CORRELATION BETWEEN SOLAR"NEUTRINO FLUX" AND OTHER SOLAR PHENOMENA

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1.Introduction.

We have made a study of the solar neutrino data obtained by Davis et al (1) with a tank of CCl_4 located 4800 mwe underground and shown in Fig.1 for the period 1970-83.These observations are on the production rates of Ar^{37}atoms via the reaction $\nu_e+Cl^{37}\rightarrow Ar^{37}+e^-$ in the tank caused presumably by a flux of neutrino's from the Sun.

It is now well known that the combined average rate of production of Ar^{37}obtained as 0.47±.04 atoms/day and depicted in Fig.1 is too low by a factor ≈3 from that expected from thermonuclear chain reactions in the Sun (2).Added to this difficulty in understanding the source of discrepancy between the expected and observed reaction rates are the numerous suggestions that the obtained data exhibit temporal variations (3,4).Recently we have carried out a statistical analysis (5) of the data shown in Fig.1.While one cannot make a strong claim for time variations based on a simple χ^2 test,we have shown that the data represented by run numbers marked 27,71 and the sequence of low values following run no.60 and some others are significantly deviated.In fact there seems to be a correlation of adjacent data points exhibiting a pattern of variation shown in Fig.2 for which the χ^2 test of constancy hypothesis yields a probability of only 0.03% (χ^2=37.5/13d.f.)

In this paper we pursue the idea of possible time variations in the data shown in Fig.1 and attempt to correlate the variations to two other phenomena of solar origin-the sunspot number and the geomagnetic Ap index.

2. CORRELATION STUDIES WITH SUNSPOTS AND GEOMAGNETIC INDICES

Following the early suggestions(4), Basu (6) has found a positive correlation between the solar neutrino data of Davis of et al and monthly average of geomagnetic Ap indices.Sakurai (3) suggested the correlation with

biennial variations in the sunspots.

We have noted a correlation between the geomagnetic Ap index and $|\dot{R}_z|$, the derivative of smoothed sunspot number (7), which is shown in Fig.3, This correlation could merely suggest a common link of solar wind between $|\dot{R}_z|$ and monthly mean Ap index. We also find a fairly good correlation between the production rate of Ar^{37} atoms and $|\dot{R}_z|$ (Fig.4). The significance of this correlation is at a level of 4σ effect. $|\dot{R}_z|$ appears to be a better correlation parameter than the biennial periodicity of the sunspot number as orignially suggested by Sakurai (3). The correlation of Ar^{37} with Ap index is somewhat less significant (3.3σ effect) than with $|\dot{R}_z|$.

3. Conculsions.

A statistical analysis of the data obtained by Davis et al on the solar neutrino flux suggests fluctuations with time within a period of 12 years or so for which the data is currently available. These variations appear to have positive correlation with $|\dot{R}_z|$ (absolute rate of variation of smoothed sunspot number) which in turn has a positive correlation with the geomagnetic Ap index. Thus the solar neutrino flux recorded in the Davis et al experiment seems to have a connection with even a low energy phenomenon occurring on the such as the generation of solar wind. We admit the possibility of isolated large fluctuations like run nos.27 and 71 (Fig.1 and 2) being correlated to large solar flares occurring on the visible disc of the sun as has been suggested by Bazilevskaya et al (3).

