Fundamentals Of Astronomy

Part 3: Measuring the Sky

David Berns
April 21, 2025

Astronomers utilize a system of measurement specifically designed to quantify the angular separation between celestial objects, and this system is based on degrees. A complete circle is divided into 360 degrees, creating a comprehensive framework for understanding angles in various contexts. This division allows astronomers and navigators alike to articulate the position of celestial bodies in relation to one another or to specific reference points in the sky.

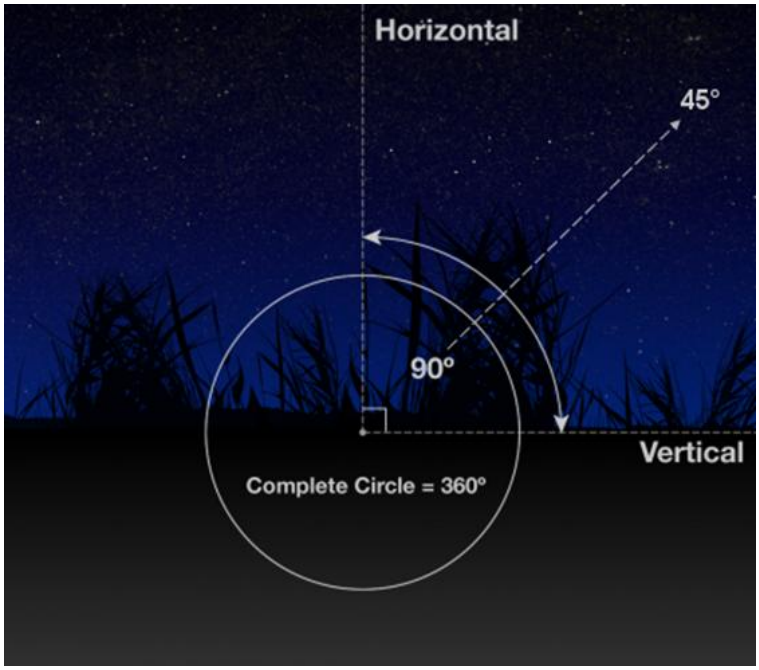


Figure 1

When discussing angular separation, one key point of reference is the zenith, which is the point in the sky that is directly overhead any observer on the Earth's surface. The angular separation between any point on the horizon—the line where the Earth and sky appear to meet—and the zenith is defined as 90 degrees. This measurement reflects the concept of a right angle, forming a perfect vertical line from the horizon straight up to the zenith.

If you imagine yourself standing outdoors while looking up at the sky, moving from the zenith downwards toward the horizon creates a gentle slope. If you travel halfway between these two points, you will find that the angle you've created measures 45 degrees. This halfway point represents a significant angle in geometry and astronomy alike, as it is often associated with the concept of balance and symmetry.

Thus, the measurement of angles in degrees not only aids astronomers in precisely categorizing the locations and movements of stars, planets, and other celestial bodies but also serves as a fundamental element of navigation and observation. Is this explanation clear so far?

Measuring smaller angles can be somewhat more challenging, but you'll be pleasantly surprised to learn that your hands and fingers make for exceptionally accurate and conveniently accessible measuring tools. By simply extending your arm fully, you can effectively estimate angles using your hand's span.

Here's how it works:

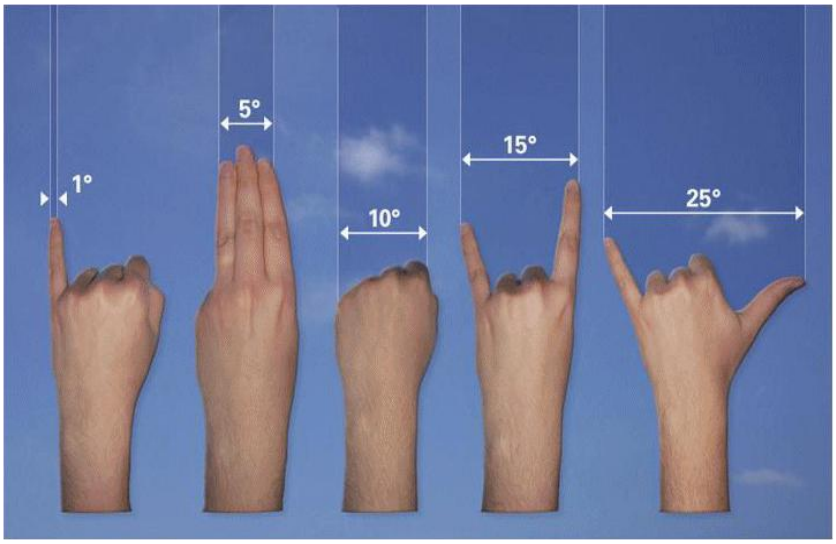


Figure 2

1. Thumb and Little Finger: Start by stretching your thumb and little finger as far apart as you can. When you do this, you'll find that the distance from the tip of your thumb to the tip of your little finger covers an angle of approximately 25 degrees. This broad span allows for a clear visual reference for larger angles.

