# Metricas del fluido perfecto e indice del politropo

In[1]:= $\xi$[r_] := Log[(A - (B) * (r^2))^2];
    └logaritmo

$\mu$[r_] := -Log[1 + (c) (r^2) ((A) - 3 (r^2) (B))^(-2/3)];
    └logaritmo

$\Gamma$ := 1 + $\dfrac{1}{n}$

# Ecuación diferencial master para la obtención de la deformación del espacio f

In[4]:= DSolve$\left[\dfrac{f'[r]}{r} + \dfrac{f[r]}{r^2} == -(Ka)^{(\Gamma)}\left(\dfrac{1}{r^2} - \text{Exp}[-\mu[r]]\left(\dfrac{1}{r^2} - \dfrac{\mu'[r]}{r}\right)\right), f[r], r\right]$
    └resolvedor diferencial    └exponencial

Out[4]= $\left\{\left\{f[r] \to \dfrac{c\,Ka^{1+\frac{1}{n}}\,r^2}{\left(A - 3\,B\,r^2\right)^{2/3}} + \dfrac{\mathbb{C}_1}{r}\right\}\right\}$

In[5]:= $f[r\_] := \dfrac{c\,Ka^{1+\frac{1}{n}}\,r^2}{\left(A - 3\,B\,r^2\right)^{2/3}}$

# Ecuación diferencial para la obtención de la derivada de la deformación del tiempo

In[6]:= gprime[r_] := $\left(\dfrac{r}{\text{Exp}[-\mu[r]] + f[r]}\right)$

$\left(\kappa\,Ka\left(\dfrac{(Ka)^{(\Gamma)}}{\kappa}\left(\dfrac{1}{r^2} - \text{Exp}[-\mu[r]]\left(\dfrac{1}{r^2} - \dfrac{\mu'[r]}{r}\right)\right)\right)^{(\Gamma)} - f[r]\left(\dfrac{1}{r^2} + \dfrac{\xi'[r]}{r}\right)\right)$
    └exponencial

In[7]:= gprime[r] // FullSimplify
    └simplifica completamente

Out[7]= $\dfrac{r\left(-\dfrac{c\,Ka^{1+\frac{1}{n}}\left(A - 5\,B\,r^2\right)}{\left(A - 3\,B\,r^2\right)^{2/3}\left(A - B\,r^2\right)} + Ka\left(-\dfrac{c\,Ka^{1+\frac{1}{n}}\left(3\,A - 5\,B\,r^2\right)}{\left(A - 3\,B\,r^2\right)^{5/3}\,\kappa}\right)^{1+\frac{1}{n}}\kappa\right)}{1 + \dfrac{c\left(1 + Ka^{1+\frac{1}{n}}\right)r^2}{\left(A - 3\,B\,r^2\right)^{2/3}}}$

In[8]:=

$$\text{gprime}[r\_] := \frac{r\left(-\frac{c\,Ka^{1+\frac{1}{n}}\,(A-5\,B\,r^2)}{(A-3\,B\,r^2)^{2/3}\,(A-B\,r^2)} + Ka\left(-\frac{c\,Ka^{1+\frac{1}{n}}\,(3\,A-5\,B\,r^2)}{(A-3\,B\,r^2)^{5/3}\,\kappa}\right)^{1+\frac{1}{n}}\kappa\right)}{1+\frac{c\left(1+Ka^{1+\frac{1}{n}}\right)r^2}{(A-3\,B\,r^2)^{2/3}}};$$

# Cambio en la geometria del espacio-tiempo

## Derivada de *v*, para el tiempo

In[9]:= vprime[r_] := D[ξ[r], r] + gprime[r]
⎣deriva

vprime[r] // FullSimplify
⎣simplifica completamente

Out[10]=
$$-\frac{4\,B\,r}{A-B\,r^2} + \frac{r\left(-\frac{c\,Ka^{1+\frac{1}{n}}\,(A-5\,B\,r^2)}{(A-3\,B\,r^2)^{2/3}\,(A-B\,r^2)} + Ka\left(-\frac{c\,Ka^{1+\frac{1}{n}}\,(3\,A-5\,B\,r^2)}{(A-3\,B\,r^2)^{5/3}\,\kappa}\right)^{1+\frac{1}{n}}\kappa\right)}{1+\frac{c\left(1+Ka^{1+\frac{1}{n}}\right)r^2}{(A-3\,B\,r^2)^{2/3}}}$$

In[11]:=
$$\text{vprime}[r\_] := -\frac{4\,B\,r}{A-B\,r^2} + \frac{r\left(-\frac{c\,Ka^{1+\frac{1}{n}}\,(A-5\,B\,r^2)}{(A-3\,B\,r^2)^{2/3}\,(A-B\,r^2)} + Ka\left(-\frac{c\,Ka^{1+\frac{1}{n}}\,(3\,A-5\,B\,r^2)}{(A-3\,B\,r^2)^{5/3}\,\kappa}\right)^{1+\frac{1}{n}}\kappa\right)}{1+\frac{c\left(1+Ka^{1+\frac{1}{n}}\right)r^2}{(A-3\,B\,r^2)^{2/3}}};$$

## Cambio de *λ*, para el espacio

In[12]:= λ[r_] := -Log[Exp[-μ[r]] + f[r]]
⎣lo⋯ ⎣exponencial

In[13]:= λ[r] // FullSimplify
⎣simplifica completamente

Out[13]=
$$-\text{Log}\left[1+\frac{c\left(1+Ka^{1+\frac{1}{n}}\right)r^2}{(A-3\,B\,r^2)^{2/3}}\right]$$

In[14]:=
$$\lambda[r\_] := -\text{Log}\left[1+\frac{c\left(1+Ka^{1+\frac{1}{n}}\right)r^2}{(A-3\,B\,r^2)^{2/3}}\right];$$
⎣logaritmo

# Ecuaciones de Einstein

## Densidad Efectiva

In[15]:= $\rho[r\_] := \frac{1}{\kappa\, r^2} \left(1 - e^{-\lambda[r]}\, (1 - r\, D[\lambda[r], r])\right);$

    deriva

$\rho[r]$ // **FullSimplify**

    simplifica completamente

Out[16]= $-\dfrac{c\left(1 + Ka^{1+\frac{1}{n}}\right)\left(3\,A - 5\,B\,r^2\right)}{\left(A - 3\,B\,r^2\right)^{5/3}\,\kappa}$

In[17]:= $\rho[r\_] := -\dfrac{c\left(1 + Ka^{1+\frac{1}{n}}\right)\left(3\,A - 5\,B\,r^2\right)}{\left(A - 3\,B\,r^2\right)^{5/3}\,\kappa};$

## Presión efectiva

In[18]:= $Pr[r\_] := -\frac{1}{\kappa\, r^2}\left(1 - e^{-\lambda[r]}\,(1 + r * \nu prime[r])\right);$

$Pr[r]$ // **FullSimplify**

    simplifica completamente

Out[19]= $\dfrac{-4\,A\,B + 12\,B^2\,r^2 + c\left(A - 5\,B\,r^2\right)\left(A - 3\,B\,r^2\right)^{1/3} + Ka\left(A - 3\,B\,r^2\right)\left(A - B\,r^2\right)\left(-\frac{c\,Ka^{1+\frac{1}{n}}\left(3\,A - 5\,B\,r^2\right)}{\left(A - 3\,B\,r^2\right)^{5/3}\,\kappa}\right)^{1+\frac{1}{n}}\kappa}{\left(A - 3\,B\,r^2\right)\left(A - B\,r^2\right)\,\kappa}$

In[20]:= $Pr[r\_] := \dfrac{1}{\left(A - 3\,B\,r^2\right)\left(A - B\,r^2\right)\,\kappa}\left(-4\,A\,B + 12\,B^2\,r^2 + \right.$

$\left. c\left(A - 5\,B\,r^2\right)\left(A - 3\,B\,r^2\right)^{1/3} + Ka\left(A - 3\,B\,r^2\right)\left(A - B\,r^2\right)\left(-\dfrac{c\,Ka^{1+\frac{1}{n}}\left(3\,A - 5\,B\,r^2\right)}{\left(A - 3\,B\,r^2\right)^{5/3}\,\kappa}\right)^{1+\frac{1}{n}}\kappa\right)$

## Presión Tangencial efectiva

In[21]:= $Pt[r\_] :=$

    $\dfrac{Exp[-\lambda[r]]}{4\,\kappa}\left(2\,\nu prime\,'[r] + (\nu prime[r])^2 - \lambda'[r]\,\nu prime[r] + \dfrac{2\,(\nu prime[r] - \lambda'[r])}{r}\right);$

$Pt[r]$ // **Simplify**

    simplifica

Out[22]= $\left(\left(1 + \dfrac{c\left(1 + Ka^{1+\frac{1}{n}}\right)r^2}{\left(A - 3\,B\,r^2\right)^{2/3}}\right)\left(-2\,c\left(1 + Ka^{1+\frac{1}{n}}\right)n\,r^3\left(A - 3\,B\,r^2\right)\right.\right.$

$$\left(A - B\,r^2\right)^2 \left(c\,Ka^{1+\frac{1}{n}}\left(A - 5\,B\,r^2\right) + 4\,B\left(c\left(1 + Ka^{1+\frac{1}{n}}\right)r^2 + \left(A - 3\,B\,r^2\right)^{2/3}\right) - \right.$$

$$\left. Ka\left(A - 3\,B\,r^2\right)^{2/3}\left(A - B\,r^2\right)\left(-\frac{c\,Ka^{1+\frac{1}{n}}\left(3\,A - 5\,B\,r^2\right)}{\left(A - 3\,B\,r^2\right)^{5/3}\varkappa}\right)^{1+\frac{1}{n}}\varkappa\right) +$$

$$n\,r^3\left(A - 3\,B\,r^2\right)^2\left(c\,Ka^{1+\frac{1}{n}}\left(A - 5\,B\,r^2\right) + 4\,B\left(c\left(1 + Ka^{1+\frac{1}{n}}\right)r^2 + \left(A - 3\,B\,r^2\right)^{2/3}\right) - \right.$$

$$\left. Ka\left(A - 3\,B\,r^2\right)^{2/3}\left(A - B\,r^2\right)\left(-\frac{c\,Ka^{1+\frac{1}{n}}\left(3\,A - 5\,B\,r^2\right)}{\left(A - 3\,B\,r^2\right)^{5/3}\varkappa}\right)^{1+\frac{1}{n}}\varkappa\right)^2 -$$

$$2\,n\left(A - 3\,B\,r^2\right)\left(A - B\,r^2\right)\left(c\left(1 + Ka^{1+\frac{1}{n}}\right)r^2 + \left(A - 3\,B\,r^2\right)^{2/3}\right)\left(-2\,c\left(1 + Ka^{1+\frac{1}{n}}\right)r\left(A - B\,r^2\right)^2 + \right.$$

$$4\,B\,r\left(A - 3\,B\,r^2\right)\left(c\left(1 + Ka^{1+\frac{1}{n}}\right)r^2 + \left(A - 3\,B\,r^2\right)^{2/3}\right) + r\left(A - 3\,B\,r^2\right)$$

$$\left.\left(c\,Ka^{1+\frac{1}{n}}\left(A - 5\,B\,r^2\right) - Ka\left(A - 3\,B\,r^2\right)^{2/3}\left(A - B\,r^2\right)\left(-\frac{c\,Ka^{1+\frac{1}{n}}\left(3\,A - 5\,B\,r^2\right)}{\left(A - 3\,B\,r^2\right)^{5/3}\varkappa}\right)^{1+\frac{1}{n}}\varkappa\right)\right) -$$

$$2\,r\left(8\,B^2\,n\,r^2\left(A - 3\,B\,r^2\right)^2\left(c\left(1 + Ka^{1+\frac{1}{n}}\right)r^2 + \left(A - 3\,B\,r^2\right)^{2/3}\right)^2 + 4\,B\,n\left(A - 3\,B\,r^2\right)^2\left(A - B\,r^2\right)\right.$$

$$\left(c\left(1 + Ka^{1+\frac{1}{n}}\right)r^2 + \left(A - 3\,B\,r^2\right)^{2/3}\right)^2 + 2\,B\,c\,Ka^{1+\frac{1}{n}}\,r^2\left(c\left(1 + Ka^{1+\frac{1}{n}}\right)r^2 + \left(A - 3\,B\,r^2\right)^{2/3}\right)$$

$$\left(n\left(A - 5\,B\,r^2\right)\left(A - 3\,B\,r^2\right)^2 + 2\,n\left(A - 5\,B\,r^2\right)\left(A - 3\,B\,r^2\right)\left(A - B\,r^2\right) - \right.$$

$$\left.5\,n\left(A - 3\,B\,r^2\right)^2\left(A - B\,r^2\right) + 10\,Ka\left(1 + n\right)\left(A - B\,r^2\right)^3\left(-\frac{c\,Ka^{1+\frac{1}{n}}\left(3\,A - 5\,B\,r^2\right)}{\left(A - 3\,B\,r^2\right)^{5/3}\varkappa}\right)^{\frac{1}{n}}\right) -$$

$$2\,c\left(1 + Ka^{1+\frac{1}{n}}\right)n\,r^2\left(A - 3\,B\,r^2\right)\left(A - B\,r^2\right)^2\left(c\,Ka^{1+\frac{1}{n}}\left(A - 5\,B\,r^2\right) - \right.$$

$$\left. Ka\left(A - 3\,B\,r^2\right)^{2/3}\left(A - B\,r^2\right)\left(-\frac{c\,Ka^{1+\frac{1}{n}}\left(3\,A - 5\,B\,r^2\right)}{\left(A - 3\,B\,r^2\right)^{5/3}\varkappa}\right)^{1+\frac{1}{n}}\varkappa\right) +$$

$$n\left(A - 3\,B\,r^2\right)^2\left(A - B\,r^2\right)\left(c\left(1 + Ka^{1+\frac{1}{n}}\right)r^2 + \left(A - 3\,B\,r^2\right)^{2/3}\right)$$

$$\left(c\,Ka^{1+\frac{1}{n}}\left(A-5\,B\,r^2\right)-Ka\left(A-3\,B\,r^2\right)^{2/3}\left(A-B\,r^2\right)\left(-\frac{c\,Ka^{1+\frac{1}{n}}\left(3\,A-5\,B\,r^2\right)}{\left(A-3\,B\,r^2\right)^{5/3}\,\kappa}\right)^{1+\frac{1}{n}}\kappa\right)\right)\right)\Bigg/$$

$$\left(4\,n\,r\left(A-3\,B\,r^2\right)^2\left(A-B\,r^2\right)^2\left(c\left(1+Ka^{1+\frac{1}{n}}\right)r^2+\left(A-3\,B\,r^2\right)^{2/3}\right)^2\right.$$

$$\left.\kappa\right)$$

In[23]:= **Pt[r_] :=**
$$\left(\left(\left(1+\frac{c\left(1+Ka^{1+\frac{1}{n}}\right)r^2}{\left(A-3\,B\,r^2\right)^{2/3}}\right)\right.\right.$$

$$\left(-2\,c\left(1+Ka^{1+\frac{1}{n}}\right)n\,r^3\left(A-3\,B\,r^2\right)\left(A-B\,r^2\right)^2\left(c\,Ka^{1+\frac{1}{n}}\left(A-5\,B\,r^2\right)+4\,B\left(c\left(1+Ka^{1+\frac{1}{n}}\right)r^2+\right.\right.\right.$$

$$\left.\left.\left(A-3\,B\,r^2\right)^{2/3}\right)-Ka\left(A-3\,B\,r^2\right)^{2/3}\left(A-B\,r^2\right)\left(-\frac{c\,Ka^{1+\frac{1}{n}}\left(3\,A-5\,B\,r^2\right)}{\left(A-3\,B\,r^2\right)^{5/3}\,\kappa}\right)^{1+\frac{1}{n}}\kappa\right)+$$

$$n\,r^3\left(A-3\,B\,r^2\right)^2\left(c\,Ka^{1+\frac{1}{n}}\left(A-5\,B\,r^2\right)+4\,B\left(c\left(1+Ka^{1+\frac{1}{n}}\right)r^2+\left(A-3\,B\,r^2\right)^{2/3}\right)-\right.$$

$$\left.Ka\left(A-3\,B\,r^2\right)^{2/3}\left(A-B\,r^2\right)\left(-\frac{c\,Ka^{1+\frac{1}{n}}\left(3\,A-5\,B\,r^2\right)}{\left(A-3\,B\,r^2\right)^{5/3}\,\kappa}\right)^{1+\frac{1}{n}}\kappa\right)^2-$$

$$2\,n\left(A-3\,B\,r^2\right)\left(A-B\,r^2\right)\left(c\left(1+Ka^{1+\frac{1}{n}}\right)r^2+\left(A-3\,B\,r^2\right)^{2/3}\right)\left(-2\,c\left(1+Ka^{1+\frac{1}{n}}\right)r\left(A-B\,r^2\right)^2+\right.$$

$$4\,B\,r\left(A-3\,B\,r^2\right)\left(c\left(1+Ka^{1+\frac{1}{n}}\right)r^2+\left(A-3\,B\,r^2\right)^{2/3}\right)+r\left(A-3\,B\,r^2\right)$$

