

Wydruk programu „Socz_wypukła” do wytworzenia rysunków do soczewki wypukłej

```
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 +  $\frac{1}{2}h$ , ##] &@@(Y +  $\frac{1}{2}k1$ );  
  k3 = h F[x +  $\frac{3}{4}h$ , ##] &@@(Y +  $\frac{3}{4}k2$ );  
  Y3 = Y + ( $\frac{2}{9}k1 + \frac{1}{3}k2 + \frac{4}{9}k3$ );  
  FIO = F[x + h, ##] &@@Y3;  
  k4 = h FIO;  
  ΔY23 = Abs[ $\frac{1}{72}(5k1 - 6k2 - 8k3 + 9k4)$ ];  
  Δk = Max@ $\frac{\Delta Y23}{Abs[Y3] + Abs[Y3 - Y]}$ ;  
  h = hstare If[ $\delta > \Delta k$ , Min[( $\frac{\delta}{\Delta k}$ )1/3, 5], Max[( $\frac{\delta}{\Delta k}$ )1/3, 1/5]];  
  ndone++;  
  Flatten@{x + hstare, Y3}]
```

```

makeGraph[iniDat_ : {-6, -1.5,  $\frac{\pi}{180}$  80, 0}, P_ : 0.8,  $\lambda_-$  : 400] :=
Module[{graf, hstart, v, dvx, dvy,  $\lambda_1 = 400$ ,  $\lambda_2 = 720$ ,
  e = 0.2, kolor = ColorData["VisibleSpectrum"] [ $\lambda$ ]},
  {w = 6, v = 0.5, a = 1, b = 0.9, ro = 1, u =  $\sqrt{\left(\frac{x}{a}\right)^2 + \left(\frac{y}{b}\right)^2}$ };
  n1 = 1 + P  $\left(\frac{1 + \text{Exp}[-ro / v]}{1 + \text{Exp}[u - ro / v]}\right)$ ;
  nn[x_, y_] = n1 +  $\frac{(-1 + n1) \epsilon (\lambda^2 - \lambda_1^2) \lambda_2^2}{\lambda^2 (\lambda_1^2 - \lambda_2^2)}$ ;
  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];

  v[x_, y_] = Log@ (nn[x, y]);
  dvx[x_, y_] = D[v[x, y], x];
  dvy[x_, y_] = D[v[x, y], y];
  F[s_, x_, y_,  $\phi_-$ , t_] = {Cos[ $\phi$ ], Sin[ $\phi$ ],
    dvy[x, y] Cos[ $\phi$ ] - dvx[x, y] Sin[ $\phi$ ], Exp@ (v[x, y])} // Simplify;

  {s0, s1} = {0,  $\infty$ };
  {x0, y0,  $\phi_0$ , t0} = iniDat;

  hstart[] := Module[{f, df, fdf, Y0, x, y,  $\phi$ , t, s, tmp},
    Y0 = Abs[{x0, y0,  $\phi_0$ }] ;
    f = Take[F[s0, x0, y0,  $\phi_0$ , t0], 3];
    df = Transpose[{D[Take[F[s, x, y,  $\phi$ , t], 3], #] & /@ {x, y,  $\phi$ }} /. s → s0 /.
      x → x0 /. y → y0 /.  $\phi$  →  $\phi_0$ ];
    fdf = Abs[f.df];
    tmp = Flatten@
      Table[If[fdf[[i]] > 0, Min[ $\sqrt{\frac{2 Y0[[i]]}{fdf[[i]]}}$ ,  $\frac{\text{Abs}[f[[i]]]}{fdf[[i]]}$ ],  $\infty$ ], {i, 1, 3}];
     $\sqrt{\delta}$  Min@tmp];
  Clear[sol, tor];
  { $\delta = 10^{-8}$ , h = hstart[], hmax =  $\infty$ , nmax = 10 000, ndone = 0,};
  FIO = F[s0, x0, y0,  $\phi_0$ , 0];
  sol = NestWhileList[KadaptRK3BS, {s0, x0, y0,  $\phi_0$ , 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 7.10

```

gr1 = makeGraph[{-5, -5,  $\frac{\pi}{180}$  0.1, 0}, 0.9, 650];
go1 = makeGraph[{-5, -5,  $\frac{\pi}{180}$  0.1, 0}, 0.9, 615];
gy1 = makeGraph[{-5, -5,  $\frac{\pi}{180}$  0.1, 0}, 0.9, 590];
gg1 = makeGraph[{-5, -5,  $\frac{\pi}{180}$  0.1, 0}, 0.9, 510];
gb1 = makeGraph[{-5, -5,  $\frac{\pi}{180}$  0.1, 0}, 0.9, 470];
gp1 = makeGraph[{-5, -5,  $\frac{\pi}{180}$  0.1, 0}, 0.9, 410];
gr15 = makeGraph[{-5, -5,  $\frac{\pi}{180}$  15, 0}, 0.9, 650];
go15 = makeGraph[{-5, -5,  $\frac{\pi}{180}$  15, 0}, 0.9, 615];
gy15 = makeGraph[{-5, -5,  $\frac{\pi}{180}$  15, 0}, 0.9, 590];
gg15 = makeGraph[{-5, -5,  $\frac{\pi}{180}$  15, 0}, 0.9, 510];
gb15 = makeGraph[{-5, -5,  $\frac{\pi}{180}$  15, 0}, 0.9, 470];
gp15 = makeGraph[{-5, -5,  $\frac{\pi}{180}$  15, 0}, 0.9, 410];
gr30 = makeGraph[{-5, -5,  $\frac{\pi}{180}$  30, 0}, 0.9, 650];
go30 = makeGraph[{-5, -5,  $\frac{\pi}{180}$  30, 0}, 0.9, 615];
gy30 = makeGraph[{-5, -5,  $\frac{\pi}{180}$  30, 0}, 0.9, 590];
gg30 = makeGraph[{-5, -5,  $\frac{\pi}{180}$  30, 0}, 0.9, 510];
gb30 = makeGraph[{-5, -5,  $\frac{\pi}{180}$  30, 0}, 0.9, 470];
gp30 = makeGraph[{-5, -5,  $\frac{\pi}{180}$  30, 0}, 0.9, 410];
gr45 = makeGraph[{-5, -5,  $\frac{\pi}{180}$  44.9, 0}, 0.9, 650];
go45 = makeGraph[{-5, -5,  $\frac{\pi}{180}$  44.9, 0}, 0.9, 615];
gy45 = makeGraph[{-5, -5,  $\frac{\pi}{180}$  44.9, 0}, 0.9, 590];
gg45 = makeGraph[{-5, -5,  $\frac{\pi}{180}$  44.9, 0}, 0.9, 510];
gb45 = makeGraph[{-5, -5,  $\frac{\pi}{180}$  44.9, 0}, 0.9, 470];
gp45 = makeGraph[{-5, -5,  $\frac{\pi}{180}$  44.9, 0}, 0.9, 410];
gr60 = makeGraph[{-5, -5,  $\frac{\pi}{180}$  60, 0}, 0.9, 650];
go60 = makeGraph[{-5, -5,  $\frac{\pi}{180}$  60, 0}, 0.9, 615];
gy60 = makeGraph[{-5, -5,  $\frac{\pi}{180}$  60, 0}, 0.9, 590];

```

