```
Manipulate[
  Row[{Show[img1, ImageSize → 350], Show[img2, ImageSize → 350]}, Spacer[20]]
  ,
  Item["", ControlPlacement → Top], Item["", ControlPlacement → Top],
  Item[
   Row[{Null, Style["液体表面张力系数自动化测量系统 ", Blue, 20], Null}, Spacer[213]],
   ControlPlacement → Top], Delimiter,
  Item[Row[{Spacer[40], Button["检查CCD", CreateDialog[Show[CurrentImage[],
        ImageSize → 350], WindowFloating → True, Modal -> True],
     ImageSize → {80, 30}],
    Spacer[20],
    Button["调整仪器", CreateDialog[Dynamic@Show[CurrentImage[], ImageSize → 450],
      WindowFloating → True, Modal -> True], ImageSize → {80, 30}], Spacer[20],
    Button["参数设定",

     CreateDialog[Column[{Control[{{dd, 1, "d = "}, InputField[#] &}],
        Control[{{n, 1.5, "n = "}, InputField[#] &}], Control[{{ρc, 1., "ρ = "},
          InputField[#] &}],
        Control[{{g, 9.8, "g = "}, InputField[#] &}], Control[{{xx, 0.13, "x = "},
          InputField[#] &}]}], Modal -> True]
     , ImageSize → {80, 30}]
    , Spacer[100], Button["比例系数测量", bilixishu, ImageSize → {120, 30}],
    Spacer[30], Dynamic[Style[StringForm["k = `1` px/cm", NumberForm[k, 5]], 13]]
   }], ControlPlacement → Top], Delimiter,
  Item[
   Row[{ Spacer[27], Button["拍照-1", img1 = CurrentImage[], ImageSize → {90, 30}],
    Spacer[20], Button["手动取点-1",

     CreateWindow[DialogNotebook[Manipulate[Show[img1, ImageSize → 350 k1],
        {{k1, 2, "放大倍数"}, 1, 4 ,
         Appearance → "Labeled", AppearanceElements → None },
        PreserveImageOptions → False, AppearanceElements → None]], WindowSize → All]


     , ImageSize → {90, 30}], Spacer[20], Button["自动取点-1",
     img = img1;
     CreateWindow[DialogNotebook[
       DynamicModule[{x1 = 3, x2 = 318, y1 = 3, y2 = 238, pp11 = Null, di = 0.35, r = 3 ,
         flag = 0(* 0:Ready; 1:正在计算; 2:显示坐标 *)     },
        Manipulate[
         Dynamic[Framed[Show[
            img,
            Graphics[
             {Yellow, Line[{{x1, y1}, {x1, y2}, {x2, y2}, {x2, y1}, {x1, y1}}]}]
            , ImageSize → 500]]],
         Item[Row[{"左", Slider[Dynamic[x1], {3, 318, 1}]}], Spacer[5]],
          ControlPlacement → Right],
         Item[Row[{"右", Slider[Dynamic[x2], {3, 318, 1}]}], Spacer[5]],
          ControlPlacement → Right],
         Item[Row[{"上", Slider[Dynamic[y2], {3, 238, 1}]}], Spacer[5]],
          ControlPlacement → Right],
         Item[Row[{"下", Slider[Dynamic[y1], {3, 238, 1}]}], Spacer[5]],
          ControlPlacement → Right],
         Delimiter,
```

```
Item[Dynamic[Style["range: " <> ToString[{{x1, x2}, {y1, y2}}]]],
 ControlPlacement → Right],
Delimiter,
Item[Row[{Style["di = ", 15], InputField[Dynamic[di], FieldSize → 15]}],
 ControlPlacement → Right],
Item[Row[{Style["  r = ", 15], InputField[Dynamic[r], FieldSize → 15]}],
 ControlPlacement → Right],
Delimiter,
Item[Row[{Button[Style["计算", 15, Red],
    img = img1;
    Which[
     di ≤ 0. || di ≥ 0.9,
     MessageDialog["di超出范围"],
     r ≤ 0 || r ≥ 10,
     MessageDialog["r超出范围"],
     True,
     flag = 1;
     Module[{ data, pp, mp , mpp , p = {} , sx, sy , xx1, xx2, yy1, yy2    },
