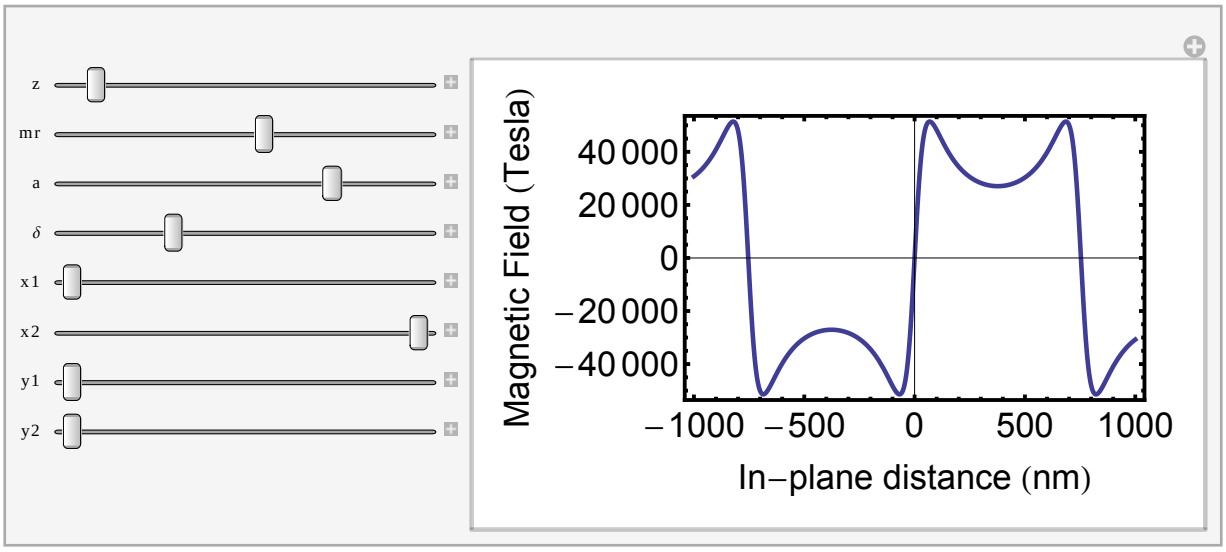
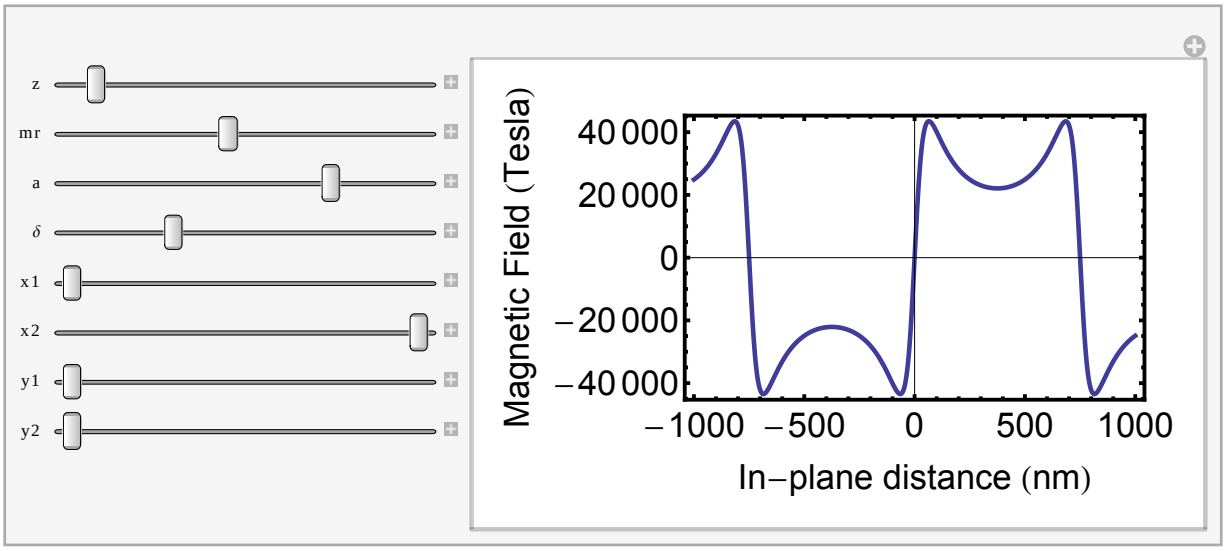
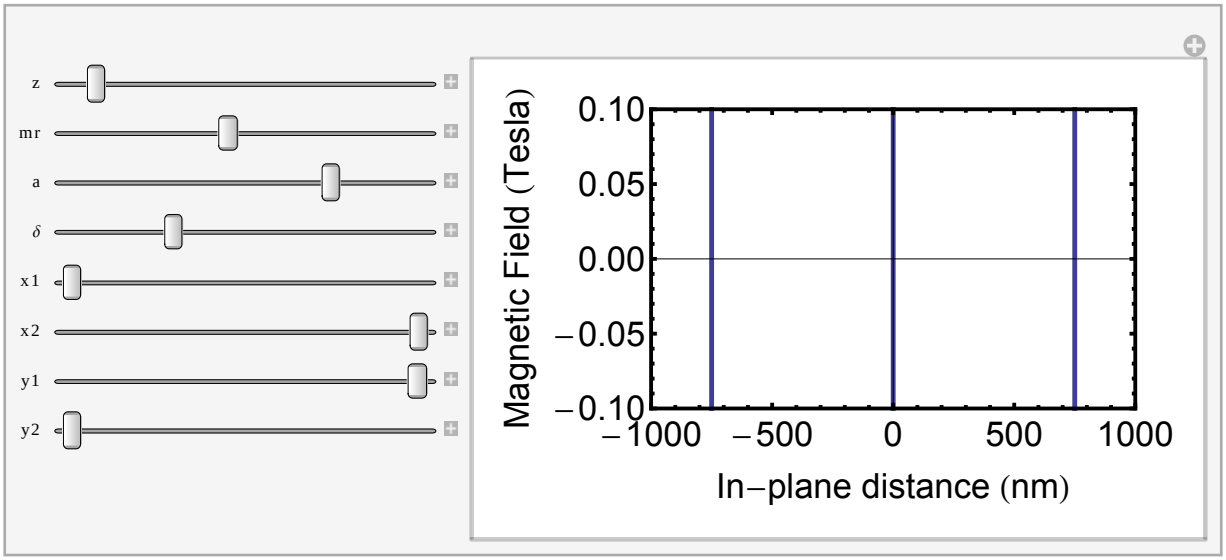
```
Hz[x_, z_] := (8 mr / π^2) *
   Sum[((1 / n) * Sin[(n * Pi * x) / a] * (1 - Exp[-Pi * (n / a) * δ]) * Exp[-Pi * (n / a) * z]),
    {n, 1, 50, 2}];

Hx[x_, z_] := (-8 mr / π^2) *
   Sum[((1 / n) * Cos[(n * Pi * x) / a] * (1 - Exp[-Pi * (n / a) * δ]) * Exp[-Pi * (n / a) * z]),
    {n, 1, 50, 2}];

HGzz[x_, z_] := Evaluate[D[Hz[x, z], z]];
HGzx[x_, z_] := Evaluate[D[Hz[x, z], x]];
HGxz[x_, z_] := Evaluate[D[Hx[x, z], z]];
HGxx[x_, z_] := Evaluate[D[Hx[x, z], x]];

ff[Ha_, Ms_] := If[Ha < Ms / 3, 3, Ms / Ha];

Vp[r_] := 4 Pi r^3 / 3;  (*NP radius r; in nm*)
Fmx[x_, z_, Rp_, Ms_] := mu0 Vp[Rp]
   ff[Sqrt[Hx[x, z]^2 + Hz[x, z]^2], Ms] (Hx[x, z] HGxx[x, z] + Hz[x, z] HGxz[x, z]);
(*Furlani_JAP_2006 eqn 15;Force units are cancelled with mass m*)
Fmz[x_, z_, Rp_, Ms_] := mu0 Vp[Rp] ff[Sqrt[Hx[x, z]^2 + Hz[x, z]^2], Ms]
   (Hx[x, z] HGzx[x, z] + Hz[x, z] HGzz[x, z]);
 (*Furlani_JAP_2006 eqn 15;Force units are cancelled with mass m*)

Hz[x, z]
```

```
Manipulate[Plot[(8 mr / π^2) *
   Sum[((1 / n) * Sin[(n * Pi * x) / a] * (1 - Exp[-Pi * (n / a) * δ]) * Exp[-Pi * (n / a) * z]),
    {n, 1, 50, 2}], {x, -1000, 1000}, PlotRange → {{x1, x2}, {y1, y2}}, Frame → True,
  FrameLabel → {"In-plane distance (nm)", "Magnetic Field (Tesla)"},
  PlotStyle → {{Thickness → 0.01}}, GridLines → None,
