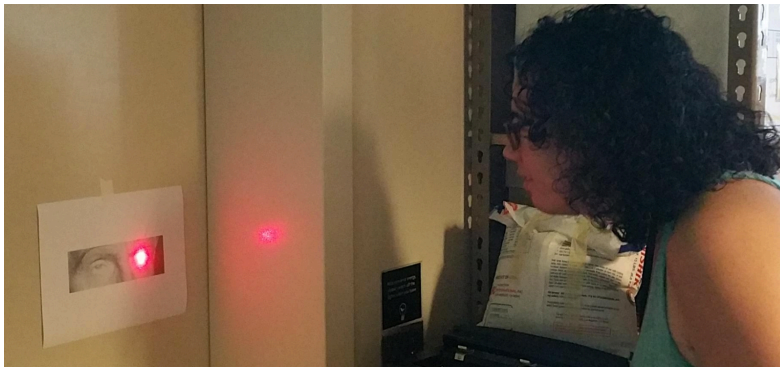


Twinkle Twinkle Little Star

How I wonder what you are

Introduction:

Why do stars twinkle? Have a scintillating experience by making your own "light twinkler." Use a hot plate and a laser to show that light can change direction and appear to twinkle on and off.

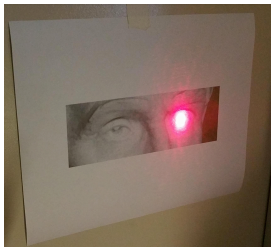
Materials and tools:

- Hot plate
- Laser pointer
- Flat stand to rest the laser pointer on next to the hot plate (a cup, books….anything)
- Tape, binder clip or other way to keep the laser pointer in the "on" position
- Wall or other vertical surface
- Image of an eye - printed from end of document

Assembly:

1. Place a hot plate on a flat surface. It should be off and cool.
2. Near the hot plate, place a stand that you can rest your laser upon. It should be slightly taller than the hot plate's surface. It can e constructed out of anything. In our example, we're using a plastic cup.
3. Tape the image of the eye to a wall or other vertical surface several meters away from your hot plate (the further the better).
4. Turn on your laser pointer by using tape or a binder clip to keep it in the "on" position.
    a. Place the laser horizontally (flat) on the stand.
    b. Aim it parallel and directly over the hot plate's surface.
    c. Target the center of the eye (pupil) on the image on the wall.
    (Note: Always use caution when working with lasers. Never point a laser into anyone's eyes)

To do and notice:



1. Closely observe the laser pointer's "spot" on the image of the eye. Note how steady the spot seems to be.
2. Turn on the hot plate and al it to heat up (this might take a few minutes). Watch to see if anything happens to the location of the spot of light. Is it still as steady?

What's going on?

Did your laser spot wiggle?

When you first turned on your laser, the beam probably stayed in one location. The air it passed through over the hot plate was the same temperature as the surrounding air. As the air above the hot plate heated up, your beam probably wiggled more and more.

As the air above the hot plate heats up, its density changes. This density change not only causes the air to rise, but it also causes mixing with the surrounding cooler air. The optical properties of hot air are also different than that of cooler air. Light can pass through hotter air more quickly then cooler air. This causes the light to bend or refract differently in one temperature of air versus another.

Did you aim your laser beam at the image of the eye? Did you notice it bounce and veer back and forth from the pupil on the image. If that was your eye (don't try this), you would see the light as it passed into your pupil. As it moved away from your pupil, you wouldn't see the light.

So, what does this have to do with a twinkling star? A star, located trillions upon trillions of miles away will broadcast light to the earth and effectively only look like a point source or very narrow beam of light (like your laser). Starlight travels through the vacuum of space unimpeded and in a straight line until it enters earth's atmosphere. As it passes through regions of gas of varying temperature it can bend. Puffs of hot or cold air can make the light bend one way or another. One moment the light might enter your eye, the next it might not. This is perceived as a flickering of the light….or a twinkling of the star!

Going Further:
This twinkling phenomena or effect of stars is also known as scintillation.
Scintillation happens to stars closer to the horizon than the zenith, because of the longer light path through our atmosphere.

For astronomers or anyone that observes celestial bodies through a telescope, this effect can cause blurred or even unusable imagery. However, it be can be mitigated.
Many modern large observatories use adaptive optics. They use fast computers and mechanisms to move about the reflective surfaces of the telescope to compensate for distortions caused by scintillation. However, the least distortion can be found outside of our atmosphere, in space. Orbiting telescopes like the Hubble and soon to be launched, James Web telescope are the best observation platforms.

Print this eye (image from the National Park Service)