```
In[•]:= p[p0_, R0_, a0_, x0_, r_, b1_] = p0 * Sinh[ R0*(1-(b1*b1)/(4 π) +b1*SphericalHarmonicY[2,0,x0,ϕ]) / a0 ] / ( Cosh[ R0*(1-(b1*b1)/(4 π) +b1*SphericalHarmonicY[2,0,x0,ϕ]) / a0 ] + Cosh[ r/a0 ] )

Out[•]=
p0 Sinh[ R0 (1-b1^2/(4 π)+1/4 b1 √(5/π) (-1+3 Cos[x0]^2)) / a0 ] / ( Cosh[ r/a0 ] + Cosh[ R0 (1-b1^2/(4 π)+1/4 b1 √(5/π) (-1+3 Cos[x0]^2)) / a0 ] )

In[•]:= pp[p0_, R0_, a0_, x0_, r_, b1_] = p0 / (1 + E^((r-R0*(1-(b1*b1)/(4 π)+b1*SphericalHarmonicY[2,0,x0,ϕ]))/a0))

Out[•]=
p0 / (1 + E^((r-R0 (1-b1^2/(4 π)+1/4 b1 √(5/π) (-1+3 Cos[x0]^2)))/a0))

In[•]:= ppp[p0_, R0_, x0_, r_, b1_] =
  p0/(1 + E^((r-R0)/b0)) + y * ( R0 * ∂R0 p0/(1 + E^((r-R0)/b0)) * b1 * SphericalHarmonicY[2, 0, x0, ϕ] +
    R0*R0/2 * ∂R0 ∂R0 p0/(1 + E^((r-R0)/b0)) * (b1 * SphericalHarmonicY[2, 0, x0, ϕ])^2 )

Out[•]=
p0/(1 + E^((r-R0)/b0)) +
 y ( b1 E^((r-R0)/b0) p0 √(5/π) R0 (-1+3 Cos[x0]^2) / (4 b0 (1 + E^((r-R0)/b0))^2) +
   5 b1^2 ( 2 E^((2 (r-R0))/b0) p0/(b0^2 (1+E^((r-R0)/b0))^3) - E^((r-R0)/b0) p0/(b0^2 (1+E^((r-R0)/b0))^2) ) R0^2 (-1+3 Cos[x0]^2)^2 / (32 π) )

In[•]:= ppp2[p0_, R0_, x0_, r_, b1_] =
  (p0/(1 + E^((r-R0)/b0)))^2 + yy * ( R0 * ∂R0 (p0/(1 + E^((r-R0)/b0)))^2 * b1 * SphericalHarmonicY[2, 0, x0, ϕ] +
    R0*R0/2 * ∂R0 ∂R0 (p0/(1 + E^((r-R0)/b0)))^2 * (b1 * SphericalHarmonicY[2, 0, x0, ϕ])^2 )

Out[•]=
p0^2/(1 + E^((r-R0)/b0))^2 +
 yy ( b1 E^((r-R0)/b0) p0^2 √(5/π) R0 (-1+3 Cos[x0]^2) / (2 b0 (1 + E^((r-R0)/b0))^3) +
   5 b1^2 ( 6 E^((2 (r-R0))/b0) p0^2/(b0^2 (1+E^((r-R0)/b0))^4) - 2 E^((r-R0)/b0) p0^2/(b0^2 (1+E^((r-R0)/b0))^3) ) R0^2 (-1+3 Cos[x0]^2)^2 / (32 π) )

In[•]:= pppp[p0_, R0_, x0_, r_, b1_] =
  p0 Sinh[R0/b0]/(Cosh[R0/b0] + Cosh[r/b0]) + y * ( R0 * ∂R0 p0 Sinh[R0/b0]/(Cosh[R0/b0] + Cosh[r/b0]) * b1 * SphericalHarmonicY[2, 0, x0, ϕ] +
    R0*R0/2 * ∂R0 ∂R0 p0 Sinh[R0/b0]/(Cosh[R0/b0] + Cosh[r/b0]) * (b1 * SphericalHarmonicY[2, 0, x0, ϕ])^2 )

Out[•]=
p0 Sinh[R0/b0]/(Cosh[r/b0] + Cosh[R0/b0]) +
 y ( 1/4 b1 √(5/π) R0 (-1+3 Cos[x0]^2) ( p0 Cosh[R0/b0]/(b0 (Cosh[r/b0] + Cosh[R0/b0])) - p0 Sinh[R0/b0]^2/(b0 (Cosh[r/b0] + Cosh[R0/b0])^2) ) +
   1/(32 π) 5 b1^2 R0^2 (-1+3 Cos[x0]^2)^2
    ( -3 p0 Cosh[R0/b0] Sinh[R0/b0]^2/(b0^2 (Cosh[r/b0] + Cosh[R0/b0])^2) + p0 Sinh[R0/b0]^2/(b0^2 (Cosh[r/b0] + Cosh[R0/b0])) + 2 p0 Sinh[R0/b0]^3/(b0^2 (Cosh[r/b0] + Cosh[R0/b0])^3) ) )
```

```
In[•]:= pppp2[p0_, R0_, x0_, r_, b1_] = (p0 * Sinh[R0/bb0] / (Cosh[R0/bb0] + Cosh[r/bb0]))^2 +
  yy * (R0 * ∂R0 (p0 * Sinh[R0/bb0] / (Cosh[R0/bb0] + Cosh[r/bb0]))^2 * b1 * SphericalHarmonicY[2, 0, x0, ϕ] +
    (R0 * R0)/2 * ∂R0 ∂R0 (p0 * Sinh[R0/bb0] / (Cosh[R0/bb0] + Cosh[r/bb0]))^2 * (b1 * SphericalHarmonicY[2, 0, x0, ϕ])^2)
```

