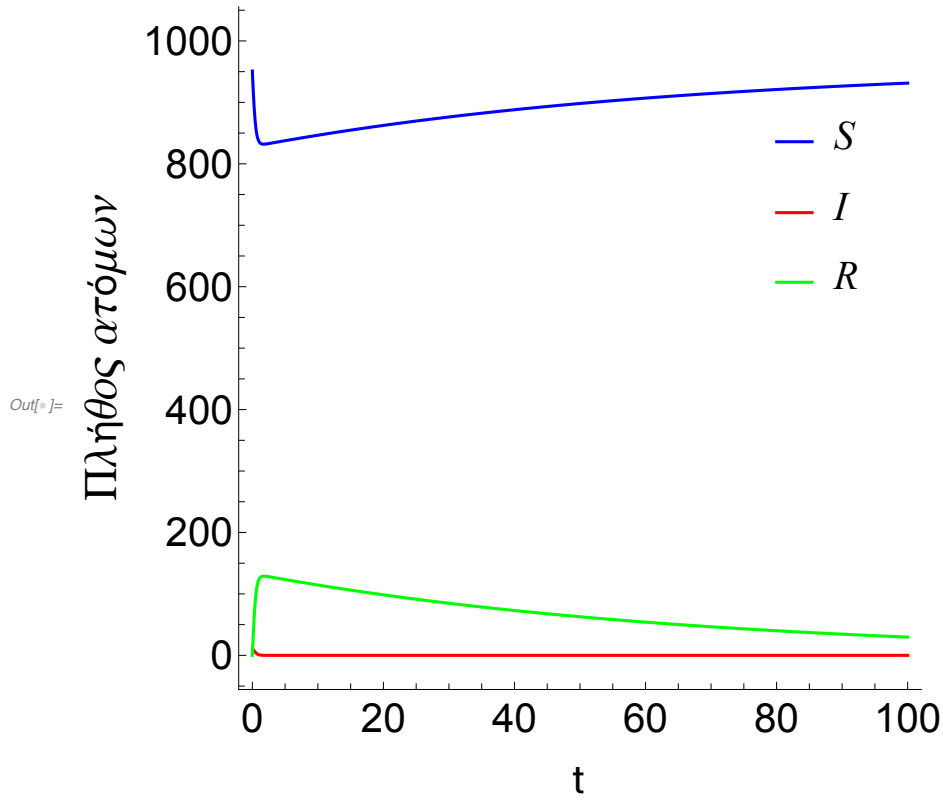


```

In[ ]:= N = 961;
mu = 0.015;
beta = 0.026;
gamma = 24.985;
I0 = 10;
S0 = N - I0;
R0 = 0;
tend = 100;
S = .; I = .; R = .;
Sol0 = NDSolve[{D[S[t], t] == mu * N - beta * S[t] * I[t] - mu * S[t], D[I[t], t] ==
  beta * S[t] * I[t] - (gamma + mu) * I[t], D[R[t], t] == gamma * I[t] - mu * R[t],
  S[0] == S0, I[0] == I0, R[0] == R0}, {S, I, R}, {t, 0, tend}];
Plot10 = Plot[Evaluate[S[t] /. First[Sol0]], {t, 0, tend}, PlotPoints -> 200,
  Mesh -> False, AxesLabel -> {t, S}, PlotRange -> All, PlotStyle -> Blue,
  FrameLabel -> {Style["t", FontFamily -> "MS Serif", FontSize -> 21],
  Style["Πλήθος ατόμων", FontFamily -> "MS Serif", FontSize -> 21]},
  RotateLabel -> True, Frame -> {{Automatic, False}, {Automatic, False}}];
Plot20 = Plot[Evaluate[I[t] /. First[Sol0]], {t, 0, tend}, PlotPoints -> 200,
  Mesh -> False, AxesLabel -> {t, I}, PlotRange -> All, PlotStyle -> Red,
  FrameLabel -> {Style["t", FontFamily -> "MS Serif", FontSize -> 21],
  Style["Πλήθος ατόμων", FontFamily -> "MS Serif", FontSize -> 21]},
  RotateLabel -> True, Frame -> {{Automatic, False}, {Automatic, False}}];
Plot30 = Plot[Evaluate[R[t] /. First[Sol0]], {t, 0, tend}, PlotPoints -> 200,
  Mesh -> False, AxesLabel -> {t, R}, PlotRange -> All, PlotStyle -> Green,
  FrameLabel -> {Style["t", FontFamily -> "MS Serif", FontSize -> 21],
  Style["Πλήθος ατόμων", FontFamily -> "MS Serif", FontSize -> 21]},
  RotateLabel -> True, Frame -> {{Automatic, False}, {Automatic, False}}];
MP0 = Show[Plot10, Plot20, Plot30, PlotRange -> {{0, tend}, {0, 1000}}, Epilog ->
  Inset[Column[{LineLegend[{Blue, Red, Green}, {"S", "I", "R"}], LabelStyle ->
  {FontFamily -> "Times New Roman", FontSize -> 21, FontSlant -> Italic}}],
  Scaled[{0.85, 0.7}]], MaxRecursion -> 0, PlotPoints -> {200, 100},
  AspectRatio -> 1, AxesOrigin -> {0, 0}, RotateLabel -> True,
  LabelStyle -> {21, GrayLevel[0]}, ImageSize -> {450, 450},
  AspectRatio -> Full, PlotLabel -> None]

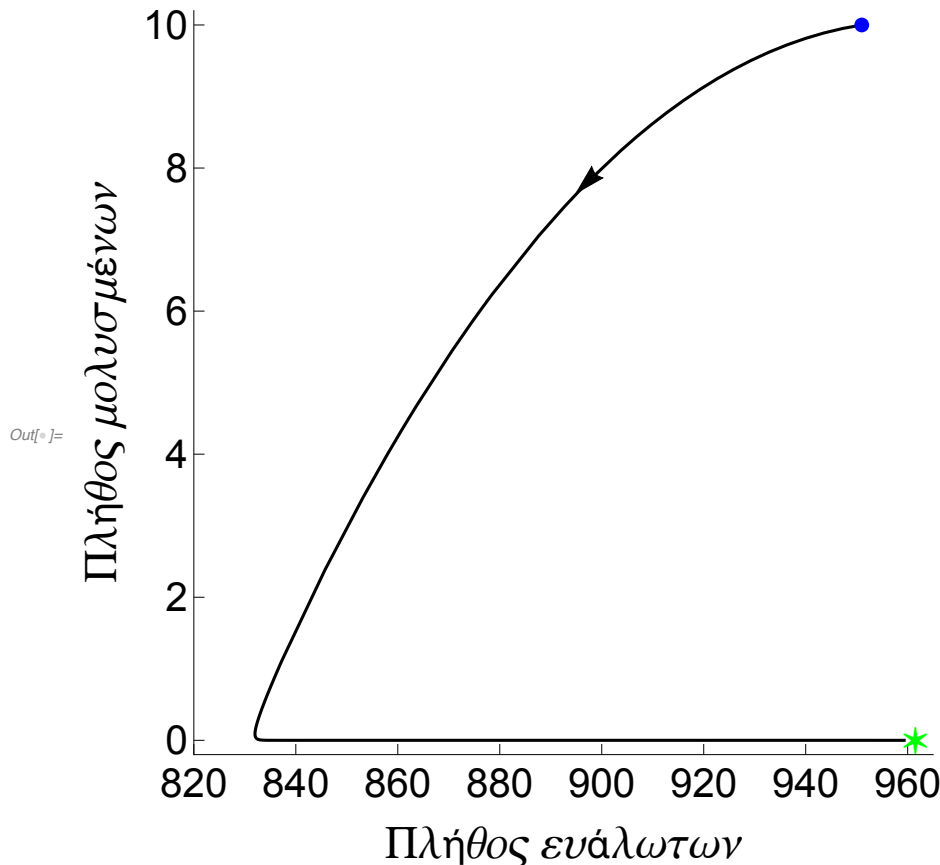
```



```

In[ ]:= Plot0 =
  ParametricPlot[{Evaluate[S[t] /. First[Sol0]], Evaluate[I[t] /. First[Sol0]]},
    {t, 0, tend + 100}, PlotPoints → 200, Mesh → False, AxesLabel → {t, I},
    PlotRange → {{820, 965}, {-0.2, 10.2}}, PlotStyle → Black,
    FrameLabel → {Style["Πλήθος ευάλωτων", FontFamily → "MS Serif", FontSize → 21,
      FontColor → Black], Style["Πλήθος μολυσμένων", FontFamily → "MS Serif",
      FontSize → 21, FontColor → Black]}, RotateLabel → True,
    Frame → {{Automatic, False}, {Automatic, False}}, FrameTicks →
      {{{0, 2, 4, 6, 8, 10}, None}, {{820, 840, 860, 880, 900, 920, 940, 960}, None}},
    Epilog → {{Green, Text[Style["*"], 20], {961.53, 0}]}];
  P10 = Graphics[{PointSize[0.02], Red, Point[{961.53, 0}]}];
  P20 = Graphics[Arrow[{{900, 8}, {895, 7.65}}]];
  G10 = Graphics[{PointSize[0.02], Blue, Point[{N - I0, I0}]}];
  Show[Plot0, P20, G10, LabelStyle → {21, GrayLevel[0]},
    ImageSize → {450, 450}, AspectRatio → Full, PlotLabel → None]

