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POLAR GEOPHYSICAL INSTITUTE

Preprint PGI 90-01-70

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APATITY
1990

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January I990
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as the bottle is destructed due to the instability and proceed to leak out during the time B_m (it can contain also the time of leaking from the corona (Bazilevskaya and Vashenyuk, 1981) and the diffusion time). Particles of PC start to escape at time $\bar{B}_n \approx 8$ min, i.e. before the bottle opening and are eventually linked with the shock propagating ahead of bottle (Cliver et al., 1982; Borovkov et al., 1987). Ejection of SCR to the interplanetary medium must proceed on the coronal altitudes 1–1.5 $R_\odot$ where the open field lines appear (Korzhov, 1982). Taking into account the shock altitude at the time of type II beginning (0.2 $R_\odot$, Mullan, 1983) – presumable time of acceleration, one can obtain the velocities of radial transport for the PC (B_n=8min) and DC (B_n=30 min) being 1200–2000 and 400–500 km/s. Such velocities are characteristic accordingly to the shock and the transient which is connected with the magnetic bottle (Schatten and Mullan, 1977).

5. MODEL OF PROMPT COMPONENT ORIGIN

All the considerations cited above give us convincing evidences of the existence of two components: a prompt and a delayed one in the relativistic SCR events. Properties of the delayed component are studied rather well, they are accounted well enough by the model of magnetic bottle. (Mullan, 1983). The physical model of the prompt component origin must in turn account all the noted above characteristics:

1. Ejection of PC from the corona begins before the bottle opening (Fig. 3);
2. generation of PC proceeds on the open field lines (fast rise and drop of intensity, short duration of increase);
3. anisotropic character of PC ejection (Miroshnichenko, Sorokin, 1987, 1989), see Fig. 7;
4. specific mechanism of fast acceleration on the open field lines (impulsive increase, anomally hard energetic spectrum of PC (Miroshnichenko, Sorokin, 1987,1989);
5. possible physical agent responsible for the PC generation–coronal shock (Cliver et al., 1982; Borovkov et al., 1987).

One more fact should be added which may not be fully understood at a first glance :

6. the flares in which PC have been registered avoid the heliolongitudes of good connection ($50^\circ - 60^\circ$W), Cliver et al., 1982, Borovkov et al., 1987).

The model of PC origin must also account for the real structure of coronal magnetic field (Fig.8, Korzhov, 1982). Open magnetic field lines are formed under the influence of solar wind into the structures like the coronal streamers belted the Sun and transforming into the heliospheric current sheet at large distances. The open structure of the magnetic field in the sheet makes the particles quickly leave the Sun. At the same time they will be affected by a fast azimuthal drift under the action of the normal to magnetic field component of speed – Fig.9. The value of this drift speed is $V_d \sim 0.6-0.7\ V_\perp$ (Fisk and Schatten, 1972). As it was noted above, the PC ejection begins at the moment of the shock arrival to the open field lines region (the base of the current sheet of the streamer – Fig.8). A possible model of PC generation accounting for all the above numbered properties (1–6), the real structure of the coronal magnetic field and the character of the particle movement in the neutral sheet are shown in Fig. 10. Coronal shock advancing before the expanding bottle heats the current sheet of a streamer (which may originate from the same active centre) causing fast reconnection and acceleration of particles (hatched region) inside it (Mullan et al., 1984). Some estimates of maximal energy gained by protons in such a kind of acceleration give 1.8–3.7 GeV (Perez-Peraza, 1986). The accelerated particles leave the Sun along the current sheet undergoing simultaneously the azimuthal drift (Fisk and Schatten, 1972). By such a drift one can explain a seemingly paradoxical fact of a delayed arrival of the first particles in well-connected (~60°W) events (Cliver et al., 1982). The direction of this drift depends on polarity of the general magnetic field of the Sun and for the situation shown in Fig.5 the drift will have a WE direction. The Sun's general magnetic field had the polarity of this sign in 1982–1989 (impulse-like events of 7.12.82 and 16.02.1984 given in Fig.1 occurred near the western limb and behind it). Such a regularity in the direction of drift (EW or WE) one can observe in a number of other GLE's containing PC but it is hard to recognise a clear regularity as a whole, for all cases. It is possible that the local magnetic fields near the Sun play in this effect the deterministic role. In particular, this must take place in the years near the maximum of solar cycle when the current sheet has a very complicated form and is located mainly in the vertical plane (Korzhov, 1982, 1983). Besides, diverging field lines remain radial up to $\sim 20R_\odot$ (Korzhov, 1977, 1982) hence the particle flux at this distance should be significantly collimated. It is indirectly confirmed by the PAD calculations (Miroshnichenko and Sorokin, 1987) near the Sun. On the other hand, because of its large dimensions (~100°) the magnetic bottle is expected to give rather isotropic particle flux at the opening.

