SOME CHARACTERISTICS OF THE SOLAR WIND IN THE ^{3}He-RICH SOLAR FLARES TIME

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The analysis of experimental data, pertinent to the speed of the solar wind issuing from regions of ^{3}He-rich solar flares, indicates the connection of these solar flares with the low speed solar wind. With the help of research of the average solar wind speed at the time of 30 ^{3}He-rich solar flares for the period 1968—1978, the minimum speed was found at the arrival time of the solar wind from regions of the Sun, in which the ^{3}He-rich solar flares took place.

НЕКОТОРЫЕ СВОЙСТВА СОЛНЕЧНОГО ВЕТРА ВО ВРЕМЯ БОГАТЫХ ГЕЛИЕМ-3 СОЛНЕЧНЫХ ВСПЫШЕК

Проведенный анализ наблюдательных данных по скорости солнечного ветра, истекающего из области гелием-3 богатых вспышек, показывает на связь этих вспышек с низкоскоростным солнечным ветром. Исследованием временной зависимости средней скорости солнечного ветра во время 30 гелием-3 богатых солнечных вспышек, было установлено наличие минимума в скорости солнечного ветра, истекающего из областей гелием-3 богатых солнечных вспышек.

I. INTRODUCTION

One of the fundamental question for understanding the origin of solar flares is the problem of accelerated particles and the generation of electromagnetic radiation at the time of these flares. The insight into the mechanism of ^{3}He-rich solar flares can also contribute to the solution of this problem, i.e. to the explanation of the recordings of solar energetic particles (SEP), enriched by ^{3}He ions. The ratio of the ^{3}He to the ^{4}He ions is from two to four orders higher in these flares, in comparison with its value measured in the solar atmosphere. These flares have been examined experimentally for obout 20 years. Hence the number of the

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registered events today is sufficiently high to determine their fundamental characteristics with the help of the detailed statistical analysis of these flares [1—4]. In the present paper we shall deal with some characteristics of the solar wind at the time of ^{3}He-rich solar flares.

II. SOLAR WIND ASSOCIATED WITH ^{3}He-RICH SOLAR FLARES

It was found with the help of measurements on board of satellites (e.g. Vela-3 [5]) that above the solar region with a close structure of the magnetic field the solar wind speed is low, while high speeds of the solar wind were observed above regions which had open magnetic field lines. Zwickl et al. [6] confirmed the mutual connection between ^{3}He-rich solar flares and the special structure of the solar magnetic field on the basis of experimental data connected with the solar wind speed analysis at the time of six ^{3}He-rich solar flares. From the distribution of these solar flares in dependence on the heliographic longitude of the flare, represented for 50 ^{3}He-rich solar flares in Fig. 1, there follows the mutual connection of these solar flares with the low speed flows of the solar wind. To ascertain this fact, we made a detailed analysis of the solar wind speeds behaviour [7] for 20 ^{3}He-rich solar flares, using data from the catalogue in [1].

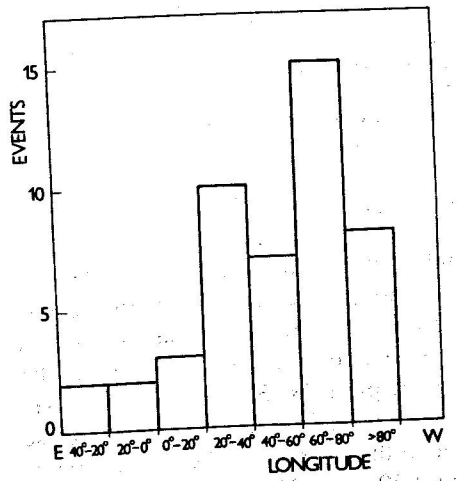

Fig. 1. The distribution of ^{3}He-rich solar flares as the function of the heliographic longitude of the flare.

In Fig. 2 the time dependence of the average solar wind speed is represented, obtained from 20 ^{3}He-rich solar flares a few days before and after the beginning of the flare. The time t_0 is the time of the flare beginning at the H_α emission. This dependence on the higher statistic confirms the results obtained by Zwickl et al.

[6] that the investigated type of flares is connected with the low speed solar wind. This testifies to the closed structure of the magnetic field in the region of these flares, which is in good agreement with the geometry of the acceleration region, proposed in [8] on the basis of the model of the preferential heating of ^{3}He ions in solar flares suggested by L. G. Kocharov [9].

