Everything You Should Know About Sound

March 9, 2016 By Tim Urban

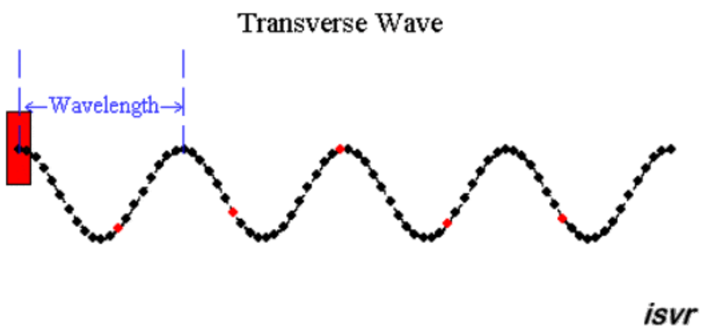
This post is part of Mini Week, where I'm posting a new mini post but not actually mini as it turns out every weekday this week.

ᅟ———

…vays been a little confused about sound. So for "Tuesday's" "mini" post, I decided to do …hing about that.

…nk of sound as something we *hear*—something that makes *noise*. But in pure physics terms, …is just a vibration going through matter.

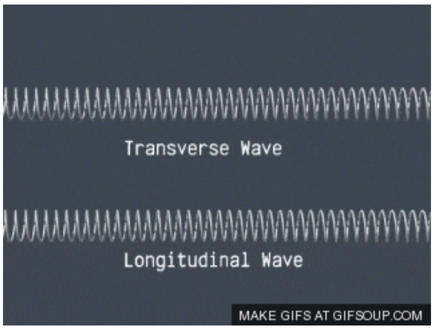
…y a vibration "goes through" matter is in the form of a sound wave. When you think of sound … you probably think of something like this:[1]



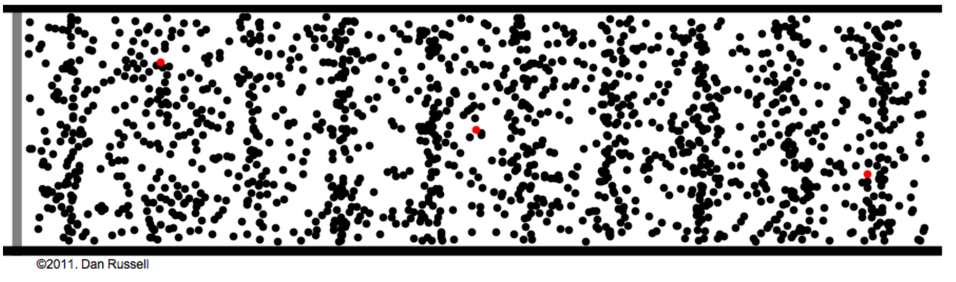
But that's not how sound waves work. A wave like that is called a transverse wave, where each individual particle moves up and down to create a snake situation.

A sound wave is more like an earthworm situation:[2]

Like an earthworm, sound moves by compressing and decompressing. This is called a longitudinal wave. A slinky can do both kinds of waves:[1] [3]

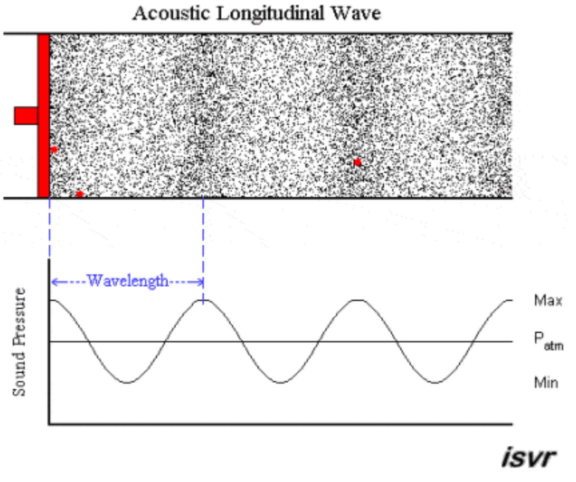


Sound starts with a vibration of some kind creating a longitudinal wave through matter. Check this out: [4]



That's what sound looks like—except picture an expanding ripple of *spheres* doing that. In this animation, the sound wave is being generated by that vibrating grey bar on the left. The bar might be your vocal chords, a guitar string, or a waterfall continually pounding down into the river below. By looking at the red dots, you can see that even though the wave moves in one direction, each individual particle only moves back and forth, mimicking the vibration of the gray bar.

So instead of a curvy snake wave, sound is a *pressure* wave, which causes each piece of the air to be at either higher-than-normal pressure or lower-than-normal pressure. So when you see a snake-like illustration of a sound wave, it's referring to the measure of pressure, *not* the literal path of movement of the particles: [5]



Sound waves can go through air, which is how we normally experience it. But it can also go through liquid [2] or solid matter—much of the jolting that happens during an earthquake is the result of a huge sound wave whizzing through the earth (in that case, the movement of the fault is serving as the gray and red bars in the animations above).

