

```
In[*]:= SetDirectory@NotebookDirectory[];  
|设置目录 |当前笔记本的目录  
Import["QLanczos_package.m"];  
|导入
```

Parameters

```
In[*]:=  $\kappa = 0.1$ ;  
 $\eta = 1.5 * 10^{-15}$ ; (*machine precision*)  
 $\eta$ List = Table[ $10.^j$ , {j, -13, -1, 0.1}];  
|表格
```

Model

```
In[*]:= Ham = HeisenbergHam;
```

Spectrum

```
In[*]:= { $\Lambda$ , U} = funSpectrum[N[Ham]];  
|数值运算  
HamNorm = Max[Abs[ $\Lambda$ ]];  
|... |绝对值  
 $\Lambda = \Lambda / \text{HamNorm}$ ;  
Eg =  $\Lambda[[1]]$   
Out[*]:= -1.  
In[*]:= htot = 27. / HamNorm  
Out[*]:= 1.58524
```

Reference state

```
In[*]:=  $\varphi = \varphi_{\text{Heisenberg}}$ ;  
 $\varphi = \text{Flatten}[\text{Conjugate}[U].\varphi]$ ;  
|压平 |共轭  
prob $\varphi = \text{Abs}[\varphi]^2$ ;  
|绝对值  
In[*]:= pg = prob $\varphi[[1]]$   
ER = Total[prob $\varphi * \Lambda$ ];  
|总计  
eR = ER - Eg  
Out[*]:= 0.682614  
Out[*]:= 0.119312
```

Power

```

In[ ]:= dList = {5, 7, 10, 15, 30};
MListP = {};
eListP = {};
Do[
  Do循环
  d = dList[[i]];
  Id = IdentityMatrix[d];
  单位矩阵

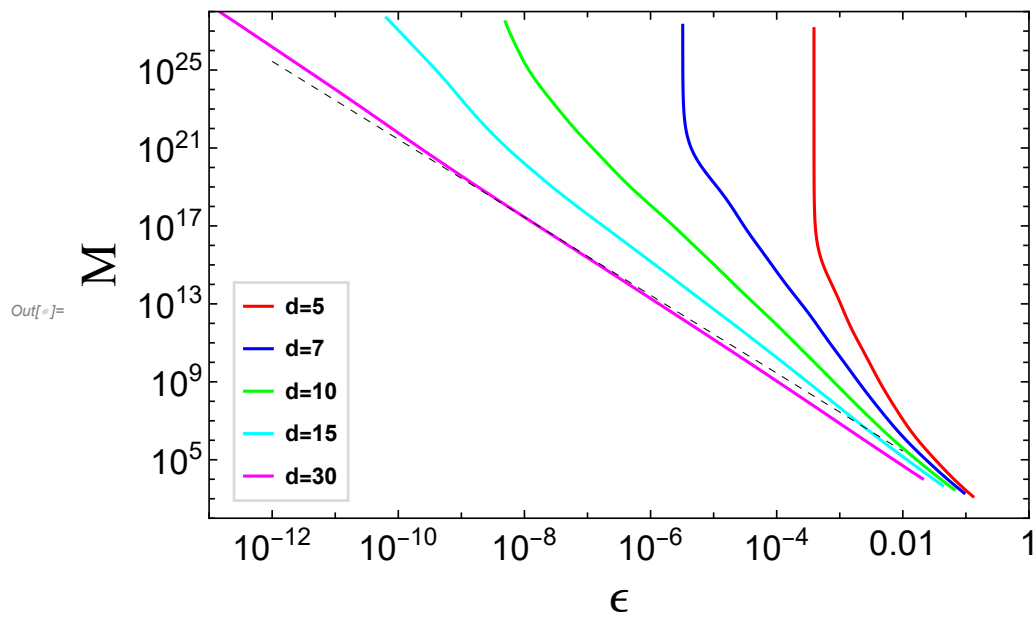
  E0 = Eg + 1.;
  {Hmat, Smat} = funMatP[Λ, E0, d, probφ];
  {MList, eList} = funEpsilonM[Hmat, Smat, 1., 1., Id, ηList, Eg, d, κ];
  AppendTo[MListP, MList];
  附加
  AppendTo[eListP, eList];
  附加
  , {i, 1, Length[dList]}}];
  长度

```

```

In[ ]:= PR = {{10.^-13, 10.^0}, {10.^2, 10.^28}};
plotP = ListLogLogPlot[{{Transpose[{eListP[[1]], MListP[[1]]}],
  点集的双对数图 转置
  Transpose[{eListP[[2]], MListP[[2]]}], Transpose[{eListP[[3]], MListP[[3]]}],
  转置 转置
  Transpose[{eListP[[4]], MListP[[4]]}], Transpose[{eListP[[5]], MListP[[5]]}]},
  转置 转置
  PlotStyle → {Red, Blue, Green, Cyan, Magenta}, PlotRange → PR, Joined → True,
  绘图样式 红色 蓝色 绿色 蓝绿色 品红色 绘制范围 连接点 真
  PlotStyle → {{Thickness[0.004], Red}, {Thickness[0.004], Blue},
  绘图样式 粗细 红色 粗细 蓝色
    {Thickness[0.004], Green}, {Thickness[0.004], Cyan}, {Thickness[0.004], Magenta}},
    粗细 绿色 粗细 蓝绿色 粗细 品红色
  Frame → True, FrameStyle → Directive[Black, Thickness[0.002]],
  边框 真 边框样式 指令 黑色 粗细
  FrameTicksStyle → Directive[Black, Thickness[0.002]], FrameLabel → {"ε", "M"},
  边框刻度样式 指令 黑色 粗细 边框标签
  LabelStyle → {FontSize → 18, FontFamily → "Arial"}, ImageSize → 500,
  标签样式 字体大小 字体系列 图像尺寸
  PlotLegends → Placed[LineLegend[{"d=5", "d=7", "d=10", "d=15", "d=30"}],
  绘图的图例 放置 线的图例
    LegendFunction → (Framed[#, FrameStyle → LightGray] &), LegendMarkerSize → {16, 8},
    图例函数 加边框 边框样式 浅灰色 图例标记尺寸
    LabelStyle → {Black, Bold, FontSize → 12, FontFamily → "Arial"},
    标签样式 黑色 粗体 字体大小 字体系列
    LegendMargins → 0, LegendLayout → {"Column", 1}], {0.1, 0.25}],
    图例边框 图例布局 列
  Epilog → {Dashed, Line[{Log[10.^-12], Log[10.^24] + FindFit[
  绘制主… 虚线 线段 对数 对数 求拟合
    Transpose[{Log[eListP[[5]], Log[MListP[[5]]}], -2 * e + b, {b}, e] [[1, 2]]},
    转置 对数 对数
    {Log[10.^-2], Log[10.^4] + FindFit[Transpose[{Log[eListP[[5]], Log[MListP[[5]]}],
    对数 对数 求拟合 转置 对数 对数
      -2 * e + b, {b}, e] [[1, 2]]}]]}]]]

