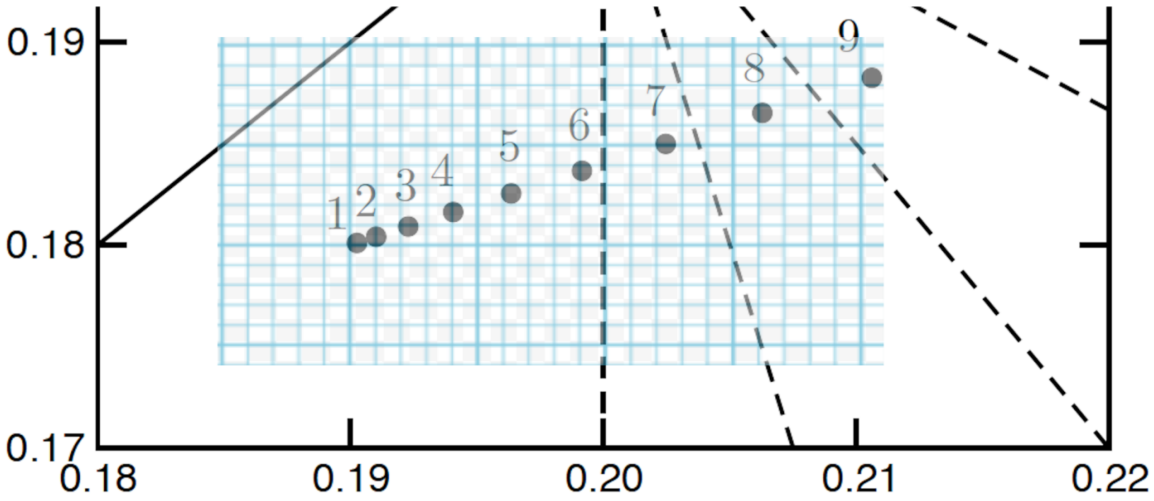
USPAS Graduate Accelerator Physics Homework 13

Due date: Friday February 12, 2021

1 Nonlinear Tune Tracking Data



(Modified from Peggs/Satogata problem 10.1) You have simulated the RHIC accelerator with a set of nine particles launched with design momentum ($\delta = 0$), $x' = 0$, and initial x offsets of 1, 2, ... 9 mm at a location with horizontal beta function $\beta_x = 40$ m. You "measure" the fractional tunes of these particles from the plot shown above to be:

x [mm]	Q_x	Q_y
1	0.1903	0.1800
2	0.1910	0.1802
3	0.1923	0.1809
4	0.1941	0.1816
5	0.1963	0.1825
6	0.1991	0.1837
7	0.2024	0.1851
8	0.2061	0.1866
9	0.2105	0.1884

a) (4 points) Plot Q_x and Q_y vs. J_x from the above table.

b) (3 points) What is the simplest fit to the tune vs. action data?

c) (3 points) What is the simplest and most likely dominant nonlinearity?

2 Dodecapole Detuning

(10 points) (Modified from Peggs/Satogata problem 10.2) If a single dodecapole (12-pole) magnet delivers an angular kick of

$$\Delta x' = -g_{12}x^5 \tag{2.1}$$

and causes normalized phase space detuning

$$Q_x = Q_{0x} + Ag_{12}a^B \tag{2.2}$$

Calculate the numerical values of coefficients A and B. Note that here you must only calculate the effect of the detuning to *first order* in dodecapole strength.