


## 4.4: Wrapping It Up 4 - The Andromeda Shift

### 4.4.1: Part I. Lookback Time to Andromeda

1.




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### 4.4.2: Part II. Measuring Andromeda's Motion

In this part of the activity, you will make measurements of Andromeda's motion using the Doppler shift. From those measurements you will determine Andromeda's rotation speed and systemic velocity.

1. First you will look at spectra taken from opposite sides of the Andromeda Galaxy (M31), and compare them to a spectrum taken *at rest* to determine which way the galaxy is spinning. By observing the Doppler shift (either redshift or blueshift) of the spectra at either end, you can tell in which direction M31 is spinning. The spectrum being observed is a very small sliver of the galaxy's actual spectrum. It is limited to the region around one of the most prominent lines of galaxy spectra, the H $\beta$  line.

- Click on either side of the galaxy to observe the spectrum at that location. Compare this spectrum to the reference spectrum above to determine if this side is redshifted or blueshifted. Redshifted means the material is moving away from you, and blueshifted means it is coming toward you. After measuring one side, click on the opposite side to determine if it is redshifted or blueshifted. Also pay attention to *how much* each side is shifted.
- Click either the “clockwise” and “counter-clockwise” buttons, depending on which way you think Andromeda is spinning.
- You will be informed whether or not you are correct. Resolve any discrepancies with your answer before moving on.

2.



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#### 4.4.3: Part III: Time to collide with the Milky Way

1.



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