SEARCH FOR SLOWLY MOVING PENETRATING PARTICLES AT BAKSAN UNDERGROUND TELESCOPE.

Alexeyev E.N.,Boliev M.M.,Chudakov A.E.,Mikheyev S.P., Shkvorets O.Yu.
Institute for Nuclear Reseach, the USSR Academy of Sciences, 60th October Anniversary pr.7[a],117312, Moscow, USSR.

Time-of-flight method is used to look for slowly moving ionizing particles underground. The acceptance of the experiment is 1800m² st. No candidates have been recorded during 230 days of observation. This corresponds to the upper limit for superheavy magnetic monopoles flux $5.6\times10^{-6}m^{-2}st^{-1}d^{-1}$ (90% c.l.).

We witness now an activity (for example E.C.Loh,1982) in experimental search for superheavy monopole, $M\sim10^{16}$GeV, μ=137e/2, caused mainly by CUT prediction. Obviously, particles with such a huge mass could exist as relics only and their flux, if not zero,should be extremely small. On the other hand nevertheless expected small velocity $\beta\lesssim10^{-2}$ these particles should have immence penetrating power and easily traverse the Earth. So the most promising way to look for slowly moving ionizing superheavy particles is to perform a conventional time-of-flight counter technique experiment underground. There is no hope to do this for extremely small velocities $\beta < (1\div3)\times10^{-3}$because of the cutoff in ionization and exitation losses. Above this, though not exactly known threshold, all the signatures of the trace of particle with magnetic charge 137e/2 or electric charge e are quite similar for $\beta<10^{-2}$. Therefore all experimental limits obtained with counter techtique should be applied not only to the GUT-monopoles, but to electrically charged superheavy particles as well.

Baksan Underground Scintillation Telescope has several adventage for the experiment in question:

i)A relatively big size, though most probably far not big enough. Total acceptance 3800m² st., for this experiment 1800m² st.

ii)8 layers of 30cm thick scintillators providing by time-of-flight method an unambiguous velocity determination, if $\geqslant 3$ layers are crossed.

iii)170g/cm² absorber separating external layers from internal ones, also internal from each other.

iv)The reconstruction of trajectory (totally 3186 scintillators 70x70x30cm³ each).

v)A 10+5 beams oscilloscope picture for pulse shape and delays analysis for all layers.

There were 3 stages of Baksan monopole search experiment:

i)First an analysis of data, accumulated in 80-81 in different experiments was made and the upper limit $4\times10^{-5}m^{-2}st^{-1}s^{-1}$ presented at ICOBAN (Jan 1982).

ii)From Dec 1981 a special trigger (1) was made to select slowly moving particles (Alexeyev et al 1982).

iii)From Nov 1982 a new trigger (2) for smaller velocities is in operation.

The logics of trigger (1) and (2) are as following: The initial signal arises in any but only one of 6 external scintillation layer and then is followed by a delayed signal from any of 2 internal 200m² layers within the delay interval .05-10μs (1) or .05-50μs (2); then the oscilloscope is triggered also all the digital data is memorized in the computer. With trigger (2) the time gate of the hodoscope is expanded from 1.5μs to 100μs thus to record slowly moving particle trajectory, also the delays from all layers are digitized up to 100μs. All the signal thresholds for trigger logic, detector co-ordinates and timing correspond to 12MeV energy loss in 30cm of scintillator or to .25 of minimum ionizing particle with 50ns integrating time.

The trigger rate $\sim 100d^{-1}$ is mostly due to stopping muons providing the delayed signal in internal layer by the decay electron and partly to accidentals. The last ones do not make any trouble, being simultaneously recorded by many layers. To exclude μ-e decays we use the requirement, that slowly moving particle should traverse one more layer.

The selection criterion for candidates was chosen to have at least 3 layers successive response with time intervals no less then .1μs the total duration of the succession being less then 20μs (1) or 100μs (2). Further analysis of trajectory data and time intervals, pulse shape and amplitudes can be made but so far no one candidate was recorded. This shows that the background is essencially negligible.

The trigger logic and selection criterion make the acceptance factor velocity dependent. This dependence can be calculated using the known geometry of the telescope (Alexeyev et al 1979). The upper limit is presented in fig.1 as a function of β together with other data (E.C.Loh 1982). Our upper limit is dated Jan 1983 and corresponds to total exposure time 5500h with trigger (1) plus 1000h with trigger (2).

It should be mentioned, that for the case of GUT's monopole the range $\beta < 10^{-3}$ can be also investigated by counter technique using the process of induced proton decay (V.A. Rubakov 1981) if the cros section is as suggested $\sigma \sim 10^{-27}/\beta$ or even 100 times smaller. The Baksan Telescope is quite appropriate instrument to detect this kind of event because of a thick absorber between scintillation layers. With the trigger system in operation we were able to detect that kind of event for $\beta \gtrsim 3\times10^{-4}$.