$$\left(c\,Ka^{1+\frac{1}{n}}\left(A-5\,B\,r^2\right)-Ka\left(A-3\,B\,r^2\right)^{2/3}\left(A-B\,r^2\right)\left(-\frac{c\,Ka^{1+\frac{1}{n}}\left(3\,A-5\,B\,r^2\right)}{\left(A-3\,B\,r^2\right)^{5/3}\,\kappa}\right)^{1+\frac{1}{n}}\kappa\right)\right)-$$

$$2\,r\left(8\,B^2\,n\,r^2\left(A-3\,B\,r^2\right)^2\left(c\left(1+Ka^{1+\frac{1}{n}}\right)r^2+\left(A-3\,B\,r^2\right)^{2/3}\right)^2+4\,B\,n\left(A-3\,B\,r^2\right)^2\left(A-B\,r^2\right)\right.$$

$$\left(c\left(1+Ka^{1+\frac{1}{n}}\right)r^2+\left(A-3\,B\,r^2\right)^{2/3}\right)^2+2\,B\,c\,Ka^{1+\frac{1}{n}}\,r^2\left(c\left(1+Ka^{1+\frac{1}{n}}\right)r^2+\left(A-3\,B\,r^2\right)^{2/3}\right)$$

$$\left(n\left(A-5\,B\,r^2\right)\left(A-3\,B\,r^2\right)^2+2\,n\left(A-5\,B\,r^2\right)\left(A-3\,B\,r^2\right)\left(A-B\,r^2\right)-\right.$$

$$
5\,n\,\left(A-3\,B\,r^2\right)^2\left(A-B\,r^2\right)+10\,Ka\,(1+n)\,\left(A-B\,r^2\right)^3\left(-\frac{c\,Ka^{1+\frac{1}{n}}\left(3\,A-5\,B\,r^2\right)}{\left(A-3\,B\,r^2\right)^{5/3}\kappa}\right)^{\frac{1}{n}}\right)-
$$

$$
2\,c\,\left(1+Ka^{1+\frac{1}{n}}\right)n\,r^2\left(A-3\,B\,r^2\right)\left(A-B\,r^2\right)^2\left(c\,Ka^{1+\frac{1}{n}}\left(A-5\,B\,r^2\right)-\right.
$$

$$
Ka\,\left(A-3\,B\,r^2\right)^{2/3}\left(A-B\,r^2\right)\left(-\frac{c\,Ka^{1+\frac{1}{n}}\left(3\,A-5\,B\,r^2\right)}{\left(A-3\,B\,r^2\right)^{5/3}\kappa}\right)^{1+\frac{1}{n}}\kappa\right)+
$$

$$
n\,\left(A-3\,B\,r^2\right)^2\left(A-B\,r^2\right)\left(c\,\left(1+Ka^{1+\frac{1}{n}}\right)r^2+\left(A-3\,B\,r^2\right)^{2/3}\right)
$$

$$
\left(c\,Ka^{1+\frac{1}{n}}\left(A-5\,B\,r^2\right)-Ka\,\left(A-3\,B\,r^2\right)^{2/3}\left(A-B\,r^2\right)\left(-\frac{c\,Ka^{1+\frac{1}{n}}\left(3\,A-5\,B\,r^2\right)}{\left(A-3\,B\,r^2\right)^{5/3}\kappa}\right)^{1+\frac{1}{n}}\kappa\right)\right)\right)\Big/
$$

$$
\left(4\,n\,r\,\left(A-3\,B\,r^2\right)^2\left(A-B\,r^2\right)^2\left(c\,\left(1+Ka^{1+\frac{1}{n}}\right)r^2+\left(A-3\,B\,r^2\right)^{2/3}\right)^2\right.
$$

$$
\kappa\Big)
$$

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# Resolución de la integral numérica de gprima, mediante MATLAB

In[24]:= **gnume := -0.000397**

In[25]:= **vnumer[r_] := ξ[r] + gnume**

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# Aplicación de las condiciones de frontera

In[26]:= **Solve$\left[\text{Exp}[-\lambda[R]] == 1 - \dfrac{2\,M}{R},\,c\right]$**
⌊resue···⌊exponencial

Out[26]= $\left\{\left\{c \to -\dfrac{2\,M\,\left(A-3\,B\,R^2\right)^{2/3}}{\left(1+Ka^{1+\frac{1}{n}}\right)R^3}\right\}\right\}$

In[27]:= **c := $-\dfrac{2\,M\,\left(A-3\,B\,R^2\right)^{2/3}}{\left(1+Ka^{1+\frac{1}{n}}\right)R^3}$**

In[28]:= **NSolve** $\left[ \textbf{Exp[vnumer[R]]} == 1 - \dfrac{2\,M}{R}, \, A \right]$
⌊resuelv··⌊exponencial

Out[28]= $\left\{ \left\{ A \rightarrow 1.55218 \times 10^{-8} \left( 6.44255 \times 10^{7}\, B\, R^{2} - \dfrac{6.44383 \times 10^{7}\, \sqrt{-2.\, M + R}}{\sqrt{R}} \right) \right\}, \right.$

$\left. \left\{ A \rightarrow 1.55218 \times 10^{-8} \left( 6.44255 \times 10^{7}\, B\, R^{2} + \dfrac{6.44383 \times 10^{7}\, \sqrt{-2.\, M + R}}{\sqrt{R}} \right) \right\} \right\}$

In[29]:= **A := 1.5521804977305803` \*^-8** $\left( \textbf{6.4425497` \*^7 B R}^{2} - \dfrac{\textbf{6.443828673049326` \*^7}\ \sqrt{\textbf{-2.` M + R}}}{\sqrt{\textbf{R}}} \right)$

## Damos las constantes que usamos en la integración

In[30]:= **B = 0.3;**
**Ka = 0.1;**
**n = 0.5;**
**κ = 8 \* π;**
**R = 1;**

In[●]:= **Clear[A, B, c, Ka, n, κ, R]**
⌊borra

# Intercambio Energético

In[35]:= `DEnergy[r_] :=` $\dfrac{\texttt{gprime[r]}}{2\,\kappa} \times \dfrac{\texttt{Exp}[-\mu[r]]}{r}\,(\xi'[r]+\mu'[r])$

`DEnergy[r] /. {M → u R, r → x R} // FullSimplify`

Lsimplifica completamente

Out[36]= $-\left(\left(1.50697\times10^{-14}\,x\,\left(\left(0.3-1.0002\,\sqrt{1-2.\,u}-0.9\,x^2\right)^{2/3}\left(-0.29994+1.\,\sqrt{1-2.\,u}+0.29994\,x^2\right)\right.\right.\right.$

$\left(\dfrac{\left(-0.6-1.0002\,\sqrt{1-2.\,u}\right)^{2/3}u\left(-0.899821+3.\,\sqrt{1-2.\,u}+1.4997\,x^2\right)}{\left(0.3-1.0002\,\sqrt{1-2.\,u}-0.9\,x^2\right)^{2/3}\left(-0.29994+1.\,\sqrt{1-2.\,u}+0.899821\,x^2\right)}\right)^{3.}+$

$\left(-0.6-1.0002\,\sqrt{1-2.\,u}\right)^{2/3}u$

$\left.\left(-4.74595\times10^{8}+1.5823\times10^{9}\,\sqrt{1-2.\,u}+2.37297\times10^{9}\,x^2\right)\right)$

$\left(-6.66133\left(-0.6-1.0002\,\sqrt{1-2.\,u}\right)^{2/3}u^2+\left(0.3-1.0002\,\sqrt{1-2.\,u}-0.9\,x^2\right)^{2/3}\right.$

$\left(-0.29994+1.\,\sqrt{1-2.\,u}+0.899821\,x^2\right)+\left(-0.6-1.0002\,\sqrt{1-2.\,u}\right)^{2/3}u$

$\left.\left.\left.\left(3.63031-1.998\,\sqrt{1-2.\,u}+1.84852\times10^{-16}\,\sqrt{1-2.\,u}\,x^2-1.4982\,x^4\right)\right)\right)\right/$

$\left(\left(0.3-1.0002\,\sqrt{1-2.\,u}-0.9\,x^2\right)^{2/3}\left(0.29994-1.\,\sqrt{1-2.\,u}-0.29994\,x^2\right)^{2}\right.$

$\left(-0.29994+1.\,\sqrt{1-2.\,u}+0.899821\,x^2\right)$

$\left.\left.\left(1.\,\left(-0.6-1.0002\,\sqrt{1-2.\,u}\right)^{2/3}u\,x^2-0.5\left(0.3-1.0002\,\sqrt{1-2.\,u}-0.9\,x^2\right)^{2/3}\right)\right)\right)$

In[37]:= $\texttt{DEnergy[x\_] := }-\Bigg(\Bigg(1.506965197892702\texttt{`}\texttt{*^}-14\ x$

$\Bigg(\Big(0.3\texttt{`}-1.0001985197024288\texttt{`}\ \sqrt{1-2.\texttt{`}\ u}-0.8999999999999999\texttt{`}\ x^2\Big)^{2/3}$

$\Big(-0.2999404559099464\texttt{`}+1.\texttt{`}\ \sqrt{1-2.\texttt{`}\ u}+0.2999404559099464\texttt{`}\ x^2\Big)$

$\Bigg(\Big(\Big(-0.5999999999999999\texttt{`}-1.0001985197024288\texttt{`}\ \sqrt{1-2.\texttt{`}\ u}\Big)^{2/3}\ u$

$\Big(-0.8998213677298392\texttt{`}+3.\texttt{`}\ \sqrt{1-2.\texttt{`}\ u}+1.499702279549732\texttt{`}\ x^2\Big)\Big)\Bigg/$

$\Big(\Big(0.3\texttt{`}-1.0001985197024288\texttt{`}\ \sqrt{1-2.\texttt{`}\ u}-0.8999999999999999\texttt{`}\ x^2\Big)^{2/3}$

$\Big(-0.2999404559099464\texttt{`}+1.\texttt{`}\ \sqrt{1-2.\texttt{`}\ u}+0.8998213677298391\texttt{`}\ x^2\Big)\Big)\Bigg)^{3.\texttt{`}}+$

$\Big(-0.5999999999999999\texttt{`}-1.0001985197024288\texttt{`}\ \sqrt{1-2.\texttt{`}\ u}\Big)^{2/3}\ u$

$\Big(-4.7459475060713965\texttt{`}\texttt{*^}8+1.5822965567193482\texttt{`}\texttt{*^}9\ \sqrt{1-2.\texttt{`}\ u}+$

$2.3729737530356984\texttt{`}\texttt{*^}9\ x^2\Big)\Bigg)$

$\Big(-6.661328802546979\texttt{`}\ \Big(-0.5999999999999999\texttt{`}-1.0001985197024288\texttt{`}\ \sqrt{1-2.\texttt{`}\ u}\Big)^{2/3}$

$u^2+\Big(0.3\texttt{`}-1.0001985197024288\texttt{`}\ \sqrt{1-2.\texttt{`}\ u}-0.8999999999999999\texttt{`}\ x^2\Big)^{2/3}$

$\Big(-0.2999404559099464\texttt{`}+1.\texttt{`}\ \sqrt{1-2.\texttt{`}\ u}+0.899821367729839\texttt{`}\ x^2\Big)+$

$\Big(-0.5999999999999999\texttt{`}-1.0001985197024288\texttt{`}\ \sqrt{1-2.\texttt{`}\ u}\Big)^{2/3}\ u$

$\Big(3.6303052163683414\texttt{`}-1.9980019980019983\texttt{`}\ \sqrt{1-2.\texttt{`}\ u}+$

$1.8485231845240704\texttt{`}\texttt{*^}-16\ \sqrt{1-2.\texttt{`}\ u}\ x^2-1.4982040754742576\texttt{`}\ x^4\Big)\Bigg)\Bigg)\Bigg/$

$\Big(\Big(0.3\texttt{`}-1.0001985197024288\texttt{`}\ \sqrt{1-2.\texttt{`}\ u}-0.8999999999999999\texttt{`}\ x^2\Big)^{2/3}$

$\Big(0.2999404559099464\texttt{`}-1.\texttt{`}\ \sqrt{1-2.\texttt{`}\ u}-0.2999404559099464\texttt{`}\ x^2\Big)^2$

$\Big(-0.2999404559099464\texttt{`}+1.\texttt{`}\ \sqrt{1-2.\texttt{`}\ u}+0.8998213677298391\texttt{`}\ x^2\Big)$

$\Big(1.\texttt{`}\ \Big(-0.5999999999999999\texttt{`}-1.0001985197024288\texttt{`}\ \sqrt{1-2.\texttt{`}\ u}\Big)^{2/3}\ u\ x^2-$

$0.5\texttt{`}\ \Big(0.3\texttt{`}-1.0001985197024288\texttt{`}\ \sqrt{1-2.\texttt{`}\ u}-0.8999999999999999\texttt{`}\ x^2\Big)^{2/3}\Big)\Bigg)\Bigg)$

In[38]:= `solu1 := Re[DEnergy[x]] /. {u → 0.34019652312288423` }`
parte real

`Plot[{solu1}, {x, 0, 1}, Evaluated → True,`
representación gráfica                    evaluado        verdadero

 `PlotStyle → {{Black, Thickness[0.005]}, {Blue, Thickness[0.005]`
estilo de represe··· negro   grosor                      azul   grosor

  `}, {Red, Thickness[0.005]}, {Green, Thickness[0.005]}, {Pink, Thickness[0.005]}},`
       rojo   grosor              verde   grosor              rosa   grosor

`Frame → True, FrameLabel → {"r/R", "ΔE"}, ImageSize → 500,`
marco   verd··· etiqueta de marco              tamaño de imagen

`LabelStyle → {FontSize → 23, FontFamily → "Times", Black}, PlotRange → Automatic]`
estilo de etiqueta  tamaño de tipo de· familia de tipo de· multipli··· negro   rango de rep··· automático

Out[39]=
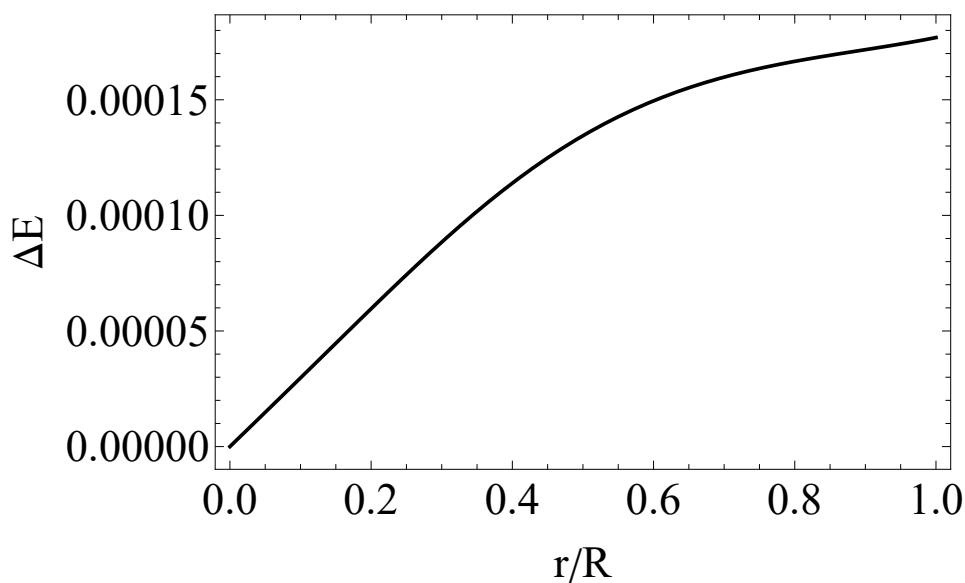
In[40]:= `DEnergy[x] /. {x →` $\sqrt{\text{x\^2+y\^2}}$ `} // FullSimplify`

⌊simplifica complet

Out[40]= $-\Bigg(\Bigg(1.50697 \times 10^{-14} \sqrt{x^2+y^2}$

$\Big(\big(0.3 - 1.0002 \sqrt{1-2.\,u} - 0.9\,(x^2+y^2)\big)^{2/3} \big(-0.29994 + 1.\,\sqrt{1-2.\,u} + 0.29994\,(x^2+y^2)\big)$

$\Big(\Big(\big(-0.6 - 1.0002 \sqrt{1-2.\,u}\big)^{2/3} u\,\big(-0.899821 + 3.\,\sqrt{1-2.\,u} + 1.4997\,(x^2+y^2)\big)\Big) \Big/$

$\big(0.3 - 1.0002 \sqrt{1-2.\,u} - 0.9\,(x^2+y^2)\big)^{2/3} \big(-0.29994 + 1.\,\sqrt{1-2.\,u} +$

$0.899821\,(x^2+y^2)\big)\Big)\Big)^{3.} + \big(-0.6 - 1.0002 \sqrt{1-2.\,u}\big)^{2/3}$

$u\,\big(-4.74595 \times 10^8 + 1.5823 \times 10^9 \sqrt{1-2.\,u} + 2.37297 \times 10^9\,(x^2+y^2)\big)\Big)$

$\big(-6.66133\,\big(-0.6 - 1.0002 \sqrt{1-2.\,u}\big)^{2/3} u^2 + \big(0.3 - 1.0002 \sqrt{1-2.\,u} - 0.9\,(x^2+y^2)\big)^{2/3}$