```



Chebyshev Polynomial

```

In[ ]:= dList = {5, 7, 10, 15, 30};
MListCP = {};
eListCP = {};
Do[
  Do循环
    d = dList[[i]];
    Id = IdentityMatrix[d];
    单位矩阵

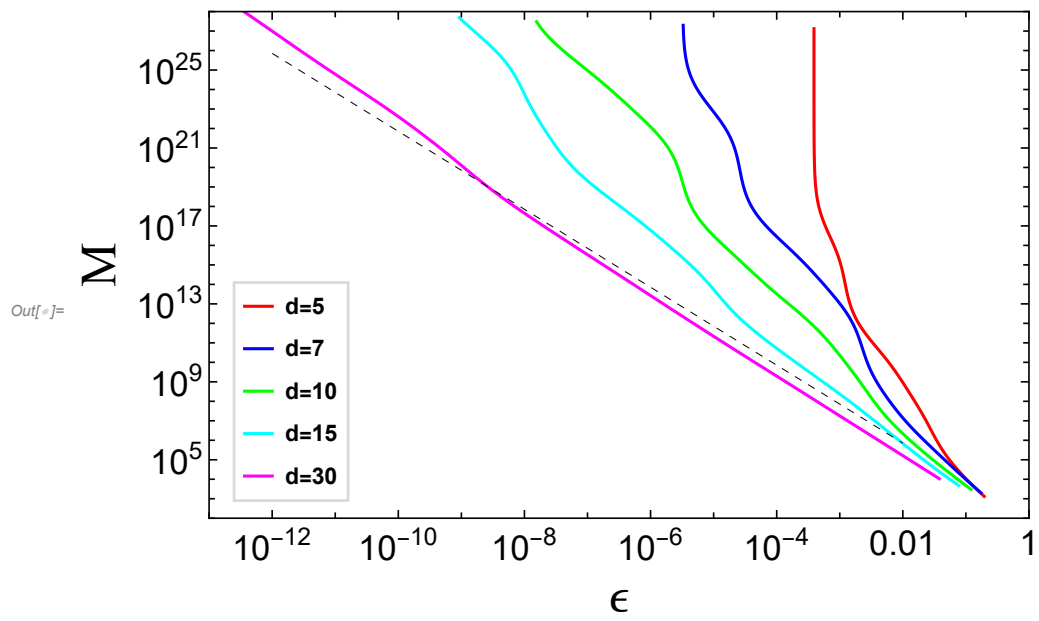
    E0 = 0;
    {Hmat, Smat} = funMatCP[Λ, E0, d, probφ, htot];
    {MList, eList} = funEpsilonM[Hmat, Smat, 1., 1., Id, ηList, Eg, d, κ];
    AppendTo[MListCP, MList];
    附加
    AppendTo[eListCP, eList];
    附加
    , {i, 1, Length[dList]};
    长度

```

```

In[ ]:= plotCP = ListLogLogPlot[ {Transpose[{ϵListCP[[1]], MListCP[[1]]}],
    |点集的双对数图 |转置
    Transpose[{ϵListCP[[2]], MListCP[[2]]}], Transpose[{ϵListCP[[3]], MListCP[[3]]}],
    |转置 |转置
    Transpose[{ϵListCP[[4]], MListCP[[4]]}], Transpose[{ϵListCP[[5]], MListCP[[5]]}],
    |转置 |转置
    PlotStyle → {Red, Blue, Green, Cyan, Magenta}, PlotRange → PR, Joined → True,
    |绘图样式 |红色 |蓝色 |绿色 |蓝绿色 |品红色 |绘制范围 |连接点 |真
    PlotStyle → {{Thickness[0.004], Red}, {Thickness[0.004], Blue},
    |绘图样式 |粗细 |红色 |粗细 |蓝色
        {Thickness[0.004], Green}, {Thickness[0.004], Cyan}, {Thickness[0.004], Magenta}},
        |粗细 |绿色 |粗细 |蓝绿色 |粗细 |品红色
    Frame → True, FrameStyle → Directive[Black, Thickness[0.002]],
    |边框 |真 |边框样式 |指令 |黑色 |粗细
    FrameTicksStyle → Directive[Black, Thickness[0.002]], FrameLabel → {"ϵ", "M"},
    |边框刻度样式 |指令 |黑色 |粗细 |边框标签
    LabelStyle → {FontSize → 18, FontFamily → "Arial"}, ImageSize → 500,
    |标签样式 |字体大小 |字体系列 |图像尺寸
    PlotLegends → Placed[LineLegend[{"d=5", "d=7", "d=10", "d=15", "d=30"}],
    |绘图的图例 |放置 |线的图例
        LegendFunction → (Framed[#, FrameStyle → LightGray] &), LegendMarkerSize → {16, 8},
        |图例函数 |加边框 |边框样式 |浅灰色 |图例标记尺寸
        LabelStyle → {Black, Bold, FontSize → 12, FontFamily → "Arial"},
        |标签样式 |黑色 |粗体 |字体大小 |字体系列
        LegendMargins → 0, LegendLayout → {"Column", 1}, {0.1, 0.25}],
        |图例边幅 |图例布局 |列
    Epilog → {Dashed, Line[{Log[10.^-12], Log[10.^24] + FindFit[
    |绘制主… |虚线 |线段 |对数 |对数 |求拟合
        Transpose[{Log[ϵListCP[[5]]], Log[MListCP[[5]]}], -2 * ϵ + b, {b}, ϵ] [[1, 2]]},
        |转置 |对数 |对数
        {Log[10.^-2], Log[10.^4] + FindFit[Transpose[{Log[ϵListCP[[5]]],
        |对数 |对数 |求拟合 |转置 |对数
            Log[MListCP[[5]]}], -2 * ϵ + b, {b}, ϵ] [[1, 2]]}]]}
    |对数

