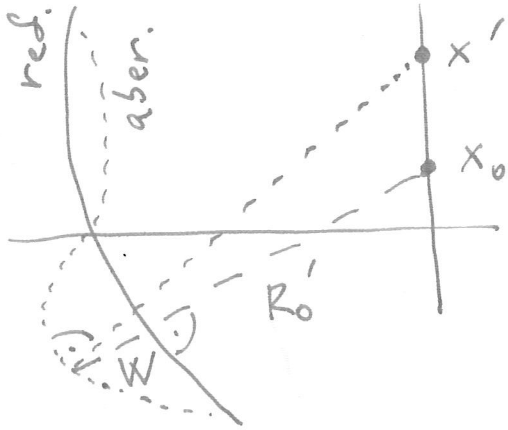
I vlnové aberace vs. geometrické (26)



$$(x_p - x_0')^2 + (y_p - y_0')^2 + (z_p - z_0')^2 - \underbrace{\left(R_0' + \frac{W}{n'}\right)^2}_{\approx R_0'^2 + 2\frac{R_0'}{n'}W} = 0$$

$$x_p - x_0' - \frac{R_0'}{n'}\frac{\partial W}{\partial x_p} \approx x_p - x'$$

$$y_p - y_0' - \frac{R_0'}{n'}\frac{\partial W}{\partial y_p} \approx y_p - y'$$

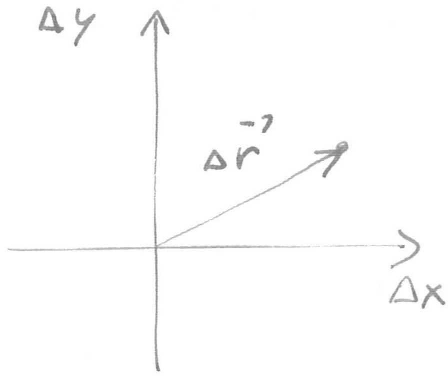
$$z_p - z_0' \approx z_p - z_0'$$

$$\Delta x' = x' - x_0' = \frac{R_0'}{n'}\frac{\partial W}{\partial x_p} = \frac{\rho_p}{n'u}\frac{\partial W}{\partial x_p} = \frac{1}{n'u}\frac{\partial W}{\partial X_p}$$

$$\Delta y' = y' - y_0' = \frac{R_0'}{n'}\frac{\partial W}{\partial y_p} = \dots$$

Výpočet vlnových vad (L6)

$\Delta x = n' u \, \Delta x'$, $\Delta y = n' u \, \Delta y'$



$\Delta \vec{r} = (\Delta x, \Delta y)$

$\Delta \vec{r} = \nabla W$

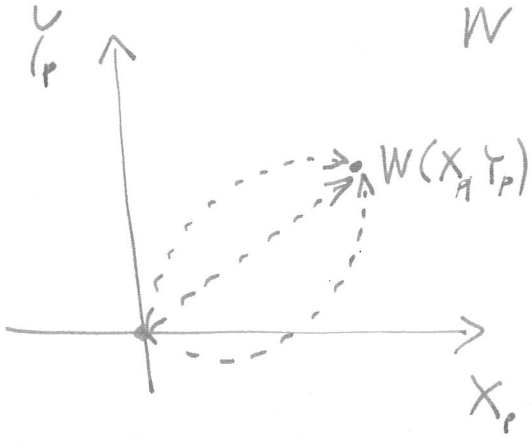
srovnej $\vec{F} = \nabla \phi$

$\vec{R}_p = (X_p, Y_p)$

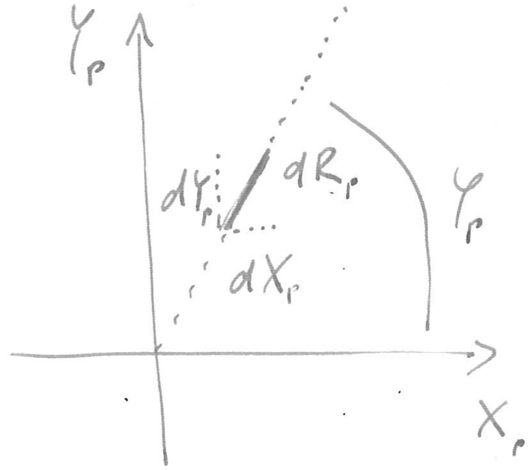
$$dW = \frac{\partial W}{\partial X_p} dX_p + \frac{\partial W}{\partial Y_p} dY_p = \nabla W \cdot d\vec{R}_p$$

$$\int_a^b dW = \int_a^b \nabla W \cdot d\vec{R}_p = W(b) - W(a)$$

nezávisí na cestě



radiální integrace



$$d\vec{R}_p = \vec{n}\, dR_p$$

radiální jedn. vektor

$$\vec{n} = (\cos\varphi_p, \sin\varphi_p) = \left(\frac{dX_p}{dR_p}, \frac{dY_p}{dR_p} \right) = \frac{d\vec{R}_p}{dR_p}$$

$$\int_0^{R_p} \nabla W \cdot d\vec{R}_p = \int_0^{R_p} \left(\frac{\partial W}{\partial X_p} \cos\varphi_p + \frac{\partial W}{\partial Y_p} \sin\varphi_p \right) dR_p'$$

$$= \int_0^{R_p} \left(\Delta X \cos\varphi_p + \Delta Y \sin\varphi_p \right) dR_p'$$