```



```

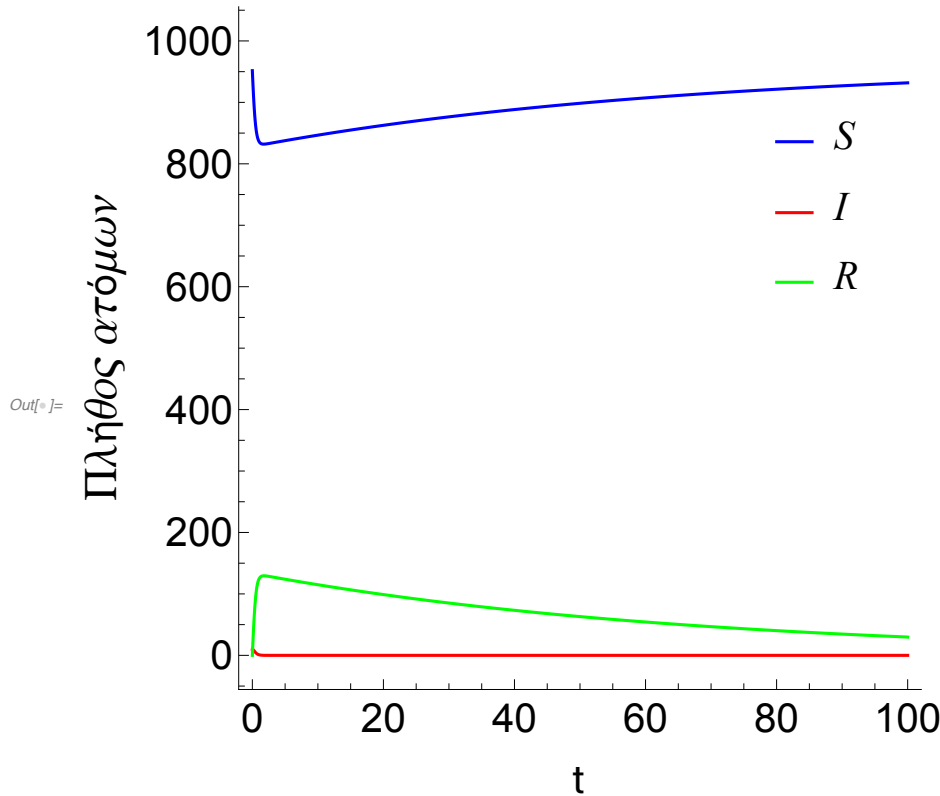
In[ ]:= (*Παίρνουμε λίγο μεγαλύτερο πλήθος N=N=961.6 *)
  N = 961.6; I0 = 10;
  S0 = N - I0;
  R0 = 0;