$\big(-0.29994 + 1.\,\sqrt{1-2.\,u} + 0.899821\,(x^2+y^2)\big) +$

$\big(-0.6 - 1.0002 \sqrt{1-2.\,u}\big)^{2/3} u\,\big(3.63031 - 1.998 \sqrt{1-2.\,u} +$

$1.84852 \times 10^{-16} \sqrt{1-2.\,u}\,(x^2+y^2) - 1.4982\,(x^2+y^2)^2\big)\big)\Big) \Big/$

$\Big(\big(0.3 - 1.0002 \sqrt{1-2.\,u} - 0.9\,(x^2+y^2)\big)^{2/3} \big(0.29994 - 1.\,\sqrt{1-2.\,u} - 0.29994\,(x^2+y^2)\big)^2$

$\big(-0.29994 + 1.\,\sqrt{1-2.\,u} + 0.899821\,(x^2+y^2)\big)\Big)$

$\Big(1.\,\big(-0.6 - 1.0002 \sqrt{1-2.\,u}\big)^{2/3} u\,(x^2+y^2) -$

$0.5\,\big(0.3 - 1.0002 \sqrt{1-2.\,u} - 0.9\,(x^2+y^2)\big)^{2/3}\Big)\Bigg)$

In[41]:= `dEnergy[x_, y_] :=` $-\Bigg(\Bigg(1.506965197892702`*^-14 \sqrt{x^2+y^2}$

$\Bigg(\Big(0.3` - 1.0001985197024288` \sqrt{1-2.`u} - 0.8999999999999999` (x^2+y^2)\Big)^{2/3}$

$\Big(-0.2999404559099464` + 1.` \sqrt{1-2.`u} + 0.2999404559099464` (x^2+y^2)\Big)$

$\Bigg(\Big(\big(-0.5999999999999999` - 1.0001985197024288` \sqrt{1-2.`u}\big)^{2/3} u$

$\Big(-0.8998213677298392` + 3.` \sqrt{1-2.`u} + 1.499702279549732` (x^2+y^2)\Big)\Big) \Big/$

$\Big(\big(0.3` - 1.0001985197024288` \sqrt{1-2.`u} - 0.8999999999999999` (x^2+y^2)\big)^{2/3}$

$\big(-0.2999404559099464` + 1.` \sqrt{1-2.`u} +$

$0.8998213677298391` (x^2+y^2)\big)\Big)\Bigg)^{3.`} +$

$\Big(-0.5999999999999999` - 1.0001985197024288` \sqrt{1-2.`u}\Big)^{2/3} u$

$\Big(-4.7459475060713965`*^8 + 1.5822965567193482`*^9 \sqrt{1-2.`u} +$

$2.3729737530356984`*^9 (x^2+y^2)\Big)\Bigg)$

$\Big(-6.661328802546979` \big(-0.5999999999999999` - 1.0001985197024288` \sqrt{1-2.`u}\big)^{2/3}$

$u^2 + \big(0.3` - 1.0001985197024288` \sqrt{1-2.`u} - 0.8999999999999999` (x^2+y^2)\big)^{2/3}$

$\big(-0.2999404559099464` + 1.` \sqrt{1-2.`u} + 0.899821367729839` (x^2+y^2)\big) +$

$\big(-0.5999999999999999` - 1.0001985197024288` \sqrt{1-2.`u}\big)^{2/3} u$

$\big(3.6303052163683414` - 1.9980019980019983` \sqrt{1-2.`u} +$

$1.8485231845240704`*^-16 \sqrt{1-2.`u} (x^2+y^2) -$

$1.4982040754742576` (x^2+y^2)^2\big)\Big)\Bigg) \Big/$

$\Bigg(\big(0.3` - 1.0001985197024288` \sqrt{1-2.`u} - 0.8999999999999999` (x^2+y^2)\big)^{2/3}$

$\big(0.2999404559099464` - 1.` \sqrt{1-2.`u} - 0.2999404559099464` (x^2+y^2)\big)^2$

$\big(-0.2999404559099464` + 1.` \sqrt{1-2.`u} + 0.8998213677298391` (x^2+y^2)\big)$

$\big(1.` \big(-0.5999999999999999` - 1.0001985197024288` \sqrt{1-2.`u}\big)^{2/3} u (x^2+y^2) -$

$0.5` \big(0.3` - 1.0001985197024288` \sqrt{1-2.`u} - 0.8999999999999999` (x^2+y^2)\big)^{2/3}\big)\Bigg)\Bigg)$

In[42]:= `DensityPlot[Re[dEnergy[x, y]] /. {u → 0.34019652312288423`},`

  `{x, -1, 1}, {y, -1, 1}, RegionFunction → Function[{x, y}, 0 < x^2 + y^2 < 1],`

  `ColorFunction → "Rainbow", MeshStyle → Opacity[0.1, Black],`

  `PlotLegends → Automatic, Background → Black, Frame → False,`

  `Epilog → Text[Style["u = 0.3401", Large, Bold], {0, -0.7}], PlotPoints → 100]`

Out[42]=
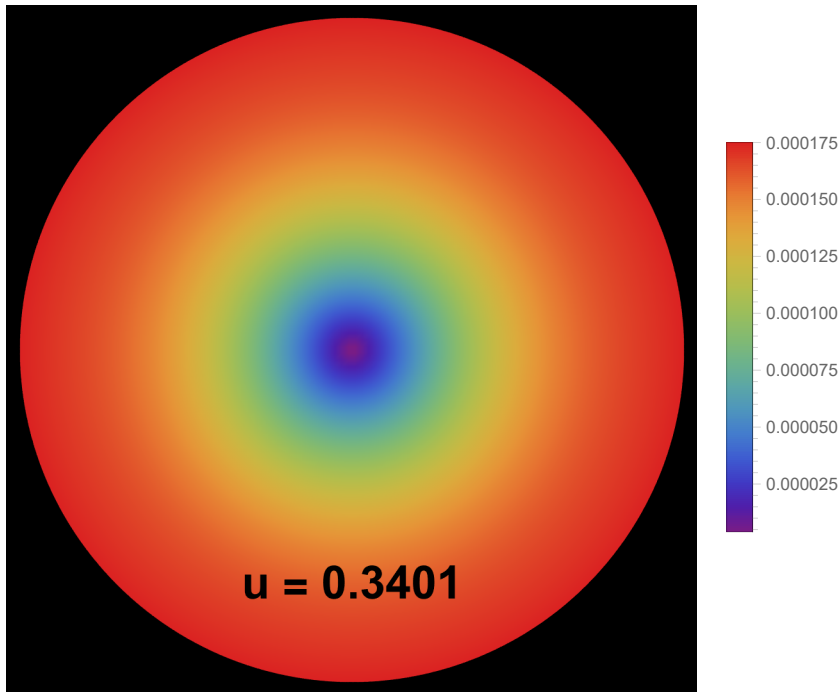
# Condiciones de aceptabilidad

## Sector material

In[43]:= **Pr[r] /. {M → u R, r → x R} // FullSimplify**
⌊simplifica completamente

Out[43]= $\Big( 0.0397729 \Big( -0.36 + 1.20024 \sqrt{1 - 2. u} + 1.08 x^2 +$

$1.26322 \times 10^{-12} \left( \dfrac{\left( -0.6 - 1.0002 \sqrt{1 - 2. u} \right)^{2/3} u \left( 0.9 - 3.0006 \sqrt{1 - 2. u} - 1.5 x^2 \right)}{\left( 0.3 - 1.0002 \sqrt{1 - 2. u} - 0.9 x^2 \right)^{5/3}} \right)^{3.}$

$\left( -0.29994 + 1. \sqrt{1 - 2. u} + 0.29994 x^2 \right) \left( -0.29994 + 1. \sqrt{1 - 2. u} + 0.899821 x^2 \right) +$

$\left( -0.6 - 1.0002 \sqrt{1 - 2. u} \right)^{2/3} u \left( 0.3 - 1.0002 \sqrt{1 - 2. u} - 0.9 x^2 \right)^{1/3}$

$\left( -0.599401 + 1.9984 \sqrt{1 - 2. u} + 2.997 x^2 \right) \Big) \Big) \Big/$

$\left( \left( -0.29994 + 1. \sqrt{1 - 2. u} + 0.29994 x^2 \right) \left( -0.29994 + 1. \sqrt{1 - 2. u} + 0.899821 x^2 \right) \right)$

In[44]:= **Prg[x_] :=** $\Big( 0.03977294277998848\grave{} \Big( -0.35999999999999993\grave{} +$

$1.2002382236429145\grave{} \sqrt{1 - 2.\grave{} u} + 1.08\grave{} x^2 + 1.263224238073166\grave{} *\hat{}-12$

$\left( \left( \left( -0.5999999999999999\grave{} - 1.0001985197024288\grave{} \sqrt{1 - 2.\grave{} u} \right)^{2/3} u \right. \right.$

$\left. \left( 0.8999999999999999\grave{} - 3.0005955591072864\grave{} \sqrt{1 - 2.\grave{} u} - 1.5\grave{} x^2 \right) \right) \Big/$

$\left( 0.3\grave{} - 1.0001985197024288\grave{} \sqrt{1 - 2.\grave{} u} - 0.8999999999999999\grave{} x^2 \right)^{5/3} \right)^{3.\grave{}}$

$\left( -0.2999404559099464\grave{} + 1.\grave{} \sqrt{1 - 2.\grave{} u} + 0.2999404559099464\grave{} x^2 \right)$

$\left( -0.2999404559099464\grave{} + 1.\grave{} \sqrt{1 - 2.\grave{} u} + 0.8998213677298391\grave{} x^2 \right) +$

$\left( -0.5999999999999999\grave{} - 1.0001985197024288\grave{} \sqrt{1 - 2.\grave{} u} \right)^{2/3} u$

$\left( 0.3\grave{} - 1.0001985197024288\grave{} \sqrt{1 - 2.\grave{} u} - 0.8999999999999999\grave{} x^2 \right)^{1/3}$

$\left( -0.5994005994005994\grave{} + 1.9983986407640937\grave{} \sqrt{1 - 2.\grave{} u} + \right.$

$\left. 2.9970029970029977\grave{} x^2 \right) \Big) \Big) \Big/$

$\left( \left( -0.2999404559099464\grave{} + 1.\grave{} \sqrt{1 - 2.\grave{} u} + 0.2999404559099464\grave{} x^2 \right) \right.$

$\left. \left( -0.2999404559099464\grave{} + 1.\grave{} \sqrt{1 - 2.\grave{} u} + 0.8998213677298391\grave{} x^2 \right) \right)$

In[45]:= **Solve[Prg[1] == 0, u]**
⌊resuelve

Out[45]= $\{\{u \to -242\,499.\}, \{u \to 0.340197\}, \{u \to 0.499999\},$
$\{u \to 242\,082. - 417.408\, \mathbb{i}\}, \{u \to 242\,082. + 417.408\, \mathbb{i}\}\}$

In[46]:= **Prg[1] /. u → 0.3401965231288423`**

Out[46]= $-1.34064 \times 10^{-17}$

In[47]:= `solu1 := Re[Prg[x]] /. {u → 0.34019652312288423`}`
└ parte real

`Plot[{solu1}, {x, 0, 1}, Evaluated → True,`
└ representación gráfica └ evaluado └ verdadero

  `PlotStyle → {{Black, Thickness[0.005]}, {Blue, Thickness[0.005]`
└ estilo de represe·· └ negro └ grosor └ azul └ grosor

    `}, {Red, Thickness[0.005]}, {Green, Thickness[0.005]}, {Pink, Thickness[0.005]}},`
└ rojo └ grosor └ verde └ grosor └ rosa └ grosor

`Frame → True, FrameLabel → {"r/R", "p_r"}, ImageSize → 500,`
└ marco └ verd·· └ etiqueta de marco └ tamaño de imagen

`LabelStyle → {FontSize → 23, FontFamily → "Times", Black}, PlotRange → Full]`
└ estilo de etiqueta └ tamaño de tipo de· └ familia de tipo de· └ multipli··· └ negro └ rango de rep··· └ completo

Out[48]=
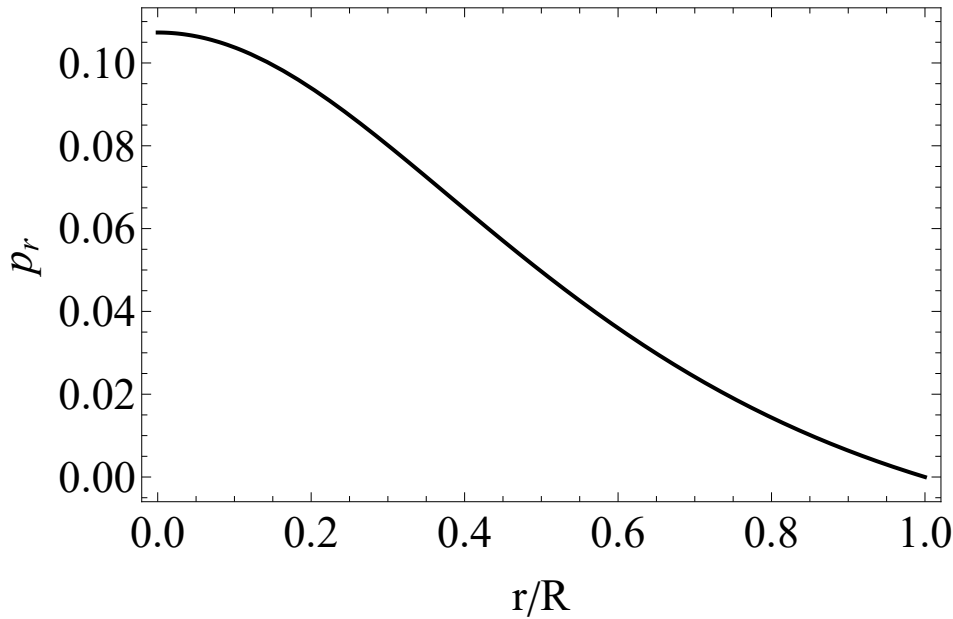


In[49]:= `Pt[r] /. {M → u R, r → x R} // Simplify`
└ simplifica

Out[49]= $\left(0.00496964\left(1 - \frac{2.\left(-0.6 - 1.0002\sqrt{1-2.u}\right)^{2/3}u\,x^2}{\left(0.3 - 1.0002\sqrt{1-2.u} - 0.9\,x^2\right)^{2/3}}\right)\right.$

$\left(-2.88114\,x^2\left(0.29994 - 1.\sqrt{1-2.u} - 0.899821\,x^2\right)^2\right.$

$\left(1.\left(-0.6 - 1.0002\sqrt{1-2.u}\right)^{2/3}u\,x^2 - 0.5\left(0.3 - 1.0002\sqrt{1-2.u} - 0.9\,x^2\right)^{2/3}\right)^2 +$

$4.80286\left(0.29994 - 1.\sqrt{1-2.u} - 0.899821\,x^2\right)^2\left(-0.29994 + 1.\sqrt{1-2.u} + 0.29994\,x^2\right)$

$\left(1.\left(-0.6 - 1.0002\sqrt{1-2.u}\right)^{2/3}u\,x^2 - 0.5\left(0.3 - 1.0002\sqrt{1-2.u} - 0.9\,x^2\right)^{2/3}\right)^2 +$

$0.0023976\left(-0.6 - 1.0002\sqrt{1-2.u}\right)^{2/3}u\,x^2$

$\left(-2.\left(-0.6 - 1.0002\sqrt{1-2.u}\right)^{2/3}u\,x^2 + \left(0.3 - 1.0002\sqrt{1-2.u} - 0.9\,x^2\right)^{2/3}\right)$

$\left(-1.0006\left(-0.29994 + 1.\sqrt{1-2.u}\right)^3 - 2.70107\left(0.29994 - 1.\sqrt{1-2.u}\right)^2x^2 -\right.$

