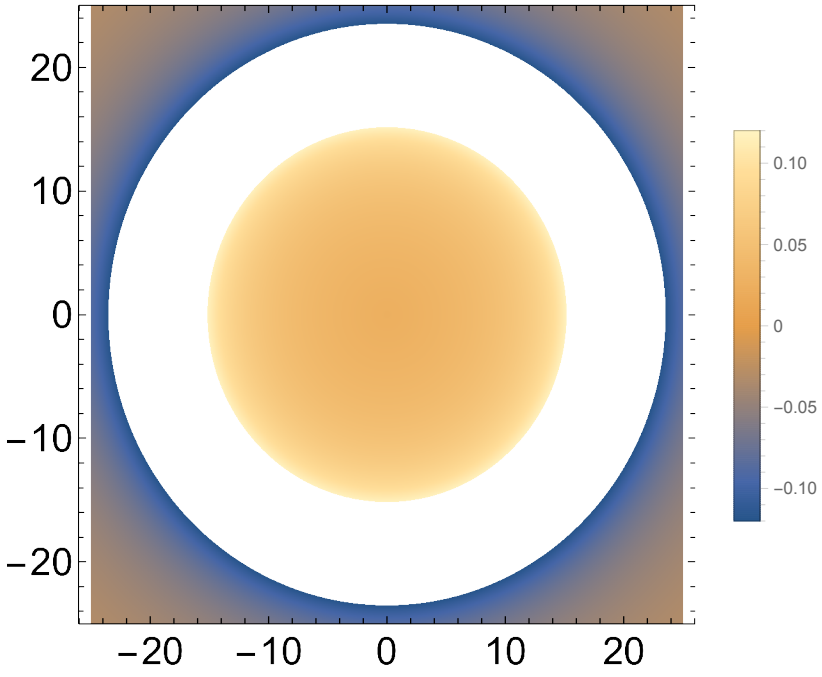
```
(* These are the different effective potentials generated
  due to the interaction of the parent ion with the photoelectron
  in presence of high-intensity laser-atom ionization*)


(*description of parameters)
(*-------------------------------------------------------------------------
                                          ---------------------------------*)

w = 0.058;
F0 = 0.092;
n = 4;
e = 1;

(*description of the potentials*)
(*-------------------------------------------------------------------------
                                          ---------------------------------*)
g[t_] := -F0 / (w^2 Sqrt[1 + e^2]) Exp[-2 Log[2] t^2 w^2 / (2 π n) ^2]
VmI[x_, y_, t_, m_] :=
 w / (2 π) 2 NIntegrate[-1 / Sqrt[(x + g[t] * Cos[w a]) ^2 + (y + g[t] * e * Sin[w a]) ^2]
    Cos[ m w a] , {a, -π / w, π / w}]
V[x_, t_, y_] := -1 / Sqrt[(x + g[t] * Cos[w t]) ^2 + (y + g[t] * e * Sin[w t]) ^2]
r[x_, y_] := Sqrt[x^2 + y^2]
VkI[x_, y_, t_, k_, xl_] :=
 -Exp[ι k N[ArcTan[y / x]]] / ((2 k) ! (x^2 + y^2) ^ ((k + 1) / 2))
  LegendreP[k, k, xl] ^2 g[t] ^k


(*evaluation*)
(*-------------------------------------------------------------------------
                                          ---------------------------------*)


(*ring potential*)
(*-------------------------------------------------------------------------
                                          ---------------------------------*)

In[•]:= Vring[x_, y_, rq_] := -1 / (Sqrt[x^2 + y^2 ] - rq)
```