```

gg60 = makeGraph[{-5, -5,  $\frac{\pi}{180}$  60, 0}, 0.9, 510];
gb60 = makeGraph[{-5, -5,  $\frac{\pi}{180}$  60, 0}, 0.9, 470];
gp60 = makeGraph[{-5, -5,  $\frac{\pi}{180}$  60, 0}, 0.9, 410];
gr75 = makeGraph[{-5, -5,  $\frac{\pi}{180}$  75, 0}, 0.9, 650];
go75 = makeGraph[{-5, -5,  $\frac{\pi}{180}$  75, 0}, 0.9, 615];
gy75 = makeGraph[{-5, -5,  $\frac{\pi}{180}$  75, 0}, 0.9, 590];
gg75 = makeGraph[{-5, -5,  $\frac{\pi}{180}$  75, 0}, 0.9, 510];
gb75 = makeGraph[{-5, -5,  $\frac{\pi}{180}$  75, 0}, 0.9, 470];
gp75 = makeGraph[{-5, -5,  $\frac{\pi}{180}$  75, 0}, 0.9, 410];
gr90 = makeGraph[{-5, -5,  $\frac{\pi}{180}$  89.9, 0}, 0.9, 650];
go90 = makeGraph[{-5, -5,  $\frac{\pi}{180}$  89.9, 0}, 0.9, 615];
gy90 = makeGraph[{-5, -5,  $\frac{\pi}{180}$  89.9, 0}, 0.9, 590];
gg90 = makeGraph[{-5, -5,  $\frac{\pi}{180}$  89.9, 0}, 0.9, 510];
gb90 = makeGraph[{-5, -5,  $\frac{\pi}{180}$  89.9, 0}, 0.9, 470];
gp90 = makeGraph[{-5, -5,  $\frac{\pi}{180}$  89.9, 0}, 0.9, 410];

```

```

Show[{tlo, gr1, go1, gy1, gg1, gb1, gp1, gr15, go15, gy15,
      gg15, gb15, gp15, gr30, go30, gy30, gg30, gb30, gp30, gr45, go45,
      gy45, gg45, gb45, gp45, gr60, go60, gy60, gg60, gb60, gp60, gr75,
      go75, gy75, gg75, gb75, gp75, gr90, go90, gy90, gg90, gb90, gp90}]

```

Rysunek 7.11a

```

gr90 = makeGraph[{-1.5, -6,  $\frac{\pi}{180}$  89.9, 0}, 0.9, 650];
go90 = makeGraph[{-1.5, -6,  $\frac{\pi}{180}$  89.9, 0}, 0.9, 615];
gy90 = makeGraph[{-1.5, -6,  $\frac{\pi}{180}$  89.9, 0}, 0.9, 590];
gg90 = makeGraph[{-1.5, -6,  $\frac{\pi}{180}$  89.9, 0}, 0.9, 510];
gb90 = makeGraph[{-1.5, -6,  $\frac{\pi}{180}$  89.9, 0}, 0.9, 470];
gp90 = makeGraph[{-1.5, -6,  $\frac{\pi}{180}$  89.9, 0}, 0.9, 410];

```

```

Show[{tlo, gr90, go90, gy90, gg90, gb90, gp90}]

```

Rysunek 7.11b

```
gr10 = makeGraph[{-5, 1,  $\frac{\pi}{180}$  10, 0}, 0.9, 650];  
go10 = makeGraph[{-5, 1,  $\frac{\pi}{180}$  10, 0}, 0.9, 615];  
gy10 = makeGraph[{-5, 1,  $\frac{\pi}{180}$  10, 0}, 0.9, 590];  
gg10 = makeGraph[{-5, 1,  $\frac{\pi}{180}$  10, 0}, 0.9, 510];  
gb10 = makeGraph[{-5, 1,  $\frac{\pi}{180}$  10, 0}, 0.9, 470];  
gp10 = makeGraph[{-5, 1,  $\frac{\pi}{180}$  10, 0}, 0.9, 410];
```

```
Show[{t10, gr60, go60, gy60, gg60, gb60, gp60}]
```