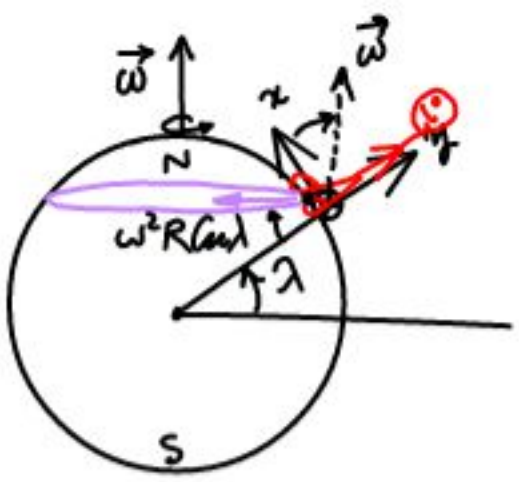
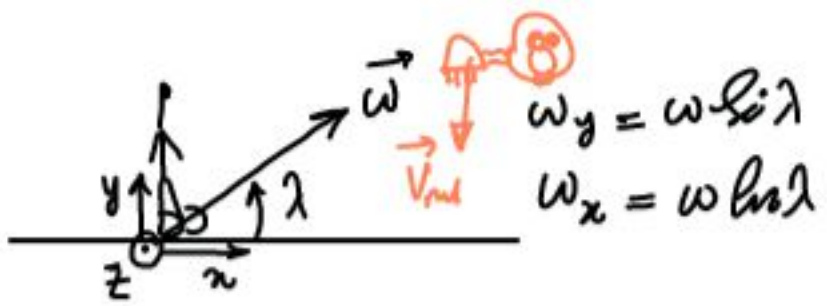


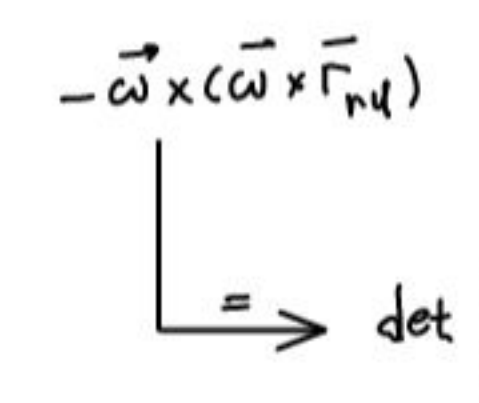
$$\vec{f} = -bm\vec{v} \qquad O(b^3)=0 \quad O(\omega^4)=0$$



$$\vec{V}_{rel} = \begin{pmatrix}\dot{x}\\ \dot{y}\\ \dot{z}\end{pmatrix}$$

$$\vec{a} = \vec{a}_0 + \vec{a}_{rel} + \vec{\omega}\times(\vec{\omega}\times\vec{r}_{rel}) + 2\vec{\omega}\times\vec{V}_{rel} + \dot{\vec{\omega}}\times\vec{r}_{rel}$$

$$\vec{f} - m(\vec{a}_0 + \vec{\omega}\times(\vec{\omega}\times\vec{r}_{rel}) + 2\vec{\omega}\times\vec{V}_{rel} + \dot{\vec{\omega}}\times\vec{r}_{rel}) = m\vec{a}_{rel} = m\begin{pmatrix}\ddot{x}\\ \ddot{y}\\ \ddot{z}\end{pmatrix}$$



$$\vec{\omega} = \begin{pmatrix}\omega\cos\lambda\\ \omega\sin\lambda\\ 0\end{pmatrix} \qquad \vec{f}_{real} = \begin{pmatrix}0\\ -mg\\ 0\end{pmatrix} - mb\begin{pmatrix}\dot{x}\\ \dot{y}\\ \dot{z}\end{pmatrix}$$

$$-\vec{a}_0 = -\begin{pmatrix}\omega^2 R\cos\lambda\sin\lambda\\ -\omega^2 R\cos^2\lambda\\ 0\end{pmatrix} = \begin{pmatrix}-\cos\lambda\sin\lambda\\ +\cos^2\lambda\\ 0\end{pmatrix}\omega^2 R$$

$$-\vec{\omega}\times(\vec{\omega}\times\vec{r}_{rel}) \qquad \vec{\omega}\times\vec{r}_{rel} = \det\begin{pmatrix}\hat{x} & \hat{y} & \hat{z}\\ \omega\cos\lambda & \omega\sin\lambda & 0\\ x & y & z\end{pmatrix} = \begin{pmatrix}\omega z\sin\lambda\\ -\omega z\cos\lambda\\ \omega\{y\cos\lambda - x\sin\lambda\}\end{pmatrix}$$

$$= \rightarrow \det\begin{pmatrix}\hat{x} & \hat{y} & \hat{z}\\ \omega z\sin\lambda & -\omega z\cos\lambda & \omega\{y\cos\lambda - x\sin\lambda\}\\ \omega\cos\lambda & \omega\sin\lambda & 0\end{pmatrix}$$

$$-\vec{\omega}\times(\vec{\omega}\times\vec{r}_{rel}) = \begin{pmatrix}\omega^2\sin\lambda\{x\sin\lambda - y\cos\lambda\}\\ \omega^2\cos\lambda\{y\cos\lambda - x\sin\lambda\}\\ \omega^2 z\end{pmatrix}, \quad \vec{V}_{rel}\times(2\vec{\omega}) = \det\begin{pmatrix}\hat{x} & \hat{y} & \hat{z}\\ 2\dot{x} & 2\dot{y} & 2\dot{z}\\ \omega\cos\lambda & \omega\sin\lambda & 0\end{pmatrix}$$

$$-2\vec{\omega}\times\vec{V}_{rel} = \begin{pmatrix}-2\dot{z}\omega\sin\lambda\\ 2\dot{z}\omega\cos\lambda\\ 2\omega\{\dot{x}\sin\lambda - \dot{y}\cos\lambda\}\end{pmatrix}$$

$$\begin{pmatrix}\ddot{x}\\ \ddot{y}\\ \ddot{z}\end{pmatrix} = \begin{pmatrix}-b\dot{x} - \omega^2 R(\sin\lambda\cos\lambda) + \omega^2\sin\lambda\{x\sin\lambda - y\cos\lambda\} - 2\dot{z}\omega\sin\lambda\\ -b\dot{y} + \omega^2 R\cos^2\lambda - g + \omega^2\cos\lambda\{y\cos\lambda - x\sin\lambda\} + 2\dot{z}\omega\cos\lambda\\ -b\dot{z} + \omega^2 z + 2\omega\{\dot{x}\sin\lambda - \dot{y}\cos\lambda\}\end{pmatrix}$$