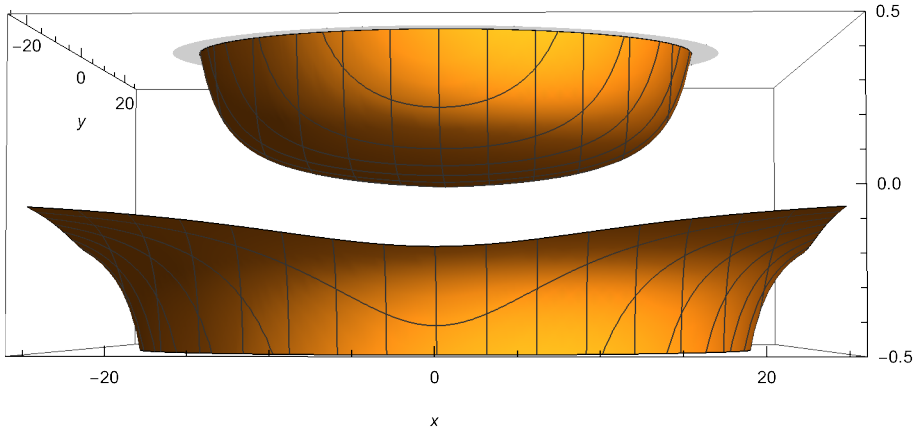
In[•]:=
```
DensityPlot[ Vring[x, y, -g[0]] / 2, {x, -25, 25}, {y, -25, 25},
 AxesLabel → Automatic , PlotLegends → Automatic, PlotRange → {-0.12, 0.12},
 PlotPoints → 300, Frame → True, FrameTicksStyle → Directive[Black, 20]]
```

Out[•]=



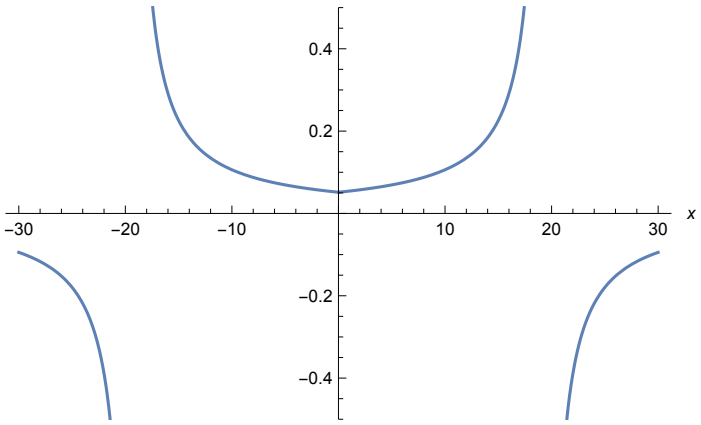
In[•]:=
```
Plot3D[Vring[x, y, 19.43], {x, -25, 25}, {y, -25, 25}, AxesLabel → Automatic ,
 PlotLegends → Automatic, PlotRange → {-0.5, 0.5}, PlotPoints → 100]
```

Out[•]=



In[•]:=
```
Plot[Vring[x, 0, 19.43], {x, -30, 30}, AxesLabel → Automatic ,
 PlotLegends → Automatic, PlotRange → {-0.5, 0.5}, PlotPoints → 100]
```

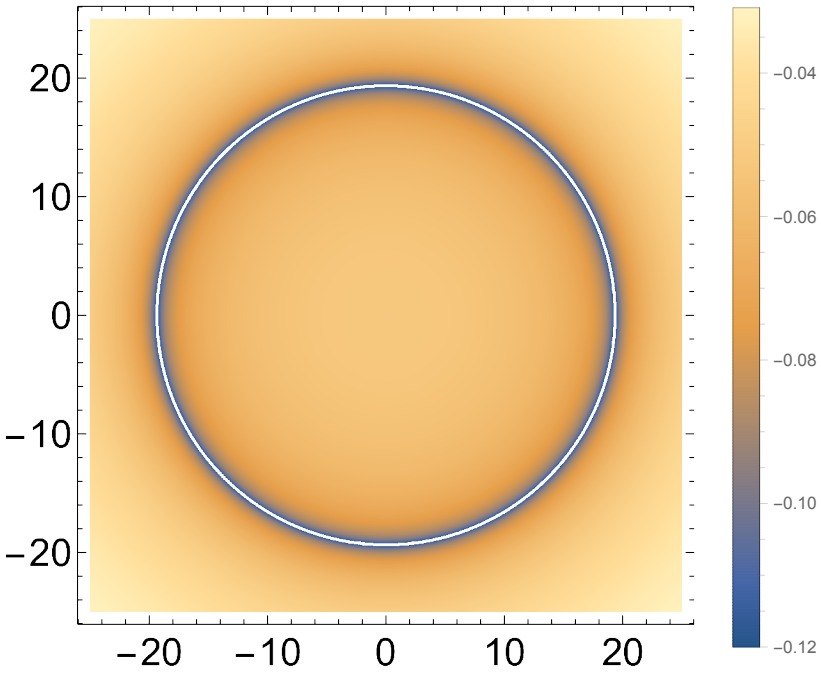
Out[•]=




```
(*VmI potential*)
(*-------------------------------------------------------------------------------
                                                    ---------------------------------*)
```

