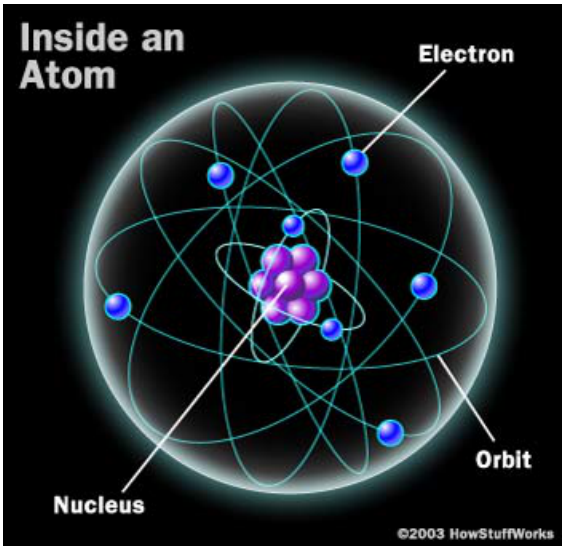
Solid Sturcture

```
Graphics3D[Join[{GrayLevel[0.25], Specularity[White, 10]},
  Table[Sphere[{i, j, k}, 0.2], {i, 1, 5}, {j, 1, 5}, {k, 1, 5}]],
 Lighting → "Neutral", Boxed → False]
```

Atom



Uniform electric field

```
plot = StreamPlot[{1, 0}, {x, 0, 5}, {y, 0, 5}];
Manipulate[Module[{work, potential, primitives}, work = 1 (p[[1]] - ax);
  potential = 1 (p0x - p[[1]]);
  primitives = Graphics[{Red, PointSize[0.03], Point[{ax, ay}],
     Blue, Point[{bx, by}], Black, Line[AppendTo[points, p]]}];
  Grid[{{Show[primitives, plot, ImageSize → Medium], SpanFromLeft},
    {"Work", "Potential"}, {work, potential}}]], {{ax, 0.5, "xA"}, InputField},
 {{ay, 4, "yA"}, InputField}, {{bx, 4, "xB"}, InputField}, {{by, 4, "yB"}, InputField},
 {{p0x, 5, "p0 x"}, InputField}, {{p0y, 0, "p0 y"}, InputField},
 {{p, {ax, ay}}, Locator}, {{points, {{ax, ay}}}, None}, TrackedSymbols → {p}]
```

Longitudinal Wave

```
Manipulate[With[{A = 1., ω = 2. π}, Graphics[{PointSize[0.02], Red,
    Point@(Table[{A Sin[ω t + ϕ], 0}, {ϕ, 0, 2 π, 0.1 π}] + Table[{i, 0}, {i, 0, 20}])},
   Axes → True, AxesOrigin → {0, 0}, PlotRange → {{-1, 21}, All}]], {t, 0, 5, 0.001}]
```

Tranverse Wave

```
Manipulate[With[{A = 1., ω = 2. π}, Graphics[{PointSize[0.02], Red,
    Point@(Table[{0, A Sin[ω t + ϕ]}, {ϕ, 0, 2 π, 0.1 π}] + Table[{i, 0}, {i, 0, 20}])},
   Axes → True, AxesOrigin → {0, 0}, PlotRange → {{0, 20}, {-1, 1}}]], {t, 0, 2, 0.001}]
```

Ampere Force

```
Manipulate[Module[{magneticField, current, wire, force},
  (*magnetic field*)
  magneticField = {Arrowheads[{{Small, 0.3}, {Small, 0.7}}],
    Arrow /@ Transpose@Flatten[Table[{i, j, #}, {i, {-1.5, 0, 1.5}},
          {j, {-1.5, 0, 1.5}}] & /@ {-3, 3}, {{1}, {2, 3}, {4}}]};
  (*points of current*)
  current[l_, θ_, ϕ_] :=
   current[l, θ, ϕ] = {-0.5 l {Sin[θ] Cos[ϕ], Sin[θ] Sin[ϕ], Cos[θ]},
     0.5 l {Sin[θ] Cos[ϕ], Sin[θ] Sin[ϕ], Cos[θ]}};
  (*wire*)
  wire = {Blue, Arrowheads[{{Medium, 0.9}}], Arrow[Tube@current[length, theta, phi]]};
  (*Ampere force*)
  force =
   {Red, Arrow[{{0, 0, 0}, Cross[(#2 - #1) &@@ current[length, theta, phi], {0, 0, 1}]}]};
  (*graphics*)
  Graphics3D[{magneticField, wire, force},
   Axes → False, PlotRange → {{-2, 2}, {-2, 2}, {-3, 3}},
   AxesLabel -> {x, y, z}, SphericalRegion → True, Boxed → False]]
 , {length, 0, 2, 0.1}, {theta, 0, π, 0.05 π}, {phi, 0, 2 π, 0.1 π}]
```