$2.07041\left(-0.29994 + 1.\sqrt{1-2.u}\right)x^4 - 0.405\,x^6 +$

$$2.00119 \left(-0.29994 + 1. \sqrt{1-2.u}\right) \left(0.29994 - 1. \sqrt{1-2.u} - 0.899821 x^2\right)^2 -$$

$$9.48554 \times 10^{-9} \left(\frac{\left(-0.6 - 1.0002 \sqrt{1-2.u}\right)^{2/3} u \left(0.9 - 3.0006 \sqrt{1-2.u} - 1.5 x^2\right)}{\left(0.3 - 1.0002 \sqrt{1-2.u} - 0.9 x^2\right)^{5/3}}\right)^{2.}$$

$$\left(-0.29994 + 1. \sqrt{1-2.u} + 0.29994 x^2\right)^3 + 0.5 x^2 \left(0.3 - 1.0002 \sqrt{1-2.u} - 0.9 x^2\right)^2$$

$$\left(2.4 \left(-0.6 - 1.0002 \sqrt{1-2.u}\right)^{2/3} u x^2 - 1.2 \left(0.3 - 1.0002 \sqrt{1-2.u} - 0.9 x^2\right)^{2/3} -\right.$$

$$1.26297 \times 10^{-12} \left(\frac{\left(-0.6 - 1.0002 \sqrt{1-2.u}\right)^{2/3} u \left(0.9 - 3.0006 \sqrt{1-2.u} - 1.5 x^2\right)}{\left(0.3 - 1.0002 \sqrt{1-2.u} - 0.9 x^2\right)^{5/3}}\right)^{3.}$$

$$\left(0.3 - 1.0002 \sqrt{1-2.u} - 0.9 x^2\right)^{2/3} \left(-0.29994 + 1. \sqrt{1-2.u} + 0.29994 x^2\right) -$$

$$\left. 0.0019984 \left(-0.6 - 1.0002 \sqrt{1-2.u}\right)^{2/3} u \left(-0.29994 + 1. \sqrt{1-2.u} + 1.4997 x^2\right)\right)^2 -$$

$$4. \left(-0.6 - 1.0002 \sqrt{1-2.u}\right)^{2/3} u x^2 \left(0.3 - 1.0002 \sqrt{1-2.u} - 0.9 x^2\right)$$
$$\left(0.3 - 1.0002 \sqrt{1-2.u} - 0.3 x^2\right)^2$$

$$\left(1.26297 \times 10^{-12} \left(\frac{\left(-0.6 - 1.0002 \sqrt{1-2.u}\right)^{2/3} u \left(0.9 - 3.0006 \sqrt{1-2.u} - 1.5 x^2\right)}{\left(0.3 - 1.0002 \sqrt{1-2.u} - 0.9 x^2\right)^{5/3}}\right)^{3.}\right.$$

$$\left(0.3 - 1.0002 \sqrt{1-2.u} - 0.9 x^2\right)^{2/3} \left(-0.29994 + 1. \sqrt{1-2.u} + 0.29994 x^2\right) +$$

$$\left. 0.0019984 \left(-0.6 - 1.0002 \sqrt{1-2.u}\right)^{2/3} u \left(-0.29994 + 1. \sqrt{1-2.u} + 1.4997 x^2\right)\right) -$$

$$1. \left(0.3 - 1.0002 \sqrt{1-2.u} - 0.9 x^2\right)^2 \left(0.3 - 1.0002 \sqrt{1-2.u} - 0.3 x^2\right)$$
$$\left(-2. \left(-0.6 - 1.0002 \sqrt{1-2.u}\right)^{2/3} u x^2 + \left(0.3 - 1.0002 \sqrt{1-2.u} - 0.9 x^2\right)^{2/3}\right)$$

$$\left(1.26297 \times 10^{-12} \left(\frac{\left(-0.6 - 1.0002 \sqrt{1-2.u}\right)^{2/3} u \left(0.9 - 3.0006 \sqrt{1-2.u} - 1.5 x^2\right)}{\left(0.3 - 1.0002 \sqrt{1-2.u} - 0.9 x^2\right)^{5/3}}\right)^{3.}\right.$$

$$\left(0.3 - 1.0002 \sqrt{1-2.u} - 0.9 x^2\right)^{2/3} \left(-0.29994 + 1. \sqrt{1-2.u} + 0.29994 x^2\right) +$$

$$\left. 0.0019984 \left(-0.6 - 1.0002 \sqrt{1-2.u}\right)^{2/3} u \left(-0.29994 + 1. \sqrt{1-2.u} + 1.4997 x^2\right)\right) +$$

$$2. \left(-0.6 - 1.0002 \sqrt{1-2.u}\right)^{2/3} u x^2 \left(0.3 - 1.0002 \sqrt{1-2.u} - 0.9 x^2\right)$$
$$\left(0.3 - 1.0002 \sqrt{1-2.u} - 0.3 x^2\right)^2$$

$$\left(-2.4 \left(-0.6 - 1.0002 \sqrt{1-2.u}\right)^{2/3} u x^2 + 1.2 \left(0.3 - 1.0002 \sqrt{1-2.u} - 0.9 x^2\right)^{2/3} +\right.$$

$$1.26297 \times 10^{-12} \left(\frac{\left(-0.6 - 1.0002 \sqrt{1-2.u}\right)^{2/3} u \left(0.9 - 3.0006 \sqrt{1-2.u} - 1.5 x^2\right)}{\left(0.3 - 1.0002 \sqrt{1-2.u} - 0.9 x^2\right)^{5/3}}\right)^{3.}$$

$$\left( 0.3 - 1.0002 \sqrt{1 - 2.\,u} - 0.9\,x^2 \right)^{2/3} \left( -0.29994 + 1.\,\sqrt{1 - 2.\,u} + 0.29994\,x^2 \right) +$$

$$0.0019984 \left( -0.6 - 1.0002 \sqrt{1 - 2.\,u} \right)^{2/3} u \left( -0.29994 + 1.\,\sqrt{1 - 2.\,u} + 1.4997\,x^2 \right) \Bigg) -$$

$$1.\,\left( 0.3 - 1.0002 \sqrt{1 - 2.\,u} - 0.9\,x^2 \right) \left( 0.3 - 1.0002 \sqrt{1 - 2.\,u} - 0.3\,x^2 \right)$$

$$\left( -2.\,\left( -0.6 - 1.0002 \sqrt{1 - 2.\,u} \right)^{2/3} u\,x^2 + \left( 0.3 - 1.0002 \sqrt{1 - 2.\,u} - 0.9\,x^2 \right)^{2/3} \right)$$

$$\Bigg( 4.00159 \left( -0.6 - 1.0002 \sqrt{1 - 2.\,u} \right)^{2/3} u \left( 0.29994 - 1.\,\sqrt{1 - 2.\,u} - 0.29994\,x^2 \right)^2 +$$

$$2.40048 \left( -0.29994 + 1.\,\sqrt{1 - 2.\,u} + 0.899821\,x^2 \right) \left( 1.\,\left( -0.6 - 1.0002 \sqrt{1 - 2.\,u} \right)^{2/3} u\,x^2 - \right.$$

$$\left. 0.5 \left( 0.3 - 1.0002 \sqrt{1 - 2.\,u} - 0.9\,x^2 \right)^{2/3} \right) + \left( 0.3 - 1.0002 \sqrt{1 - 2.\,u} - 0.9\,x^2 \right)$$

$$\left( 1.26297 \times 10^{-12} \left( \frac{\left( -0.6 - 1.0002 \sqrt{1 - 2.\,u} \right)^{2/3} u \left( 0.9 - 3.0006 \sqrt{1 - 2.\,u} - 1.5\,x^2 \right)}{\left( 0.3 - 1.0002 \sqrt{1 - 2.\,u} - 0.9\,x^2 \right)^{5/3}} \right)^{3.} \right.$$

$$\left( 0.3 - 1.0002 \sqrt{1 - 2.\,u} - 0.9\,x^2 \right)^{2/3} \left( -0.29994 + 1.\,\sqrt{1 - 2.\,u} + 0.29994\,x^2 \right) +$$

$$0.0019984 \left( -0.6 - 1.0002 \sqrt{1 - 2.\,u} \right)^{2/3} u$$

$$\left. \left. \left. \left( -0.29994 + 1.\,\sqrt{1 - 2.\,u} + 1.4997\,x^2 \right) \right) \right) \right) \Bigg) \Bigg/$$

$$\left( \left( 0.29994 - 1.\,\sqrt{1 - 2.\,u} - 0.899821\,x^2 \right)^2 \left( 0.29994 - 1.\,\sqrt{1 - 2.\,u} - 0.29994\,x^2 \right)^2 \right.$$

$$\left. \left( 1.\,\left( -0.6 - 1.0002 \sqrt{1 - 2.\,u} \right)^{2/3} u\,x^2 - 0.5 \left( 0.3 - 1.0002 \sqrt{1 - 2.\,u} - 0.9\,x^2 \right)^{2/3} \right)^2 \right)$$

In[50]:= **Ptg[x_] :=** $\Bigg( 0.0049696445069471185\grave{}$

$$\left( 1 - \frac{2.\grave{}\ \left( -0.5999999999999999\grave{} - 1.0001985197024288\grave{}\ \sqrt{1 - 2.\grave{}\,u} \right)^{2/3} u\,x^2}{\left( 0.3\grave{} - 1.0001985197024288\grave{}\ \sqrt{1 - 2.\grave{}\,u} - 0.8999999999999999\grave{}\,x^2 \right)^{2/3}} \right)$$

$$\Bigg( -2.8811435869869975\grave{}\ x^2$$

$$\left( 0.29994045590994645\grave{} - 1.\grave{}\ \sqrt{1 - 2.\grave{}\,u} - 0.8998213677298391\grave{}\,x^2 \right)^2$$

$$\left( 1.\grave{}\ \left( -0.5999999999999999\grave{} - 1.0001985197024288\grave{}\ \sqrt{1 - 2.\grave{}\,u} \right)^{2/3} u\,x^2 - \right.$$

$$\left. 0.5\grave{}\ \left( 0.3\grave{} - 1.0001985197024288\grave{}\ \sqrt{1 - 2.\grave{}\,u} - 0.8999999999999999\grave{}\,x^2 \right)^{2/3} \right)^2 +$$

$$4.802859251257568\grave{}\ \left( 0.29994045590994645\grave{} - 1.\grave{}\ \sqrt{1 - 2.\grave{}\,u} - 0.8998213677298391\grave{} \right.$$

$$\left. x^2 \right)^2 \left( -0.2999404559099464\grave{} + 1.\grave{}\ \sqrt{1 - 2.\grave{}\,u} + 0.2999404559099464\grave{}\,x^2 \right)$$

$$\left( 1.\grave{}\ \left( -0.5999999999999999\grave{} - 1.0001985197024288\grave{}\ \sqrt{1 - 2.\grave{}\,u} \right)^{2/3} u\,x^2 - \right.$$

$$\left. 0.5\grave{}\ \left( 0.3\grave{} - 1.0001985197024288\grave{}\ \sqrt{1 - 2.\grave{}\,u} - 0.8999999999999999\grave{}\,x^2 \right)^{2/3} \right)^2 +$$

$$0.0023976023976023985\grave{}\ \left( -0.5999999999999999\grave{} - 1.0001985197024288\grave{}\ \sqrt{1 - 2.\grave{}\,u} \right)^{2/3}$$

$$u\, x^2 \left(-2.` \left(-0.5999999999999999` - 1.0001985197024288` \sqrt{1 - 2.` u}\right)^{2/3} u\, x^2 + \right.$$

$$\left. \left(0.3` - 1.0001985197024288` \sqrt{1 - 2.` u} - 0.8999999999999999` x^2\right)^{2/3}\right)$$

$$\left(-1.0005956773453266` \left(-0.2999404559099464` + 1.` \sqrt{1 - 2.` u}\right)^3 - \right.$$

$$2.7010721128003103` \left(0.2999404559099464` - 1.` \sqrt{1 - 2.` u}\right)^2 x^2 -$$

$$2.0704109357840275` \left(-0.2999404559099464` + 1.` \sqrt{1 - 2.` u}\right) x^4 -$$

$$0.40499999999999997` x^6 + 2.0011913546906537`$$

$$\left(-0.2999404559099464` + 1.` \sqrt{1 - 2.` u}\right)\left(0.2999404559099464` - \right.$$

$$\left. 1.` \sqrt{1 - 2.` u} - 0.8998213677298391` x^2\right)^2 - 9.485538659894861` *\wedge-9$$

$$\left(\left(\left(-0.5999999999999999` - 1.0001985197024288` \sqrt{1 - 2.` u}\right)^{2/3} u \right.\right.$$

$$\left. \left(0.8999999999999999` - 3.0005955591072864` \sqrt{1 - 2.` u} - 1.5` x^2\right)\right) \Big/$$

$$\left. \left(0.3` - 1.0001985197024288` \sqrt{1 - 2.` u} - 0.8999999999999999` x^2\right)^{5/3}\right)^{2.`}$$

$$\left. \left(-0.2999404559099464` + 1.` \sqrt{1 - 2.` u} + 0.2999404559099464` x^2\right)^3\right) +$$

$$0.5` x^2 \left(0.3` - 1.0001985197024288` \sqrt{1 - 2.` u} - 0.8999999999999999` x^2\right)^2$$

$$\left(2.4` \left(-0.5999999999999999` - 1.0001985197024288` \sqrt{1 - 2.` u}\right)^{2/3} u\, x^2 - \right.$$

$$1.2` \left(0.3` - 1.0001985197024288` \sqrt{1 - 2.` u} - 0.8999999999999999` x^2\right)^{2/3} -$$

$$1.2629735129472004` *\wedge-12$$

$$\left(\left(\left(-0.5999999999999999` - 1.0001985197024288` \sqrt{1 - 2.` u}\right)^{2/3} u \right.\right.$$

$$\left. \left(0.8999999999999999` - 3.0005955591072864` \sqrt{1 - 2.` u} - 1.5` x^2\right)\right) \Big/$$

$$\left. \left(0.3` - 1.0001985197024288` \sqrt{1 - 2.` u} - 0.8999999999999999` x^2\right)^{5/3}\right)^{3.`}$$

$$\left(0.3` - 1.0001985197024288` \sqrt{1 - 2.` u} - 0.8999999999999999` x^2\right)^{2/3}$$

$$\left(-0.2999404559099464` + 1.` \sqrt{1 - 2.` u} + \right.$$

$$\left. 0.2999404559099464` x^2\right) - 0.0019983986407640943`$$

$$\left(-0.5999999999999999` - 1.0001985197024288` \sqrt{1 - 2.` u}\right)^{2/3} u$$

$$\left. \left(-0.2999404559099464` + 1.` \sqrt{1 - 2.` u} + 1.4997022795497321` x^2\right)\right)^2 -$$

$$4.` \left(-0.5999999999999999` - 1.0001985197024288` \sqrt{1 - 2.` u}\right)^{2/3} u\, x^2$$

$$\left(0.3` - 1.0001985197024288` \sqrt{1 - 2.` u} - 0.8999999999999999` x^2\right)$$

$$\left(0.3` - 1.0001985197024288` \sqrt{1 - 2.` u} - 0.3` x^2\right)^2$$

$$\left(1.2629735129472004` *\wedge-12\right.$$

$$\left(\left(\left(-0.5999999999999999` - 1.0001985197024288` \sqrt{1 - 2.` u}\right)^{2/3} u \right.\right.$$

$$\left. \left(0.8999999999999999` - 3.0005955591072864` \sqrt{1 - 2.` u} - 1.5` x^2\right)\right) \Big/$$

$$\left(0.3` - 1.0001985197024288` \sqrt{1 - 2.`u} - 0.8999999999999999` x^2\right)^{5/3}\Big)^{3.`}$$

$$\left(0.3` - 1.0001985197024288` \sqrt{1 - 2.`u} - 0.8999999999999999` x^2\right)^{2/3}$$

$$\left(-0.2999404559099464` + 1.` \sqrt{1 - 2.`u} + 0.2999404559099464` x^2\right) +$$

$$0.0019983986407640943`$$

$$\left(-0.5999999999999999` - 1.0001985197024288` \sqrt{1 - 2.`u}\right)^{2/3} u$$

$$\left(-0.2999404559099464` + 1.` \sqrt{1 - 2.`u} + 1.4997022795497321` x^2\right)\Big) -$$

$$1.` \left(0.3` - 1.0001985197024288` \sqrt{1 - 2.`u} - 0.8999999999999999` x^2\right)^2$$

$$\left(0.3` - 1.0001985197024288` \sqrt{1 - 2.`u} - 0.3` x^2\right)$$

$$\left(-2.` \left(-0.5999999999999999` - 1.0001985197024288` \sqrt{1 - 2.`u}\right)^{2/3} u x^2 +$$

$$\left(0.3` - 1.0001985197024288` \sqrt{1 - 2.`u} - 0.8999999999999999` x^2\right)^{2/3}\right)$$

$$\Big(1.2629735129472004` *^-12$$

$$\left(\left(\left(-0.5999999999999999` - 1.0001985197024288` \sqrt{1 - 2.`u}\right)^{2/3} u\right.\right.$$

$$\left.\left(0.8999999999999999` - 3.0005955591072864` \sqrt{1 - 2.`u} - 1.5` x^2\right)\right) \Big/$$

$$\left(0.3` - 1.0001985197024288` \sqrt{1 - 2.`u} - 0.8999999999999999` x^2\right)^{5/3}\Big)^{3.`}$$

$$\left(0.3` - 1.0001985197024288` \sqrt{1 - 2.`u} - 0.8999999999999999` x^2\right)^{2/3}$$

$$\left(-0.2999404559099464` + 1.` \sqrt{1 - 2.`u} + 0.2999404559099464` x^2\right) +$$

$$0.0019983986407640943`$$

$$\left(-0.5999999999999999` - 1.0001985197024288` \sqrt{1 - 2.`u}\right)^{2/3} u$$

$$\left(-0.2999404559099464` + 1.` \sqrt{1 - 2.`u} + 1.4997022795497321` x^2\right)\Big) +$$

$$2.` \left(-0.5999999999999999` - 1.0001985197024288` \sqrt{1 - 2.`u}\right)^{2/3} u x^2$$

$$\left(0.3` - 1.0001985197024288` \sqrt{1 - 2.`u} - 0.8999999999999999` x^2\right)$$

$$\left(0.3` - 1.0001985197024288` \sqrt{1 - 2.`u} - 0.3` x^2\right)^2$$

$$\left(-2.4` \left(-0.5999999999999999` - 1.0001985197024288` \sqrt{1 - 2.`u}\right)^{2/3} u x^2 +$$

$$1.2` \left(0.3` - 1.0001985197024288` \sqrt{1 - 2.`u} - 0.8999999999999999` x^2\right)^{2/3} +$$