```

```

In[ ]:= Sol1 = NDSolve[{D[S[t], t] == mu * N - beta * S[t] * I[t] - mu * S[t], D[I[t], t] ==
  beta * S[t] * I[t] - (gamma + mu) * I[t], D[R[t], t] == gamma * I[t] - mu * R[t],
  S[0] == S0, I[0] == I0, R[0] == R0}, {S, I, R}, {t, 0, tend}];
Plot11 = Plot[Evaluate[S[t] /. First[Sol1]], {t, 0, tend}, PlotPoints -> 200,
  Mesh -> False, AxesLabel -> {t, S}, PlotRange -> All, PlotStyle -> Blue,
  FrameLabel -> {Style["t", FontFamily -> "MS Serif", FontSize -> 21],
  Style["Πλήθος ατόμων", FontFamily -> "MS Serif", FontSize -> 21]},
  RotateLabel -> True, Frame -> {{Automatic, False}, {Automatic, False}}];
Plot21 = Plot[Evaluate[I[t] /. First[Sol1]], {t, 0, tend}, PlotPoints -> 200,
  Mesh -> False, AxesLabel -> {t, I}, PlotRange -> All, PlotStyle -> Red,
  FrameLabel -> {Style["t", FontFamily -> "MS Serif", FontSize -> 21],
  Style["Πλήθος ατόμων", FontFamily -> "MS Serif", FontSize -> 21]},
  RotateLabel -> True, Frame -> {{Automatic, False}, {Automatic, False}}];
Plot31 = Plot[Evaluate[R[t] /. First[Sol1]], {t, 0, tend}, PlotPoints -> 200,
  Mesh -> False, AxesLabel -> {t, R}, PlotRange -> All, PlotStyle -> Green,
  FrameLabel -> {Style["t", FontFamily -> "MS Serif", FontSize -> 21],
  Style["Πλήθος ατόμων", FontFamily -> "MS Serif", FontSize -> 21]},
  RotateLabel -> True, Frame -> {{Automatic, False}, {Automatic, False}}];
MP1 = Show[Plot11, Plot21, Plot31, PlotRange -> {{0, tend}, {0, 1000}}, Epilog ->
  Inset[Column[{LineLegend[{Blue, Red, Green}, {"S", "I", "R"}], LabelStyle ->
  {FontFamily -> "Times New Roman", FontSize -> 21, FontSlant -> Italic}}],
  Scaled[{0.85, 0.7}]], MaxRecursion -> 0, PlotPoints -> {200, 100},
  AspectRatio -> 1, AxesOrigin -> {0, 0}, RotateLabel -> True,
  LabelStyle -> {21, GrayLevel[0]}, ImageSize -> {450, 450},
  AspectRatio -> Full, PlotLabel -> None]

