# SOLAR COSMIC RAY BURSTS AND SOLAR NEUTRINO FLUXES

G.A.Bazilevskaya, S.I.Nikolsky, Yu.I.Stozhkov

P.N.Lebedev Physical Institute of the Academy of Sciences of the USSR, 117924, Leninsky Prospect,53, Moscow, USSR

T.N.Charakhchyan

Institute of Nuclear Physics, Moscow State University, 119899, Moscow, USSR

Abstract

The neutrino flux detected in the Cl-Ar experiment /1/ seems to respond to the powerful solar cosmic ray bursts. The ground-based detectors,the balloons and the satellites detect about 50% of the bursts of solar cosmic ray generated on the Sun's visible side. As a rule, such bursts originate from the Western side of the visible solar disk. Since the solar cosmic ray bursts are in opposite phase with the 11-year galactic cosmic ray cycle which also seems to be reflected by neutrino experiment, the neutrino generation in the bursts will flatten the possible 11-year behaviour of the $^{37}Ar$ production rate, Q, in the Cl-Ar experiment. The detection of solar-flare-generated gamma-quanta with energies above tens of Mev is indicative of the generation of high-energy particles which in turn may produce neutrinos. Thus, the increased Q during the runs, when the flare-generated high energy gamma-quanta have been registered, may be regarded as additional evidence for neutrino generation in the solar flare processes.

Definite evidence for neutrino generation in powerful solar cosmic ray bursts has been obtained by now /2-4/. During the period from 1970 up to the present the mean $^{37}Ar$ production rate in the Cl-Ar experiment /1/ was $Q=0.47\pm0.04$ $^{37}Ar$ atoms/day. The highest value of Q were observed during the periods when powerful solar cosmic ray bursts have been registered, namely, the run No 27, $Q=1.23\pm0.41$ $^{37}Ar$ atoms/day (the bursts of August 4 and 7, 1972) and the run No 71, $Q=1.21\pm0.37$ $^{37}Ar$ atoms/day (the burst of October 12,1981) /5,6/. A powerful solar cosmic ray burst can hardly be expected in 1985-1987 because the solar activity will approach its minimum whereas the solar flare events are usually observed near solar maximum.

It should be noted that the solar-flare-generated neutrinos will flatten the 11-year cycle of Q which, according to /2-4/ is in the opposite phase with the solar activity.

The fluctuations of the Q-value from one run to another may be due to the cosmic ray bursts, which have not been detected at the Earth. Fig. 1 a, b shows the heliolongitudinal distribution of the parent flares of solar cosmic ray bursts detected at sea-level since 1942 (35 events) /7/, and in the stratosphere since 1958 (68 events). The strong heliolongitudinal dependence of detection probability of solar cosmic ray bursts gives a $\sim 50\%$ probability of the detection such events with the charged-particle detectors installed on the Earth'surface, on balloons and satellites.

It may be assumed that the detection of high-energy $\gamma$-quanta ($E_\gamma$ is more than several tens of MeV) from $\pi^0$-meson decays in solar flares will significantly increase the detection probability of the events occurring on the Eastern side of the visible solar disk. Such events must generate $\pi^\pm$-mesons whose decays will produce $\nu_e$. In their turn the fluxes of such neutrinos may raise the Cl-Ar detector counting rate.

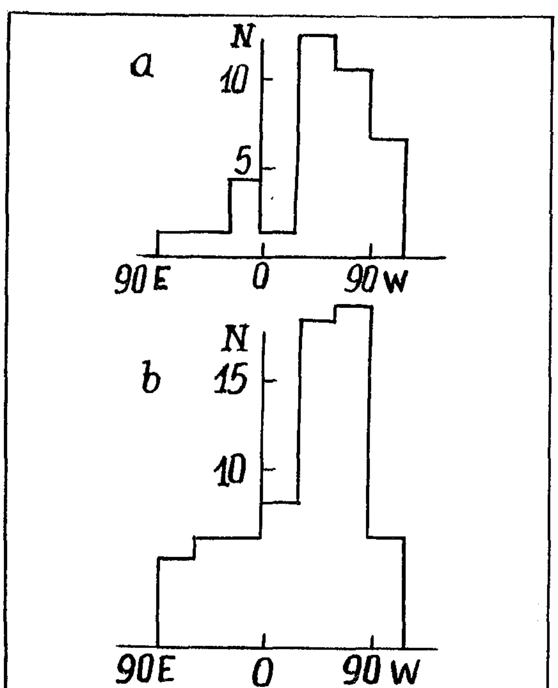


Fig.1. Heliolongitudinal distribution of the parent flares of solar cosmic ray bursts detected at sea-level (a), and in the stratosphere (b).

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The Table presents the solar flare events in which the $\gamma$-quanta with $E \gtrsim 50$ MeV were detected /8/. Solar neutrons were also detected in these events. It may be asserted quite safely that nuclear reactions, in which $\pi$-mesons are produced and then decay, occure in the solar flares presented. The rate of $^{37}Ar$ production in the Cl-Ar detector during the flare runs proved to be increased ($Q_o$) compared with the previous ($Q_{-2}$, $Q_{-1}$) and subsequent ($Q_{+1}$, $Q_{+2}$) runs. The run numbers which are indicated in the brackets and Q-values are taken from /5/. The bottom of the Table presents the mean values of Q for two events.

Table

| No | Date of $\gamma$-burst | $Q_{-2}$ | $Q_{-1}$ | $Q_o$ | $Q_{+1}$ | $Q_{+2}$ |
|---|---|---|---|---|---|---|
| 1 | 21.06.80 | (62) 0.023± 0.231 | (63) 0.000± 0.325 | (64) 0.488± 0.266 | (65) 0.224± 0.425 | (66) 0.361± 1.253 |
| 2 | 03.06.82 | (73) 0.077± 0.151 | (74) 0.478± 0.242 | (75) 0.503± 0.327 | (76) 0.475± 0.231 | (77) 0.461± 0.224 |
| the mean value | | 0.050± 0.138 | 0.239± 0.203 | 0.496± 0.211 | 0.350± 0.242 | 0.411± 0.636 |

The increased values of Q were registered durihg the runs when the high-energy $\gamma$-quanta and solar neutrons were observed. The results obtained agree with the conclusion /2-4/ concerning the possible generation of neutrinos in solar cosmic ray bursts.

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