# 12.1.2: Circular Drum Head Simulation

The following simulation allows you to see and manipulate the pure modes for a circular drum head (fixed around the edge). The simulation can be viewed as a two dimensional surface or as a surface in three dimensions. In the 3D view you can grab the surface with the mouse and rotate it. The amplitudes of the vibrations are exaggerated compared to a real surface to make them more visible. Increasing $\Delta t$ makes the simulation run faster but also less accurately, particularly for higher mode numbers.

The shapes for a circular membrane are given by Bessel Functions multiplied by sine waves instead of sine waves as was the case in the rectangular surface (which is as much math as we need to know for now). For a rectangular surface the values of $n$ and $m$ start at one and one and are always positive. For a circular membrane $n$ starts at one and must be positive but $m$ can be zero and also negative.

> **Note**
>
> The relative mode amplitudes in the case of more than one mode are not properly normalized, mathematically, in this simulation.

## Simulation Questions

1. Set $n=1$ and $m=0$, run the simulation and describe the motion in the surface view. Also describe the motion in the 3D view (if the surface is too large to fit in the window, use the mouse to shrink it to fit).
2. What is the frequency of the $n=1,\ m=0$ mode? What is the period?
3. Look at the $n=1$ and $m=1$ mode and describe the motion in the surface and 3D view. (Don't forget you can rotate the view using the mouse to get a better angle.) Describe the location of the nodal line.
4. For the $n=1$ and $m=1$ mode, what is the frequency? Is this a harmonic?
5. For the $n=2$ and $m=0$ mode, what is the frequency? Is this a harmonic?
6. Try several different pure modes. Can you find any harmonics of the lowest frequency mode?
7. Look at the pure modes for $n=1,2,3,4$ and $m=0$ (a pure mode has one of the two mode numbers equal to zero). What do the $m=0$ modes all have in common?
8. For any of the modes you have looked at, is there a cross section through the 3D view that would be a sine or cosine shape? The shape of the curve from the center out to the edge is given by Bessel Functions instead of sines or cosines.
9. Compare the $n=1,\ m=1$ mode with the $n=1,\ m=-1$ mode. What is the difference? Are these degenerate modes (the same frequency for two different choices of mode numbers)?
10. This simulation only shows pure modes. What would be the effect of having lots of different modes on the surface at the same time? (Go back to the rectangular plate simulation for a hint.)