Momentum Distribution for GENEPI

Duplicating He – 4 results at genepi.

He – 4 momentum distribution is found at R.Schiavilla, V.R.Pandharipande and R.B.Wiringa, Nucl.Phys.A 449 (1986) 219 (https : // doi.org / 10.1016 / 0375 – 9474 (86) 90 003 – 5) as commented in the code.

Table 11 is used for amplitude $f(k)\,dk = A(k)^2\, 4\pi k^2\, dk$,
where f (k) dk is probability distribution function. CDF of f (k) will be used for inverse sampling.

In[1]:=
```
AmplitudeHe4 = {46.32, 44.27, 38.78, 31.46, 24.00, 17.50,
  12.31, 8.40, 5.56, 3.56, 2.19, 1.29, 0.71, 0.36, 0.14, 0.007, 0.07}
```

Out[1]= {46.32, 44.27, 38.78, 31.46, 24., 17.5, 12.31, 8.4, 5.56, 3.56, 2.19, 1.29, 0.71, 0.36, 0.14, 0.007, 0.07}

In[2]:=
```
funcHe4 = Interpolation[AmplitudeHe4]
```

Out[2]= InterpolatingFunction[ Domain: (1. 17.) Output: scalar]

In[3]:=
```
hbar = 197.33
```

Out[3]= 197.33

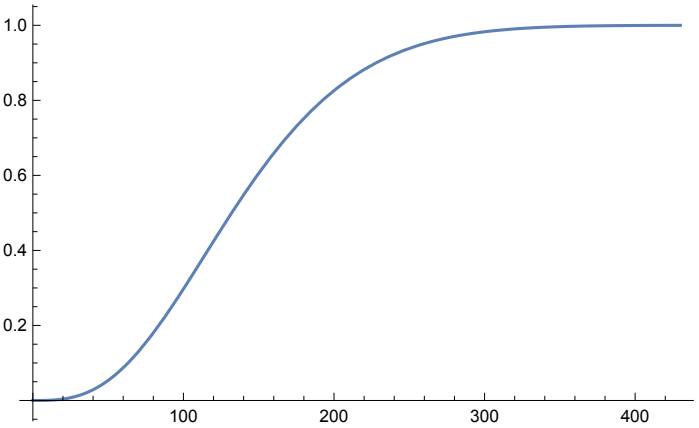
In[4]:=
```
AmpHe4[x_] := funcHe4[1 + x / 0.16]
```

In[5]:=
```
AmpmomHe4[x_] := AmpHe4[x / hbar]
```

In[6]:=
```
CumulativeHe4[x_] := Integrate[AmpmomHe4[y] * AmpmomHe4[y] * y * y, {y, 0, x}]
```

In[7]:=
```
Plot[CumulativeHe4[x] / CumulativeHe4[2.56 * hbar], {x, 0, 430}]
```

Out[7]=



In[8]:=
```
2 * CumulativeHe4[2] / CumulativeHe4[2.56 * hbar] // N (*for 2 MeV/c*)
```

Out[8]= 7.82474×10^{-6}

In[9]:=
```
2 * CumulativeHe4[4] / CumulativeHe4[2.56 * hbar] // N (*for 4 MeV/c*)
```

Out[9]= 0.0000625758

In[10]:=
```
2 * CumulativeHe4[6] / CumulativeHe4[2.56 * hbar] // N (*for 6 MeV/c*)
```

Out[10]= 0.000211012

In[11]:=
```
2 * CumulativeHe4[1] / CumulativeHe4[2.56 * hbar] // N (*for 1 MeV/c*)
```

Out[11]= 9.78076×10^{-7}

In[12]:=
```
CumulativeHe4[1] / CumulativeHe4[430] //
 N (* However, this must be used for stva!*)
```

Out[12]= 4.89075×10^{-7}

First three values from this task perfectly matches with spro at the code!
Also, the corresponding value to 1 MeV/c is about similar to 9.74513 E – 07!
However, the code must be corrected if this is the case. Because random is multiplied by stro[214], order of 2, not 9.74513 E – 07 but its half value should be placed.

