

The evaluation of synchrotron radiation in SAD is done using based on “kinematical method”:

Let  $\mathbf{q}$  denote the orientation vector of the momentum of a particle:

$$\mathbf{q} = \left( \frac{p_x}{p}, \frac{p_y}{p}, \frac{p_z}{p} \right), \quad (81)$$

$$p_z = \sqrt{p^2 - p_x^2 - p_y^2}. \quad (82)$$

Suppose a particle traverses a section (1, 2) of an accelerator component, then the orientation changes from  $\mathbf{q}_1$  to  $\mathbf{q}_2$ . The bending angle  $\phi$  and the radius of curvature  $\rho_r$  are approximated, assuming a uniform bending, by:

$$\sin |\phi| = |\mathbf{q}_2 \times \mathbf{q}_1|, \quad (83)$$

$$\rho_r = \frac{L_{12} - z_2 + z_1}{|\phi|}, \quad (84)$$

where  $L_{12}$  is the nominal length of the component between 1 and 2, and  $z_{1,2}$  are the values of longitudinal coordinate  $z \equiv -v(t - t_0)$  at the locations 1 and 2.

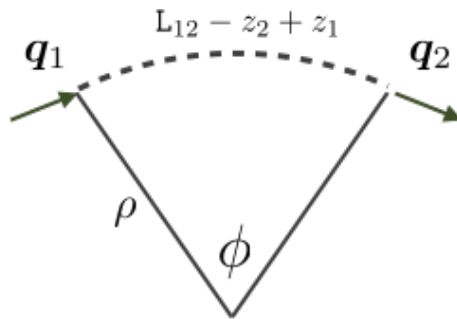


Figure 1: The kinematical method for synchrotron radiation.

By knowing  $\phi$  and  $\rho_r$  as well as the momentum of the particle, we can derive all information about the emission of synchrotron radiation (if we can use a classical formula with uniform bending).

- Thus the synchrotron radiation can be handled by a single routine for any type of component, such as multipoles, solenoid, fringe field, even including electric field, without knowing the details of the field.
- A component is sliced so that  $N_\gamma \lesssim 1$ .
- Not only the radiation itself, its derivatives by phase space coordinates can be obtained kinematically using the transfer matrix. These derivatives are used to evaluate the damping and excitation matrices.
- In the region where the field is not uniform, such as the F1 region of a BEND, a special treatment for  $\rho_r$  is applied.
- This method may be applied for a *spin motion* if the longitudinal field is taken care properly.