How about the speed of sound? Well it depends on how quickly the pressure wave can move in a given medium. A medium that's more fluid, like air, is highly compressible, so it takes longer for the wave to move, while water is far less compressible, so there's less "give" to slow the wave down. It's like two people holding an outstretched slinky between them—if one pushes their end toward the other person, the wave will take a little time to travel down the slinky before the other person feels it. But if the two people are holding a broomstick, when one pushes, the other feels it immediately, because the broomstick is much less compressible. [6]

So it makes sense that the speed of sound in air (768 mph / 1,234 kmph under normal conditions) is about four times slower than the speed of sound in water, which itself is about four times slower than the speed of sound through a solid like iron.

Back to us and *hearing*. Ears are an evolutionary innovation that allows us to register sound waves in the air around us and process them as information—without ears, most sound waves would be imperceptible to a human with only the loudest sounds registering as a felt vibration on our skin. Ears give us a magical ability to sense even slight sound waves in a way so nuanced, it can usually tell us exactly where the sound is coming from and what the meaning of it is. And it enables us to talk. The most important kind of human communication happens when our brains send information to other brains through complex patterns of *air pressure waves*. Have you ever stopped and thought about how incredible that is?

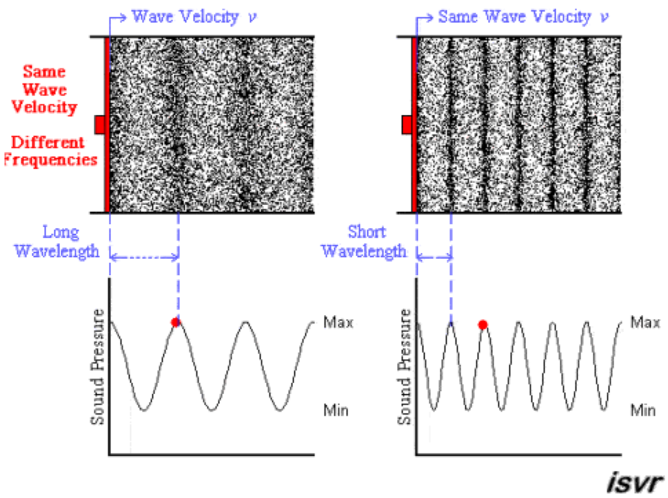
I was about to move on, but sorry, I can't get over this. The next time you're talking to someone, I want you to stop and think about what's happening. Your brain has a thought. It translates that thought into a pattern of pressure waves. Then your lungs send air out of your body, but as you do that, you vibrate your vocal chords in *just* the right way and you move your mouth and tongue into *just* the right shapes that by the time the air leaves you, it's embedded with a pattern of high and low pressure areas. The code in that air then spreads out to all the air in the vicinity, a little bit of which ends up in your friend's ear, where it passes by their eardrum. When it does, it vibrates their eardrum in such a way as to pass on not only the code, but exactly where in the room it came from and the particular tone of voice it came with. The eardrum's vibrations are transmitted through three tiny bones and into a little sac of fluid, which then transmits the information into electrical impulses and sends them up the auditory nerve and into the brain, where the information is decoded. And all of that happens in an eighth of a second, without any effort from either of you. Talking is a *miracle*.

Anyway—

The ear can discern many qualities of a sound it hears, but two of the most fundamental are pitch and loudness.

Pitch

Pitch is all about wavelength—i.e. how far apart the pressure waves are:[7]



The shorter the wavelength, the higher the pitch. Humans can hear frequencies as low as 20 Hz (which is a 56 ft /17 m long wave) and as high as 20,000 Hz (.7 in / 1.7 cm). As you age, you lose your ability to hear the highest pitches, so most of you probably hear nothing when you listen to the frequencies approaching 20,000 Hz (your dog will disagree). But you'll have an easier time hearing the lowest part of the range.[8] The reason you can *feel* low sounds, like low bass notes in music, is that the wavelength is so long that it actually takes 1/20th of a second for a full wave to pass your body (hence 20 Hz).[3][4]

Loudness

The loudness[5] of a sound we hear is determined by the *amplitude* of the pressure waves. In the animation above, the high and low-pitched sounds depicted have the same loudness, because the pressure curves at the bottom of the animation are the same size *vertically*. Louder sounds have a larger oscillation between the low and high pressure sections of the wave—i.e. loud sounds have higher high-pressure and lower low-pressure parts than quiet sounds.

For sounds through the air on Earth's surface, the average of the high-pressure and low-pressure parts of the wave is our normal atmospheric pressure—what we call 1 "atmosphere" of pressure. So a sound wave might have a high pressure component of 1.0001 atmospheres and a low pressure component of .9999 atmospheres, and a louder sound might be 1.01/.99 instead—but in both cases, the average of the two is 1 atmosphere.