$$1.2629735129472004` *^-12$$

$$\left(\left(\left(-0.5999999999999999` - 1.0001985197024288` \sqrt{1 - 2.`u}\right)^{2/3} u\right.\right.$$

$$\left.\left(0.8999999999999999` - 3.0005955591072864` \sqrt{1 - 2.`u} - 1.5` x^2\right)\right) \Big/$$

$$\left(0.3` - 1.0001985197024288` \sqrt{1 - 2.`u} - 0.8999999999999999` x^2\right)^{5/3}\Big)^{3.`}$$

$$\left(0.3` - 1.0001985197024288` \sqrt{1 - 2.`u} - 0.8999999999999999` x^2\right)^{2/3}$$

$$\left(-0.2999404559099464` + 1.` \sqrt{1 - 2.`u} + 0.2999404559099464` x^2\right) +$$

$$0.0019983986407640943`$$

$$\left(-0.5999999999999999` - 1.0001985197024288` \sqrt{1 - 2.`u}\right)^{2/3} u$$

$$\left(-0.2999404559099464` + 1.` \sqrt{1 - 2.`u} + 1.4997022795497321` x^2\right)\Bigg) -$$

$$1.` \left(0.3` - 1.0001985197024288` \sqrt{1 - 2.`u} - 0.8999999999999999` x^2\right)$$

$$\left(0.3` - 1.0001985197024288` \sqrt{1 - 2.`u} - 0.3` x^2\right)$$

$$\left(-2.` \left(-0.5999999999999999` - 1.0001985197024288` \sqrt{1 - 2.`u}\right)^{2/3} u x^2 + \right.$$

$$\left. \left(0.3` - 1.0001985197024288` \sqrt{1 - 2.`u} - 0.8999999999999999` x^2\right)^{2/3}\right)$$

$$\Bigg(4.00158831525972` \left(-0.5999999999999999` - 1.0001985197024288` \sqrt{1 - 2.`u}\right)^{2/3}$$

$$u \left(0.2999404559099464` - 1.` \sqrt{1 - 2.`u} - 0.2999404559099464` x^2\right)^2 +$$

$$2.400476447285829` \left(-0.2999404559099464` + 1.` \sqrt{1 - 2.`u} + 0.8998213677298391`\right.$$

$$\left. x^2\right) \left(1.` \left(-0.5999999999999999` - 1.0001985197024288` \sqrt{1 - 2.`u}\right)^{2/3} u x^2 - \right.$$

$$\left. 0.5` \left(0.3` - 1.0001985197024288` \sqrt{1 - 2.`u} - 0.8999999999999999` x^2\right)^{2/3}\right) +$$

$$\left(0.3` - 1.0001985197024288` \sqrt{1 - 2.`u} - 0.8999999999999999` x^2\right)$$

$$\Bigg(1.2629735129472004`*^-12$$

$$\left(\left(\left(-0.5999999999999999` - 1.0001985197024288` \sqrt{1 - 2.`u}\right)^{2/3} u\right.\right.$$

$$\left. \left(0.8999999999999999` - 3.0005955591072864` \sqrt{1 - 2.`u} - 1.5` x^2\right)\right) \Bigg/$$

$$\left(0.3` - 1.0001985197024288` \sqrt{1 - 2.`u} - 0.8999999999999999` x^2\right)^{5/3}\Bigg)^{3.`}$$

$$\left(0.3` - 1.0001985197024288` \sqrt{1 - 2.`u} - 0.8999999999999999` x^2\right)^{2/3}$$

$$\left(-0.2999404559099464` + 1.` \sqrt{1 - 2.`u} + 0.2999404559099464` x^2\right) +$$

$$0.0019983986407640943` \left(-0.5999999999999999` -\right.$$

$$\left. 1.0001985197024288` \sqrt{1 - 2.`u}\right)^{2/3} u$$

$$\left(-0.2999404559099464` + 1.` \sqrt{1 - 2.`u} + 1.4997022795497321` x^2\right)\Bigg)\Bigg)\Bigg) \Bigg/$$

$$\left(\left(0.2999404559099464` - 1.` \sqrt{1 - 2.`u} - 0.8998213677298391` x^2\right)^2\right.$$

$$\left(0.2999404559099464` - 1.` \sqrt{1 - 2.`u} - 0.2999404559099464` x^2\right)^2$$

$$\left(1.` \left(-0.5999999999999999` - 1.0001985197024288` \sqrt{1 - 2.`u}\right)^{2/3} u x^2 - \right.$$

$$\left.\left. 0.5` \left(0.3` - 1.0001985197024288` \sqrt{1 - 2.`u} - 0.8999999999999999` x^2\right)^{2/3}\right)^2\right)$$

In[51]:= `solu1 := Re[Ptg[x]] /. {u → 0.34019652312288423` }`
⌊parte real

`Plot[{solu1}, {x, 0, 1}, Evaluated → True,`
⌊representación gráfica      ⌊evaluado    ⌊verdadero

  `PlotStyle → {{Black, Thickness[0.005]}, {Blue, Thickness[0.005]`
⌊estilo de represe·· ⌊negro ⌊grosor      ⌊azul ⌊grosor

    `}, {Red, Thickness[0.005]}, {Green, Thickness[0.005]}, {Pink, Thickness[0.005]}},`
⌊rojo ⌊grosor      ⌊verde ⌊grosor      ⌊rosa ⌊grosor

  `Frame → True, FrameLabel → {"r/R", "pₜ"}, ImageSize → 500,`
⌊marco ⌊verd··· ⌊etiqueta de marco      ⌊tamaño de imagen

  `LabelStyle → {FontSize → 23, FontFamily → "Times", Black}, PlotRange → Automatic]`
⌊estilo de etiqueta ⌊tamaño de tipo de· ⌊familia de tipo de·⌊multipli··· ⌊negro ⌊rango de rep··· ⌊automático

Out[52]=



In[53]:= `ρ[r] /. {M → u R, r → x R} // FullSimplify`
                           ⌊simplifica completamente
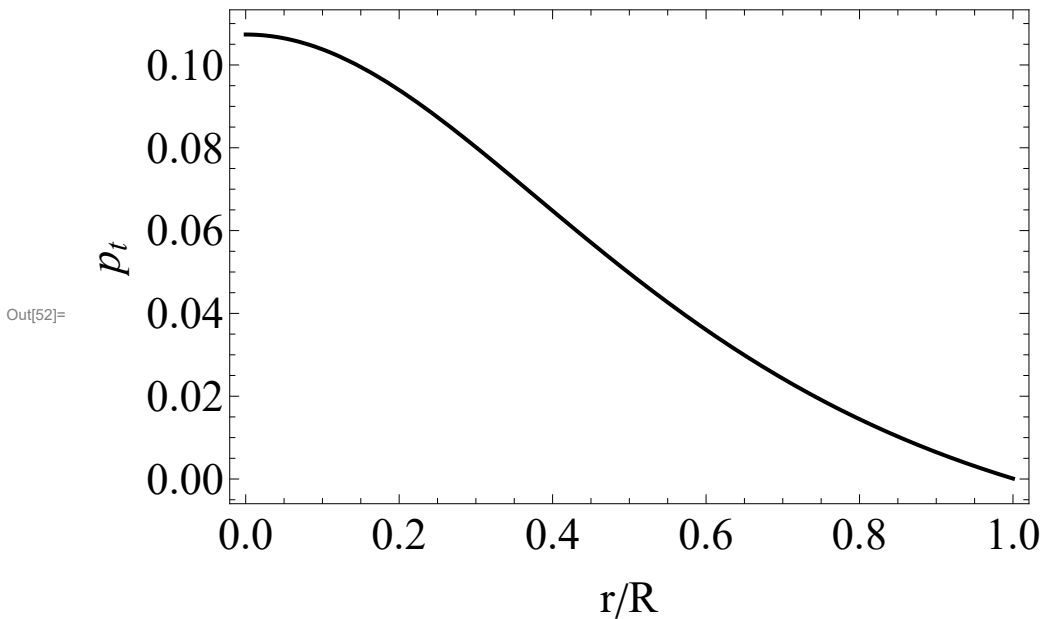
Out[53]= 

$$\frac{0.0795775 \left(-0.6 - 1.0002 \sqrt{1 - 2. u}\right)^{2/3} u \left(0.9 - 3.0006 \sqrt{1 - 2. u} - 1.5 x^2\right)}{\left(0.3 - 1.0002 \sqrt{1 - 2. u} - 0.9 x^2\right)^{5/3}}$$
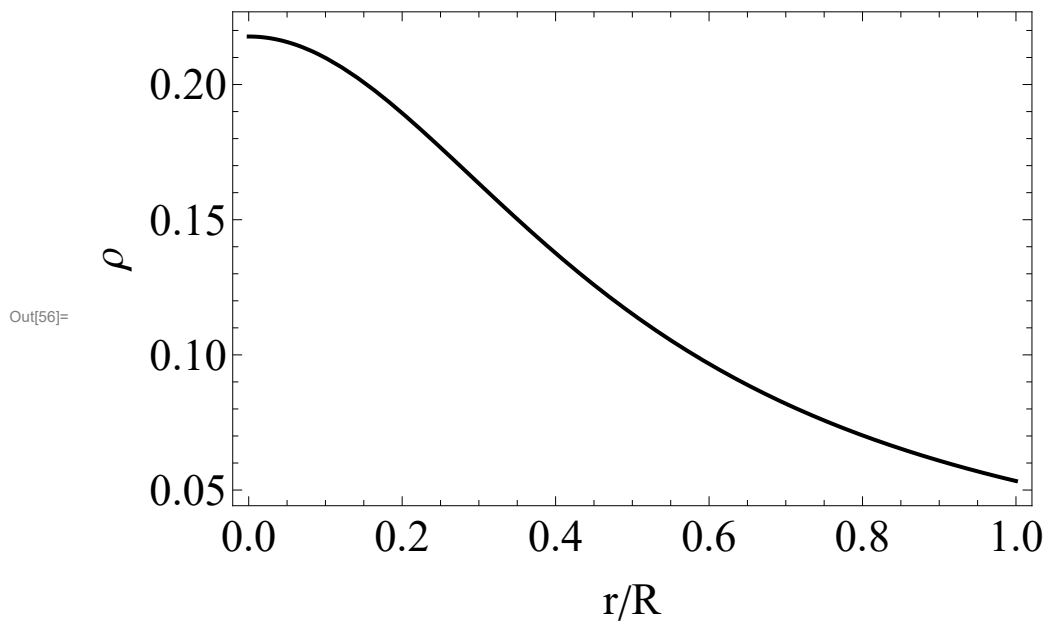
In[54]:= `ρg[x_] :=`

$$\left(0.07957747154594767` \left(-0.5999999999999999` - 1.0001985197024288` \sqrt{1 - 2.`u}\right)^{2/3}\right.$$

$$\left. u \left(0.8999999999999999` - 3.0005955591072864` \sqrt{1 - 2.`u} - 1.5` x^2\right)\right) \Big/$$

$$\left(0.3` - 1.0001985197024288` \sqrt{1 - 2.`u} - 0.8999999999999999` x^2\right)^{5/3}$$

In[55]:= `solu1 := Re[ρg[x]] /. {u → 0.34019652312288423` }`
                    └ parte real

`Plot[{solu1}, {x, 0, 1}, Evaluated → True,`
└ representación gráfica          └ evaluado     └ verdadero

 `PlotStyle → {{Black, Thickness[0.005]}, {Blue, Thickness[0.005]`
 └ estilo de represe··· └ negro └ grosor              └ azul └ grosor

   `}, {Red, Thickness[0.005]}, {Green, Thickness[0.005]}, {Pink, Thickness[0.005]}},`
        └ rojo └ grosor            └ verde └ grosor            └ rosa └ grosor

`Frame → True, FrameLabel → {"r/R", "ρ"}, ImageSize → 500,`
└ marco └ verd··· └ etiqueta de marco              └ tamaño de imagen

`LabelStyle → {FontSize → 23, FontFamily → "Times", Black}, PlotRange → Automatic]`
└ estilo de etiqueta └ tamaño de tipo de· └ familia de tipo de· └ multipli··· └ negro └ rango de rep··· └ automático

Out[56]=



## Gráficas de componentes métricas del espacio-tiempo

In[57]:= `Exp[νnumer[r]] /. {M → u R, r → x R} // FullSimplify`
         └ exponencial                          └ simplifica completamente

Out[57]= $1. \left(0.29994 - 1. \sqrt{1 - 2. u} - 0.29994 x^2\right)^2$
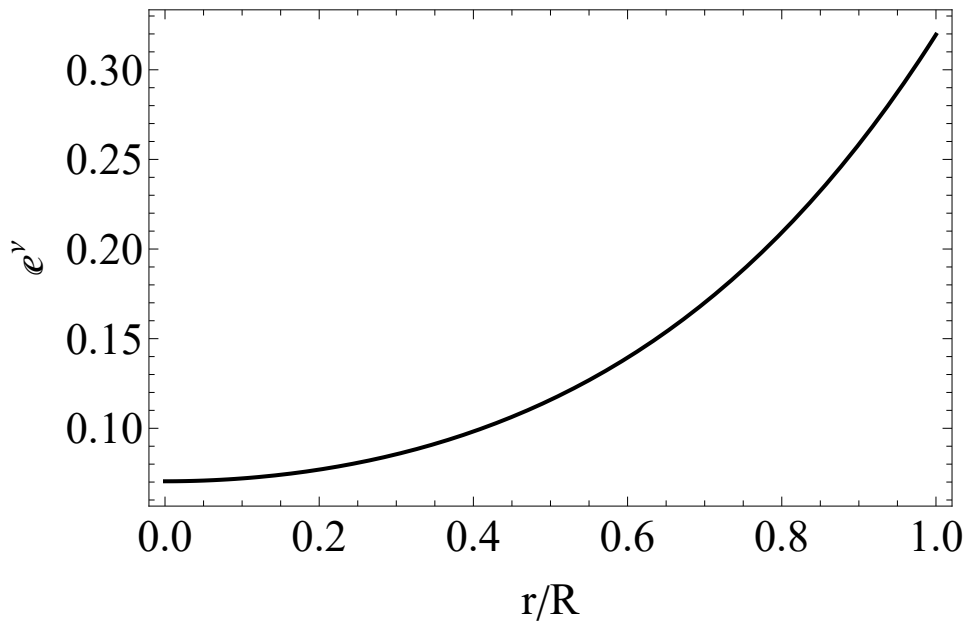
In[58]:= `metric1[x_] :=`

$1.0000000000000004` \left(0.299940455909464` - 1.` \sqrt{1 - 2.` u} - 0.299940455909464` x^2\right)^2$

In[59]:= `solu1 := Re[metric1[x]] /. {u → 0.34019652312288423`}`
 └ parte real

`Plot[{solu1}, {x, 0, 1}, Evaluated → True,`
 └ representación gráfica └ evaluado └ verdadero

 `PlotStyle → {{Black, Thickness[0.005]}, {Blue, Thickness[0.005]`
 └ estilo de represe··· └ negro └ grosor └ azul └ grosor

  `}, {Red, Thickness[0.005]}, {Green, Thickness[0.005]}, {Pink, Thickness[0.005]}},`
  └ rojo └ grosor └ verde └ grosor └ rosa └ grosor

 `Frame → True, FrameLabel → {"r/R", "e^ν"}, ImageSize → 500,`
 └ marco └ verd··· └ etiqueta de marco └ tamaño de imagen

 `LabelStyle → {FontSize → 23, FontFamily → "Times", Black}, PlotRange → Automatic]`
 └ estilo de etiqueta └ tamaño de tipo de· └ familia de tipo de· └ multipli··· └ negro └ rango de rep··· └ automático

Out[60]=



In[61]:= `Exp[-λ[r]] /. {M → u R, r → x R} // FullSimplify`
 └ exponencial └ simplifica completamente

$$\text{Out[61]= } 1 - \frac{2.\left(-0.6 - 1.0002\sqrt{1-2.\,u}\right)^{2/3} u\,x^2}{\left(0.3 - 1.0002\sqrt{1-2.\,u} - 0.9\,x^2\right)^{2/3}}$$

In[62]:= $\texttt{metric2[x\_]} := 1 - \dfrac{2.`\left(-0.599999999999999` - 1.0001985197024288`\sqrt{1-2.`\,u}\right)^{2/3} u\,x^2}{\left(0.3` - 1.0001985197024288`\sqrt{1-2.`\,u} - 0.8999999999999999`\,x^2\right)^{2/3}}$

```
In[63]:= solu1 := Re[metric2[x]] /. {u → 0.34019652312288423` }
              parte real

         Plot[{solu1}, {x, 0, 1}, Evaluated → True,
         representación gráfica           evaluado      verdadero

          PlotStyle → {{Black, Thickness[0.005]}, {Blue, Thickness[0.005]
          estilo de represe··· negro  grosor          azul  grosor
             }, {Red, Thickness[0.005]}, {Green, Thickness[0.005]}, {Pink, Thickness[0.005]}},
                rojo  grosor              verde  grosor              rosa  grosor

          Frame → True, FrameLabel → {"r/R", "e^−λ"}, ImageSize → 500,
          marco   verd··· etiqueta de marco              tamaño de imagen

          LabelStyle → {FontSize → 23, FontFamily → "Times", Black}, PlotRange → Automatic]
          estilo de etiqueta tamaño de tipo de· familia de tipo de··· multipli··· negro  rango de rep··· automático
```