```



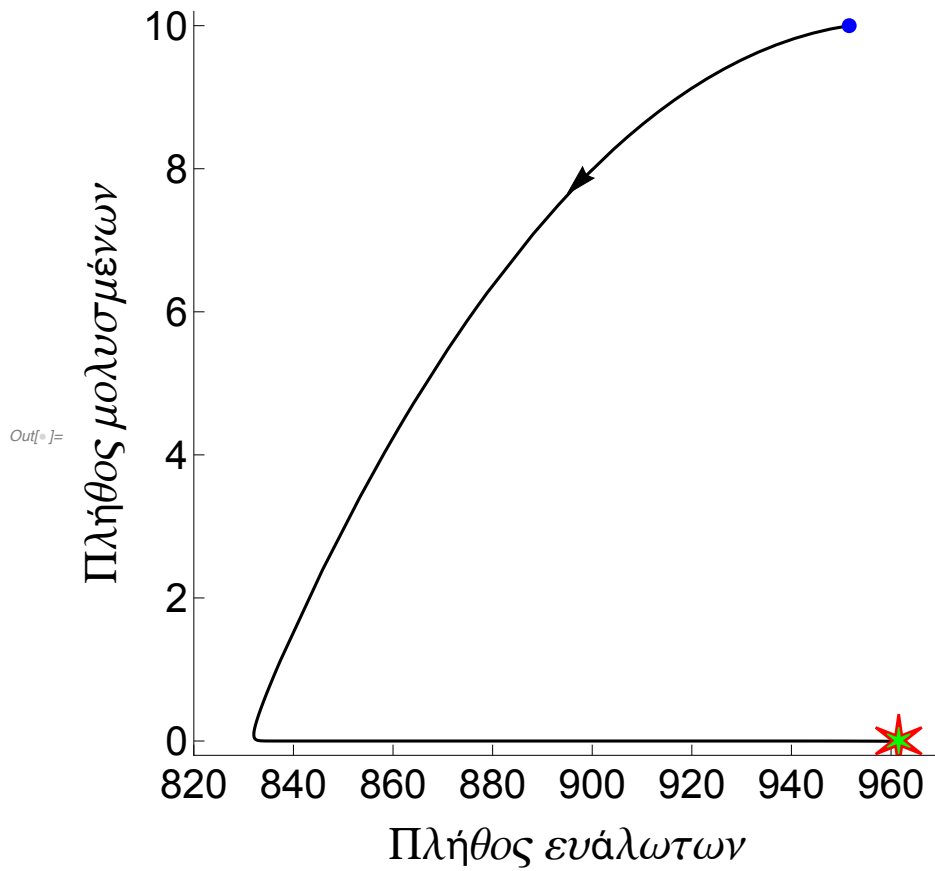
In[]:= Plot1 =

```

ParametricPlot[{Evaluate[S[t] /. First[Sol1]], Evaluate[I[t] /. First[Sol1]]},
  {t, 0, tend + 100}, PlotPoints → 200, Mesh → False, AxesLabel → {t, I},
  PlotRange → {{820, 970}, {-0.2, 10.2}}, PlotStyle → Black,
  FrameLabel → {Style["Πλήθος ευάλωτων", FontFamily → "MS Serif", FontSize → 21,
    FontColor → Black], Style["Πλήθος μολυσμένων", FontFamily → "MS Serif",
    FontSize → 21, FontColor → Black]}, RotateLabel → True,
  Frame → {{Automatic, False}, {Automatic, False}}, FrameTicks →
  {{{0, 2, 4, 6, 8, 10}, None}, {{820, 840, 860, 880, 900, 920, 940, 960}, None}},
  Epilog → {{Red, Text[Style["★", 40], {(gamma + mu) / beta,
    mu * N / (gamma + mu) - mu / beta}]}, {Green, Text[Style["★", 20], {N, 0}]}];
P11 = Graphics[{PointSize[0.02], Red, Point[{N, 0}]}];
P21 = Graphics[Arrow[{{900, 8}, {895, 7.65}}]];
P31 = Graphics[
  {Red, Circle[{(gamma + mu) / beta, mu * N / (gamma + mu) - mu / beta}, {3, 0.2}]}];
G11 = Graphics[{PointSize[0.02], Blue, Point[{N - I0, I0}]}];

```

```
In[ ]:= Show[Plot1, P21, G11, LabelStyle -> {21, GrayLevel[0]},
  ImageSize -> {450, 450}, AspectRatio -> Full, PlotLabel -> None]
```

