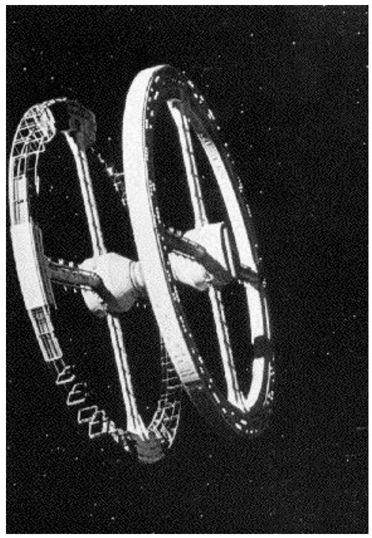
HON 210: Physics on a Rotating Space Station

For this project you will work in pairs to answer the questions below and write a group report. All work should be typed with double-spacing and 12 pt font. You will be expected to use correct English grammar and punctuation. Your work should also be supported with properly labeled and embedded figures. Any references used should be cited as well.

First form a group and report the group composition to Dr. Herman by the next class.



When one thinks about colonies in space, one typically thinks of a rotating space station. Such space stations have been popularized in science fiction, beginning with Arthur C. Clarke's 2001: A Space Odyssey in 1968. The earliest such designs have been attributed to O'Neill, who also provided designs for rotating cylinders, as opposed to the Clarke-Kubrick depiction of a rotating doughnut. The idea is simply that such rotating systems provide an artificial gravitational environment that is familiar to its inhabitants. However, there are some interesting consequences of living in such an environment. The purpose of this project is to explore what it would be like living on a rotating doughnut shaped space station and provide your best arguments in answering the questions.

Let's consider a space station that is 160 m in diameter and 15 m wide.

1. Considering that a typical house for a family of four has about 2000 sq. ft. of floor space, about how many people might this space station comfortably house?
2. How long would the station need to complete one revolution to provide the typical 1.0 g of gravitational acceleration that we are used to on the Earth? [Think centripetal acceleration, $a_c = v^2 / r,$ and the period is $T = 2\pi r / v.$]
3. What would the velocity be at the rim of the space station?
4. How much faster would a space station of twice the diameter have to rotate to give 1.0 g?

5. Standing on the rim floor, how far down the hallway could you see, assuming a ceiling height of 8 ft?
6. Place a turntable (like an old record player) on the floor. Now place a pan filled with water on the turntable. Turn on the turntable. [You might consider it rotates att 78 RPM and that the cake pan has a 40 cm diameter.] Describe the following:
    a. How does the water at the edge of the pan move with respect to the floor.
    b. How does the water at the edge of the pan move with respect to the walls.
    c. Your sense of balance is based upon fluid in your ear canals. Assuming that you are looking spinward down the space station hallway, what would happen if you quickly turned your head clockwise? What if you were facing the wall and turned your head?
    d. What would you experience, if any, if you were to jog down the hall? (Such a jogging scene took place in the 2001 movie.)
7. The force that you should have encountered in the last problem is called the Coriolis force. This force is also responsible for some other effects on the space station. Shuttle flights, delivering supplies and passengers to the space station, should dock at the hub (center of rotation) for obvious reasons. Passengers and delivery personnel would get off at the hub and find a zero gravity environment. They then take an elevator to the rim, 80 m away. Let's assume that the elevator accelerates for a few seconds. [For example it goes from zero to 5.0 m/s in 2.0 seconds.] It then travels at a constant speed and then decelerates to zero in the final few seconds. [For example, it does not accelerate for 14 seconds and slow to a stop over the last two second.]
    a. Describe the effects of this ride on the passengers as the elevator moves from the hub to the rim.
    b. If a 70 kg person we riding the elevator on a scale, how would her weight change during this ride, if at all? [How do you feel going up and down an elevator on Earth?]
8. Of course, living in the space station for long periods of time, the astronauts would need some recreation time. They could play racquet ball, squash, or ping pong.
    a. From your previous observations, describe the projectile path for a ball thrown/hit up or down the long hallways of the space station.
    b. What would a game of ping-pong look like? In what ways might you need to adjust your game?