Out[•]=

$$\frac{p0^2 \text{Sinh}\left[\frac{R0}{bb0}\right]^2}{\left(\text{Cosh}\left[\frac{r}{bb0}\right]+\text{Cosh}\left[\frac{R0}{bb0}\right]\right)^2} + yy \left(\frac{1}{4} b1 \sqrt{\frac{5}{\pi}}\, R0 \left(-1+3\,\text{Cos}[x0]^2\right)\left(\frac{2\,p0^2\,\text{Cosh}\left[\frac{R0}{bb0}\right]\text{Sinh}\left[\frac{R0}{bb0}\right]}{bb0\left(\text{Cosh}\left[\frac{r}{bb0}\right]+\text{Cosh}\left[\frac{R0}{bb0}\right]\right)^2} - \frac{2\,p0^2\,\text{Sinh}\left[\frac{R0}{bb0}\right]^3}{bb0\left(\text{Cosh}\left[\frac{r}{bb0}\right]+\text{Cosh}\left[\frac{R0}{bb0}\right]\right)^3}\right) + \frac{1}{32\pi} 5\,b1^2\,R0^2\left(-1+3\,\text{Cos}[x0]^2\right)^2\left(\frac{2\,p0^2\,\text{Cosh}\left[\frac{R0}{bb0}\right]^2}{bb0^2\left(\text{Cosh}\left[\frac{r}{bb0}\right]+\text{Cosh}\left[\frac{R0}{bb0}\right]\right)^2} - \frac{10\,p0^2\,\text{Cosh}\left[\frac{R0}{bb0}\right]\text{Sinh}\left[\frac{R0}{bb0}\right]^2}{bb0^2\left(\text{Cosh}\left[\frac{r}{bb0}\right]+\text{Cosh}\left[\frac{R0}{bb0}\right]\right)^3} + \frac{2\,p0^2\,\text{Sinh}\left[\frac{R0}{bb0}\right]^2}{bb0^2\left(\text{Cosh}\left[\frac{r}{bb0}\right]+\text{Cosh}\left[\frac{R0}{bb0}\right]\right)^2} + \frac{6\,p0^2\,\text{Sinh}\left[\frac{R0}{bb0}\right]^4}{bb0^2\left(\text{Cosh}\left[\frac{r}{bb0}\right]+\text{Cosh}\left[\frac{R0}{bb0}\right]\right)^4}\right)\right)$$

```
In[•]:=
In[•]:= A = 236
```

