contents

The Scholar and the Caliph

Seeing the light: Ibn al-Haytham, the father of modern optics

Adapted from the article by

Jennifer Ouellette

Ibn al-Haytham (from AD 965 to AD 1040) is considered by many historians to be the father of modern optics. In her article, Jennifer Ouellette imagined how his life and times must have been. While reading her article, we can almost imagine those golden days of Arabic science, come to life again. Here is her story, retold.

In the beginning: the Dam

As an ambitious young man back in Basra, he devoured the works of Aristotle and dreamed of scientific pursuits. "The ink of the scholar is more holy than the blood of the martyrs," the Koran says, and he believed it. So he followed the throngs of Basran fortuneseekers to Cairo, home to the Dar al-'llm (*House of Knowledge*), and found lodgings near the Azhar Mosque. He taught in the mosque's school, and worked as a scribe in the Dar al-'llm, copying Arabic translations of Euclid, Ptolemy and his beloved Aristotle, being careful not to smudge the pages with ink-stained fingers.

One day he received a summons from Cairo's reigning Caliph, al-Hakim bi-Amr Allah - a tremendous honour for a humble scribe. The

Scholar felt small and insignificant as he passed through the palace gates into a large courtyard, through to the majesty of the blue-domed throne room.

There he met the Caliph who was most eager to find a man who could solve a perplexing problem: the waters of the Nile. Too much flooding, and the crops would be destroyed; too little, and drought and famine would ravage the land. Could not a dam be built to control the flooding and bend the Nile to the Caliph's will?

Failure

The Scholar was flattered by the Caliph's attentions, and tempted by the promise of riches and fame should he succeed. But when the Scholar arrived at the proposed site, a cold dread ran through him, despite the dry heat of the desert: the sheer scale of the river and valley were beyond imagination. He

Ibn al-Haytham

Ibn al-Haytham developed an early version of the scientific method 200 years before scholars in Western Europe, and is most celebrated for the seven-volume Kitab al-Manazir (Book of Optics). The first three books deal with visual perception and psychology, while the remaining volumes focus on physical optics. It is frequently ranked alongside Newton's Principia as one of the most influential books in physics.

Very little is known about al-Haytham, other than what is contained in his written works. Of these, few survived the pillaging of the Crusades in the 11th century and the sacking of Baghdad in the mid-13th century, which effectively ended the golden age.

It is believed that al-Haytham failed to build a dam (near the modern Aswan Dam) to regulate the flooding of the Nile. Fearing execution by the Caliph, he pretended madness. He was kept under house arrest (or he may have been put in an asylum) during which he wrote the Book of Optics, although details of the exact conditions under which he worked are lacking.

There really was a House of Knowledge, and visitors to Cairo can still visit the Azhur Mosque where he taught. Al- Haytham went on to make contributions to astronomy, mathematics, engineering, medicine and physics. The year 2011 marks the millennial celebration (1000 years) of the Book of Optics.

realised that the scale of the engineering needed was beyond even the vast resources of the Caliph. In the end, he realized that it could not be done. He had failed. And in those times, failure on such a scale was punished by death through fearsome means.

As he made his way back to his lodgings along the narrow winding streets of Cairo, he had a heavy heart, anxiety building with every step. The sight of a passing beggar gave him an idea: suppose he pretended to be mad? Would not the Caliph show mercy to a madman?

Punishment

His fellow scribes at the Dar al-'llm agreed to help. Heart pounding, the Scholar shambled into the throne room, doing his best to mimic the beggar's behaviour - rocking and muttering to himself, even pulling out tufts of hair in only half-feigned agitation. His friends swore that he had been in this state for weeks, and they feared he would not recover.

"Very well," the Caliph said at last. "He shall be placed under house arrest until further notice. But his worldly goods shall be forfeited." "Yes, yes, of course, a small price to pay." The Scholar's friends kissed the hem of the Caliph's robes in relief, bowing repeatedly as they backed towards the door with the newly diagnosed lunatic between them.

"Wait." Al-Hakim held up a hand, and guards promptly blocked their exit. "Confiscate his books, too." He smiled slyly. "After all, what use does a madman have for reading?" And so the Scholar escaped with his life, but not his freedom - a forgotten man leading a solitary life. No books, no visitors - no distractions to fill the hours. Al-Hakim chose the punishment well; it could drive a sane man mad.

Watcher in the Dark

Now, many moons later, the Scholar watches the first light of dawn stream through the bedchamber door and finds himself wondering how that light can reach him in the darkness. “If only I had my books”, the Scholar sighs.

He ponders what he recalls from the Ancients. Aristotle wrote of mysterious “*forms*” travelling from objects into the eye, while Euclid and Ptolemy proclaimed that the eye emits rays of light that strike and illuminate surrounding objects. Yet when lying alone in his darkened room, no light shines forth from the Scholar’s eyes to illuminate the bare walls before him. He sees nothing until sunrise. Only then does the sunlight stream through the single window and reflect off the walls, providing faint illumination in his bedchamber.

As the morning light grows stronger, so does the light reflecting into his bedchamber. Is it possible that the Ancients were mistaken? This is an audacious thought - who is he to question Aristotle? But then he conceives an alternative explanation. Perhaps light radiates in many different straight lines, from every point of a luminous object, travelling in every direction at once. We only “see” objects that reflect those rays of light that enter the eye.

Test of the Theory

The Scholar decides to put his theory to the test. He lacks his books, but he has lamps and candles; screens and wooden blocks; tubes and makeshift rulers, and a sheet of thin copper. He has paper and ink. And not even al-Hakim has the power to take away his senses, or his mind. “I can still be a Scholar,” he thinks.

First, he gazes through a tube at a candle flame in the room, using a ruler to measure the line of sight. He can only “see” the flame when it is directly in front of the tube’s opening.

His excitement mounting, the Scholar thinks, “the light must radiate from each point of the fire.”

“I will make myself the enemy of all I have read, attack the old ideas from every angle and dismantle all that do not pass my tests until only the truth remains.” He then came to the conclusion that there is no mysterious “*form*” that all objects emit, nor do our eyes emit rays of light so we can see. Instead, there are sources of primary light - the Sun or a candle’s flame - and this light is reflected from other objects (secondary light) and passes into our eyes so that we can perceive them.

So Aristotle was wrong about light and vision. So were Euclid and Ptolemy. And if such great minds could be wrong about this, they might be wrong about other supposed “*truths*” as well!

Never again will the Scholar blindly accept assertions made by the Ancients, however revered; he vows to test and question everything. The outside world fades as he works with increasingly feverish intensity, oblivious to the sounds of city life echoing in the streets beyond his stone walls. Days turn into weeks, then months, then years, as he painstakingly records the details of all he discovers. There are seven volumes by the time he is done - a unified theory of light and vision that cites not a single ancient authority. He calls his manuscript Kitab al-Manazir (Book of Optics).

Ten years have passed. One morning the Scholar hears a knock on his door, something that hasn't happened for 10 years. The guards leave food, water and other necessities, but have never interacted with him. He opens the door to al- Hakim's vizier, who clears his throat. "Our Caliph is missing," he says. Lately, he explained, al-Hakim had taken to riding out into the al-Muqattam hills at night to fast and meditate. "Alas - this time, he has not returned."

The vizier studies the Scholar for a moment, then pulls a scroll from his robes. "This is a decree by the court physicians that the curse of madness is no longer upon you. Your house arrest is lifted. You are free to go."

The Scholar stands trembling in the cool shadows. Could it be true? He takes a shuffling step towards the door, then another. No guard tries to stop him. In the bright bustle of *dhuhr*, as the Sun reaches its zenith and the devout kneel for their noontime prayers, he emerges from his prison, blinking in the sudden glare, as if awakening from an unpleasant dream. He tilts his head back, raises his palms, and embraces the light.

Jennifer Ouellette is a science writer based in Los Angeles, US. This article first appeared in the January 2011 issue of Physics World.

Chocolate

Kamal Lodaya,
The Institute of Mathematical Sciences,
Chennai

To be a scientist you must be prepared to do experiments, and you must be very patient to wait until you have the results of the experiments. Here is a difficult experiment which even young children can persuade their parents to let them do.

Take a piece of chocolate and put it in your mouth. Now the difficult part of the experiment: *don't bite it!* Be patient, keep the chocolate there and wait.