      data = ImageData[ColorConvert[img, "Grayscale"]];
      pp = {};
      mp = cmaxDetect[data, {{x1, x2}, {y1, y2}}, pp];
      mpp = pointDetect[data, mp, di, r];
      Do[AppendTo[pp, mpp[[i]]], {i, 1, Length[mpp]}];
      sx = 0; sy = 0;
      Do[sx += mpp[[i, 1]]; sy += mpp[[i, 2]], {i, 1, Length[mpp]}];
      xx1 = N[sx / Length[mpp]]; yy1 = N[sy / Length[mpp]];
      img = Show[img,
        Graphics[{Blue,
          Line[{{xx1 - 10, yy1}, {xx1 + 10, yy1}}], Line[{{xx1, yy1 - 10},
            {xx1, yy1 + 10}}]}]];
      mp = cmaxDetect[data, {{x1, x2}, {y1, y2}}, pp];
      mpp = pointDetect[data, mp, di, r];
      Do[AppendTo[pp, mpp[[i]]], {i, 1, Length[mpp]}];
      sx = 0; sy = 0;
      Do[sx += mpp[[i, 1]]; sy += mpp[[i, 2]], {i, 1, Length[mpp]}];
      xx2 = N[sx / Length[mpp]]; yy2 = N[sy / Length[mpp]];
      img = Show[img,
        Graphics[{Blue,
          Line[{{xx2 - 10, yy2}, {xx2 + 10, yy2}}], Line[{{xx2, yy2 - 10},
            {xx2, yy2 + 10}}]}]];
      If[xx1 < xx2,
       pp11 = {{xx1, yy1}, {xx2, yy2}},
       pp11 = {{xx2, yy2}, {xx1, yy1}}]
     ];
     flag = 3
    ],
    Method -> "Queued"
    , ImageSize → {65, 30}],
   Button[Style["确定", 15],
    pp1 = pp11; DialogReturn[], ImageSize → {65, 30}],
   Button[Style["取消", 15], DialogReturn[], ImageSize → {65, 30}]
  }, Spacer[5]],
 ControlPlacement → Right],
Delimiter,
Item[
```

```
      Dynamic@Which[
        flag == 0,
        Style["Ready", 15],
        flag == 1,
        Style["正在计算...", 15],
        flag == 3,
        pp11
       ], ControlPlacement → Right]



    ]]]]

 , ImageSize → {90, 30}] ,
Spacer[69] ,
  Button["拍照-2", img2 = CurrentImage[], ImageSize → {90, 30}], Spacer[20],
Button["手动取点-2",
 CreateWindow[DialogNotebook[Manipulate[Show[img2, ImageSize → 350 k2],
    {{k2, 2, "放大倍数"}, 1, 4  , Appearance → "Labeled",
     AppearanceElements → None  },
    PreserveImageOptions → False, AppearanceElements → None]], WindowSize → All]
 , ImageSize → {90, 30}] , Spacer[20],
Button["自动取点-2",
 img = img2;
 CreateWindow[DialogNotebook[
   DynamicModule[{x1 = 3, x2 = 318, y1 = 3, y2 = 238, pp22 = Null, di = 0.35, r = 3 ,
     flag = 0(* 0:Ready; 1:正在计算; 2:显示坐标 *)     },
    Manipulate[
     Dynamic[Framed[Show[
        img,
        Graphics[
         {Yellow, Line[{{x1, y1}, {x1, y2}, {x2, y2}, {x2, y1}, {x1, y1}}]}]
        , ImageSize → 500]]],
     Item[Row[{"左", Slider[Dynamic[x1], {3, 318, 1}]}, Spacer[5]],
      ControlPlacement → Right],
     Item[Row[{"右", Slider[Dynamic[x2], {3, 318, 1}]}, Spacer[5]],
      ControlPlacement → Right],
     Item[Row[{"上", Slider[Dynamic[y2], {3, 238, 1}]}, Spacer[5]],
      ControlPlacement → Right],
     Item[Row[{"下", Slider[Dynamic[y1], {3, 238, 1}]}, Spacer[5]],
      ControlPlacement → Right],
     Delimiter,
     Item[Dynamic[Style["range: " <> ToString[{{x1, x2}, {y1, y2}}]]],
      ControlPlacement → Right],
     Delimiter,
     Item[Row[{Style["di = ", 15], InputField[Dynamic[di], FieldSize → 15]}],
      ControlPlacement → Right],
     Item[Row[{Style["  r = ", 15], InputField[Dynamic[r], FieldSize → 15]}],
