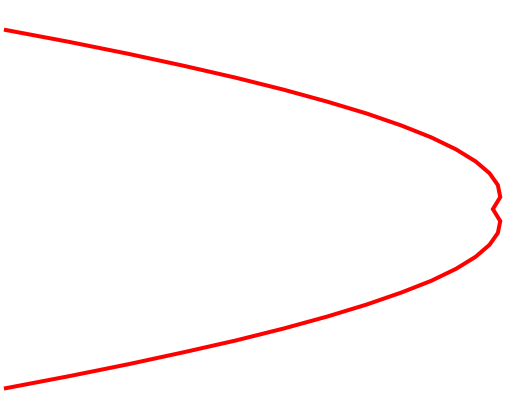
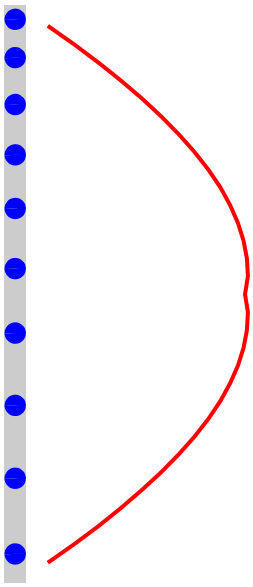
# 半波長ダイポール

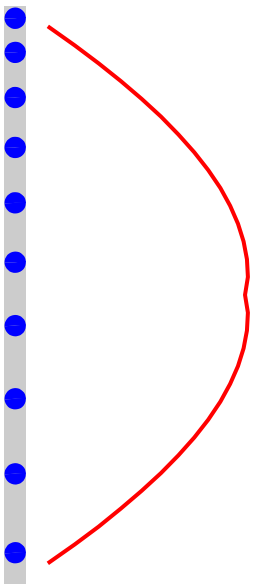
By 平野拓一

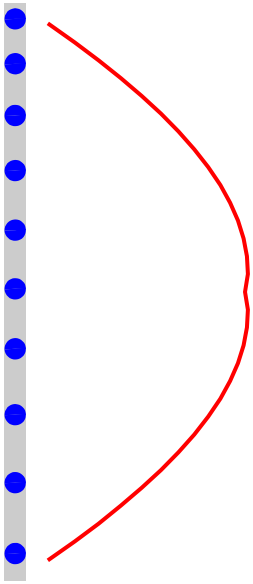
```
<< Graphics`Colors`

(* モーメント法の結果 *)
ivec = {{0.0015993914407161295`, -0.638326039248772`},
   {0.0027831608122753076`, -0.6325631210094189`}, {0.003901425945848874`,
    -0.626899099492919`}, {0.004943792355583696`, -0.6210407749991087`},
   {0.005915568720751507`, -0.6149339167612491`}, {0.006814306518962076`,
    -0.6085180370926005`}, {0.007635948282381321`, -0.6017301860351156`},
   {0.008375699124354924`, -0.5944970505766951`}, {0.009028639464416678`,
    -0.586729335457548`}, {0.009590034347251829`, -0.5783140102107232`},
   {0.01005550072072821`, -0.5691022309455882`}, {0.010421052498610209`,
    -0.5588863529252784`}, {0.010683083515825849`, -0.5473679964174963`},
   {0.010837141645569558`, -0.5339289636856862`}, {0.010883995930053006`,
    -0.518519737056533`}, {0.010745778116230915`, -0.4873006127297302`},
   {0.010883995930052999`, -0.518519737056533`}, {0.010837141645569539`,
    -0.5339289636856862`}, {0.010683083515825825`, -0.5473679964174962`},
   {0.010421052498610183`, -0.5588863529252782`}, {0.010055500720728179`,
    -0.5691022309455882`}, {0.009590034347251798`, -0.578314010210723`},
   {0.009028639464416646`, -0.586729335457548`}, {0.008375699124354883`,
    -0.594497050576695`}, {0.007635948282381277`, -0.6017301860351156`},
   {0.006814306518962035`, -0.6085180370926004`}, {0.00591556872075147`,
    -0.6149339167612489`}, {0.004943792355583666`, -0.6210407749991085`},
   {0.0039014259458488502`, -0.6268990994929189`}, {0.002783160812275291`,
    -0.6325631210094186`}, {0.00159939144071612`, -0.6383260392487717`}};

c = 3 * 10^8;
λ0 = 1.;
k0 = 2 π / λ0;
h = λ0 / 4;
nn = Length[ ivec ];
cur[n_, t_] := ivec[[n, 1]] * Cos[t + ivec[[n, 2]]];

grapdist = {Red, AbsoluteThickness[2],
   Line[Table[{20 * ivec[[i, 1]], ((i - 1) / (nn - 1)) * (2 * h) - h}, {i, 1, nn}]]};
Show[ Graphics[grapdist] ];
```