  FrameStyle → {{Directive[Thick, FontFamily → "Arial", Black, 18],
     Directive[Thick, FontFamily → "Arial", Black, 18]},
    {Directive[Thick, FontFamily → "Arial", Black, 18],
     Directive[Thick, FontFamily → "Arial", Black, 18]}}],
 {z, .1, 750}, {mr, 1, 1000 × 10^3}, {a, 10, 1000}, {δ, 1, 100},
 {x1, -1, 0}, {x2, 0, 1000},
 {y1, -100, 0}, {y2, 0, 100}]
```



```
Manipulate[
 Plot[1/π^2 8 mr (e^(-π z/a) (1 - e^(-π δ/a)) Sin[π x/a] + 1/3 e^(-3 π z/a) (1 - e^(-3 π δ/a)) Sin[3 π x/a] + 1/5 e^(-5 π z/a) (1 - e^(-5 π δ/a))
      Sin[5 π x/a] + 1/7 e^(-7 π z/a) (1 - e^(-7 π δ/a)) Sin[7 π x/a] + 1/9 e^(-9 π z/a) (1 - e^(-9 π δ/a)) Sin[9 π x/a] +
     1/11 e^(-11 π z/a) (1 - e^(-11 π δ/a)) Sin[11 π x/a] + 1/13 e^(-13 π z/a) (1 - e^(-13 π δ/a)) Sin[13 π x/a] +
     1/15 e^(-15 π z/a) (1 - e^(-15 π δ/a)) Sin[15 π x/a] + 1/17 e^(-17 π z/a) (1 - e^(-17 π δ/a)) Sin[17 π x/a] +
     1/19 e^(-19 π z/a) (1 - e^(-19 π δ/a)) Sin[19 π x/a] + 1/21 e^(-21 π z/a) (1 - e^(-21 π δ/a)) Sin[21 π x/a] +
     1/23 e^(-23 π z/a) (1 - e^(-23 π δ/a)) Sin[23 π x/a] + 1/25 e^(-25 π z/a) (1 - e^(-25 π δ/a)) Sin[25 π x/a] +
     1/27 e^(-27 π z/a) (1 - e^(-27 π δ/a)) Sin[27 π x/a] + 1/29 e^(-29 π z/a) (1 - e^(-29 π δ/a)) Sin[29 π x/a] +
     1/31 e^(-31 π z/a) (1 - e^(-31 π δ/a)) Sin[31 π x/a] + 1/33 e^(-33 π z/a) (1 - e^(-33 π δ/a)) Sin[33 π x/a] +
     1/35 e^(-35 π z/a) (1 - e^(-35 π δ/a)) Sin[35 π x/a] + 1/37 e^(-37 π z/a) (1 - e^(-37 π δ/a)) Sin[37 π x/a] +
