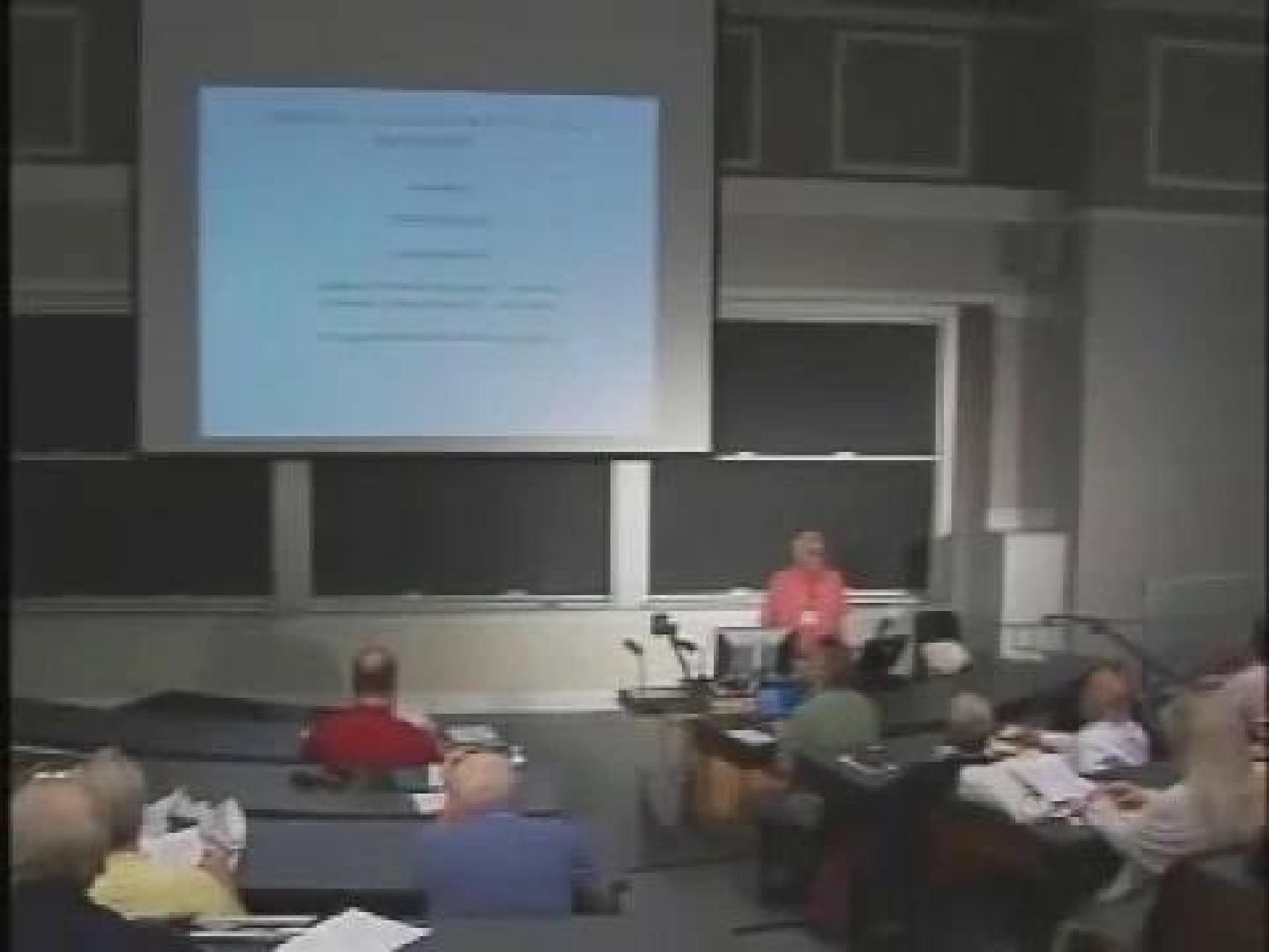

1
00:00:09,310 --> 00:00:05,210
let me give a brief abstract to the talk

2
00:00:11,839 --> 00:00:09,320
rather than start into the sequence of

3
00:00:16,340 --> 00:00:11,849
PowerPoint slides if you look up

4
00:00:18,890 --> 00:00:16,350
textbooks on physics you'll find decay

5
00:00:21,800 --> 00:00:18,900
rates of the radioactive elements listed

6
00:00:25,250 --> 00:00:21,810
and you'll be told that these are

7
00:00:28,040 --> 00:00:25,260
constants nothing nothing changes the

8
00:00:33,650 --> 00:00:28,050
decay rate of any of these radioactive

9
00:00:39,200 --> 00:00:33,660
elements well my colleagues here

10
00:00:41,420 --> 00:00:39,210
function and etc Purdue University have

11
00:00:43,340 --> 00:00:41,430
realized that there's contradictory

12
00:00:46,790 --> 00:00:43,350
evidence of this at least three

13
00:00:50,360 --> 00:00:46,800

laboratories who have carried out not a

14
00:00:52,819 --> 00:00:50,370
year studies of several elements

15
00:00:55,279 --> 00:00:52,829
radioactive elements have found annual

16
00:01:00,200 --> 00:00:55,289
variations in the decay rates these

17
00:01:04,130 --> 00:01:00,210
elements there they there thurs

18
00:01:07,670 --> 00:01:04,140
interpretation was that this must be due

19
00:01:11,109 --> 00:01:07,680
to the varying distance between the

20
00:01:13,340 --> 00:01:11,119
Earth and the Sun that there's some

21
00:01:16,130 --> 00:01:13,350
particles or some other effect coming

22
00:01:17,990 --> 00:01:16,140
from the Sun that therefore varies with

23
00:01:20,570 --> 00:01:18,000
the variation of distance of the Earth

24
00:01:22,310 --> 00:01:20,580
and the Sun and is at this point that I

25
00:01:27,109 --> 00:01:22,320
came into the picture and joined them

26
00:01:29,600 --> 00:01:27,119
and I have concluded that is not the

27
00:01:33,640 --> 00:01:29,610
case that there is something else going

28
00:01:36,590 --> 00:01:33,650
on and that it really is due to a

29
00:01:39,499 --> 00:01:36,600
process that I have involved neutrinos

30
00:01:42,410 --> 00:01:39,509
solar neutrinos or is closely related to

31
00:01:47,889 --> 00:01:42,420
solar neutrinos so now I'll try to give

32
00:01:53,410 --> 00:01:47,899
you the evidence for that conclusion

33
00:01:58,569 --> 00:01:55,490
radioactive decays as involved from

34
00:02:00,770 --> 00:01:58,579
radium to actinium giving off an

35
00:02:03,020 --> 00:02:00,780
electron this is one of the processes

36
00:02:06,740 --> 00:02:03,030
that was involved i think by the PTP

37
00:02:08,309 --> 00:02:06,750
experiment alfred there to kinda came

38
00:02:11,399 --> 00:02:08,319

mainly alpha decay

39
00:02:14,610 --> 00:02:11,409
which of a nucleus will lose two protons

40
00:02:17,220 --> 00:02:14,620
two neutrons or beta decay in which the

41
00:02:21,270 --> 00:02:17,230
nucleus loses an electron and the others

42
00:02:24,089 --> 00:02:21,280
as well and will this doesn't matter to

43
00:02:25,920 --> 00:02:24,099
us as the one the experiments carries at

44
00:02:29,910 --> 00:02:25,930
Brookhaven National Laboratory a very

45
00:02:34,369 --> 00:02:29,920
distinguished laboratory dealing with

46
00:02:39,239 --> 00:02:34,379
radium and they had silicon as a

47
00:02:46,379 --> 00:02:39,249
