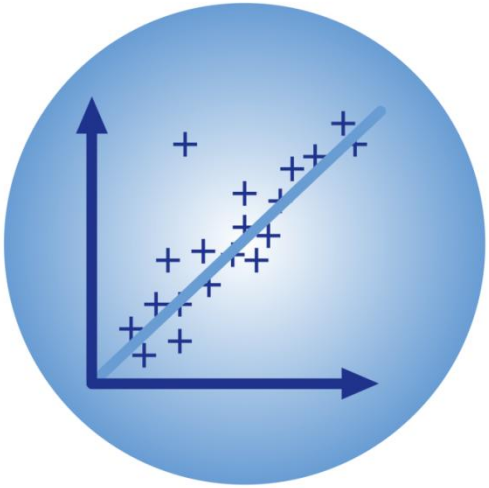


BPhO Computational Challenge

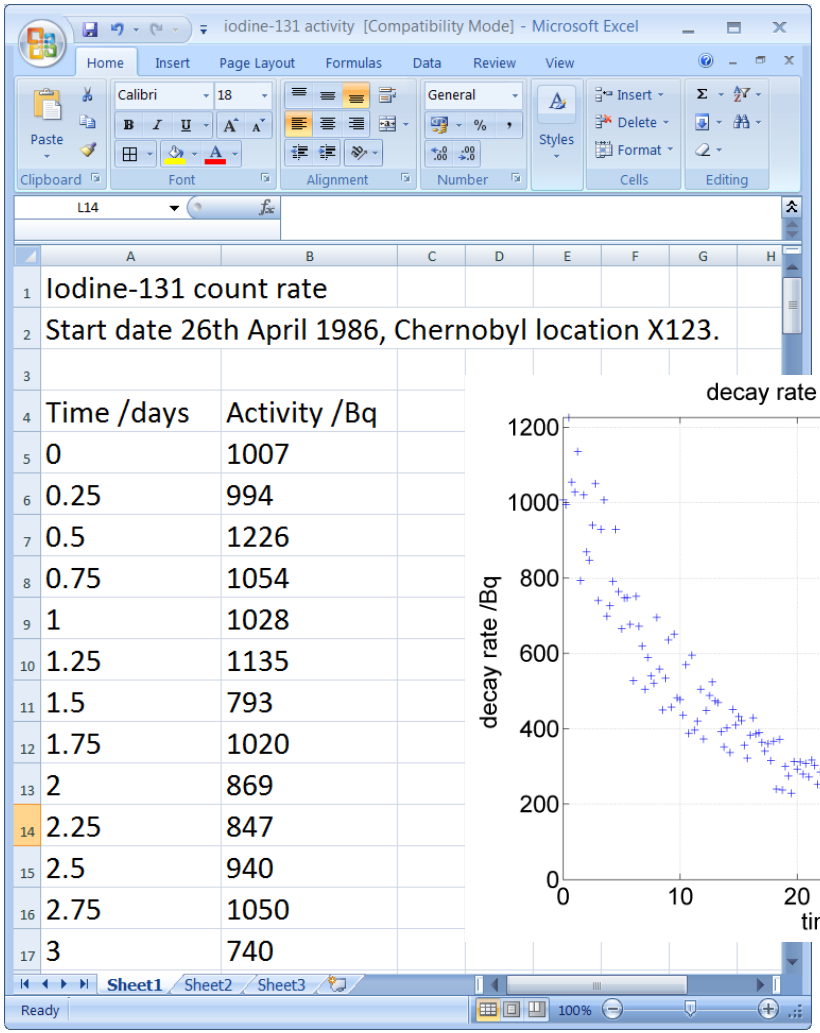
Seminar 04: Chernobyl

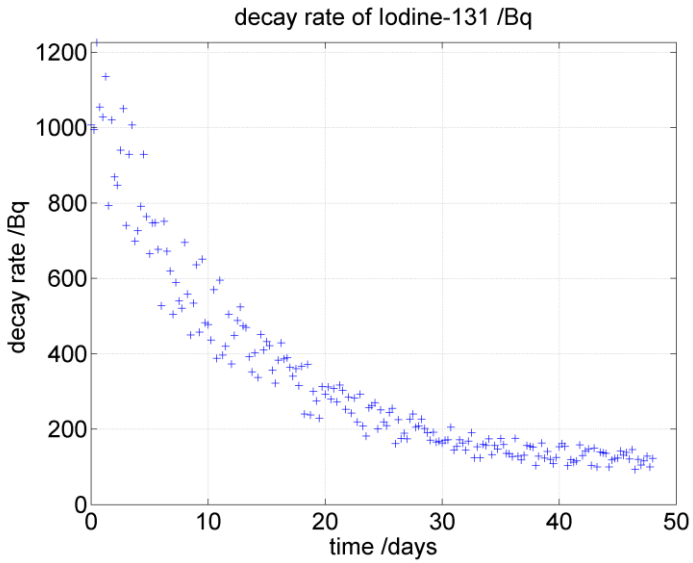
Dr Andrew French.
December 2021.