      ControlPlacement → Right],
     Delimiter,
     Item[Row[{Button[Style["计算", 15, Red],
         img = img2;
         Which[
          di ≤ 0. || di ≥ 0.9,
          MessageDialog["di超出范围"],
```

```
                r ≤ 0 || r ≥ 10,
                MessageDialog["r超出范围"],
                True,
                flag = 1;
                Module[{ data, pp, mp , mpp , p = {} , sx, sy , xx1, xx2, yy1, yy2    },
                 data = ImageData[ColorConvert[img, "Grayscale"]];
                 pp = {};
                 mp = cmaxDetect[data, {{x1, x2}, {y1, y2}}, pp];
                 mpp = pointDetect[data, mp, di, r];
                 Do[AppendTo[pp, mpp[[i]]], {i, 1, Length[mpp]}];
                 sx = 0; sy = 0;
                 Do[sx += mpp[[i, 1]]; sy += mpp[[i, 2]], {i, 1, Length[mpp]}];
                 xx1 = N[sx / Length[mpp]]; yy1 = N[sy / Length[mpp]];
                 img = Show[img,
                   Graphics[{Blue, Line[{{xx1 - 10, yy1}, {xx1 + 10, yy1}}],
                     Line[{{xx1, yy1 - 10}, {xx1, yy1 + 10}}]}]];
                 mp = cmaxDetect[data, {{x1, x2}, {y1, y2}}, pp];
                 mpp = pointDetect[data, mp, di, r];
                 Do[AppendTo[pp, mpp[[i]]], {i, 1, Length[mpp]}];
                 sx = 0; sy = 0;
                 Do[sx += mpp[[i, 1]]; sy += mpp[[i, 2]], {i, 1, Length[mpp]}];
                 xx2 = N[sx / Length[mpp]]; yy2 = N[sy / Length[mpp]];
                 img = Show[img,
                   Graphics[{Blue, Line[{{xx2 - 10, yy2}, {xx2 + 10, yy2}}],
                     Line[{{xx2, yy2 - 10}, {xx2, yy2 + 10}}]}]];
                 If[xx1 < xx2,
                  pp22 = {{xx1, yy1}, {xx2, yy2}},
                  pp22 = {{xx2, yy2}, {xx1, yy1}}]
                ];
                flag = 3
               ], Method -> "Queued", ImageSize → {65, 30}],
              Button[Style["确定", 15],
               pp2 = pp22; DialogReturn[], ImageSize → {65, 30}],
              Button[Style["取消", 15], DialogReturn[], ImageSize → {65, 30}]
             }, Spacer[5]],
            ControlPlacement → Right],
           Delimiter,
           Item[
            Dynamic@Which[
              flag == 0,
              Style["Ready", 15],
              flag == 1,
              Style["正在计算...", 15],
              flag == 3,
              pp22
             ], ControlPlacement → Right]
          ]]]], ImageSize → {90, 30}] , Spacer[40] }], ControlPlacement → Bottom ],
    Delimiter,
    Item[Row[{Spacer[30],
       Row[{"坐标-1", InputField[Dynamic[pp1], FieldSize → 23]}, Spacer[4]]
       , Spacer[70],
       Row[{"坐标-2", InputField[Dynamic[pp2], FieldSize → 23]}, Spacer[4]]}],
     ControlPlacement → Bottom],
    Delimiter,
```

```
  Item[Row[{Spacer[80], Button[Style["计算-输出报告"
       , 15, Red],
      If[Dimensions[pp1] == {2, 2} && Dimensions[pp2] == {2, 2},
       jisuan,
       Which[
        pp1 === Null && pp2 === Null, MessageDialog["没有输入坐标数据"]; Beep[],
        True, MessageDialog["坐标数据有误"] ; Beep[] ]
      ], ImageSize → {200, 35}], Spacer[180], Button[Style["清空数据", 15],