6. CONCLUSIONS

Analysis of experimental data along with the characteristics of relativistic SCR near the Sun led to conclusion about the existence of two (maybe independent) components : prompt (PC) and delayed (DC) ones in the relativistic SPE's. DC has the isotropic PAD and relatively soft energetic spectrum. Its possible origin is the magnetic bottle opening over the wide area (60–100°) in the corona. PC is characterized by hard energetic spectrum and large anisotropy. Ejection of PC from the corona begins 20 min before the bottle opening. A possible way of PC generation is the particle acceleration in a current sheet of coronal streamer disturbed by a flare induced shock wave.

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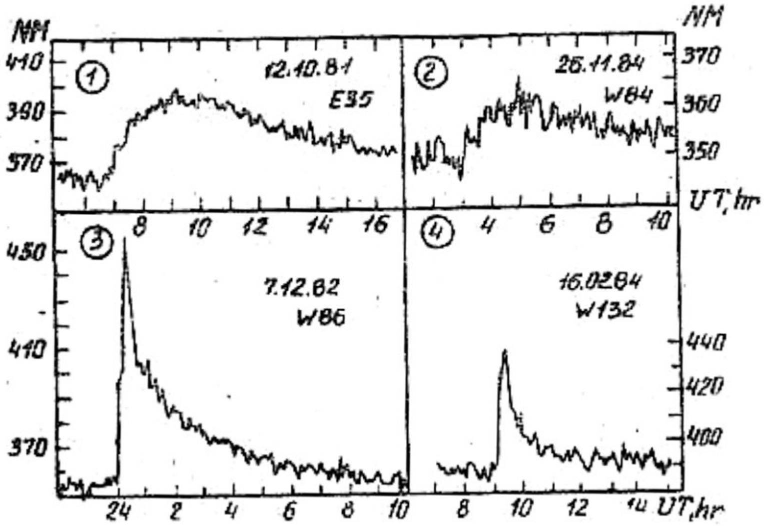

Fig.1. Time-intensity profiles of GLE's registered in 1981-84 on the NM Apatity.

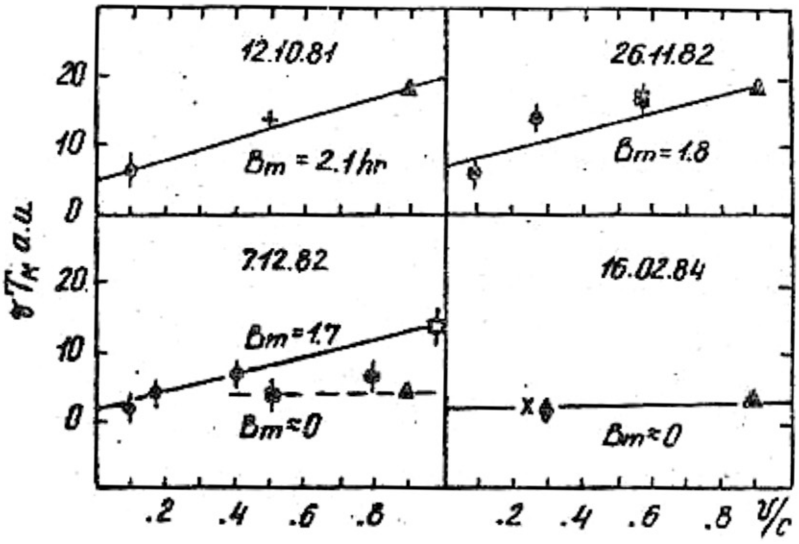

Fig.2. V · T_m analysis of SPE's (Fig.1).

▲ - neutron monitor }
\+ - ballons } Apatity
x - riometer }
● - protons, METEOR - Sattellite (Avdyushin et al., 1984)
♦ - protons, ICEE - ——"—— (Bieber et al., 1986)
■ - protons }
} GOES - ——"—— Solar Geophys. Data
□ - electrons } 1983 NN 466, 472, p.2.