     1/39 e^(-39 π z/a) (1 - e^(-39 π δ/a)) Sin[39 π x/a] + 1/41 e^(-41 π z/a) (1 - e^(-41 π δ/a)) Sin[41 π x/a] +
     1/43 e^(-43 π z/a) (1 - e^(-43 π δ/a)) Sin[43 π x/a] + 1/45 e^(-45 π z/a) (1 - e^(-45 π δ/a)) Sin[45 π x/a] +
     1/47 e^(-47 π z/a) (1 - e^(-47 π δ/a)) Sin[47 π x/a] + 1/49 e^(-49 π z/a) (1 - e^(-49 π δ/a)) Sin[49 π x/a]),
  {x, -1000, 1000}, PlotRange → {{x1, x2}, {y1, y2}}, Frame → True,
  FrameLabel → {"In-plane distance (nm)", "Magnetic Field (Tesla)"},
  PlotStyle → {{Thickness → 0.01}}, GridLines → None,
  FrameStyle → {{Directive[Thick, FontFamily → "Arial", Black, 18],
     Directive[Thick, FontFamily → "Arial", Black, 18]},
    {Directive[Thick, FontFamily → "Arial", Black, 18],
     Directive[Thick, FontFamily → "Arial", Black, 18]}}],
 {z, .1, 750}, {mr, 1, 1000 × 10^3}, {a, 10, 1000},
 {δ, 1, 100},
 {x1, -1, 0},
 {x2, 0, 1000},
 {y1, -100, 0},
 {y2, 0, 100}]
```





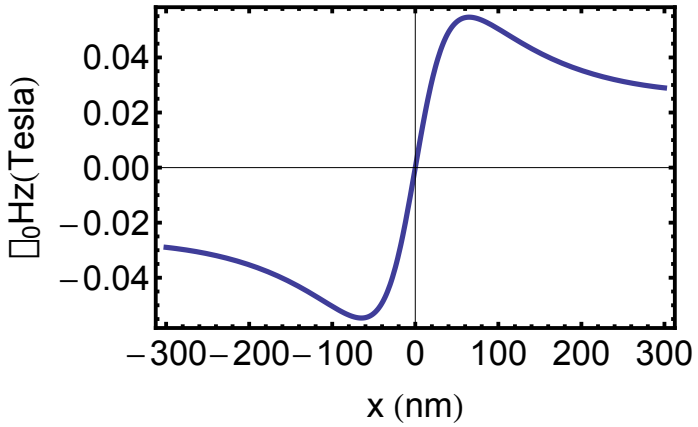

```
Manipulate[Plot[Hz[x_, z_], {x, -1000, 1000}, PlotRange → {{x1, x2}, {y1, y2}},
  Frame → True, FrameLabel → {"In-plane distance (nm)", "Magnetic Field (Tesla)"},
  PlotStyle → {{Thickness → 0.01}}, GridLines → None,
  FrameStyle → {{Directive[Thick, FontFamily → "Arial", Black, 18],
     Directive[Thick, FontFamily → "Arial", Black, 18]},
    {Directive[Thick, FontFamily → "Arial", Black, 18],
     Directive[Thick, FontFamily → "Arial", Black, 18]}}],
