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ON THE INADEQUACIES OF THE MAGNETIC FLARE THEORIES AND THE RESOLUTION OF THESE PROBLEMS WITH THE CONVECTIVE FLARE THEORY

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I give here a short review of some of the main problems of the magnetic theories for the flare origin. I point out that the magnetic theories are unable to solve the problems of the energetics,height and compactness of the acceleration region, compressive inflows, magnetic field structures, particle numbers, preflare upflows and the global cause of the flare origin. Then I outline the convecLxve flare theory which have proposals for the solutions of these problems. I show here what is the role of the magnetic field at flare origins in the frame of the convective flare theory. The convective flare theory gives a deeper level understanding than the magnetic theories and therefore it also can supply us with the derivation of some input parameters and assumptions used for the magnetic theories and so it offers a wider perspective to understand the physics of the explosive astrophysical processes.

As I pointed out (Grandpierre 1986,1988), the flare energetics has a central role in revealing the basic physics of the flare phenomena. I show here that the flare energetics present a crucial test for any flare theory. Since a long time the only factor to supply the flare energy seemed to be the magnetic field. Nevertheless, recently a fresh eomuH.Litor arise.d by the explosive convection. I think that if a theory cannot satisfy the requirements of energetics in agreement with the observations, it can be ruled out, it doesn't matter how many secondary parameters are derived by rule of thumb methods and “plausible” assumptions.

The main problem with the magnetic theories consists in the fact that the large energy release in flares goes on within very localized dimensions and in a very fast way at the same time.

1. While it is usual to guess the energy of the largest solar flares to be about 10^{32} ergs, it is surely an underestimation. Firstly, the dominant part of the flare energy could be involved in blast waves and high energy particles what could supply the chromospheric and coronal heating too. Secondly, the energy spectrum of the solar flares (Korotin and Krasnobabtsev 1986) also shows that the solar flare energy spectrum is not saturated for the high energies. Thirdly, the maximum energy of the solar flares can be projected as above 10^{34} ergs by the usual interpretation of the observed X-ray fluxes of the solar flares (Zirin 1988). And we cannot think that the energy of the primary explosion could transfer by 100% into flare energy.

There are observations showing also that the magnetic field annihilation - if it happens at all - is not the cause but the result of the flare (Mouradian et al.,1983) and that the reconnection is not important in the impulsive phase of flared (Katsova and Lifschitz 1988).

Now let me see the energetic problems of the spotless flares. The local magnetic field strength at spotless flare sites is a few tens Gauss. Luo (1982) argues that this magnetic field for some unknown reason can strengthen in the whole flare volume of 10^{27} cm^3 to 100 G to be able to supply enough energy the flares. But it is reasonable to think that the magnetic field during the flares can strengthen only locally. Nevertheless, Luo with his assumption can get only 4 x 10^{29} ergs for the flare energy, while an important part of spotless flares release energies more by two orders of magnitude. At the same time, it remains the problem of finding a mechanism for the magnetic field strengthening.

Most of the flares show signs of photospheric heating during the flares.The energy of the photospheric heating is comparable to that of the chromospheric and coronal ones. This suggest that the energy source of solar flares is at least subphotospheric (Machado and Linsky 1975).

There are magnetic theories assuming that the flare energy is supplied from the footpoint motions.The problem is that the footpoint motions don't show consequently systematic trends. -**ENERGY PROBLEM**

2. Wentzel (1963) has shown that the flare energy release happens in fibrils with a total volume of about 10^{18} cm^3. Although two assumptions of this interpretation doesn't fulfill (Zirin 1988, 399) this does not mean that the whole problem is gone. There are other observations showing the compactness of the flare acceleration region. De Jager (1986) got a linear dimension for the flare acceleration site less than 50 km. Dinh (1980) got 40 km for it. And we know that most of the flare energy releases within the flare kernels with linear dimensions less than 30 000 km. These constraints presents another limits on the abilities of magnetic theories to give the proper energies (Grandpierre 1988). The magnetic theory says that it needs linear dimension less than 1 km (Priest 1981) or even 17 cm (Martens 1988) to got the proper time scales. -**COMPACTNESS PROBLEM**

3. The interpretation of the observed Balmer jump in flares by the models of Gershberg (1974) and Grinin and Sobolev (1977) involves explosive high-speed motions of the chromospheric material. The magnetic flare models also postulate the existence of high-speed compressive inflow for the reconnection as a necessary condition to the acceleration of the particles. It would be also necessary for the interpretation of the filamentary structure of the flares to postulate these compressive inflows. Nevertheless, I pointed out that this requirement can fulfill only for a fraction of a second for 10^4 current sheets as fibrils (Grandpierre 1989). The compressive inflows also appear as necessary triggers in the theory of Alfven and Carlquist (1967). At the same time, there are no observations proving the presence of these compressive inflows at flare sites.

