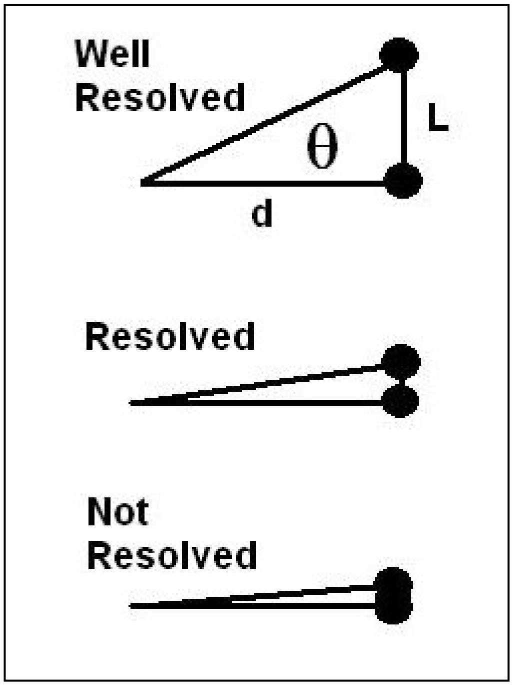


Satellites are often designed to photograph or 'image' the surface of Earth, the Moon or other celestial objects. One of the most basic properties of imaging systems is how well they can resolve details.

The most elementary way to define resolution is in terms of the angle between two closely-spaced objects that can just be distinguished by the imaging system. The figure shows how the angle, θ, changes as the objects are considered well-resolved, resolved or not-resolved. Imaging systems are designed to be resolved for objects separated by a length **L** viewed from a distance of **d**.

From trigonometry, the angle separating two objects is simply $\tan\theta = L/d$. However, for angles much smaller than 1^{o}, which is a common resolution angle for modern imaging systems, the trigonometric relationship becomes $\theta = L/d$ when θ is measured in radians. One radian = 57.296^{o}, and since 1^{o} = 3600 arcseconds, therefore, we have $\theta = 206265\ L/d$, where the apparent angular size θ is now in units of arcseconds when L andd are measured in the same units (meters, kilometers, light years). This is the fundamental formula for determining angular scales in astronomy and remote sensing.

Problem 1 – The altitude of the imaging satellite is designed to be 350 kilometers. If a biologist wants to study deforestation in plots of land 10-meters across, what will be the minimum angular resolution of the CCD camera system used on the satellite?

Problem 2 – The Lunar Reconnaissance Orbiter (LRO) operates from a lunar altitude of 60 kilometers. What is the resolution of the CCD imager which can resolve details at a level of 1-meter per pixel?

Problem 3 – The Solar Dynamics Observatory (SDO) has an imaging system with 1 arcsecond per pixel resolution. At a distance of 150 million kilometers, what is the resolution of this system in kilometers per pixel?

Problem 1 – The altitude of the imaging satellite is designed to be 350 kilometers. If a biologist wants to study deforestation in plots of land 10-meters across, what will be the minimum angular resolution of the CCD camera system used on the satellite?

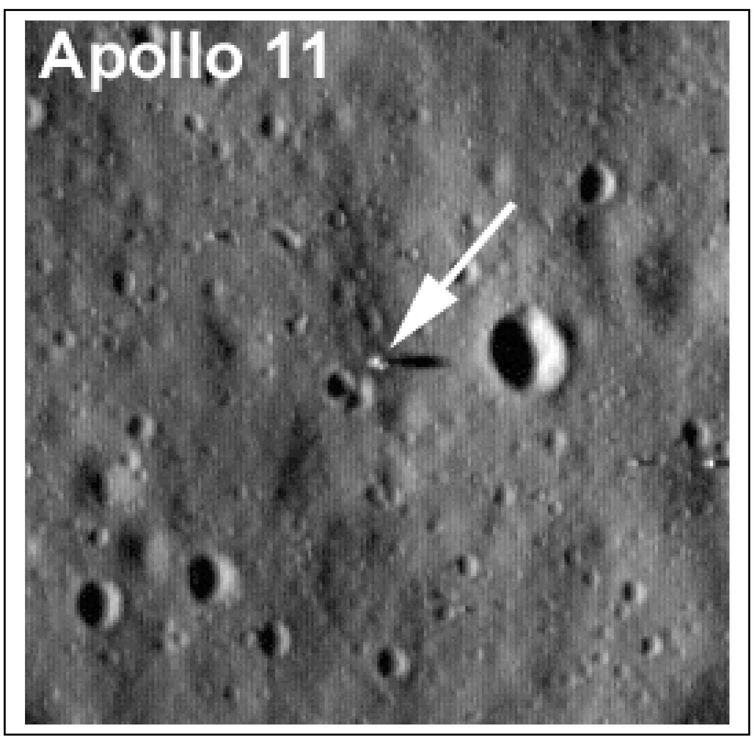
Answer: θ = 206265 x (10 meters/350000 meters) so θ **= 6 arcseconds**.

Problem 2 – The Lunar Reconnissance Orbiter operates from a lunar altitude of 60 kilometers. What is the resolution of the CCD imager which can resolve details at a level of 1-meter per pixel?

Answer: θ = 206265 x (1 meter/60000 meters) so θ **= 3 arcseconds**

Problem 3 – The Solar Dynamics Observatory (SDO) has an imaging system with 1 arcsecond per pixel resolution. At a distance of 150 million kilometers, what is the resolution of this system in kilometers per pixel?

Answer: θ = 206265 x (L/d) so
L = 150 million kilometers x (1 arcsecond/206265 arcseconds)
L = 727 kilometers per pixel



This LRO image was obtained in 2009 from an altitude of 60 kilometers above the Apollo-11 landing area. The **1-meter** resolution clearly shows the Apollo Landing Module that served as the launch pad for the returning Lunar Excursion Module (LEM) carrying Astronauts Armstrong and Aldrin.