REFERENCES

1. E.N.Alexeyev et al 1979 Proc. of the 16th ICRC v.10, p.276, Kyoto, Japan.
2. E.N.Alexeyev et al 1982 Lett.Nuovo Cim. 35,413.
3. M.E.Crouch et al 1978 Phys.Rev. 18D,2239.
4. E.C.Loh 1982 Monopole Conference, Racine, Wisconsin, preprint UU/HEP, 82/5.
5. V.A.Rubakov 1981 Pis'ma Zh. Eksp. Teor. Fiz. 33,658.

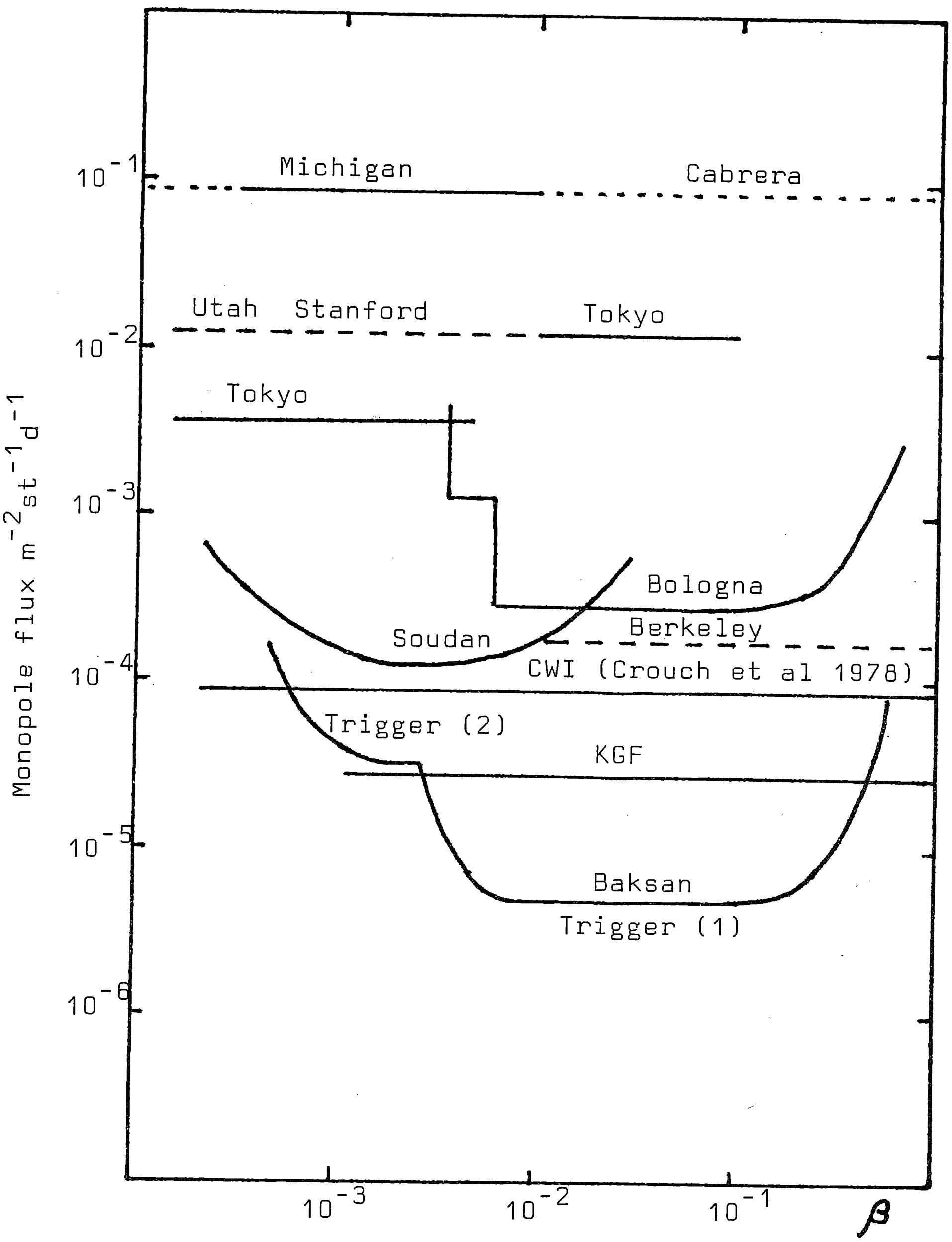

Fig.1 Upper limits for flux of superheavy magnetic monopole (for references see E.C.Loh 1982).