Out[64]=



## Condiciones de energía

### Condición de energía dominante

```
In[65]:= dec1[x_] := ρg[x] – Prg[x];
```

In[68]:= **solu1 := Re[dec1[x]] /. {u → 0.34019652312288423` }**
parte real

**Plot[{solu1}, {x, 0, 1}, Evaluated → True,**
representación gráfica          evaluado          verdadero

  **PlotStyle → {{Black, Thickness[0.005]}, {Blue, Thickness[0.005]**
estilo de represe·· negro   grosor                    azul   grosor

    **}, {Red, Thickness[0.005]}, {Green, Thickness[0.005]}, {Pink, Thickness[0.005]}},**
        rojo  grosor                   verde  grosor                   rosa  grosor

**Frame → True, FrameLabel → {"r/R", "ρ-p_r"}, ImageSize → 500,**
marco     verd··· etiqueta de marco                    tamaño de imagen

**LabelStyle → {FontSize → 23, FontFamily → "Times", Black}, PlotRange → Automatic]**
estilo de etiqueta  tamaño de tipo de· familia de tipo de· multipli··· negro   rango de rep··· automático

Out[69]=
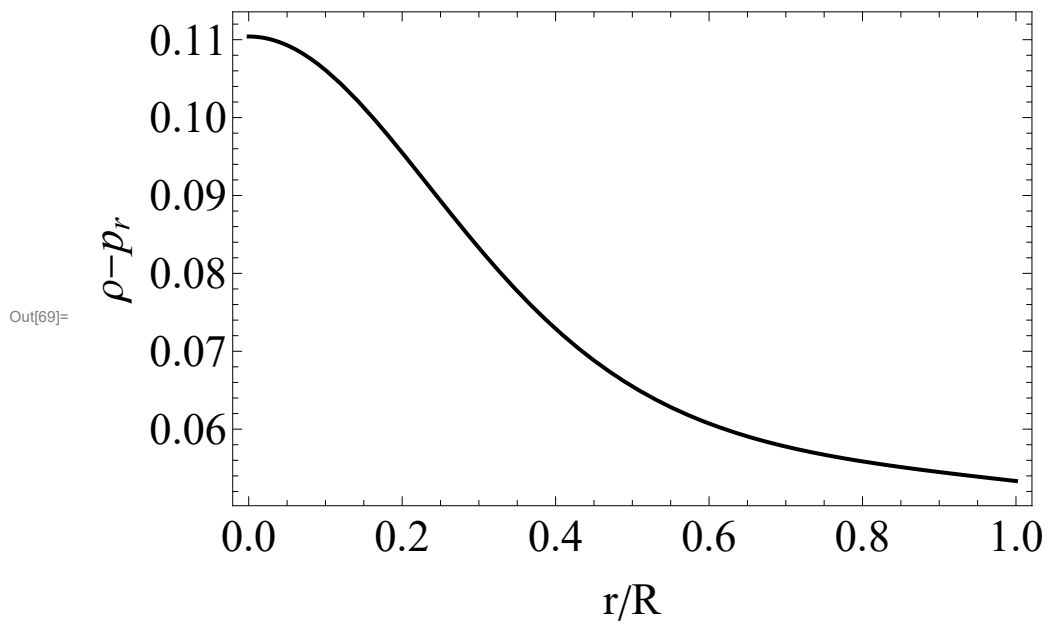


In[70]:= **dec2[x_] := ρg[x] - Ptg[x];**

In[71]:= `solu1 := Re[dec2[x]] /. {u → 0.34019652312288423` }`
　　　　　　　 └parte real

`Plot[{solu1}, {x, 0, 1}, Evaluated → True,`
└representación gráfica　　　　└evaluado　　　└verdadero

　`PlotStyle → {{Black, Thickness[0.005]}, {Blue, Thickness[0.005]`
　└estilo de represe··· └negro └grosor　　　　　　　　　└azul └grosor

　　　`}, {Red, Thickness[0.005]}, {Green, Thickness[0.005]}, {Pink, Thickness[0.005]}},`
　　　　　└rojo └grosor　　　　　　└verde └grosor　　　　　└rosa └grosor

`Frame → True, FrameLabel → {"r/R", "ρ-p_t"}, ImageSize → 500,`
└marco └verd··· └etiqueta de marco　　　　　　　└tamaño de imagen

`LabelStyle → {FontSize → 23, FontFamily → "Times", Black}, PlotRange → Automatic]`
└estilo de etiqueta └tamaño de tipo de· └familia de tipo de·· └multipli··· └negro └rango de rep··· └automático

Out[72]=



## Condicion de energía fuerte

In[73]:= `sec[x_] := ρg[x] - Prg[x] - 2 * Ptg[x];`

In[74]:= **solu1 := Re[sec[x]] /. {u → 0.34019652312288423` }**
        ⌊parte real

    **Plot[{solu1}, {x, 0, 1}, Evaluated → True,**
    ⌊representación gráfica       ⌊evaluado    ⌊verdadero

     **PlotStyle → {{Black, Thickness[0.005]}, {Blue, Thickness[0.005]**
     ⌊estilo de represe··· ⌊negro  ⌊grosor            ⌊azul  ⌊grosor

       **}, {Red, Thickness[0.005]}, {Green, Thickness[0.005]}, {Pink, Thickness[0.005]}},**
            ⌊rojo  ⌊grosor         ⌊verde  ⌊grosor          ⌊rosa  ⌊grosor

    **Frame → True, FrameLabel → {"r/R", "$\rho-pr-2pt$"}, ImageSize → 500,**
    ⌊marco  ⌊verd··· ⌊etiqueta de marco                ⌊tamaño de imagen

    **LabelStyle → {FontSize → 23, FontFamily → "Times", Black}, PlotRange → Automatic]**
    ⌊estilo de etiqueta ⌊tamaño de tipo de· ⌊familia de tipo de··· ⌊multipli··· ⌊negro  ⌊rango de rep··· ⌊automático

Out[75]=



## Corrimiento al rojo

In[76]:= **Z[r_] := $\dfrac{1}{\sqrt{(e^{(\nu numer[r])})}}$ - 1**

In[77]:= **Z[r] /. {M → u R, r → x R} // FullSimplify**
                         ⌊simplifica completamente

Out[77]= $-1 + \dfrac{1.}{\sqrt{\left(0.29994 - 1.\sqrt{1 - 2.\, u} - 0.29994\, x^2\right)^2}}$

In[78]:= **Z[x_] := -1 + $\dfrac{0.999999999999998\text{`}}{\sqrt{\left(0.2999404559099464\text{`} - 1.\text{`}\sqrt{1 - 2.\text{`}\, u} - 0.2999404559099464\text{`}\, x^2\right)^2}}$**

In[79]:= `solu1 := Re[Z[x]] /. {u → 0.34019652312288423` }`
  parte real

`Plot[{solu1}, {x, 0, 1}, Evaluated → True,`
representación gráfica        evaluado        verdadero

  `PlotStyle → {{Black, Thickness[0.005]}, {Blue, Thickness[0.005]`
  estilo de represe·· negro grosor                azul grosor

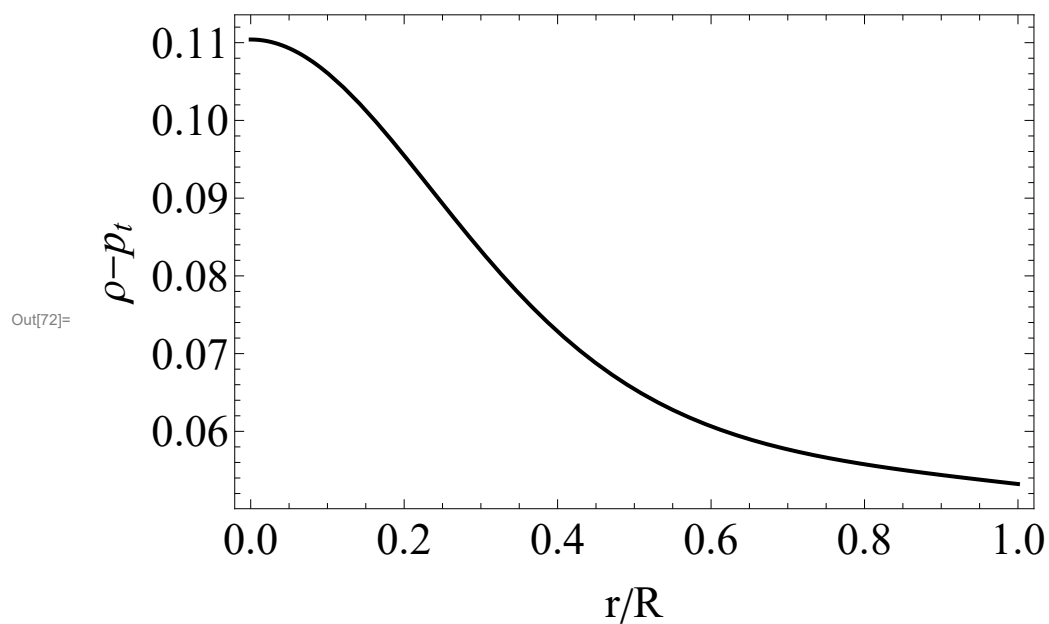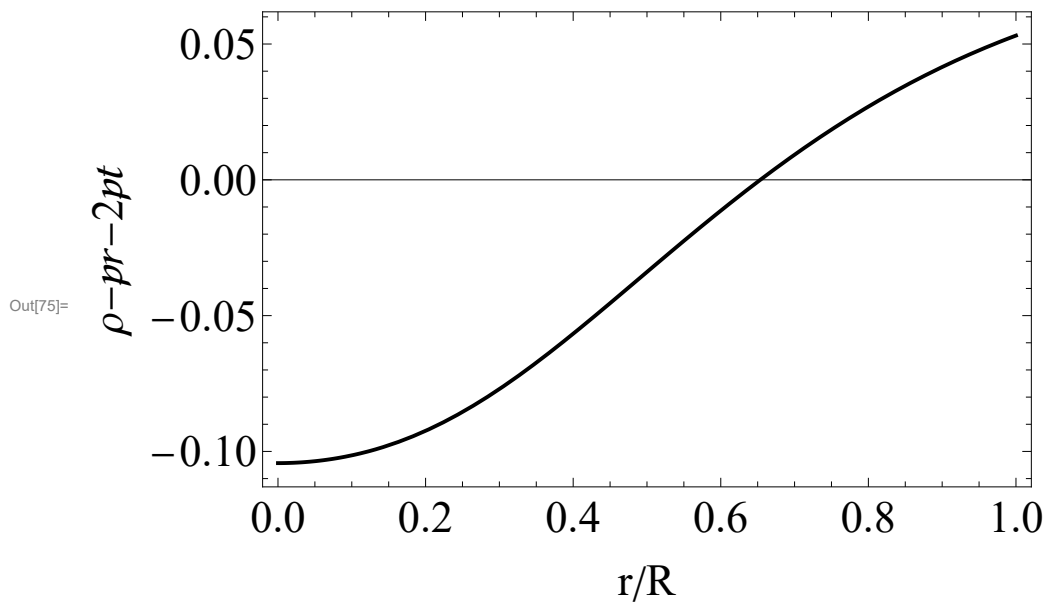    `}, {Red, Thickness[0.005]}, {Green, Thickness[0.005]}, {Pink, Thickness[0.005]}},`
        rojo grosor                verde grosor                rosa grosor

`Frame → True, FrameLabel → {"r/R", "Z(r)"}, ImageSize → 500,`
marco    verd·· etiqueta de marco                tamaño de imagen

`LabelStyle → {FontSize → 23, FontFamily → "Times", Black}, PlotRange → Automatic]`
estilo de etiqueta  tamaño de tipo de· familia de tipo de· multipli·· negro   rango de rep·· automático

Out[80]=
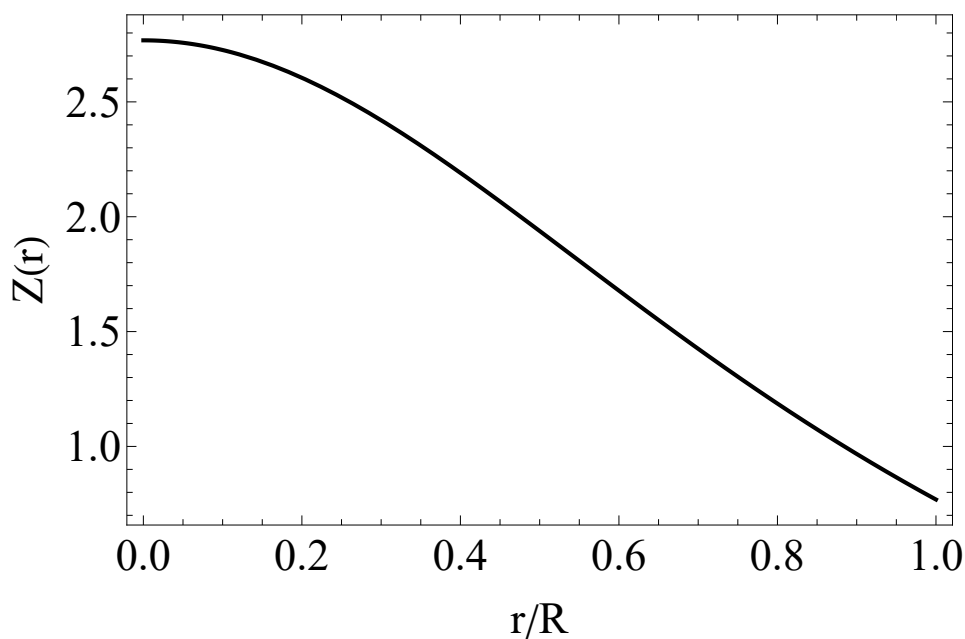


## Anisotropía

In[81]:= `Π[x_] := Ptg[x] – Prg[x]`

In[82]:= **solu1 := Re[Π[x]] /. {u → 0.34019652312288423`}**
　　　　　　⌊parte real

**Plot[{solu1}, {x, 0, 1}, Evaluated → True,**
⌊representación gráfica　　　　　⌊evaluado　　⌊verdadero

　**PlotStyle → {{Black, Thickness[0.005]}, {Blue, Thickness[0.005]**
　⌊estilo de represe··⌊negro　⌊grosor　　　　　　　⌊azul　⌊grosor

　　**}, {Red, Thickness[0.005]}, {Green, Thickness[0.005]}, {Pink, Thickness[0.005]}},**
　　　　⌊rojo　⌊grosor　　　　　⌊verde　⌊grosor　　　　　⌊rosa　⌊grosor

　**Frame → True, FrameLabel → {"r/R", "Π(r)"}, ImageSize → 500,**
　⌊marco　⌊verd··⌊etiqueta de marco　　　　　　⌊tamaño de imagen

　**LabelStyle → {FontSize → 23, FontFamily → "Times", Black}, PlotRange → Automatic]**
　⌊estilo de etiqueta ⌊tamaño de tipo de·⌊familia de tipo de··⌊multipli··⌊negro　⌊rango de rep···⌊automático

