```
In[ ]:= (* C3.AI COVID CHALLENGE *)

In[1127]:= Clear["Global`*"]

In[1765]:= type = "Cases_per_Million";
           policy = "C6_Policy";

In[1495]:= pD0 = 0.7609;
           pD1 = 0.0967;
           pD2 = 0.0266;
           pD3 = 0.0155;
           pD4 = 0.1003;
           pD0 + pD1 + pD2 + pD3 + pD4

In[ ]:= (* COnditional Prob *)

In[1545]:= pD0C6l0 = 0.3349;
           pD1C6l0 = 0.0019;
           pD2C6l0 = 0.1458;
           pD3C6l0 = 0.0119;
           pD4C6l0 = 1 - pD0C6l0 - pD1C6l0 - pD2C6l0 - pD3C6l0;

In[1550]:= pD0C6l1 = 0.13603298639670133;
           pD1C6l1 = 0.23091590763363695;
           pD2C6l1 = 0.2847222847222847;
           pD3C6l1 = 0.011904804761921906;
           pD4C6l1 = 1 - pD0C6l1 - pD1C6l1 - pD2C6l1 - pD3C6l1;

In[1555]:= pD0C6l2 = 0.5095;
           pD1C6l2 = 0.3073;
           pD2C6l2 = 0.4236;
           pD3C6l2 = 0.7262;
           pD4C6l2 = 1 - pD0C6l2 - pD1C6l2 - pD2C6l2 - pD3C6l2;

In[1560]:= pD0C6l3 = 0.0196;
           pD1C6l3 = 0.4599;
           pD2C6l3 = 0.1458;
           pD3C6l3 = 0.2500;
           pD4C6l3 = 1 - pD0C6l3 - pD1C6l3 - pD2C6l3 - pD3C6l3;

In[ ]:= (* C6 - 1 *)

In[1567]:= prC6l0 = pD0 pD0C6l0 + pD1 pD1C6l0 + pD2 pD2C6l0 + pD3 pD3C6l0 + pD4 pD4C6l0
Out[ ]= 0.309774

In[1568]:= prC6l1 = pD0 pD0C6l1 + pD1 pD1C6l1 + pD2 pD2C6l1 + pD3 pD3C6l1 + pD4 pD4C6l1
Out[ ]= 0.167339

In[1569]:= prC6l2 = pD0 pD0C6l2 + pD1 pD1C6l2 + pD2 pD2C6l2 + pD3 pD3C6l2 + pD4 pD4C6l2
Out[ ]= 0.342968
```

In[1570]:=
```
prC6l3 = pD0 pD0C6l3 + pD1 pD1C6l3 + pD2 pD2C6l3 + pD3 pD3C6l3 + pD4 pD4C6l3
```

Out[•]= 0.0796467

In[1774]:=
```
prC6l0 + prC6l1 + prC6l2 + prC6l3
```

Out[•]= 0.899727

In[•]:=
```
(* Quantum Prob *)
```

In[1571]:=
```
interfC6l0 = Sqrt[pD0 pD0C6l0 pD1 pD1C6l0] Cos[θ00 - θ10] +
   Sqrt[pD0 pD0C6l0 pD2 pD2C6l0] Cos[θ00 - θ20] + Sqrt[pD0 pD0C6l0 pD3 pD3C6l0]
    Cos[θ00 - θ30] + Sqrt[ pD0 pD0C6l0 pD4 pD4C6l0] Cos[θ00 - θ40] +
   Sqrt[pD1 pD1C6l0 pD2 pD2C6l0 ] Cos[θ10 - θ20] + Sqrt[pD1 pD1C6l0 pD3 pD3C6l0]
    Cos[θ10 - θ30] + Sqrt[pD1 pD1C6l0 pD4 pD4C6l0 ] Cos[θ10 - θ40] +
   Sqrt[pD2 pD2C6l0 pD3 pD3C6l0] Cos[θ20 - θ30] + Sqrt[pD2 pD2C6l0 pD4 pD4C6l0 ]
    Cos[θ20 - θ40] + Sqrt[pD3 pD3C6l0 pD4 pD4C6l0 ] Cos[θ30 - θ40];
```