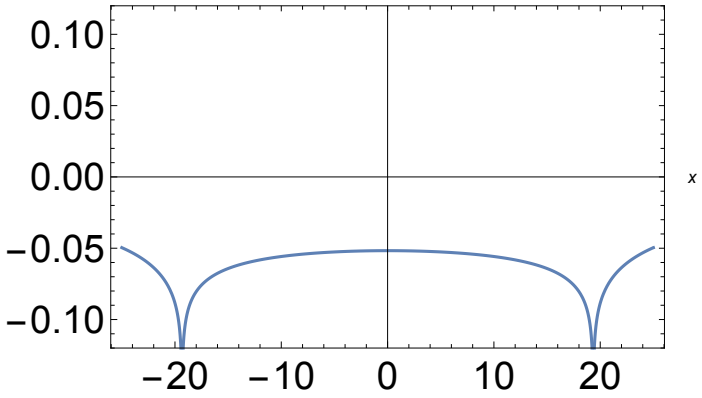
In[•]:=
```
DensityPlot[ VmI[x, y, 0, 0] / 2, {x, -25, 25}, {y, -25, 25},
 AxesLabel → Automatic , PlotLegends → Automatic, PlotRange → {-0.12, 0.12},
 PlotPoints → 300, Frame → True, FrameTicksStyle → Directive[Black, 20]]
```

Out[•]=



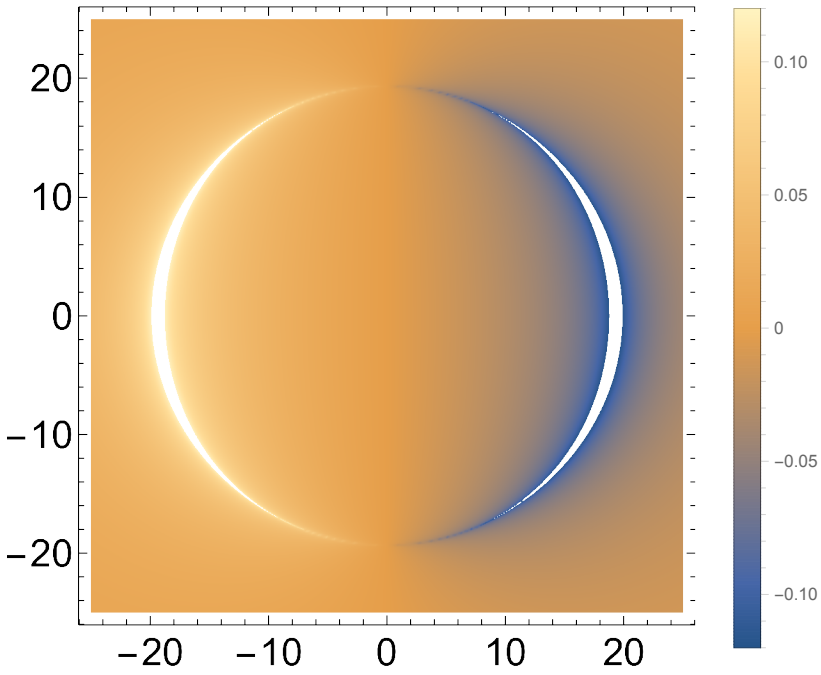
In[•]:=
```
Plot[ VmI[x, 0, 0, 0] / 2, {x, -25, 25}, AxesLabel → Automatic ,
 PlotLegends → Automatic, PlotRange → {-0.12, 0.12}, PlotPoints → 300,
 Frame → True,  FrameTicksStyle → Directive[Black, 20]]
```