standard and this is the paper they

48
00:02:49,289 --> 00:02:46,389
published in 1986 in which they give

49
00:02:51,780 --> 00:02:49,299
their measurement of the half-life and

50
00:02:53,159 --> 00:02:51,790
if they know what they're after was

51
00:02:59,240 --> 00:02:53,169
getting a more accurate measurement of

52
00:03:03,689 --> 00:02:59,250
the half-life of silicon but they found

53
00:03:07,319 --> 00:03:03,699
that the measurements showed a very

54
00:03:10,199 --> 00:03:07,329
clear annual variation of a fraction of

55
00:03:12,719 --> 00:03:10,209
a percent and of course this makes you

56
00:03:14,369 --> 00:03:12,729
very worried because you know that the

57
00:03:16,890 --> 00:03:14,379
temperature of laboratory there is

58
00:03:20,909 --> 00:03:16,900
between summer and winter you know that

59
00:03:22,170 --> 00:03:20,919
the radon flux there is annually for

60
00:03:25,319 --> 00:03:22,180
similar because the temperature

61
00:03:27,899 --> 00:03:25,329
variations and so that the immediate

62
00:03:32,550 --> 00:03:27,909
conclusion is that your is contamination

63
00:03:36,020 --> 00:03:32,560

in your experiments and that is not a

64
00:03:39,479 --> 00:03:36,030
rule variation it's a just an apparent

65
00:03:42,679 --> 00:03:39,489
12 to 22 environmental effects but they

66
00:03:44,580 --> 00:03:42,689
make careful studies and they could not

67
00:03:47,249 --> 00:03:44,590
convince themselves that were the case

68
00:03:48,749 --> 00:03:47,259
it was left as an open question that

69
00:03:52,800 --> 00:03:48,759
there appears to be an annual variation

70
00:03:56,879 --> 00:03:52,810
they could not explain and here is a

71
00:04:00,030 --> 00:03:56,889
plot of their data and the blue points

72
00:04:04,069 --> 00:04:00,040
are their measurements and either five

73
00:04:09,390 --> 00:04:04,079
point average and the red curve is

74
00:04:11,309 --> 00:04:09,400
appropriately scaled representation of

75
00:04:13,349 --> 00:04:11,319
the distance of the earth-sun distance

76
00:04:15,300 --> 00:04:13,359
and if you look carefully you'll notice

77
00:04:17,399 --> 00:04:15,310
they're not quite in phase and that's a

78
00:04:18,849 --> 00:04:17,409
very important point which will come

79
00:04:21,339 --> 00:04:18,859
back to later on

80
00:04:24,309 --> 00:04:21,349
another experiment of an even longer

81
00:04:28,899 --> 00:04:24,319
time scale I think almost 20 years Carol

82
00:04:33,159 --> 00:04:28,909
in Germany and they were studying radium

83
00:04:36,189 --> 00:04:33,169
and they found a variation of a fraction

84
00:04:40,540 --> 00:04:36,199
of a percent a similar variation an

85
00:04:43,959 --> 00:04:40,550
annual variation and here amines it's a

86
00:04:46,089 --> 00:04:43,969
very impressive curve showing again the

87
00:04:47,559 --> 00:04:46,099
blue points are their data are their

88
00:04:49,839 --> 00:04:47,569

measurements of the other decay rates

89
00:04:52,659 --> 00:04:49,849
and the red curve is the earth-sun

90
00:04:54,369 --> 00:04:52,669
distance so it looks at first sight as

91
00:04:57,700 --> 00:04:54,379
if there really is a correlation between

92
00:05:00,429 --> 00:04:57,710
earth-sun distance and the decay rate

93
00:05:03,480 --> 00:05:00,439
and that led the Purdue scientists to

