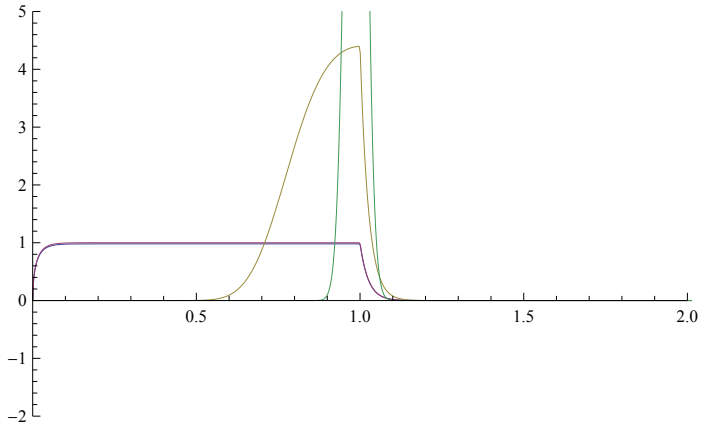
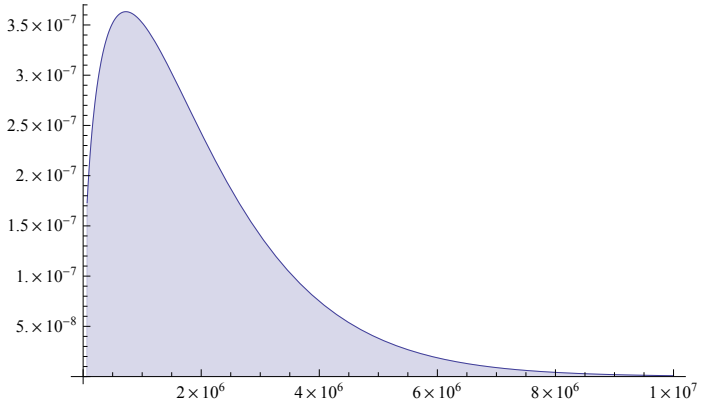
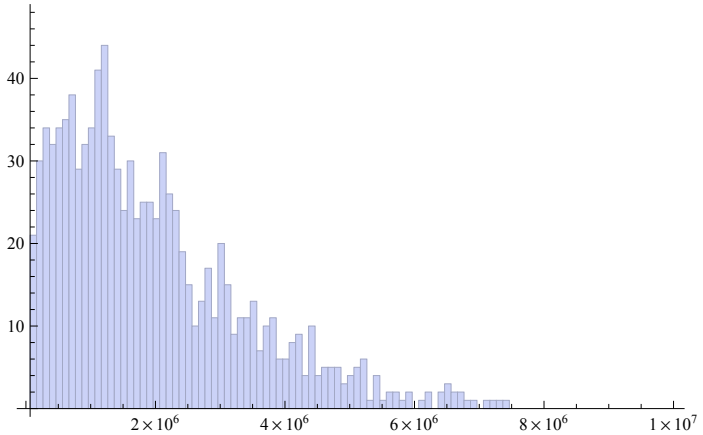
```
(* Here we simulate how many collisions
 are necessary to slow down a neutron on average *)
(* MassA: Mass number *)
alph[MassA_] := N[((MassA - 1) / (MassA + 1)) ^ 2];
(* Ef: energy after collision; Ei: original energy *)
(* simple scattering off an infinitely heavy nucleus at rest *)
Ef[Ei_, a_] := RandomReal[{a * Ei, Ei}];
(* scattering kernel for a proton gas at temperature T *)
(* free atom scattering cross section for hydrogen *)
k = (8.6173324 * 10^-5); (* eV/K *)
T = 293; (* K *)
sigmaHfree = 1;
(* Duderstadt page 53 *)
ProtonKernel[Ei_, Ef_] := (sigmaHfree / Ei) *
    If[Ei ≥ Ef, Erf[Sqrt[Ef / (k * T)]], Exp[(Ei - Ef) / (k * T)] * Erf[Sqrt[Ei / (k * T)]]];

sigmaNfree = 1;
thet[MassA_] := (MassA + 1) / (2 * Sqrt[MassA]);
ro[MassA_] := (MassA - 1) / (2 * Sqrt[MassA]);

f[Ei_, Ef_, MassA_] := sigmaNfree * (thet[MassA]) ^ 2 / (2 * Ei) * 1 *
    ((Erf[thet[MassA] * Sqrt[Ei / (k * T)] - ro[MassA] * Sqrt[Ef / (k * T)]] -
        Erf[thet[MassA] * Sqrt[Ei / (k * T)] + ro[MassA] * Sqrt[Ef / (k * T)]]) +
      (Erf[thet[MassA] * Sqrt[Ef / (k * T)] - ro[MassA] * Sqrt[Ei / (k * T)]] +
