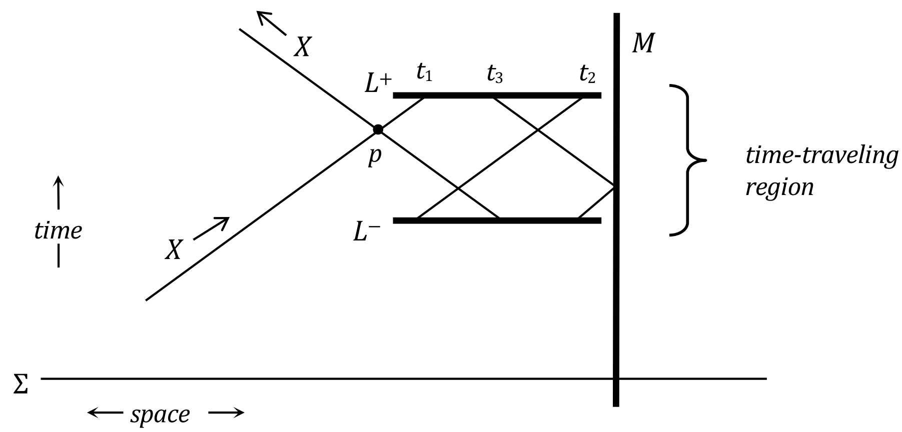
Extra credit #2 (optional)

1. Consider the following paradox: The topology of a region of spacetime has been altered to produce closed time-like curves. (In this region, the lines L^+ and L^- have been identified.) A particle *X* traveling at constant speed enters this region from the left, travels back in time once at t_1, continues to the right at constant speed, travels back in time again at t_2, continues to the right and is reflected back into the region by a mirror *M*. It is now traveling at constant speed to the left, goes back in time once at t_3, continues at constant speed to the left, and collides with an earlier version of itself at *p*, thus preventing it's earlier self from entering the time-travel region in the first place. Thus:

   (I) If *X* did enter the time-traveling region, it didn't (since if it did, it collides with its earlier self to prevent it from entering).

   (II) But, if *X* did not enter the time-traveling region, then it did (since if it didn't enter the region, it could not have gone back in time to prevent itself from entering; so nothing prevents it from entering).



   (a) Explain how this paradox can be avoided by reinterpreting what is going on in the time-traveling region. (<u>*Hint*</u>: How might the paths in the region be interpreted as paths of *more* than one particle?)

   (b) Can the initial data surface Σ be said to completely determine what goes on inside the time-traveling region? Why or why not?