-THE PROBLEM OF THE COMPRESSIVE INFLOWS

4. The magnetic flare theories claim that at flare sites the structure of the magnetic fields are appropriate for the reconnection, i.e. they are antiparallel. Nevertheless, the observations show us that the lines at where the field lines are antiparralel, are not the places from where the flare radiation comes to us - the ribbons of the flares are not at the neutral lines. At the same time, these models are irrelevant also because just at the flare sites there is the strongest shear, and along the shear line the fields are not oppositely directed: they are parallel (Zirin 1988).

-FIELD STRUCTURE PROBLEM

5. Hoyng (1977) and Spicer (1983) pointed out that by the observations more particles are accelerated in the flare process than it were at the flare onset in the flare region. Zirin (1988) also asks: "What is the significance of the loop tops, where much of the energy release seems to occur? It is really hard to understand how density peak at the loop tops".

-PARTICLE NUMBER PROBLEM

6. Cheng and Widing (1988) has shown that the observed blueshifts at flare onset and around cannot be interpreted by the chromospheric evaporation hypothese. Another - yet unknown - mechanism has to work.

-THE PROBLEM OF PREELARE UPFL0WS

7. There are accumulating more and more observations showing that the flare origin is not related to local atmospheric phenomena as the magnetic theories assume, but they are related closely to global solar processes. Basilevskaya et al. (1982) among others pointed out, that there is a correlation between the flare activity and the neutrino flux from the central energy liberating region of the Sun. Mouradian et al. (1988) has shown that the flare activity is connected to rigidly rotating pivot points. Bai (1987) presented a result showing that the active regions are produced by a mechanism which is stable at least for some solar rotation. This mechanism produces the active region producing hot spots on the Sun.

-GLOBAL FLARE ORIGIN

To surmount these difficulties I propose to work with the convective flare theory (Grandpierre 1981, 1984, 1986, 1988, 1989, Grandpierre and Melikyan 1985). This theory suggests that the ultimate cause of the flare phenomena lies in the unstable character of the energy liberation in stellar

interiors. These instabilities generates in an explosive way primal convective cells with high temperature excesses at stellar cores which then propagate upwards and reach the subphotospheric regions of the star (see also Gorbatsky 1964). These primal convective cells develop a channel on their way to the surface which could be related to the pivot points (connection to problems 6 and 7).
Approaching the subphotospheric layers the sound speed decreases outwards, therefore in some channel the newly and newly arising primal convective cells can reach the treshold of sonic boom at which they are destroyed by the generated shocks. The surplus inner energy together with the kinetic energy of the convective cell abruptly liberates at this subphotospheric level. This energy is concentrated into the shock front which means that this energy then turns into the energy of high energy particle beams propagating upwards. The parameters describing the energetics are the dimension of the cell L and the depth of explosion d.

$E_{\text{convective cell}} = \rho(d) \times L^3 \times v_{\text{sound}}(d)$

TABLE 1

E (ergs)	L (km)	d (km)
$1{,}07 \times 10^{32}$	10^4	0
$8{,}56 \times 10^{32}$	2×10^4	0
$2{,}64 \times 10^{33}$	2×10^4	33
$1{,}53 \times 10^{34}$	3×10^4	170
$5{,}94 \times 10^{34}$	3×10^4	513

where I used the model of Spruit (1970) for the solar convection zone. This means that the convective flare theory is able to supply the flare energies.

The high energy particle beams then propagates upwards in the solar (stellar) atmospheres. When they find in their pathways magnetic flux tubes, their energy suddenly liberates and transforms into all kinds of radiation we detect. In the magnetic flux rope the protons and electrons tend to separate, therefore high local field-aligned electric fields are instantaneously created which accelerate the particles to higher energies. This explosive ambipolar diffusion then naturally gives us synchrotron and bremsstrahlung radiation at loop tops and there high energy particle beams are partly governed to loop footpoint by the magnetic fields (connection to problems 1, 2, 3, 4, 5). This explosive arnbipolar diffusion also can help us in the more effective radiation mechanism than the thick-target bremsstrahlung process.
I think it is natural to assume that the primal convective cells on their pathways meet with magnetic fields because just they are the agents

creating the flux tubes by their upward motion. Nevertheless, if there are no concentrated flux ahead of them when they explode, they can generate the solar noise storms.

The convective flare theory offers a dynamic alternative instead of the magnetic theories while at the same time it can give us a deeper insight to the stellar energy liberation mechanisms at stellar cores.

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