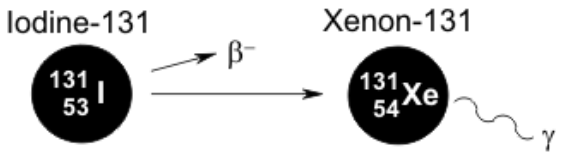
BPhO
British Physics Olympiad

Chernobyl

You are a soviet nuclear physicist sent to help with the Chernobyl disaster in 1986. You need to determine the presence of an isotope from its half life, but background levels are huge.... All you have is a text file of count rates. Your military commander demands results as soon as possible.







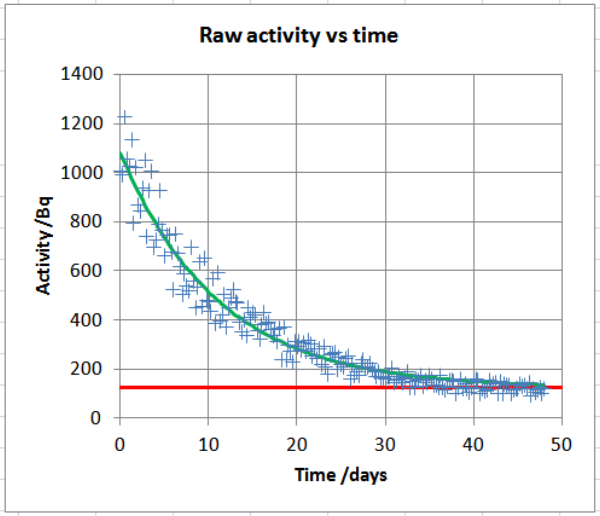
PERFORM ANALYSIS IN EXCEL

Iodine-131 count rate

Start date 26th April 1986, Chernobyl location X123.

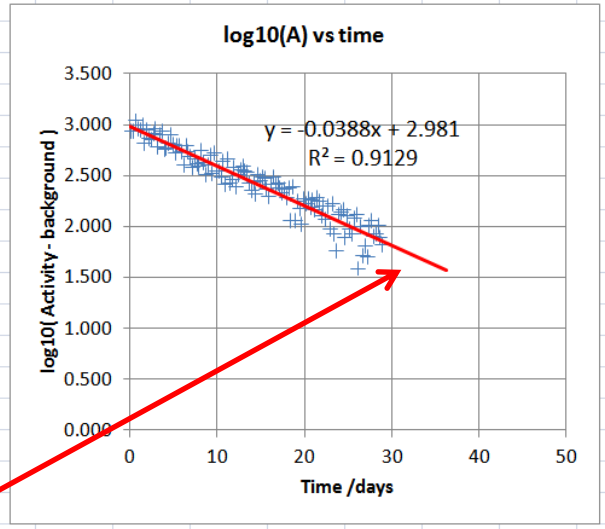
Time /days	Activity /Bq	A = Activity - Background	log10(A)	Model Activity /Bq
0	1007	884	2.946	1080.2
0.25	994	871	2.940	1059.1
0.5	1226	1103	3.043	1038.4
0.75	1054	931	2.969	1018.2
1	1028	905	2.957	998.39
1.25	1135	1012	3.005	979.05
1.5	793	670	2.826	960.14
1.75	1020	897	2.953	941.65
2	869	746	2.873	923.57
2.25	847	724	2.860	905.89
2.5	940	817	2.912	888.6
2.75	1050	927	2.967	871.69
3	740	617	2.790	855.15
3.25	929	806	2.906	838.98
3.5	1007	884	2.946	823.16
3.75	699	576	2.760	807.7
4	726	603	2.780	792.58
4.25	791	668	2.825	777.79
4.5	929	806	2.906	763.32
4.75	764	641	2.807	749.18
5	665	542	2.734	735.35
5.25	747	624	2.795	721.83
5.5	748	625	2.796	708.6
5.75	677	554	2.744	695.66
6	527	404	2.606	683.02
6.25	751	628	2.798	670.65
6.5	672	549	2.740	658.55
6.75	619	496	2.695	646.72
7	505	382	2.582	635.15
7.25	589	466	2.668	623.84
7.5	540	417	2.620	612.78
7.75	521	398		
8	695	572		
8.25	558	435		
8.5	450	327		
8.75	534	411		