Out[•]=

```
236
```

```
A1 =
```

Out[•]=

```
58
```

```
In[•]:= a1 = 0.55
```

Out[•]=

```
0.55
```

```
In[•]:= a2 = a1 - 0.015 * (2 * A1 - A)/A
```

Out[•]=

```
0.557627
```

```
In[•]:= p0 = 0.17
```

Out[•]=

```
0.17
```



```
In[•]:= R01 = 1.16 * A1^(1/3)
```

Out[•]=

```
4.49022
```

```
In[•]:= R02 = 1.16 * (A - A1)^(1/3)
```

Out[•]=

```
6.52526
```

```
b1 =
```

```
b2 =
```

```
In[•]:= x1 = 0
```

Out[•]=

```
0
```

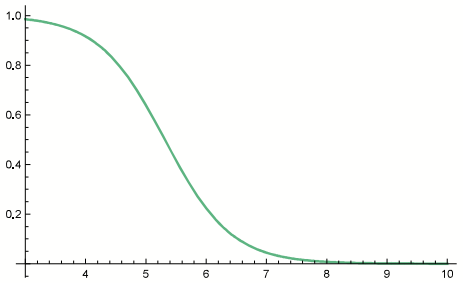
```
In[•]:= x2 = 0
```

Out[•]=

```
0
```

```
In[•]:= l1 =
  Plot[{(p0*Sinh[R1*(1-(b1+b1*SphericalHarmonicY[2,0,x1,ϕ])/4π)/a1]) / (Cosh[R1*(1-(b1+b1*SphericalHarmonicY[2,0,x1,ϕ])/4π)/a1] + Cosh[r/a1])} /. R1 → R01 /. p0 → 0.17 /. a1 → 0.55 /. x1 → 0 /. b1 → b1, {r, 3, 10}]
```

Out[•]=



In[•]:=
```
FindRoot[{Sum[∂y ((p[p0, R1, a1, x1, r, b1] - ppp[p0, R1, x1, r, b1])^2), {r, 4, 10, 0.1}] == 0,
  Sum[∂b0 ((p[p0, R1, a1, x1, r, b1] - ppp[p0, R1, x1, r, b1])^2), {r, 4, 10, 0.1}] == 0},
 {y, 1}, {b0, 0.65}] /. R1 → R01 /. p0 → 0.17 /. a1 → 0.55 /. x1 → 0 /. b1 → b1
```

FindRoot: The function value

$$\left\{2.\left(-\frac{0.0499871\ 2.71828^{1.53846\ \text{Plus}[\ll 2\gg]}\ \text{R1}}{(1.+\text{Power}[\ll 2\gg])^2}-0.0182648\ (0.804734\ \text{Power}[\ll 2\gg]\ \text{Power}[\ll 2\gg]-0.402367\ \text{Power}[\ll 2\gg]\right.\right.$$
$$\left.\text{Power}[\ll 2\gg])\ \text{R1}^2\right)\left(-\frac{0.17}{1.+\text{Power}[\ll 2\gg]}-1.\ (0.0499871\ \text{Power}[\ll 2\gg]\ \text{Power}[\ll 2\gg]\ \text{R1}+0.0182648\ \text{Plus}[\right.$$
$$\left.\ll 2\gg]\ \text{Power}[\ll 2\gg])+\frac{0.17\ \text{Sinh}[2.1524\ \text{R1}]}{720.237+\text{Cosh}[\ll 1\gg]}\right)+\ll 49\gg+\ll 11\gg,\ 2.\left(-\frac{\ll 1\gg}{(\ll 3\gg+\ll 1\gg)^2}-1.\ (\ll 1\gg)\right)\left(-\frac{}{1.+\text{Pc}\right.$$
$$\left.-1.\ (\ll 1\gg)+\frac{0.17\ \text{Sinh}[2.1524\ \text{R1}]}{720.237+\text{Cosh}[\ll 1\gg]}\right)+\ll 49\gg+\ll 11\gg\}\ \text{is not a list of numbers}$$

with dimensions {2} at {y, b0} = {1., 0.65}.

