Physics 562 - Computational Physics

Midterm 4

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May 6, 2014

Abstract

This paper examines two different questions.

1 Problem 1

2 The Fortran95 code

Numtype is the same for problems 1 and 2.

Listing 1: program `gamma.f95`

```
1
2  module setup
3
4      use numtype
5      implicit none
6      integer, parameter :: nsp = 146, npar = 8
7      integer :: yy(nsp), minsp, maxsp, iprint, ifcal
8
9
10 end module setup
11
12
```

```
13
14  program gamma_spectrum
15
16      use setup
17      implicit none
18      real(dp) :: ii, stuff
19      integer :: i, itmin, itmax
20      real(dp) :: fstart, xstart(npar), stepi, epsf
21      real(dp), external :: least2
22
23
24      open(unit=2, file='Sigma_pion_nucleus.dat')
25      open(unit=3, file='Sigma_pion_nucleus.d')
26      do i = 1, nsp
27          read(3,*) stuff,ii
28          write(2,*) ii
29          yy(i) = ii
30      end do
31      close(2)
32      close(3)
33
34
35
36
37      minsp = 5
38      maxsp = 140
39      xstart(1:npar) = (/ -5.01, 0.002, 300000.0, 23.0, 2.0, 150000.0, 60.0
    /)
40
41      ifcal = 0
42      iprint = 1
43      fstart = least2(xstart(1:npar))
44
45      itmin = 100
46      itmax = 1000
47      epsf = 0.001_dp
48      stepi = 0.1_dp
49      iprint = 0
50
51      call downhill(npar, least2, xstart, fstart, stepi, epsf, itmin, itmax
```

```
52
53      iprint = 2
54      fstart = least2(xstart(1:npar))
55
56
57  end program gamma_spectrum
58
59
60  function least2(par) result(ss)
61
62
63      use setup
64      implicit none
65      real(dp) :: par(npar), a, b, y1, x1, sig1, y2, x2, sig2, ss, fi
66      integer :: i
67
68
69      ifcal = ifcal +1
70      a = par(1); b = par(2);
71      y1 = par(3);     x1 = par(4);     sig1 = par(5)
72      y2 = par(6);     x2 = par(7);     sig2 = par(8)
73
74      ss = 0._dp
75
76      do i = minsp, maxsp
77          fi = a*i + b + y1*exp(-((i-x1)/sig1)**2) + y2*exp(-((i-x2)/sig2)*
78          ss = ss + (fi-yy(i))**2/sqrt(yy(i)+1.0)
79      end do
80      ss = ss/(maxsp-minsp)
81      print '(i5,8f12.4,␣f20.5)', ifcal, par(1:npar), ss
82      write(8,*) ifcal, ss
83
84      if ( iprint /= 0 ) then
85          do i = minsp, maxsp
86              fi = a*i + b + y1*exp(-((i-x1)/sig1)**2) + y2*exp(-((i-x2)/si
87              write(unit=iprint,fmt='(i4,i10,f15.2)') i,yy(i),fi
88          end do
89
90      end if
91
```

```
92
93
94 end function least2
```

3 Problem 2

4 The Fortran95 code

Listing 2: `int.f95`

```
1
2  program integral
3
4      use numtype
5      use integr
6      implicit none
7
8      real(dp) :: a,b,c,d,res,eps,ifail,scale
9      real(dp), dimension(maxint) :: w_legendre,x_legendre, w_cc, x_cc, &
10                                    w_lag, x_lag, w_new, x_new
11     integer :: nint, itype, i,n_legendre, n_cc, n_lag, n_new
12     print *, '=============================================================
13     print *, 'Midterm4'
14
15     print *, 'first integration'
16
17     itype = 1
18     a = 0._dp
19     b = 1._dp
20     c = 3/2._dp
21     d = 1/2._dp
22     ifail = 0._dp
23     n_new = 50._dp
24
25     call d01bcf(itype,a,b,c,d,n_new,w_new,x_new,ifail)
26
27     res = 0._dp
28     do i = 1,n_new
```

```
29          res = res + mid1(x_new(i))*w_new(i)
30  !       write(44,*) x_new(i),sqa3(x_new(i))*w_new(i)
31      end do
32      print *, 'gauss my  value =', res
33      print *, 'true value=pi/16=', pi/16
34      print *, 'accurate to 15 digits!!!!'
35
36      print *, '=============================================================
37      print *, 'Midterm4'
38
39      print *, 'second integration'
40
41      itype = 3
42      a = 0._dp
43      b = 1._dp
44      c = -1/2._dp
45      d = 0._dp
46      ifail = 0._dp
47      n_new = 50._dp
48
49      call d01bcf(itype,a,b,c,d,n_new,w_new,x_new,ifail)
50
51      res = 0._dp
52      do i = 1,n_new
53          res = res + mid1(x_new(i))*w_new(i)
54  !       write(44,*) x_new(i),sqa3(x_new(i))*w_new(i)
55      end do
56
57      print *, '  gauss  my  value =', res
58      print *, 'true value=sqrt(pi)=', sqrt(pi)
59      print *, 'accurate to 14 digits!!!!'
60
61
62
63      contains
64
65
66              function mid1(x) result(fx)
67
68              real(dp) :: x,fx
```

```
69
70
71                fx = 1
72
73            end function mid1
74
75
76  end program integral
```