```



Gaussian-Power

In[]:=

```

dList = {2, 3, 4, 5, 6};
MListGP = {};
eListGP = {};

Do[
  Do循环
  d = dList[[i]];
  Id = IdentityMatrix[d];
  单位矩阵

  E0 = Eg + 1.;
  {Hmat, Smat} = funMatP[Δ, E0, d, probφ];
  EB = Hmat[[d, d]] / Smat[[d, d]];
  eB = EB - Eg;

  τMIN = Sqrt[(d - 1) / E];
  平方根 自然常数
  τMAX = Sqrt[d - 1] / 0.1;
  平方根

  Do[ (
    Do循环
    τ = (τMIN + τMAX) / 2.;
    {Hmat, Smat} = funMatGP[Δ, Eg, τ, 1, probφ, htot];
    EK = Hmat[[1, 1]] / Smat[[1, 1]];
    err = EK - Eg;
    If[err > eB, τMIN = τ];
    如果
    If[err < eB, τMAX = τ];
    如果
  ), {j, 1, 30}];
  τ = (τMIN + τMAX) / 2.; Print["τGP:", τ];
  打印

  δ = RandomReal[{-0.1, 0.1}];
  伪随机实数
  E0 = Eg + δ;
  {Hmat, Smat} = funMatGP[Δ, E0, τ, d, probφ, htot];
  {MList, eList} = funEpsilonM[Hmat, Smat, htot, 1., Id, ηList, Eg, d, κ];
  AppendTo[MListGP, MList];
  附加
  AppendTo[eListGP, eList];
  附加
  , {i, 1, Length[dList]}}];
  长度

