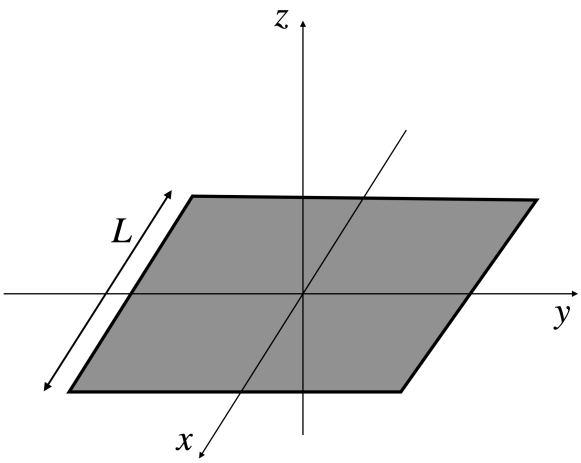
# PHYS2502 Mathematical Physics Lab #2 30 Jan 2022

*This lab assignment is at 8am, the morning after the date shown, although you should able to complete it easily before the end of the lab period. When you're done, upload your code to the* github *repository, and a PDF of your output to the* canvas *page for the course.*

This lab is an exercise in symbolic manipulation. You will likely find that the best way to solve it is with MATHEMATICA.

A flat, square plate of side length $L$ lies in the $xy$ plane, centered on the origin:




The plate is uniformly charged with total charge $Q$. Integrate over the surface of the plate to find the electric potential $V(z)$ along the $z$-axis. Recall that the electric potential at a point a distance $r$ from some charge $q$ is given by

$$V(r) = k\frac{q}{r}$$

where $k = 1$ in CGS units and $k = 1/4\pi\epsilon_0$ in SI units.

If you do the integral in MATHEMATICA, then you will probably use the function Integrate, including integration over the *two* variables $x$ and $y$. You will also want to use $Assumptions to make sure MATHEMATICA knows that both $L$ and $z$ are positive. This will make it much easier for the program to carry out the integral.

Then find the electric field $E(z) = -dV/dz$. The result may look rather complicated, but use can use Simplify in MATHEMATICA to reduce it to something less complicated. My result involves the function ArcCot.

Now check that you get the correct answer for the electric field in the limits $z \to 0$ and $z \to \infty$. (You know these answers from your introductory physics course!) You should be able to just set $z = 0$ in your result to get the field close to the plate, but if you'd like, you can experiment with the MATHEMATICA functions Limit and SERIES. For $z \to \infty$, I found it easiest to use Limit, but take care to divide the field first by the expected $z$ dependence, otherwise you'll get an answer that is correct but useless for checking against what you expect.