2. Index Finger to Little Finger: Next, stretch your index finger and little finger widely apart. The angle spanned here measures about 15 degrees. This smaller extension still provides a useful estimate for many practical applications.

3. Clenched Fist: Now, make a fist and extend it out at arm's length, holding the back of your hand facing you. The width of your clenched fist covers roughly 10 degrees, making it a handy reference point.

4. Three Middle Fingers Together: If you were to hold your three middle fingers (the middle, ring, and pinky fingers) tightly together, the span would be around 5 degrees. This degree of precision can come in handy when you need to measure smaller angles.

5. Little Finger Width: Lastly, if you extend just your little finger at arm's length, you'll see that it measures about 1 to 1.5 degrees. This fine measurement offers a great tool for very small angles.

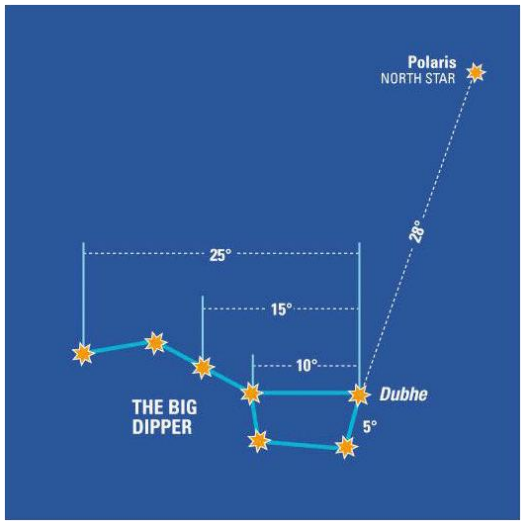


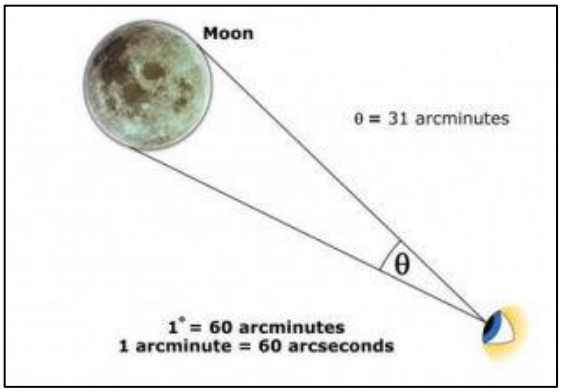
Figure 3

Utilizing your hands and fingers in this way not only provides a practical method for estimating angles but also allows you to do so without requiring any additional tools. By understanding these hand measurements, you can develop a more intuitive sense of angling in various contexts.

Not everyone's hands are the same size, which can lead to inaccuracies when using this method for anything beyond quickly locating objects. However, you can reduce these errors by "calibrating" your hands. By using this reference image, you can determine the optimal position for your hand in front of you to achieve consistent results.

Now let's delve into even smaller measurements. When you observe the night sky through a telescope, you're typically viewing a field of view that spans just 1 degree or even less—a mere fraction of the vast expanse of the universe. To provide more precision, astronomers measure angles that are smaller than 1 degree using units known as arcminutes, or "minutes of arc." Each degree is divided into 60 arcminutes, meaning that 1 arcminute represents 1/60 of a degree. The symbol used to denote arcminutes is a single apostrophe (‘).

For instance, the apparent diameter of the full Moon is approximately 31 arcminutes across. Interestingly, the Sun has a similar angular size, measuring about 31 arcminutes as well. This equivalence in size accounts for the phenomenon during a solar eclipse, where the Moon can almost perfectly obscure the Sun.



Furthermore, each arcminute can be subdivided into 60 arcseconds, referred to as "seconds of arc." Therefore, 1 arcsecond is equal to 1/60 of an arcminute, which translates to 1/3600 of a degree. The measurement for arcseconds is represented by an open quotation mark (“).

These smaller angular measurements are crucial in astronomy, allowing scientists to make precise calculations and observations about celestial objects and their movements across the sky.

For example:

The face of Jupiter is about 50" across in apparent diameter.

The two larger components of the multiple star system, α Herculi, are 4.6" apart. A good optical telescope in steady skies can resolve down to about 1" (one arc second).

FINDING YOUR LATITUDE

The angle between the visible horizon and the north celestial pole, marked almost exactly by the North Star (Polaris), is your latitude. Same for southerners, relative to the south celestial pole (although there is no equivalent bright star at the