NOTE IGNORE DATA AFTER 28.75 DAYS FOR BEST FIT



m	-0.039
c	2.981

Half life /days	7.759
A0 /Bq	957.2



Note this estimate is slightly different to the 100Bq used in the subsequent MATLAB analysis

Estimate background level /Bq

123

Time /days	Activity /Bq
0	123
50	123

$$A = \frac{A_0}{2^{t/t_{1/2}}}$$

$$\log_{10} A = \log_{10} A_0 - \log_{10}\left(2^{t/t_{1/2}}\right)$$

$$\log_{10} A = \log_{10} A_0 - \frac{t}{t_{1/2}}\log_{10} 2$$

$$y = \log_{10} A$$

$$x = t$$

$$y = mx + c$$

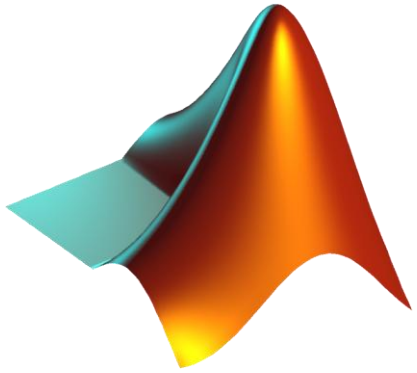
$$m = -\frac{\log_{10} 2}{t_{1/2}} \qquad c = \log_{10} A_0$$

$$t_{1/2} = -\frac{\log_{10} 2}{m} \qquad A_0 = 10^c$$

Data flow
Data processing and
Information Presentation

is often best achieved by ***writing code*.**

In other words
a **text file** which
is interpreted
by a *programming language* like
MATLAB or Python



E:\Programming\A Course in Coding\2. MATLAB\Short Scientific Computing Course\1. The Signal and the Noise\radioactive_decay_analysis.m

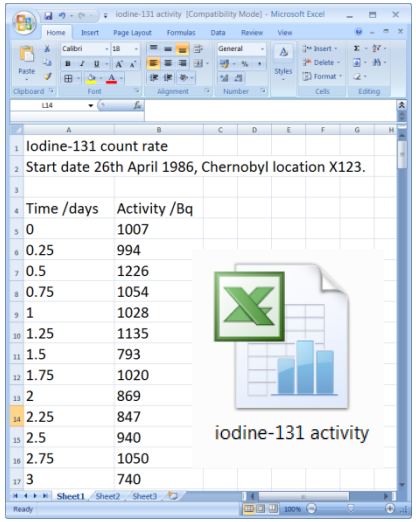
File Edit Text Go Cell Tools Debug Desktop Window Help

Stack: Base

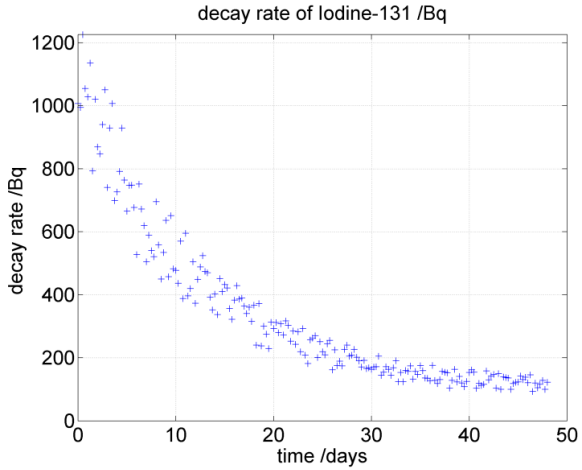
```
1   %radioactive_decay_analysis
2   % Analysis of Iodine-131 decay rate vs time data.
3   %
4   % LAST UPDATED by Andy French June 2019
5
6   function radioactive_decay_analysis
7
8   %Estimated background rate /Bq
9   B = 100;
10
11  %Fontsize for graphs
12  fsize = 18;
13
14  %
15
16  %Ingest Excel file of activity vs time
17  [num,txt,raw] = xlsread( 'iodine-131 activity.xls' );
18
19  %Extract vectors for time /days and activity /Bq
20  t = num(:,1); A = num(:,2);
21
22  %Plot activity vs time
23  fig1 = figure('color',[1 1 1],'name','radioactive decay curve');
24  plot(t,A,'+');
25  xlabel('time /days','fontsize',fsize);
26  ylabel('decay rate /Bq ','fontsize',fsize);
27  set(gca,'fontsize',fsize);
28  grid on; ylim([0,max(A)]);
29
30  %Overlay background level
31  xlimits = get( gca, 'xlim' ); hold on; plot( xlimits,[B,B],'r-' );
32
```