Here is what the results of the experiment should be. The piece of chocolate becomes limp, then liquid, and its sweetness fills your mouth.

What did you learn from your experiment? Your body has a temperature of 37 degrees Celsius, so of course does your tongue. The heat from the tongue melts the chocolate. This works because chocolate melts at 34 degrees Celsius. This article is to tell you that this is not chance, but engineering. Chocolate is designed to melt in your mouth, that is one of the reasons eating it feels delicious.

Cocoa trees are native to Mexico and central America. Their fruit looks like something between an orange and a melon and is purple in colour. Inside each fruit there are 30 to 40 white seeds, which are the size of plums. If you try to eat them they are really bitter. Cocoa farmers harvest heaps of these beans and leave them to *rot*. This is the first step to making chocolate.

After fermentation (rotting) for about two weeks, the beans are dried and roasted. The carbohydrates (sugars and starches), long molecules inside these beans, are *caramelized*, broken up into smaller units and they turn brown. If you roast them too much you will only get black charcoal, which is all carbon. Also the carbohydrates react with the proteins inside the beans, this is called a *Maillard reaction* and it makes a huge variety of flavourful molecules.

The Mayans of central America would grind the fermented and roasted beans and add hot water to make a thick drink they called *chocolatl*, which means "bitter water" in their language. When the Europeans conquered America, they exported the drink to the rest of the world. As you may have expected it was not a success.

In 1828 a Dutch company called **van Houten** came up with the industrial process of pressing these beans so that the "butter" (fat) of the cocoa flowed out. The remaining powder was dark, smooth and sleek. This pulverized powder, mixed with sugar and milk, was sold under the name "drinking chocolate". This was a more successful product.

In 1847, an English company called **Fry and Sons** came up with a new idea. They mixed the powder and clarified cocoa butter with some sugar back into a solid which they called "eating chocolate". Any one eating this could perform the experiment we saw earlier. The butter melted releasing the powder and drinking chocolate was produced in your mouth. This unique sensation led to a boom in the industry.

Then in 1875 a Swiss dairy company called **Nestle** decided they wanted to make it even less bitter, and they added their milk powder to the product. Again this was a big hit with the market.

After that different companies have kept on developing techniques to give you newer and newer flavours. Where the cocoa is grown, the weather there, how long the fermentation is done, how diseases of the cocoa bean are avoided, these are big secrets because thousands of crores of rupees are involved in the chocolate trade today. Today almost half of the world's cocoa production is from the small African country of Ivory Coast.

Why does almost every one like chocolate? It has some addictive ingredients but in very small quantities: *caffeine*, *theobromine*, *cannabinoids*. Theobromine is even a poison for dogs and cats (so do not give chocolate to pets). But even if you eat several bars of chocolate in a day it is only equivalent to one or two cups of strong coffee.

Our bodies convert the cocoa butter into unsaturated fat, but unlike other such fats such as ghee (*nei*), cocoa butter does not seem to have any unhealthy effects. Of course if you eat a lot of chocolates your body puts on weight.

We have a long history of processing food in order to make it tasty. Amazingly, unlike many other products, chocolate seems to be deliciously engineered without dangerous side-effects.

Adapted from ***Stuff Matters*** by *Mark Miodownik*

Light

Types of Light

To understand light you have to know that what we call light is what is visible to us. **Visible light** is the light that humans can see. Other animals can see different types of light. Dogs can see only shades of gray and some insects can see light from the ultraviolet part of the spectrum. The key thing to remember is that our light is what scientists call visible light.

Scientists also call light **electromagnetic radiation**. Visible light is only one small portion of a family of waves called electromagnetic (EM) radiation. The entire **spectrum** of these EM waves includes **radio waves**, which have very long wavelengths and both **gamma rays** and **cosmic rays**, which are at the other end of the spectrum and have very small wavelengths. Visible light is near the middle of the spectrum.

It's all Energy

The key thing to remember is that light and EM radiation carry **energy**. The **quantum theory** suggests that light consists of very small bundles of energy/particles; it's just that simple. Scientists call those small particles photons, and the wavelength determines the energy and type of EM radiation, and the number of photons tells you how much radiation there is. A lot of photons give a brighter, more intense type of light. Fewer photons give a very dim and less intense light. When you use the dimmer switch on the wall, you are decreasing the number of photons sent from the light bulb. The type of light is the same while the amount has changed.

Different Speeds of Light?

As far as we know, all types of light move at one speed when in a vacuum. The speed of light in a vacuum is 299,792,458 meters per second. That speed is really fast, but even when you're travelling that fast, it takes a while to get places in space. It takes about seven minutes for light from the Sun to reach Earth. It takes over four years for the light from our Sun to get to the nearest star. It would take a particle of light over 100,000 years to get from one side of our galaxy to the other side. All of those values are light moving through a vacuum. You can slow light down in other substances such as the atmosphere, water, or a diamond. Light moves at about 124,000,000 meters per second (less than half the speed in a vacuum) in a diamond.

Types of Electromagnetic Radiation

There are waves of **energy** and light moving all around us in the form of TV and audio transmissions, gamma radiation from space, and heat in the atmosphere. Scientists call them all electromagnetic radiation. The waves of energy are called electromagnetic (EM) because they have oscillating**electric and magnetic fields**. Scientists classify them by their frequency or wavelength, going from high to low frequency (short to long wavelength). For a wave with a high frequency, it has a lot of energy, so it could be a gamma ray or x-ray. If it has low frequency, it has less energy and could be a TV or radio wave.

All EM energy waves travel at the speed of light. No matter what their frequency or wavelength, they always move at the same speed. Some properties of waves, such as diffraction and interference, are also seen in EM radiation. Scientists have figured out that there are tiny particles in these waves; they are called photons. The photons are specific units, or packets, of energy. Sometimes those particles interact with each other and change the way the light originally behaved.

Listening to the Heavens

All types of EM radiation are useful to the world of science. Look at radio waves as an example. Radio stations and ham radio operators of Earth work with radio waves every day. Radio waves are used to carry communications from one point to another. Radio waves are also extremely important to astronomers. Astronomers are constantly listening to the radio waves of other galaxies to learn more about their stars. Stars give off large amounts of EM radiation across the entire spectrum, and we can study that radiation to learn more about the universe.

Radiation Doesn't Scare Us... Much

An important idea you should always remember is that sometimes we use the word radiation. When you think of radiation, you probably think about nuclear power plants, bombs, and X-rays. Sure, those are all types of radiation. Nevertheless, more important to physics is the idea that all light is considered radiation. That means that everything from television and radio waves to gamma rays are all types of radiation. Think about the word **LASER**. The R stands for radiation, while a laser is just a souped-up flashlight. Think about heat. Most heat is actually infrared light being given off by an object. That heat is also radiation.

Seeing the Light

Let's take a moment to talk about visible light. As you can tell by the name, visible light is the light that humans can see. More specifically, you see the light that is not **absorbed** by objects. Green plants are green because they absorb all of the colors of the visible spectrum except the green color (you could also say the green wavelengths). A red wall is red to your eyes because it is not absorbing light from the red wavelengths. **Mirrors** reflect all of the colors of visible light.

Not Seeing the Light

We describe the world the way we see it as humans. Other living things on Earth see the world in different ways. Dogs only see things in black, white and gray. Some insects see colors that none of us can see. When you are learning about visible light you should remember we mean visible to humans. We should also mention that not all humans can see all the colors. There is an eye defect called color-blindness that affects many men. Color-blind men cannot see certain colors of the **spectrum**. It has to do with a genetic defect in their eyes.

Visible Light Colors

We now introduce you to Mr. Roy G. Biv. Was he a scientist? No. Did he create great optics and telescopes? No. He is not even a he. ROY-G-BIV is the acronym that represents all of the colors in the visible spectrum of light. R (red) - O (orange) - Y (yellow) - G (green) - B (blue) - I (indigo) - V (violet). Not only are those the colors we can see as humans, but they are also in the right order. Red has the longest wavelength and violet has the shortest. You could also say that red is the least energetic and violet is the most energetic of the visible spectrum.

Edges of Visibility

Although we can't see them with our eyes, some wavelengths of light that bookend the visible spectrum are also important. **Infrared**

radiation is next to the red portion of the spectrum. Infrared light is heat. Scientists use infrared light sensing optics when they want to see differences in temperature. **Ultraviolet radiation** (UV) is just beyond the violet end of the visible spectrum. UV light is given off by the Sun and absorbed by ozone in the atmosphere. Ultraviolet light can also mutate cells in your skin and give you skin cancer.