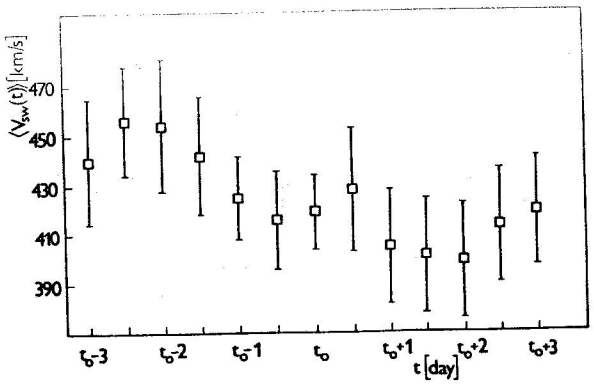

Fig. 2. The time dependence of the average solar wind speed at the ^{3}He-rich solar flares time (t_0 is the time of the beginning of the H_α flare).

If for the time t_0 we choose that time when the solar wind has been observed near the Earth, issuing from that region of the Sun, in which later the ^{3}He-rich solar flare takes place, we can obtain information about the structure of magnetic fields in the region of this flare. From the paper by Nolte et al. [10] it follows that the solar wind speed V_{sw} is conversely proportional to the longitude of the region of the Sun in which the flare takes place. We can estimate the time t_0 *from the equation* [10]:

$$\frac{\Omega R}{V_{sw}(t_0)} = \lambda_{opt} + \Omega t_0 \qquad (1)$$

where R is the distance between the Sun and the Earth, Ω is the angle speed of the Sun rotation, λ_{opt} is the longitude of the H_α flare.

Equation (1) takes into consideration changes of the location of the ^{3}He-rich solar flare with time, because of solar rotation. By the solution of equation (1) we determined the time t_0 of the arrival of the solar wind from that region of the Sun, in which later the ^{3}He-rich solar flare took place. The dependence of the average solar wind speed (obtained from 20 ^{3}He-rich solar flares) as the function of time, in which for time t_0 we took the time obtained by the solution of equation (1), is in Fig. 3. In Fig. 4 there is for comparison the same dependence for "normal" solar flares not enriched by ^{3}He ions. In Fig. 5 there are the time dependences of the

solar wind speed at the time of the six ^{3}He-rich solar flares. The dart indicates the time t_0 obtained from equation (1), the vertical dashed line indicates the beginning of the solar flare in the optic.

III. CONCLUSION

On the basis of the analysis of the above dependences we can make the following conclusions:

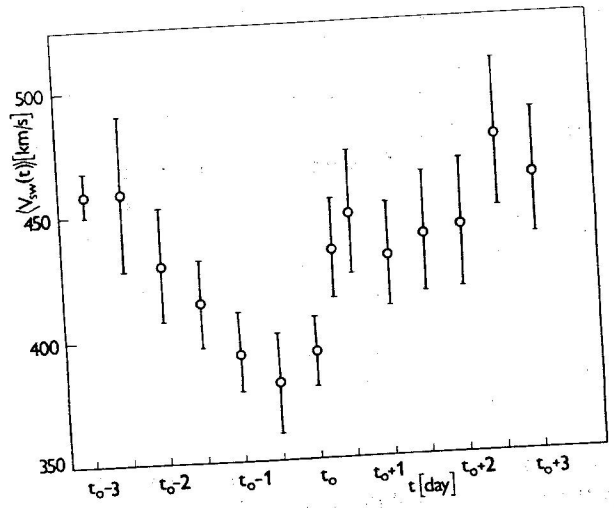

Fig. 3. The time dependence of the average solar wind speed at the ^{3}He-rich solar flares time (t_0 is the time, when there was observed near the Earth the solar wind issuing from that region of the Sun, in which later the ^{3}He-rich solar flare took place).

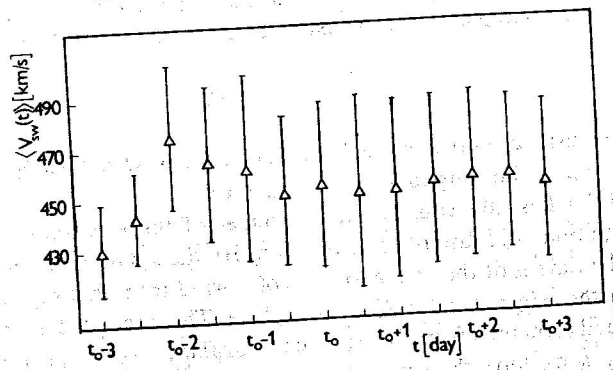

Fig. 4. The time dependence of the average value of the solar wind speed for normal solar flares (t_0 is the same as in Fig. 3).

