On peut faire un développement en série autour de $R = R_0$.

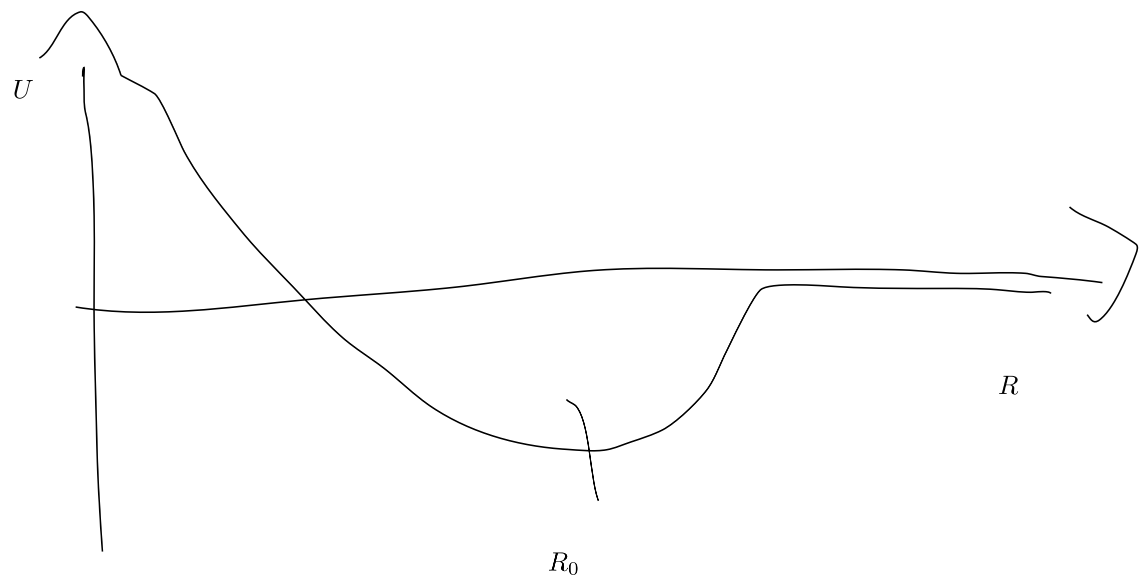

Figure 1 – potentiel

$$U(x) = U(x_0) + (x - x_0) \left.\frac{\mathrm{d}U}{\mathrm{d}x}\right|_{x_0} + \frac{1}{2}(x - x_0)^2 \frac{\mathrm{d}^2U}{\mathrm{d}x^2}$$

$$F_s = \sum_p c_p(u_{s+p} - u_s)$$

$$u_s(t) = u_0 e^{-i\omega t} e^{ikx}$$

$$m\frac{\mathrm{d}^2u}{\mathrm{d}t^2} = \sum_p (U_{sp} - U_s)$$
$$\ldots$$
$$-m\omega = \sum_{p>0} C_p(e^{ikpa} - 1) + \sum_{p<0} C_p(e^{ikpa} - 1)$$
$$\ldots$$
$$-m\omega^2 = 2\sum_{p>0} c_p(\cos(kpa) - 1)$$
$$\omega^2 = \frac{2c}{m}(1 - \cos(ka))$$

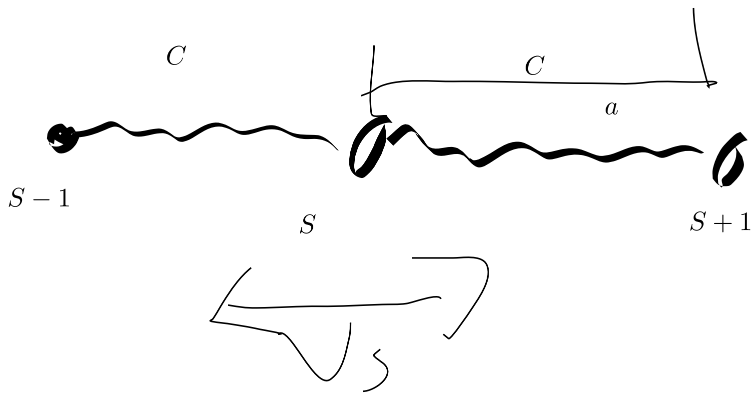

Figure 2 – force

$$\omega^2 = \frac{4C}{m}\sin^2\left(\frac{ka}{2}\right)$$

Pourquois je suis surpris d'obtenir ce résultat ? - Françis <3

$$v_g \frac{\mathrm{d}\omega}{\mathrm{d}k} \quad \mathbf{V}_g = \boldsymbol{\nabla}\omega(\mathbf{k})$$

$$a_{allo}$$

$$a_{1,2,3}$$

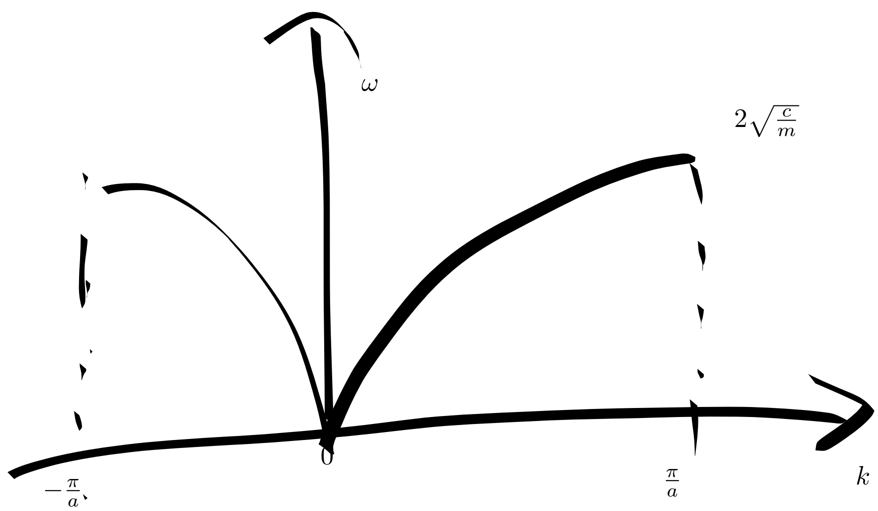

Figure 3 – relation de dispertion

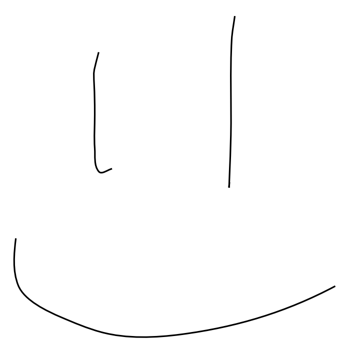

Figure 4 – banane