```

$\tau_{GP}:2.56034$

$\tau_{GP}:3.9666$

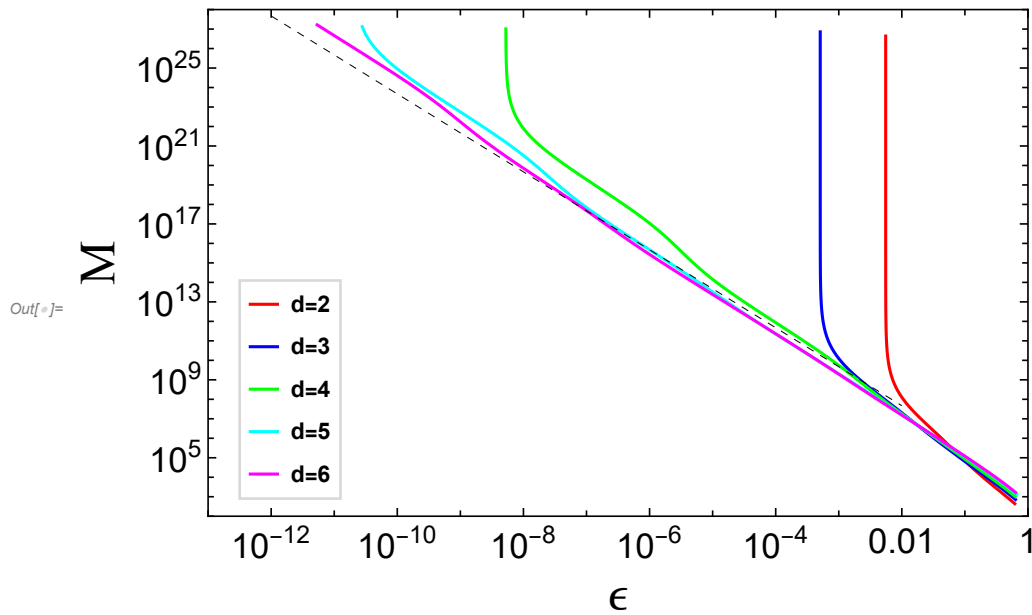
$\tau_{GP}:5.24256$

$\tau_{GP}:6.34638$

$\tau_{GP}:7.26576$

```

In[ ]:= plotGP = ListLogLogPlot[ {Transpose[{ $\epsilon$ ListGP[[1]], MListGP[[1]]}],
  |点集的双对数图 |转置
    Transpose[{ $\epsilon$ ListGP[[2]], MListGP[[2]]}], Transpose[{ $\epsilon$ ListGP[[3]], MListGP[[3]]}],
    |转置 |转置
    Transpose[{ $\epsilon$ ListGP[[4]], MListGP[[4]]}], Transpose[{ $\epsilon$ ListGP[[5]], MListGP[[5]]}],
    |转置 |转置
    PlotStyle → {Red, Blue, Green, Cyan, Magenta}, PlotRange → PR, Joined → True,
    |绘图样式 |红色 |蓝色 |绿色 |蓝绿色 |品红色 |绘制范围 |连接点 |真
    PlotStyle → {{Thickness[0.004], Red}, {Thickness[0.004], Blue},
    |绘图样式 |粗细 |红色 |粗细 |蓝色
      {Thickness[0.004], Green}, {Thickness[0.004], Cyan}, {Thickness[0.004], Magenta}},
      |粗细 |绿色 |粗细 |蓝绿色 |粗细 |品红色
    Frame → True, FrameStyle → Directive[Black, Thickness[0.002]],
    |边框 |真 |边框样式 |指令 |黑色 |粗细
    FrameTicksStyle → Directive[Black, Thickness[0.002]], FrameLabel → {" $\epsilon$ ", "M"},
    |边框刻度样式 |指令 |黑色 |粗细 |边框标签
    LabelStyle → {FontSize → 18, FontFamily → "Arial"}, ImageSize → 500,
    |标签样式 |字体大小 |字体系列 |图像尺寸
    PlotLegends → Placed[LineLegend[{"d=2", "d=3", "d=4", "d=5", "d=6"},
    |绘图的图例 |放置 |线的图例
      LegendFunction → (Framed[#, FrameStyle → LightGray] &), LegendMarkerSize → {16, 8},
      |图例函数 |加边框 |边框样式 |浅灰色 |图例标记尺寸
      LabelStyle → {Black, Bold, FontSize → 12, FontFamily → "Arial"},
      |标签样式 |黑色 |粗体 |字体大小 |字体系列
      LegendMargins → 0, LegendLayout → {"Column", 1}, {0.1, 0.25}},
      |图例边幅 |图例布局 |列
    Epilog → {Dashed, Line[{Log[10.^-12], Log[10.^24] + FindFit[
    |绘制主... |虚线 |线段 |对数 |对数 |求拟合
      Transpose[{Log[ $\epsilon$ ListGP[[5]]], Log[MListGP[[5]]}], -2 *  $\epsilon$  + b, {b},  $\epsilon$ ] [[1, 2]]},
      |转置 |对数 |对数
      {Log[10.^-2], Log[10.^4] + FindFit[Transpose[{Log[ $\epsilon$ ListGP[[5]]],
      |对数 |对数 |求拟合 |转置 |对数
        Log[MListGP[[5]]}], -2 *  $\epsilon$  + b, {b},  $\epsilon$ ] [[1, 2]]}}]}]
    |对数
  
```

Inverse Power

```

In[ ]:= dList = {5, 7, 10, 15, 30};
MListIP = {};
eListIP = {};
Do[
  Do循环
    d = dList[[i]];
    Id = IdentityMatrix[d];
    单位矩阵

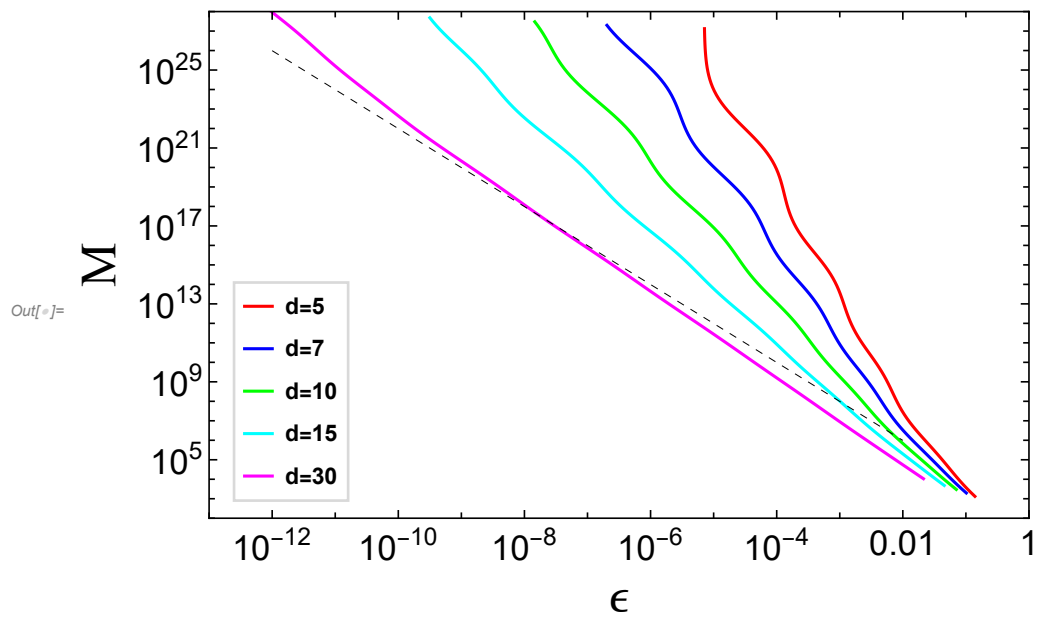
    E0 = Eg - 1.;
    {Hmat, Smat} = funMatIP[Λ, E0, d, probφ];
    {MList, eList} = funEpsilonM[Hmat, Smat, 1., 1., Id, ηList, Eg, d, κ];
    AppendTo[MListIP, MList];
    附加
    AppendTo[eListIP, eList];
    附加
    , {i, 1, Length[dList]};
    长度

