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** Contact details appear below. **

Related Text & Graphics:
http://solar-center.stanford.edu/SoSH

LISTENING TO THE SUN:
THE SONIFICATION OF SOLAR HARMONICS PROJECT

The Sun revealed its voice to us in the summer of 1960, when it was discovered that the solar surface is moving up and down with a period of about five minutes. Eventually this oscillation was explained as the result of sound waves trapped in the solar interior. Just as one hears the wind blow, these sound waves are excited by plasma flows near the solar surface. And like any acoustic cavity, the Sun supports a number of oscillation modes, commonly known has harmonics. The Sonification of Solar Harmonics (SoSH) Project is a developing collaboration between Dr. Tim Larson, a helioseismologist and Stanford alumnus, Dr. Seth Shafer, Professor of Music Technology at the University of Nebraska at Omaha, and Elaine diFalco, a composer and Media Arts graduate student at the University of North Texas. The SoSH Project provides a software tool that sonifies solar oscillation data, creating a listening experience for scientists, artists, and anyone interested in hearing the song of the Sun.

As an alternative to visualization, sonification invites us to apply our extensive experience of sound waves in natural settings to the interpretation of data. Especially in the case of data that is already acoustic in nature, we might expect listening to reveal relationships that have not been discovered before. The fact is that we have no idea what might be audible in the data because, although we have studied it for decades, we have never listened to it.

Today we know that the Sun is reverberating with millions of harmonics, each inhabiting a particular region inside the Sun and oscillating at a characteristic frequency. The strongest of these harmonics have frequencies of only about 0.003 hertz, corresponding to their roughly five-minute oscillation periods. This is far below the range of human hearing, which is generally accepted as 20 to 20,000 hertz. Therefore, in order to experience the sound of the Sun with our ears, these very low sounds must be scaled up to an audible range. This reveals the most obvious advantage of sonification over visualization for solar oscillations, which is time compression. Our ears are able to process many thousands of samples per second, allowing us to listen to a year’s worth of data in only a minute.

As long as each harmonic is scaled the same, the frequency relationships between them will be preserved. Hence, the SoSH tool enables one to hear the same musical intervals that occur on the Sun. Composers can use it to create new works that feature the Sun as a musical instrument, while a curious public can engage with SoSH to gain an acoustic understanding of our home star. Solar listening is now accessible to everyone.

The study of solar oscillations begins with observations of the Sun's surface. Since the launch of the Michelson Doppler Imager (MDI) onboard the Solar and Heliospheric Observatory in 1995, such observations have been made from space nearly continuously. When MDI was superseded by the Helioseismic and Magnetic Imager (HMI) onboard the Solar Dynamics Observatory in 2010, the quality and quantity of observations increased further still. Although MDI data has been sonified sporadically in the past, the SoSH Project represents the first sonification of HMI data and the only sonification of two full solar cycles of data spanning both instruments.

The frequencies of the Sun's harmonics allow us to make physical inferences about the solar interior. Just as the pitch of a plucked guitar string gets higher with greater tension and lower with greater thickness, solar frequencies give us information about parameters such as the Sun's interior pressure and density. Because the different harmonics have different extents in radius and latitude, we can infer these parameters as a function of position inside the Sun. In fact, these oscillations provide the only probe we have of the solar interior. In other words, listening to them can tell us about the Sun's acoustic cavity and even how it changes over time.

Moving forward, the SoSH Project is currently developing visual components to complement the sonifications for a variety of potential uses. One example is a smartphone app where users can trace out a trajectory inside the Sun and play with the relative amplitudes of modes with a finger. Another is a navigable virtual reality (VR) environment with spatial audio that replicates the interior of the Sun as well as an audio/visual software program that can be applied to planetarium consoles for educational purposes at museums and universities. With VR and full-dome animated projections that visually correspond to the sonifications, the complexities of solar harmonics can be viscerally experienced in these immersive contexts, enhancing the learning impact on general audiences.

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