Particles and Waves

During the early 1900's scientists proved that **electromagnetic radiation** not only has packs of energy (**quanta**), but also proved that light moves in a **wave** pattern. It's like a stream of individual packets.

Looking at the Waves

All types of light move in wave-like patterns. In each wave pattern are high points and low points. The distance between two high points, or low points, is called the wavelength. Scientists use the Greek letter lambda to describe that distance. Depending on what type of light you are talking about, each type has a different lambda, or wavelength. All of the wavelengths of light together are called the EM spectrum.

Looking at the Particles

Light not only moves in waves; it also moves with a flow of little particles. Scientists call these particles of light, **photons**. The packets contain the energy that makes up the energy of the light. Scientists measure something called the relative energy of different types of light. The energy increases as the wavelength decreases.

Looking at the Energy

Compare different types of light. You will see that as you move up the EM spectrum and the wavelengths get smaller, those types of light have more energy. The big idea to remember is that light consists of both waves, and energy (transmitted with particles). EM radiation, like gamma waves and cosmic waves, has huge amounts of energy compared to a radio wave. When you look at the visible part of the spectrum, you will see that violet light is more energetic than light from the red part of the spectrum.

Reflection

When a **light ray** hits an object and bounces off, it is called reflection. When you think of reflection, think about **mirrors**. They reflect all of the light. That is the reason you can see yourself. Even the ocean reflects light, just not all of it. If you are above the ocean, you can't see the reflection that well, but when you are at an angle, look closely; you can see a reflection of the sky. So the ocean only has partial reflectivity.

R. K. Laxman

Born Rasipuram Krishnaswami Laxman

24 October 1921

Mysuru, British India (Karnataka, India)

Died26 January 2015 (aged 93)

Pune, Maharashtra, India

Nationality Indian

Occupation Cartoonist, illustrator

Known for Common Man cartoon

Spouse(s)

Rasipuram Krishnaswami Laxman[1] (24 October 1921 – 26 January 2015) was an Indian cartoonist, illustrator, and humorist.[2] He is best known for his creation The Common Man and for his daily cartoon strip, "You Said It" in The Times of India, which started in 1951.[3]

Laxman started his career as a part-time cartoonist, working mostly for local newspapers and magazines. While a college student, he illustrated his elder brother R. K. Narayan's stories in The Hindu. His first full-time job was as a political cartoonist for the The Free Press Journal in Mumbai. Later, he joined The Times of India, and became famous for the Common Man character.

Birth and childhood

R. K. Laxman was born in Mysore in 1921.[4] His father was a headmaster and Laxman was the youngest of six sons (he had a sister as well[5]);[6] an older brother is the famous novelist R. K. Narayan. Laxman was known as "Pied Piper of Delhi".[7]

Laxman was engrossed by the illustrations in magazines such as The Strand, Punch, Bystander, Wide World and Tit-Bits, before he had even begun to read.[8] Soon he was drawing on his own, on the floors, walls and doors of his house and doodling caricatures of his teachers at school; praised by a teacher for his drawing of a peepal leaf, he began to think of himself as an artist in the making.[9] Another early influence on Laxman was the work of the world-renowned British cartoonist, Sir David Low (whose signature he misread as "cow" for a long time) that appeared now and then in The Hindu.[10] Laxman notes in his autobiography, The Tunnel of Time:

I drew objects that caught my eye outside the window of my room – the dry twigs, leaves and lizard-like creatures crawling about, the servant chopping firewood and, of course, and number of crows in various postures on the rooftops of the buildings opposite

— R. K. Laxman[11]

Laxman was the captain of his local "Rough and Tough and Jolly" cricket team and his antics inspired the stories "Dodu the Money Maker" and "The Regal Cricket Club" written by his brother, Narayan.[12] Laxman's idyllic childhood was shaken for a while when his father suffered a paralytic stroke and died around a year later, but the elders at home bore most of the increased responsibility, while Laxman continued with his schooling.[13]

After high school, Laxman applied to the J. J. School of Art, Bombay hoping to concentrate on his lifelong interests of drawing and painting, but the dean of the school wrote to him that his drawings lacked "the kind of talent to qualify for enrolment in our institution as a student", and refused admission.[14] He finally graduated with a Bachelor of Arts from the University of Mysore. In the meantime he continued his freelance artistic activities and contributed cartoons to Swarajya and an animated film based on the mythological character Narada.[15]