```

```

In[ ]:= plotIP = ListLogLogPlot[ {Transpose[{ϵListIP[[1]], MListIP[[1]]}],
    |点集的双对数图 |转置
    Transpose[{ϵListIP[[2]], MListIP[[2]]}], Transpose[{ϵListIP[[3]], MListIP[[3]]}],
    |转置 |转置
    Transpose[{ϵListIP[[4]], MListIP[[4]]}], Transpose[{ϵListIP[[5]], MListIP[[5]]}],
    |转置 |转置
    PlotStyle → {Red, Blue, Green, Cyan, Magenta}, PlotRange → PR, Joined → True,
    |绘图样式 |红色 |蓝色 |绿色 |蓝绿色 |品红色 |绘制范围 |连接点 |真
    PlotStyle → {{Thickness[0.004], Red}, {Thickness[0.004], Blue},
    |绘图样式 |粗细 |红色 |粗细 |蓝色
        {Thickness[0.004], Green}, {Thickness[0.004], Cyan}, {Thickness[0.004], Magenta}},
        |粗细 |绿色 |粗细 |蓝绿色 |粗细 |品红色
    Frame → True, FrameStyle → Directive[Black, Thickness[0.002]],
    |边框 |真 |边框样式 |指令 |黑色 |粗细
    FrameTicksStyle → Directive[Black, Thickness[0.002]], FrameLabel → {"ϵ", "M"},
    |边框刻度样式 |指令 |黑色 |粗细 |边框标签
    LabelStyle → {FontSize → 18, FontFamily → "Arial"}, ImageSize → 500,
    |标签样式 |字体大小 |字体系列 |图像尺寸
    PlotLegends → Placed[LineLegend[{"d=5", "d=7", "d=10", "d=15", "d=30"}],
    |绘图的图例 |放置 |线的图例
        LegendFunction → (Framed[#, FrameStyle → LightGray] &), LegendMarkerSize → {16, 8},
        |图例函数 |加边框 |边框样式 |浅灰色 |图例标记尺寸
        LabelStyle → {Black, Bold, FontSize → 12, FontFamily → "Arial"},
        |标签样式 |黑色 |粗体 |字体大小 |字体系列
        LegendMargins → 0, LegendLayout → {"Column", 1}, {0.1, 0.25}],
        |图例边幅 |图例布局 |列
    Epilog → {Dashed, Line[{Log[10.^-12], Log[10.^24] + FindFit[
    |绘制主... |虚线 |线段 |对数 |对数 |求拟合
        Transpose[{Log[ϵListIP[[5]]], Log[MListIP[[5]]}], -2 * ϵ + b, {b}, ϵ] [[1, 2]]},
        |转置 |对数 |对数
        {Log[10.^-2], Log[10.^4] + FindFit[Transpose[{Log[ϵListIP[[5]]],
        |对数 |对数 |求拟合 |转置 |对数
            Log[MListIP[[5]]}], -2 * ϵ + b, {b}, ϵ] [[1, 2]]}]]}
    |对数

```



Imaginary-time Evolution

```

In[ ]:= dList = {5, 7, 10, 15, 30};
MListITE = {};
eListITE = {};
Do[
  Do循环
  d = dList[[i]];
  Id = IdentityMatrix[d];
  单位矩阵

  E0 = Eg + 1.;
  {Hmat, Smat} = funMatP[Λ, E0, d, probφ];
  EB = Hmat[[d, d]] / Smat[[d, d]];
  eB = EB - Eg;

  τMIN = 0;
  τMAX = 128;
  Do[ (
    Do循环
    τ = (τMIN + τMAX) / 2.;
    {Hmat, Smat} = funMatITE[Λ, Eg, τ, d, probφ];
    EK = Hmat[[d, d]] / Smat[[d, d]];
    err = EK - Eg;
    If[err > eB, τMIN = τ];
    如果
    If[err < eB, τMAX = τ];
    如果
  ), {j, 1, 30}];
  τ = (τMIN + τMAX) / 2.; Print["τITE:", τ];
  打印

  E0 = Eg;
  {Hmat, Smat} = funMatITE[Λ, E0, τ, d, probφ];
  {MList, eList} = funEpsilonM[Hmat, Smat, 1., 1., Id, ηList, Eg, d, κ];
  AppendTo[MListITE, MList];
  附加
  AppendTo[eListITE, eList];
  附加
  , {i, 1, Length[dList]}}];
  长度

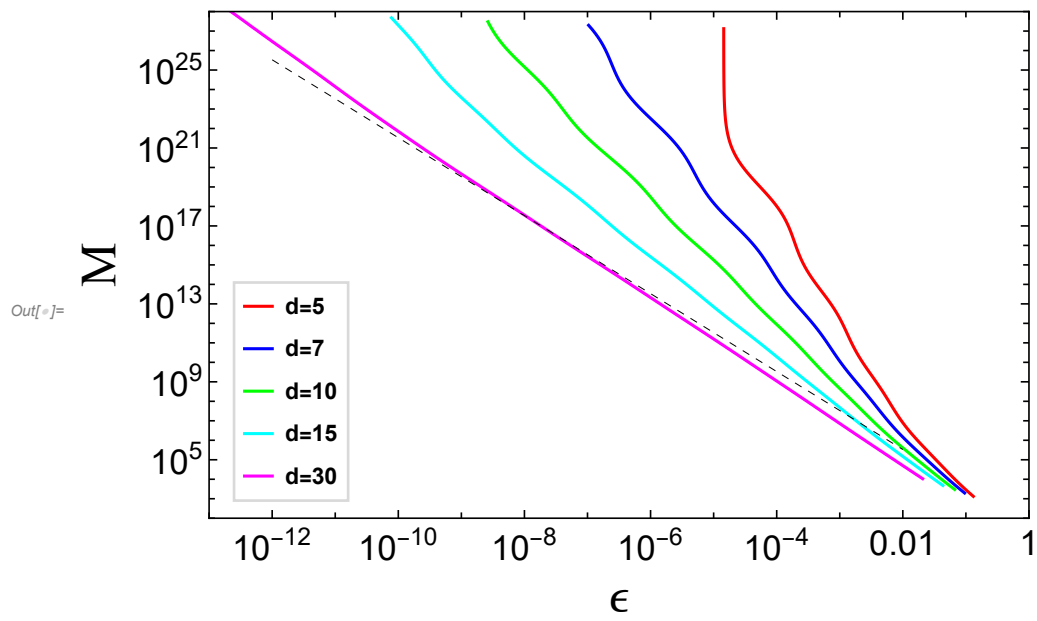
τITE:1.1768
τITE:1.14179
τITE:1.1235
τITE:1.11794
τITE:1.11733

