Wydruk programu ,,Ukl_socz” do wytworzenia rysunków do układu dwóch soczewek

```
Exit[]
```

```
KadaptRK3BS[XY_] :=
 Module[{k1, k2, k3, k4, x = First@XY, Y = Drop[XY, 1], ΔY23, Δk, hstare},
  hstare = h;
  k1 = h FIO;
  k2 = h F[x + 1/2 h, ##] & @@ (Y + 1/2 k1);
  k3 = h F[x + 3/4 h, ##] & @@ (Y + 3/4 k2);
  Y3 = Y + (2/9 k1 + 1/3 k2 + 4/9 k3);
  FIO = F[x + h, ##] & @@ Y3;
  k4 = h FIO;
  ΔY23 = Abs[1/72 (5 k1 - 6 k2 - 8 k3 + 9 k4)];
  Δk = Max@ ΔY23/(Abs[Y3] + Abs[Y3 - Y]);
  h = hstare If[δ > Δk, Min[(δ/Δk)^(1/3), 5], Max[(δ/Δk)^(1/3), 1/5]];
  ndone++;
  Flatten@{x + hstare, Y3}]
```

```
makeGraph[iniDat_: {-6, -1.5, π/180 80, 0}, P_: 0.8, λ_: 400] :=
 Module[{graf, hstart, ν, dνx, dνy, λ1 = 400, λ2 = 720,
   ϵ = 0.2, kolor = ColorData["VisibleSpectrum"][λ]},
  {w = 6, v = 0.2, a = 1, b = 0.9, ro = 0.9, u = Sqrt[(x/a)^2 + (y/b)^2]};
  n1 = 1 + P ((1 + Exp[-ro / v])/(1 + Exp[u - ro / v]) + (x - 1)/(1 + Exp[u - ro / v]));
  nn[x_, y_] = n1 + (-1 + n1) ϵ (λ^2 - λ1^2) λ2^2/(λ^2 (λ1^2 - λ2^2));
  gWsp = Plot[nn[x, 0], {x, -w, w}, PlotRange → {All, {0, 3}}];
  tlo = ContourPlot[nn[x, y],
    {x, -w, w}, {y, -w, w}, Contours → 29, PlotPoints → 39];

  ν[x_, y_] = Log@(nn[x, y]);
  dνx[x_, y_] = D[ν[x, y], x];
  dνy[x_, y_] = D[ν[x, y], y];
  F[s_, x_, y_, ϕ_, t_] = {Cos[ϕ], Sin[ϕ],
     dνy[x, y] Cos[ϕ] - dνx[x, y] Sin[ϕ], Exp@(ν[x, y])} // Simplify;

  {s0, s1} = {0, ∞};
  {x0, y0, ϕ0, t0} = iniDat;

  hstart[] := Module[{f, df, fdf, Y0, x, y, ϕ, t, s, tmp},
    Y0 = Abs[{x0, y0, ϕ0}];
    f = Take[F[s0, x0, y0, ϕ0, t0], 3];
    df = Transpose[(D[Take[F[s, x, y, ϕ, t], 3], #] & /@ {x, y, ϕ}) /. s → s0 /.