5 Results

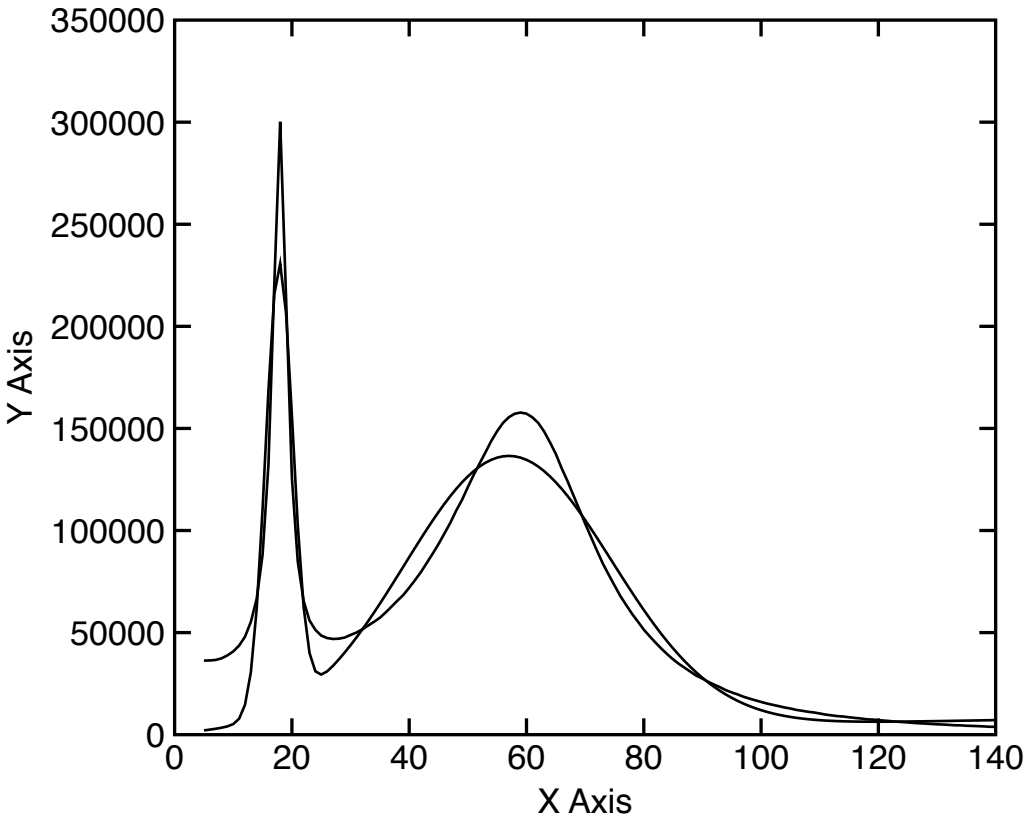

Figure 1: first image

You can see from Figure 1 that I came up with a fit of the data. E0

should be the energy where the peaks are, which are around 23 and 60. Look at fort.2 in the files to get this graph. The half life should be how fast it decays away, which should be 56.8739 if I am reading terminal correctly.

For question two, the result of the first integral should be $\frac{\pi}{16}$. My value using d01b was 0.19634954084936221. For the second integral, the value should be $\sqrt{\pi}$. My value using d01b was 1.7724538509055101.

References

[1] M. Metcalf, J. Reid and M. Cohen, *Fortran 95/2003 explained*. Oxford University Press, 2004.