```

```

In[ ]:= plotITE = ListLogLogPlot[Transpose[{eListITE[[1]], MListITE[[1]]}],
  |点集的双对数图 |转置
  Transpose[{eListITE[[2]], MListITE[[2]]}], Transpose[{eListITE[[3]], MListITE[[3]]}],
  |转置 |转置
  Transpose[{eListITE[[4]], MListITE[[4]]}], Transpose[{eListITE[[5]], MListITE[[5]]}],
  |转置 |转置
  PlotStyle → {Red, Blue, Green, Cyan, Magenta}, PlotRange → PR, Joined → True,
  |绘图样式 |红色 |蓝色 |绿色 |蓝绿色 |品红色 |绘制范围 |连接点 |真
  PlotStyle → {{Thickness[0.004], Red}, {Thickness[0.004], Blue},
  |绘图样式 |粗细 |红色 |粗细 |蓝色
    {Thickness[0.004], Green}, {Thickness[0.004], Cyan}, {Thickness[0.004], Magenta}},
  |粗细 |绿色 |粗细 |蓝绿色 |粗细 |品红色
  Frame → True, FrameStyle → Directive[Black, Thickness[0.002]],
  |边框 |真 |边框样式 |指令 |黑色 |粗细
  FrameTicksStyle → Directive[Black, Thickness[0.002]], FrameLabel → {"ε", "M"},
  |边框刻度样式 |指令 |黑色 |粗细 |边框标签
  LabelStyle → {FontSize → 18, FontFamily → "Arial"}, ImageSize → 500,
  |标签样式 |字体大小 |字体系列 |图像尺寸
  PlotLegends → Placed[LineLegend[{"d=5", "d=7", "d=10", "d=15", "d=30"}],
  |绘图的图例 |放置 |线的图例
    LegendFunction → (Framed[#, FrameStyle → LightGray] &), LegendMarkerSize → {16, 8},
    |图例函数 |加边框 |边框样式 |浅灰色 |图例标记尺寸
    LabelStyle → {Black, Bold, FontSize → 12, FontFamily → "Arial"},
    |标签样式 |黑色 |粗体 |字体大小 |字体系列
    LegendMargins → 0, LegendLayout → {"Column", 1}, {0.1, 0.25}},
    |图例边幅 |图例布局 |列
  Epilog → {Dashed, Line[{Log[10.^-12], Log[10.^24] + FindFit[
  |绘制主… |虚线 |线段 |对数 |对数 |求拟合
    Transpose[{Log[eListITE[[5]], Log[MListITE[[5]]}], -2 * e + b, {b}, e] [[1, 2]]},
    |转置 |对数 |对数
    {Log[10.^-2], Log[10.^4] + FindFit[Transpose[{Log[eListITE[[5]],
    |对数 |对数 |求拟合 |转置 |对数
      Log[MListITE[[5]]}], -2 * e + b, {b}, e] [[1, 2]]}]]}]
    |对数

```



Real-time Evolution

```

In[ ]:= dList = {5, 7, 10, 15, 30};
MListRTE = {};
eListRTE = {};
Do[
  Do循环
  d = dList[[i]];
  Id = IdentityMatrix[d];
  单位矩阵

  dtList = Table[(2. *  $\pi$ ) / 100] j, {j, 1, 100}];
  表格

  eList = ConstantArray[0, Length[dtList]];
  常量数组 长度

  Do[
  Do循环
  dt = dtList[[j]];
  {Hmat, Smat} = funMatRTE[ $\Delta$ , Eg, dt, d, prob $\phi$ ];
  {EK, cn} = funSubDiag[Hmat +  $\eta$  * Id, Smat +  $\eta$  * Id];
  err = Abs[EK - Eg];
  绝对值

  eList[[j]] = err;
  , {j, 1, Length[dtList]}}];
  长度

  dt = dtList[[Position[eList, Min[eList]][[1, 1]]]; Print["dt:", dt];
  位置 最小值 打印

  E0 = Eg;
  {Hmat, Smat} = funMatRTE[ $\Delta$ , E0, dt, d, prob $\phi$ ];
  {MList, eList} = funEpsilonMRTE[Hmat, Smat, 1., 1., Id,  $\eta$ List, Eg, d,  $\times$ ];
  AppendTo[MListRTE, MList];
  附加

  AppendTo[eListRTE, eList];
  附加

  , {i, 1, Length[dList]}}];
  长度

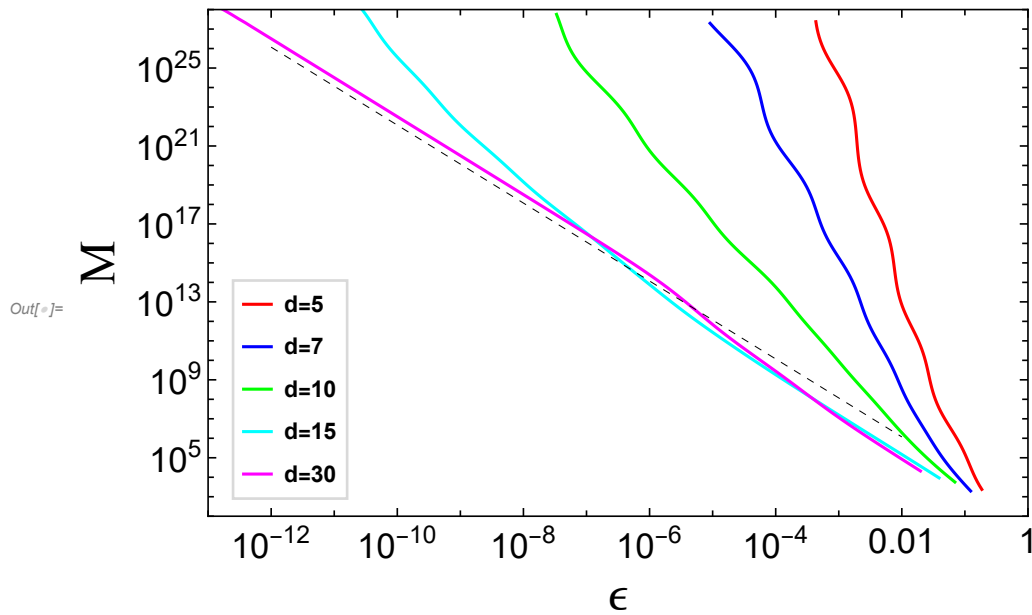
dt:0.314159
dt:0.753982
dt:1.3823
dt:2.38761
dt:5.65487