         x → x0 /. y → y0 /. ϕ → ϕ0];
    fdf = Abs[f.df];
    tmp = Flatten@
      Table[If[fdf[[i]] > 0, Min[Sqrt[2 Y0[[i]]/fdf[[i]]], Abs[f[[i]]]/fdf[[i]]], ∞], {i, 1, 3}];
    Sqrt[δ] Min@tmp];
Clear[sol, tor];
  {δ = 10^-8, h = hstart[], hmax = ∞, nmax = 10000, ndone = 0,};
  FIO = F[s0, x0, y0, ϕ0, 0];
  sol = NestWhileList[KadaptRK3BS, {s0, x0, y0, ϕ0, t0},
    (w ≥ Abs[#[[2]]] && w ≥ Abs[#[[3]]] && #[[1]] < s1 && ndone < nmax) &];
  Print["ndone= ", ndone];
  tor[tkolor_] :=
   ListPlot[{#[[2]], #[[3]]} & /@ sol, Joined → True, PlotStyle → tkolor];
  graf = Show[tor[kolor], PlotRange → All, AspectRatio → 1];
  Print[Show[{tlo, graf}]];
  graf]
```

Rysunek 7.13a

```
gr20 = makeGraph[{-6, -1.1, π/180 20, 0}, 0.35, 650];
go20 = makeGraph[{-6, -1.1, π/180 20, 0}, 0.35, 615];
gy20 = makeGraph[{-6, -1.1, π/180 20, 0}, 0.35, 590];
gg20 = makeGraph[{-6, -1.1, π/180 20, 0}, 0.35, 510];
gb20 = makeGraph[{-6, -1.1, π/180 20, 0}, 0.35, 470];
gp20 = makeGraph[{-6, -1.1, π/180 20, 0}, 0.35, 410];
```

```
Show[{tlo, gr20, go20, gy20, gg20, gb20, gp20}]
```

Rysunek 7.13b

```
gr335 = makeGraph[{-4.5, -0.1, π/180 335, 0}, 0.35, 650];
go335 = makeGraph[{-4.5, -0.1, π/180 335, 0}, 0.35, 615];
gy335 = makeGraph[{-4.5, -0.1, π/180 335, 0}, 0.35, 590];
gg335 = makeGraph[{-4.5, -0.1, π/180 335, 0}, 0.35, 510];
gb335 = makeGraph[{-4.5, -0.1, π/180 335, 0}, 0.35, 470];
gp335 = makeGraph[{-4.5, -0.1, π/180 335, 0}, 0.35, 410];
```

```
Show[{tlo, gr335, go335, gy335, gg335, gb335, gp335}]
```

Rysunek 7.14a

```
gr179 = makeGraph[{5, -2, π/180 179, 0}, 0.35, 650];
go179 = makeGraph[{5, -2, π/180 179, 0}, 0.35, 615];
gy179 = makeGraph[{5, -2, π/180 179, 0}, 0.35, 590];
gg179 = makeGraph[{5, -2, π/180 179, 0}, 0.35, 510];
gb179 = makeGraph[{5, -2, π/180 179, 0}, 0.35, 470];
gp179 = makeGraph[{5, -2, π/180 179, 0}, 0.35, 410];
```

```
Show[{tlo, gr179, go179, gy179, gg179, gb179, gp179}]
```

Rysunek 7.14b

```
gr79 = makeGraph[{-3, -6, π/180 79, 0}, 0.35, 650];
go79 = makeGraph[{-3, -6, π/180 79, 0}, 0.35, 615];
gy79 = makeGraph[{-3, -6, π/180 79, 0}, 0.35, 590];
gg79 = makeGraph[{-3, -6, π/180 79, 0}, 0.35, 510];
gb79 = makeGraph[{-3, -6, π/180 79, 0}, 0.35, 470];
gp79 = makeGraph[{-3, -6, π/180 79, 0}, 0.35, 410];
```

```
Show[{tlo, gr79, go79, gy79, gg79, gb79, gp79}]
```

Rysunek 7.15

```
gr135 = makeGraph[{6, 0.01, π/180 135, 0}, 0.35, 650];
go135 = makeGraph[{6, 0.01, π/180 135, 0}, 0.35, 615];
gy135 = makeGraph[{6, 0.01, π/180 135, 0}, 0.35, 590];
gg135 = makeGraph[{6, 0.01, π/180 135, 0}, 0.35, 510];