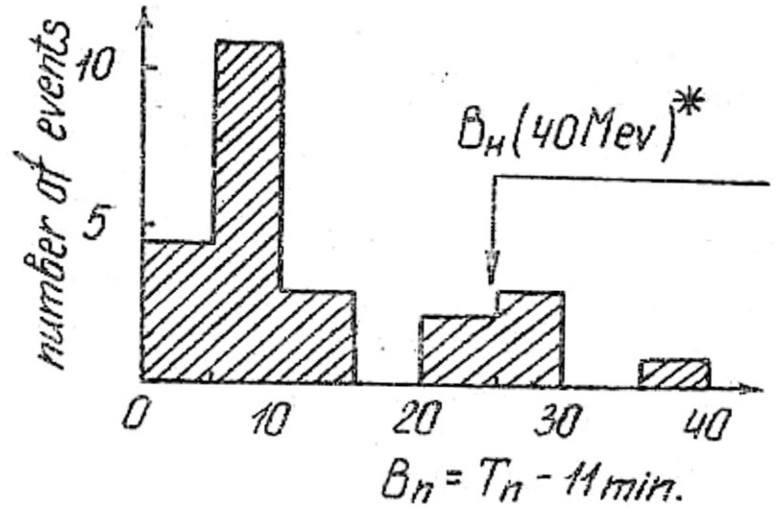

Fig.3. Distribution of the SPE number in parameter B_n
* (Bazilevskaya, Sladkova 1986)

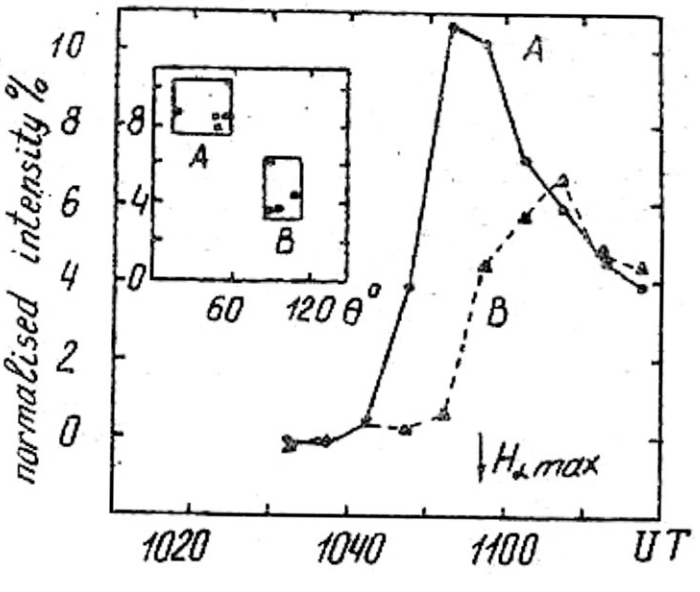

Fig.4. Prompt (A) and delayed (B) components in the 18.11.1968 GLE. $\theta = 0°$ – mean IMF direction (Duggal et al., 1971).

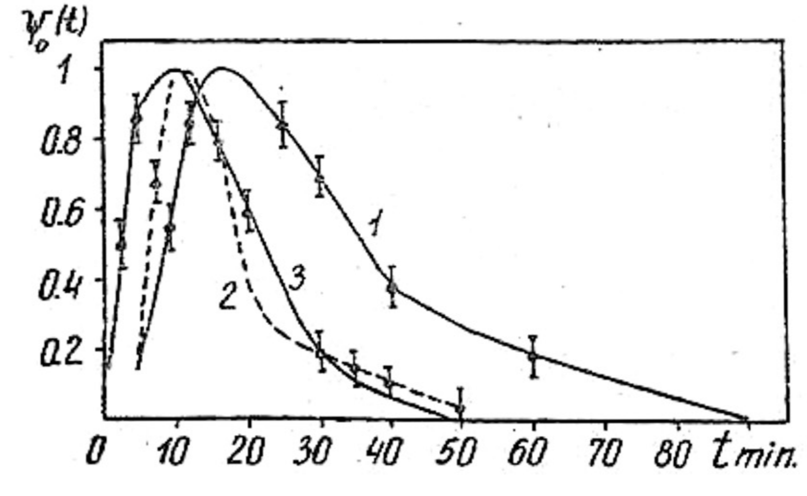

Fig.5 Reconstructed time profiles of relativistic particles ejection from the corona for SPE's 19.11.1949(1), 7.12. 1982 (2) and 23.02. 1956(3), (Miroshnichenko and Sorokin, 1989)

