

Home Work PHY 554 #6

HW 1 (3 point): A multi-cell accelerating RF linac operating at 500 MHz in a standing wave π -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 π -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 change with time?
- (c) What will be losses of the energy for Q-factor of 30,000?