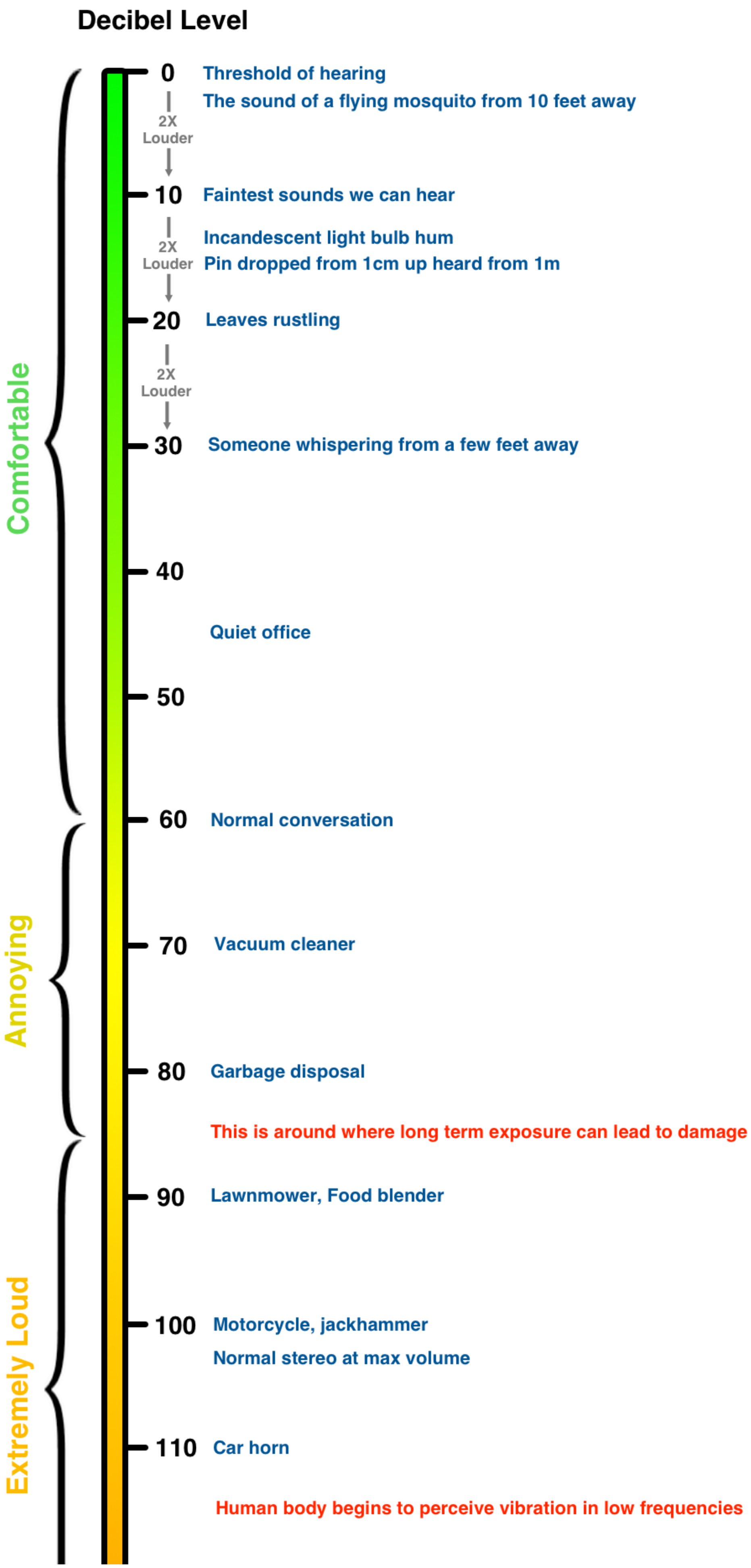
We often measure loudness using a unit called the decibel (named after Alexander Graham Bell). If you want to be confused, read the Wikipedia page on decibels. It's a super icky unit. And rather than bore us both by explaining it, let's just talk about how we use decibels to measure sound.

