Tutorial 4

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TUTORIAL 4: FIRST PART I

Chromaticity and sextupoles

1. After the definition of the sequence, convert it in thin lenses with the commands:
   MAKETHIN, SEQUENCE=MY_SEQUENCE;
   use, sequence=MY_SEQUENCE;
   This step is required to allow particle tracking in MAD-X.
2. With a matching block adjust the tunes of the cell to 0.25.
3. Using the chromaticities obtained from the Twiss, compute the tunes for $\Delta p/p = 10^{-3}$.

TUTORIAL 4: FIRST PART II

4. Track a particle with initial coordinates $x, y, px, py = (1, 1, 0, 0)$ mm in 100 cells. Plot the x-px phase space. Hint:

```
track,dump;
start, x= 1e-3, px=0, y= 1e-3, py=0;
run,turns=100;
endtrack;
plot, file="MAD_track",table=track,haxis=x,vaxis=px,
particle=1, colour=100;
plot, file="MAD_track",table=track,haxis=y,vaxis=py,
particle=1, colour=100;
```

How does the particle move in the phase space, cell after cell? Do you see the tunes?

TUTORIAL 4: FIRST PART III

5. Track a particle with initial coordinates $x, y, px, py = (100, 100, 0, 0)$ mm in 100 cells. Plot the x-px phase space. Does something change with respect to the previous case? Why?
6. Repeat point 4 adding $DELTAP = 10^{-3}$ to the track command. How does the phase space look now? Is the tune still the same? It may help to look only at the first few (4) turns, to get a clearer picture.

Tutorial 4: Second Part

Non-linearities and large amplitude oscillations.

7. Add 0.5 m long sextupoles attached to the two quadrupoles. With a matching block adjust the vertical and horizontal chromaticity of the cell (global parameters $DQ1$, $DQ2$) to zero, by powering the two sextupoles ($K2_1$ and $K2_2$).
8. using the obtained $K2_1$ and $K2_2$, β-function and dispersion at sextupoles location, evaluate using the formulas the sextupolar effect on the Q1 for a particle at $DELTAP = 0.01$. Compare the results with the value obtained in point 1.
9. Repeat point 4 adding $DELTAP = 0.01$ to the track command. Did you manage to recover the original tune for the off-momentum particle?
10. Repeat point 5. What is going on now?
11. Move the tunes to $(0.23, 0.23)$ and repeat the previous point. Is now the particle stable?