        Erf[thet[MassA] * Sqrt[Ef / (k * T)] + ro[MassA] * Sqrt[Ei / (k * T)]]));

(* Duderstadt page 388 *)
NuklideKernel[Ei_, Ef_, MassA_] :=
  If[Ei < Ef, sigmaNfree * (thet[MassA]) ^ 2 / (2 * Ei) * Exp[- (Ef - Ei) / (k * T)] *
    ((Erf[thet[MassA] * Sqrt[Ei / (k * T)] - ro[MassA] * Sqrt[Ef / (k * T)]] +
        Erf[thet[MassA] * Sqrt[Ei / (k * T)] + ro[MassA] * Sqrt[Ef / (k * T)]]) +
      (Erf[thet[MassA] * Sqrt[Ef / (k * T)] - ro[MassA] * Sqrt[Ei / (k * T)]] -
        Erf[thet[MassA] * Sqrt[Ef / (k * T)] +
          ro[MassA] * Sqrt[Ei / (k * T)]])), f[Ei, Ef, MassA]];

Plot[{0.98 * ProtonKernel[1, x], NuklideKernel[1, x, 1], NuklideKernel[1, x, 16],
  NuklideKernel[1, x, 235]}, {x, 0, 10}, PlotRange → {{0, 2}, {-2, 5}}]
```




```
(* prompt U235 fission spectrum *)
Nrm = 986 229; (* normalized to 1 between 0.5 and 10 MeV *)
s235U[en_] := 0.453 * Exp[-1.036 * en / 10^6] * Sinh[Sqrt[2.29 * en / 10^6]] / Nrm;
s235UP = ProbabilityDistribution[s235U[x], {x, 64 700, 10 * 10^6}];
dis = RandomVariate[s235UP, 1000];

Plot[Evaluate[PDF[s235UP, x]], {x, 0, 10 * 10^6}, Filling → Axis]
Histogram[dis, {64 700, 10 * 10^6, 100 000}]
```



