USPAS summer 2023, Grad Accelerator Physics

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Homework #6

Exercise (Coupling)
Write the Hamilton function for a midplane symmetric accelerator with tunes ν_x and ν_y that has the following perturbations from midplane symmetry. What resonances can occur? Which of these resonances can lead to very large oscillation amplitudes and therefore have to be avoided?
(a) Weak skew quadrupole perturbations with strength $k_{1s}(s) = \frac{q}{p}\partial_x B_x(s)$.
(b) Weak skew sextupoles perturbations with strength $k_{2s}(s) = \frac{q}{p}\frac{1}{2}\partial_x^2 B_x(s)$.

Exercise (Amplitude dependent tune shift)
Write the Hamilton function for a midplane symmetric accelerator with tunes ν_x and ν_y that has small midplane symmetric oktopoles with strength k_3.
(a) Derive the horizontal and vertical amplitude dependent tune shifts as functions of J_x and J_y.
(b) Show that $\partial_{J_x}\nu_y = \partial_{J_y}\nu_x$ for your result from (a).
(c) Show that the J_x derivative of the vertical tune is always the same as the J_y derivative of the horizontal tune, for any amplitude-dependent tune shift.