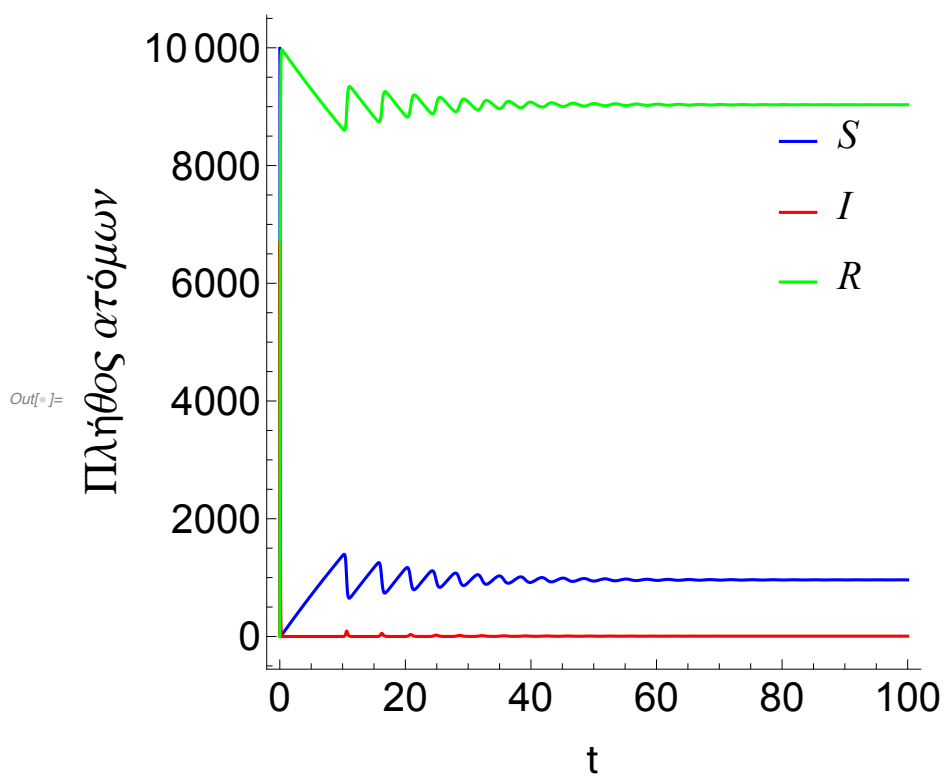


```
In[ ]:= (*Παίρνουμε πολύ μεγαλύτερο πλήθος N=N=10000 *)
N = 10 000; I0 = 10;
S0 = N - I0;
R0 = 0;
```

```

In[ ]:= Sol2 = NDSolve[{D[S[t], t] == mu * N - beta * S[t] * I[t] - mu * S[t], D[I[t], t] ==
  beta * S[t] * I[t] - (gamma + mu) * I[t], D[R[t], t] == gamma * I[t] - mu * R[t],
  S[0] == S0, I[0] == I0, R[0] == R0}, {S, I, R}, {t, 0, tend}];
Plot12 = Plot[Evaluate[S[t] /. First[Sol2]], {t, 0, tend}, PlotPoints -> 200,
  Mesh -> False, AxesLabel -> {t, S}, PlotRange -> All, PlotStyle -> Blue,
  FrameLabel -> {Style["t", FontFamily -> "MS Serif", FontSize -> 21],
  Style["Πλήθος ατόμων", FontFamily -> "MS Serif", FontSize -> 21]},
  RotateLabel -> True, Frame -> {{Automatic, False}, {Automatic, False}}];
Plot22 = Plot[Evaluate[I[t] /. First[Sol2]], {t, 0, tend}, PlotPoints -> 200,
  Mesh -> False, AxesLabel -> {t, I}, PlotRange -> All, PlotStyle -> Red,
  FrameLabel -> {Style["t", FontFamily -> "MS Serif", FontSize -> 21],
  Style["Πλήθος ατόμων", FontFamily -> "MS Serif", FontSize -> 21]},
  RotateLabel -> True, Frame -> {{Automatic, False}, {Automatic, False}}];
Plot32 = Plot[Evaluate[R[t] /. First[Sol2]], {t, 0, tend}, PlotPoints -> 200,
  Mesh -> False, AxesLabel -> {t, R}, PlotRange -> All, PlotStyle -> Green,
  FrameLabel -> {Style["t", FontFamily -> "MS Serif", FontSize -> 21],
  Style["Πλήθος ατόμων", FontFamily -> "MS Serif", FontSize -> 21]},
  RotateLabel -> True, Frame -> {{Automatic, False}, {Automatic, False}}];
MP2 = Show[Plot12, Plot22, Plot32, PlotRange -> {{0, tend}, {0, 10000}}, Epilog ->
  Inset[Column[{LineLegend[{Blue, Red, Green}, {"S", "I", "R"}], LabelStyle ->
  {FontFamily -> "Times New Roman", FontSize -> 21, FontSlant -> Italic}}],
  Scaled[{0.85, 0.7}]], MaxRecursion -> 0, PlotPoints -> {200, 100},
  AspectRatio -> 1, AxesOrigin -> {0, 0}, RotateLabel -> True,
  LabelStyle -> {21, GrayLevel[0]}, ImageSize -> {450, 450},
  AspectRatio -> Full, PlotLabel -> None]

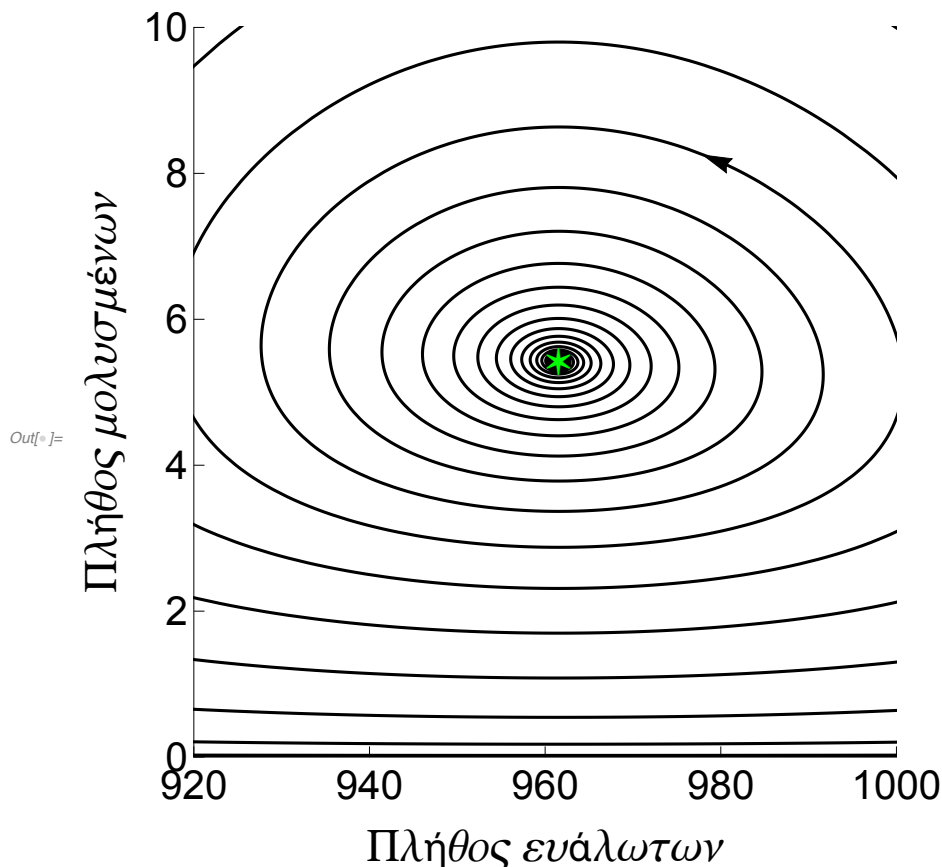
```




```

In[ ]:= Plot2 =
  ParametricPlot[{Evaluate[S[t] /. First[Sol2]], Evaluate[I[t] /. First[Sol2]]},
    {t, 0, tend}, PlotPoints → 200, Mesh → False, AxesLabel → {t, I},
    PlotRange → {{920, 1000}, {0, 10}}, PlotStyle → Black,
    FrameLabel → {Style["Πλήθος ευάλωτων", FontFamily → "MS Serif",
      FontSize → 21, FontColor → Black], Style["Πλήθος μολυσμένων",
      FontFamily → "MS Serif", FontSize → 21, FontColor → Black]},
    RotateLabel → True, Frame → {{Automatic, False}, {Automatic, False}},
    FrameTicks → {{0, 2, 4, 6, 8, 10}, None}, {{920, 940, 960, 980, 1000}, None}},
    Epilog → {{Green, Text[Style["*"], 20],
      {(gamma + mu) / beta, mu * N / (gamma + mu) - mu / beta}}]};
P12 = Graphics[{PointSize[0.02], Red,
  Point[{(gamma + mu) / beta, mu * N / (gamma + mu) - mu / beta}]}];
P22 = Graphics[Arrow[{{980, 8.15}, {978, 8.25}}]];
P32 = Graphics[{Red, Circle[{N, 0}, {3, 0.2}]}];
Show[Plot2, P22, P32, LabelStyle → {21, GrayLevel[0]},
  ImageSize → {450, 450}, AspectRatio → Full, PlotLabel → None]