 {z, .1, 750}, {mr, 1, 1000 × 10^3}, {a, 10, 1000}, {δ, 1, 100}, {x1, -1, 0},
 {x2, 0, 1000}, {y1, -100, 0}, {y2, 0, 100}]
```

```
ClearAll
```

```
ClearAll
```

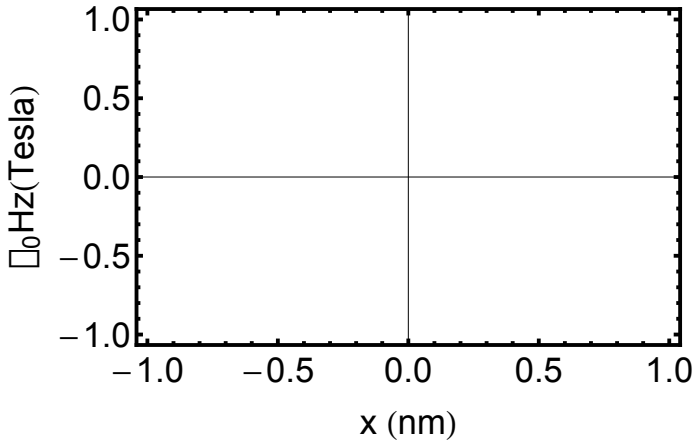
```
ClearAll["Global"]
```

```
Plot[4 Pi 10^-7 (8 × 450 000 / π^2) *
  Sum[((1 / n) * Sin[(n * Pi * x) / 750] * (1 - Exp[-Pi * (n / 750) * 30]) *
      Exp[-Pi * (n / 750) * 50]), {n, 1, 50, 2}], {x, -300, 300},
 PlotRange → All, Frame → True, FrameLabel → {"x (nm)", "□₀Hz(Tesla)"},
 PlotStyle → {{Thickness → 0.01}}, GridLines → None,
 FrameStyle → {{Directive[Thick, FontFamily → "Arial", Black, 18],
    Directive[Thick, FontFamily → "Arial", Black, 18]},
   {Directive[Thick, FontFamily → "Arial", Black, 18],
    Directive[Thick, FontFamily → "Arial", Black, 18]}}]
```




```
R1 = (-8 mr / π^2) *
    Sum[((1 / n) * Cos[(n * Pi * x) / a] * (1 - Exp[-Pi * (n / a) * δ]) * Exp[-Pi * (n / a) * z]),
     {n, 1, 50, 2}];
```

```
Plot[4 Pi 10^-7 R1, {x, -300, 300}, PlotRange → All, Frame → True,
 FrameLabel → {"x (nm)", "□₀Hz(Tesla)"}, PlotStyle → {{Thickness → 0.01}},
 GridLines → None, FrameStyle → {{Directive[Thick, FontFamily → "Arial", Black, 18],
    Directive[Thick, FontFamily → "Arial", Black, 18]},
   {Directive[Thick, FontFamily → "Arial", Black, 18],
    Directive[Thick, FontFamily → "Arial", Black, 18]}}]
```



Hx

Hx

Hx[x, z]

