TRAJECTORIES with COSMOGRAVITY TUTORIAL

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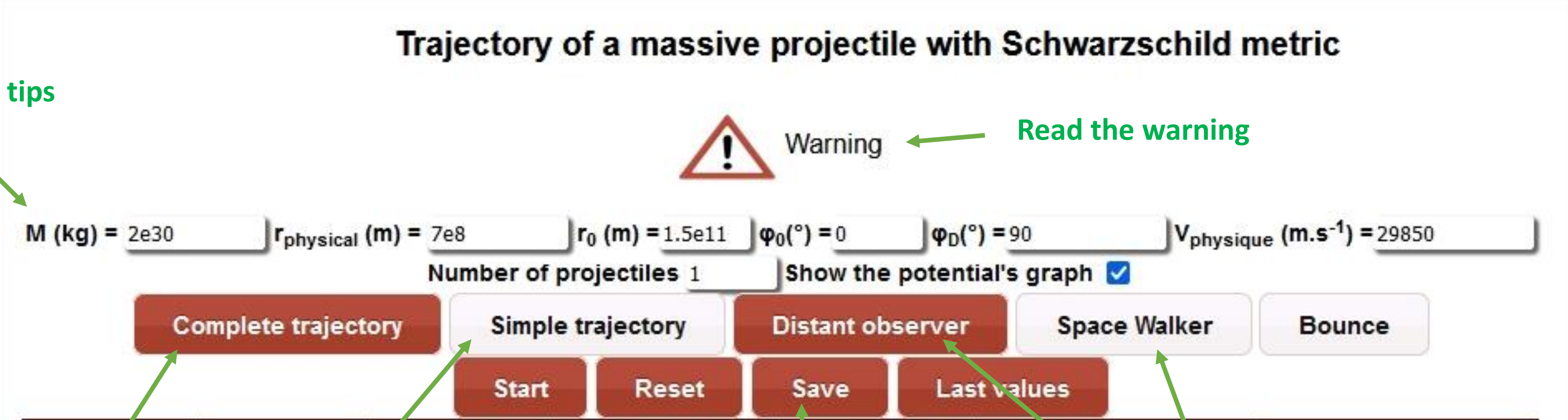
Choose the type of mass and mobile

Enter the physical parameters of the trajectory

Use tool tips

Read the warning



$L1(m)$	$E1$	$rs = \frac{2GM}{c^2}(m)$	$grav = \frac{GM}{R^2}\frac{1}{9.81}(g)$	$Vlib = c(\frac{rs}{R})^{1/2}$	$T = 6.15 * 10^{-8}\frac{M\odot}{M}(K)$	$t = 6.6 * 10^{74}(\frac{M}{M\odot})^3(s)$
1.49853324e+7	9.99999995e-1	2.97041960e+3	2.777e+1	6.176e+5	6.464e-8	6.710e+74

Continuous or point-by-point plotting

Possibility to save an image of the trajectory after it has been traced

Choose the reference frame

Click on **Start** to start the simulation

Calculated values during the simulation

r(m)	Proper time	Gradient	$V_r(m.s^{-1})$	$V_\varphi(m.s^{-1})$	Distant observer time	spectral shift	Speed(m/s)
1.498e+11	6.750e+5	2.563e-14	4.756e+2	2.803e+4	6.750e+5	1.428e-8	2.803e+4

Calculation on break

Baryonic mass and particle

Inputs :

$M = 2.000e+30$ kg

$r_{phy} = 7.000e+8$ m

reference frame

Distant observer

mobile1:

$r_0 = 1.500e+11$ m

$\varphi = 9.000e+1$ °

$V_{phy} = 2.985e+4$ $m.s^{-1}$

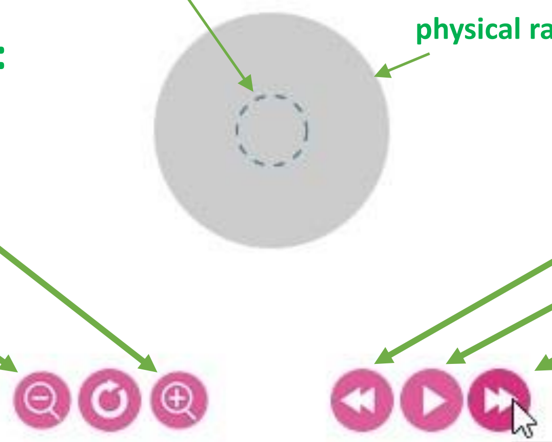
Scale of the simulation

1e+4 m

The Save button saves the graphic and the Inputs.
The Stop key ends the simulation and resets the inputs to the default values ... but the Last values key is used to recall the previous inputs.