```



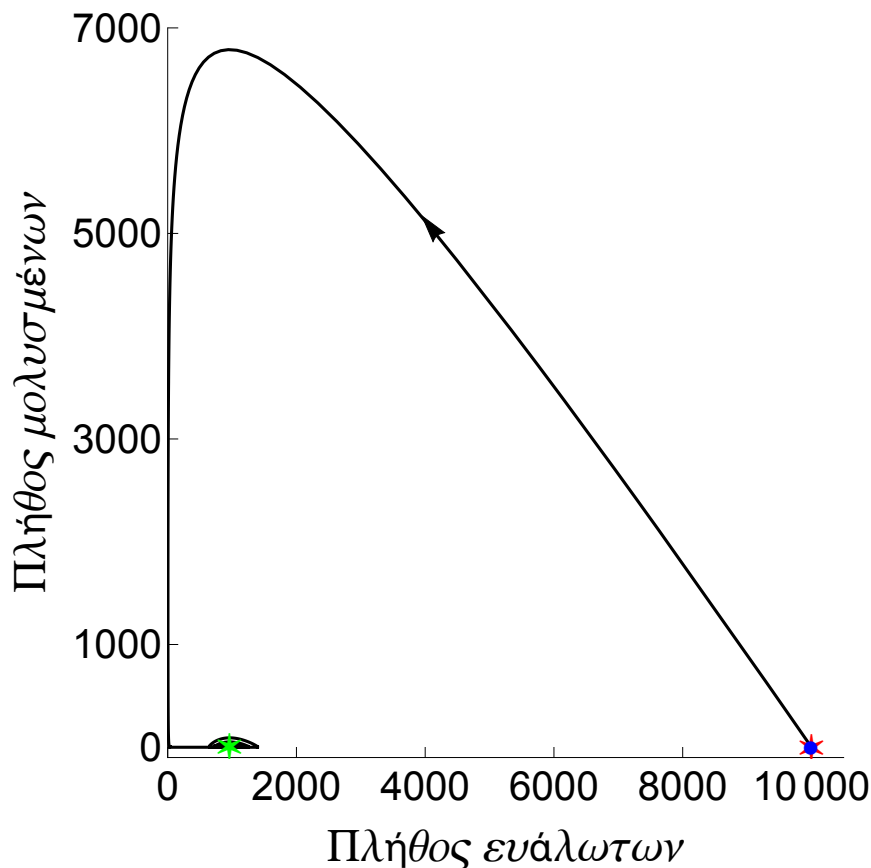
In[]:= Plot3 =

```

ParametricPlot[{Evaluate[S[t] /. First[Sol2]], Evaluate[I[t] /. First[Sol2]]},
  {t, 0, tend}, PlotPoints → 2000, Mesh → False, AxesLabel → {t, I},
  PlotRange → {{0, 10 500}, {-100, 7000}}, PlotStyle → Black,
  FrameLabel → {Style["Πλήθος ευάλωτων", FontFamily → "MS Serif",
    FontSize → 21, FontColor → Black], Style["Πλήθος μολυσμένων",
    FontFamily → "MS Serif", FontSize → 21, FontColor → Black]},
  RotateLabel → True, Frame → {{Automatic, False}, {Automatic, False}},
  FrameTicks → {{0, 1000, 3000, 5000, 7000}, None},
  {{0, 2000, 4000, 6000, 8000, 10 000}, None}}, Epilog → {{Green, Text[
  Style["★", 20], {(gamma + mu) / beta, mu * N / (gamma + mu) - mu / beta}}, {Red,
  Text[Style["★", 20], {N, 0}]}, {Blue, Text[Style["●", 11], {S0, I0}]}}];
P23 = Graphics[Arrow[{{4000, 5130}, {3950, 5170}}]];
P31n = Graphics[{Red, Circle[{N, 0}, {100, 100}]}];
G12 = Graphics[{PointSize[0.02], Blue, Point[{S0 - 400, I0}]}];
Show[Plot3, P23, LabelStyle → {21, GrayLevel[0]},
  ImageSize → {450, 450}, AspectRatio → Full, PlotLabel → None]