$$-\frac{1}{\pi^2}\,8\,mr\left(e^{-\frac{\pi z}{a}}\left(1-e^{-\frac{\pi\delta}{a}}\right)\text{Cos}\left[\frac{\pi x}{a}\right]+\frac{1}{3}e^{-\frac{3\pi z}{a}}\left(1-e^{-\frac{3\pi\delta}{a}}\right)\text{Cos}\left[\frac{3\pi x}{a}\right]+\frac{1}{5}e^{-\frac{5\pi z}{a}}\left(1-e^{-\frac{5\pi\delta}{a}}\right)\text{Cos}\left[\frac{5\pi x}{a}\right]+\frac{1}{7}e^{-\frac{7\pi z}{a}}\left(1-e^{-\frac{7\pi\delta}{a}}\right)\text{Cos}\left[\frac{7\pi x}{a}\right]+\frac{1}{9}e^{-\frac{9\pi z}{a}}\left(1-e^{-\frac{9\pi\delta}{a}}\right)\text{Cos}\left[\frac{9\pi x}{a}\right]+\frac{1}{11}e^{-\frac{11\pi z}{a}}\left(1-e^{-\frac{11\pi\delta}{a}}\right)\text{Cos}\left[\frac{11\pi x}{a}\right]+\frac{1}{13}e^{-\frac{13\pi z}{a}}\left(1-e^{-\frac{13\pi\delta}{a}}\right)\text{Cos}\left[\frac{13\pi x}{a}\right]+\frac{1}{15}e^{-\frac{15\pi z}{a}}\left(1-e^{-\frac{15\pi\delta}{a}}\right)\text{Cos}\left[\frac{15\pi x}{a}\right]+\frac{1}{17}e^{-\frac{17\pi z}{a}}\left(1-e^{-\frac{17\pi\delta}{a}}\right)\text{Cos}\left[\frac{17\pi x}{a}\right]+\frac{1}{19}e^{-\frac{19\pi z}{a}}\left(1-e^{-\frac{19\pi\delta}{a}}\right)\text{Cos}\left[\frac{19\pi x}{a}\right]+\frac{1}{21}e^{-\frac{21\pi z}{a}}\left(1-e^{-\frac{21\pi\delta}{a}}\right)\text{Cos}\left[\frac{21\pi x}{a}\right]+\frac{1}{23}e^{-\frac{23\pi z}{a}}\left(1-e^{-\frac{23\pi\delta}{a}}\right)\text{Cos}\left[\frac{23\pi x}{a}\right]+\frac{1}{25}e^{-\frac{25\pi z}{a}}\left(1-e^{-\frac{25\pi\delta}{a}}\right)\text{Cos}\left[\frac{25\pi