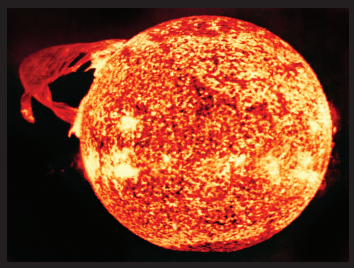
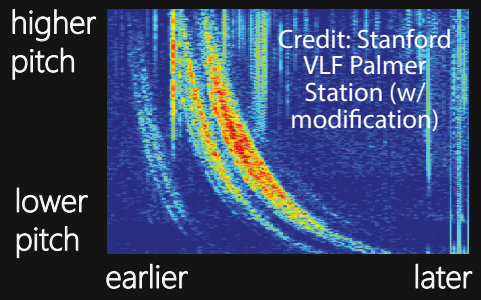
UNDERSTANDING ASTROPHYSICAL EXPLOSIONS (AND OTHER CURIOSITIES OF WHISTLER WAVES)

Storms on the surface of the Sun involve complex interactions between solar plasma and magnetic fields, sometimes leading to explosive solar flares. Whistler waves are a type of electromagnetic wave that could explain some of these complex interactions.



Credit: NASA Skylab

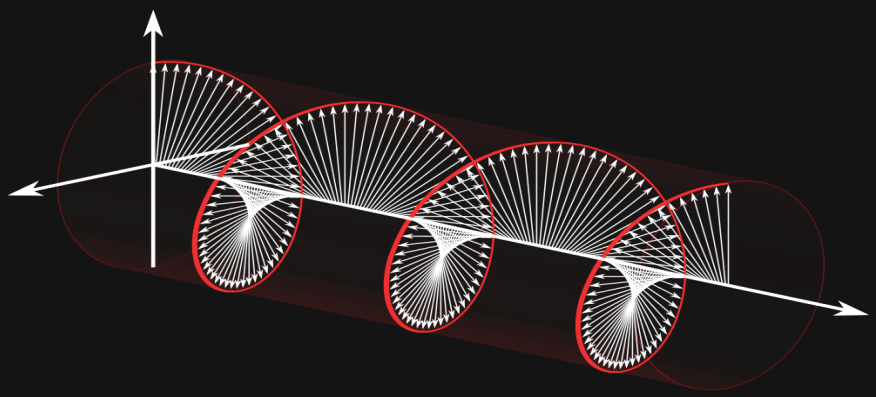
WHY THEY'RE CALLED WHISTLER WAVES



In Earth's atmosphere, sensitive radios can hear whistlers as a descending pitch over time (the "whistle") since higher frequency (pitch) whistlers travel faster.

WHAT THEY'RE MADE OF

Whistler waves are made of electromagnetic (EM) fields, which control how electrons and protons found in plasmas move. EM fields are not static. They change in intensity, loop around, and move in wave patterns. For whistler waves, magnetic fields rotate in a circle (called circular polarization, shown below).



WHERE THEY'RE FOUND

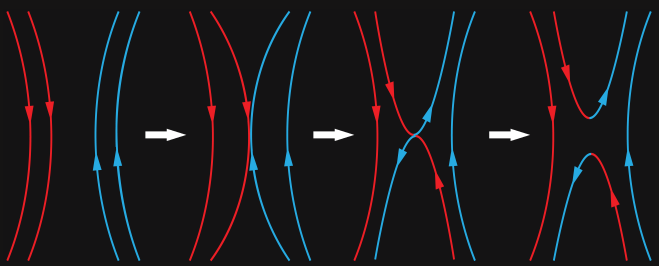
On the sun's surface (image below) and elsewhere in outer space, atoms are often split into their component nuclei and electrons. Called a plasma, these particles freely move around, feel electromagnetic forces, and generate electromagnetic fields.

Credit: M. Aschwanden et al. (LMSAL), TRACE, NASA

WHY THEY EXIST

The mathematical representation of whistler waves is a solution to equations governing fluids (like plasmas) and EM fields under a specific condition: the presence of a strong background magnetic field permeating the plasma.

WHY THEY'RE IMPORTANT



MAGNETIC RECONNECTION

In plasmas, magnetic field lines (not a part of the whistlers) can collide and recombine (shown above), releasing enormous amounts of energy, in explosive events like solar flares. Whistler waves are thought to mediate a powerful, fast variety of reconnection called Hall reconnection.

GALACTIC HEAT FLOW

Previous simulations have found that whistlers can regulate heat flow in galaxy clusters, helping us to build better models of how galaxy clusters operate.

NUCLEAR RECOVERY

Whistlers may be key to dissipating radiation after a high-altitude nuclear blast in Earth's atmosphere, helping to restore satellites (such as for satellite phones and weather).