About Doppler Effect

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Abstract

The generally accepted explanation of the Doppler effect is that in the case, when the source of waves is moving towards the observer, each successive wave crest is emitted from a position closer to the observer than the crest of the previous wave causing an increase in the frequency and, *vice versa,* when the source of waves is moving away from the observer, the arrival time between successive waves is increased reducing the frequency. This statement is incomplete. It cannot explain the fact of Doppler shift conservation in photons when stars having emitted them do not exist any more. The article shows the actual reason of the Doppler effect, i.e., the independency of emitted waves from their source and Energy conservation law.

Keywords: Doppler effect, physics, space, philosophy of science, energy, EM wave, space, sound, wave, time, frequency, field theory, cosmology

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Introduction

Everybody can hear the Doppler effect from a passing train. One hears a high tone when the train is approaching and a low tone when the train is moving away. Usually

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the effect is explained in the following way [1, 2]. When the source of the waves is moving towards the observer, the time between the waves is shorter causing an increase in frequency and when the source of the waves is moving away the time between the waves is longer causing a decrease in frequency. This may explain the Doppler effect in the immediate vicinity of the source of the waves. In this case the wave can be considered as continuous and tied with the source. In reality all waves have a beginning and an end. Thus there are only wave packets. They are independent from the source from the moment of irradiation. Therefore, the motion of the source affects the wave only at the moment of irradiation.

Complete explanation of Doppler effect

The waves in proximity to the source are affected by the source. In the case of an electromagnetic field it is called a near field. In the near field the Doppler effect depends on the velocity of the source. Far away from the source the waves are independent from the source. It is a case of a far field. The above applies to all types of waves. Below the Doppler effect of a far field is analysed.

The speed of a wave depends only on medium properties in which the wave propagates.

For a sound the speed is $$c_s^2 = K/\rho, \qquad (1)$$

where: K – elastic bulk modulus of medium,
ρ – density of medium.

For light the speed is $$c^2 = 1/\varepsilon\mu, \qquad (2)$$

where: ε – electric permittivity of medium,
μ – magnetic permeability of medium.

Analogous formulae can be written for all other waves. Other wave properties are similar as well. Therefore, light waves will be used for further analysis.

The energy of a light wave is $W = h\upsilon$, (3)

where: h – Planck constant,

υ – frequency.

If the propagation direction of the waves coincides with the direction of the source motion, then the velocity of the waves should increase. The increase of velocity in general is equivalent to the increase of energy. However, the velocity of the waves is determined by the properties of the environment (μ and ε for light). Therefore the energy of the waves can increase only in one way by increasing the frequency (eq. 3). And, *vice versa,* if the propagation direction of the waves is opposite to the direction of the source motion, then the velocity of the waves should decrease. The decrease of velocity in general is equivalent to the decrease of energy. The velocity should be constant which results in the decrease of frequency. It is the **actual Doppler effect** according to the environment.

If the observer moves according to the same environment, he/she sees the sum of the actual and additional Doppler shift. The actual Doppler shift is conserved in the wave and remains unchangeable until the end of the wave existence. The additional Doppler shift depends on the direction and speed of the observer and can change in any way.

The above applies to all types of waves.

Conclusions

The cause of the Doppler effect is the mutual interaction of Energy conservation law [3., 4.] with independency of waves from its source.

The Doppler effect plays an important role in evaluating the motion of stars and galaxies. Therefore, a proper understanding of the Doppler effect can give a much more accurate picture of the world. In some cases, this may lead to a correction of existing theories.

References

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