```

```

In[ ]:= plotRTE = ListLogLogPlot[Transpose[{eListRTE[[1]], MListRTE[[1]]}],
    |点集的双对数图 |转置
    Transpose[{eListRTE[[2]], MListRTE[[2]]}], Transpose[{eListRTE[[3]], MListRTE[[3]]}],
    |转置 |转置
    Transpose[{eListRTE[[4]], MListRTE[[4]]}], Transpose[{eListRTE[[5]], MListRTE[[5]]}],
    |转置 |转置
    PlotStyle → {Red, Blue, Green, Cyan, Magenta}, PlotRange → PR, Joined → True,
    |绘图样式 |红色 |蓝色 |绿色 |蓝绿色 |品红色 |绘制范围 |连接点 |真
    PlotStyle → {{Thickness[0.004], Red}, {Thickness[0.004], Blue},
    |绘图样式 |粗细 |红色 |粗细 |蓝色
        {Thickness[0.004], Green}, {Thickness[0.004], Cyan}, {Thickness[0.004], Magenta}},
        |粗细 |绿色 |粗细 |蓝绿色 |粗细 |品红色
    Frame → True, FrameStyle → Directive[Black, Thickness[0.002]],
    |边框 |真 |边框样式 |指令 |黑色 |粗细
    FrameTicksStyle → Directive[Black, Thickness[0.002]], FrameLabel → {"ε", "M"},
    |边框刻度样式 |指令 |黑色 |粗细 |边框标签
    LabelStyle → {FontSize → 18, FontFamily → "Arial"}, ImageSize → 500,
    |标签样式 |字体大小 |字体系列 |图像尺寸
    PlotLegends → Placed[LineLegend[{"d=5", "d=7", "d=10", "d=15", "d=30"}],
    |绘图的图例 |放置 |线的图例
        LegendFunction → (Framed[#, FrameStyle → LightGray] &), LegendMarkerSize → {16, 8},
        |图例函数 |加边框 |边框样式 |浅灰色 |图例标记尺寸
        LabelStyle → {Black, Bold, FontSize → 12, FontFamily → "Arial"},
        |标签样式 |黑色 |粗体 |字体大小 |字体系列
        LegendMargins → 0, LegendLayout → {"Column", 1}, {0.1, 0.25}},
        |图例边幅 |图例布局 |列
    Epilog → {Dashed, Line[{Log[10.^-12], Log[10.^24] + FindFit[
    |绘制主... |虚线 |线段 |对数 |对数 |求拟合
        Transpose[{Log[eListRTE[[5]], Log[MListRTE[[5]]}], -2 * e + b, {b}, e] [[1, 2]]},
        |转置 |对数 |对数
        {Log[10.^-2], Log[10.^4] + FindFit[Transpose[{Log[eListRTE[[5]],
        |对数 |对数 |求拟合 |转置 |对数
            Log[MListRTE[[5]]}], -2 * e + b, {b}, e] [[1, 2]]}]]}]]
    |对数

```

Filter

```

In[ ]:= dList = {5, 7, 10, 12, 15};
MListF = {};
eListF = {};
Do[
  |Do循环
  d = dList[[i]];
  Id = IdentityMatrix[d];
  |单位矩阵

  E0 = Eg + 1.;
  {Hmat, Smat} = funMatP[Δ, E0, d, probφ];
  EB = Hmat[[d, d]] / Smat[[d, d]];
  eB = EB - Eg;

  τMIN = 0;
  τMAX = 1024;
  Do[ (
    |Do循环
    τ = (τMIN + τMAX) / 2.;
    {Hmat, Smat} = funMatF[Δ, Eg, 0, τ, 1, probφ];
    EK = Hmat[[1, 1]] / Smat[[1, 1]];
    err = EK - Eg;
    If[err > eB, τMIN = τ];
    |如果
    If[err < eB, τMAX = τ];
    |如果
  ), {j, 1, 30}];
  τ = (τMIN + τMAX) / 2.; Print["τF:", τ];
  |打印
  ΔEList = Table[(2. / (d * 100)) * j, {j, 1, 100}];
  |表格