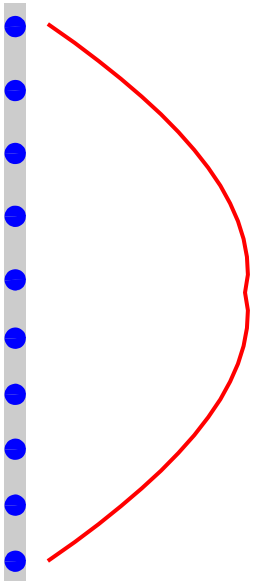


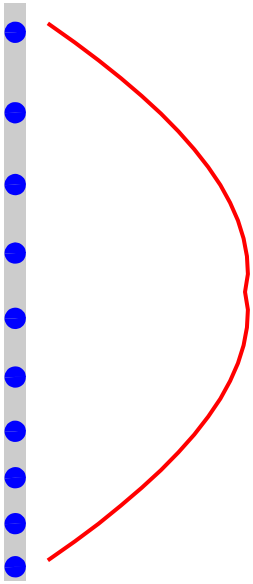
```
(* t: 時間, n: 電荷数 *)
charges[n_, t_] := Module[{r = (2 * h) / 50},
  {{GrayLevel[0.8], Rectangle[{-r, -h - 2 * r}, {r, h + 2 * r}]},
   (* 電子 *)
   {Blue, Table[Disk[{0, ((i - 1) / (n - 1)) * (2 * h) - h + 100. * (2 * h / (n - 1)) *
         cur[IntegerPart[((i - 1) / (n - 1)) * (nn - 1)] + 1, t]}, r], {i, 1, n}]}}
 ]

Table[Show[ Graphics[ {grapdist, charges[10, t]} ], AspectRatio → Automatic ],
 {t, 0, 2 Pi - 0.001, 2 Pi / 8}]
```