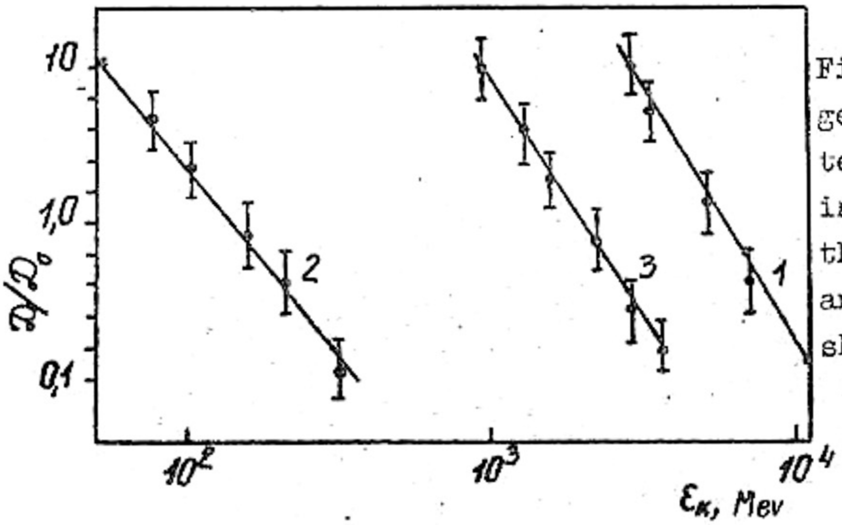

Fig.6. Differential energetic spectra reconstructed in origin(intensities in arbitrary units) for the SPE's 19.11.1949 (1) and 7.12.1982(2,3), Miroshnichenko and Sorokin, (1989).

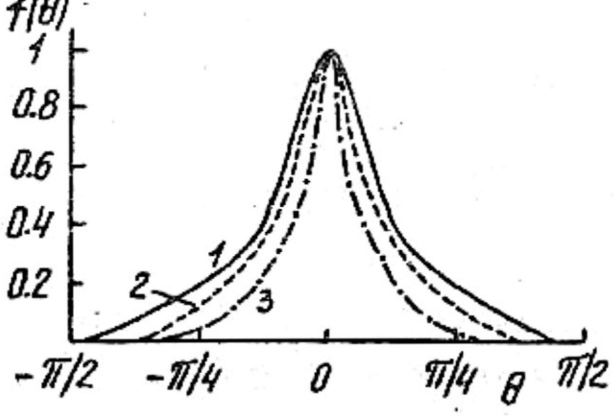

Fig.7. PAD for 16.02. 1984 GLE observed at the Earth (1), and the one reconstructed near the Sun for two different values of θ^2 square mean angle of scattering (curves 2 and 3, respectively, Miroshnichenko and Sorokin (1987 b).

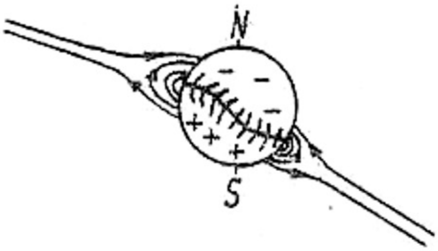

Fig.8. Coronal magnetic field with the neutral current sheet (Korzhov, 1982).

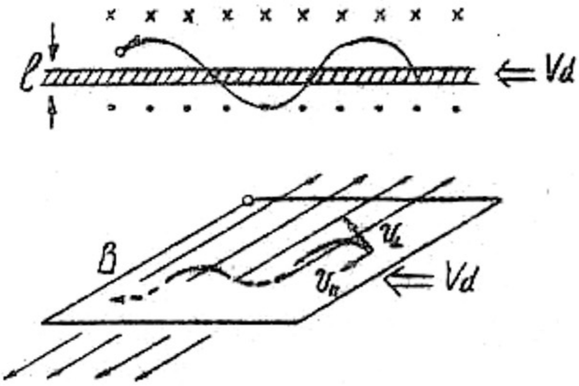

Fig.9. Schematic picture showing the motion of energetic protons in a current sheet (Fisk and Schatten, 1972).

Fig.10. Possible model of prompt component generation.

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Print Editor V.A.Ganichev

Signed for publication on 16.02.1990.
Paper 60x84 1/16. Offset paper. Offset printing. Order N 103.
Circulation 200 . Price 5 kop.

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184200 Apatity Murmansk region, USSR.