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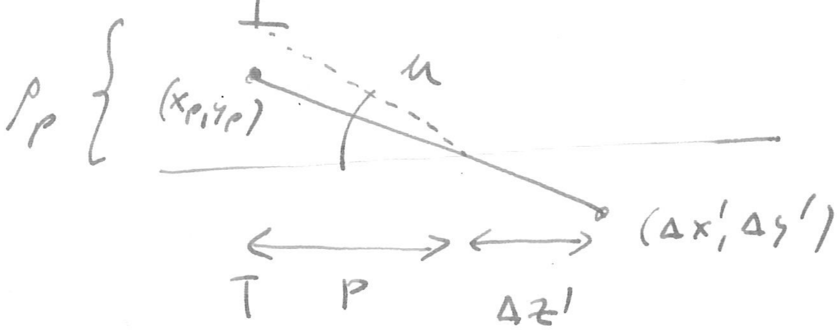
nebo použitím

$$dW = \frac{\partial W}{\partial X_p} dX_p + \frac{\partial W}{\partial Y_p} dY_p$$

$$= \frac{\partial W}{\partial X_p} \underbrace{\frac{dX_p}{dR_p}}_{\cos\varphi_p} dR_p + \frac{\partial W}{\partial Y_p} \underbrace{\frac{dY_p}{dR_p}}_{\sin\varphi_p} dR_p$$

rozostření



$$u = \frac{\rho_p}{p} \Rightarrow \frac{1}{p} = \frac{u}{\rho_p}$$

$$x_p = \rho_p X_p = \rho_p R_p \cos \varphi_p \, , \quad y_p = \rho_p R_p \sin \varphi_p$$

$$\Delta x' = - x_p \frac{\Delta z'}{p} = - u R_p \Delta z' \cos \varphi_p$$

$$\Delta y' = - u R_p \Delta z' \sin \varphi_p$$

$$\underbrace{n' u \Delta x' \cos \varphi_p + n' u \Delta y' \sin \varphi_p}_{dW/dR} = - n' u^2 R_p \Delta z'$$

$$\downarrow$$

$$W = - \frac{n' u^2 R_p^2 \Delta z'}{2}$$

polynom

$W(X_p, Y_p, x_0', y_0')$

rotační symetrie

$X_p^2 + Y_p^2, \quad x_0'^2 + y_0'^2, \quad x_0' X_p + y_0' Y_p$

$X_p = R_p \cos \varphi_p, \quad Y_p = R_p \sin \varphi_p$

$X_p^2 + Y_p^2 \to R_p^2, \quad x_0'^2 + y_0'^2 \to x_0'^2 \quad (y_0' = 0)$

$x_0' X_p + y_0' Y_p \to x_0' R_p \cos \varphi_p$

$$x_0'^{2a} R_p^{2b} (x_0' R_p \cos \varphi_p)^c$$

$$\downarrow$$

$$x_0'^{2a+c} R_p^{2b+c} \cos^c \varphi_p$$

$$\downarrow$$

$$x_0'^k R_p^l \cos^m \varphi_p$$

m liché $\to k, l$ liché

m sudé $\to k, l$ sudé

$m \leq k, l$

$a\ b\ c \to k\ l\ m$

$1\ 0\ 0 \to 2\ 0\ 0$ konst.

$0\ 1\ 0 \to 0\ 2\ 0$ primární

$0\ 0\ 1 \to 1\ 1\ 1$

$2\ 0\ 0 \to 4\ 0\ 0$ konst.

$0\ 2\ 0 \to 0\ 4\ 0$

$0\ 0\ 2 \to 2\ 2\ 2$

$1\ 1\ 0 \to 2\ 2\ 0$ 3. řád

$1\ 0\ 1 \to 3\ 1\ 1$

$0\ 1\ 1 \to 1\ 3\ 1$

koma vln. → geom

$$W_{131} = A_{131}\, x_0'\, R_p^3 \cos\varphi_p = A_{131}\, x_0' \left(X_p^2 + Y_p^2\right) X_p$$

$$\Delta x' = \frac{1}{n'u}\,\frac{\partial W_{131}}{\partial X_p} = \frac{A_{131}\, x_0'}{n'u}\left[2 X_p X_p + X_p^2 + Y_p^2\right]$$

$$\Delta y' = \frac{1}{n'u}\,\frac{\partial W_{131}}{\partial Y_p} = \frac{A_{131}\, x_0'}{n'u}\, 2 X_p Y_p$$

$$\Delta x' = \Omega\left(2\cos^2\varphi_p + 1\right) = \Omega\left(\cos 2\varphi_p + 2\right)$$

$$\Delta y' = \Omega\, 2 \sin\varphi_p \cos\varphi_p = \Omega \sin 2\varphi_p$$

$$\Delta x' - 2\Omega = \Omega \cos 2\varphi_p$$

$$\Delta y' = \Omega \sin 2\varphi_p$$

$$\left(\Delta x' - 2\Omega\right)^2 + \Delta y'^2 = \Omega^2$$

geom. → v/n

$$dW_{131} = n'u \left(\Delta x' \cos\varphi_p + \Delta y' \sin\varphi_p \right) dR_p$$

$$= n'u\,\Omega \left[\left(2\cos^2\varphi_p + 1 \right)\cos\varphi_p + 2\sin\varphi_p \cos\varphi_p \sin\varphi_p \right] dR_p$$

$$= A_{131}\, x_0'\, R_p^2 \left[2\cos\varphi_p \underbrace{\left(\cos^2\varphi_p + \sin^2\varphi_p \right)}_{1} + \cos\varphi_p \right] dR_p$$

$$= 3 A_{131}\, x_0'\, R_p^2 \cos\varphi_p\, dR_p$$

$$W_{131} = \int_0^{R_p} dW_{131}\, dR_p'$$

$$= 3 A_{131}\, x_0' \cos\varphi_p \int_0^{R_p} R_p'^2\, dR_p'$$

$$= \cancel{3} A_{131}\, x_0' \frac{R_p^3}{\cancel{3}} \cos\varphi_p$$