The evaluation of synchrotron radiation in SAD is done usingbased on "kinematical method":

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

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

$$p_z = \sqrt{p^2 - p_x^2 - p_y^2} . \tag{82}$$

Suppose a particles traverses a section (1, 2) of an accelerator component, then the orientation changes from $\boldsymbol{q}_1$ to $\boldsymbol{q}_2$. The bending angle ϕ and the radius of curvature $\rho_{\rm r}$ are approximated, assuming a uniform bending, by:

$$\sin|\phi| = |\boldsymbol{q}_2 \times \boldsymbol{q}_1| , \tag{83}$$

$$\rho_{\rm r} = \frac{\mathtt{L}_{12} - z_2 + z_1}{|\phi|}, \tag{84}$$

where $\mathtt{L}_{12}$ 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.

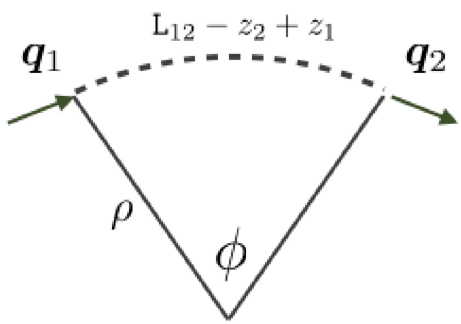

Figure 1: The kinematical method for synchrotron radiation.

By knowing ϕ and $\rho_{\rm r}$ 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 $\rho_{\rm r}$ is applied.
- This method may be applied for a *spin motion* if the longitudinal filed is taken care properly.