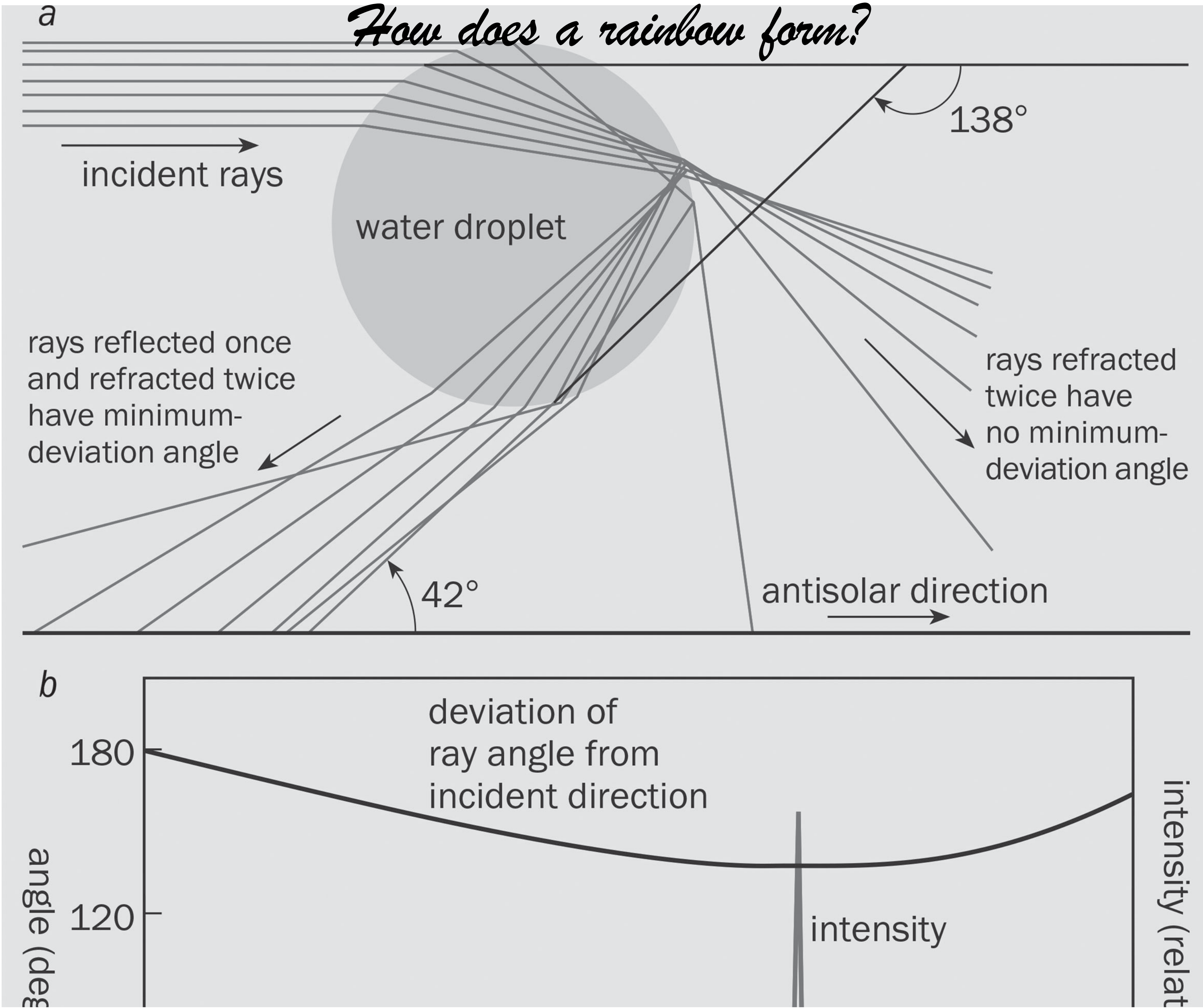
Career

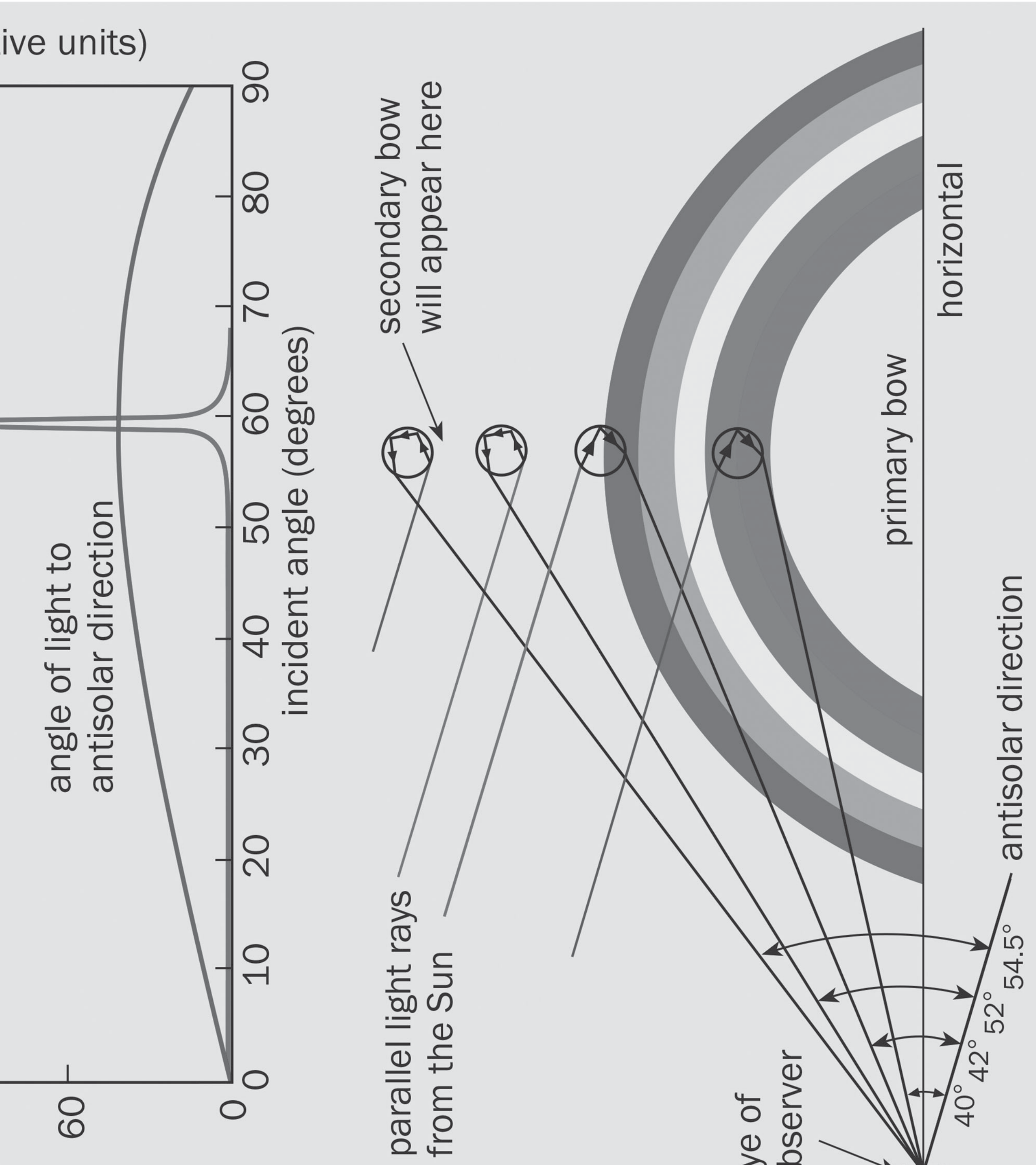
Beginning

Laxman's earliest work was for newspapers and magazines including Swarajya and Blitz. While still at the Maharaja College of Mysore, he began to illustrate his elder brother R. K. Narayan's stories in The Hindu, and he drew political cartoons for the local newspapers and for the Swatantra. Laxman also drew cartoons for the Kannada humour magazine, Koravanji (which was founded in 1942 by Dr M. Shivaram who was an allopath and had a clinic in the Majestic area of Bangalore. He started this monthly magazine, dedicating it to humorous and satirical articles and cartoons. Shivaram himself was an eminent humourist in Kannada. He encouraged Laxman.)

Laxman held a summer job at the Gemini Studios, Madras. His first full-time job was as a political cartoonist for the The Free Press Journal in Mumbai, where Bal Thackeray was his cartoonist colleague. Laxman later joined The Times of India, Bombay, beginning a career that spanned over fifty years. His "Common Man" character, featured in his pocket cartoons, is portrayed as a witness to the making of democracy.[16] Anthropologist Ritu G. Khanduri notes, "R. K. Laxman structures his cartoon-news through a plot about corruption and a set of characters. This news is visualized and circulates through the recurring figures of the mantri (minister), the Common Man and the trope of modernity symbolized by the airplane (2012: 304)."[17]

How does a rainbow form?

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Beachbot, The World's Most Adorable Sand Artist

Allegra Staples

The world is filled with extremely talented sand artists - people that can masterfully carve up giant castles, sculptures and even paintings, using just sand and water. But very few are as adorable as Beachbot - a robot which will keep the audience entertained as it scurries around creating beautiful masterpieces.

Unveiled on January 9th, the turtle-shaped robot that measures about 2 feet long, and 15 inches in width and height, is the result of a collaboration between Disney's Zurich Research Lab and a team of student engineers from the University in Zurich.

Like most sand artists, Beachbot creates the magnificent paintings using a rake that is attached to the underside of its body. Built with an automatic pressure control, it allows the robot to exert the right amount of force on the soft sand. Seven servo motors ensure that Beachbot can configure the rake prongs, allowing it to create "brush strokes" measuring anywhere from two to fifteen inches wide. The rake can also be retracted at any time, enabling the robot to create the outline with multiple lines instead of a continuous one. Its three cushioned balloon-like wheels not only help in painting smoother curves, but also allow the robot to drive over the artwork, without ruining it.

Of course all this skill and agility is only possible because of Beachbot's incredible "brain", which has been programmed with a series of algorithms that turn images into trajectories that the robot can easily follow. An inbuilt laser scanner allows the detection of the four reflective poles that act as parameters for its sandy canvas. In addition, the inertial measurement unit allows the artist to make precise movements that become lines, patterns, and eventually beautiful shapes and images, some as big as 30 feet by 30 feet. While Beachbot's artwork, which it completes in a speedy quick ten minutes is certainly impressive, what is even more so is watching the robot create it - a sight its inventors aptly describe as "an exceptional, magical show."

Though it may appear perfect to the onlooker, the Zurich team maintains that the Beachbot, which is still in the concept stage, is not quite ready for production. That's because it is not completely autonomous and still requires manual tweaking, especially when creating larger sand paintings. In addition, they envision future Beachbots to be able to erase their own masterpieces, paint entire shorelines and even be proficient snow artists - a talent that will certainly be appreciated by all "Frozen" fans!

Resources: Discovery.com, wired.com,engadet.com

Baby Birds Mimic Toxic Caterpillars to Fool Predators

Sarah Benton Feitlinger

Animals adapt in various ways to protect themselves from predators. Some take on the smell of the food they consume, while others build decoys. But very few are able to do what the cinereous mourner that resides in the Peruvian Amazon rainforests has done. This dull gray bird has evolved such that its chicks not only closely resemble a brightly colored toxic neighbor, but also act like it!

Scientists have long speculated that the gorgeous color was probably the reason the chicks were largely ignored by predators like snakes and monkeys. They were just not sure why it worked. A 1982 study suggested that it was because the fluffy orange chicks resembled a moss covered fruit that was not particularly desired by the animals. In 2012, another report proposed that the fuzz contained toxic chemicals or that the chicks may be mimicking an unknown animal that was harmful. However, it was difficult to confirm any of the theories since they were all made from the observation of two museum specimens.