Simple Harmonic resonance

- 同方向同频率, 不同振幅和初相位

```
Manipulate[Module[{x1, x2, x}, x1[t_] := A1 Sin[ω t + α1];
  x2[t_] := A2 Sin[ω t + α2];
  x[t_] := x1[t] + x2[t];
  Plot[{x1[t], x2[t], x[t]}, {t, 0, τ},
   PlotLegends → {"x₁(t)", "x₂(t)", "x(t)"}, PlotRange → {-10, 10}]],
 {A1, 0, 10}, {A2, 0, 10}, {ω, 0, 10}, {α1, 0, 2 π}, {α2, 0, 2 π}, {τ, 0.1, 10.}]
```

同方向, 不同频率

```
Manipulate[Module[{x1, x2, x}, x1[t_] := A Cos[ω1 t];
  x2[t_] := A Cos[ω2 t];
  x[t_] := x1[t] + x2[t];
  Plot[{x1[t], x2[t], x[t]}, {t, 0, τ}, PlotLegends → {"x1(t)", "x2(t)", "x(t)"}]],
 {A, 0, 5}, {ω1, 0, 10}, {ω2, 0, 10}, {τ, 0.1, 10. π}]
```

垂直方向, 同频率, 不同振幅和相位差

```
Manipulate[ContourPlot[x^2/A1^2 + y^2/A2^2 - 2 x y/(A1 A2) Cos[α2 - α1] == Sin[α2 - α1]^2,
  {x, -A1, A1}, {y, -A2, A2}, PlotRange → {{-5.5, 5.5}, {-5.5, 5.5}}],
 {A1, 0.01, 5}, {A2, 0.01, 5}, {α1, 0.1, 2 π}, {α2, 0.1, 2 π}]
```

```
Manipulate[Module[{x1, x2}, x1[t_] := A1 Cos[2 π t + α1];
  x2[t_] := A2 Cos[2 π t + α2];
  Graphics[Line@Rest@AppendTo[points, {x1[t], x2[t]}],
   PlotRange → {{-5, 5}, {-5, 5}}]], {A1, 0.01, 5}, {A2, 0.01, 5}, {α1, 0.1, 2 π},
 {α2, 0.1, 2 π}, {t, 0.001, 1, 0.001}, {{points, {}}, None}, Button["Reset", points = {};
  t = 0.001;], TrackedSymbols :→ {t}]
```

垂直方向, 不同频率 (李萨如图)

```
Manipulate[Module[{x1, x2}, x1[t_] := A1 Cos[2 π f1 t + α1];
  x2[t_] := A2 Cos[2 π f2 t + α2];
  Graphics[Line@Rest@AppendTo[points, {x1[t], x2[t]}],
   PlotRange → {{-5, 5}, {-5, 5}}]], {A1, 0.01, 5}, {A2, 0.01, 5},
 {α1, 0.1, 2 π}, {α2, 0.1, 2 π}, {{points, {}}, None}, {f1, 0.001, 10},
 {f2, 0.001, 10}, {t, 0.001, 5, 0.001}, Button["Reset", points = {};
  t = 0.001;], TrackedSymbols :→ {t}]
```

Chaotic oscillator

```
With[{δ = 1, γ = 1, ω = 1, τ = 200}, eqn = x''[t] + δ x'[t] - x[t] + x[t]^3 == γ Cos[ω t];
 sol1 = NDSolve[{eqn, x'[0] == 1, x[0] == 3}, x, {t, 0, τ}];
 sol2 = NDSolve[{eqn, x'[0] == 1, x[0] == 3.1}, x, {t, 0, τ}];
 GraphicsRow[
  {Plot[Evaluate[(x[t] /. #[[1]]) & /@ {sol1, sol2}], {t, 0, τ}, PlotLegends → Automatic],
   ParametricPlot[Evaluate[{x[t], x'[t]} /. #[[1]] & /@ {sol1, sol2}], {t, 0, τ}]}]]
```