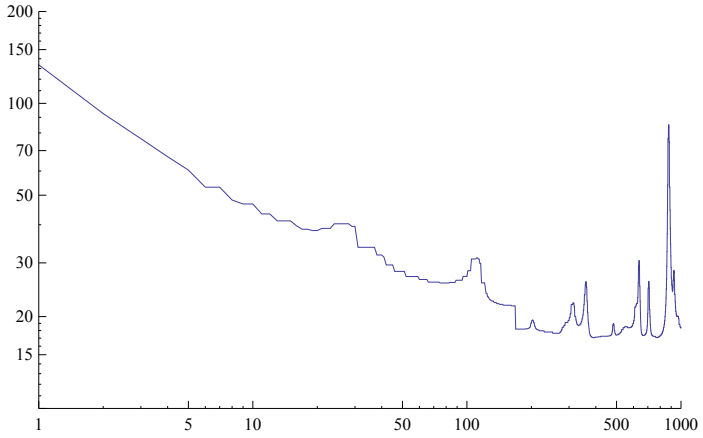



```
MyProb = ProbabilityDistribution[NuklideKernel[100, x, 235], {x, 1, 10 000}];
SlowMeDownNext = 1.0;
```

```
(* NGet235 is an approximaion to the computationally expensive
 solution of: NSolve[(f[Estart,Eff,kern]==0.1*f[Estart,Estart,kern]) &&
    (0.01*Estart<Eff<Estart),Eff,Reals,WorkingPrecision→1] *)

NGet235[Es_, ke_] := Module[{j, soli},
   For[j = 1, j < 100, soli = f[Es, Es * (1 - j * 0.01), ke];
    If[soli < 0.01 * f[Es, Es, ke], Break[]];
    j++];
   Es * (1 - j * 0.01)
  ];

SlowMeDown[Estart_, kern_] := Module[{tup, sol, xk, Eff},
   If[kern == 1,
    MyProb = ProbabilityDistribution[NuklideKernel[Estart, x, kern],
      {x, Max[0.0025, Estart / 1000], If[Estart > 64 700, Estart, 5 * Estart]}];
    SlowMeDownNext = RandomVariate[MyProb];

    Clear[sol, xk, Eff, MyProb];
   ];

   If[kern > 200,
    (*
    sol=NSolve[(f[Estart,Eff,kern]==0.01*f[Estart,Estart,kern]) &&
          (0.0<Eff<Estart),Eff,Reals][[1]][[1]];
    xk=Eff/.sol;
    *)
    xk = NGet235[Estart, kern];
    MyProb = ProbabilityDistribution[NuklideKernel[Estart, x, kern] ,
      {x, Max[0.0025, xk], If[Estart > 64 700, Estart, 1.1 * Estart]}] ;
    SlowMeDownNext = RandomVariate[MyProb];
    (*SlowMeDownNext=RandomVariate[ProbabilityDistribution[NuklideKernel[Estart,
         x,kern] ,{x,Max[0.0025,xk],If[Estart>64700,Estart,1.1*Estart]}]];*)
    Clear[sol, xk, Eff, MyProb];
   ];
  ];
(* we have to catch Mathematica underflow issues here,
therefore above 64keV only downscattering *)

(* SetDirectory["C:\\MathematicWork\\endf\\"]; *)
SetDirectory["C:\\Users\\Documents\\n-ENDF-VII0.endf\\endf-sigmaPlot\\"];
H1Elastic = Import["H-1-elastic.txt", "csv"];
U235Total = Import["U-235-total.txt", "csv"];
U235Elastic = Import["U-235-elastic.txt", "csv"];
U235Gamma = Import["U-235-gamma.txt", "csv"];
U235Fission = Import["U-235-fission.txt", "csv"];

nh1e = Length[H1Elastic];
nu235t = Length[U235Total];
```

```
nu235e = Length[U235Elastic];
nu235g = Length[U235Gamma];
nu235f = Length[U235Fission];

CleanUp[data_] := Module[{i = Length[data], j, x1, x2, y2, lis},
    lis = data;
    For[j = 2, j < i,
     x1 = lis[[j]][[1]];
     x2 = lis[[j + 1]][[1]];
     y2 = lis[[j + 1]][[2]];
     If[x1 == x2, lis = ReplacePart[lis, (j + 1) → {x2 + 0.0001, y2}];];
     j++;];
    lis
   ];

U235Totalc = CleanUp[U235Total];
U235Elasticc = CleanUp[U235Elastic];
U235Gammac = CleanUp[U235Gamma];
U235Fissionc = CleanUp[U235Fission];

ih1e = Interpolation[H1Elastic[[2 ;; nh1e]], InterpolationOrder → 0];
iu235t = Interpolation[U235Totalc[[2 ;; nu235t]], InterpolationOrder → 0];
iu235e = Interpolation[U235Elasticc[[2 ;; nu235e]], InterpolationOrder → 0];
iu235g = Interpolation[U235Gammac[[2 ;; nu235g]], InterpolationOrder → 0];
iu235f = Interpolation[U235Fissionc[[2 ;; nu235f]], InterpolationOrder → 0];

nH = 1; nU = 0.1;

MYbinstore = HistogramList[{0}, {0.01, 10, 0.01}][[2]];
MYbins = HistogramList[{0}, {0.01, 10, 0.01}][[1]];