1. For ^{3}He-rich solar flares a low speed solar wind (~400 km per sec.) is characteristic.
2. There has been proved the existence of the local minimum in the solar wind

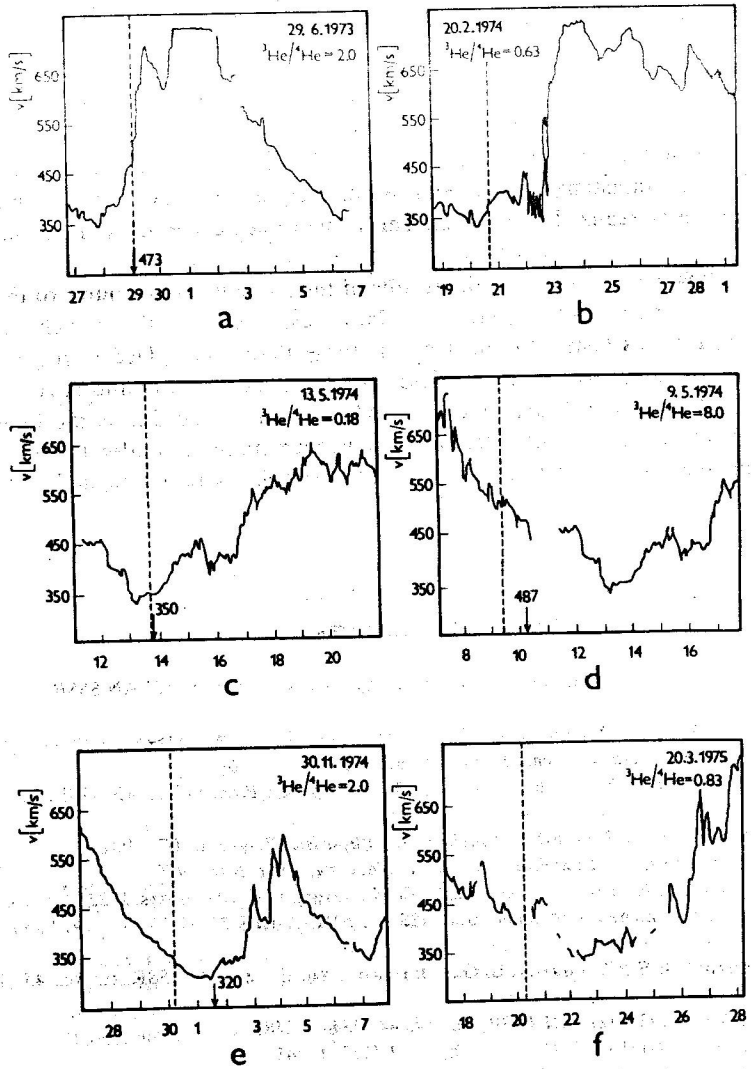

Fig. 5. The time dependences of the solar wind speed at the time of six ^{3}He-rich solar flares, for the period 1973—1975. The beginning of the solar flare in the H_α emission is indicated by the dashed line. The dart in these pictures indicates the speed of the solar wind at the time t_0, obtained with the help of equation (1).

speed at time, when this solar wind is coming from the region of ^{3}He-rich solar flare, after which there follows its increase from 400 to 450 km per sec.

3. The observed structure of the solar wind is connected with the character of the region of the flares of the Sun and not with the character of the region of the spreading of the SEP in the interplanetary space.

4. The characteristic dimension of the corresponding region on the Sun's surface, which we can estimate from Fig. 3, is about 5×10^8 m. This is the value near to the dimension of the active region.

5. From the time of the increase of the solar wind speed after its reaching the minimum we can estimate the dimension of this region of the Sun, in which this increase is being realized as $\sim 10^7$ m. This is the value near to the dimension of the H_α flare.

Concluding we can state that the results of the analysis of the course of the solar wind speed at the time of the ^{3}He-rich solar flares, together with other characteristics of these flares testify to the fact that these flares take place in regions with a special structure of the magnetic field. The investigation of a mutual connection between ^{3}He-rich solar flares and other phenomena of the Sun is the inevitable condition for the attainment of the future advancement in our understanding of the nature of solar fares as well as for the forecast of solar flares connected with flows of SEP.

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Received January 4th, 1983
Revised version received January 17th, 1984