Out[•]=
```
{y → 0.905228, b0 → 0.604795}
```

In[•]:=
```
FindRoot[
 {Sum[∂y ((p[p0, R1, a1, x1, r, b1] - pppp[p0, R1, x1, r, b1])^2), {r, 6.5, 10, 0.1}] == 0,
  Sum[∂b0 ((p[p0, R1, a1, x1, r, b1] - pppp[p0, R1, x1, r, b1])^2), {r, 6.5, 10, 0.1}] == 0},
 {y, 1}, {b0, 0.7}] /. R1 → R01 /. p0 → 0.17 /. a1 → 0.55 /. x1 → 0 /. b1 → b1
```

FindRoot: The function value

$$\left\{2.\left(-0.280068\ \text{R1}\ (0.242857\ \text{Cosh}[\ll 1\gg]\ \text{Power}[\ll 2\gg]-0.242857\ \text{Power}[\ll 2\gg]\ \text{Power}[\ll 2\gg])-0.039219\ \text{R1}^2\ (-1.04082\right.\right.$$
$$\text{Cosh}[\ll 1\gg]\ \text{Power}[\ll 2\gg]\ \text{Sinh}[\ll 1\gg]+0.346939\ \text{Power}[\ll 2\gg]\ \text{Sinh}[\ll 1\gg]+0.693878\ \text{Power}[\ll 2\gg]$$
$$\left.\text{Power}[\ll 2\gg]))\left(-\frac{0.17\ \text{Sinh}[1.42857\ \text{R1}]}{5391.44+\text{Cosh}[\ll 1\gg]}-1.\ (0.280068\ \text{R1}\ \text{Plus}[\ll 2\gg]+0.039219\ \text{Power}[\ll 2\gg]\ \text{Plus}[\ll 3\right.\right.$$
$$\left.\left.\gg])+\frac{0.17\ \text{Sinh}[2.29887\ \text{R1}]}{67848.6+\text{Cosh}[\ll 1\gg]}\right)+\ll 35\gg,\ \ll 1\gg\}\ \text{is not a list}$$

of numbers with dimensions {2} at {y, b0} = {1., 0.7}.

Out[•]=
```
{y → 0.884334, b0 → 0.757875}
```

In[•]:=
```
y = 0.905
```

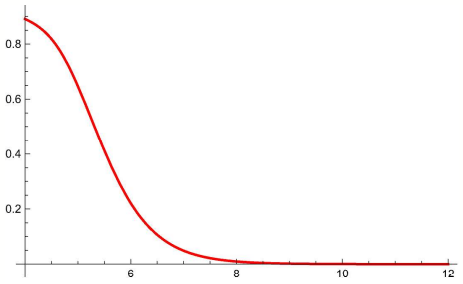
Out[•]=
```
0.905
```

In[•]:=
```
b0 = 0.605
```

Out[•]=
```
0.605
```

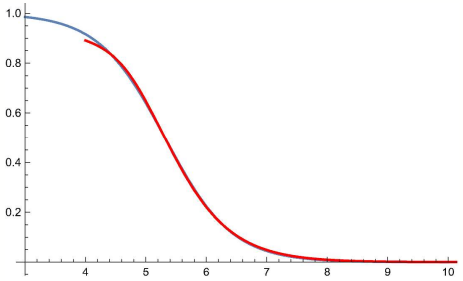

In[•]:=
```
l2 = Plot[{1/p0 (p0/(1 + e^((r - R1)/b0)) + y * (R1 * ∂R1 p0/(1 + e^((r - R1)/b0)) * b1 * SphericalHarmonicY[2, 0, x1, ϕ] + R1 * R1/2 *
      ∂R1 ∂R1 p0/(1 + e^((r - R1)/b0)) * (b1 * SphericalHarmonicY[2, 0, x1, ϕ])^2))} /. R1 → R01 /.
  p0 → 0.17 /. a1 → a1 /. x1 → 0 /. b1 → b1, {r, 4, 12}, ColorFunction → Function[{Red}]]
```