Now it' s time to create CDF for He – 3 inverse sampling! From table 9,

In[34]:=
```
Amplitude1He3 = {97.8, 85.99, 60.7, 38.2, 23.5, 14.4,
  8.75, 5.37, 3.25, 1.96, 1.17, 0.64, 0.31, 0.1, -0.02, -0.07}
```

Out[34]= {97.8, 85.99, 60.7, 38.2, 23.5, 14.4, 8.75, 5.37, 3.25, 1.96, 1.17, 0.64, 0.31, 0.1, –0.02, –0.07}

In[35]:=
```
Amplitude2He3 = {0, -0.461, -1.31, -1.79, -1.86, -1.74, -1.53,
  -1.30, -1.07, -0.87, -0.70, -0.56, -0.45, -0.37, -0.29, -0.23}
```

Out[35]= {0, –0.461, –1.31, –1.79, –1.86, –1.74, –1.53, –1.3, –1.07, –0.87, –0.7, –0.56, –0.45, –0.37, –0.29, –0.23}

In[37]:=
```
func1He3 = Interpolation[Amplitude1He3]
```

Out[37]=
```
InterpolatingFunction[  ]
```


In[38]:=
```
func2He3 = Interpolation[Amplitude2He3]
```

Out[38]=
```
InterpolatingFunction[  ]
```


In[39]:=
```
Amp1He3[x_] := func1He3[1 + x / 0.16]
```

In[40]:=
```
Ampmom1He3[x_] := Amp1He3[x / hbar]
```

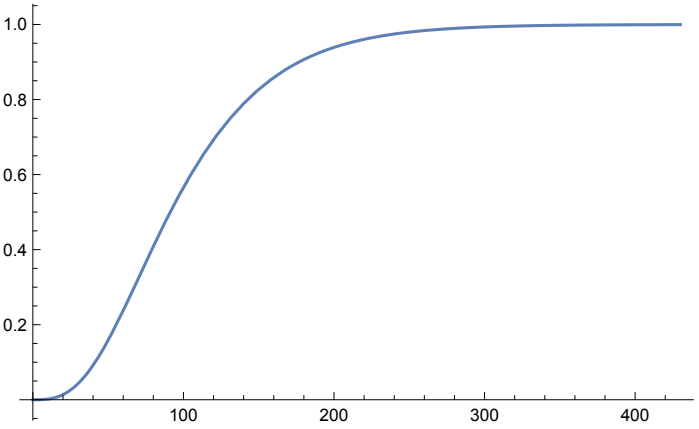
In[41]:=
```
Amp2He3[x_] := func2He3[1 + x / 0.16]
```

In[42]:=
```
Ampmom2He3[x_] := Amp2He3[x / hbar]
```

In[44]:=
```
CumulativeHe3[x_] := Integrate[
  (Ampmom1He3[y] * Ampmom1He3[y] + Ampmom2He3[y] * Ampmom2He3[y]) * y * y, {y, 0, x}]
```

In[45]:=
```
Plot[CumulativeHe3[x] / CumulativeHe3[2.4 * hbar], {x, 0, 430}]
```

Out[45]=



In[19]:=
```
MomentumArray = Range[216]
```

Out[19]=
```
{1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32,
 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60,
 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87,
 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100, 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, 111,
 112, 113, 114, 115, 116, 117, 118, 119, 120, 121, 122, 123, 124, 125, 126, 127, 128, 129, 130, 131, 132,
 133, 134, 135, 136, 137, 138, 139, 140, 141, 142, 143, 144, 145, 146, 147, 148, 149, 150, 151, 152, 153,
 154, 155, 156, 157, 158, 159, 160, 161, 162, 163, 164, 165, 166, 167, 168, 169, 170, 171, 172, 173, 174,
 175, 176, 177, 178, 179, 180, 181, 182, 183, 184, 185, 186, 187, 188, 189, 190, 191, 192, 193, 194, 195,
 196, 197, 198, 199, 200, 201, 202, 203, 204, 205, 206, 207, 208, 209, 210, 211, 212, 213, 214, 215, 216}
```

In[20]:=
```
spro = Range[216]
```

Out[20]=
```
{1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32,
 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60,
 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87,
 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100, 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, 111,
 112, 113, 114, 115, 116, 117, 118, 119, 120, 121, 122, 123, 124, 125, 126, 127, 128, 129, 130, 131, 132,
 133, 134, 135, 136, 137, 138, 139, 140, 141, 142, 143, 144, 145, 146, 147, 148, 149, 150, 151, 152, 153,
 154, 155, 156, 157, 158, 159, 160, 161, 162, 163, 164, 165, 166, 167, 168, 169, 170, 171, 172, 173, 174,
 175, 176, 177, 178, 179, 180, 181, 182, 183, 184, 185, 186, 187, 188, 189, 190, 191, 192, 193, 194, 195,
 196, 197, 198, 199, 200, 201, 202, 203, 204, 205, 206, 207, 208, 209, 210, 211, 212, 213, 214, 215, 216}
```