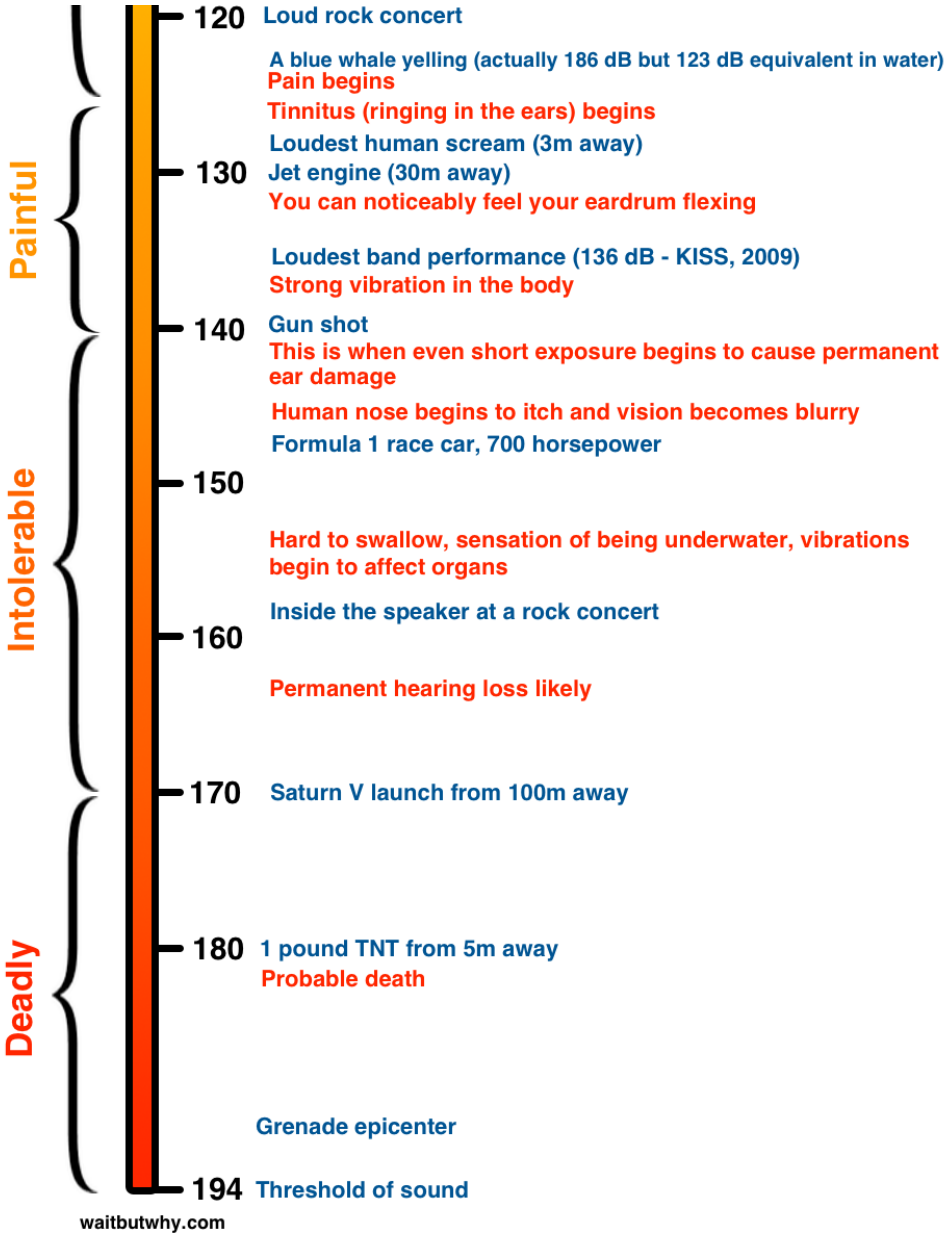
The scale of loudness has a very tiny minimum. The faintest sounds are far softer than any human could hear—even softer than any of our finest scientific instruments could detect. But depending on where you are, sound has a hard maximum. The reason is that sound isn't a thing in itself—it's a pressure wave moving through a medium. And since, as we talked about, the average of the high and low pressure points of a sound wave has to be the normal pressure of the medium, loudness is limited by the fact that eventually, the low pressure point hits zero-pressure—a vacuum. Since the low pressure can't go any lower, that point determines the max amplitude of a sound wave, and the loudest a sound can be, in any given place.

The convenient thing about decibels (dB) is that the absolute faintest sound detectable to the human ear is, by definition, 0 dB—we call that "the threshold of hearing." Scientists do their best to study sounds far down into the negative decibel scale and there are man-made rooms on Earth that register as low as -9.4 dB—where it's so quiet you can hear the blood pumping through your own brain—but we can only hear sounds in the dB positives. The loudest a sustained sound can possibly be on Earth's surface is 194 dB—which is when the amplitude of the sound wave is so intense that the low pressure part is a perfect vacuum (the wave alternates between double the normal atmospheric pressure and no air at all—not something you want to be present for). Let's take a look at the full scale, starting with the really quiet.

One thing to keep in mind is that with decibels, each increase of 10 dB *doubles* the loudness. So 20 dB is twice as loud as 10 dB, 30 dB is four times as loud as 10 dB, and 80 dB is 128 times louder than 10 dB.[6]

The Sound Scale





The scale stops at 194 because there's no such thing as a louder sound on Earth's surface. But we can go beyond here in two ways:

1) Shock Waves

When enough energy is released to pass the 194 dB mark, it's too much to create a sustained pressure *wave* because we've bottomed out on low pressure—but things still *happen*. Very, very intense things.

At 194 dB, there's a maxed out wave alternating between double the normal pressure and a total vacuum—but once we get to 195 dB, the energy stops moving *through* the air and starts *pushing* the air outward with an expanding vacuum. The more dBs above 194 there are, the farther reaching and higher-impact that vacuum bubble will be. It expands outward as a rapidly-growing half-sphere:[10]

On the edge of the bubble is a barrier of super-compressed gas, and when this barrier sweeps over the land, it usually flattens whatever's in its path:[11]

As the hemisphere expands, it loses energy and eventually dissipates. But if you found yourself in the path of a shock wave before that happened, you'd have a bad time. First, the impact of the super-compressed barrier would be like hitting a brick wall (in the same way and for the same reason falling on water from a bridge is like falling on concrete). Second, compressed air is *hot*. Third, it wouldn't just hit all parts of your body, it would go *through* your body, and if it were powerful enough it could turn your bones to powder and your organs to soup.

Here are some famous 194dB+ events:

Saturn V launch: The Saturn V was a beast, and the sound waves from its launches were so intense that they could light grass on fire a mile away. Even at three miles away, an observer would experience ear-splitting 135 dB sound.[12] Rocket launches create such a powerful sound, that space agencies flood the launchpad with water as the rocket launches to absorb the sound so the force of the pressure wave doesn't damage the rocket.

The Hiroshima and Nagasaki bombs: According to sources I read, these clocked in at well over 200 dB. The shock wave was so charged that it traveled 7 mi / 11 km in 30 seconds.