gb135 = makeGraph[{6, 0.01, π/180 135, 0}, 0.35, 470];
gp135 = makeGraph[{6, 0.01, π/180 135, 0}, 0.35, 410];
gr150 = makeGraph[{6, 0.01, π/180 150, 0}, 0.35, 650];
go150 = makeGraph[{6, 0.01, π/180 150, 0}, 0.35, 615];
gy150 = makeGraph[{6, 0.01, π/180 150, 0}, 0.35, 590];
gg150 = makeGraph[{6, 0.01, π/180 150, 0}, 0.35, 510];
gb150 = makeGraph[{6, 0.01, π/180 150, 0}, 0.35, 470];
gp150 = makeGraph[{6, 0.01, π/180 150, 0}, 0.35, 410];
gr165 = makeGraph[{6, 0.01, π/180 165, 0}, 0.35, 650];
go165 = makeGraph[{6, 0.01, π/180 165, 0}, 0.35, 615];
gy165 = makeGraph[{6, 0.01, π/180 165, 0}, 0.35, 590];
gg165 = makeGraph[{6, 0.01, π/180 165, 0}, 0.35, 510];
gb165 = makeGraph[{6, 0.01, π/180 165, 0}, 0.35, 470];
gp165 = makeGraph[{6, 0.01, π/180 165, 0}, 0.35, 410];
gr180 = makeGraph[{6, 0.01, π/180 179.9, 0}, 0.35, 650];
```

```
go180 = makeGraph[{6, 0.01, π/180 179.9, 0}, 0.35, 615];
gy180 = makeGraph[{6, 0.01 π/180 179.9, 0}, 0.35, 590];
gg180 = makeGraph[{6, 0.01, π/180 179.9, 0}, 0.35, 510];
gb180 = makeGraph[{6, 0.01, π/180 179.9, 0}, 0.35, 470];
gp180 = makeGraph[{6, 0.01, π/180 179.9, 0}, 0.35, 410];
gr195 = makeGraph[{6, 0.01, π/180 195, 0}, 0.35, 650];
go195 = makeGraph[{6, 0.01, π/180 195, 0}, 0.35, 615];
gy195 = makeGraph[{6, 0.01, π/180 195, 0}, 0.35, 590];
gg195 = makeGraph[{6, 0.01, π/180 195, 0}, 0.35, 510];
gb195 = makeGraph[{6, 0.01, π/180 195, 0}, 0.35, 470];
gp195 = makeGraph[{6, 0.01, π/180 195, 0}, 0.35, 410];
gr210 = makeGraph[{6, 0.01, π/180 210, 0}, 0.35, 650];
go210 = makeGraph[{6, 0.01, π/180 210, 0}, 0.35, 615];
gy210 = makeGraph[{6, 0.01, π/180 210, 0}, 0.35, 590];
gg210 = makeGraph[{6, 0.01, π/180 210, 0}, 0.35, 510];
gb210 = makeGraph[{6, 0.01, π/180 210, 0}, 0.35, 470];
gp210 = makeGraph[{6, 0.01, π/180 210, 0}, 0.35, 410];
gr225 = makeGraph[{6, 0.01, π/180 225, 0}, 0.35, 650];
go225 = makeGraph[{6, 0.01, π/180 225, 0}, 0.35, 615];
gy225 = makeGraph[{6, 0.01, π/180 225, 0}, 0.35, 590];
gg225 = makeGraph[{6, 0.01, π/180 225, 0}, 0.35, 510];
gb225 = makeGraph[{6, 0.01, π/180 225, 0}, 0.35, 470];
gp225 = makeGraph[{6, 0.01, π/180 225, 0}, 0.35, 410];
```

```
Show[{tlo, gr135, go135, gy135, gg135, gb135, gp135, gr150, go150, gy150, gg150,
  gb150, gp150, gr165, go165, gy165, gg165, gb165, gp165, gr180, go180, gy180,
  gg180, gb180, gp180, gr195, go195, gy195, gg195, gb195, gp195, gr210, go210,
  gy210, gg210, gb210, gp210, gr225, go225, gy225, gg225, gb225, gp225}]
```

Rysunek 7.16

```
gr45 = makeGraph[{-3, 0.01, π/180 45, 0}, 0.35, 650];
```

```