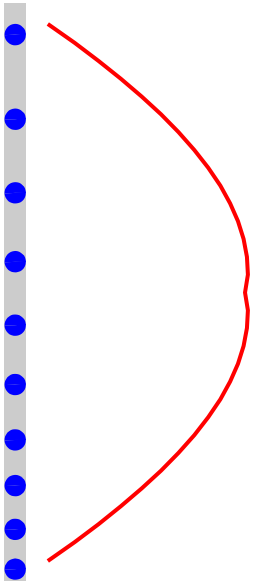


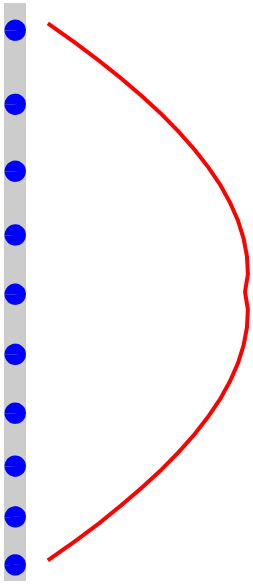


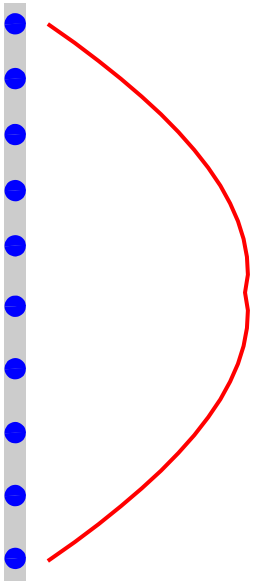








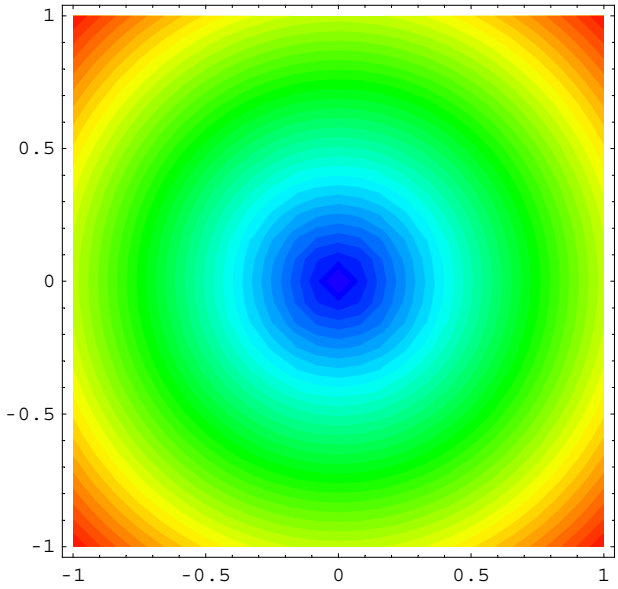




```
{-Graphics-, -Graphics-, -Graphics-, -Graphics-,
 -Graphics-, -Graphics-, -Graphics-, -Graphics-}
```

## Hue のテスト

```
ContourPlot[Sqrt[x^2 + y^2], {x, -1, 1}, {y, -1, 1},
 ColorFunction → (Hue[-0.7 * (# - 1), 1, 1] &), ContourLines → False, Contours → 40]
```




- ContourGraphics -

## 微小ダイポールの放射電界

$\hat{r}.\hat{x} = \text{Sin}[\theta]\ \text{Cos}[\varphi];$
$\hat{\theta}.\hat{x} = \text{Cos}[\theta]\ \text{Cos}[\varphi];$
$\hat{\varphi}.\hat{x} = \text{Sin}[\varphi];$

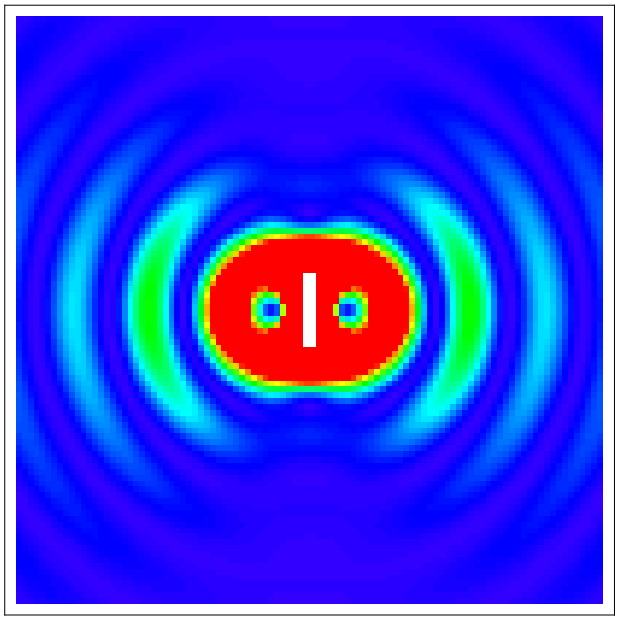
$\hat{r}.\hat{y} = \text{Sin}[\theta]\ \text{Sin}[\varphi];$
$\hat{\theta}.\hat{y} = \text{Cos}[\theta]\ \text{Sin}[\varphi];$
$\hat{\varphi}.\hat{y} = \text{Cos}[\varphi];$