Fortunately, California-based researcher Gustavo Londono was recently able to locate a cinereous mourner nest in the rainforest and observe the bird's behavior in the wild. According to the scientist who published his findings in the

January edition of the American Naturalist, the chicks are indeed mimicking another insect - an enormous caterpillar from the family Magalopygidae, that lives near cinereous mourner nests. Measuring 12 centimeters long or about the size of the chick, it is covered in hair that contains an irritating toxin, keeping it safe from predators.

The researchers observed that in addition to sporting the same color, the chicks also grow unusual feathers that contain long white tips, very similar to the insect's toxic hair. What was even more interesting was that the tiny birds even acted like the caterpillar. While most chicks open their mouths to be fed the minute the nest is disturbed, these baby birds would slither their bodies back and forth - much like the caterpillars they were impersonating. It was only when they heard a special vocal cue from their parent, that the baby mourners would raise their heads and open their mouths for food.

This survival tactic, where a species mimics a more dangerous one to gain protection from predators, is known as Batesian mimicry. First discovered in the mid-1800's by British naturalist Henry Bates, it is a phenomena that has previously been observed largely in invertebrates. The only other birds known to have adapted the Batesian mimicry are the burrowing owls who imitate the sound of rattlesnake rattles, to keep predators at bay.

Scientists are not sure how this bird was able to develop this cool disguise that enables it to survive for the first three weeks until its wings sprout. However, they have a good idea of why it was necessary. Cinereous mourner chicks nest for up to twenty days, much longer than birds of similar size and type. Researchers believe that it may have to do with the fact that they are not fed as frequently as other chicks, which also means they are left unsupervised for longer periods of time. This makes them more susceptible to predators. They believe that the orange color also acts as a camouflage allowing the chicks to blend into the leaves of their cup nests.

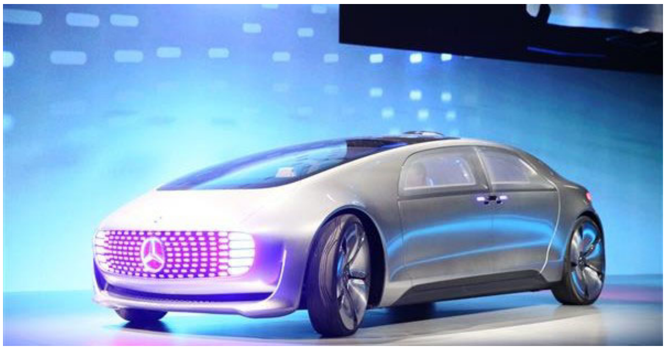
Although the observations made by Londono are extremely interesting, the researcher warns that the sample size of this study was very small. He believes that scientists need to study the behavior of additional Cinereous mourner chicks in the wild, before reaching any broad conclusions about their unusual adaptation.

Resources:newscientist.com, sciencenews.org, nationalgeographic.com

Look, No Hands! Futuristic Driverless Cars Are All The Rage

Kendall Costello

In early January, Mercedes-Benz captured the world's imagination by unveiling a futuristic self-driving car prototype at the Consumer Electronics Show in Las Vegas, Nevada. In addition to being autonomous, the F015 Luxury in Motion, also promises to be fuel efficient and as its name indicates, the epitome of luxury. While this is in complete contrast to Google's compact, koala-like autonomous vehicle, one thing is apparent - if manufacturers have their way, driverless



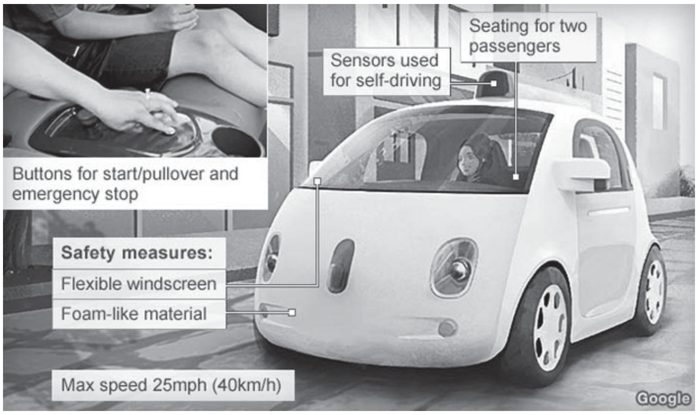
cars will be sharing the highways with human-driven vehicles, within the next decade.

While big automobile companies like Audi, General Motors and even Mercedes, are slowing working toward complete autonomy with features like pedestrian recognition and self-parking, newcomer Google Inc. has decided to go all out. The company, which has been working on this endeavor since 2008, began by modifying cars made by other manufacturers using their proprietary technology.

Then in May 2014, they unveiled the first prototype of a Google manufactured autonomous vehicle. The small toy-like car, the first to feature no steering wheel, accelerator or brake pedal, was impressive, but it still had a few manual controls and was also missing essentials like headlights. The company's second prototype released in December 2014, is a little more advanced with features that may take away the fear of robot cars - things like foam and a soft windshield to dampen the blow of any potential collisions. But the company still has some work to do to get to its final goal - a bare-bones car that has two seats (with seatbelts of course), a start and stop button, a screen that shows the route and some luggage room!

While Google prides itself for designing a simplistic car model that is 100% autonomous, Mercendes-Benz, is going with a design that is visually appealing and environmentally friendly. With a smooth and streamlined roof, a flat front windscreen, and touch screen interior walls, the Mercedes F015 sure knows how to combine autonomy with sophisticated design.

These features are accompanied with



swiveling front chairs that allow passengers to turn around and face the backseat passengers while the car is still in motion! The icing on the cake? The car will be powered by fuel cells, and is therefore completely "green"! However, this veteran car manufacturer does plan to furnish its autonomous vehicle with steering wheel and brakes, allowing the driver some control in case of a software malfunction.

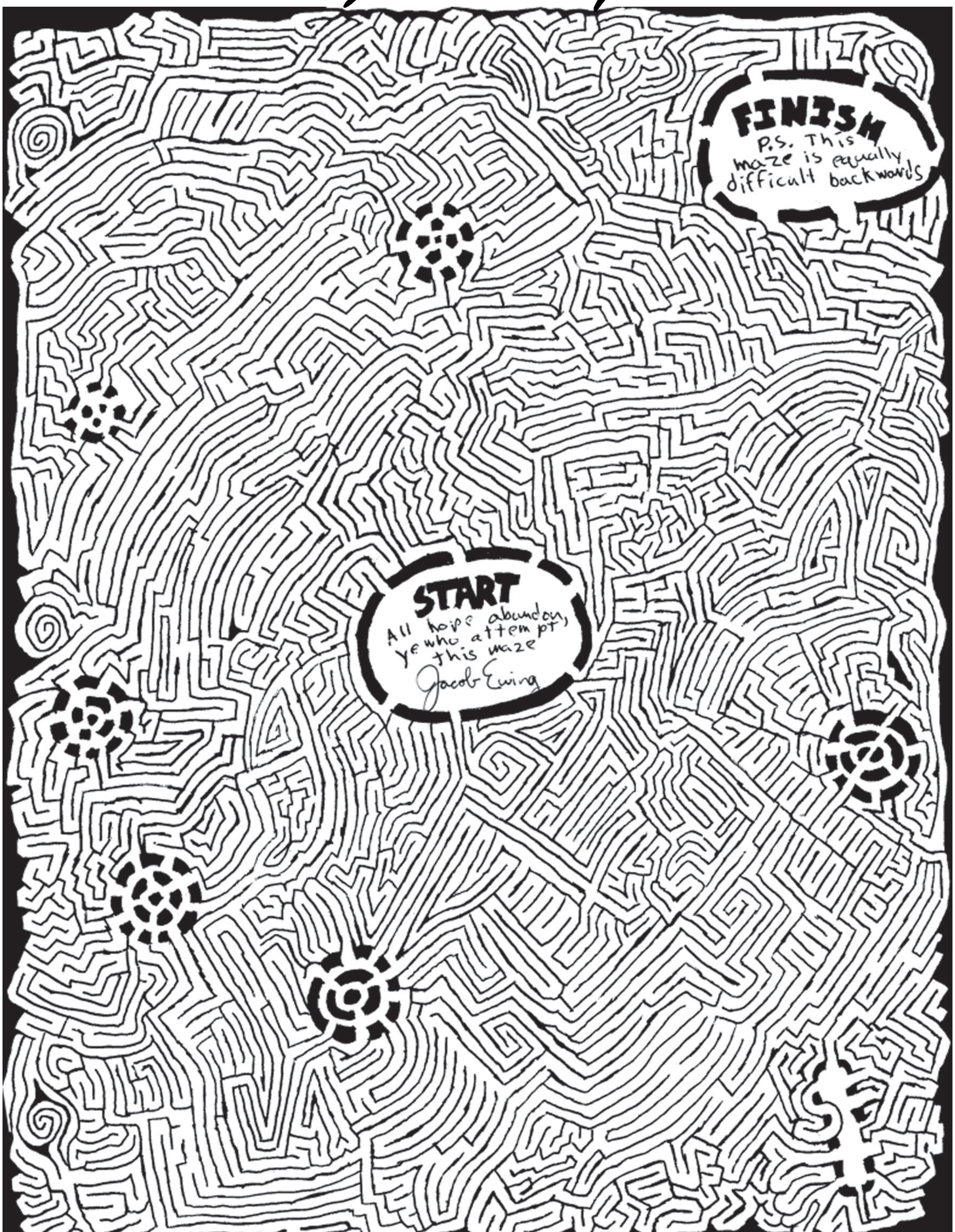
There are however a number of challenges that still need to be addressed. In order for autonomous cars to navigate through a terrain effectively, each new area must be painstakingly mapped out, with every detail accounted for. Driveways, stop signs, traffic lights, and speed limits all must be implemented into the vehicle's mapping system before the car can get to its destination.