The 1883 Krakatoa volcano eruption:[13] I'm overwhelmed by the amount of things I need to tell you about the Krakatoa. Let's do bullets.

- Krakatoa is an island in Indonesia, and the eruption happened on August 27, 1883.
- The eruption completely annihilated the island, sending an enormous amount of debris 17 miles (27 km) high into the sky at half a mile per second. It also caused one of the most deadly and far-reaching tsunamis in history. In total, the eruption killed 36,000 people.
- But the most amazing thing about the eruption was its sound. It made arguably the loudest sound on Earth in modern history.
- It was so loud that the shock wave extended far enough to rupture the eardrums of sailors 40 miles away.
- 100 miles away, the sound was still 172 dB, enough to permanently destroy someone's ears or even kill them. Wherever you are, think of a place that's about 100 miles (161 km) away. Now imagine something happening there that causes a sound so loud where *you* are that if you were screaming at the top of your lungs directly into someone's ear when the sound hit, they wouldn't be able to hear that you were doing it. For comparison, the Saturn V launch sound was at 170 dB 100 *meters* away. Krakatoa was higher than that 100 *miles* away.
- The sound cracked a foot-thick concrete wall 300 miles (483 km) away.
- The sound was heard all the way in Australia (where it sounded like a distant canon ball being fired) and even as far away as Rodrigues Island, 3,000 miles away. *3,000 miles away*. I'm currently in New York. *Imagine if something happened in California or in Europe that I could hear in New York.* I can't even.
- After the sound eventually got far enough away that humans couldn't hear it anymore, barometers all over the world were going nuts for the next few days, as the sound waves circled the Earth *3.5 times*.
- Finally, you know the famous painting The Scream? Well you know how the sky's all red for some reason? The sky is red because the painter, Edvard Munch, was inspired to paint it after seeing the Krakatoa-caused red skies all over the Western Hemisphere in the year after the eruption.

It was a big eruption.

2) Other Mediums

There *can* be louder sound than 194 dB—just not on the Earth's surface. There can be louder sounds in the ocean, in the land, or on other planets. The gas giants in our Solar System, for example, have denser atmospheres than Earth's, which allow for higher pressure wave amplitudes, and with incredibly fast winds and powerful storms, there's plenty of opportunity there to make loud things.

What *isn't* loud is almost everything else in space. You've probably heard the term, "Sound doesn't travel in a vacuum," but it makes sense now, right? Sound is pressure waves through matter. If there's no matter, there's no sound. There can be immense *heat*, and *radiation*, and *force*, but to a nearby observing human, it's all dead silent.

If, hypothetically, there *were* air filling the universe, then suddenly things would get *very* loud. Forget the terrifying concept of the sound of a supernova—just the dumb sun sitting there hanging out would ring in at an astounding 290 dB. According to one solar physicist, we'd hear that on *Earth* as a 100 dB sound—*the volume of a motorcycle*—all the time, every day, everywhere. Be happy that sound doesn't travel in a vacuum.

One last thought—

Researching for this post and learning about what sound is gave me a new perspective on the tree falling in the forest with nobody there to hear it question. I now think that no, it doesn't make a sound. It makes an air pressure wave and that's it. The concept of sound is by definition a biological being's perception of the pressure wave—and if there are no ears around to perceive the pressure wave, there's no sound. It's a little like asking, "If humans go extinct, and somewhere in the post-apocalyptic rubble, there's a photo of a beautiful woman lying there—is she still beautiful?" I kind of don't think she is. Because the only thing that's beautiful about her is that humans found her beautiful, and without humans, she's no more beautiful than the female beetle a few feet away, rummaging around the rubble. Right?

Three things I want you to read:

If you're into Wait But Why, sign up for the **Wait But Why email list** and we'll send you the new posts right when they come out. Better than having to check the site and wonder!

If you'd like to support Wait But Why, **here's our Patreon**.

And the full Elon Musk post series is now available **as an ebook**.

If you liked this, here are a few more Wait But Why explainers:

How Tesla Will Change the World

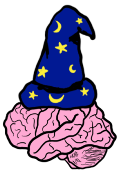
The AI Revolution: The Road to Superintelligence

Putting Time in Perspective

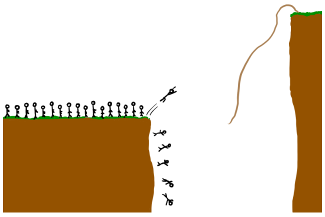
Sources
The awesome GIFS: Dan Russell and ISVR
CDC: Noise and Hearing Loss Prevention
US Department of Labor: Occupational Noise Exposure
Nautil.us: The Sound So Loud That It Circled the Earth Four Times
UNSW: What is a Decibel?
Decibelcar.com: Decibel Equivalent Table
Make it Louder: Ultimate Sound Pressure Level Decibel Table
NASA: Sound Suppression Test Unleashes a Flood
Idiom Zero: How Loud is the Sun?
Gibson.com: It Might Get Loud: The 10 Loudest Rock Bands of All Time
GC Audio: Decibel (Loudness) Comparison Chart
Mathpages.com: The Speed of Sound
Turn it to the Left: Noise Levels
Extreme Tech: Can a Loud Enough Sound Kill You?
Abelard.com: Loud Music and Hearing Damage
Soundproof Cow: Loudest Sound Ever Heard
Chalmers: Quantum microphone captures extremely weak sound
born.gov.au: The eruption of Krakatoa, August 27, 1883

