Tibor Gyula Balogh

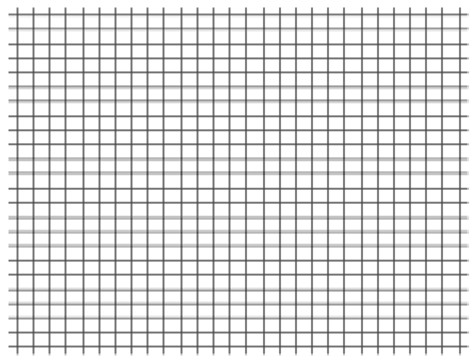
From: "Tibor Gyula Balogh" <tiborgbalogh@gmail.com>
To: "g5intd" <g5intd@yahoo.com>; "Adam S. Balogh" <adambalogh2003@yahoo.com>
Sent: Sunday, December 10, 2006 15:42
Subject: Longitudinal wave - from bellow my apartment, this type of disruting wave is generated to my direction...

Longitudinal wave

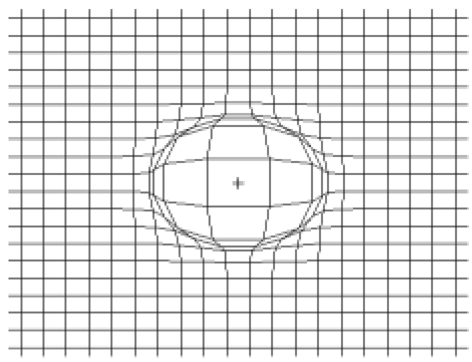
From Wikipedia, the free encyclopedia

Longitudinal waves are waves that have vibrations along or parallel to their direction of travel. They include waves in which the motion of the medium is in the same direction as the motion of the wave. Mechanical longitudinal waves have been also referred to as **compressional waves** or **pressure waves**.

Contents



Plane pressure wave



Representation of the propagation of a longitudinal wave on a 2d grid (empirical shape)

Non-electromagnetic

Examples of non-electromagnetic longitudinal waves include sound waves (alternation in pressure, particle displacement, or particle velocity propagated in an elastic material) and seismic P-waves (created by earthquakes and explosions).

Sound waves

In the case of longitudinal harmonic sound waves, the frequency and wavelength can be described with the equation

$$y(x,t) = y_0 \sin\left(\omega\left(t - \frac{x}{c}\right)\right)$$

where:

- $y(x,t)$ is the displacement of particles from the stable position, in the direction of propagation of the wave;
- x is the displacement from the source of the wave to the point under consideration;
- t is the time elapsed;
- y_0 is the amplitude of the oscillations,
- c is the speed of the wave; and
- ω is the angular frequency of the wave.

The quantity x/c is the time that the wave takes to travel the distance x.

The (nonangular) frequency of the wave can be found using the formula

$$f = \frac{\omega}{2\pi}$$

where f is the frequency of the wave, usually measured in Hz.

For sound waves, the amplitude of the wave is the difference between the pressure of the undisturbed air and the maximum pressure caused by the wave.

Sound's propagation speed depends on the type, temperature and pressure of the medium through which it propagates.

Pressure waves

In an elastic medium with rigidity, a harmonic pressure wave oscillation has the form,

$$y(x,t) = y_0 \cos(kx - \omega t + \phi)$$

where:

- y_0 is the amplitude of displacement,
- k is the wave number,
- x is distance along the axis of propagation,
- ω is angular frequency,
- t is time, and
- φ is phase difference.

The force acting to return the medium to its original position is provided by the medium's bulk modulus.[1]

Electromagnetic

Maxwell's equations lead to the prediction of electromagnetic waves in a vacuum, which are transverse (in that the electric fields and magnetic fields vary perpendicularly to the direction of propagation).[2] However, in a plasma or a confined space, there can exist waves which are either longitudinal or transverse, or a mixture of both. [2][3] In waves of plasma, there exists some examples and these plasma waves can occur in the situation of force-free magnetic fields.

