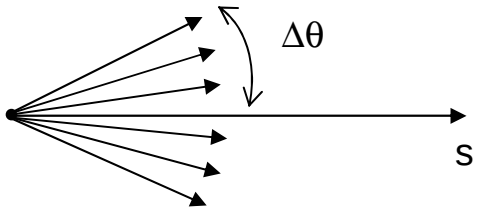
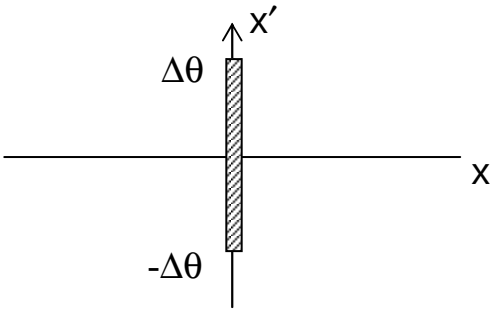
Homework Set #2
(due: Wednesday, January 22, 2003)

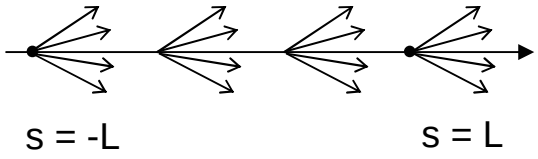
1. A point source of light (or particles) is a source of vanishing size emitting light rays within an angle $\pm\Delta\theta$:



The x-plane phase space diagram corresponding to this is:

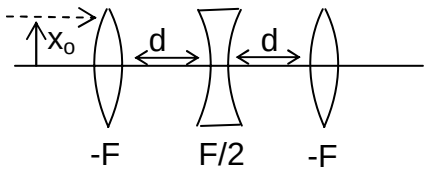


Consider an extended source, which is a collection of point sources distributed over a length $-L < s < L$ along the s-direction.



Sketch the phase space diagram of the extended source as an effective source located at $s = 0$.

2. Consider a quadrupole triplet consisting of three thin quadrupoles of focal lengths –F, F/2, and –F as follows:



a) What are the horizontal (x) and the vertical (y) transfer matrices?

b) What are the focal lengths?

c) Sketch the x-trajectory for particles starting with $x' = 0$. Do the same for the y-trajectory.

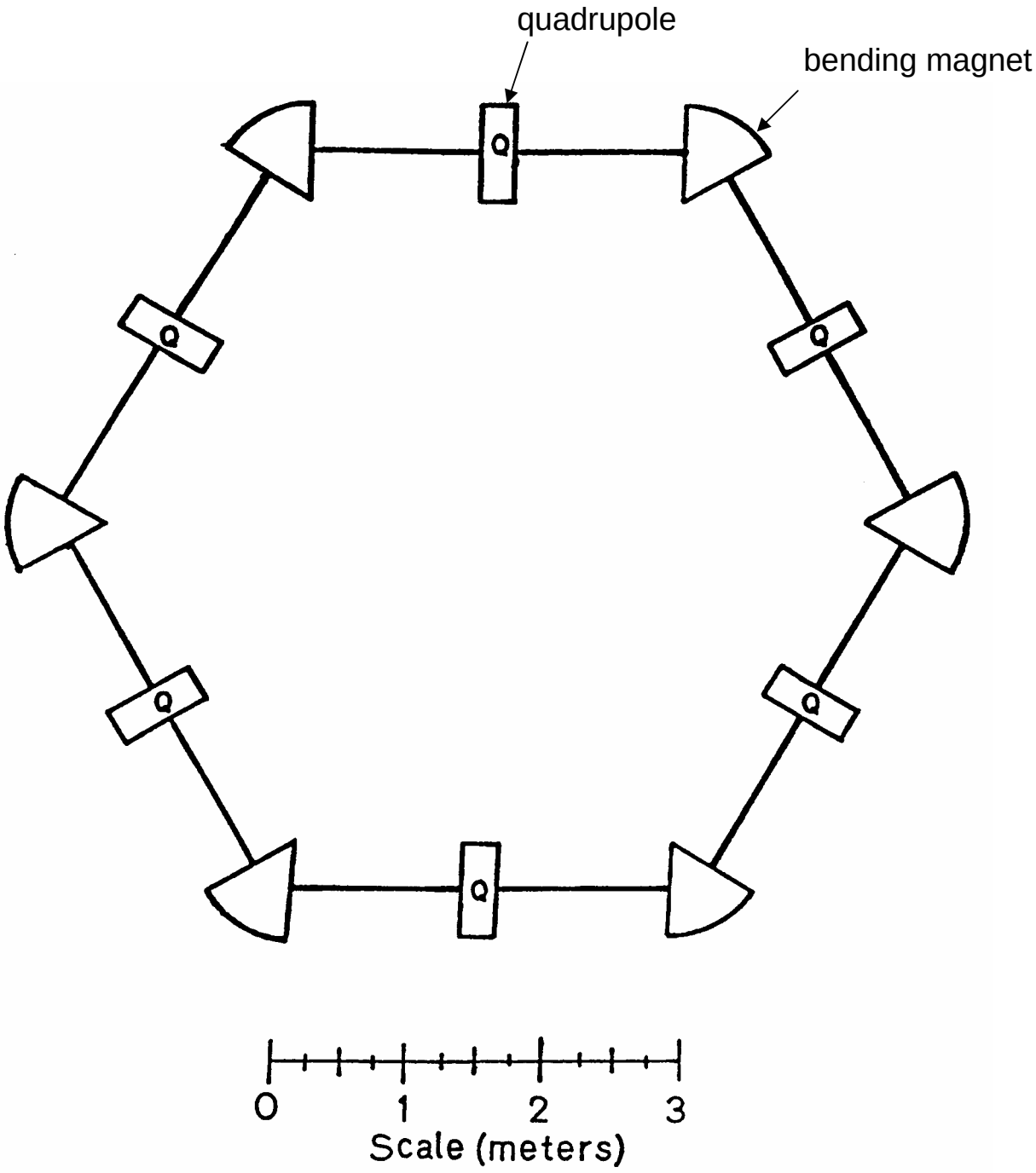
d) At what point after the triplet will the x-trajectory cross the s axis? This point is called the x-focal point. How about in y?

3. The drawing on the next page is a layout of a small ring designed as a positron accumulator. The bending magnets are combined function sector magnets with a horizontally defocusing gradient, and the quadrupoles are horizontally focusing. Some parameters are listed in the table below. You should treat the quadrupoles as thick lenses.

a) Find the range of quadrupole K's (qG/p, G = gradient $(\partial B_y/\partial x)_0$) for which both the horizontal and vertical motions are stable. Plot the tunes versus K.

b) Adjust the quadrupole to give $Q_x \approx 3.23$, $Q_y \approx 1.94$ and calculate the β-functions for the ring.

Bending Magnet	bend angle	60°
	bending radius	0.352 m
	quadrupole strength	$\|K\| = 3.226\ m^{-2}$
	length	0.369 m
Quadrupole length		0.25 m
Drift Space length		1.271 m


quadrupole
bending magnet
Q
Q
Q
Q
Q
Q
0
1
2
3
Scale (meters)