Previous Post
Next Post

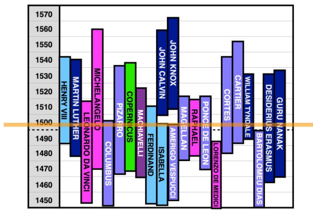
RECOMMENDED POSTS



Neuralink and the Brain’s Magical Future



Why Cryonics Makes Sense



Horizontal History

79 Comments Wait But Why 1 Login

Recommend 5 Share Sort by Newest

Join the discussion…

LOG IN WITH

OR SIGN UP WITH DISQUS ?

Name

Spider Jerusalem • 6 months ago

Why can you hear a sound only so far away. for example during a thunderstorm you can only hear thunder up to approximately 16 km. But why? Does it have to do with interference between the sound waves passing through water and air?

Reply • Share ›

Lu ZV → Spider Jerusalem • 2 months ago

I guess the pressure waves get progressively weaker and they cannot compress the medium in which they are traveling any further.

Reply • Share ›

Masterchief • 8 months ago

"The most important kind of human communication happens when our brains send information to other brains through complex patterns of air pressure waves. Have you ever stopped and thought about how incredible that is?"
An actual Wait But Why -moment. This is the reason I keep coming back to this site.

1 • Reply • Share ›

Waliy • a year ago

krakatoa is near from my house

Reply • Share ›

This comment is awaiting moderation. Show comment.

Avatar This comment was deleted.

S0ldier → Guest • 2 years ago

Either this or she's gonna become a sound engineer.

4 • Reply • Share ›

Charlie • a year ago

A small mention, there is sound in space: http://gizmodo.com/there-ac... and http://canyouactually.com/n...

Reply • Share ›

A • a year ago

please do a post like this one about light

9 • Reply • Share ›

pauselaugh • 2 years ago

> When it does, it vibrates their eardrum in such a way as to pass on not only the code, but exactly where in the room it came from

Not true.

We have two ears and that helps us triangulate direction. With only one ear, you can potentially get one vector of direction as the sound hits the ear from multiple directions, but to truly pinpoint sound you need a second "microphone."

1 • Reply • Share ›

Guilherme Carvalho • 2 years ago

I'm quite late to this party, but I'm glad I joined. :) This Is True just sent me here through its "Top 11 Hidden Gems of the Internet".

All the things about the Krakatoa completely blew my mind. I had no idea. And the gifs are great, I'm going to use them in class.

I wanted to add something to the part about pitch: what you're talking about is frequency. Pitch depends on our perception, it's the "name of the note" - C, F#, slightly-low-B-flat, and what have you. Frequency plays a role in that, clearly, but it's definitely not as straightforward as frequency = pitch. That only works in some particular cases.

What's more important in our perception of pitch is periodicity, the fact that those pressure waves have a repeating pattern (simple or complex). You could take a complex sound, like a low C on a piano or a bassoon, and take out the lowest frequency (heck, sometimes even the three or four lowest) and still hear the same pitch, only with slightly different timbre. This is the well-known (for musicians) missing fundamental, a particular case of virtual pitch.

4 • Reply • Share ›

Hi • 2 years ago

10 decibels higher is 10x higher, not 2x higher. Just saying. Also, the particles do vibrate, but what createes the sound is the pressure difference.

An interesting idea is if you were in a room with a pressure oscillating between two values. Presumably that would produce the same effect as sound, so you would hear sound even though there was none. This is all hypothetical, it's hard to change the pressure of a room without causing unwanted pressure variations.

4 • Reply • Share ›

> **Matt** → Hi • a month ago
>
> Not entirely true brus, have a crack at this. Specifically the section on the different definitions of dB in sound.
>
> http://www.sengpielaudio.co...
>
> • Reply • Share ›

> **Christian Hidde** → Hi • a year ago
>
> You are right, and unfortunately it has not been corrected yet.
>
> • Reply • Share ›

Doug Meserve • 2 years ago

Interesting article on how loud sounds shut down a data center:

http://motherboard.vice.com...

1 • Reply • Share ›

Improv Queen • 2 years ago

Tim: Actually, there is a louder sound on Earth than 194 dB. The tiny Alpheidae shrimp produces sounds up to 218 dB, which is enough to instantly kill a small fish. It makes this sound by snapping its claws shut, and they produce a sonoluminescent bubble - where a sound is so extreme that it actually produces light! It's a fascinating creature, and one of my favorites. I'm sure your procrastination monkey would love to learn about him. :)

11 • Reply • Share ›

> **Max Levy** → Improv Queen • 2 years ago
>
> The limit of 194 dB applies to air at sea level. The Alpheidae shrimp produces the cavitation bubble and sound underwater. More dense medium --> more pressure available --> higher possible amplitude (high pressure minus low pressure) --> higher maximum sound
>
> 9 • Reply • Share ›

DrFil • 2 years ago

Surprised I didn't see this discussed in the article or comments...

https://aeon.co/videos/is-i...

