

**Home Work PHY 554 #4.****Due October 12, 2016**

**HW 1 (3 point):** A multi-cell accelerating RF linac operating at 500 MHz in a standing wave  $\pi$ -mode (e.g. each cell has opposite sign of the accelerating voltage from the neighboring cell) is used to accelerate non-relativistic heavy ion ( $Z=2$ ,  $A=79$ ) moving with velocity  $v=c/3$  ( $\beta=1/3$ ).

- (a) find the length of the cell required for resonant acceleration in such a linac – 1 point  
 (b) at what velocity (ies) (and energy(ies) of the ion), the energy gain in 5-cell cavity would vanish (became zero) – 2 point

**HW 2 (2 points):** A n-cell standing wave cavity operates in  $\pi$ -mode with field on the axis describes as

$$E_z = E_o(z) \cdot \sin(\kappa z) \cdot \sin(\omega t + \varphi); \quad \kappa = \omega / 2c;$$

$$E_o(z) = \begin{pmatrix} E_o; 0 \leq z \leq \frac{n\pi}{\kappa} \\ 0; z < 0 \\ 0; z > \frac{n\pi}{\kappa} \end{pmatrix}$$

Find the energy gain and transit time factor in such a linac for particle moving with the speed of light.

Extra points: what will be modification if  $v = \beta c$ ;  $\beta \neq 1$ .

**HW 3 (5 points):** A 0.3 m long 500 MHz pillbox cavity operates in fundamental accelerating  $TM_{010}$  mode with peak accelerating electric field of 20 MV/m.

- (a) Find the energy stored in electric and magnetic fields as function of time;  
 (b) What is the total energy of EM field in the cavity? Does it changes with time?  
 (c) What will be losses of the energy for Q-factor of 30,000?