Out[•]=



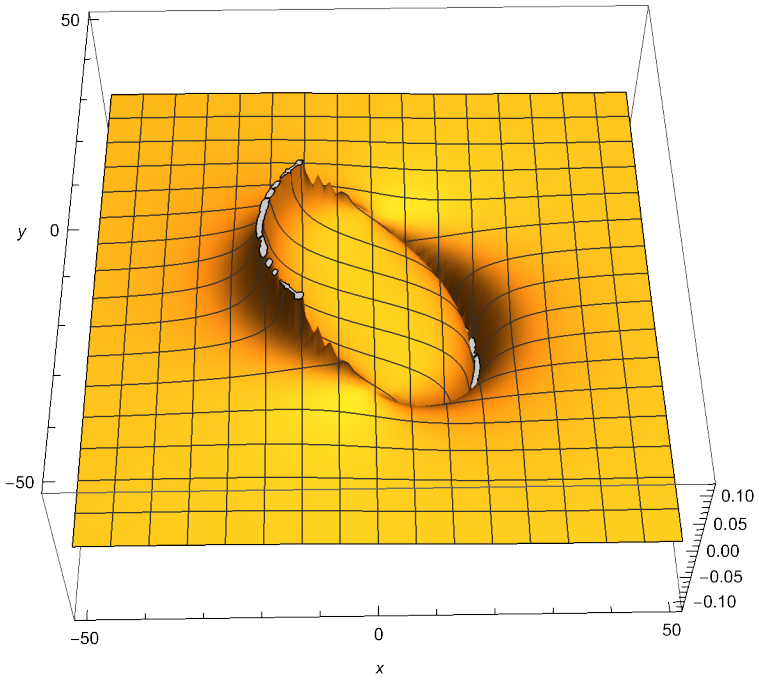
In[•]:=
```
DensityPlot[VmI[x, y, 0, 1], {x, -25, 25}, {y, -25, 25},
 AxesLabel → Automatic , PlotLegends → Automatic, PlotRange → {-0.12, 0.12},
 PlotPoints → 300, Frame → True,  FrameTicksStyle → Directive[Black, 20] ]
```

Out[•]=



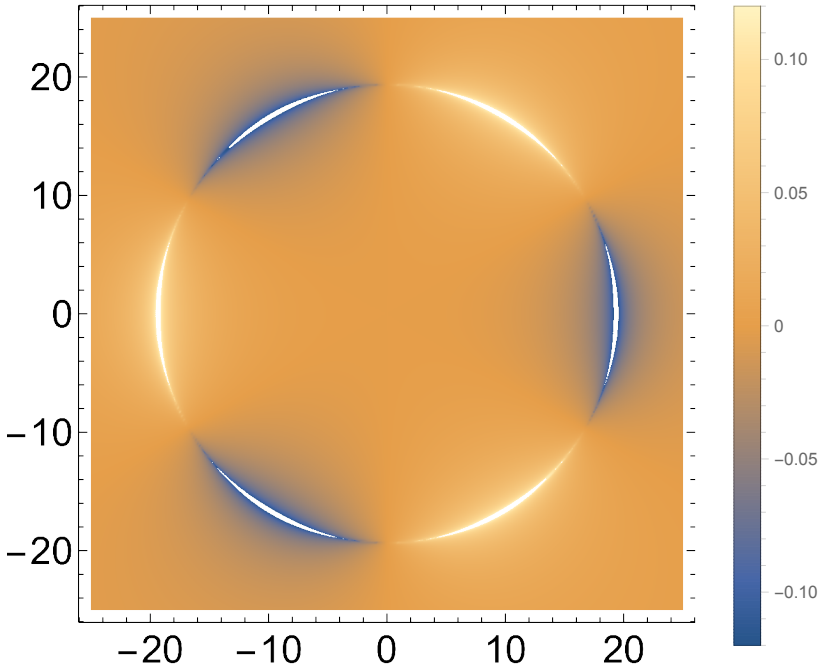
```
Plot3D[VmI[x, y, 0, 1], {x, -25, 25}, {y, -25, 25}, AxesLabel → Automatic ,
 PlotLegends → Automatic, PlotRange → {-0.12, 0.12}, PlotPoints → 100]
```

Out[•]=




```
DensityPlot[VmI[x, y, 0, 3], {x, -25, 25}, {y, -25, 25},
 AxesLabel → Automatic , PlotLegends → Automatic, PlotRange → {-0.12, 0.12},
 PlotPoints → 300, Frame → True, FrameTicksStyle → Directive[Black, 20] ]
```

Out[•]=



In[•]:=
```
Plot[VmI[x, 0, 0, 3], {x, -25, 25}, AxesLabel → Automatic ,
 PlotLegends → Automatic, PlotRange → {-0.12, 0.12}, PlotPoints → 300,
 Frame → True,  FrameTicksStyle → Directive[Black, 20] ]
```

Out[•]=