In the early development of electromagnetism, there was some controversy, in that Helmholtz theory lead to the prediction of longitudinal waves. Oliver Heaviside examined this problem as there was no evidence suggesting that longitudinal electromagnetic waves existed in a vacuum. After Heaviside's attempts to generalize Maxwell's equations, Heaviside came to the conclusion that electromagnetic waves were not to be found as longitudinal waves in "*free space*" or a homogeneous mediums.[4] But, it should be stated, that longitudinal waves can exist along the interface between differing mediums.

Maxwell's equations do lead to the appearance of longitudinal waves under some circumstances in either plasmas waves or guided waves. Basically distinct from the "free-space" waves, such as those studied by Hertz in his UHF experiments, are Zenneck waves. [5] The longitudinal mode of a resonant cavity is a particular standing wave pattern formed by waves confined in a cavity. The longitudinal modes correspond to the wavelengths of the wave which are reinforced by constructive interference after many reflections from the cavity's reflecting surfaces.

See also

List of wave topics

- Waves : disturbances that propagates through space, often transferring energy.
- Surface wave : waves that is guided along the interface between two different media for a mechanical wave or by a refractive index gradient for an electromagnetic wave. The surface wave is also known as the *Norton surface wave*, the *Zenneck wave* or the *gliding wave*.
- Rectilinear propagation : wave property which states that waves propagate (move or spread out) in straight lines.
- Transverse wave : wave that oscillates perpendicular to the direction it advances.

Plasmas

- Particle displacement : measurement of distance of the movement of a particle in a medium as it transmits a wave.
    - Electrostatic ion cyclotron wave : longitudinal oscillation of the ions (and electrons) in a magnetized plasma, propagating nearly (but not exactly) perpendicular to the magnetic field.
    - Ion acoustic wave : longitudinal oscillation of the ions (and the electrons) in an unmagnetized plasma or in a magnetized plasma parallel to the magnetic field.
    - Waves in plasmas : interconnected set of particles and fields which propagates in a periodically repeating fashion.

Other

- Reflection seismology : branch of seismology that uses reflected seismic waves to produce images of the Earth's subsurface

References

1. ^ Weisstein, Eric W., "*P-Wave*". Eric Weisstein's World of Science.
2. ^ ***a b*** David J. Griffiths, Introduction to Electrodynamics, ISBN 0-13-805326-X
3. ^ John D. Jackson, Classical Electrodynamics, ISBN 0-471-30932-X.
4. ^ Heaviside, Oliver, "*Electromagnetic theory*". *Appendices: D. On compressional electric or magnetic waves*. Chelsea Pub Co; 3rd edition (1971) 082840237X
5. ^ Corum, K. L., and J. F. Corum, "*The Zenneck surface wave*", *Nikola Tesla, Lightning observations, and stationary waves, Appendix II*. 1994.

Media

Video of a longitudinal wave (file info)
Video of a longitudinal wave (166KB, Ogg/Theora format).

Problems seeing the videos? See media help.

Further reading

- Varadan, V. K., and Vasundara V. Varadan, "*Elastic wave scattering and propagation*". *Attenuation due to scattering of ultrasonic compressional waves in granular media* - A.J. Devaney, H. Levine, and T. Plona. Ann Arbor, Mich., Ann Arbor Science, 1982.
- Schaaf, John van der, Jaap C. Schouten, and Cor M. van den Bleek, "*Experimental Observation of Pressure Waves in Gas-Solids Fluidized Beds*". American Institute of Chemical Engineers. New York, N.Y., 1997.
- Krishan, S, and A A Selim, "*Generation of transverse waves by non-linear wave-wave interaction*". Department of Physics, University of Alberta, Edmonton, Canada.
- Barrow, W. L., "*Transmission of electromagnetic waves in hollow tubes of metal*", Proc. IRE, vol. 24, pp. 1298-1398, Oct. 1936.

External articles

- Russell, Dan, "*Longitudinal and Transverse Wave Motion*". Acoustics Animations, Kettering University Applied Physics.

- Longitudinal Waves, with animations "*The Physics Classroom*"

Categories: Wave mechanics | Waves