1 Equations

(%i1) kill(all);
(%o0) *done*

(%i1) E3: d2 = (x^2-1)*L^2/(m*r^3)-x^2*L^2/(alpha*m*r^2)+L^2/(m*r^3);

(%o1) $d2 = -\dfrac{x^2 L^2}{\alpha\, m\, r^2} + \dfrac{(x^2-1)L^2}{m\, r^3} + \dfrac{L^2}{m\, r^3}$

(%i2) E3a: ratsimp(E3);

(%o2) $d2 = -\dfrac{(r-\alpha)x^2 L^2}{\alpha\, m\, r^3}$

(%i3) E3b: expand(ratsubst(L^2/(m^2*M*G), alpha, E3a));

(%o3) $d2 = \dfrac{x^2 L^2}{m\, r^3} - \dfrac{m\, x^2 G M}{r^2}$

(%i4) E11: m*d2r = -m*M*G/r^2+L^2/(m*r^3)-3*G*M*L^2/(m*c^2*r^4);

(%o4) $d2r\, m = -\dfrac{3 G L^2 M}{c^2 m\, r^4} - \dfrac{m\, G M}{r^2} + \dfrac{L^2}{m\, r^3}$

2 Comparison of Eqs.(3),(11)

(%i5) E12: rhs(E3b) = rhs(E11);

(%o5) $\dfrac{x^2 L^2}{m\, r^3} - \dfrac{m\, x^2 G M}{r^2} = -\dfrac{3 G L^2 M}{c^2 m\, r^4} - \dfrac{m\, G M}{r^2} + \dfrac{L^2}{m\, r^3}$

(%i6) E12a: first(solve(E12, x^2));

(%o6) $x^2 = \dfrac{(3 G L^2 + c^2 m^2 r^2 G)M - c^2 r L^2}{c^2 m^2 r^2 G M - c^2 r L^2}$

(%i7) A: -m*M*G/r^2+L^2/(m*r^3);

(%o7) $\dfrac{L^2}{m\, r^3} - \dfrac{m\, G M}{r^2}$

(%i8) E14: x2 = 1-3*G*M*L^2/(A*m*c^2*r^4);

(%o8) $x2 = 1 - \dfrac{3 G L^2 M}{c^2 m\, r^4 \left(\dfrac{L^2}{m\, r^3} - \dfrac{m\, G M}{r^2} \right)}$

(%i9) ratsimp(E12a-E14);
(%o9) $x^2 - x2 = 0$

3 Plots

(%i10) kill(x);
(%o10) *done*

(%i11) E16: xx: 1+3*M*G/(c^2*alpha);

$$(\%o11) \quad \frac{3\,G\,M}{\alpha\,c^2}+1$$

(%i12) xx: expand(ratsubst(L^2/(m^2*alpha), G*M, xx));

$$(\%o12) \quad \frac{3\,L^2}{\alpha^2\,c^2\,m^2}+1$$

(%i13) E17: xE2a: (expand(ratsimp(rhs(E14))));

$$(\%o13) \quad \frac{3\,G\,L^2\,M}{c^2\,m^2\,r^2\,G\,M-c^2\,r\,L^2}+\frac{c^2\,m^2\,r^2\,G\,M}{c^2\,m^2\,r^2\,G\,M-c^2\,r\,L^2}-\frac{c^2\,r\,L^2}{c^2\,m^2\,r^2\,G\,M-c^2\,r\,L^2}$$

(%i14) xE2b: factor(ratsubst(L^2/(m^2*alpha), G*M, xE2a));

$$(\%o14) \quad \frac{3\,L^2+c^2\,m^2\,r^2-\alpha\,c^2\,m^2\,r}{c^2\,m^2\,r\,(r-\alpha)}$$

(%i15) xE2: (3*L^2)/(c^2*m^2*r*(r-alpha))+1;

$$(\%o15) \quad \frac{3\,L^2}{c^2\,m^2\,r\,(r-\alpha)}+1$$

(%i16) ratsimp(xE2-xE2b);
(%o16) 0

(%i17) xE: sqrt(xE2);

$$(\%o17) \quad \sqrt{\frac{3\,L^2}{c^2\,m^2\,r\,(r-\alpha)}+1}$$

(%i18) theta: 1/x*acos(1/epsilon*(alpha/r-1));

$$(\%o18) \quad \frac{\mathrm{acos}\!\left(\dfrac{\frac{\alpha}{r}-1}{\varepsilon}\right)}{x}$$

(%i19) theta1: ev(theta, [x=xx]);

$$(\%o19) \quad \frac{\mathrm{acos}\!\left(\dfrac{\frac{\alpha}{r}-1}{\varepsilon}\right)}{\dfrac{3\,L^2}{\alpha^2\,c^2\,m^2}+1}$$

(%i20) theta2: ev(theta, [x=xE]);

$$(\%o20) \quad \dfrac{acos\left(\dfrac{\dfrac{\alpha}{r}-1}{\varepsilon}\right)}{\sqrt{\dfrac{3\,L^2}{c^2\,m^2\,r\,(r-\alpha)}+1}}$$

(%i21) th1: ev(theta1, [alpha=1, epsilon=0.3, L=1, m=1, c=10]);

$$(\%o21) \quad \dfrac{100\,acos\left(3.333333333333334\left(\dfrac{1}{r}-1\right)\right)}{103}$$

(%i22) th2: ev(theta2, [alpha=1, epsilon=0.3, L=1, m=1, c=10]);

$$(\%o22) \quad \dfrac{acos\left(3.333333333333334\left(\dfrac{1}{r}-1\right)\right)}{\sqrt{\dfrac{3}{100\,(r-1)\,r}+1}}$$

(%i23) wxplot2d([th1,th2], [r,0,1.5], [y,0,5],
        [ylabel, "theta"], [legend, "x from x theory", "x from Einstein the

plot2d: expression evaluates to non-numeric value somewhere in plotting ra
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plot2d: some values were clipped.

(%t23)