If Rainbows Are Circular, Why Do We Only See Arches?

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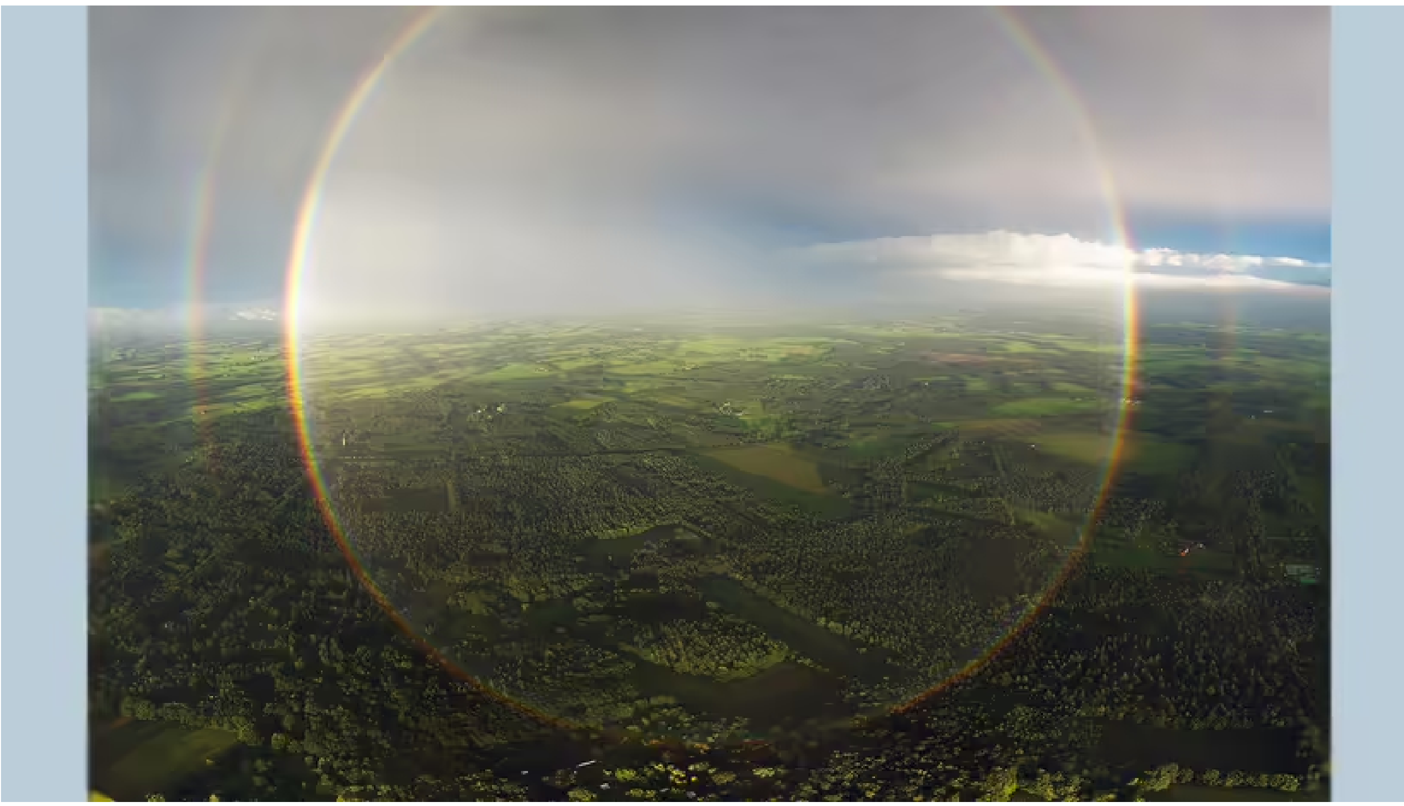

The majority of rainbows we see look like arches, because they are partly blocked by the ground and horizon. In reality, all rainbows are complete circles, like this one photographed over Gorssel, Netherlands.
MARTIJN HARLEMAN/SPACEGALLERY

Seeing a rainbow can feel like a reward. After a violent thunderstorm, it's nice to spot a colorful arch crossing the calming sky. But you might (or might not) be surprised to know that rainbows aren't really arches, nor are they "bows." They're actually full circles.