```

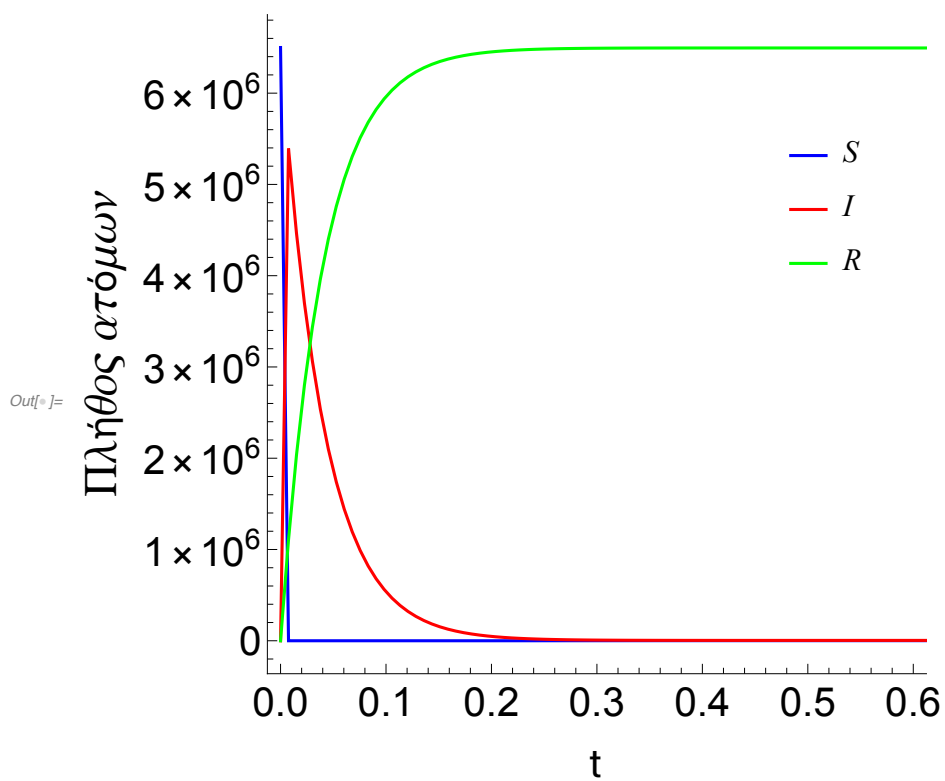
Out[]:=



```

In[ ]:= (*Παίρνουμε πολύ μεγάλο πλήθος N=N=6.5*10^6 *)
N = 6.5 * 10 ^ 6; I0 = 10;
S0 = N - I0;
R0 = 0;
Sol3 = NDSolve[{D[S[t], t] == mu * N - beta * S[t] * I[t] - mu * S[t], D[I[t], t] ==
  beta * S[t] * I[t] - (gamma + mu) * I[t], D[R[t], t] == gamma * I[t] - mu * R[t],
  S[0] == S0, I[0] == I0, R[0] == R0}, {S, I, R}, {t, 0, tend}];
Plot14 = Plot[Evaluate[S[t] /. First[Sol3]], {t, 0, tend}, PlotPoints -> 200,
  Mesh -> False, AxesLabel -> {t, S}, PlotRange -> All, PlotStyle -> Blue,
  FrameLabel -> {Style["t", FontFamily -> "MS Serif", FontSize -> 21],
  Style["Πλήθος ατόμων", FontFamily -> "MS Serif", FontSize -> 21]},
  RotateLabel -> True, Frame -> {{Automatic, False}, {Automatic, False}}];
Plot24 = Plot[Evaluate[I[t] /. First[Sol3]], {t, 0, tend}, PlotPoints -> 200,
  Mesh -> False, AxesLabel -> {t, I}, PlotRange -> All, PlotStyle -> Red,
  FrameLabel -> {Style["t", FontFamily -> "MS Serif", FontSize -> 21],
  Style["Πλήθος ατόμων", FontFamily -> "MS Serif", FontSize -> 21]},
  RotateLabel -> True, Frame -> {{Automatic, False}, {Automatic, False}}];
Plot34 = Plot[Evaluate[R[t] /. First[Sol3]], {t, 0, tend}, PlotPoints -> 200,
  Mesh -> False, AxesLabel -> {t, R}, PlotRange -> All, PlotStyle -> Green,
  FrameLabel -> {Style["t", FontFamily -> "MS Serif", FontSize -> 21],
  Style["Πλήθος ατόμων", FontFamily -> "MS Serif", FontSize -> 21]},
  RotateLabel -> True, Frame -> {{Automatic, False}, {Automatic, False}}];
MP3 = Show[Plot14, Plot24, Plot34, PlotRange -> {{0, 0.6}, {0, N}}, Epilog ->
  Inset[Column[{LineLegend[{Blue, Red, Green}, {"S", "I", "R"}, LabelStyle ->
    {FontFamily -> "Times New Roman", FontSize -> 16, FontSlant -> Italic}]}],
  Scaled[{0.85, 0.7}]], MaxRecursion -> 0, PlotPoints -> {200, 100},
  AspectRatio -> 1, AxesOrigin -> {0, 0}, RotateLabel -> True,
  LabelStyle -> {21, GrayLevel[0]}, ImageSize -> {450, 450},
  AspectRatio -> Full, PlotLabel -> None]