Out[83]=
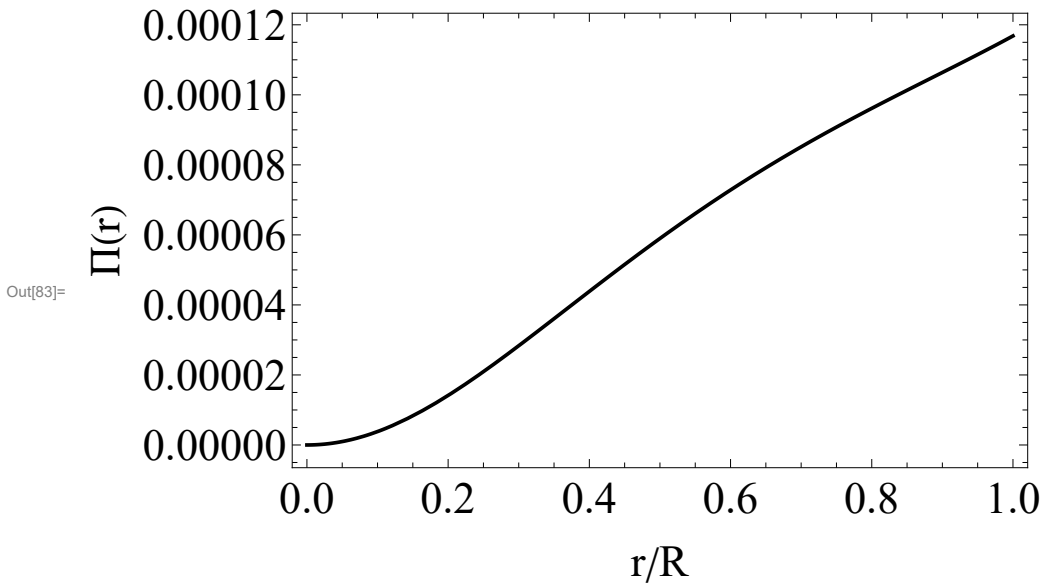


In[84]:= **Π[x] /. {x → √(x^2 + y^2)} // Simplify**
　　　　　　　　　　　　　　　⌊simplifica

Out[84]= $-\left(\left(\left(0.0397729\left(-0.36+1.20024\sqrt{1-2.\,u}+1.08\left(x^2+y^2\right)+1.26322\times10^{-12}\right.\right.\right.\right.$

$$\left(\frac{\left(-0.6-1.0002\sqrt{1-2.\,u}\right)^{2/3}u\left(0.9-3.0006\sqrt{1-2.\,u}-1.5\left(x^2+y^2\right)\right)}{\left(0.3-1.0002\sqrt{1-2.\,u}-0.9\left(x^2+y^2\right)\right)^{5/3}}\right)^{3.}$$

$$\left(-0.29994+1.\sqrt{1-2.\,u}+0.29994\left(x^2+y^2\right)\right)$$

$$\left(-0.29994+1.\sqrt{1-2.\,u}+0.899821\left(x^2+y^2\right)\right)+$$

$$\left(-0.6-1.0002\sqrt{1-2.\,u}\right)^{2/3}u\left(0.3-1.0002\sqrt{1-2.\,u}-0.9\left(x^2+y^2\right)\right)^{1/3}$$

$$\left.\left(-0.599401+1.9984\sqrt{1-2.\,u}+2.997\left(x^2+y^2\right)\right)\right)\Bigg/$$

$$\left(\left(-0.29994+1.\sqrt{1-2.\,u}+0.29994\left(x^2+y^2\right)\right)\right.$$

$$\left.\left.\left(-0.29994+1.\sqrt{1-2.\,u}+0.899821\left(x^2+y^2\right)\right)\right)\right)+$$

$$\left(0.00496964\left(1-\frac{2.\left(-0.6-1.0002\sqrt{1-2.u}\right)^{2/3}u\left(x^2+y^2\right)}{\left(0.3-1.0002\sqrt{1-2.u}-0.9\left(x^2+y^2\right)\right)^{2/3}}\right)\right.$$

$$\left(-2.88114\left(x^2+y^2\right)\left(0.29994-1.\sqrt{1-2.u}-0.899821\left(x^2+y^2\right)\right)^2\right.$$

$$\left(1.\left(-0.6-1.0002\sqrt{1-2.u}\right)^{2/3}u\left(x^2+y^2\right)-\right.$$
$$\left.0.5\left(0.3-1.0002\sqrt{1-2.u}-0.9\left(x^2+y^2\right)\right)^{2/3}\right)^2+$$
$$4.80286\left(0.29994-1.\sqrt{1-2.u}-0.899821\left(x^2+y^2\right)\right)^2$$
$$\left(-0.29994+1.\sqrt{1-2.u}+0.29994\left(x^2+y^2\right)\right)\left(1.\left(-0.6-1.0002\sqrt{1-2.u}\right)^{2/3}\right.$$
$$\left.u\left(x^2+y^2\right)-0.5\left(0.3-1.0002\sqrt{1-2.u}-0.9\left(x^2+y^2\right)\right)^{2/3}\right)^2+$$
$$0.0023976\left(-0.6-1.0002\sqrt{1-2.u}\right)^{2/3}u\left(x^2+y^2\right)\left(-2.\left(-0.6-1.0002\sqrt{1-2.u}\right)^{2/3}\right.$$
$$\left.u\left(x^2+y^2\right)+\left(0.3-1.0002\sqrt{1-2.u}-0.9\left(x^2+y^2\right)\right)^{2/3}\right)$$

$$\left(-1.0006\left(-0.29994+1.\sqrt{1-2.u}\right)^3-2.70107\left(0.29994-1.\sqrt{1-2.u}\right)^2\left(x^2+y^2\right)-\right.$$
$$2.07041\left(-0.29994+1.\sqrt{1-2.u}\right)\left(x^2+y^2\right)^2-0.405\left(x^2+y^2\right)^3+2.00119$$
$$\left(-0.29994+1.\sqrt{1-2.u}\right)\left(0.29994-1.\sqrt{1-2.u}-0.899821\left(x^2+y^2\right)\right)^2-9.48554\times$$
$$10^{-9}\left(\frac{\left(-0.6-1.0002\sqrt{1-2.u}\right)^{2/3}u\left(0.9-3.0006\sqrt{1-2.u}-1.5\left(x^2+y^2\right)\right)}{\left(0.3-1.0002\sqrt{1-2.u}-0.9\left(x^2+y^2\right)\right)^{5/3}}\right)^{2.}$$
$$\left.\left(-0.29994+1.\sqrt{1-2.u}+0.29994\left(x^2+y^2\right)\right)^3\right)+0.5\left(x^2+y^2\right)$$

$$\left(0.3-1.0002\sqrt{1-2.u}-0.9\left(x^2+y^2\right)\right)^2\left(2.4\left(-0.6-1.0002\sqrt{1-2.u}\right)^{2/3}u\left(x^2+y^2\right)-\right.$$
$$1.2\left(0.3-1.0002\sqrt{1-2.u}-0.9\left(x^2+y^2\right)\right)^{2/3}-1.26297\times10^{-12}$$
$$\left(\frac{\left(-0.6-1.0002\sqrt{1-2.u}\right)^{2/3}u\left(0.9-3.0006\sqrt{1-2.u}-1.5\left(x^2+y^2\right)\right)}{\left(0.3-1.0002\sqrt{1-2.u}-0.9\left(x^2+y^2\right)\right)^{5/3}}\right)^{3.}$$
$$\left(0.3-1.0002\sqrt{1-2.u}-0.9\left(x^2+y^2\right)\right)^{2/3}$$
$$\left(-0.29994+1.\sqrt{1-2.u}+0.29994\left(x^2+y^2\right)\right)-0.0019984$$
$$\left.\left(-0.6-1.0002\sqrt{1-2.u}\right)^{2/3}u\left(-0.29994+1.\sqrt{1-2.u}+1.4997\left(x^2+y^2\right)\right)\right)^2-$$

$$4.\left(-0.6-1.0002\sqrt{1-2.u}\right)^{2/3}u\left(x^2+y^2\right)\left(0.3-1.0002\sqrt{1-2.u}-0.9\left(x^2+y^2\right)\right)$$

$$\left(0.3-1.0002\sqrt{1-2.u}-0.3\left(x^2+y^2\right)\right)^2\left(1.26297\times10^{-12}\right.$$

$$\left( \frac{\left(-0.6 - 1.0002 \sqrt{1 - 2.\, u}\right)^{2/3} u \left(0.9 - 3.0006 \sqrt{1 - 2.\, u} - 1.5 \left(x^2 + y^2\right)\right)}{\left(0.3 - 1.0002 \sqrt{1 - 2.\, u} - 0.9 \left(x^2 + y^2\right)\right)^{5/3}} \right)^{3.}$$

$$\left(0.3 - 1.0002 \sqrt{1 - 2.\, u} - 0.9 \left(x^2 + y^2\right)\right)^{2/3}$$
$$\left(-0.29994 + 1.\, \sqrt{1 - 2.\, u} + 0.29994 \left(x^2 + y^2\right)\right) + 0.0019984$$

$$\left(-0.6 - 1.0002 \sqrt{1 - 2.\, u}\right)^{2/3} u \left(-0.29994 + 1.\, \sqrt{1 - 2.\, u} + 1.4997 \left(x^2 + y^2\right)\right) \Bigg) -$$

$$1.\, \left(0.3 - 1.0002 \sqrt{1 - 2.\, u} - 0.9 \left(x^2 + y^2\right)\right)^2 \left(0.3 - 1.0002 \sqrt{1 - 2.\, u} - 0.3 \left(x^2 + y^2\right)\right)$$
$$\left(-2.\, \left(-0.6 - 1.0002 \sqrt{1 - 2.\, u}\right)^{2/3} u \left(x^2 + y^2\right) +\right.$$

$$\left(0.3 - 1.0002 \sqrt{1 - 2.\, u} - 0.9 \left(x^2 + y^2\right)\right)^{2/3}\right) \Bigg(1.26297 \times 10^{-12}$$

$$\left( \frac{\left(-0.6 - 1.0002 \sqrt{1 - 2.\, u}\right)^{2/3} u \left(0.9 - 3.0006 \sqrt{1 - 2.\, u} - 1.5 \left(x^2 + y^2\right)\right)}{\left(0.3 - 1.0002 \sqrt{1 - 2.\, u} - 0.9 \left(x^2 + y^2\right)\right)^{5/3}} \right)^{3.}$$

$$\left(0.3 - 1.0002 \sqrt{1 - 2.\, u} - 0.9 \left(x^2 + y^2\right)\right)^{2/3}$$
$$\left(-0.29994 + 1.\, \sqrt{1 - 2.\, u} + 0.29994 \left(x^2 + y^2\right)\right) + 0.0019984$$

$$\left(-0.6 - 1.0002 \sqrt{1 - 2.\, u}\right)^{2/3} u \left(-0.29994 + 1.\, \sqrt{1 - 2.\, u} + 1.4997 \left(x^2 + y^2\right)\right) \Bigg) +$$

$$2.\, \left(-0.6 - 1.0002 \sqrt{1 - 2.\, u}\right)^{2/3} u \left(x^2 + y^2\right) \left(0.3 - 1.0002 \sqrt{1 - 2.\, u} - 0.9 \left(x^2 + y^2\right)\right)$$
$$\left(0.3 - 1.0002 \sqrt{1 - 2.\, u} - 0.3 \left(x^2 + y^2\right)\right)^2$$

$$\left(-2.4 \left(-0.6 - 1.0002 \sqrt{1 - 2.\, u}\right)^{2/3} u \left(x^2 + y^2\right) +\right.$$

$$1.2 \left(0.3 - 1.0002 \sqrt{1 - 2.\, u} - 0.9 \left(x^2 + y^2\right)\right)^{2/3} + 1.26297 \times 10^{-12}$$

$$\left( \frac{\left(-0.6 - 1.0002 \sqrt{1 - 2.\, u}\right)^{2/3} u \left(0.9 - 3.0006 \sqrt{1 - 2.\, u} - 1.5 \left(x^2 + y^2\right)\right)}{\left(0.3 - 1.0002 \sqrt{1 - 2.\, u} - 0.9 \left(x^2 + y^2\right)\right)^{5/3}} \right)^{3.}$$

$$\left(0.3 - 1.0002 \sqrt{1 - 2.\, u} - 0.9 \left(x^2 + y^2\right)\right)^{2/3}$$
$$\left(-0.29994 + 1.\, \sqrt{1 - 2.\, u} + 0.29994 \left(x^2 + y^2\right)\right) + 0.0019984$$

$$\left(-0.6 - 1.0002 \sqrt{1 - 2.\, u}\right)^{2/3} u \left(-0.29994 + 1.\, \sqrt{1 - 2.\, u} + 1.4997 \left(x^2 + y^2\right)\right) \Bigg) -$$

$$1.\, \left(0.3 - 1.0002 \sqrt{1 - 2.\, u} - 0.9 \left(x^2 + y^2\right)\right) \left(0.3 - 1.0002 \sqrt{1 - 2.\, u} - 0.3 \left(x^2 + y^2\right)\right)$$
$$\left(-2.\, \left(-0.6 - 1.0002 \sqrt{1 - 2.\, u}\right)^{2/3} u \left(x^2 + y^2\right) +\right.$$
$$\left(0.3 - 1.0002 \sqrt{1 - 2.\, u} - 0.9 \left(x^2 + y^2\right)\right)^{2/3}\right)$$

$$\left(4.00159 \left(-0.6 - 1.0002 \sqrt{1 - 2.\, u}\right)^{2/3} u \left(0.29994 - 1.\, \sqrt{1 - 2.\, u} - 0.29994 \left(x^2 + y^2\right)\right)^2 +\right.$$

$$2.40048 \left(-0.29994 + 1.\, \sqrt{1 - 2.\, u} + 0.899821 \left(x^2 + y^2\right)\right)$$

$$\left(1. \left(-0.6 - 1.0002 \sqrt{1 - 2. \, u}\right)^{2/3} u \left(x^2 + y^2\right) - \right.$$
$$\left. 0.5 \left(0.3 - 1.0002 \sqrt{1 - 2. \, u} - 0.9 \left(x^2 + y^2\right)\right)^{2/3}\right) +$$

$$\left(0.3 - 1.0002 \sqrt{1 - 2. \, u} - 0.9 \left(x^2 + y^2\right)\right) \left( 1.26297 \times 10^{-12} \right.$$

$$\left(\frac{\left(-0.6 - 1.0002 \sqrt{1 - 2. \, u}\right)^{2/3} u \left(0.9 - 3.0006 \sqrt{1 - 2. \, u} - 1.5 \left(x^2 + y^2\right)\right)}{\left(0.3 - 1.0002 \sqrt{1 - 2. \, u} - 0.9 \left(x^2 + y^2\right)\right)^{5/3}}\right)^{3.}$$

$$\left(0.3 - 1.0002 \sqrt{1 - 2. \, u} - 0.9 \left(x^2 + y^2\right)\right)^{2/3} \left(-0.29994 + 1. \, \sqrt{1 - 2. \, u} + \right.$$
$$\left. 0.29994 \left(x^2 + y^2\right)\right) + 0.0019984 \left(-0.6 - 1.0002 \sqrt{1 - 2. \, u}\right)^{2/3}$$

$$\left.\left.\left.\left.u \left(-0.29994 + 1. \, \sqrt{1 - 2. \, u} + 1.4997 \left(x^2 + y^2\right)\right)\right)\right)\right)\right/$$

$$\left(\left(0.29994 - 1. \, \sqrt{1 - 2. \, u} - 0.899821 \left(x^2 + y^2\right)\right)^2 \left(0.29994 - 1. \, \sqrt{1 - 2. \, u} - 0.29994 \left(x^2 + y^2\right)\right)^2\right.$$
$$\left(1. \left(-0.6 - 1.0002 \sqrt{1 - 2. \, u}\right)^{2/3} u \left(x^2 + y^2\right) - \right.$$
$$\left.\left. 0.5 \left(0.3 - 1.0002 \sqrt{1 - 2. \, u} - 0.9 \left(x^2 + y^2\right)\right)^{2/3}\right)^2\right)$$

In[85]:= **Π[x_, y_] :=**
$$-\left(\left(\left(0.03977294277998848\grave{} \left(-0.35999999999999993\grave{} + 1.2002382236429145\grave{} \sqrt{1 - 2.\grave{}\, u} + \right.\right.\right.$$
$$1.08\grave{} \left(x^2 + y^2\right) + 1.263224238073166\grave{} *\hat{}-12$$
$$\left(\left(\left(-0.599999999999999\grave{} - 1.0001985197024288\grave{} \sqrt{1 - 2.\grave{}\, u}\right)^{2/3} u\right.\right.$$
$$\left(0.8999999999999999\grave{} - 3.0005955591072864\grave{} \sqrt{1 - 2.\grave{}\, u} - \right.$$
$$\left.\left. 1.5\grave{} \left(x^2 + y^2\right)\right)\right) \Big/ \left(0.3\grave{} - 1.0001985197024288\grave{} \sqrt{1 - 2.\grave{}\, u} - \right.$$
$$\left.\left. 0.8999999999999999\grave{} \left(x^2 + y^2\right)\right)^{5/3}\right)^{3.\grave{}}$$
$$\left(-0.2999404559099464\grave{} + 1.\grave{} \sqrt{1 - 2.\grave{}\, u} + 0.2999404559099464\grave{} \left(x^2 + y^2\right)\right)$$
$$\left(-0.2999404559099464\grave{} + 1.\grave{} \sqrt{1 - 2.\grave{}\, u} + 0.8998213677298391\grave{} \left(x^2 + y^2\right)\right) +$$
$$\left(-0.599999999999999\grave{} - 1.0001985197024288\grave{} \sqrt{1 - 2.\grave{}\, u}\right)^{2/3} u$$
$$\left(0.3\grave{} - 1.0001985197024288\grave{} \sqrt{1 - 2.\grave{}\, u} - 0.8999999999999999\grave{} \left(x^2 + y^2\right)\right)^{1/3}$$
$$\left(-0.5994005994005994\grave{} + 1.9983986407640937\grave{} \sqrt{1 - 2.\grave{}\, u} + \right.$$
$$\left.\left.\left.\left. 2.9970029970029977\grave{} \left(x^2 + y^2\right)\right)\right)\right) \Big/$$
$$\left(\left(-0.2999404559099464\grave{} + 1.\grave{} \sqrt{1 - 2.\grave{}\, u} + 0.2999404559099464\grave{} \left(x^2 + y^2\right)\right)\right.$$
$$\left(-0.2999404559099464\grave{} + 1.\grave{} \sqrt{1 - 2.\grave{}\, u} + \right.$$
$$\left.\left.\left. 0.8998213677298391\grave{} \left(x^2 + y^2\right)\right)\right)\right) + \left(0.0049696445069471185\grave{} \right.$$
$$\left(1 - \left(2.\grave{} \left(-0.599999999999999\grave{} - 1.0001985197024288\grave{} \sqrt{1 - 2.\grave{}\, u}\right)^{2/3} u \left(x^2 + y^2\right)\right)\right) \Big/$$

$$\left(0.3` - 1.0001985197024288` \sqrt{1 - 2.` u} - 0.8999999999999999` \left(x^2 + y^2\right)\right)^{2/3}\right)$$