So why do we only see an arch? Oftentimes, the rainbows we see are partly blocked by the ground and horizon. To observe one in all its circular glory, you'd have to find a nice high vantage point. We'll explain how the phenomenon happens.

Degrees of Separation

Mediums matter: In air, light cruises along at 186,000 miles per second (300,000 kilometers per second). But since liquid water is denser, light can't move through it as quickly. So once a beam of light that's been zipping through the air hits a body of water, it slows down quite a bit.

In the case of rainbows, sunlight that enters individual water droplets bends — or refracts — multiple times. First, it bends upon passing into a bead of H2O. After that, the light bounces off the inside wall at the far side of the droplet and reenters the air. The light gets refracted again while exiting.

Through refraction, the droplets separate sunlight into its component colors. Although it looks white, rays of sunshine are in fact a mixture of all the colors within the visible light spectrum.

Each of these has a different wavelength; the longest belongs to red light while the shortest is reserved for purple light. Because of those idiosyncrasies, when a beam of white sunshine enters a water droplet, its component colors refract — and exit the H2O — at different angles. That's why all the colors in a rainbow are divided into separate layers.

If you're hoping to witness a rainbow, your eyes must be pointed away from the sun — and there needs to be a large concentration of airborne water droplets in front of you. Once a beam of white light hits these, its component colors disperse.

Skydiving above a full 360 Rainbow!

Rain O's

Your ability to perceive some of those colors is dictated by your physical whereabouts. Each drop in that curtain of liquid water is a tiny prism. They all break white light into distinct beams of red, orange, yellow, green, blue, indigo and purple light. But your eyeballs will never see more than one color per drop (if that). All the others exit the drop at the wrong angle to meet your pupils.

Purple is the lowest color on a rainbow because purple light exits water beads at the sharpest angle: 40 degrees relative to its entry point. Meanwhile, red light — which sits at the top of a rainbow — gets sent back in your general direction at a 42-degree angle.

A key factor here is the location of the antisolar point. This is the spot in the sky — or on the ground — that's exactly 180 degrees away from the sun relative to your perspective. On a bright, sunny day, the head of your shadow marks the antisolar point. Every rainbow is a perfectly circular ring centered around this very spot.

Yet if you're standing at ground level, you won't be able to see the circle's lower half. Indeed, from this vantage point, basically any part of a rainbow that dips below the horizon is rendered invisible. One of the reasons for this is that the close proximity of Earth's surface limits the amount and concentration of raindrops within your line of sight.

As such, the percentage of a rainbow that's visible to most people is directly correlated with the sun's position. When our solar neighbor is just barely peeking over the horizon, the antisolar point will be fairly high up, affording you the chance to see a much bigger rainbow than you would when the sun climbs higher.

Conversely, if the sun is more than 42 degrees above the horizon, it becomes impossible for ground-based observers to see any portion of a rainbow whatsoever. But when you're soaring in an aircraft, things get more interesting. On rainy or misty days, airplane passengers and pilots occasionally see full circular rainbows. Better yet, in 2013, photographer Colin Leonhardt captured this picture of a circular *double* rainbow while flying around Australia's Cottesloe Beach.

Glory Be

We'll close by talking about some round and colorful optical illusions that *look* like rainbows but aren't. Book a window seat on your next flight and you could bear witness to a glory. These are tight circles that can appear around the antisolar point when you're staring downward at a cloud or a blanket of fog. Unlike rainbows, they're the product of electromagnetic waves. It's possible to see glories from tall mountain peaks.

Also noteworthy are the multicolored halos that sometimes encircle the sun or moon. The eerie rings are made by the interaction of light and suspended ice crystals.

Now That's Wonderful

A bridge that runs through Jim Henson's childhood hometown of Leland, Mississippi, has been officially named "The Rainbow Connection Bridge" in his honor. (If you don't get the reference, "Rainbow Connection" is the name of an

Oscar-nominated ballad sung by Kermit the Frog — Henson's most popular character — in 1979's "The Muppet Movie".)