```

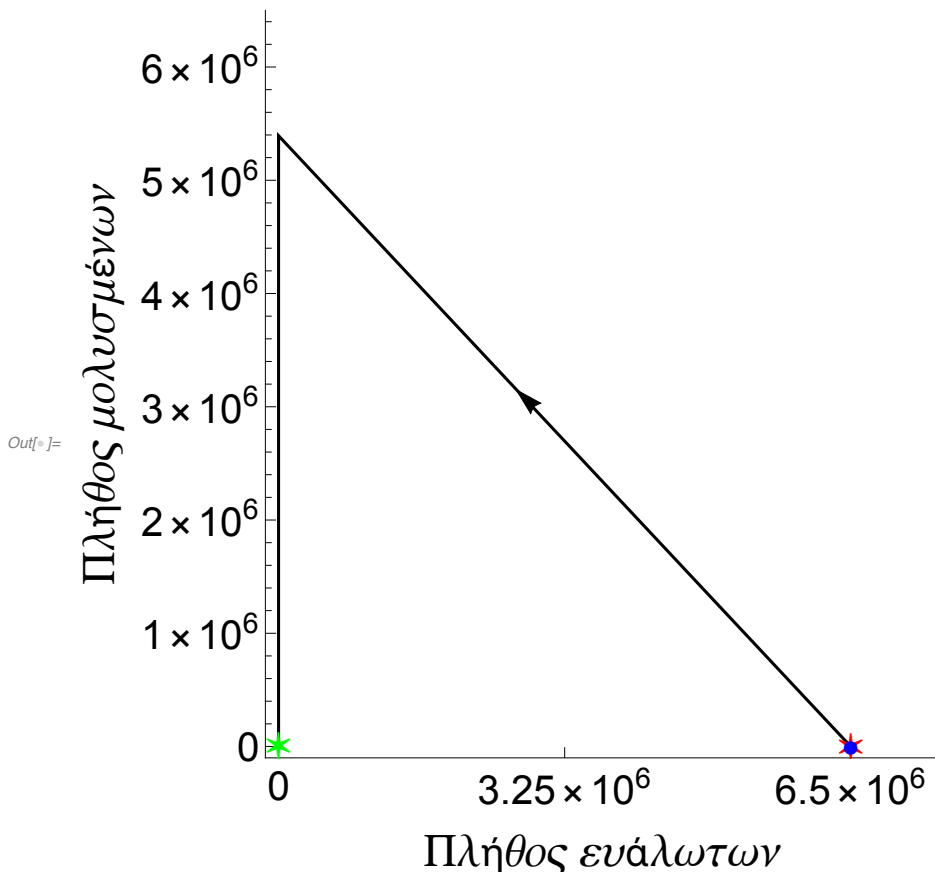


In[]:= Plot4 =

```

ParametricPlot[{Evaluate[S[t] /. First[Sol3]], Evaluate[I[t] /. First[Sol3]]},
  {t, 0, tend}, PlotPoints → 200, Mesh → False,
  PlotRange → {{-150 000, N + 1 000 000}, {-100 000, N}}, PlotStyle → Black,
  FrameLabel → {Style["Πλήθος ευάλωτων", FontFamily → "MS Serif",
    FontSize → 21, FontColor → Black], Style["Πλήθος μολυσμένων",
    FontFamily → "MS Serif", FontSize → 21, FontColor → Black]},
  RotateLabel → True, Frame → {{Automatic, False}, {Automatic, False}},
  FrameTicks → {All, {{0, N / 2, N}, None}}, Epilog → {{Green, Text[Style["*", 20],
    {(gamma + mu) / beta, mu * N / (gamma + mu) - mu / beta}]}, {Red,
    Text[Style["*", 20], {N, 0}]}, {Blue, Text[Style["●", 11], {S0, I0}]}];
P15 = Graphics[{PointSize[0.02], Red,
  Point[{(gamma + mu) / beta, mu * N / (gamma + mu) - mu / beta}]}];
P25 = Graphics[Arrow[{{2.9 * 10^6, 3 * 10^6}, {2.7 * 10^6, 3.15 * 10^6}}]];
P35 = Graphics[{Red, Circle[{N, 0}, {100 000, 100 000.2}]}];
Show[Plot4, P25, LabelStyle → {21, GrayLevel[0]},
  ImageSize → {450, 450}, AspectRatio → Full, PlotLabel → None]

```



```

In[ ]:= Plot5 =
  ParametricPlot[{Evaluate[S[t] /. First[Sol3]], Evaluate[I[t] /. First[Sol3]]},
    {t, 0, tend}, PlotPoints → 200, Mesh → False,
    PlotRange → {{910, 970}, {3850, 4100}}, PlotStyle → Black,
    FrameLabel → {Style["Πλήθος ευάλωτων", FontFamily → "MS Serif",
      FontSize → 21, FontColor → Black], Style["Πλήθος μολυσμένων",
      FontFamily → "MS Serif", FontSize → 21, FontColor → Black]},
    RotateLabel → True, Frame → {{Automatic, False}, {Automatic, False}},
    FrameTicks → {{{3900, 3950, 4000, 4050, 4100}, None},
      {{910, 920, 930, 940, 950, 960, 970}, None}}, Epilog → {{Green,
      Text[Style["*"], 20], {(gamma + mu) / beta, mu * N / (gamma + mu) - mu / beta}}]};
P16 = Graphics[{PointSize[0.02], Red,
  Point[{(gamma + mu) / beta, mu * N / (gamma + mu) - mu / beta}]}];
P26 = Graphics[Arrow[{{926, 4000}, {928, 3995}}]];
Show[Plot5, P26, LabelStyle → {21, GrayLevel[0]},
  ImageSize → {450, 450}, AspectRatio → Full, PlotLabel → None]

```