Print[{Length[MYbins], Length[MYbinstore]}];


SH[x_] := nH * ih1e[x]; SU[x_] := nU * iu235f[x];
xss = {};
For[k = 1, k ≤ Length[MYbins],
  AppendTo[xss, SH[MYbins[[k]]] + SU[MYbins[[k]]]]; k++];
ListLogLogPlot[xss, PlotRange → {{1, 1000}, {10, 200}}, Joined → True]
```

```
{1000, 999}
```




```
EventList[runs_] := Module[
   {Estart, Enext, tuppel, ti, slows, SigmaH, SigmaU, rs, r1, r2, r3, hit, x1, x2},
   Estart = RandomVariate[s235UP]; tuppel = {Estart};

   Do[
    (* Print[Estart]; *)
    (* determine total interaction frequencies *)
    SigmaH = nH * ih1e[Estart]; SigmaU = nU * iu235t[Estart];
    rs = RandomReal[];
    (* interaction with hydrogen *)
    If[rs ≤ SigmaH / (SigmaH + SigmaU), rs = 1, rs = 2];
    (* interaction with uranium *)
    If[rs == 1, SlowMeDown[Estart, 1]; Enext = SlowMeDownNext;];
    If[rs == 2, rs = RandomReal[];
     r1 = iu235e[Estart]; r2 = iu235g[Estart]; r3 = iu235f[Estart];
     If[rs ≤ r1 / (r1 + r2 + r3), (*Print[{"235 :",Estart}];*)
      SlowMeDown[Estart, 235]; Enext = SlowMeDownNext;];
     If[rs ≤ r2 / (r1 + r2 + r3) && rs > r1 / (r1 + r2 + r3) , Enext = 0;];
     If[rs ≥ r3 / (r1 + r2 + r3)  , Enext = 0;];
    ];

    (* Print[{Estart,Enext,rs}]; *)
    Estart = N[Enext, 4];
    If[Estart > 0, AppendTo[tuppel, Enext],
     ti = Drop[tuppel, -1]; Clear[tuppel]; tuppel = ti;];
    Clear[rs, r1, r2, r3, SigmaH, SigmaU, Enext];
    If[Estart ≤ 0.0025, Break[]],
    {runs}];

   (* MYbinstore=HistogramList[tuppel,{0,10000,1}][[2]];*)
   Print[{Length[tuppel], tuppel}];
   For[r1 = 1, r1 ≤ Length[MYbins] - 1,
    x1 = MYbins[[r1]]; x2 = MYbins[[r1 + 1]];
    For[r2 = 1, r2 ≤ Length[tuppel],
     If[tuppel[[r2]] ≥ x1 && tuppel[[r2]] < x2,
      MYbinstore[[r1]] = MYbinstore[[r1]] + 1; Break[];];
```

```
      r2++];
     Clear[x1, x2];
     r1++];

    Clear[Estart, tuppel];
   ];

$HistoryLength = 0;
Off[General::unfl];
Off[CompiledFunction::cfexe];
Off[Refine::fas];
Off[CompiledFunction::cfse];
N[NuklideKernel[10^6, 1.99999999 * 10^1, 235], 3]
(*
SlowMeDown[0.003,235];Print[SlowMeDownNext];
SlowMeDown[2.0*10^6,235];Print[SlowMeDownNext];
*)
{iu235g[0.5], iu235f[0.5], iu235e[0.5], nH * ih1e[0.5], nU * iu235t[0.5]}
```

```
0.
```

```
{9.45794, 78.3446, 13.0291, 20.2988, 9.76164}
```

```
For[h = 1, h < 100 000, EventList[1000]; ClearSystemCache[];
  If[FractionalPart[(h / 1)] == 0, Print[{h, Total[MYbinstore]}];]; h++] ;
```

```
{8, {2.73921 × 10^6, 1.19683 × 10^6, 791 161., 544 118., 261 710., 174 538., 206 533., 135 854.}}
{1, 0}
{0, {}}
{2, 0}
{1, {1.68104 × 10^6}}
{3, 0}
{8, {1.71032 × 10^6, 1.23926 × 10^6, 926 121., 754 196., 218 315., 60 510.8, 30 759.9, 54 849.9}}
{4, 0}
{21, {1.22563 × 10^6, 654 312., 565 810., 438 695., 320 290.,
  236 856., 211 121., 110 853., 183 846., 246 377., 204 975., 167 046., 248 876.,
  87 111.4, 104 097., 132 036., 228 573., 146 492., 213 288., 128 590., 208 066.}}
{5, 0}
{1, {583 305.}}
{6, 0}
{1, {7.18932 × 10^6}}
{7, 0}
```