94
00:05:06,909 --> 00:05:03,490
conclude that there's some kind of flux

95
00:05:10,119 --> 00:05:06,919
that is affecting the decay rate but it

96
00:05:14,129 --> 00:05:10,129
falls off the distance from the Sun but

97
00:05:17,369 --> 00:05:14,139
if you look carefully at the phase of

98
00:05:20,439 --> 00:05:17,379
this annual variation which is shown in

99
00:05:22,629 --> 00:05:20,449
green and compare that with with the

100
00:05:24,519 --> 00:05:22,639
phase of the earth-sun distance is shown

101
00:05:28,930 --> 00:05:24,529
in red you see they don't quite match

102
00:05:30,730 --> 00:05:28,940
and so this makes one suspect that is

103
00:05:35,740 --> 00:05:30,740
not just the earth-sun distance that is

104
00:05:38,079 --> 00:05:35,750
of influencing this process and my

105
00:05:41,800 --> 00:05:38,089
colleagues applaud you therefore propose

106
00:05:43,749 --> 00:05:41,810
there is some scale of fuel or something

107
00:05:46,360 --> 00:05:43,759
emitted from the Sun well no actually

108
00:05:51,909 --> 00:05:46,370
this was there this was their model

109
00:05:56,290 --> 00:05:51,919
before noticing the phase problem now

110
00:06:01,149 --> 00:05:56,300
their experience carried out by a group

111
00:06:07,679 --> 00:06:01,159
in Italy on dark matter and they were

112
00:06:14,350 --> 00:06:07,689
looking for evidence of dark matter by

113
00:06:18,459 --> 00:06:14,360

the variation of a scintillation

114
00:06:23,920 --> 00:06:18,469
detector measurements and they'd knowing

115
00:06:25,899 --> 00:06:23,930
the rosti of Earth respect to the the

116
00:06:29,290 --> 00:06:25,909
galactic background or a cosmological

117
00:06:31,629 --> 00:06:29,300
background they figured that there

118
00:06:34,540 --> 00:06:31,639
should be an

119
00:06:36,719 --> 00:06:34,550
annual variation with pigs I think

120
00:06:40,390 --> 00:06:36,729
sometime in June June too and

121
00:06:44,559 --> 00:06:40,400
interestingly enough they they found

122
00:06:46,809 --> 00:06:44,569
annual variation and they found that it

123
00:06:48,429 --> 00:06:46,819
does indeed peek around that time so

124
00:06:53,559 --> 00:06:48,439
here is a correlation here's a

125
00:06:57,159 --> 00:06:53,569
comparison of the phases the PTB a

126
00:07:01,749 --> 00:06:57,169
German experiment had a maximum January

127
00:07:03,700 --> 00:07:01,759
31 whereas the earth-sun distance had

128
00:07:06,519 --> 00:07:03,710
its minimum giving a maximum effects

129
00:07:09,100 --> 00:07:06,529
from the sun on january three the

130
00:07:12,850 --> 00:07:09,110
magnitude affect the sun's axis is

131
00:07:14,890 --> 00:07:12,860
tilted reflect ecliptic and you get the

132
00:07:18,540 --> 00:07:14,900
best view of the northern hemisphere of

133
00:07:22,029 --> 00:07:18,550
the sun on march eight the neutrino flux

134
00:07:24,969 --> 00:07:22,039
had been found to vary annually and that

135
00:07:28,659 --> 00:07:24,979
peaks around februari to the wimps

136
00:07:32,110 --> 00:07:28,669
observed by the weekly suspected wimps

137
00:07:35,110 --> 00:07:32,120
observed by the da ma group peaks around

138
00:07:39,129 --> 00:07:35,120

june two now what you see is that the

139
00:07:41,709 --> 00:07:39,139
PTP data sea is closest to the neutrino

140