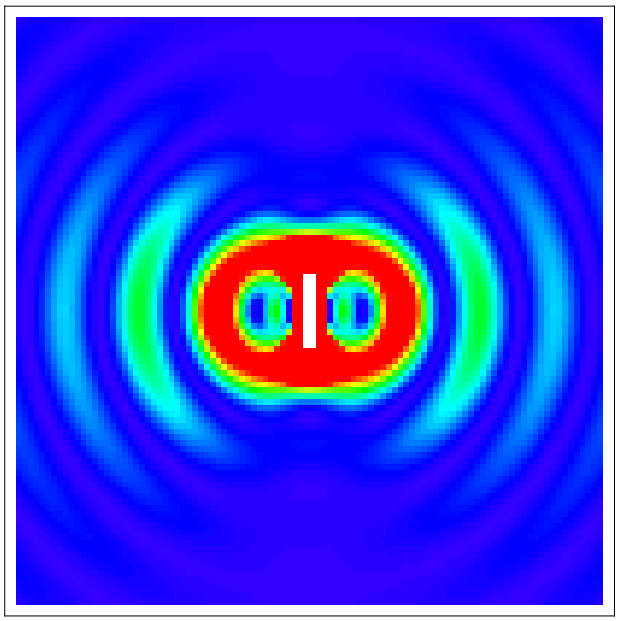
$\hat{r}.\hat{z} = \text{Cos}[\theta];$
$\hat{\theta}.\hat{z} = \text{Sin}[\theta];$
$\hat{\varphi}.\hat{z} = 0;$

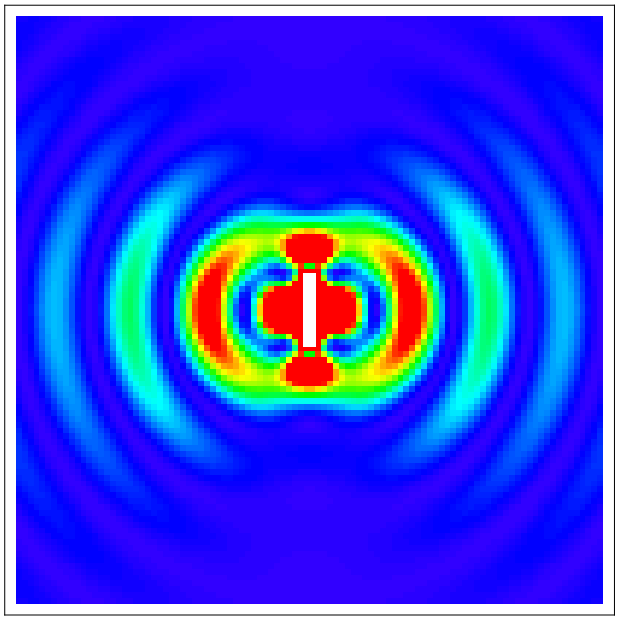
```
er[i_, r_, θ_, t_] :=
  2 * Cos[θ] * ( Cos[k0 * (c * t - r) + ivec[[i, 2]]] / (k0 * r)^2 + Sin[k0 * (c * t - r) + ivec[[i, 2]]] / (k0 * r)^3 );
etheta[i_, r_, θ_, t_] := Sin[θ] * ( Cos[k0 * (c t - r) + ivec[[i, 2]]] / (k0 * r)^2 -
    ( 1 / (k0 * r) - 1 / (k0 * r)^3 ) * Sin[k0 * (c t - r) + ivec[[i, 2]]] );
ex[i_, r_, θ_, φ_, t_] := Sin[θ] Cos[φ] er[i, r, θ, t] + Cos[θ] Cos[φ] etheta[i, r, θ, t];
ey[i_, r_, θ_, φ_, t_] := Sin[θ] Sin[φ] er[i, r, θ, t] + Cos[θ] Sin[φ] etheta[i, r, θ, t];
ez[i_, r_, θ_, φ_, t_] := Cos[θ] er[i, r, θ, t] + Sin[θ] etheta[i, r, θ, t];
energy[xo_, yo_, zo_, t_] :=
 Module[{xs = 0, ys = 0, zs = 0, r, θ, φ, exsum = 0, eysum = 0, ezsum = 0},
  Do[
   zs = (i - 1) / (nn - 1) * (2 * h) - h;
   r = Sqrt[(xo - xs)^2 + (yo - ys)^2 + (zo - zs)^2];
   θ = ArcCos[ (zo - zs) / Sqrt[(xo - xs)^2 + (yo - ys)^2 + (zo - zs)^2] ];
   φ = ArcCos[ (xo - xs) / Sqrt[(xo - xs)^2 + (yo - ys)^2] ];
   exsum += ivec[[i, 1]] * ex[i, r, θ, φ, t];
   eysum += ivec[[i, 1]] * ey[i, r, θ, φ, t];
   ezsum += ivec[[i, 1]] * ez[i, r, θ, φ, t]
   , {i, 1, nn}
  ];
  exsum^2 + eysum^2 + ezsum^2
 ]
```

