CHAPTER OVERVIEW

14: Forces in Relativity

In this chapter we ask an apparently simple question: How can the idea of potential energy be extended to the relativistic case? The answer to this question is unexpectedly complex, but it leads us to immensely fruitful results. In particular, it prompts us to investigate the idea of potential momentum, which results ultimately in **gauge theory** , of which electromagnetism is an example.

Along the way we show that conservation of four-momentum has an unexpected consequence — the idea of force at a distance is inconsistent with the theory of relativity. This means that momentum and energy must be carried between interacting particles by another type of particle that we call an **intermediary particle** . These particles are **virtual** in the sense that they don't have their real-world mass when acting in this role. In relativistic quantum mechanics, we find that particles can take on negative energies. Feynman's interpretation of this fact is discussed, which leads us to a model for antiparticles.