radioactive_decay_analysis.m

make_decay_rate_data.m

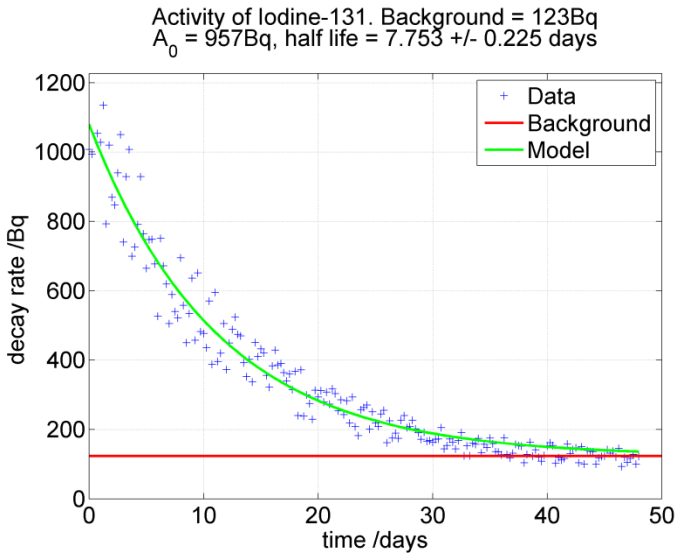


iodine-131 activity .xls

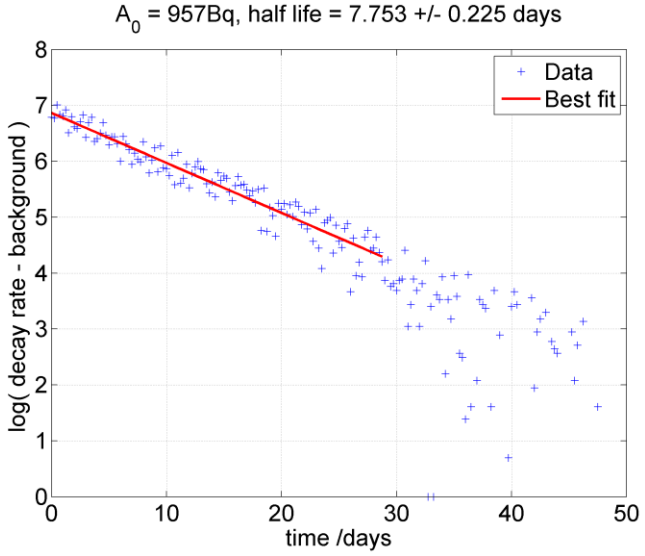


radioactive decay curve.png

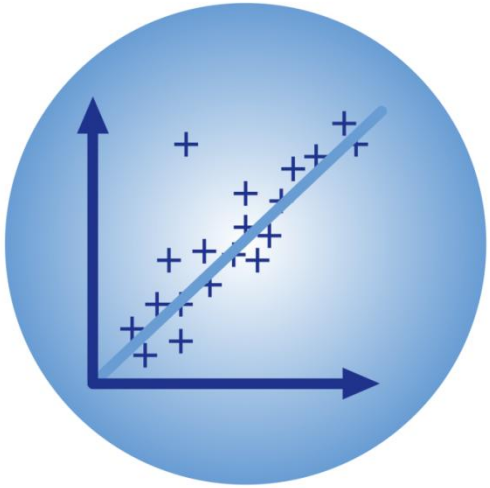
radioactive_decay_analysis.m



radioactivity analysis graph.png



radioactivity analysis log graph.png



BPhO Computational Challenge

- Suggested homework
- Q&A

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