rs : Schwarzschild radius

physical radius



During the simulation you can :

- enlarge it (Zoom+)
- reset
- decrease it (Zoom-)

During the simulation you can :

- slow it down
- pause
- speed it up

More (warning, calculations will be accurateless)

Example 1: Small asteroid

Trajectory of a massive projectile with Schwarzschild metric

Warning

2 mobiles around the asteroid

M (kg) = 2e13 | $r_{physical}$ (m) = 1000 | r_0 (m) = 3000 | 5000 | φ_0(°) = 0 | 0 | φ_D(°) = 65 | 230 | $V_{physique}$ ($m.s^{-1}$) = 0.4 | 0.5

Number of projectiles 2 | Show the potential's graph ☑

Complete trajectory | Simple trajectory | Distant observer | Space Walker | Bounce

Possibility of bounce

Choose the impact absorption coefficient

Shock absorption : the bounce is limited to an impact speed of 300 m/s | 0.3

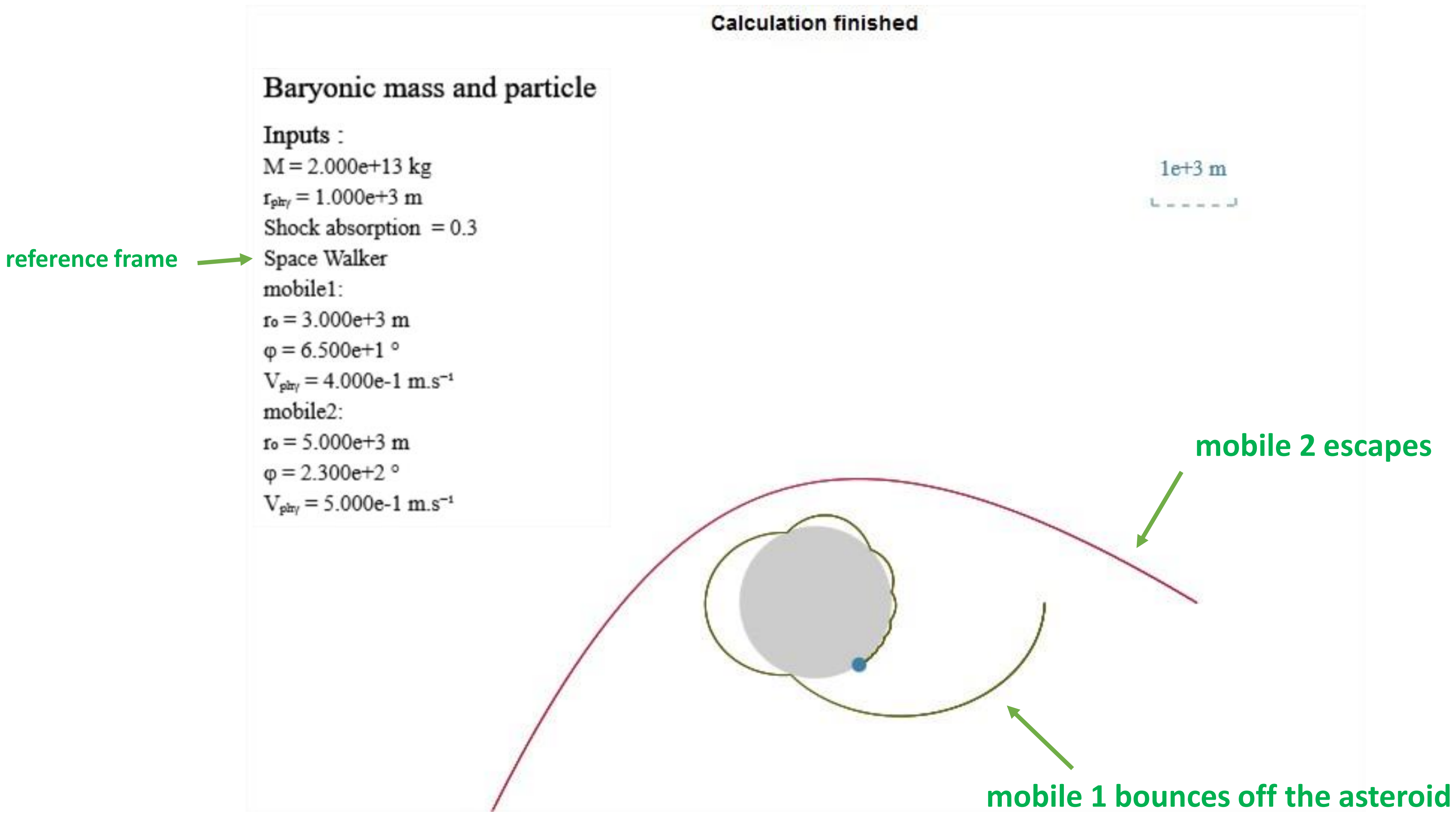
Start | Reset | Save | Last values

$L1(m)$	$L2(m)$	$E1$	$E2$	$rs = \frac{2GM}{c^2}(m)$	$grav = \frac{GM}{R^2}\frac{1}{9.81}(g)$
3.628e-6	-6.388e-6	1.000e+0	1.000e+0	2.970e-14	1.36e-4

r(m)	Proper time	Gradient	$V_r(m.s^{-1})$	$V_\varphi(m.s^{-1})$	Distant observer time	spectral shift	Speed(m/s)
3.140e+3	1.897e+3	4.971e-8	0.000e+0	3.464e-1	1.897e+3		3.464e-1
r(m)	Proper time	Gradient	$V_r(m.s^{-1})$	$V_\varphi(m.s^{-1})$	Distant observer time	spectral shift	Speed(m/s)
