CHAPTER OVERVIEW

5: Applications of Special Relativity

In this chapter we continue the study of special relativity. Three important applications of the ideas developed in the previous chapter are made here. First, we show how to describe waves in the context of spacetime. We then see how waves which have no preferred reference frame (such as that of a medium supporting them) are constrained by special relativity to have a dispersion relation of a particular form. This dispersion relation turns out to be that of the relativistic matter waves of quantum mechanics. Second, we investigate the Doppler shift phenomenon, in which the frequency of a wave takes on different values in different coordinate systems. Third, we show how to add velocities in a relativistically consistent manner.

A new mathematical idea is presented in the context of relativistic waves, namely the spacetime vector or four-vector. Writing the laws of physics totally in terms of relativistic scalars and four-vectors insures that they will be valid in all inertial reference frames.

5.1: Waves in Spacetime
5.2: Math Tutorial – Four-Vectors
5.3: Principle of Relativity Applied
5.4: Characteristics of Relativistic Waves
5.5: The Doppler Shift
5.6: Addition of Velocities
5.7: Problems