Out[•]=



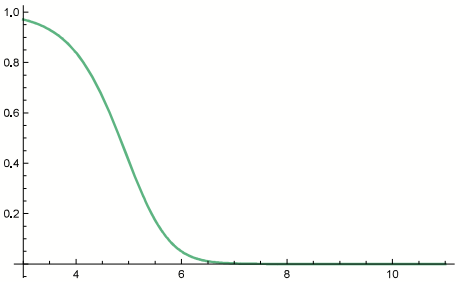
In[•]:=
```
Show[l11, l2]
```

Out[•]=



```
In[•]:= l11 = Plot[{(p[p0, R1, a1, x1, r, b1]/p0)^2} /. R1 → R01 /. p0 → 0.17 /. a1 → 0.55 /. x1 → 0 /. b1 → b1,
          {r, 3, 11}]
```

Out[•]=




```
In[•]:= FindRoot[{Sum[∂yy ((p[p0, R1, a1, x1, r, b1]^2 - ppp2[p0, R1, x1, r, b1])^2), {r, 4, 8, 0.1}] == 0,
          Sum[∂bb0 ((p[p0, R1, a1, x1, r, b1]^2 - ppp2[p0, R1, x1, r, b1])^2), {r, 4, 8, 0.1}] == 0},
          {yy, 1.2}, {bb0, 1}] /. R1 → R01 /. p0 → 0.17 /. a1 → 0.55 /. x1 → 0 /. b1 → b1
```

FindRoot: The function value

{2. (-(0.0110472 2.71828^(1. Plus[<<2>>]) R1/(1. + Power[<<2>>])^3) - 0.0182648 (0.1734 Power[<<2>>] Power[<<2>>] - 0.0578 Power[<<2>>] Power[<<2>>]) R1^2) (-(0.0289/(1. + Power[<<2>>])^2) - 1.2 (0.0110472 Power[<<2>>] Power[<<2>>] R1 + 0.0182648 Plus[<<2>>] Power[<<2>>]) + 0.0289 Sinh[Times[<<2>>]]^2/(720.237 + Cosh[<<1>>])^2) + <<39>> + 2. (<<1>>) (-(0.0289/(1. + Power[<<2>>])^2) - 1.2 (0.0110472 Power[<<2>>] <<1>> R1 + <<1>>) + 0.0289 Sinh[<<1>>]^2/(<<21>> + Cosh[<<1>>])^2), <<1>>} is not a list of numbers with dimensions {2} at {yy, bb0} = {1.2, 1.}.

Out[•]=

```
{yy → 1.0285, bb0 → 0.682526}
```

```
In[•]:= yy = 1.03
```

Out[•]=

```
1.03
```

```
In[•]:= bb0 = 0.68
```

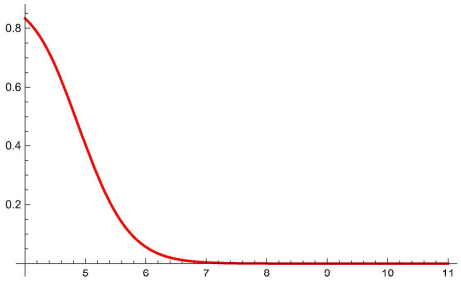
Out[•]=

```
0.68
```



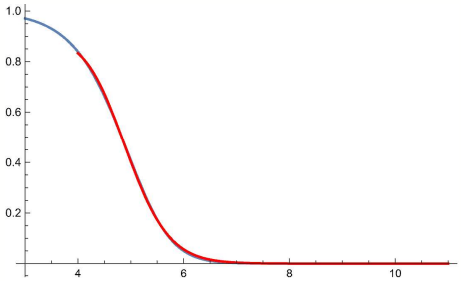
```
In[•]:= l22 = Plot[{ppp2[p0, R1, x1, r, b1]/p0^2} /. R1 → R01 /. p0 → 0.17 /. a1 → 0.55 /. x1 → 0 /. b1 → b1,
          {r, 4, 11}, ColorFunction → Function[{Red}]]
```

