

$$v \sin^2 \varphi - x^2 \sin^2 \varphi = v^2 \lambda^2 c^2 - 2v \lambda c x (1 + \cos \varphi) + x^2 (1 + \cos \varphi)^2$$

$$v \sin^2 \varphi - x^2 \sin^2 \varphi = v^2 \lambda^2 c^2 - 2v \lambda c x (1 + \cos \varphi) + x^2 + 2x^2 \cos \varphi + x^2 \cos^2 \varphi \Rightarrow$$

$$x^2 (-\sin^2 \varphi - 1 - 2\cos \varphi - \cos^2 \varphi) + 2v \lambda c x (1 + \cos \varphi) + v \sin^2 \varphi - v^2 \lambda^2 c^2 = 0$$

$$-2x^2 (1 + \cos \varphi) + 2v \lambda c x (1 + \cos \varphi) + v \sin^2 \varphi - v^2 \lambda^2 c^2 = 0$$

$$x^2 - v \lambda c x + \frac{v^2 \lambda^2 c^2 - v \sin^2 \varphi}{2(1 + \cos \varphi)} \quad M = v \lambda c$$

$$x^2 - Mx + \frac{M^2 - v \sin^2 \varphi}{2(\cos \varphi + 1)} = 0$$

diskriminans nezáporný!

$$\Delta = M^2 - 4 \frac{M^2 - v \sin^2 \varphi}{2(\cos \varphi + 1)} = \frac{M^2(\cos \varphi + 1) - 2(M^2 - v \sin^2 \varphi)}{2\cos \varphi + 1} =$$

$$= \frac{M^2 \cos \varphi + M^2 - 2M^2 + 2v \sin^2 \varphi}{\cos \varphi + 1} = \frac{M^2(\cos \varphi - 1) + 2v \sin^2 \varphi}{\cos \varphi + 1} =$$

$$= \frac{M^2(\cos \varphi - 1)(\cos \varphi + 1) + 2v \sin^2 \varphi(\cos \varphi + 1)}{(\cos \varphi + 1)^2} = \frac{M^2(\cos^2 \varphi - 1) + 2v \sin^2 \varphi(\cos \varphi + 1)}{(\cos \varphi + 1)^2} =$$

$$= \frac{-M^2 \sin^2 \varphi + 2v \sin^2 \varphi(\cos \varphi + 1)}{(\cos \varphi + 1)^2} = \frac{4v \sin^2 \varphi}{(\cos \varphi + 1)^2} \left(\frac{\cos \varphi + 1}{2} - \frac{M^2}{4} \right)$$

$$\Rightarrow \Delta \geq 0 \Rightarrow \frac{\cos \varphi + 1}{2} - \frac{M^2}{4} \geq 0$$

$$\frac{(v \lambda c)^2}{4} \leq \frac{\cos \varphi + 1}{2}$$

$$v \leq \frac{1}{\lambda c} \sqrt{2(\cos \varphi + 1)}$$

maximálný
použitelný vlnový

