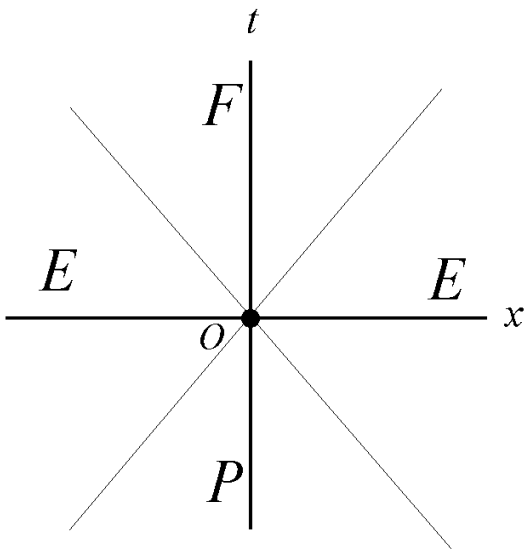
2.11 Temporal Order and Causality

Note. Suppose a flash of light is emitted at the origin of a spacetime diagram. The wavefront is determined by the lines $x = t$ and $x = -t$ where $t > 0$ (we use geometric units). We label the region in the upper half plane that is between these two lines as region F. Extending the lines into the lower half plane we similarly define region P. The remaining two regions we label E.



Note. Events in F are separated from O by a timelike interval. So O could influence events in F and we say O is *causally connected* to the events in F. In fact, if A is an event in the interior of F, then there is an inertial frame S' in which O and A occur at the same place. The separation between O and A is then only one of time (and as we claimed, O and A are separated by a timelike interval). The point A will lie in the "future" relative to O, regardless of the inertial frame. Therefore, region F is the *absolute future* relative to O.

Note. Similarly, events in P can physically influence O and events in P are causally connected to O. The region P is the *absolute past* relative to O.

Note. Events in region E are separated from O by a spacelike interval. For each event C in region E, there is an inertial frame S' in which C and O are separated only in space (and are simultaneous in time). This means that the terms "before" and "after" have no set meaning between O and an event in E. The region E is called *elsewhere*.

Note. We can extend these ideas and represent two physical dimensions and one time dimension. We then find the absolute future relative to an event to be a cone (called the *future light cone*). The *past light cone* is similarly defined. We can imagine a 4-dimensional version where the absolute future relative to an event is a sphere expanding in time.

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