Sounds in Space: Silencing Misconceptions

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posted: 06:00 am ET
22 September 2003

It's often said that in space, you can't hear yourself scream. True enough, more or less, but rather misleading. Recently, several *SPACE.com* readers wrote to ask how a B-flat emanating from a black hole could be detected from 250 million light-years away, as we reported earlier this month.

The answer, along with related interesting facts, reveals that silence is in the ear of the beholder, and ears come in a variety of configurations.

Sound can travel through space, because space is not the total vacuum it's often made out to be. Atoms of gas give the universe a ubiquitous atmosphere of sorts, albeit a very thin one.

Sound, unlike light, travels by compressing a medium. On Earth, the atmosphere works well as a sound-carrying medium, as does water. The planet itself is very adept at transmitting an earthquake's seismic waves, a form of sound.

Space, though not as efficient, can also serve as a medium.

If a brave and clever astronaut could safely remove her helmet and shout into the cosmos, her voice would carry.

"We wouldn't be able to hear the sound because our ears aren't sensitive enough," explains Lynn Carter, a graduate student in astronomy at Cornell University. Not enough atoms -- if any -- would strike our eardrums. "Maybe if we had an amazingly large and sensitive microphone we could detect these sounds, but to our human ear it would be silent."

An amazingly sensitive microphone, in a sense, was used to discover the constant B-flat coming from the black hole [Story here]. NASA's Chandra X-ray Observatory observed gas, compressed by the sound, in concentric rings much like ripples on a pond.

Seeing sound

Andrew Fabian of the Institute of Astronomy in Cambridge, England, explained in an e-mail interview how the sound was generated and why its signature crossed the cosmos.

The black hole under study sits amid a cluster of galaxies, a region of space where gas is denser than the universe on average.

Playing the role of speaker membranes in the galaxy cluster are two huge cavities, filled with gas that is hotter than its surroundings. This heat is generated by energy shot out from the black hole's environment as it accelerates matter to nearly the speed of light, just prior to swallowing it.

"The repetition needed to make the sound into a note is due to the cavities being buoyant -- the ultrahot gas is thinner than the cluster gas," Fabian said. "So the process resembles what happens when a child blows through a straw into a glass of milk."

Every 10 million years, a fresh wave bubbles out of the system.

"Sound waves are waves or ripples of pressure traveling through a gas," Fabian said. "Displace some nearby particles by pushing -- say the membrane of a loudspeaker -- so there's a pressure peak, and those particles will push on particles further out and so on. The result is that the pressure peak moves outward, although no individual particle actually goes very far from its original position."

Ocean waves work similarly. A swell can travel thousands of miles, but it moves through the water rather than packing the molecules along.

As the pressure peaks travel outward from the cavities around the black hole, collisions occur between atoms in the gas, generating X-rays that reveal a concentric ring pattern. Being a form of light, X-rays can traverse the universe sans any medium, and these are what Chandra detected.

The sound waves rapidly die out, their energy converted to heat. So in essence the B-flat was seen, not heard, from 250 million light-years away.

Martian sounds

Our astronaut in space would experience something quite different from one on Mars, where sound could be heard with a modest microphone and some technological help. The Martian atmosphere is less than 1 percent as dense as Earth at sea level. This probably is not enough to carry sounds that the human ear could detect, experts say.

Of course, anyone outside on Mars would be wearing a pressurized suit, so the only sounds they'd hear would have to be electronically delivered. There's no reason a sensitive external microphone could not be used to pick up sounds and amplify them to some terrestrial approximation.

In fact, there were plans to listen to the natural sounds of Mars in this manner with a microphone aboard the 1999 Mars Polar Lander. The idea was to hear wind, blowing dust, perhaps even lightning within dust storms.

The microphone, funded by the Planetary Society and piggybacked on the Russian Lidar instrument oboard the NASA craft, was tested under Mars-like laboratory conditions.

"Even at Mars' low pressure, acoustic signals within the frequency range of the human ear can be detected," said Greg Delory, who at the time was a postdoctoral physicist at the University of California, Berkeley.

Mars remains silent to earthlings, because Mars Polar Lander failed to land properly and was never heard from. The microphone idea lives on, though, and the Planetary Society hopes to get one to Mars on some other mission.

And who knows what we'll hear? As Delory said, "The most exciting sounds are likely to be ones that we don't even know about yet."

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