      img1 = img2 = Image[Table[0, {240}, {320}]];
      pp1 = pp2 = Null, ImageSize → {200, 35}]}],
   ControlPlacement → Bottom],
  Delimiter,
  Item[
   Dynamic[Row[{StringForm["d=`1`cm", NumberForm[dd, {3, 2}]], StringForm["n=`1`",
       NumberForm[n, {3, 2}]], StringForm["ρ=`1`", NumberForm[ρc, {4, 3}]],
      StringForm["g=`1`", NumberForm[g, {3, 2}]], StringForm["x=`1`",
       NumberForm[xx, {3, 2}]],
      "pp1=" <> ToString[pp1], "pp2=" <> ToString[pp2]}, ", "]],
   ControlPlacement → Bottom],
  (*####################################
   ##################################################################*)

  Initialization :→ (img1 = img2 = Image[Table[0, {240}, {320}]]; k = 43.9876;

    pp1 = pp2 = Null;
    bilixishu := CreateWindow[DialogNotebook[
(Manipulate[
Framed[Dynamic@Show[imgt, ImageSize -> 400]],
Item[Style["比例系数测量", {17, Blue}], ControlPlacement -> Top],
Delimiter,
Item[Row[{"", Column[
              {Button[Style["拍摄"], imgt := CurrentImage[], ImageSize -> {150, 25}],
               Button[Style["拍照"], imgt = CurrentImage[],
                ImageSize -> {150, 25}]}]},
            Spacer[30]], ControlPlacement -> Right],
Delimiter,
Item[Style["k值的测量\n", {15, Bold}], ControlPlacement -> Right],
Item[Column[{Control[{{p, {{0, 0}, {0, 0}}, "p"}}],
Control[{{l, 0, "l"}}]
}, Spacings -> 3, Frame -> All,
           FrameStyle -> GrayLevel[0.6]], ControlPlacement -> Right],
Item[Column[{Row[{"", Button[Style["计算", {Red, 15}], (If[l != 0,
                  k = Norm[p[[1]] - p[[2]]] / l]),
                ImageSize -> {150, 30}], ""}, Spacer[30]],
Row[{"",
              Row[{"k = ", InputField[Dynamic[k], FieldSize → 5], " px/cm"}], ""},
             Spacer[50]]}, Spacings -> 2, Frame -> All,
           FrameStyle -> GrayLevel[0.6]],
          ControlPlacement -> Right], AppearanceElements → None,
Initialization :> (imgt := CurrentImage[]))
], WindowTitle -> "比例系数测量", WindowSize -> All
];
```

```
jisuan := Module[{ lp33, lp44 },
  lp33 = Norm[pp1[[1]] - pp2[[1]]];
  lp44 = Norm[pp1[[2]] - pp2[[2]]];
  l33 = lp33 / k;
  l44 = lp44 / k;
  dx1 = l44 / 100; dx2 = l33 / 100;
  x = xx / 100;
  d = dd / 100;
  ρ = 1000 ρc;
  θ1 = (θ /. FindRoot[dx1 == d (Tan[2 θ] - Tan[ArcSin[Sin[2 θ] / n]]), {θ, 0, 0, π / 4}]);
  θ2 = (θ /. FindRoot[dx2 == d (Tan[2 θ] - Tan[ArcSin[Sin[2 θ] / n]]), {θ, 0, 0, π / 4}]);
  γ = ρ g (x / (Log[Tan[θ2 / 4]] + 2 Cos[θ2 / 2] - Log[Tan[θ1 / 4]] - 2 Cos[θ1 / 2]))^2;

  CreateWindow[DialogNotebook[
    Panel[
     Column[{
       "坐标-1 :" <> ToString[pp1],
       "坐标-2 :" <> ToString[pp2],
       Null,
       Rasterize@Framed[Style[
          Grid[{
            {"d :", ToString[NumberForm[dd, {4, 2}]] <> "cm" , , "x :",
             ToString[NumberForm[xx, {4, 2}]] <> "cm"        },
            {"n :", ToString[NumberForm[n, {4, 2}]], ,  "g :",
             ToString[NumberForm[g, {4, 2}]] <> "m/s^2"         },
            {"ρ :", ToString[NumberForm[ρc, {4, 2}]] <> "g/cm^3", , "k :",
             ToString[NumberForm[k, {5, 3}]] <> "px/cm"       }
           }, Alignment → {
             {Right, Left, Automatic, Right, Left},