In[1572]:=
```
interfC6l1 = Sqrt[pD0 pD0C6l1 pD1 pD1C6l1] Cos[θ01 - θ11] +
   Sqrt[pD0 pD0C6l1 pD2 pD2C6l1] Cos[θ01 - θ21] + Sqrt[pD0 pD0C6l1 pD3 pD3C6l1]
    Cos[θ01 - θ31] + Sqrt[ pD0 pD0C6l1 pD4 pD4C6l1] Cos[θ01 - θ41] +
   Sqrt[pD1 pD1C6l1 pD2 pD2C6l1 ] Cos[θ11 - θ21] + Sqrt[pD1 pD1C6l1 pD3 pD3C6l1]
    Cos[θ11 - θ31] + Sqrt[pD1 pD1C6l1 pD4 pD4C6l1] Cos[θ11 - θ41] +
   Sqrt[pD2 pD2C6l1 pD3 pD3C6l1 ] Cos[θ21 - θ31] + Sqrt[pD2 pD2C6l1 pD4 pD4C6l1]
    Cos[θ21 - θ41] + Sqrt[pD3 pD3C6l1 pD4 pD4C6l1] Cos[θ31 - θ41];
```

In[1573]:=
```
interfC6l2 = Sqrt[pD0 pD0C6l2 pD1 pD1C6l2] Cos[θ02 - θ12] +
   Sqrt[pD0 pD0C6l2 pD2 pD2C6l2] Cos[θ02 - θ22] + Sqrt[pD0 pD0C6l2 pD3 pD3C6l2]
    Cos[θ30 - θ32] + Sqrt[ pD0 pD0C6l2 pD4 pD4C6l2] Cos[θ02 - θ42] +
   Sqrt[pD1 pD1C6l2 pD2 pD2C6l2 ] Cos[θ12 - θ22] + Sqrt[pD1 pD1C6l2 pD3 pD3C6l2]
    Cos[θ12 - θ32] + Sqrt[pD1 pD1C6l2 pD4 pD4C6l2] Cos[θ12 - θ42] +
   Sqrt[pD2 pD2C6l2 pD3 pD3C6l2 ] Cos[θ22 - θ32] + Sqrt[pD2 pD2C6l2 pD4 pD4C6l2]
    Cos[θ22 - θ42] + Sqrt[pD3 pD3C6l2 pD4 pD4C6l2] Cos[θ32 - θ42];
```

In[1574]:=
```
interfC6l3 = Sqrt[pD0 pD0C6l3 pD1 pD1C6l3] Cos[θ03 - θ13] +
   Sqrt[pD0 pD0C6l3 pD2 pD2C6l3] Cos[θ03 - θ23] + Sqrt[pD0 pD0C6l3 pD3 pD3C6l3]
    Cos[θ03 - θ33] + Sqrt[ pD0 pD0C6l3 pD4 pD4C6l3] Cos[θ03 - θ43] +
   Sqrt[pD1 pD1C6l3 pD2 pD2C6l3 ] Cos[θ13 - θ23] + Sqrt[pD1 pD1C6l3 pD3 pD3C6l3]
    Cos[θ13 - θ33] + Sqrt[pD1 pD1C6l3 pD4 pD4C6l3] Cos[θ13 - θ43] +
   Sqrt[pD2 pD2C6l3 pD3 pD3C6l3 ] Cos[θ23 - θ33] + Sqrt[pD2 pD2C6l3 pD4 pD4C6l3]
    Cos[θ23 - θ43] + Sqrt[pD3 pD3C6l3 pD4 pD4C6l3] Cos[θ33 - θ43];
```

In[1575]:=
```
qprC6l0 = prC6l0 + 2 interfC6l0;
```

In[1576]:=
```
qprC6l1 = prC6l1 + 2 interfC6l1;
```

In[1577]:=
```
qprC6l2 = prC6l2 + 2 interfC6l2;
```

In[1578]:=
```
qprC6l3 = prC6l3 + 2 interfC6l3;
```

In[1594]:=
```
qprC6l0Norm = FullSimplify[qprC6l0 / (qprC6l0 + qprC6l1 + qprC6l2 + qprC6l3]];
```

In[1595]:=
```
qprC6l1Norm = FullSimplify[qprC6l1 / (qprC6l0 + qprC6l1 + qprC6l2 + qprC6l3]];
```

In[1596]:=
```
qprC6l2Norm = FullSimplify[qprC6l2 / (qprC6l0 + qprC6l1 + qprC6l2 + qprC6l3]];
```

In[1597]:=
```
qprC6l3Norm = 1 - qprC6l2Norm - qprC6l1Norm - qprC6l0Norm;
```

In[1604]:=
```
Clear[θ00, θ10, θ20, θ30, θ40, θ01, θ11, θ21,
  θ31, θ41, θ02, θ12, θ22, θ32, θ42, θ03, θ13, θ23, θ33, θ43];
```

