转移矩阵方法计算一维光子晶体透射率

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编写程序计算一块一维光子晶体的透反射率

In [ ]:

```
import numpy as np
import matplotlib.pyplot as plt

# 仅给出基本定义，具体代码参见TMM_1dim.py
class PhotonicCrystal1d():
    # 类成员变量（科学常数）
    Eps0 = 8.854e-12
    Mu0 = 4 * np.pi * 1e-7

    # 给定实例成员变量（光子晶体参数）
    def __init__(self, N, d1, d2, epsr1, epsr2, mur1=1, mur2=1):
        """
        :params
        N: number of layers (NOT periods. If N==3, arranged like d1, d2, d1)
        d1: thickness of layer 1 (in "meter")
        d2: thickness of layer 2 (in "meter")
        epsr1: relative permittivity of layer 1
        epsr2: relative permittivity of layer 2
        mur1: relative permeability of layer 1
        mur2: relative permeability of layer 2
        """
        pass

    # 实例方法
    def calculateTransferMatrices(self, envEpsr, envMur=1):
        """
        :params
        envEpsr: environment permittivity
        envMu: environment permeability
        """
        pass

    def calculatePropagationMatrices(self, omega):
        """
        :params
        omega: angular frequency of the wave (in "Hz")
        """
        pass

    def showParas(self):
        """
        print out the parameters of the photonic crystal
        """
        pass

    def simulate_rt(self, RT=False):
        """
        :param
        RT: default False, return r and t
```

```
        if True, return R and T

    :return
    r, t: reflection and transmission coefficients
    or
    R, T: reflection and transmission rates
    up to the given parameter
    """
    pass
```

如何调控带隙位置

由光子晶体的色散关系

$$2\cos(Ka)=2\cos(\bar{n}k_0a)-\left(\frac{Z_1}{Z_2}+\frac{Z_2}{Z_1}-2\right)\sin(n_1k_0d_1)\sin(n_2k_0d_2)$$

其中，$\bar{n}=\dfrac{n_1d_1+n_2d_2}{a}$，$k_0=\omega\sqrt{\varepsilon_0\mu_0}=\dfrac{\omega}{c}$.

当 $\bar{n}k_0a=m\pi$ 时，

□ 当满足 $\boxed{\bar{n}k_0a=m\pi}$ 时

⇨ $$\bar{n}k_0a=\frac{n_1d_1+n_2d_2}{a}k_0a=n_1k_0d_1+n_2k_0d_2=m\pi$$

⇨ $$2\cos(Ka)=2\times(-1)^m+\left(\frac{Z_1}{Z_2}+\frac{Z_2}{Z_1}-2\right)[\sin(n_1k_0d_1)]^2\times(-1)^m$$

如果 ⇨ $\boxed{Z_1\neq Z_2 \text{ and } n_1k_0d_1\neq l\pi \ (l\text{是小于}m\text{的整数})}$

$$|2\cos(Ka)|>2$$

⇨ K没有实数解时，此频率处在光子晶体禁带。

若 $Z_1\neq Z_2$ 且 $n_1k_0d_1\neq l\pi$（l是小于 m 的整数），

K 没有实数解，电磁波无法在光子晶体中传播.

将此时处于禁带中的频率记作 ω_m，则

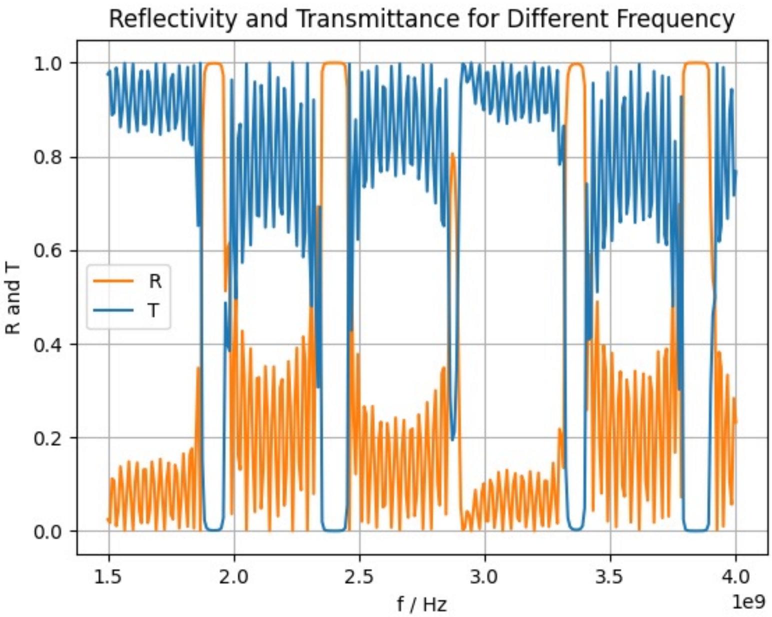
$$\bar{n}\omega_m\sqrt{\varepsilon_0\mu_0}\,a=m\pi$$

$$\omega_m=m\frac{\pi}{\sqrt{\varepsilon_0\mu_0}}\frac{1}{\bar{n}a}$$

唯一可调节的是 $\bar{n}a=n_1d_1+n_2d_2$

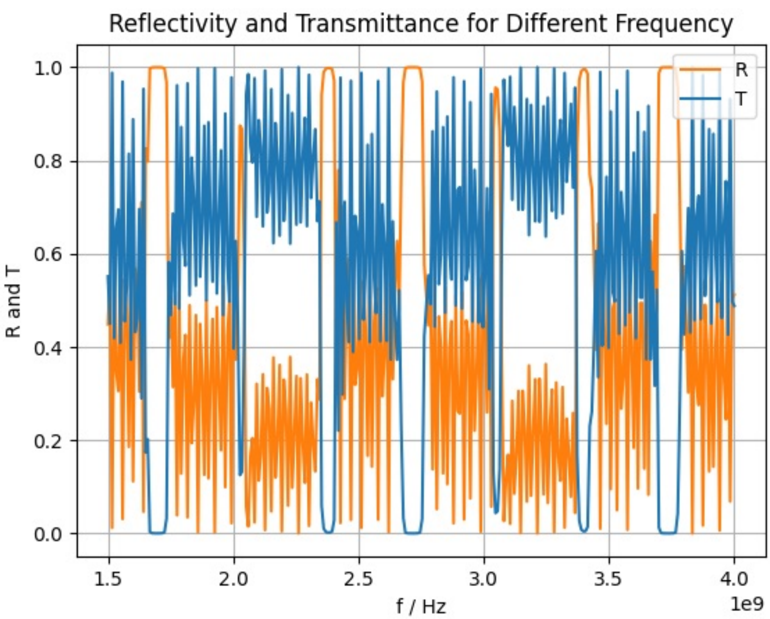
$$\therefore \omega_m\propto\frac{m}{n_1d_1+n_2d_2}$$

调节 $n_1d_1+n_2d_2$ 可调节带隙位置.



$d_1 = 15\times10^{-2}, \ d_2 = 5\times10^{-2}$

$n_1 = \sqrt{2}, \ n_2 = \sqrt{4}$



$d_1 = 15\times10^{-2}, \ d_2 = 5\times10^{-2}$

$n_1 = \sqrt{4}, \ n_2 = \sqrt{8}$