Out[•]=




```
In[•]:= Show[l11, l22]
```

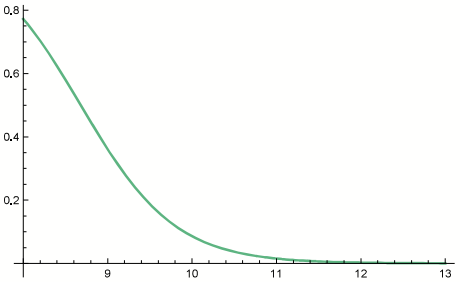
Out[•]=




```
In[•]:= Clear[b0, y, bb0, yy, r]
```

In[ ]:=
```
l111 = Plot[
  {p[p0, R2, a2, x2, r, b2]/p0} /. R2 → R02 /. p0 → 0.17 /. a2 → 0.57 /. x2 → 0 /. b2 → b2, {r, 8, 13}]
```

Out[ ]=



In[ ]:=
```
FindRoot[{Sum[∂y ((p[p0, R2, a2, x2, r, b2] - ppp[p0, R2, x2, r, b2])^2), {r, 8.5, 12, 0.1}] == 0,
  Sum[∂b0 ((p[p0, R2, a2, x2, r, b2] - ppp[p0, R2, x2, r, b2])^2), {r, 8.5, 12, 0.1}] == 0},
 {y, 1.1}, {b0, 0.8}] /. R2 → R02 /. p0 → 0.17 /. a2 → a2 /. x2 → 0 /. b2 → b2
```

FindRoot: The function value {≪1≫, ≪1≫} is not a list of numbers with dimensions {2} at {y, b0} = {1.1, 0.8}.

Out[ ]=
```
{y → 1.21265, b0 → 0.74044}
```

In[ ]:=
```
y = 1.21
```

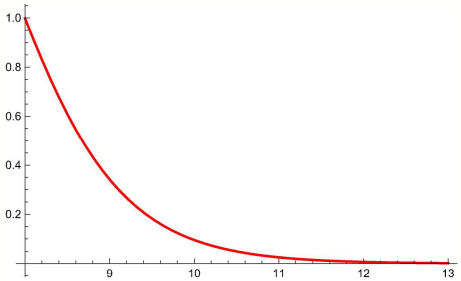
Out[ ]=
```
1.21
```

In[ ]:=
```
b0 = 0.74
```

Out[ ]=
```
0.74
```

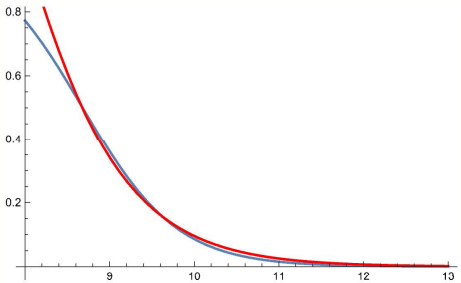

In[ ]:=
```
l222 = Plot[{1/p0 (p0/(1 + e^((r-R2)/b0)) + y * (R2 * ∂R2 p0/(1 + e^((r-R2)/b0)) * b2 * SphericalHarmonicY[2, 0, x2, ϕ] + (R2 * R2)/2 *
      ∂R2 ∂R2 p0/(1 + e^((r-R2)/b0)) * (b2 * SphericalHarmonicY[2, 0, x2, ϕ])^2))} /. R2 → R02 /.
  p0 → 0.17 /. a2 → a2 /. x2 → 0 /. b2 → b2, {r, 8, 13}, ColorFunction → Function[{Red}]]
```