In[•]:=
```
θ20 = π;
θ31 = 0.1;
θ22 = π / 2;
θ43 = π / 2;
θ23 = π;
θ30 = π;
θ21 = π;
θ42 = π;
```

In[1605]:=
```
res = FindInstance[{qprC6l0Norm + qprC6l1Norm + qprC6l2Norm + qprC6l3Norm == 1},
  {θ00, θ10, θ20, θ30, θ40, θ01, θ11, θ21, θ31, θ41,
   θ02, θ12, θ22, θ32, θ42, θ03, θ13, θ23, θ33, θ43}, Reals]
```

Out[•]=
$$\left\{\left\{\theta 00 \to -\frac{12}{5}, \theta 10 \to -\frac{1}{2}, \theta 20 \to -\frac{9}{5}, \theta 30 \to \frac{3}{5}, \theta 40 \to -\frac{24}{5}, \theta 01 \to -\frac{21}{5}, \theta 11 \to \frac{11}{5},\right.\right.$$
$$\theta 21 \to -\frac{3}{5}, \theta 31 \to -\frac{6}{5}, \theta 41 \to -\frac{14}{5}, \theta 02 \to -\frac{19}{5}, \theta 12 \to -\frac{14}{5}, \theta 22 \to -\frac{41}{10}, \theta 32 \to -\frac{3}{10},$$
$$\left.\left.\theta 42 \to -\frac{17}{10}, \theta 03 \to \frac{18}{5}, \theta 13 \to -\frac{37}{10}, \theta 23 \to \frac{13}{5}, \theta 33 \to -\frac{39}{10}, \theta 43 \to -\frac{21}{10}\right\}\right\}$$

In[•]:=
```
(* Params *)
```

In[1659]:=
```
θ10 = res[[1]][[2]][[2]];
θ20 = res[[1]][[3]][[2]];
θ30 = res[[1]][[4]][[2]];
θ40 = res[[1]][[5]][[2]];
θ11 = res[[1]][[7]][[2]];
θ21 = res[[1]][[8]][[2]];
θ31 = res[[1]][[9]][[2]];
θ41 = res[[1]][[10]][[2]];
θ02 = res[[1]][[11]][[2]];
θ12 = res[[1]][[12]][[2]];
θ22 = res[[1]][[13]][[2]];
θ32 = res[[1]][[14]][[2]];
θ42 = res[[1]][[15]][[2]];
θ03 = res[[1]][[16]][[2]];
θ13 = res[[1]][[17]][[2]];
θ23 = res[[1]][[18]][[2]];
θ33 = res[[1]][[19]][[2]];
θ43 = res[[1]][[20]][[2]];
```

In[•]:=

In[•]:=
```
qprC6l0Norm = FullSimplify[qprC6l0 / (qprC6l0 + qprC6l1 + qprC6l2 + qprC6l3)];
```

In[•]:=
```
qprC6l0Norm = (20.625876849732148` +
      2.110074299383087` Cos[θ00] + 12.136563618945598` Sin[θ00]) /
    ((91.03182491156085`) + 2.110074299383087` Cos[θ00] - 8.647382932576596`
       Cos[θ01] + 12.136563618945598` Sin[θ00] - 0.11828274209686551` Sin[θ01]);
```

In[•]:=
```
qprC6l1Norm = FullSimplify[qprC6l1 / (qprC6l0 + qprC6l1 + qprC6l2 + qprC6l3)];
```

In[•]:=
```
qprC6l1Norm = (1.4297233187681255` -
      1.2331596774696156` Cos[θ01] - 0.01686770543546845` Sin[θ01]) /
    ((12.981589542486294`) + 0.3009070562449182` Cos[θ00] - 1.2331596774696143`
       Cos[θ01] + 1.7307341417189919` Sin[θ00] - 0.01686770543546756` Sin[θ01]);
```

In[•]:=
```
qprC6l2Norm = FullSimplify[qprC6l2 / (qprC6l0 + qprC6l1 + qprC6l2 + qprC6l3)];
```

In[•]:=
```
qprC6l2Norm = (21.775708576757673` - 6.3792965325476665) /
    ((43.141525840192166`) + 1.` Cos[θ00] - 4.098141442272811` Cos[θ01] +
      5.7517233504497485` Sin[θ00] - 0.056056197704245365` Sin[θ01]);
```