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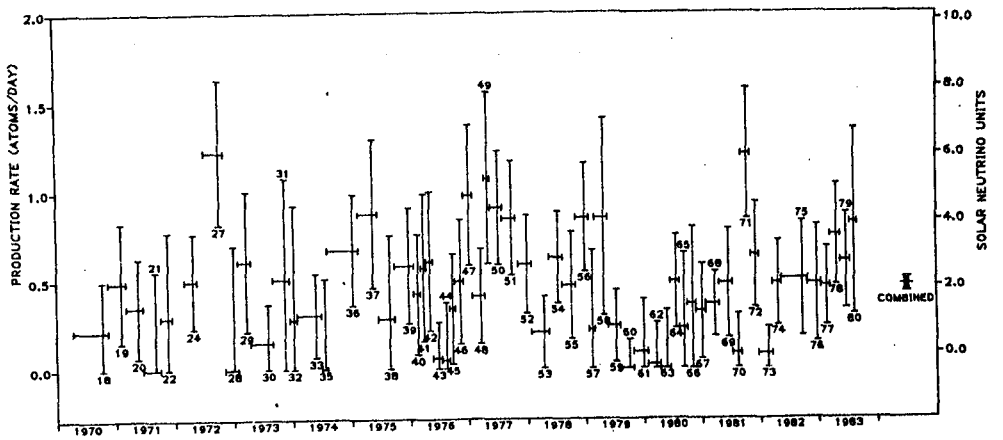

Fig.1 The data of R.Davis Jr. et al (1) on the solar neutrino flux during the period 1970-83.

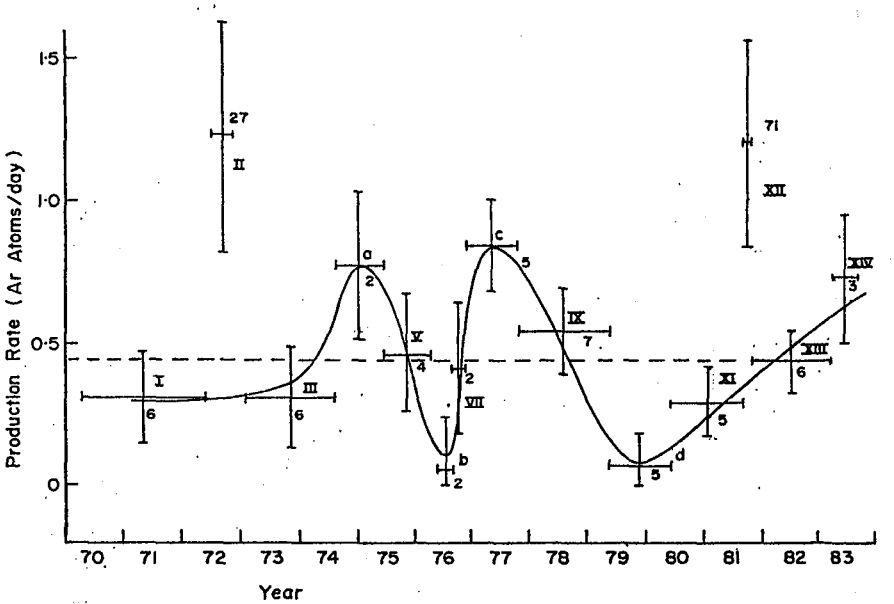

Fig.2 Grouped averages of the solar neutrino flux data given in Fig.1 which exhibit variations in time as suggested by the guiding continuous curve excluding run no.27 and 71. The grouped data points are labelled by Roman number or alphabets. The numbers attached to the groups except II and XII indicate the no.of independent measurements that have gone into the grouping.