Out[ ]=



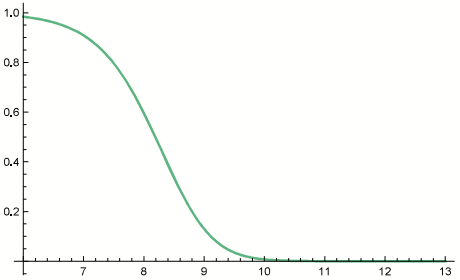
In[ ]:=
```
Show[l111, l222]
```

Out[ ]=



In[ ]:=
```
l1111 =
 Plot[{(p[p0, R2, a2, x2, r, b2]/p0)^2} /. R2 → R02 /. p0 → 0.17 /. a2 → 0.57 /. x2 → 0 /. b2 → 0.892,
  {r, 6, 13}]
```

Out[ ]=



In[ ]:=
```
FindRoot[{Sum[∂yy ((p[p0, R2, a2, x2, r, b2]^2 - ppp2[p0, R2, x2, r, b2])^2), {r, 7, 12, 0.1}] == 0,
  Sum[∂bb0 ((p[p0, R2, a2, x2, r, b2]^2 - ppp2[p0, R2, x2, r, b2])^2), {r, 7, 12, 0.1}] == 0},
 {yy, 2}, {bb0, 1}] /. R2 → R02 /. p0 → 0.17 /. a2 → a2 /.
 x2 → 0 /. b2 → b2
```

FindRoot: The function value

$$\left\{2.\left(-\frac{0.020563\ 2.71828^{1.\ \text{Plus}[\ll 2\gg]}\ R2}{(1.+\text{Power}[\ll 2\gg])^3}-0.0632832\ (0.1734\ \text{Power}[\ll 2\gg]\ \text{Power}[\ll 2\gg]-0.0578\ \text{Power}[\ll 2\gg]\ \text{Power}[\ll 2\gg])\right.\right.$$
$$R2^2\left(-\frac{0.0289}{(1.+\text{Power}[\ll 2\gg])^2}-2.\ (0.020563\ \text{Power}[\ll 2\gg]\ \text{Power}[\ll 2\gg]\ R2+0.0632832\ \text{Plus}[\ll 2\gg]\ \text{Power}[\ll 2\gg])\right.$$
$$\left.\left.+\frac{0.0289\ \text{Sinh}[\text{Times}[\ll 2\gg]]^2}{(141498.+\text{Cosh}[\ll 1\gg])^2}\right)+\ll 49\gg+\ll 1\gg,\ \ll 1\gg\right\}$$

is not a list of numbers with dimensions {2} at {yy, bb0} = {2., 1.}.

Out[ ]=
```
{yy → 1.35007, bb0 → 1.25094}
```

In[ ]:=
```
yy = 1.35
```

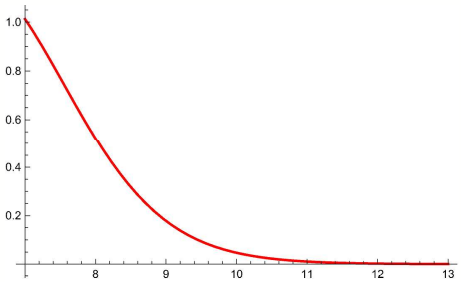
Out[ ]=
```
1.35
```

In[ ]:=
```
bb0 = 1.25
```

Out[ ]=
```
1.25
```


In[ ]:=
```
12222 = Plot[
 {1/p0^2 (((p0/(1 + e^((r-R2)/bb0)))^2 + yy * (R2 * ∂R2 (p0/(1 + e^((r-R2)/bb0)))^2 * b2 * SphericalHarmonicY[2, 0, x2, ϕ] + (R2 * R2)/2 *
 ∂R2 ∂R2 (p0/(1 + e^((r-R2)/bb0)))^2 * (b2 * SphericalHarmonicY[2, 0, x2, ϕ])^2))} /. R2 → R02 /.
 p0 → 0.17 /. a2 → a2 /. x2 → 0 /. b2 → b2, {r, 7, 13}, ColorFunction → Function[{Red}]]
```

Out[ ]=



In[ ]:=
```
Show[l1111, 12222]
```

Out[ ]=