In[•]:=
```
qprC6l3Norm = 1 - qprC6l2Norm - qprC6l1Norm - qprC6l0Norm;
```

In[•]:=
```
(* Updated probabilities *)
```

In[•]:=
```
{qprC6l0Norm, qprC6l1Norm, qprC6l2Norm, qprC6l3Norm}
```

Out[•]=
$$\left\{\frac{20.6259 + 2.11007\,\text{Cos}[\theta 00] + 12.1366\,\text{Sin}[\theta 00]}{91.0318 + 2.11007\,\text{Cos}[\theta 00] - 8.64738\,\text{Cos}[\theta 01] + 12.1366\,\text{Sin}[\theta 00] - 0.118283\,\text{Sin}[\theta 01]},\right.$$
$$\left(1.42972 - 1.23316\,\text{Cos}[\theta 01] - 0.0168677\,\text{Sin}[\theta 01]\right) \Big/ \left(12.9816 + 0.300907\,\text{Cos}[\theta 00] - 1.23316\,\text{Cos}[\theta 01] + 1.73073\,\text{Sin}[\theta 00] - 0.0168677\,\text{Sin}[\theta 01]\right),$$
$$\frac{15.3964}{43.1415 + 1.\,\text{Cos}[\theta 00] - 4.09814\,\text{Cos}[\theta 01] + 5.75172\,\text{Sin}[\theta 00] - 0.0560562\,\text{Sin}[\theta 01]},$$
$$1 - \left(20.6259 + 2.11007\,\text{Cos}[\theta 00] + 12.1366\,\text{Sin}[\theta 00]\right) \Big/ \left(91.0318 + 2.11007\,\text{Cos}[\theta 00] - 8.64738\,\text{Cos}[\theta 01] + 12.1366\,\text{Sin}[\theta 00] - 0.118283\,\text{Sin}[\theta 01]\right) -$$
$$\frac{15.3964}{43.1415 + 1.\,\text{Cos}[\theta 00] - 4.09814\,\text{Cos}[\theta 01] + 5.75172\,\text{Sin}[\theta 00] - 0.0560562\,\text{Sin}[\theta 01]} -$$
$$\left.\left(1.42972 - 1.23316\,\text{Cos}[\theta 01] - 0.0168677\,\text{Sin}[\theta 01]\right) \Big/ \left(12.9816 + 0.300907\,\text{Cos}[\theta 00] - 1.23316\,\text{Cos}[\theta 01] + 1.73073\,\text{Sin}[\theta 00] - 0.0168677\,\text{Sin}[\theta 01]\right)\right\}$$

In[1767]:=
```
p0 = Plot3D[qprC6l0Norm, {θ00, 0, 2 π},
   {θ01, 0, 2 π}, ColorFunction → (ColorData["DarkRainbow"][#3] &),
   AxesLabel → {Style[type, 16], Style[policy, 16], Style["Prob", 16]},
   BoundaryStyle → Thick, Boxed → False,
   Ticks → {{0, Pi / 2, Pi, 3 Pi / 2, 2 Pi}, {0, Pi / 2, Pi, 3 Pi / 2, 2 Pi}, Automatic},
   TicksStyle → Directive[Black, 12]];
```