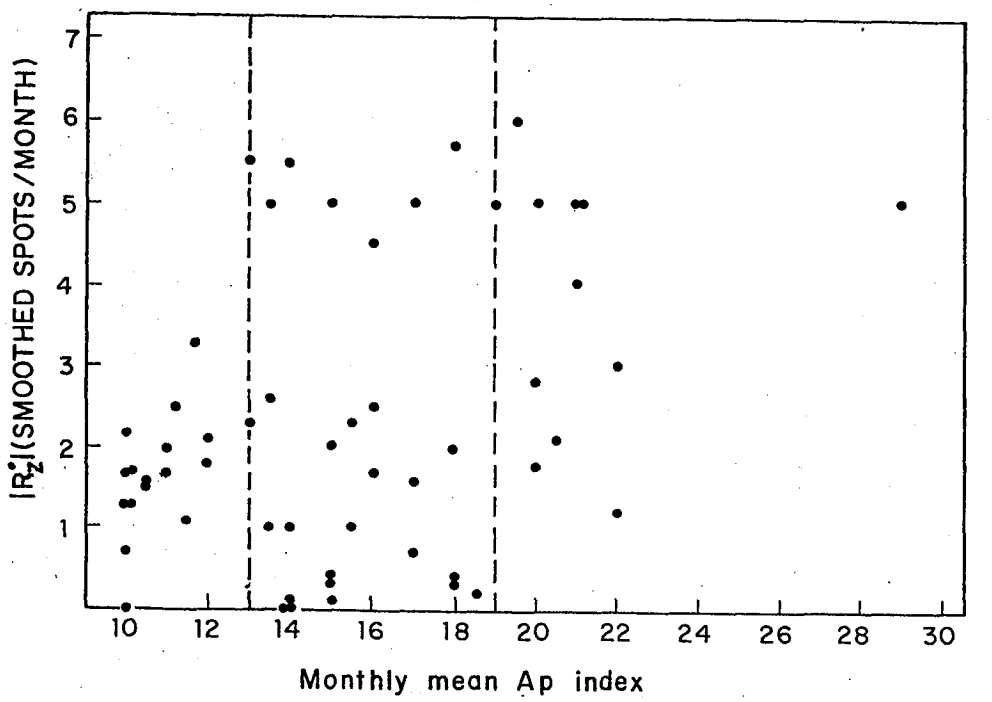

Fig.3 A plot showing the correlation between monthly average geomagnetic Ap index and the absolute derivative $|\dot{R}_Z|$ of smoothed sunspots. Vertical dashed lines separate different regions of the mean Ap.

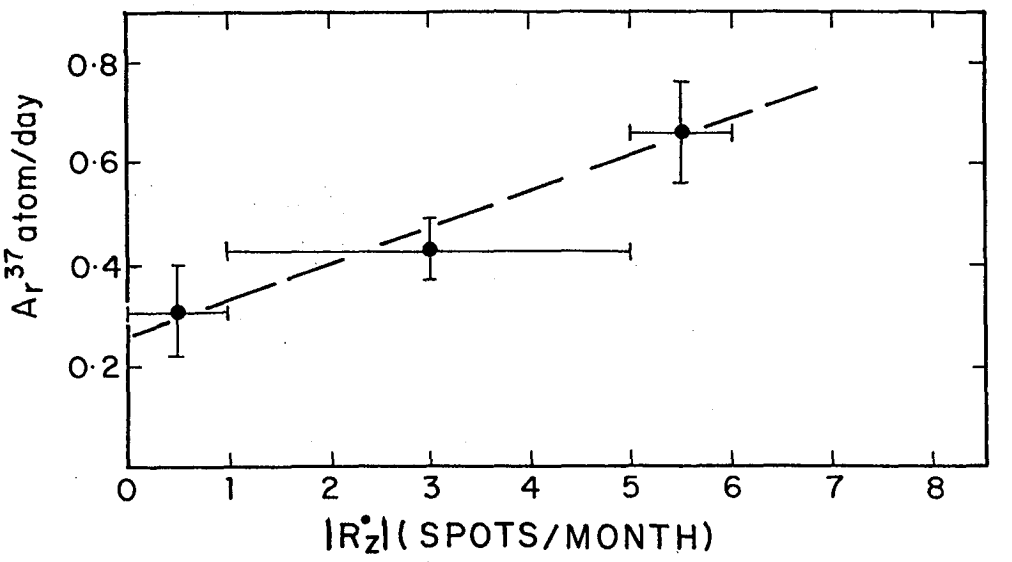

Fig.4 The correlation between Ar^{37} production rate in the Davis et al experiment and $|\dot{R}_Z|$, the absolute derivative of smoothed sunspots.