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Combining Real World Experiences with WorldWide Telescope Visualization to Build a Better Parallax Lab

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Abstract. We present a lab activity designed to help students understand the concept of parallax in both astronomical and non-astronomical contexts. In an outdoor setting, students learn the methodology of distance determination via parallax. They identify a distant landmark to establish a reference of direction, and then measure the change in apparent direction for more nearby objects as they change position in a 2 meter radius "orbit" around the "Sun." This hands-on activity involves large, visually-discernable angles so that students can internalize the concept of parallax from everyday experience. However, students often have difficulty transferring this experience to the astronomical realm, so we pair this hands-on activity with a more explicitly astronomically-based activity using the WorldWide Telescope visualization environment. Students apply the same methodology in this environment and learn how the apparent motion of stars is related to their distance from Earth. The combination of hands-on activity and computer-aided visualization is designed to produce a deeper understanding of parallax in the astronomical environment, and an improved understanding of the inherently three-dimensional distribution of objects in our universe. More formal assessment is underway.

1. Introduction

Students learn best in active exploratory environments that draw upon their intuitive understanding of the world around them. Transferring this learning into the astronomical context is often difficult because the size, scale, and structure of the universe and its primary contents are so different from students' everyday experience (Miller & Brewer 2010).

Because of the large distances to even nearby stars (compared to the size of the Earth's orbit), astronomical parallax measurements typically involve small angles—far too small for visual observation. However, the concept of distance determination via parallax is not limited to these small angles, and students can be introduced to the technique in the terrestrial environment. In this lab activity, students use small terrestrial telescopes to measure the distances to nearby campus landmarks.

Visualization tools, such as Microsoft's WorldWide Telescope (WWT), can help students to better understand the astronomical realm by providing multiple perspectives on the universe

The laboratory activity presented here is the first in a series of labs designed to integrate hands-on exploration with WWT visualization to improve student understanding of the size, scale, and structure of the universe. The new lab is based on a non-WWT parallax lab previously developed and used for many years by the astronomy faculty in the Department of Physics & Astronomy at Bucknell University.

2. WorldWide Telescope

WorldWide Telescope is a rich visualization environment that functions as a virtual telescope (or spaceship!) allowing anyone to make use of real astronomical data to explore and understand the universe.

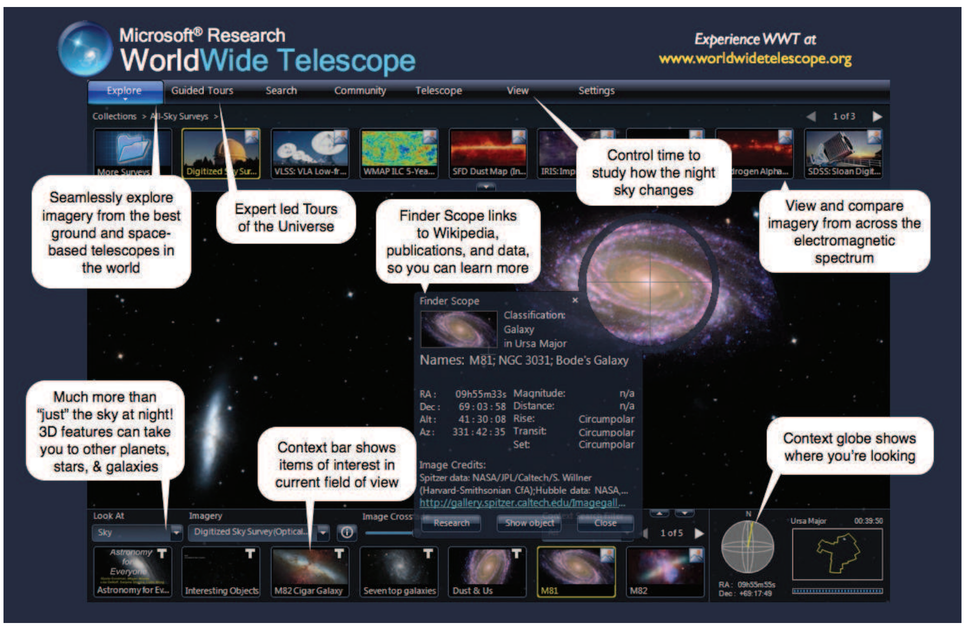

Figure 1. Annotated WWT screenshot.

WorldWide Telescope provides the tools and framework to revolutionize STEM education by offering students, learners, and educators:

- unprecedented access to astronomical data, allowing them to experience the thrill of discovery that comes from exploring and understanding our universe;
- tours that guide and encourage learners to engage actively with the material;
- the ability to explore the universe in three dimensions, helping them visualize ideas that are otherwise challenging to understand through traditional media.