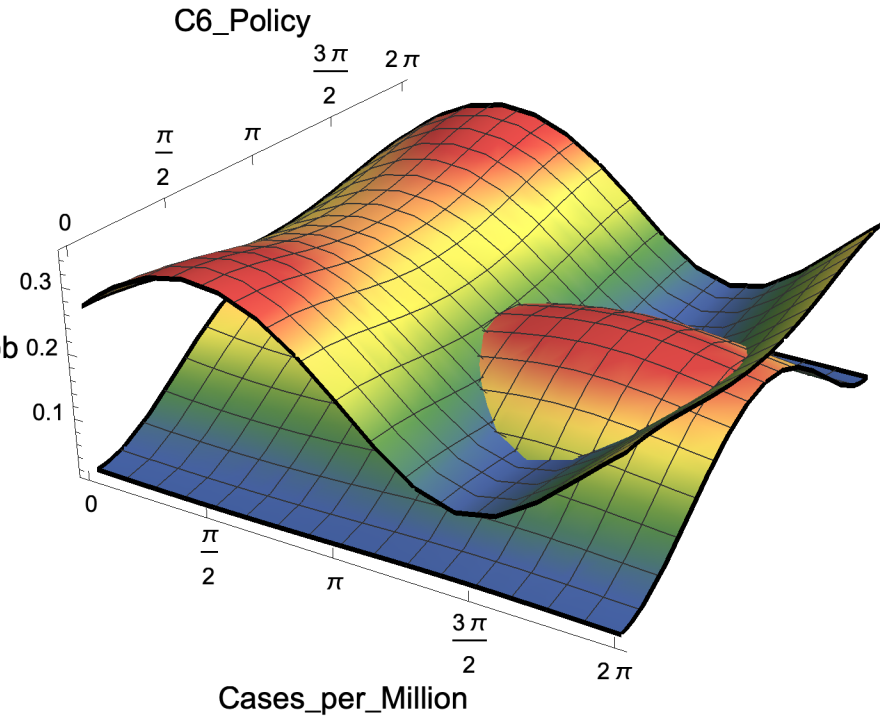
In[1768]:=
```
p1 = Plot3D[qprC6l1Norm, {θ00, 0, 2 π},
   {θ01, 0, 2 π}, ColorFunction → (ColorData["DarkRainbow"][#3] &),
   AxesLabel → {Style[type, 16], Style[policy, 16], Style["Prob", 16]},
   BoundaryStyle → Thick, Boxed → False,
   Ticks → {{0, Pi / 2, Pi, 3 Pi / 2, 2 Pi}, {0, Pi / 2, Pi, 3 Pi / 2, 2 Pi}, Automatic},
   TicksStyle → Directive[Black, 12]];
```

In[1769]:=
```
p2 = Plot3D[qprC6l2Norm, {θ00, 0, 2 π},
   {θ01, 0, 2 π}, ColorFunction → (ColorData["DarkRainbow"][#3] &),
   AxesLabel → {Style[type, 16], Style[policy, 16], Style["Prob", 16]},
   BoundaryStyle → Thick, Boxed → False,
   Ticks → {{0, Pi / 2, Pi, 3 Pi / 2, 2 Pi}, {0, Pi / 2, Pi, 3 Pi / 2, 2 Pi}, Automatic},
   TicksStyle → Directive[Black, 12]];
```

In[1770]:=
```
p3 = Plot3D[qprC6l3Norm, {θ00, 0, 2 π},
   {θ01, 0, 2 π}, ColorFunction → (ColorData["DarkRainbow"][#3] &),
   AxesLabel → {Style[type, 16], Style[policy, 16], Style["Prob", 16]},
   BoundaryStyle → Thick, Boxed → False,
   Ticks → {{0, Pi / 2, Pi, 3 Pi / 2, 2 Pi}, {0, Pi / 2, Pi, 3 Pi / 2, 2 Pi}, Automatic},
   TicksStyle → Directive[Black, 12]];
```