1 • Reply • Share ›

Timofei Larkin • 2 years ago

One interesting point that got overlooked is that in a solid that snake like drawing *can* actually refer to the path of the particles, 'cause a solid can transmit transversal acoustic waves. It's got shear forces too.

1 ^ | v • Reply • Share ›

Hi ➦ Timofei Larkin • 2 months ago

https://www.google.fr/searc...

^ | v • Reply • Share ›

Jeff Lewis • 2 years ago

I really like your take on a tree falling in the woods. That's pretty much the same conclusion I'd come to a few years ago, so it's nice to see someone else that agrees with me.

^ | v • Reply • Share ›

Hi ➦ Jeff Lewis • 2 years ago

The whole point of the analogy is "If no one observes it, does it still happen?" Yes. Saying "sound" is just a loophole, the tree still falls and makes pressure waves. Saying it produces no sound because sound is a concept is not a good answer.

^ | v • Reply • Share ›

Perceptron ➦ Hi • 5 months ago

Is that the point of the analogy? Or is that the point that you interpret when you encounter the analogy? Because this question has been asked at various times in publications for more than a century and the answer has often been in accordance with the "sound is only a psychophysical phenomenon" stance that Tim and Jeff here have taken.

^ | v • Reply • Share ›

ImmortalWind • 2 years ago

That was quite interesting, thanks for the info!

^ | v • Reply • Share ›

Zuzana Zoňová • 2 years ago

Thank you for bringing those interesting informations in such a lovely way. I heard there was/is an ancient Japanese 'teaching' called Koto dama (Sound of soul) thousands years ago.They say martial art,like aikido etc.,developed from it. Those guys didn't use katanas,but pure sound. I was told they could kill just with 'singing' E letter. I didn't experience that,but what I saw was a guy flying across half of the room just because the master used sound to defend himself. That was a part of a demonstration of sound power during Voice Healing training. It was very interesting to see and feel the power of the sound and what impact it could have on our healthy body and mind. How easily we are able to harmonize and tune ourselves using our own 'sound' and how helpful and healing/transformative it could be for the wellbeing. Singing in the shower got totally into different perspective since then. There sure is a lot more to be explored in this field,so thank you for bringing it into better picture for me.(from scientific point of view)

4 ^ | v • Reply • Share ›

Doug Meserve • 2 years ago

Tim -- perhaps following on the "tree falling in the forest" question, you might consider this for a future post: what is information?

One odd question within that topic: is information actually the same thing as energy, the way mass is? Why or why not?

3 ^ | v • Reply • Share ›

Sören • 2 years ago

Perception is a mind-blowing subject, and this is a marvellous post on it. About the tree falling in the forest with nobody there to hear it question - exactly the same applies to our experience of colours, which are just light frequencies.“Colour doesn’t occur in the world, but in the mind,” wrote poet Diane Ackerman. “If no human eye is around to view it, is an apple really red? The answer is no, not red in the way we mean red… We think of our eyes as wise seers, but all the eye does is gather light.” - http://number-42.org/2016/0...

2 ^ | v • Reply • Share ›

Kentleigh • 2 years ago

While we're on the topic of sound.
I like music... so this works out well in some cases.

7 • Reply • Share ›

Vikram Kalra • 2 years ago

Today, March 10, 1876, Alexander Graham Bell made the first ever telephone call to his assistant Thomas Watson. Though biological evolution is insanely impressive, I also ponder in amazement of how human technology has evolved as well, here in terms of converting and transmitting sound over vast distances.

1 • Reply • Share ›

Kibrom Fesseha • 2 years ago

Okay so...What is Smell?

5 • Reply • Share ›

Alberto • 2 years ago

Great, I loved reading this. It clarified a few questions I always had, and never took the time to answer. One thing: the part about the painting "the scream" and Krakatoa sounded wrong, and in fact the Wikipedia page says it's disputed. Sounds weird because Munch always painted green humans and similar stuff, so even if the sky was blue, he could decide to paint it red to convey a certain meaning... But then, still, the Krakatoa eruption did make the sky look red for a long time (and the moon look blue, also!), so crazy..

Reply • Share ›

Johannes • 2 years ago

Fascinating post Tim! Although I was aware of many of the facts in isolation, the way you put them all together made for compelling reading and revealed what an incredible world we live in.

2 • Reply • Share ›

Ferival • 2 years ago

A clarification about the Saturn V: it was loud enough to set grass on fire a mile away, not melt concrete a mile away. Tim's source, The Ultimate Sound Pressure Level Decibel Table, is a bit confusing with the wording. From Tim's source, this reddit thread on a post about the Saturn V goes into detail about the sound of the launch. The commentors speculated about the mechanics of the concrete melting and the extent to which it theoretically could melt, most likely only a few meters away at most. The post discusses quite a bit about the launch and is pretty interesting, if you're into that sort of thing. As a materials engineering student I'd say they do a pretty good job of a rough estimate, but they or I could have very well missed something so if anyone has anything to add I'd be very interested in learning more about it.

7 • Reply • Share ›

MetalMonkey • 2 years ago

Great article! Interesting and very clear. Teaching skills.

Reply • Share ›

Patrick McNeil • 2 years ago

I always thought the pistol shrimp was the loudest animal, at 200+ decibels, then the blue whale.

