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(* (c) 2009 Andisheh Mahdavi *)
(* This Mathematica notebook shows the exact differential equations for the
 evolution of the t and r coordinates in Hartle's wormhole metric. Can you
 complete it so as to recover and plot the correct motion in the wormhole metric,
using the commands in wormhole-approximate.nb as your guides? Only
  the first two differential equations are explicitly calculated,
so you will have to fill in the code for phi[tau],
and you will have to set theta[sig]=Pi/2,
theta'[sig]=0 in order to match the metric in the wormhole-approximate.nb notebook. You
   will need two initial conditions per parameter---for example, r[0]==2,
r'[0]==-0.5 for r. What are sensible initial conditions for t[0] and t'[0]? *)
Lsq = -t'[sig]^2 + r'[sig]^2 + (r[sig]^2 + 1) (theta'[sig]^2 + Sin[theta[sig]]^2 phi'[sig]^2)
eq1 = -D[D[Lsq, t'[sig]] /. sig → tau, tau] + D[Lsq, t[sig]] /. sig → tau
eq2 = -D[D[Lsq, r'[sig]] /. sig → tau, tau] + D[Lsq, r[sig]] /. sig → tau
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$$r'[sig]^2 - t'[sig]^2 + \left(1 + r[sig]^2\right) \left(\text{Sin}[\text{theta}[sig]]^2\, \text{phi}'[sig]^2 + \text{theta}'[sig]^2\right)$$

$$2\, t''[tau]$$

$$2\, r[tau] \left(\text{Sin}[\text{theta}[tau]]^2\, \text{phi}'[tau]^2 + \text{theta}'[tau]^2\right) - 2\, r''[tau]$$