go45 = makeGraph[{-3, 0.01, π/180 45, 0}, 0.35, 615];
gy45 = makeGraph[{-3, 0.01, π/180 45, 0}, 0.35, 590];
gg45 = makeGraph[{-3, 0.01, π/180 45, 0}, 0.35, 510];
gb45 = makeGraph[{-3, 0.01, π/180 45, 0}, 0.35, 470];
gp45 = makeGraph[{-3, 0.01, π/180 45, 0}, 0.35, 410];
gr30 = makeGraph[{-3, 0.01, π/180 30, 0}, 0.35, 650];
go30 = makeGraph[{-3, 0.01, π/180 30, 0}, 0.35, 615];
gy30 = makeGraph[{-3, 0.01, π/180 30, 0}, 0.35, 590];
gg30 = makeGraph[{-3, 0.01, π/180 30, 0}, 0.35, 510];
gb30 = makeGraph[{-3, 0.01, π/180 30, 0}, 0.35, 470];
gp30 = makeGraph[{-3, 0.01, π/180 30, 0}, 0.35, 410];
gr15 = makeGraph[{-3, 0.01, π/180 15, 0}, 0.35, 650];
go15 = makeGraph[{-3, 0.01, π/180 15, 0}, 0.35, 615];
gy15 = makeGraph[{-3, 0.01, π/180 15, 0}, 0.35, 590];
gg15 = makeGraph[{-3, 0.01, π/180 15, 0}, 0.35, 510];
gb15 = makeGraph[{-3, 0.01, π/180 15, 0}, 0.35, 470];
gp15 = makeGraph[{-3, 0.01, π/180 15, 0}, 0.35, 410];
gr0 = makeGraph[{-3, 0.01, π/180 0.1, 0}, 0.35, 650];
go0 = makeGraph[{-3, 0.01, π/180 0.1, 0}, 0.35, 615];
gy0 = makeGraph[{-3, 0.01, π/180 0.1, 0}, 0.35, 590];
gg0 = makeGraph[{-3, 0.01, π/180 0.1, 0}, 0.35, 510];
gb0 = makeGraph[{-3, 0.01, π/180 0.1, 0}, 0.35, 470];
gp0 = makeGraph[{-3, 0.01, π/180 0.1, 0}, 0.35, 410];
gr345 = makeGraph[{-3, 0.01, π/180 345, 0}, 0.35, 650];
go345 = makeGraph[{-3, 0.01, π/180 345, 0}, 0.35, 615];
gy345 = makeGraph[{-3, 0.01, π/180 345, 0}, 0.35, 590];
gg345 = makeGraph[{-3, 0.01, π/180 345, 0}, 0.35, 510];
gb345 = makeGraph[{-3, 0.01, π/180 345, 0}, 0.35, 470];
```

```
gp345 = makeGraph[{-3, 0.01, π/180 345, 0}, 0.35, 410];
gr330 = makeGraph[{-3, 0.01, π/180 330, 0}, 0.35, 650];
go330 = makeGraph[{-3, 0.01, π/180 330, 0}, 0.35, 615];
gy330 = makeGraph[{-3, 0.01, π/180 330, 0}, 0.35, 590];
gg330 = makeGraph[{-3, 0.01, π/180 330, 0}, 0.35, 510];
gb330 = makeGraph[{-3, 0.01, π/180 330, 0}, 0.35, 470];
gp330 = makeGraph[{-3, 0.01, π/180 330, 0}, 0.35, 410];
gr315 = makeGraph[{-3, 0.01, π/180 315, 0}, 0.35, 650];
go315 = makeGraph[{-3, 0.01, π/180 315, 0}, 0.35, 615];
gy315 = makeGraph[{-3, 0.01, π/180 315, 0}, 0.35, 590];
gg315 = makeGraph[{-3, 0.01, π/180 315, 0}, 0.35, 510];
gb315 = makeGraph[{-3, 0.01, π/180 315, 0}, 0.35, 470];
gp315 = makeGraph[{-3, 0.01, π/180 315, 0}, 0.35, 410];
```

```
Show[{tlo, gr0, go0, gy0, gg0, gb0, gp0, gr15, go15, gy15, gg15, gb15,
  gp15, gr30, go30, gy30, gg30, gb30, gp30, gr45, go45, gy45, gg45,
  gb45, gp45, gr345, go345, gy345, gg345, gb345, gp345, gr330, go330,
  gy330, gg330, gb330, gp330, gr315, go315, gy315, gg315, gb315, gp315}]
```