1. Consider a particle of mass $m$ in a circular orbit in a Yukawa potential,

$$V(r) = -\frac{GM}{r} \exp(-r/\rho),$$

where $\rho$ is a parameter related to the mass of the graviton.

(a) Show that such a circular orbit exists only if the angular momentum of the orbit is smaller than a critical value $l_{\text{crit}}$.

(b) Evaluate the critical angular momentum $l_{\text{crit}}$.

(c) Using a computer, sketch the effective potential for different values of the angular momentum (above and below $l_{\text{crit}}$) and comment on the number and stability of circular orbits.

2. A train is moving with a very high velocity $V$. A person is standing in the middle of the train and, at some instant, is shining light towards the front and the back door. When the light hits each door, that door opens. Another person is standing on the platform and is watching the whole incident.

(a) Draw the spacetime diagram for the person standing in the middle of the train. Put on the spacetime diagram the worldlines of the doors and of the light.

(b) On the same plot, draw the spacetime diagram for the persons standing on the platform. Use this diagram to argue that, as seen from the platform, the doors do not open simultaneously. Which one opens first?