Atmospheric Effects and Non-visible Observing

10-5-2005

Opening Discussion

- Have you seen anything interesting in the news?
- Bashing telescope mirrors. How did he get to the mirror with a sledgehammer?
- Assignment #4 due date.
- Physics of slingshotting.
- You can see 5 planets with you naked eye (not including the Earth). The hardest is Mercury because it is always quite close to the Sun.

Looking Through the Atmosphere

- When we use telescopes on the Earth we have to fight with the fact that we are always looking through the Earth's atmosphere. This has a number of implications.
- Poor weather kills any visible light observing.
- Scattered light/light pollution can greatly reduce visibility.
- Turbulence in the air bends light and distorts images. This is why you see stars twinkle.
- The atmosphere absorbs almost all light other than visible and radio.

Reducing Atmospheric Effects

- Large telescopes are built on very high, dry places to minimize weather problems as well as atmospheric turbulence.
- Some observations can be done from planes or balloons that get above much of the atmosphere.
- Adaptive optics is the coolest way of dealing with the atmosphere. In a telescope with adaptive optics the mirror is flexed in just the right way to mostly eliminate the bending of light caused by the atmosphere. This requires fast computation and a good point source of light.
- Of course, going to space is even better.

UV and IR Observing

- Long wavelength UV and short wavelength IR behave enough like visible light that we can use standard telescopes to observe them. The problem is that the telescopes have to be located above the atmosphere so that the light gets to them.
- Long wavelength IR is a real pain to observe because that is the main thermal emission wavelength of the telescopes themselves. Observing in these wavelengths requires that the telescopes be kept very cold.

X-Ray and Gamma-Ray Observing

- At the highest energy levels, normal optics are insufficient. X-rays aren't bent by glass lenses and gamma-rays go through all types of stuff.
- To focus X-rays telescopes use grazing incidence mirrors. These are arranged so the the incoming X-rays hit them at a grazing angle. The Chandra X-ray telescope uses these.
- Even that doesn't work for gamma-rays. That's why you never see high resolution gamma-ray observations, despite the fact that in theory they could provide an excellent diffraction limit.

Radio Observing

- Radio waves are well behaved in that they come all the way down to the ground. They also bounce very nicely off of metal surfaces and “perfect optics” aren't all that big an issue.
- The real problem with observing radio waves is that of angular resolution. Let's go through a calculation to see how big of a radio telescope (λ=21 cm) you need to match the angular resolution of a 1 meter optical telescope (λ=500nm).
- The solution to this is interferometry. The signal from multiple telescopes can be combined and the resolution is determined by their baseline.

Minute Essay

- The largest telescopes in the world have been built in Hawaii and Chile. Why?
- Remember to bring your calculator and your cheat sheet to class Friday.