             {Right, Left, Automatic, Right, Left},
             {Right, Left, Automatic, Right, Left},
             {Right, Left, Automatic, Right, Left}

           }], 20]],
       Null,
       Rasterize@Framed[Grid[{
           {Style["P1P1' = " <> ToString[NumberForm[l33, {4, 2}]] <> "cm", 25, Red],
            Style[
             "P2P2' = " <> ToString[NumberForm[l44, {4, 2}]] <> "cm", 25, Red]},
           {Style["θ1 = " <> ToString[NumberForm[θ1 * 180 / Pi, 4]] <>
              "°", 25, Red],
            Style["θ2 = " <> ToString[NumberForm[θ2 * 180 / Pi, 4]] <>
              "°", 25, Red]}
          }, Spacings → {3, Automatic}, Alignment → Left]],
       Null,
```

```
        Column[{
          Style["所测液体表面张力系数为 :", 20],
          Panel@Rasterize[Column[
              {form, "", Style["= " <> ToString[NumberForm[γ, 10]], 15, Blue]}]]
         }],
        Null,
        Style["数据储存 :", 20],
        Row[{Style["储存文件 :", 15],
          InputField[Dynamic[dir], String, FieldSize → 35],
          FileNameSetter[Dynamic[dir], "Save"]}],

        Row[{Null, Null, Button[Style["数据覆盖", 15], chucun[True] ;
            MessageDialog["覆盖储存成功"],      ImageSize → {100, 30}],
          Button[Style["数据追加", 15], chucun[False];
           MessageDialog["追加储存成功"], ImageSize → {100, 30}],
          Button[Style["打开文件", 15], SystemOpen[dir], ImageSize → {100, 30}]
         }, Spacer[30]]
       }
      ],
      Background → White
     ]], WindowTitle → "测量报告与计算结果 ", WindowSize → All]];
```

$$\text{form} = \gamma = \rho\, g \left(\frac{x}{\log\left(\tan\left(\frac{\theta 2}{4}\right)\right) + 2\cos\left(\frac{\theta 2}{2}\right) - \log\left(\tan\left(\frac{\theta 1}{4}\right)\right) - 2\cos\left(\frac{\theta 1}{2}\right)} \right)^2 ;$$

```
dir = FileNameJoin[{Directory[], "tmp.txt"}];

chucun[flag_] := Module[{str   },
  If[flag,
   str = OpenWrite[dir],
   str = OpenAppend[dir]
  ];
  WriteString[str, "pp1 : " <> ToString[pp1] <> "\n"];
  WriteString[str, "pp2 : " <> ToString[pp2] <> "\n"];
  WriteString[str,
   "--------------------------------------------------------------------------\n
  WriteString[str, "d : "];
  WriteString[str, ToString[NumberForm[dd, {4, 2}]] <> "cm" ];
  WriteString[str, "\n"];
  WriteString[str, "n : "];
  WriteString[str, ToString[NumberForm[n, {4, 2}]]];
  WriteString[str, "\n"];
  WriteString[str, "r : "];
  WriteString[str, ToString[NumberForm[ρc, {4, 2}]] <> "g/cm^3"];
  WriteString[str, "\n"];
  WriteString[str, "x : "];
  WriteString[str, ToString[NumberForm[xx, {4, 2}]] <> "cm"];
  WriteString[str, "\n"];
  WriteString[str, "g : "];
  WriteString[str, ToString[NumberForm[g, {4, 2}]] <> "m/s^2"];
  WriteString[str, "\n"];
  WriteString[str, "k : " <> ToString[NumberForm[k, {5, 3}]] <> "px/cm"];
  WriteString[str, "\n\n"];
  WriteString[str, "P1-P1' = "];
  WriteString[str, ToString[NumberForm[l33, {4, 2}]] <> "cm"];
```

```
      WriteString[str, "\n"];
      WriteString[str, "P2-P2' = "];
      WriteString[str, ToString[NumberForm[l44, {4, 2}]] <> "cm"];
      WriteString[str, "\n"];