In[46]:=
```
For[i = 1, i < 217, i++,
 spro[[i]] = 2 * CumulativeHe3[2 * (MomentumArray[[i]] - 1)] / CumulativeHe3[2.4 * hbar]]
```

In[47]:=
```
NumberForm[spro // N, 10]
```

Out[47]//NumberForm=
```
{0., 0.00002923515952, 0.0002334594114, 0.0007854165059, 0.001853301777, 0.003598623338, 0.006174262882,
 0.00972274763, 0.0143747419, 0.02024776382, 0.02744512991, 0.0360551278, 0.04615041483, 0.05778763806,
 0.07100726927, 0.08583364655, 0.1022752124, 0.120324937, 0.139960913, 0.1611471087, 0.1838342643,
 0.2079609141, 0.2334545202, 0.2602326992, 0.2882045244, 0.3172718875, 0.3473309013, 0.3782733262,
 0.4099880053, 0.4423622891, 0.4752834384, 0.5086399871, 0.5423351993, 0.5763658109, 0.610659043,
 0.6451225989, 0.6796665632, 0.7142039589, 0.7486512646, 0.7829288885, 0.8169615992, 0.8506789105,
 0.8840154207, 0.9169111047, 0.9493115608, 0.9811682101, 1.012438451, 1.043085769, 1.07310442,
 1.102558113, 1.131435399, 1.159719921, 1.187397971, 1.214458353, 1.24089225, 1.266693086, 1.291856386,
 1.316379645, 1.340262182, 1.363505012, 1.386110708, 1.408083274, 1.429428015, 1.450151415, 1.470260746,
 1.489764048, 1.508670658, 1.526990663, 1.544734789, 1.561914299, 1.578540902, 1.594626663, 1.610183923,
 1.625225213, 1.639763187, 1.65381055, 1.667379993, 1.680484135, 1.693135465, 1.705346256, 1.717119196,
 1.728459233, 1.739378722, 1.749890075, 1.760005715, 1.769738036, 1.779099367, 1.788101934,
 1.796757832, 1.805078992, 1.813077154, 1.820763846, 1.828150359, 1.835247727, 1.842066714,
 1.848617693, 1.85490914, 1.860950376, 1.866751092, 1.8723207, 1.877668323, 1.882802788, 1.887732621,
 1.892466041, 1.897010955, 1.901374957, 1.905565326, 1.909589025, 1.913452703, 1.917162692,
 1.920725017, 1.924144486, 1.92742109, 1.930559351, 1.933564605, 1.936442053, 1.939196756, 1.941833637,
 1.944357471, 1.946772891, 1.949084382, 1.951296284, 1.953412788, 1.95543794, 1.957375637, 1.959229633,
 1.961003537, 1.96270059, 1.964323508, 1.965875494, 1.967359675, 1.96877906, 1.970136541, 1.971434898,
 1.972676796, 1.973864788, 1.975001321, 1.976088731, 1.977129251, 1.978125012, 1.979078043,
 1.979990276, 1.980863546, 1.981699308, 1.982498848, 1.983263776, 1.983995633, 1.984695893,
 1.985365959, 1.986007172, 1.986620806, 1.987208075, 1.987770132, 1.988308072, 1.988822932,
 1.989315697, 1.989787298, 1.990238615, 1.990670471, 1.991083034, 1.99147672, 1.991852308, 1.992210552,
 1.99255219, 1.992877935, 1.993188481, 1.993484499, 1.99376664, 1.994035535, 1.994291794, 1.994536004,
 1.994768736, 1.994990538, 1.995201938, 1.995403452, 1.995595621, 1.995778927, 1.995953817,
 1.996120717, 1.996280034, 1.996432159, 1.996577462, 1.9967163, 1.99684901, 1.996975915, 1.997097324,
 1.997213529, 1.997324809, 1.99743143, 1.997533645, 1.997631691, 1.997725794, 1.997816177, 1.997903056,
 1.997986636, 1.998067112, 1.998144667, 1.998219475, 1.9982917, 1.998361496, 1.998429006, 1.998494365,
 1.998557701, 1.998619129, 1.998678757, 1.998736685, 1.998792958, 1.998847554, 1.998900553,
 1.998952035, 1.999002075, 1.999050746, 1.999098116, 1.999144251, 1.999189214, 1.999233063}
```

In[48]:=
```
stva = CumulativeHe3[1] / CumulativeHe3[430] // N
```

Out[48]=
$$1.82858 \times 10^{-6}$$