Furthermore, both Google and Mercedes-Benz face the daunting task of testing their autonomous vehicles in snow, heavy rain, and extreme weather conditions. This may not be an easy thing to do given that the currently available remote sensing technology systems do not do particularly well in foul weather. Additionally, both vehicles are currently not great at detecting the color of traffic lights when the sun's rays are blinding the car's sensors and have yet to figure out how to park in multi-level car garages and open parking lots.

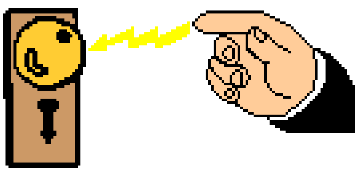
The biggest challenge however, will be to convince passengers and those driving alongside the cars, that they are completely safe to be in or around. It is therefore no wonder that so far only four states: California, Michigan, Florida, and Nevada, have passed legislation to allow for automated vehicles. There is also the issue of the disruption a wide-scale deployment would cause, for the millions of people that make their living driving others to their destinations. Hence, it may take some time before human drivers disappear completely - but the future sure looks interesting.

Resources: gizmag.com, technologyreview.com, independent.co.uk

Find the way


FINISH
P.S. This maze is equally difficult backwards
START
All hope abandon, ye who attempt this maze
Jacob Ewing

What is Static Electricity?



You walk across the rug, reach for the doorknob and... ZAP! You get a static shock.

Or, you come inside from the cold, pull off your hat and... static hair!!

The static electricity makes your hair stand straight out from your head.

What is going on here? And why is static more of a problem in the winter?

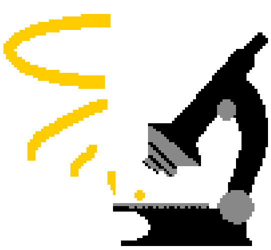
(Learn how to eliminate static electricity problems in your home or office.)

To understand static electricity, we have to learn a little bit about the nature of matter. Or in other words, what is all the stuff around us made of?

Everything Is Made Of Atoms

Imagine a pure gold ring. Divide it in half and give one of the halves away. Keep dividing and dividing and dividing. Soon you will have a piece so small you will not be able to see it without a microscope. It may be very, very small, but it is still a piece of gold.

microscope



If you could keep dividing it into smaller and smaller pieces, you would finally get to the smallest piece of gold possible. It is called an atom. If you divided it into smaller pieces, it would no longer be gold.

Everything around us is made of atoms and scientists so far know of 118 different kinds. These different kinds of atoms are called "elements." There are 98 elements that exist naturally (although some are only found in very small amounts). Four of these 118 elements have reportedly been discovered, but have not yet been confirmed.

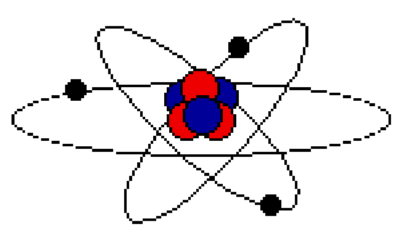
Atoms join together in many different combinations to form molecules, and create all of the materials you see around you.

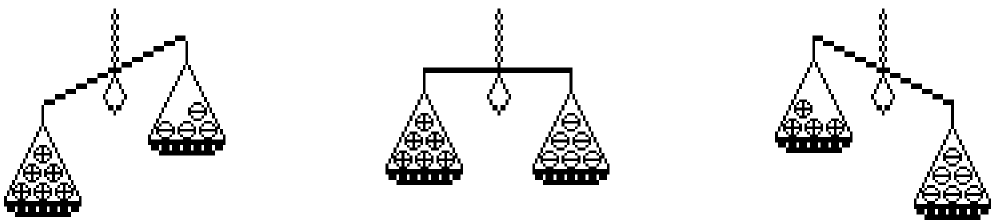
Parts Of An Atom

So what are atoms made of? In the middle of each atom is a "nucleus." The nucleus contains two kinds of tiny particles, called protons and neutrons. Orbiting around the nucleus are even smaller particles called electrons. The 115 kinds of atoms are different from each other because they have different numbers of protons, neutrons and electrons.

atom & electrons

It is useful to think of a model of the atom as similar to the solar system. The nucleus is in the center of the atom, like the sun in the center of the solar system. The electrons orbit around the nucleus like the planets around the sun.





Just like in the solar system, the nucleus is large compared to the electrons. The atom is mostly empty space. And the electrons are very far away from the nucleus. While this model is not completely accurate, we can use it to help us understand static electricity.

(Note: A more accurate model would show the electrons moving in 3- dimensional volumes with different shapes, called orbitals. This may be discussed in a future issue.)

Electrical Charges

Protons, neutrons and electrons are very different from each other. They have their own properties, or characteristics. One of these properties is called an electrical charge. Protons have what we call a "positive" (+) charge. Electrons have a "negative" (-) charge. Neutrons have no charge, they are neutral.

The charge of one proton is equal in strength to the charge of one electron. When the number of protons in an atom equals the number of electrons, the atom itself has no overall charge, it is neutral.

Electrons Can Move

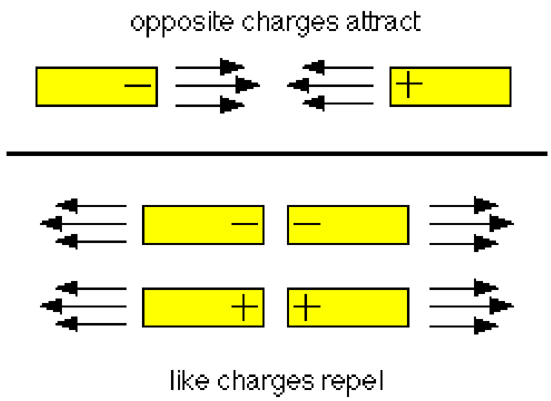
The protons and neutrons in the nucleus are held together very tightly. Normally the nucleus does not change. But some of the outer electrons are held very loosely. They can move from one atom to another.

An atom that loses electrons has more positive charges (protons) than negative charges (electrons). It is positively charged. An atom that gains electrons has more negative than positive particles. It has a negative charge. A charged atom is called an "ion."

electrical charges

Some materials hold their electrons very tightly. Electrons do not move through them very well. These things are called insulators. Plastic, cloth, glass and dry air are good insulators. Other materials have some loosely held electrons, which move through them very easily. These are called conductors. Most metals are good conductors.

How can we move electrons from one place to another? One very common way is to rub two objects together. If they are made of different materials, and are both insulators, electrons may be transferred (or moved) from one to the other. The more rubbing, the more electrons move, and the larger the static charge that builds up. (Scientists believe that it is not the rubbing or friction that causes electrons to move. It is simply the contact between two different materials. Rubbing just increases the contact area between them.)



Static electricity is the imbalance of positive and negative charges.

Opposites Attract static charges.