{3, {713 684., 476 581., 466 780.}}

{8, 0}

{1, {388 837.}}

{9, 0}

{28, {1.06423 × 10^6, 574 704., 537 961., 461 541., 53 695., 110 056., 198 993., 285 945., 314 541., 77 678., 13 979.7, 26 978.3, 50 821.9, 126 176., 114 103., 11 942.6, 46 982.6, 102 881., 158 234., 175 885., 177 917., 54 839.4, 121 818., 192 262., 61 378.2, 48 327.8, 101 054., 135 225.}}

{10, 0}

{1, {2.94838 × 10^6}}

{11, 0}

{0, {}}

{12, 0}

{1, {3.21436 × 10^6}}

{13, 0}

{26, {3.31953 × 10^6, 466 655., 155 344., 158 668., 79 392.1, 156 734., 139 197., 179 767., 138 131., 21 516.2, 50 054.7, 115 882., 198 783., 201 417., 307 791., 239 870., 84 483.8, 111 828., 140 727., 92 077.6, 75 541.3, 66 030.4, 102 941., 129 677., 191 964., 177 042.}}

{14, 0}

{2, {635 425., 614 713.}}

{15, 0}

{0, {}}

{16, 0}

{11, {918 368., 65 242.1, 88 066.4, 89 106.2, 110 933., 103 488., 89 046.5, 54 731.1, 86 469.9, 103 228., 49 605.4}}

{17, 0}

{24, {2.2917 × 10^6, 1.52975 × 10^6, 1.02624 × 10^6, 350 907., 395 370., 454 875., 554 896., 508 899., 557 937., 688 537., 88 436.4, 89 640.6, 148 663., 231 705., 162 652., 24 117.6, 68 133.7, 6507.09, 13 169.8, 3784.52, 25 051.6, 83 078.7, 121 507., 28 834.8}}

{18, 0}

{6, {2.70143 × 10^6, 2.053 × 10^6, 712 586., 691 065., 511 925., 236 752.}}

{19, 0}

{8, {1.35506 × 10^6, 995 112., 448 629., 363 184., 266 638., 241 369., 62 253.7, 48 504.3}}

{20, 0}

{25, {2.73127 × 10^6, 1.92437 × 10^6, 1.97002 × 10^6, 1.43923 × 10^6, 305 970., 73 453.5, 107 047., 56 629.1, 156 132., 202 443., 139 376., 63 390.7, 103 928., 184 289., 239 822., 235 255., 169 790., 211 704., 317 360., 101 145., 183 994., 89 655.4, 165 726., 5399.87, 19 823.6}}

{21, 0}

```
{26, {1.04837 × 10^6, 1.17978 × 10^6, 1.2811 × 10^6, 151 210., 161 462., 187 320., 181 950., 120 297.,
  50 301.6, 65 984.4, 121 584., 159 645., 220 146., 226 931., 217 022., 10 372.9, 18 077.5,
  64 619.9, 26 170.4, 80 546., 109 100., 190 210., 187 035., 251 857., 319 935., 259 167.}}
```

```
{22, 0}
```

```
{4, {2.12917 × 10^6, 1.84352 × 10^6, 1.44631 × 10^6, 302 921.}}
```

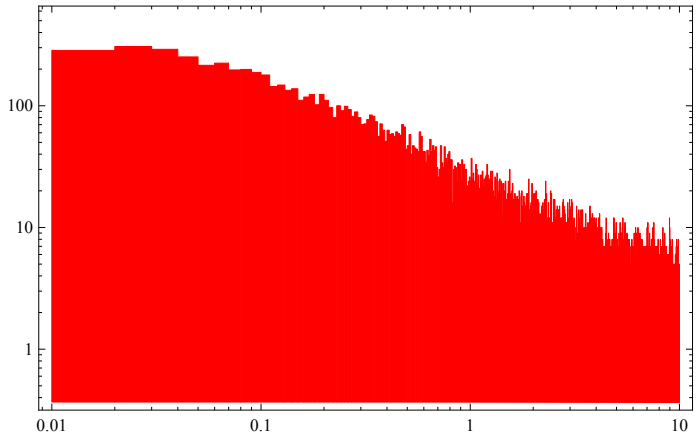
```
{23, 0}
```

```
$Aborted
```

```
Total[MYbinstore]
```

```
14 609
```

```
data = {0};
Histogram[data, {MYbins}, MYbinstore &, Axes → True,
 Ticks → Automatic, FrameTicks → Automatic, Frame → True,
 ScalingFunctions → {"Log", "Log"}, ChartStyle → {Red}]
```




```
Export["SlowMeDown05-13aData001.dat", {MYbins, MYbinstore}, "Table"]
```

```
SlowMeDown05-13aData001.dat
```