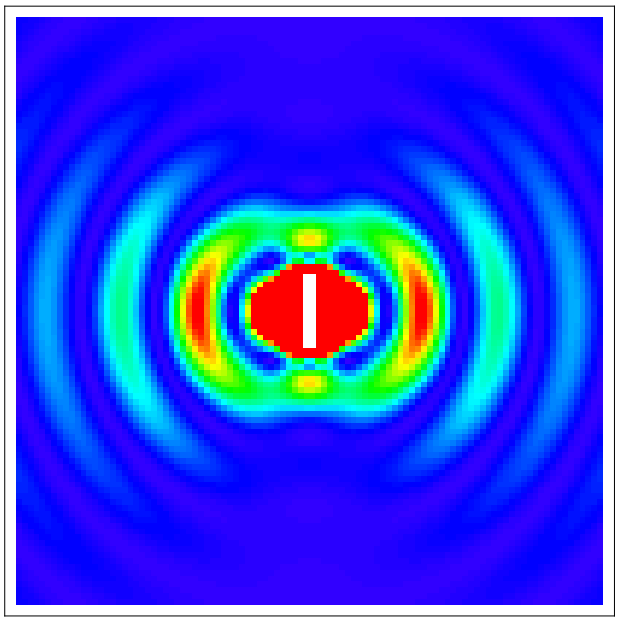
# アニメーション

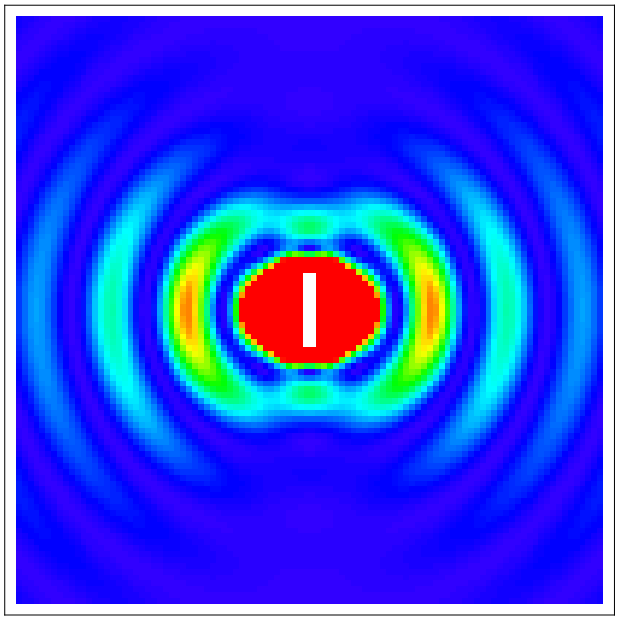
```
Table[DensityPlot[energy[0, x, y, t], {x, -2, 2},
  {y, -2, 2}, ColorFunction → (Hue[-0.7 * (# - 1), 1, 1] &),
  Mesh → False,
  FrameTicks → None,
  PlotRange → {0, 0.002},
  PlotPoints → 100,
  Epilog → {White, Rectangle[{-h / 6., -h}, {h / 6., h}]}],
 {t, 0, (π / (c k0)) - 0.001 * (π / (c k0)), (π / (c k0)) / 8}]
```