```

```

 $\epsilon$ List = ConstantArray[0, Length[ $\Delta$ EList]];
Do[
   $\Delta$ E =  $\Delta$ EList[[j]];
  {Hmat, Smat} = funMatF[ $\Lambda$ , Eg,  $\Delta$ E,  $\tau$ , d, prob $\phi$ ];
  {EK, cn} = funSubDiag[Hmat +  $\eta$  * Id, Smat +  $\eta$  * Id];
  err = EK - Eg;
   $\epsilon$ List[[j]] = err;
], {j, 1, Length[ $\Delta$ EList]};
 $\Delta$ E =  $\Delta$ EList[[Position[ $\epsilon$ List, Min[ $\epsilon$ List]][[1, 1]]]; Print[" $\Delta$ E:",  $\Delta$ E];
E0 = Eg;
{Hmat, Smat} = funMatF[ $\Lambda$ , E0,  $\Delta$ E,  $\tau$ , d, prob $\phi$ ];
{MList,  $\epsilon$ List} = funEpsilonM[Hmat, Smat, 1., 1., Id,  $\eta$ List, Eg, d,  $\kappa$ ];
AppendTo[MListF, MList];
AppendTo[ $\epsilon$ ListF,  $\epsilon$ List];
, {i, 1, Length[dList]};

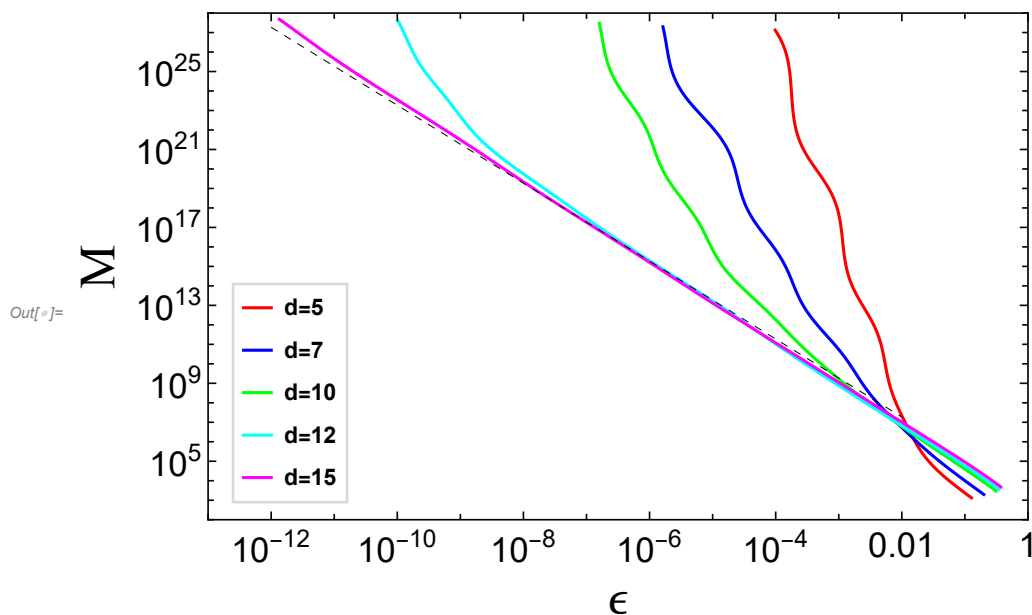
```

τ_F :11.2447
 ΔE :0.02
 τ_F :13.7022
 ΔE :0.0485714
 τ_F :15.3563
 ΔE :0.092
 τ_F :30.9147
 ΔE :0.055
 τ_F :61.796
 ΔE :0.032

```

In[ ]:= plotF = ListLogLogPlot[Transpose[{eListF[[1]], MListF[[1]]}],
  |点集的双对数图 |转置
  Transpose[{eListF[[2]], MListF[[2]]}], Transpose[{eListF[[3]], MListF[[3]]}],
  |转置 |转置
  Transpose[{eListF[[4]], MListF[[4]]}], Transpose[{eListF[[5]], MListF[[5]]}],
  |转置 |转置
  PlotStyle → {Red, Blue, Green, Cyan, Magenta}, PlotRange → PR, Joined → True,
  |绘图样式 |红色 |蓝色 |绿色 |蓝绿色 |品红色 |绘制范围 |连接点 |真
  PlotStyle → {{Thickness[0.004], Red}, {Thickness[0.004], Blue},
  |绘图样式 |粗细 |红色 |粗细 |蓝色
    {Thickness[0.004], Green}, {Thickness[0.004], Cyan}, {Thickness[0.004], Magenta}},
  |粗细 |绿色 |粗细 |蓝绿色 |粗细 |品红色
  Frame → True, FrameStyle → Directive[Black, Thickness[0.002]],
  |边框 |真 |边框样式 |指令 |黑色 |粗细
  FrameTicksStyle → Directive[Black, Thickness[0.002]], FrameLabel → {"ε", "M"},
  |边框刻度样式 |指令 |黑色 |粗细 |边框标签
  LabelStyle → {FontSize → 18, FontFamily → "Arial"}, ImageSize → 500,
  |标签样式 |字体大小 |字体系列 |图像尺寸
  PlotLegends → Placed[LineLegend[{"d=5", "d=7", "d=10", "d=12", "d=15"},
  |绘图的图例 |放置 |线的图例
    LegendFunction → (Framed[#, FrameStyle → LightGray] &), LegendMarkerSize → {16, 8},
    |图例函数 |加边框 |边框样式 |浅灰色 |图例标记尺寸
    LabelStyle → {Black, Bold, FontSize → 12, FontFamily → "Arial"},
    |标签样式 |黑色 |粗体 |字体大小 |字体系列
    LegendMargins → 0, LegendLayout → {"Column", 1}], {0.1, 0.25}],
    |图例边幅 |图例布局 |列
  Epilog → {Dashed, Line[{Log[10.^-12], Log[10.^24] + FindFit[
  |绘制主... |虚线 |线段 |对数 |对数 |求拟合
    Transpose[{Log[eListF[[5]], Log[MListF[[5]]}], -2 * e + b, {b}, e] [[1, 2]],
    |转置 |对数 |对数
    {Log[10.^-2], Log[10.^4] + FindFit[Transpose[{Log[eListF[[5]], Log[MListF[[5]]}],
    |对数 |对数 |求拟合 |转置 |对数 |对数
      -2 * e + b, {b}, e] [[1, 2]]}]]}]]]

```



```
In[ ]:= path = "scalingP.pdf"; Export[path, plotP];  
      导出  
path = "scalingCP.pdf"; Export[path, plotCP];  
      导出  
path = "scalingGP.pdf"; Export[path, plotGP];  
      导出  
path = "scalingIP.pdf"; Export[path, plotIP];  
      导出  
path = "scalingITE.pdf"; Export[path, plotITE];  
      导出  
path = "scalingRTE.pdf"; Export[path, plotRTE];  
      导出  
path = "scalingF.pdf"; Export[path, plotF];  
      导出
```