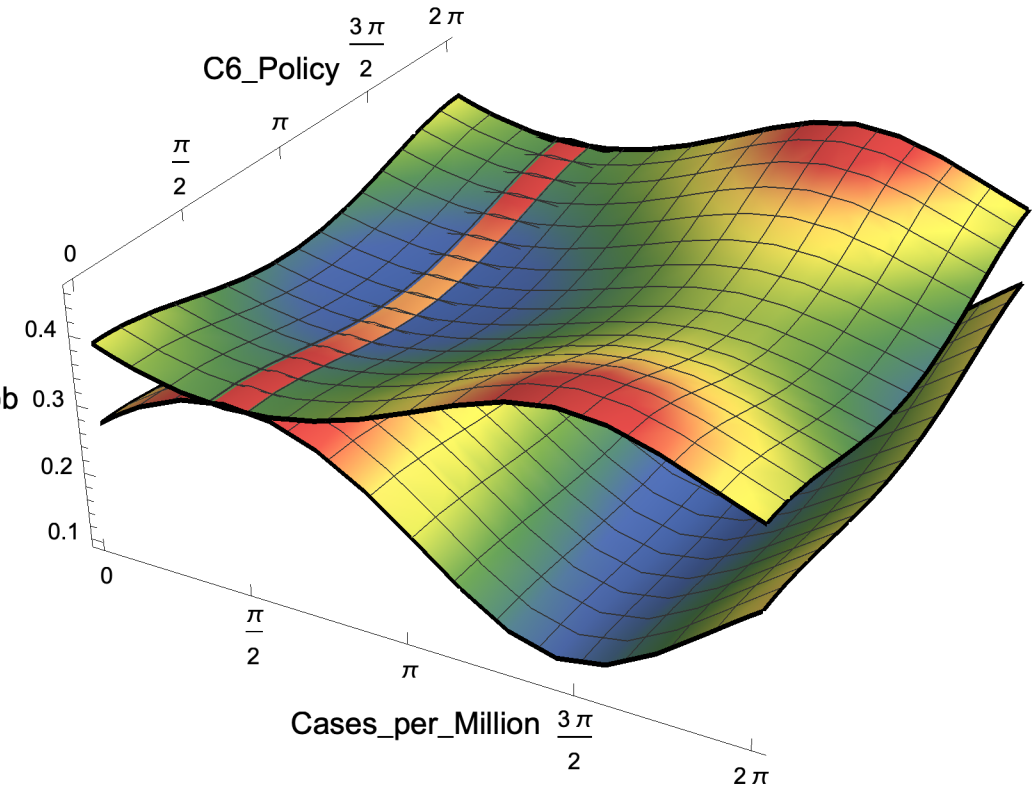
In[1771]:= `Show[p0, p1]`

Out[•]=



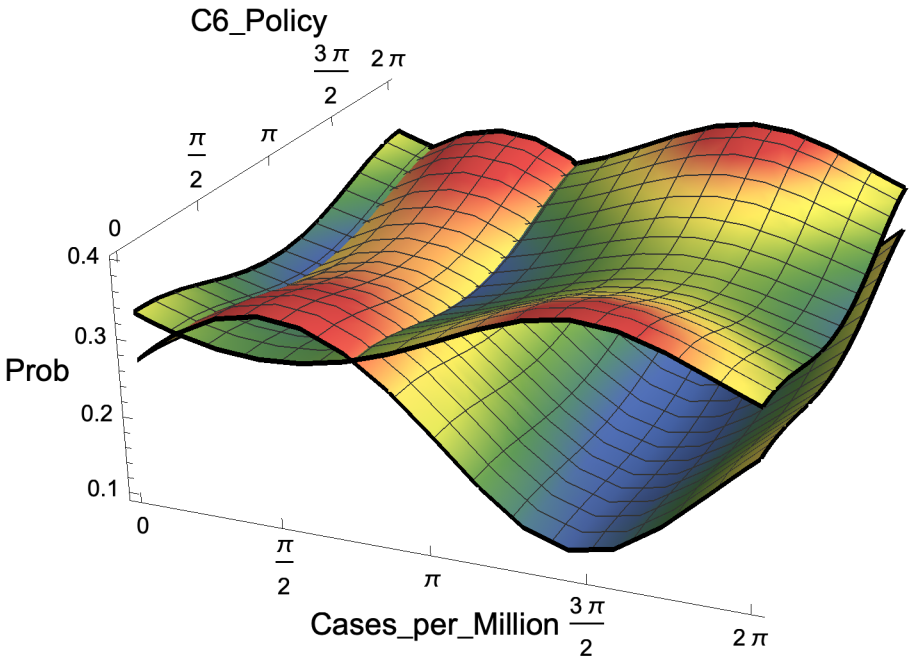
In[1772]:= `Show[p0, p2]`

Out[•]=



In[1773]:= **Show[p0, p3]**

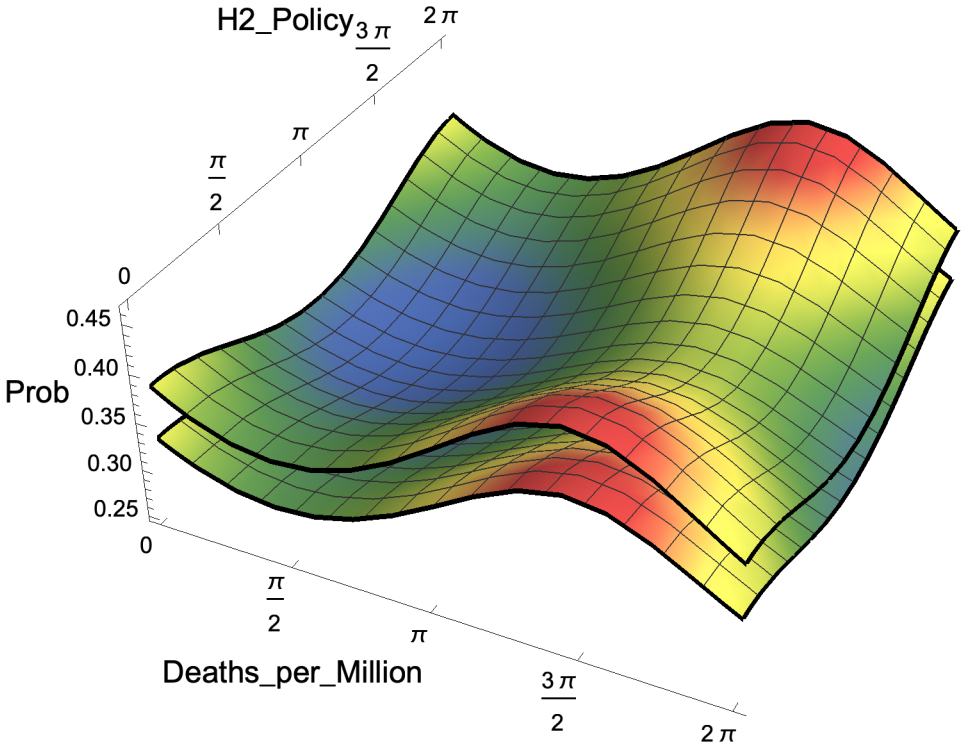
Out[•]=



In[1761]:= **Show[p1, p2]**

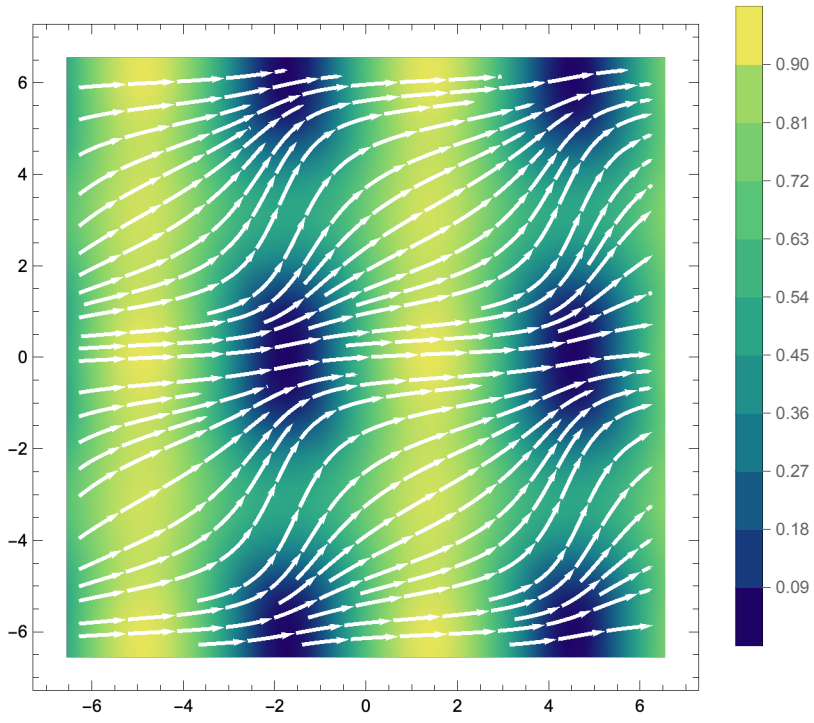
In[1763]:= **Show[p2, p3]**

Out[•]=

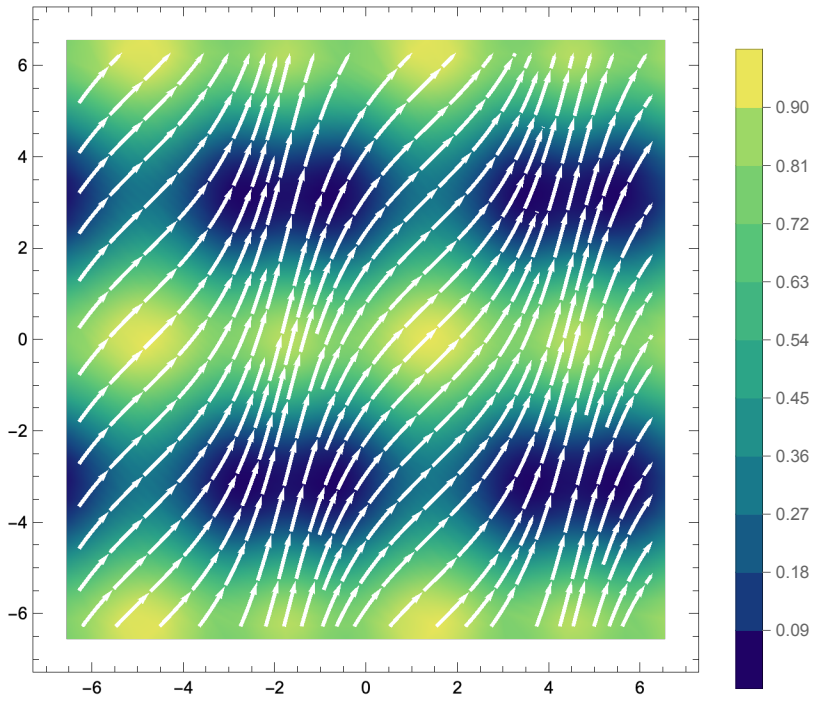


In[•]:=

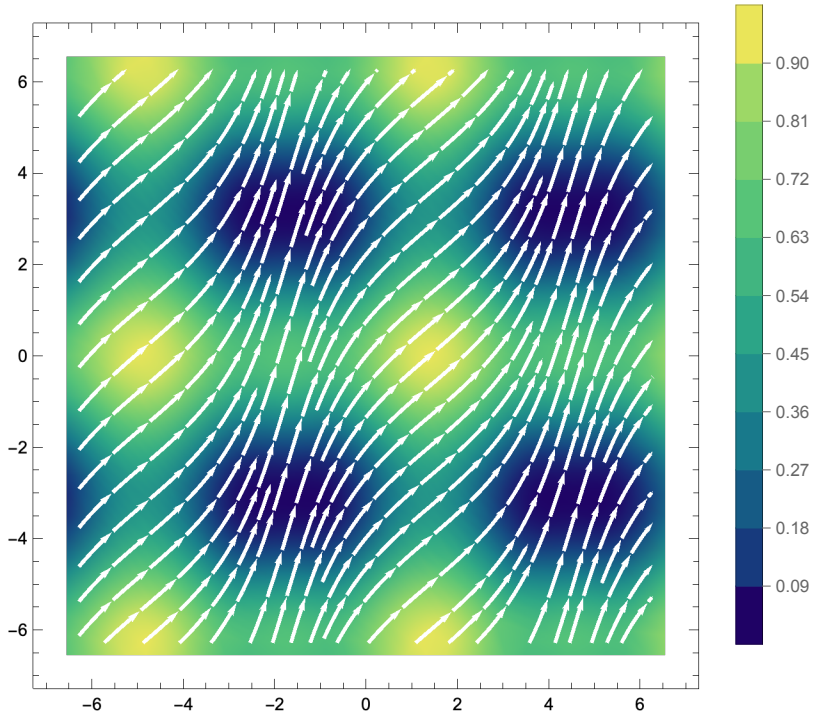
In[1758]:=
```
fig = StreamDensityPlot[{qprC6l0Norm, qprC6l1Norm},