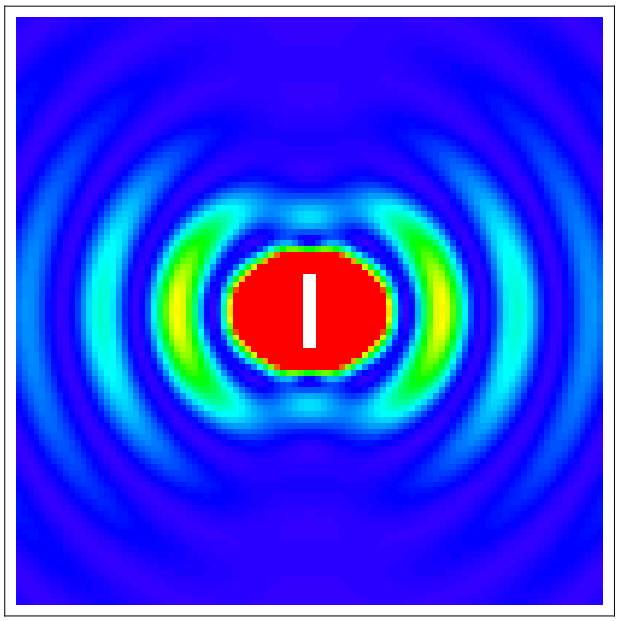


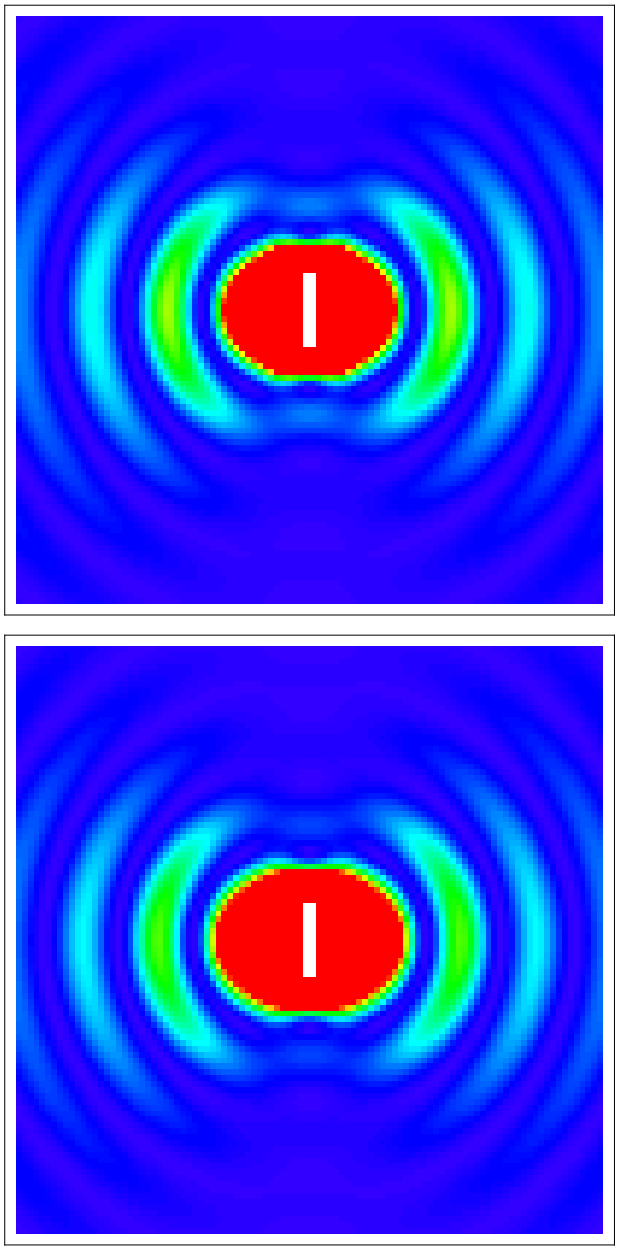












{- DensityGraphics -, - DensityGraphics -, - DensityGraphics -, - DensityGraphics -,
 - DensityGraphics -, - DensityGraphics -, - DensityGraphics -, - DensityGraphics -}