SOLUTION FOR HOMEWORK ASSIGNMENT NO. 07

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Exercise 7.1

We are asked to determine the expected standard deviation of λ where $I(\lambda)$ is the Fisher information and $\hat{\lambda}$ an efficient operator. The decay time distributions for $\mathcal{B}^0 \to J/\Psi K_s^0$ and $\overline{\mathcal{B}^0} \to J/\Psi K_s^0$ are

$$N_{\mathcal{B}^0 \to J/\Psi K_0^0} \propto e^{-t} \left[1 + \lambda \sin(0.7t) \right],$$

$$N_{\overline{\mathcal{B}^0} o J/\Psi K_s^0} \propto e^{-t} \left[1 - \lambda \sin(0.7t)\right].$$

To calculate the standard deviation we shall use a value of $\lambda = 0.3$.

considering a) and b)

As $\hat{\lambda}$ is a proper operator the standard deviation of λ is

$$std(\lambda) = \sqrt{var(\lambda)} = \frac{1}{\sqrt{I(\lambda)}}$$
 (1)

The Fisher information can be written as

$$I(\lambda) = E\left[\frac{\delta L^{2}}{\delta \lambda}\right]$$

$$= \int_{-\inf}^{\inf} \lambda \sum_{k=1}^{500} \left(\frac{\sin(0.7t_{k})}{1 \pm \lambda \sin(0.7t_{k})}\right)^{2} d\lambda$$
(2)

Where L are the likelihood functions

$$L = \sum_{k=1}^{500} log \left(e^{-t} \left[1 - \lambda \sin(0.7t) \right] \right)$$

$$= \sum_{k=1}^{500} -t_k + log (1 \pm \lambda \sin(0.7t_k))$$
(3)

- a) We consider 500 decays of \mathcal{B}^0 .
- **b)** We consider 500 decays of $\overline{\mathcal{B}^0}$.
- c) We consider 250 decays of \mathcal{B}^0 and 250 decays of $\overline{\mathcal{B}^0}$.

d) Put very nice explanation here.

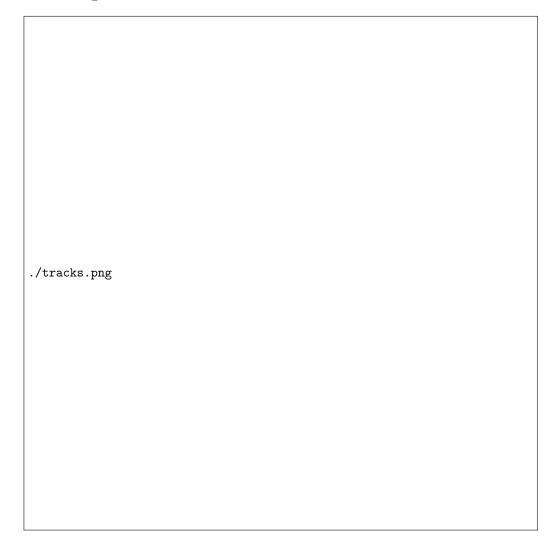
Exercise 7.2

Given electron tracks we are asked to first plot five tracks into one image. Afterwards we shall construct a theoretical model for the motion of electrons under the influence of a magnetic field. Using this model we have to fit it to the given data using a self-written χ^2 model. After plotting different values we eventually state a potential isotope from which the electrons come from.

As usual, please find the script in the text file exercise7_2.C.

You can find the visualisation of the tracks of the first five electrons in figure 1.

Figure 1: Movement of the first five tracks from the file exercise07.root. Please not that the x and z positions are switched to enable fitting.



The equation we are looking for have the following expressions

$$x = -\frac{v_z m_e \gamma}{c \cdot |q| \cdot |B|} \cdot \cos\left(\frac{|q||B|}{m_e}\right),\tag{4}$$

$$y = +\frac{v_z m_e \gamma}{c \cdot |q| \cdot |B|} \cdot \sin\left(\frac{|q||B|}{m_e}\right),\tag{5}$$

where
$$x^2 + y^2 = \left(\frac{v_z \cdot m_e \cdot \gamma}{c \cdot |q| \cdot |B|}\right)^2$$
 and therefore $y = \sqrt{\left(\frac{v_z \cdot m_e \cdot \gamma}{c \cdot |q| \cdot |B|}\right)^2 - x^2}$.