Now, positive and negative charges behave in interesting ways. Did you ever hear the saying that opposites attract? Well, it's true. Two things with opposite, or different charges (a positive and a negative) will attract, or pull towards each other. Things with the same charge (two positives or two negatives) will repel, or push away from each other.

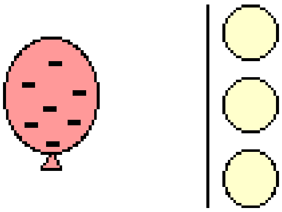
A charged object will also attract something that is neutral. Think about how you can make a balloon stick to the wall.

If you charge a balloon by rubbing it on your hair, it picks up extra electrons and has a negative charge. Holding it near a neutral object will make the charges in that object move.

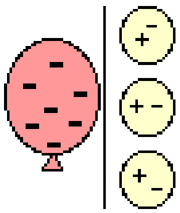
balloon stuck to wall

If it is a conductor, many electrons move easily to the other side, as far from the balloon as possible.

If it is an insulator, the electrons in the atoms and molecules can only move very slightly to one side, away from the balloon.



In either case, there are more positive charges closer to the negative balloon.



Opposites attract. The balloon sticks. (At least until the electrons on the balloon slowly leak off.) It works the same way for neutral and positively charged objects.

So what does all this have to do with static shocks? Or static electricity in hair?

When you take off your wool hat, it rubs against your hair. Electrons move from your hair to the hat. A static charge builds up and now each of the hairs has the same positive charge.

Remember, things with the same charge repel each other. So the hairs try to get as far from each other as possible. The farthest they can get is by standing up and away from the others. And that is how static electricity causes a bad hair day!

Where Do the Electrons Go?

When we rub two different materials together, which becomes positively charged and which becomes negative? Scientists have ranked materials in order of their ability to hold or give up electrons...

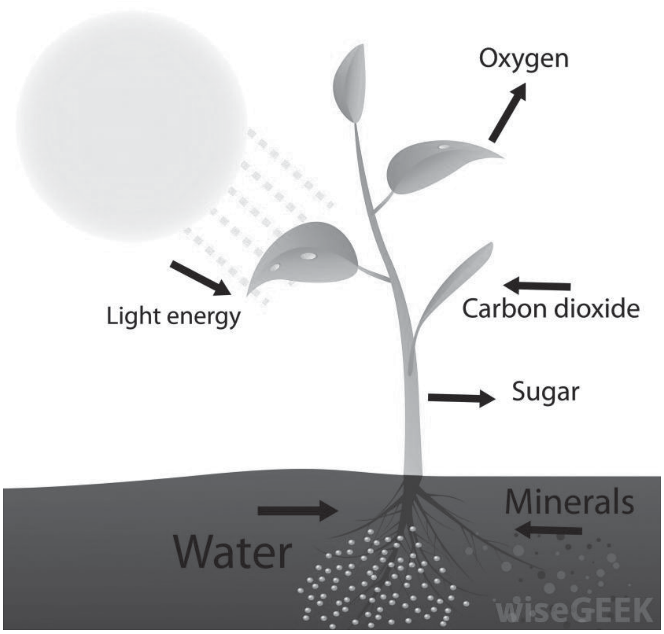
http://www.sciencemadesimple.com/static_electricity.html

Why Do Leaves Change Color in Autumn?

We all enjoy the colors of autumn leaves. The changing fall foliage never fails to surprise and delight us. Did you ever wonder how and why a fall leaf changes color? Why a maple leaf turns bright red? Where do the yellows and oranges come from?

To answer those questions, we first have to understand what leaves are and what they do.

Leaves are nature's food factories. Plants take water from the ground through their roots. They take a gas called carbon dioxide from the air. Plants use sunlight to turn water and carbon dioxide into oxygen and glucose. Oxygen is a gas in the air that we need to breathe. Glucose is a kind of sugar. Plants use glucose as food for energy and as a building block for growing.



Photosynthesis

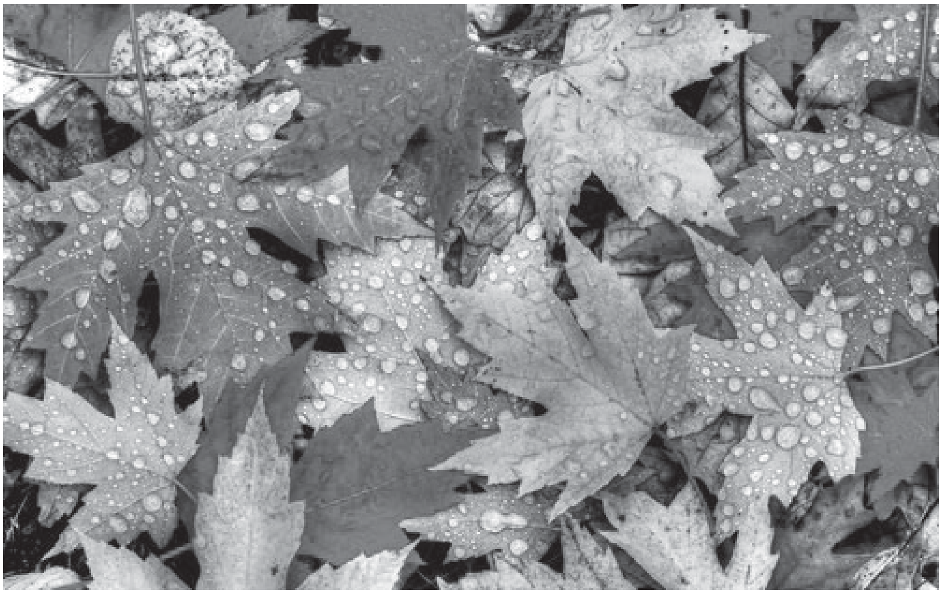
The way plants turn water and carbon dioxide into oxygen and sugar is called photosynthesis. That means "putting together with light." A chemical called chlorophyll helps make photosynthesis happen. Chlorophyll is what gives plants their green color.

Autumn Preparations for Winter

As summer ends and autumn comes, the days get shorter and shorter. This is how the trees "know" to begin getting ready for winter.

During winter, there is not enough light or water for photosynthesis. The trees will rest, and live off the food they stored during the summer. They begin to shut down their food-making factories. The green chlorophyll disappears from the leaves.

autumn leaves sceneryAs the bright green fades away, we begin to see yellow and orange colors. Small amounts of these colors have been in the leaves all along. We just can't see them in the summer, because they are covered up by the green



different ways to get through the harsh days of winter.

chlorophyll.

The bright reds and purples we see in leaves are made mostly in the fall. In some trees, like maples, glucose is trapped in the leaves after photosynthesis stops. Sunlight and the cool nights of autumn cause the leaves turn this glucose into a red color.

The brown color of trees like oaks is made from wastes left in the leaves.

It is the combination of all these things that make the beautiful fall foliage colors we enjoy each year.

Plants are busy growing all summer long. But how do they survive the dark, dry days of winter?

How Plants Prepare for Winter

All summer, with the long hours of sunlight and a good supply of liquid water, plants are busy making and storing food, and growing. But what about wintertime? The days are much shorter, and water is hard to get. Plants have found many different ways to get through the harsh days of winter.

Some plants, including many garden flowers, are called "annuals," which means they complete their life cycle in one growing season. They die when winter comes, but their seeds remain, ready to sprout again in the spring.

"Perennials" live for more than two years. This category includes trees and shrubs, as well as herbaceous plants with soft, fleshy stems. When winter comes, the woody parts of trees and shrubs can survive the cold. The above ground parts of herbaceous plants (leaves, stalks) will die off, but underground parts (roots, bulbs) will remain alive. In the winter, plants rest and live off stored food until spring.

As plants grow, they shed older leaves and grow new ones. This is important because the leaves become damaged over time by insects, disease and weather. The shedding and replacement continues all the time. In addition, deciduous trees, like maples, oaks and elms, shed all their leaves in the fall in preparation for winter.

"Evergreens" keep most of their leaves during the winter. They have special leaves, resistant to cold and moisture loss.evergreen needlesevergreen needles Some, like pine and fir trees, have long thin needles. Others, like holly, have broad leaves with tough, waxy surfaces. On very cold, dry days, these leaves sometimes curl up to reduce their exposed surface. Evergreens may continue to photosynthesize during the winter as long as they get enough water, but the reactions occur more slowly at colder temperatures.