  {θ00, -2 π, 2 π}, {θ01, -2 π, 2 π}, ColorFunction → "BlueGreenYellow",
  PlotLegends → BarLegend[{"BlueGreenYellow", {0, 1}}, 10],
  AxesLabel → Automatic, StreamStyle → {White, Thick}]
```



In[1759]:=
```
fig = StreamDensityPlot[{qprC6l0Norm, qprC6l2Norm},
  {θ00, -2 π, 2 π}, {θ01, -2 π, 2 π}, ColorFunction → "BlueGreenYellow",
  PlotLegends → BarLegend[{"BlueGreenYellow", {0, 1}}, 10],
  AxesLabel → Automatic, StreamStyle → {White, Thick}]
```



In[1760]:=
```
fig = StreamDensityPlot[{qprC6l0Norm, qprC6l3Norm},
  {θ00, -2 π, 2 π}, {θ01, -2 π, 2 π}, ColorFunction → "BlueGreenYellow",
  PlotLegends → BarLegend[{"BlueGreenYellow", {0, 1}}, 10],
  AxesLabel → Automatic, StreamStyle → {White, Thick}]
```



In[1764]:=
```
fig = StreamDensityPlot[{qprC6l2Norm, qprC6l3Norm},
  {θ00, -2 π, 2 π}, {θ01, -2 π, 2 π}, ColorFunction → "BlueGreenYellow",
  PlotLegends → BarLegend[{"BlueGreenYellow", {0, 1}}, 10],
  AxesLabel → Automatic, StreamStyle → {White, Thick}]
```