      WriteString[str, "q1 = "];
      WriteString[str, ToString[NumberForm[θ1 * 180 / Pi, 4]]];
      WriteString[str, "\n"];
      WriteString[str, "q2 = "];
      WriteString[str, ToString[NumberForm[θ2 * 180 / Pi, 4]]];
      WriteString[str, "\n\n"];
      WriteString[str, "y = "];
      WriteString[str, ToString[NumberForm[γ, 10]]];
      WriteString[str, "\n"];
      WriteString[str,
       "--------------------------------------------------------------------------\n
      WriteString[str, "Date: "];
      WriteString[str, DateString[]];
      WriteString[str, "\n\n"];
      WriteString[str,
       "==========================================================================\n
      Close[str];
     ];

    pointDetect[
data_(* 图像灰度数据 *),
grM_(* 几何坐标 (x,y) *),
di_(* 灰度容许范围 *),
r_(* 斑点最大半径 *)] :=
Module[
       { u = {}, su = {}, mgray, lgray, lzuo, rgray, rzuo, tgray, tzuo, bgray, bzuo ,
        cen , lou , gu = {} , L, l , dim , cenM         },
dim = Dimensions[data];
L = dim[[1]];
l = dim[[2]];
cenM = {L - grM[[2]] + 1, grM[[1]]};

mgray = data[[cenM[[1]], cenM[[2]]]];
u = {cenM};
su = {cenM};

While[Length[u] > 0,
lou = u;
u = {};
Do[
cen = lou[[i]];
If[(Norm[cen - cenM] < r) && (3 < cen[[1]] < L - 1) && (2 < cen[[2]] < l - 2),
(*====================*)
(*左*)
lzuo = {cen[[1]], cen[[2]] - 1};
lgray = data[[lzuo[[1]], lzuo[[2]]]];
If[(mgray - di <= lgray <= mgray) && (! MemberQ[su, lzuo]),
AppendTo[u, lzuo]; AppendTo[su, lzuo]];
(*右*)
rzuo = {cen[[1]], cen[[2]] + 1};
rgray = data[[rzuo[[1]], rzuo[[2]]]];
If[(mgray - di <= rgray <= mgray) && (! MemberQ[su, rzuo]),
```

```
AppendTo[u, rzuo]; AppendTo[su, rzuo]];
(*上*)
tzuo = {cen[[1]] - 1, cen[[2]]};
tgray = data[[tzuo[[1]], tzuo[[2]]]];
If[(mgray - di <= tgray <= mgray) && (! MemberQ[su, tzuo]),
AppendTo[u, tzuo]; AppendTo[su, tzuo]];
(*下*)
bzuo = {cen[[1]] + 1, cen[[2]]};
bgray = data[[bzuo[[1]], bzuo[[2]]]];
If[(mgray - di <= bgray <= mgray) && (! MemberQ[su, bzuo]),
AppendTo[u, bzuo]; AppendTo[su, bzuo]]]
(*======================*)
, {i, 1, Length[lou]}
]
];
(*坐标转换*)

Do[AppendTo[gu, {su[[k, 2]], L - su[[k, 1]] + 1}], {k, 1, Length[su]}];
gu
];
    cmaxDetect = Compile[{
{data(* 图像灰度数据 *), _Real, 2},
{range(*取点范围, { {left,right} , {bottom,top} } *), _Integer, 2},
{su(* 排除点集,几何坐标 *), _Integer, 2}},
Module[{ dim = {0, 0} , L = 0, l = 0  ,
        max = 0.  , gl = 0. , x = 0, y = 0 ,  xy = {0, 0}, mxy = {0, 0}  },
dim = Dimensions[data];
L = dim[[1]];
l = dim[[2]];
max = 0;
Do[
gl = data[[i, j]];
xy = {j, L - i + 1};
If[(max < gl) && (! MemberQ[su, xy]),
max = gl;
mxy = xy;
],
{i, L - Max[range[[2]]] + 1, L - Min[range[[2]]] + 1},
{j, Min[range[[1]]], Max[range[[1]]]}];
mxy]];
    ), AppearanceElements → None
 ] // Framed
Rasterize@Style[TraditionalForm[
    HoldForm[γ = ρ g (x / (Log[Tan[θ2/4]] + 2 Cos[θ2/2] - Log[Tan[θ1/4]] - 2 Cos[θ1/2]))^2]], 15, Blue]
```

$$\gamma = \rho\, g \left(\frac{x}{\log\left(\tan\left(\frac{\theta 2}{4}\right)\right) + 2\cos\left(\frac{\theta 2}{2}\right) - \log\left(\tan\left(\frac{\theta 1}{4}\right)\right) - 2\cos\left(\frac{\theta 1}{2}\right)} \right)^2$$