During summer days, leaves make more glucose than the plant needs for energy and growth. The excess is turned into starch and stored until needed. As the daylight gets shorter in the autumn, plants begin to shut down their food production.

Many changes occur in the leaves of deciduous trees before they finally fall from the branch. The leaf has actually been preparing for autumn since it started to grow in the spring. At the base of each leaf is a special layer of cells called the "abscission" or separation layer. All summer, small tubes which pass through this layer carry water into the leaf, and food back to the tree. In the fall, the cells of the abscission layer begin to swell and form a cork-like material, reducing and finally cutting off flow between leaf and tree. Glucose and waste products are trapped in the leaf. Without fresh water to renew it, chlorophyll begins to disappear.

The bright red and purple fall foliage colors come from anthocyanin (an-thuh-'si-uh-nuhn) pigments. These are potent antioxidants common in many plants; for example, beets, red apples, purple grapes (and red wine), and flowers like violets and hyacinths. In some leaves, like maple leaves, these pigments are formed in the autumn from trapped glucose.

Why would a plant use energy to make these red pigments, when the leaves will soon fall off? Some scientists think that the anthocyanins help the trees keep their leaves a bit longer. The pigments protect the leaves from the sun, and lower their freezing point, giving some frost protection. The leaves remain on the tree longer, and more of the sugars, nitrogen and other valuable substances can be removed before the leaves fall. Another possible reason has been proposed: when the leaves decay, the anthocyanins seep into the ground and prevent other plant species from growing in the spring.

Brown fall foliage colors come from tannin, a bitter waste product. Other colors, which have been there all along, become visible when the chlorophyll disappears. The orange colors come from carotene ('kar-uh-teen) and the yellows from xanthophyll ('zan-thuh-fil). They are common pigments, also found in flowers, and foods like carrots, bananas and egg yolks. We do not know their exact role in leaves, but scientists think they may be involved somehow in photosynthesis. Different combinations of these pigments give us a wide range of colors each fall.

As the bottom cells in the separation layer form a seal between leaf and tree, the cells in the top of the separation layer begin to disintegrate. They form a tear-line, and eventually the leaf is blown away or simply falls from the tree.

One more important question remains. What causes the most spectacular display? The best place in the world for viewing fall colors is probably the Eastern United States. This is because of the climate there, and the wide variety of deciduous trees. The brightest colors are seen when late summer is dry, and autumn has bright sunny days and cool (low 40's Fahrenheit) nights. Then trees make a lot of anthocyanin pigments. A fall with cloudy days and warm nights brings drab colors. And an early frost quickly ends the beautiful fall foliage color display.

The subtlety of rainbows

Subtle physics is needed to explain many of nature's mysterious atmospheric optical phenomena, including rainbows, ice-crystal haloes and the much rarer fog-bows, dew-bows and glories. John Hardwick investigates

In his poem of 1820 entitled Lamia, John Keats complained that cold phi-losophy had destroyed the mystery of nature, and that Newton, through his work on optics, had "unweave[d the] rainbow". Such a sentiment would find little sympathy with most scientists – or with many artists today for that matter. Indeed, an understanding of natural phe--nomena can only enhance our ap-preciation of nature and art.

Although it has long been known that a rainbow is produced by the dispersion of white light through rain droplets via refraction, there is far more to this op-tical phenomenon than first meets the eye. More complex and subtle interactions between light and water droplets can also create the "fog-bow", the "dew-bow" and the "glory".

Rainbows explained

Despite being a familiar sight (figure 1), rainbows are much harder to understand than one might think. The ingredients are, of course, sunlight and rain droplets. Although the Sun's rays that reach the Earth are essentially parallel, the light impinges on a spherical droplet at a wide range of angles to the surface, where it undergoes refraction. When the light reaches the back of the droplet, two things can happen (figure 2a). The light can either refract and continue in a forward direction out of the drop, or it can be reflected internally, be-fore passing back out through the front surface of the droplet via another refraction. It is this second process – in which light is refracted, reflected and refracted again – that creates the rainbow, which explains why rainbows only ap-pear when one looks away from the Sun into a rain shower.

1 Bow beautiful

There are, however, innumerable raindrops

at many different heights and positions above the horizon. As a result – and because of the many different angles at which the sunlight strikes the droplets’ surfaces – we receive light rays at many different angles to the “antisolar direction”, which is the di-rection looking away from the Sun towards the shadow of our head. So why does the bright, coloured arc of the rainbow only appear centred on this direction and at a specific and narrow range of angles to it?

Consider first what happens when the incident light strikes the surface of a drop-let head on. Some of the light continues straight through the drop, while the rest reflects directly back. For the lat--ter, the “angle of deviation” between the incident and reflected beams is 180°. But as the incident light strikes the droplet at a larger angle, the angle of deviation falls below 180°. When the in-cident light strikes at even larger angles, the devi-ation eventually reaches a minimum value, before rising again (figure 2).

2 Rainbow optics

(a) A parallel beam of sunlight striking a spherical rain droplet. Despite being parallel, the light strikes the droplet at a wide range of different angles. The light undergoes refraction as it enters the droplet before undergoing reflection and further refraction. (b) The “angle of deviation” (black line) between the incoming and outgoing rays passes through a minimum value for each wavelength, which is 138° for red light. The intensity of the deviated light (red line) reaches a maximum at this angle and is responsible for the creation of a “primary” rainbow. (c) Different colours have different minimum-deviation angles because the refractive index of water depends on wavelength. The angle between light from the primary rainbow and the “antisolar direction” is 42° for the red bow and 40° for the violet bow. A separate, less intense, “secondary” bow can also be created from light that undergoes not one but two reflections from inside the droplet. The colours of this bow appear in reverse order to the primary bow.

At the minimum-deviation angle the rate of change of deviation angle with in-cident angle is zero. What this means is that light striking a

droplet over a rel-atively wide range of incident angles emerges concentrated in a narrow – and almost parallel – direction. For example, light rays spanning a 13° interval around the incident angle for minimum devi-ation are focused down to an emerging beam with an angular width of just 1°. Light travelling in this direction has a relatively high intensity and forms part of the standard – or "primary" – rainbow with which we are all familiar.

Different colours have slightly different minimum deviation angles; it is about 140° for short-wavelength violet light and falls to 138° for red light. The violet component of a primary rainbow is therefore on the bow's inner side – about 40° to the antisolar direction – while the red component is on the outside at about 42° (figure 2c). Other colours fall in between. As the Sun rises, all that changes is that we see less and less of the rainbow's arc as the "antisolar point" – the centre of the circle of which the rainbow is a part – and the outer limbs of the bow gradually sink below the horizon. Interestingly, if the Sun is higher than 42° above the horizon, minimum-devi-ation rays can only be received from drops located at angles below it, which is why rainbows are generally not visible when the Sun is high in the sky at the middle of the day.

Another interesting property of a primary rainbow is that the intensity of light coming from below it is higher than the background intensity from above it. This effect is visible in -figure 1. The reason for this is that rain droplets cannot contribute to any light coming from angles above the rainbow because light cannot be bent round a droplet by less than the minimum angle of deviation. Some of the light scattered by the raindrops can, however, reach the observer from below the rainbow, which is therefore brighter than the area above it – but, of course, not nearly as bright as the rainbow itself.

Although a large proportion of light exits the drops after a single internal reflection to form the primary rainbow, some light can undergo two internal reflections. Such twice-reflected rays, which also have minimum-deviation angles and associated intensity maxima, form a "secondary" bow. This appears above the primary bow at an angle of about 52° to the antisolar direction. The secondary bow is fainter than the primary bow and its colours appear in the reverse order. A secondary bow is just visible in figure 1.

What about those light rays that pass out through the drop-lets in the forward direction after two refractions and no re-flection? These have no minimum deviation, which means that this light does not reach a maximum intensity at any -particular angle. In other words, if we look towards the Sun through rain, we will see no bright rainbow but just an overall forward glare.

However, in principle, a "tertiary" bow can also be formed after the light has undergone three internal reflections in a droplet. This would occur when looking towards the Sun at an angle of about 40°, but it would be fainter than the secondary bow and obscured by forward glare. There have been some reported sightings of a tertiary bow (D E Pedgley 1986 A tertiary rainbow Weather 41 401) but no photographs exist, so far at least!