$$\left(-2.8811435869869975` \left(x^2 + y^2\right)\right.$$

$$\left(0.29994045590994645` - 1.` \sqrt{1 - 2.` u} - 0.8998213677298391` \left(x^2 + y^2\right)\right)^2$$

$$\left(1.` \left(-0.5999999999999999` - 1.0001985197024288` \sqrt{1 - 2.` u}\right)^{2/3} u \left(x^2 + y^2\right) - 0.5`\right.$$

$$\left(0.3` - 1.0001985197024288` \sqrt{1 - 2.` u} - 0.8999999999999999` \left(x^2 + y^2\right)\right)^{2/3}\right)^2 +$$

$$4.802859251257568` \left(0.29994045590994645` - 1.` \sqrt{1 - 2.` u} -\right.$$

$$0.8998213677298391` \left(x^2 + y^2\right)\right)^2$$

$$\left(-0.2999404559099464` + 1.` \sqrt{1 - 2.` u} + 0.2999404559099464` \left(x^2 + y^2\right)\right)$$

$$\left(1.` \left(-0.5999999999999999` - 1.0001985197024288` \sqrt{1 - 2.` u}\right)^{2/3} u \left(x^2 + y^2\right) - 0.5`\right.$$

$$\left(0.3` - 1.0001985197024288` \sqrt{1 - 2.` u} - 0.8999999999999999` \left(x^2 + y^2\right)\right)^{2/3}\right)^2 +$$

$$0.0023976023976023985` \left(-0.5999999999999999` - 1.0001985197024288` \sqrt{1 - 2.` u}\right)^{2/3}$$

$$u \left(x^2 + y^2\right)$$

$$\left(-2.` \left(-0.5999999999999999` - 1.0001985197024288` \sqrt{1 - 2.` u}\right)^{2/3} u \left(x^2 + y^2\right) +\right.$$

$$\left(0.3` - 1.0001985197024288` \sqrt{1 - 2.` u} - 0.8999999999999999` \left(x^2 + y^2\right)\right)^{2/3}\right)$$

$$\left(-1.0005956773453266` \left(-0.2999404559099464` + 1.` \sqrt{1 - 2.` u}\right)^3 -\right.$$

$$2.7010721128003103` \left(0.2999404559099464` - 1.` \sqrt{1 - 2.` u}\right)^2 \left(x^2 + y^2\right) -$$

$$2.0704109357840275` \left(-0.2999404559099464` + 1.` \sqrt{1 - 2.` u}\right) \left(x^2 + y^2\right)^2 -$$

$$0.40499999999999997` \left(x^2 + y^2\right)^3 +$$

$$2.0011913546906537` \left(-0.2999404559099464` + 1.` \sqrt{1 - 2.` u}\right)$$

$$\left(0.2999404559099464` - 1.` \sqrt{1 - 2.` u} - 0.8998213677298391` \left(x^2 + y^2\right)\right)^2 -$$

$$9.485538659894861` *^-9 \left(\left(\left(-0.5999999999999999` -\right.\right.\right.$$

$$1.0001985197024288` \sqrt{1 - 2.` u}\right)^{2/3} u \left(0.8999999999999999` -\right.$$

$$3.0005955591072864` \sqrt{1 - 2.` u} - 1.5` \left(x^2 + y^2\right)\right)\right) \Big/ \left(0.3` -\right.$$

$$1.0001985197024288` \sqrt{1 - 2.` u} - 0.8999999999999999` \left(x^2 + y^2\right)\right)^{5/3}\right)^{2.`}$$

$$\left(-0.2999404559099464` + 1.` \sqrt{1 - 2.` u} + 0.2999404559099464` \left(x^2 + y^2\right)\right)^3\right) +$$

$$0.5` \left(x^2 + y^2\right) \left(0.3` - 1.0001985197024288` \sqrt{1 - 2.` u} -\right.$$

$$0.8999999999999999` \left(x^2 + y^2\right)\right)^2$$

$$\left(2.4` \left(-0.5999999999999999` - 1.0001985197024288` \sqrt{1 - 2.` u}\right)^{2/3} u \left(x^2 + y^2\right) - 1.2`\right.$$

$$\left(0.3` - 1.0001985197024288` \sqrt{1 - 2.` u} - 0.8999999999999999` \left(x^2 + y^2\right)\right)^{2/3} -$$

$$1.2629735129472004` *^-12 \left(\left(\left(-0.5999999999999999` - 1.0001985197024288`\right.\right.\right.$$

$$\sqrt{1-2.\text{`}u}\Big)^{2/3} u\Big(0.8999999999999999\text{`} - 3.0005955591072864\text{`}$$

$$\sqrt{1-2.\text{`}u} - 1.5\text{`}\left(x^2+y^2\right)\Big)\Big) \Big/ \Big(0.3\text{`} - 1.0001985197024288\text{`}$$

$$\sqrt{1-2.\text{`}u} - 0.8999999999999999\text{`}\left(x^2+y^2\right)\Big)^{5/3}\Big)^{3.\text{`}}\Big)$$

$$\left(0.3\text{`} - 1.0001985197024288\text{`}\ \sqrt{1-2.\text{`}u} - 0.899999999999999\text{`}\left(x^2+y^2\right)\right)^{2/3}$$

$$\left(-0.2999404559099464\text{`} + 1.\text{`}\ \sqrt{1-2.\text{`}u}\ +\right.$$

$$0.2999404559099464\text{`}\left(x^2+y^2\right)\Big) - 0.0019983986407640943\text{`}$$

$$\left(-0.5999999999999999\text{`} - 1.0001985197024288\text{`}\ \sqrt{1-2.\text{`}u}\right)^{2/3} u$$

$$\left(-0.2999404559099464\text{`} + 1.\text{`}\ \sqrt{1-2.\text{`}u} + 1.4997022795497321\text{`}\left(x^2+y^2\right)\Big)\right)^2 -$$

$$4.\text{`}\left(-0.5999999999999999\text{`} - 1.0001985197024288\text{`}\ \sqrt{1-2.\text{`}u}\right)^{2/3} u\left(x^2+y^2\right)$$

$$\left(0.3\text{`} - 1.0001985197024288\text{`}\ \sqrt{1-2.\text{`}u} - 0.899999999999999\text{`}\left(x^2+y^2\right)\right)$$

$$\left(0.3\text{`} - 1.0001985197024288\text{`}\ \sqrt{1-2.\text{`}u} - 0.3\text{`}\left(x^2+y^2\right)\right)^2$$

$$\Big(1.2629735129472004\text{`}*\char94-12 \Big(\Big(\Big(-0.5999999999999999\text{`} -$$

$$1.0001985197024288\text{`}\ \sqrt{1-2.\text{`}u}\Big)^{2/3} u\Big(0.899999999999999\text{`} -$$

$$3.0005955591072864\text{`}\ \sqrt{1-2.\text{`}u} - 1.5\text{`}\left(x^2+y^2\right)\Big)\Big)\Big/\Big(0.3\text{`} -$$

$$1.0001985197024288\text{`}\ \sqrt{1-2.\text{`}u} - 0.8999999999999999\text{`}\left(x^2+y^2\right)\Big)^{5/3}\Big)^{3.\text{`}}$$

$$\left(0.3\text{`} - 1.0001985197024288\text{`}\ \sqrt{1-2.\text{`}u} - 0.8999999999999999\text{`}\left(x^2+y^2\right)\right)^{2/3}$$

$$\left(-0.2999404559099464\text{`} + 1.\text{`}\ \sqrt{1-2.\text{`}u}\ +\right.$$

$$0.2999404559099464\text{`}\left(x^2+y^2\right)\Big) + 0.0019983986407640943\text{`}$$

$$\left(-0.5999999999999999\text{`} - 1.0001985197024288\text{`}\ \sqrt{1-2.\text{`}u}\right)^{2/3} u$$

$$\left(-0.2999404559099464\text{`} + 1.\text{`}\ \sqrt{1-2.\text{`}u} + 1.4997022795497321\text{`}\left(x^2+y^2\right)\Big)\right) -$$

$$1.\text{`}\left(0.3\text{`} - 1.0001985197024288\text{`}\ \sqrt{1-2.\text{`}u} - 0.8999999999999999\text{`}\left(x^2+y^2\right)\right)^2$$

$$\left(0.3\text{`} - 1.0001985197024288\text{`}\ \sqrt{1-2.\text{`}u} - 0.3\text{`}\left(x^2+y^2\right)\right)$$

$$\left(-2.\text{`}\left(-0.5999999999999999\text{`} - 1.0001985197024288\text{`}\ \sqrt{1-2.\text{`}u}\right)^{2/3} u\left(x^2+y^2\right)\ +\right.$$

$$\left(0.3\text{`} - 1.0001985197024288\text{`}\ \sqrt{1-2.\text{`}u} - 0.8999999999999999\text{`}\left(x^2+y^2\right)\right)^{2/3}\Big)$$

$$\Big(1.2629735129472004\text{`}*\char94-12 \Big(\Big(\Big(-0.5999999999999999\text{`} -$$

$$1.0001985197024288\text{`}\ \sqrt{1-2.\text{`}u}\Big)^{2/3} u\Big(0.8999999999999999\text{`} -$$

$$3.0005955591072864\text{`}\ \sqrt{1-2.\text{`}u} - 1.5\text{`}\left(x^2+y^2\right)\Big)\Big)\Big/\Big(0.3\text{`} -$$

$$1.0001985197024288\text{`}\ \sqrt{1-2.\text{`}u} - 0.8999999999999999\text{`}\left(x^2+y^2\right)\Big)^{5/3}\Big)^{3.\text{`}}$$

$$\left(0.3\text{`} - 1.0001985197024288\text{`}\ \sqrt{1-2.\text{`}u} - 0.8999999999999999\text{`}\left(x^2+y^2\right)\right)^{2/3}$$

$$\left(-0.2999404559099464\text{`} + 1.\text{`}\ \sqrt{1-2.\text{`}u}\ +\right.$$

$$0.2999404559099464` \left(x^2 + y^2\right)\right) + 0.0019983986407640943`$$

$$\left(-0.5999999999999999` - 1.0001985197024288` \sqrt{1 - 2.`u}\right)^{2/3} u$$

$$\left(-0.2999404559099464` + 1.` \sqrt{1 - 2.`u} + 1.4997022795497321` \left(x^2 + y^2\right)\right)\right) +$$

$$2.` \left(-0.5999999999999999` - 1.0001985197024288` \sqrt{1 - 2.`u}\right)^{2/3} u \left(x^2 + y^2\right)$$

$$\left(0.3` - 1.0001985197024288` \sqrt{1 - 2.`u} - 0.8999999999999999` \left(x^2 + y^2\right)\right)$$

$$\left(0.3` - 1.0001985197024288` \sqrt{1 - 2.`u} - 0.3` \left(x^2 + y^2\right)\right)^2$$

$$\left(-2.4` \left(-0.5999999999999999` - 1.0001985197024288` \sqrt{1 - 2.`u}\right)^{2/3} u \left(x^2 + y^2\right) +$$

$$1.2` \left(0.3` - 1.0001985197024288` \sqrt{1 - 2.`u} - 0.8999999999999999` \left(x^2 + y^2\right)\right)^{2/3} +$$

$$1.2629735129472004` *\!\wedge\!-12 \left(\left(\left(-0.5999999999999999` -$$

$$1.0001985197024288` \sqrt{1 - 2.`u}\right)^{2/3} u \left(0.8999999999999999` -$$

$$3.0005955591072864` \sqrt{1 - 2.`u} - 1.5` \left(x^2 + y^2\right)\right)\right) \Big/ \left(0.3` -$$

$$1.0001985197024288` \sqrt{1 - 2.`u} - 0.8999999999999999` \left(x^2 + y^2\right)\right)^{5/3}\right)^{3.`}$$

$$\left(0.3` - 1.0001985197024288` \sqrt{1 - 2.`u} - 0.8999999999999999` \left(x^2 + y^2\right)\right)^{2/3}$$

$$\left(-0.2999404559099464` + 1.` \sqrt{1 - 2.`u} +$$

$$0.2999404559099464` \left(x^2 + y^2\right)\right) + 0.0019983986407640943`$$

$$\left(-0.5999999999999999` - 1.0001985197024288` \sqrt{1 - 2.`u}\right)^{2/3} u$$

$$\left(-0.2999404559099464` + 1.` \sqrt{1 - 2.`u} + 1.4997022795497321` \left(x^2 + y^2\right)\right)\right) -$$

$$1.` \left(0.3` - 1.0001985197024288` \sqrt{1 - 2.`u} - 0.8999999999999999` \left(x^2 + y^2\right)\right)$$

$$\left(0.3` - 1.0001985197024288` \sqrt{1 - 2.`u} - 0.3` \left(x^2 + y^2\right)\right)$$

$$\left(-2.` \left(-0.5999999999999999` - 1.0001985197024288` \sqrt{1 - 2.`u}\right)^{2/3} u \left(x^2 + y^2\right) +$$

$$\left(0.3` - 1.0001985197024288` \sqrt{1 - 2.`u} - 0.8999999999999999` \left(x^2 + y^2\right)\right)^{2/3}\right)$$

$$\left(4.00158831525972` \left(-0.5999999999999999` - 1.0001985197024288` \sqrt{1 - 2.`u}\right)^{2/3}$$

$$u \left(0.2999404559099464` - 1.` \sqrt{1 - 2.`u} - 0.2999404559099464` \left(x^2 + y^2\right)\right)^2 +$$

$$2.400476447285829` \left(-0.2999404559099464` + 1.` \sqrt{1 - 2.`u} +$$

$$0.8998213677298391` \left(x^2 + y^2\right)\right) \left(1.` \left(-0.5999999999999999` -$$

$$1.0001985197024288` \sqrt{1 - 2.`u}\right)^{2/3} u \left(x^2 + y^2\right) - 0.5`$$

$$\left(0.3` - 1.0001985197024288` \sqrt{1 - 2.`u} - 0.8999999999999999` \left(x^2 + y^2\right)\right)^{2/3}\right) +$$

$$\left(0.3` - 1.0001985197024288` \sqrt{1 - 2.`u} - 0.8999999999999999` \left(x^2 + y^2\right)\right)$$

$$\left(1.2629735129472004` *\!\wedge\!-12 \left(\left(\left(-0.5999999999999999` - 1.0001985197024288`\right.\right.\right.$$

$$\sqrt{1 - 2.`u}\right)^{2/3} u \left(0.8999999999999999` - 3.0005955591072864`$$

$$\left.\sqrt{1 - 2.\text{`}\, u} - 1.5\text{`}\, \left(x^2 + y^2\right)\right)\right) \bigg/ \left(0.3\text{`} - 1.0001985197024288\text{`}\right.$$

$$\left.\sqrt{1 - 2.\text{`}\, u} - 0.8999999999999999\text{`}\, \left(x^2 + y^2\right)\right)^{5/3}\right)^{3.\text{`}}$$

$$\left(0.3\text{`} - 1.0001985197024288\text{`}\, \sqrt{1 - 2.\text{`}\, u} - 0.8999999999999999\text{`}\, \left(x^2 + y^2\right)\right)^{2/3}$$

$$\left(-0.2999404559099464\text{`} + 1.\text{`}\, \sqrt{1 - 2.\text{`}\, u} + 0.2999404559099464\text{`}\, \left(x^2 + y^2\right)\right) +$$

$$0.0019983986407640943\text{`}\, \left(-0.5999999999999999\text{`} - \right.$$

$$\left.1.0001985197024288\text{`}\, \sqrt{1 - 2.\text{`}\, u}\right)^{2/3} u \left(-0.2999404559099464\text{`} + \right.$$

$$\left.\left.\left.\left.\left.1.\text{`}\, \sqrt{1 - 2.\text{`}\, u} + 1.4997022795497321\text{`}\, \left(x^2 + y^2\right)\right)\right)\right)\right)\right) \bigg/$$

$$\left(\left(0.2999404559099464\text{`} - 1.\text{`}\, \sqrt{1 - 2.\text{`}\, u} - 0.8998213677298391\text{`}\, \left(x^2 + y^2\right)\right)^2\right.$$

$$\left(0.2999404559099464\text{`} - 1.\text{`}\, \sqrt{1 - 2.\text{`}\, u} - 0.2999404559099464\text{`}\, \left(x^2 + y^2\right)\right)^2$$

$$\left(1.\text{`}\, \left(-0.5999999999999999\text{`} - 1.0001985197024288\text{`}\, \sqrt{1 - 2.\text{`}\, u}\right)^{2/3} u \left(x^2 + y^2\right) - \right.$$

$$\left.\left.0.5\text{`}\, \left(0.3\text{`} - 1.0001985197024288\text{`}\, \sqrt{1 - 2.\text{`}\, u} - 0.8999999999999999\text{`}\, \left(x^2 + y^2\right)\right)^{2/3}\right)^2\right)$$

In[91]:= `DensityPlot[Re[Π[x, y]] /. {u → 0.34019652312288423`}, {x, -1, 1},`
  `{y, -1, 1}, RegionFunction → Function[{x, y}, 0 < x^2 + y^2 < 1],`
  `ColorFunction → "Rainbow", MeshStyle → Opacity[0.1, Black],`
  `PlotLegends → Automatic, Background → Black, Frame → False,`
  `Epilog → Text[Style["u = 0.3401", Large, Bold], {0, -0.7}], PlotPoints → 100]`

Out[91]=