4.111e+3	2.520e+3	9.519e-11	0.000e+0	4.659e-1	2.520e+3		4.659e-1

Calculation on break

Example 1 : Simulation result



Example 2 :

photon and massive rotating black hole

Trajectory of a photon with Kerr metric

Warning

M (kg) = 2e39 | r_0 (m) = 5e12 | J (kg.m^2.s^{-1})= 8.4e59 | φ_0 (°) = 0 | φ_D (°) = 138 | nzoom = -5 | Show the potential's graph ☑

Complete trajectory | Simple trajectory | Distant observer | Photon

Stop | Reset | Save | Last values | Pre-zoom

Choose a decrease - or an increase + of scale before the plot

$L(m)$	E	$rs = \frac{2GM}{c^2}(m)$	$a = \frac{J}{cM}(m)$	$Rh+(m)$	$Rh-(m)$	$g = \frac{c^2}{2Rh+}\frac{(Rh+^2-a^2)}{(Rh+^2+a^2)}(m.s^{-2})$
3.686e+12	1.000e+0	2.970e+12	1.401e+12	1.978e+12	9.921e+11	1.492e+16

r(m)	Proper time	Acceleration gradient	V_r (m.s^{-1})	V_φ (m.s^{-1})	$V_{physique}$ (m.s^{-1})	Distant observer time
1.97829545e+12	0.00000000e+0					2.11961102e+5

Calculation on break

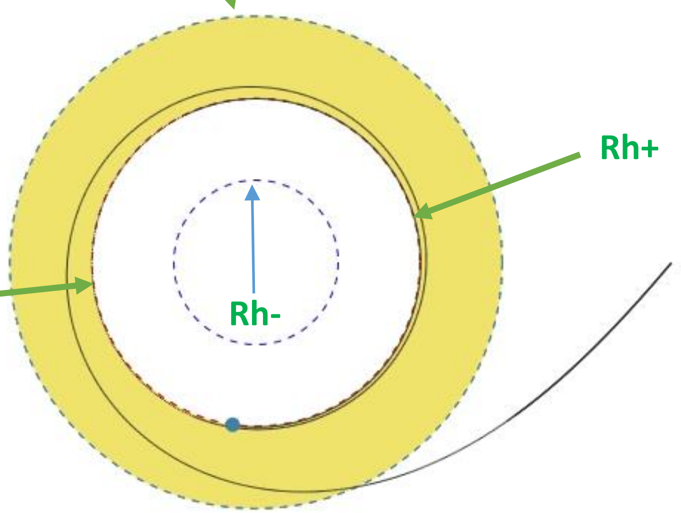
The proper time of a photon is always zero.

Trajectory of a photon with Kerr metric

Inputs :
M = 2.000e+39 kg
r_0 = 5.000e+12 m
a = 1.401e+12 m
φ = 1.380e+2 °
Distant observer

Reference frame

1e+12 m



In the reference frame of the distant observer, the photon wraps itself indefinitely around the event horizon Rh+

Potential graph (see **Theory**)