

Generalized Equations for the Collinear Doppler Effect

Steven D. Deines

sddeines@hotmail.com

Donatech Corporation, Inc., Fairfield, IA 52556

Key words: Doppler Effect, Sound Speed, Waves

Abstract

Some physics textbooks state that the equation for the collinear Doppler effect applies only to a reference frame fixed on the medium, while several textbooks ignore this limitation. The wavelength recorded by a moving observer can be transformed by the textbook Doppler equation in terms of only the source's frequency and velocity, which demonstrates the textbook equation is inaccurate with a stationary source. The equation for the Doppler effect in textbooks approximates the observer's frequency, even when the observer's velocity is much less than the propagation velocity through the medium. The generalized Doppler equations for an observer are derived using infinite series for the moving observer in any inertial frame. The inaccuracy of the textbook equation is due to the false assumption that the observed wavelength in the observer's frame is the same transmitted wavelength in the frame of the medium. It is also shown for sound that a moving source and moving observer with identical velocities through still air is the equivalent of having a stationary source and stationary observer with a wind of opposite velocity. This particular example also demonstrates that moving interferometers preserve wavelengths. These newly derived Doppler equations for the observer will add more precision with wave phenomena.