Reply • Share ›

> **Max Levy** → Patrick McNeil • 2 years ago
>
> The Alpheidae shrimp produces the cavitation bubble and sound underwater. More dense medium --> more pressure available --> higher possible amplitude (high pressure minus low pressure) --> higher maximum sound (~218 dB)
>
> Reply • Share ›

Blaidd Drwg • 2 years ago

So wait, let me get this straight. 180 dB will probably kill you. Yet blue whales yell at 188 dB? So basically a blue whale could kill people with his voice?
That is so fucking cool.

2 • Reply • Share ›

> **Korakys** → Blaidd Drwg • 2 years ago
>
> But sadly (or luckily) not true. Someone pointed out in the facebook comments section that dBs in air and dBs are in no way equivalent.
>
> Subtracting ~62dB from water loudness measurements should give you a rough equivalent to "standard" air loudness levels.
>
> In other words a blue whale could duel with a rock concert, but not kill you with a shout.

1 ^ | v • Reply • Share ›

Blaidd Drwg ➦ Korakys • 2 years ago

Definitely sad. Thanks for clarifying though.

1 ^ | v • Reply • Share ›

Deksel • 2 years ago

So: after reading this post, I can now totally visualy understand how sound travels through air, and in the case of an explosion that's enough.
The part I still have a really hard time understanding is how soundwaves 'encode' complex nuanced sounds such as music and speech (words, soundtexture, layered tones, etc.) in such a way that it creates all these wonderfull sounds. Same with a needle on a groove. I get it, sort of, but mostly I really don't.

1 ^ | v • Reply • Share ›

Rob ➦ Deksel • 2 years ago

Same. I've always wondered about that. Especially when it's a speaker driver reproducing the sound of an instrument. I can imagine for example, the overtones of an acoustic piano created by three strings per key. It might create multiple, very similar sound waves that all hit my ear drum to create a particular texture of sound. A speaker however can only vibrate to produce a certain wave at any point in time, so then how do you get things like "texture" out of a single wave? Maybe I'm confusing pure sine waves as my mental model of sound, when really the wave itself can have lots of nuances.

^ | v • Reply • Share ›

Doug Meserve ➦ Rob • 2 years ago

A "sound" is usually a lot of different waves of different wavelengths and intensities mixed together. So, your're asking, how does a speaker manage to convey them all at once (of for that matter, our eardrums, or even the air itself)? When transmitting multiple mixed waves, the individual elements don't move in pure, simple movements as in the idealized diagrams at the top of the post; it's more like a jagged, stock-market-index kind of movement. The speaker cone may move near one end of its range, start moving back, and then suddenly reverse course and go back to the end a bit, then a little further, and back again, and then way over towards the other end, and then keep going in that direction at a different speed, etc. etc.

It is remarkable that such movement of a single object can convey all those wavelengths, but that's one of the fundamentally interesting things about our universe, I guess, that information can propagate in this way. :)

^ | v • Reply • Share ›

James Noyes • 2 years ago

No post about the science of sound is complete without referencing the Aphex Twin song "Equation." If you visualize the end of the song in a spectrogram viewer, the wave form creates the picture of a face.

see more

5 ^ | v • Reply • Share ›

Matthew Lindner ➦ James Noyes • 2 years ago

That song is one of the most horrendous pieces of crap I've ever heard. That's a noise generator hooked up to a recorder. Not music.

^ | v • Reply • Share ›

MSN ➦ Matthew Lindner • a year ago

Cause it's a spectrogram. Unless you mean the song itself then welcome to the world of electronic music, this isn't your boring music where it's the same sound over and over. It's full of experimenting for a better music future, without AT, some of the great songs wouldn't exist without the inspiration. (but seriously, he does make some good music, I suggest Rhubarb or Xtal)

^ | v • Reply • Share ›

S0ldier ➜ Matthew Lindner • 2 years ago

Well, otherwise that face would sound suspicious amongst the well-ordered soundwaves :).

Reply • Share ›

Stephen Meo • 2 years ago

When you say "loudness" I think of perceived loudness, i.e. the Fletcher Munson curve. Would "amplitude" perhaps be a better term?

Reply • Share ›

Jebmak • 2 years ago

Will you, or someone else please reconcile these two things? I'm not following. Were the bombs and volcano able to do this because they weren't "sustained"?
"The Hiroshima and Nagasaki bombs: According to sources I read, these clocked in at well over 200 dB."
"There can be louder sound than 194 dB—just not on the Earth's surface."

Reply • Share ›

Bm ➜ Jebmak • 2 years ago

Hi,

He explains this at the very beginning of the section labeled "shock waves." Basically the atomic bombs didn't create "sound" in the conventional sense because the energy pushed the air instead of moving through it.

1 • Reply • Share ›

Jebmak ➜ Bm • 2 years ago

Yep. Missed that the first time through. Thanks!

Reply • Share ›

Load more comments

2 Comments Sort by Top

Add a comment...

Aishwarya Kandpal

very cool

Like · Reply · 2 · 48w

PJ Rice

Hey Im a science teacher - thanks this is a VERY nice summary!! Could you do circuits, E & M and Thermo next? JK!

Like · Reply · 32w

Facebook Comments Plugin

Home

Archive