3. Measuring Parallax on Campus

The hands-on component of the lab activity involves measurement of the parallax shifts for prominent objects in the campus landscape. Students use a surveyor's transit to identify lines of sight to distant and nearby objects.

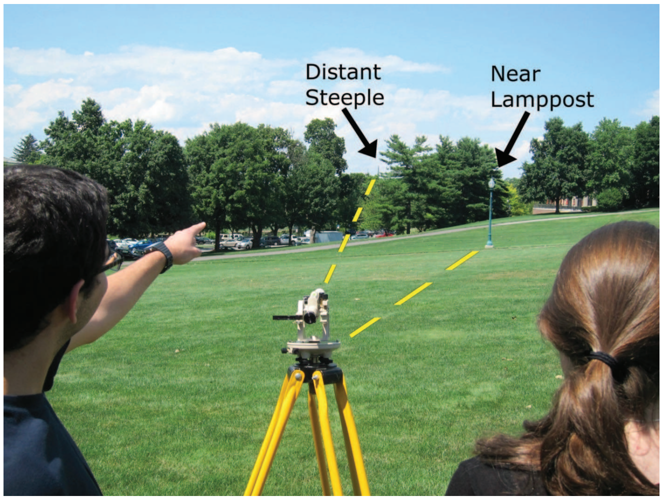

Figure 2. The line of sight to a distant landmark (here, the steeple of a church in town) is used as a reference direction for angle measurements. Students measure the angle between the reference direction, and the direction to a more nearby object, such as an on-campus lamp post.

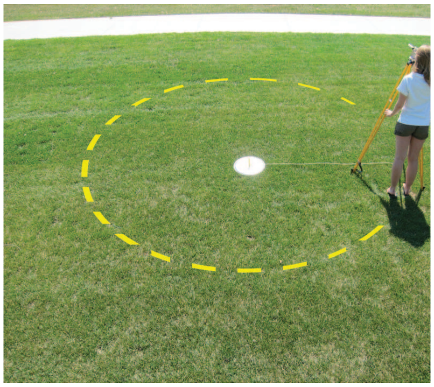

Figure 3. Measurements of the angular separation between the reference direction and the direction to the nearby object are made at several positions in an "orbit" around a central "Sun." The Sun is a pizza tin marked with twelve sections denoting the months of the year. Students typically make measurements at six positions in the orbit.

4. Visualizing Astronomical Parallax

Students use WWT to transfer their parallax intuition from the terrestrial to celestial environments. Using the pseudo-3D multi-perspective capability of WWT, students view the well-known asterism the Big Dipper from Earth, and from another location six parsecs from Earth. Over this large baseline, the parallax shift is quite obvious, and students can discriminate between nearby and faraway stars. They make detailed measurements of the parallax shift, and determine the distances to several Big Dipper stars.

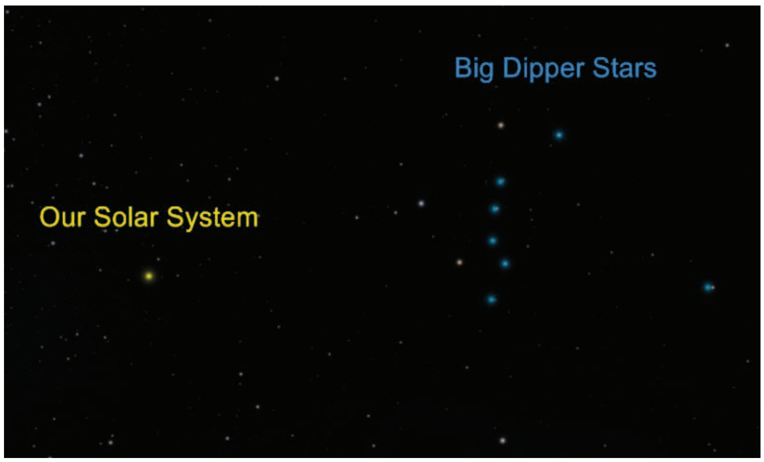

Figure 4. Students can observe the Big Dipper from an "overhead" perspective, which shows the actual distances of these stars from Earth. Here, the grey dots mark the seven prominent stars in the asterism. All are located at a distance of about 80 ly from Earth, except for one which is substantially more distant.

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References

Miller, B. W., & Brewer, W. F. 2010, IJSE, 32, 1549