00:07:43,329 --> 00:07:41,719
data and that attracted my attention so

141
00:07:47,800 --> 00:07:43,339
i've been studying solar neutrinos for

142
00:07:49,809 --> 00:07:47,810
quite a few years so what are the

143
00:07:51,610 --> 00:07:49,819
possible explanations say of the annual

144
00:07:52,899 --> 00:07:51,620
variation one is that there's

145
00:07:54,999 --> 00:07:52,909
environmental effects and

146
00:07:57,429 --> 00:07:55,009
experimentalists say that now we've been

147
00:07:59,679 --> 00:07:57,439
very careful we've ruled that out the

148
00:08:01,540 --> 00:07:59,689
other ear is it due to these weakly

149
00:08:03,850 --> 00:08:01,550
interacting massive particles that the

150
00:08:06,730 --> 00:08:03,860
Italian group claimed to observe but the

151
00:08:10,779 --> 00:08:06,740
phases don't agree neutrinos the face is

152
00:08:12,189 --> 00:08:10,789
ok but the mechanism is unknown there

153
00:08:17,529 --> 00:08:12,199
could be something else of course going

154
00:08:19,839 --> 00:08:17,539
on so I decided one needs to do find

155
00:08:21,279 --> 00:08:19,849
something else about this data set to

156
00:08:27,629 --> 00:08:21,289
try to see whether it really is due to

157
00:08:31,749 --> 00:08:27,639
neutrinos or not and I have found that

158
00:08:34,779 --> 00:08:31,759
the neutrino flux is closely correlated

159
00:08:36,880 --> 00:08:34,789
with the total light output from the Sun

160
00:08:38,439 --> 00:08:36,890
called in radiance was a very surprising

161
00:08:44,350 --> 00:08:38,449
rule out resolved with very strong

162
00:08:46,000 --> 00:08:44,360
result and that that has a variation

163
00:08:49,889 --> 00:08:46,010

if there is with a pure frequency of

164
00:08:52,750 --> 00:08:49,899
about 11.1 cycles per year about

165
00:08:55,930 --> 00:08:52,760
30-something days per year different

166
00:08:58,870 --> 00:08:55,940
from the surface rotation rate so what I

167
00:09:02,370 --> 00:08:58,880
did was to take the Iranian data and

168
00:09:05,139 --> 00:09:02,380
compare it with this decay rate data

169
00:09:08,170 --> 00:09:05,149
using the Decatur using the radians as a

170
00:09:10,470 --> 00:09:08,180
proxy for neutrinos and I found that

171
00:09:13,690 --> 00:09:10,480
there's a very strong this is a

172
00:09:16,690 --> 00:09:13,700
correlation measurement that this curve

173
00:09:19,389 --> 00:09:16,700
shows the correlation between the decay

174
00:09:21,550 --> 00:09:19,399
rates and the Iranian siz a function of

175
00:09:24,430 --> 00:09:21,560
frequency and you see the very sharp

176
00:09:31,540 --> 00:09:24,440
peak at eleven point oh eight cycles per

177
00:09:35,620 --> 00:09:31,550
year confirming the conjecture that what

178
00:09:39,940 --> 00:09:35,630
is affecting the decay rate of these

179
00:09:42,370 --> 00:09:39,950
elements is in fact neutrinos and i did

180
00:09:44,769 --> 00:09:42,380
a monte carlo calculation to see whether

181
00:09:47,470 --> 00:09:44,779
the chance effect and i ran a hundred

182
00:09:49,810 --> 00:09:47,480
thousand monte carlo's and not one of

183
00:09:52,630 --> 00:09:49,820
them gave a strong a result as the

184
00:09:56,530 --> 00:09:52,640
actual data so this this correlation

185
00:09:59,620 --> 00:09:56,540
between a radiance was the proxy for