x}{a}\right]+\frac{1}{27}e^{-\frac{27\pi z}{a}}\left(1-e^{-\frac{27\pi\delta}{a}}\right)\text{Cos}\left[\frac{27\pi x}{a}\right]+\frac{1}{29}e^{-\frac{29\pi z}{a}}\left(1-e^{-\frac{29\pi\delta}{a}}\right)\text{Cos}\left[\frac{29\pi x}{a}\right]+\frac{1}{31}e^{-\frac{31\pi z}{a}}\left(1-e^{-\frac{31\pi\delta}{a}}\right)\text{Cos}\left[\frac{31\pi x}{a}\right]+\frac{1}{33}e^{-\frac{33\pi z}{a}}\left(1-e^{-\frac{33\pi\delta}{a}}\right)\text{Cos}\left[\frac{33\pi x}{a}\right]+\frac{1}{35}e^{-\frac{35\pi z}{a}}\left(1-e^{-\frac{35\pi\delta}{a}}\right)\text{Cos}\left[\frac{35\pi x}{a}\right]+\frac{1}{37}e^{-\frac{37\pi z}{a}}\left(1-e^{-\frac{37\pi\delta}{a}}\right)\text{Cos}\left[\frac{37\pi x}{a}\right]+\frac{1}{39}e^{-\frac{39\pi z}{a}}\left(1-e^{-\frac{39\pi\delta}{a}}\right)\text{Cos}\left[\frac{39\pi x}{a}\right]+\frac{1}{41}e^{-\frac{41\pi z}{a}}\left(1-e^{-\frac{41\pi\delta}{a}}\right)\text{Cos}\left[\frac{41\pi x}{a}\right]+\frac{1}{43}e^{-\frac{43\pi z}{a}}\left(1-e^{-\frac{43\pi\delta}{a}}\right)\text{Cos}\left[\frac{43\pi x}{a}\right]+\frac{1}{45}e^{-\frac{45\pi z}{a}}\left(1-e^{-\frac{45\pi\delta}{a}}\right)\text{Cos}\left[\frac{45\pi x}{a}\right]+\frac{1}{47}e^{-\frac{47\pi z}{a}}\left(1-e^{-\frac{47\pi\delta}{a}}\right)\text{Cos}\left[\frac{47\pi x}{a}\right]+\frac{1}{49}e^{-\frac{49\pi z}{a}}\left(1-e^{-\frac{49\pi\delta}{a}}\right)\text{Cos}\left[\frac{49\pi x}{a}\right]\right)$$