$_arrayfigure{\times}4$
**??**
$\sin\phi\cos\theta$
$y =$
$r\sin\phi\sin\theta$
$z =$
$r\cos\phi$
$f(x,y,z)$

$$\frac{\partial f}{\partial r} = \frac{\partial f}{\partial x}\frac{\partial x}{\partial r}+\frac{\partial f}{\partial y}\frac{\partial y}{\partial r}+\frac{\partial f}{\partial z}\frac{\partial z}{\partial r} \quad (1)$$

$$\frac{\partial f}{\partial r} = \frac{\partial f}{\partial x}\sin\phi\cos\theta+\frac{\partial f}{\partial y}\sin\phi\sin\theta+\frac{\partial f}{\partial z}\cos\phi \quad (2)$$

$_coordsDownward-facingright-handedcoordinatesystemwithradialdistancefromtheorigin, distancefromtheaxis, z$
$\theta$

$$D = \left\{\vec{x} \in^3 : \leq \vec{x}\cdot\hat{x} \leq \ \leq \vec{x}\cdot\hat{y} \leq \ \leq \vec{x}\cdot\hat{z} \leq \ \right\} \quad (3)$$

$\{\vec{x_s} \in D : \vec{x_s}\cdot\hat{z} = 0\}$
$B =$
$\{\vec{x_b} \in D : \vec{x_b}\cdot\hat{z} = 0\}$
$l$
$w$
$f_a$
$f_b$

$$f_a+f_b = l \quad (4)$$

$_r =$
$\frac{l}{w}$
$f_s =$
$\frac{f_a}{f_b}$
$l$
$f_r$
$f_s$
$w$
$f_a$
$f_b$
$\overline{f_r f_a = \frac{lf_s}{1+f_s} f_b = \frac{l}{1+f_s}}$
$\alpha$

$$\alpha = \tan^{-1}\left(\frac{2f_r f_s}{1+f_s}\right) \quad (5)$$

$[-\pi,\pi]$
$(-\infty,\infty)$
$\mu$
$\kappa$
$1/\sigma$
$\mu =$
$\theta_w$
$\kappa =$
$v_w$

$$P_{\theta_f}(\theta_f) = \frac{\exp\left(v_w\cos(\theta_f - v_w)\right)}{2\pi I_0(v_w)} \quad (6)$$

$I_0(x)$
$non$-
$zero$
$\kappa$

$$\lim_{v_w\to 0} P_{\theta_f}(\theta_f) = \frac{1}{2\pi}\ \forall\,\theta_f \in [-\pi,\pi] \quad (7)$$

$\theta_w$
$v_w$
$_2figurevonMisesdistributionforavarietyofparameters$
$A$
$B$

$$P(A\cap B) = P(A)P(B) \quad (8)$$

$l$
$\theta_f$

$$P_{2D}(\theta_f,l) = P_{\theta_f}(\theta_f)\cdot L(l) \quad (9)$$

**??**
**??**
$P_{\theta_f}$
$l$
$P_{2D}$
$_probwouldnolongerhold, anditwouldbenecessarytousethefollowingmoregeneralrelation. P(A\cap$
$B) =$
$P(A)P(B|A) =$
$P(B)P(B|A)(10)$
$_2dfigure2Dlength-angleprobabilitydistributionwith\theta_w =$
$2\pi/3, v_w =$
$1$