FLARING PROCESSES IN STELLAR ATMOSPHERES: THE IMPORTANCE OF ELECTROMAGNETIC COUPLING

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(cf. D.S.Spicer in Activity and Outer Atmospheres of the Sun and Stars, 11th Adv.Course Suiss Soc.Astron.Astrophys., Observatoire de Geneve, p. 91, 1981).

DISCUSSION

Linsky: We do not know all of the energy released in the course of a dMe star flare. What we actually measure however is often 10^4 to 10^5 times larger than what is seen in large solar flares. I have two questions. Why do you think flares in dMe stars are so much more energetic than in the solar case? Secondly, why are solar flares so much less energetic than those in dMe stars?

Spicer: First of all I know nothing about stellar flares. I believe the most likely reason is that the gradients of the free magnetic field are much steeper in dMe stars than they are in the Sun. The magnitudes of the fields are much larger. So the magnetic energy release should be faster, by whatever method of release one chooses.

Linsky: In the previous talk we heard that the flare energy should be proportional to the magnetic field squared and some volume element. Just saying that the magnetic fields or the shears are larger, then to get four orders of magnitudes in the energy you need two orders of magnitude in the magnetic field.

Spicer: Well, you must take into account the volume element. There are a lot of free parameters in the system.

Evans: One of the problems here is the constraints provided by the observations. Nobody has yet demonstrated convinvingly the presence of high magnitude fields on the dM stars. It may be that there are very localized areas (of high field). In the case of the Sun we are discussing a stately minuet as compared with the violent disco of the dM stars. Account must be taken, therefore, of the non-detection of magnetic fields and the fact

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that the energy release is undoubtedly limited to a very small area of the stellar surface.

Spicer: This may be a matter of perspective. Even in the solar case 10^{32} ergs is a hell of a lot of energy.

Nordlund: I think that it is very important as you have done here to bring out the aspect of closing of a circuit. For example, with regard to the case of the dMe stars - in the case of the Sun we are talking about instabilities in the coronal plasma. Suppose that with some mechanical force we can shear the magnetic field in the interior of a very large spot on stars having larger fields, then it is possible to consider a circuit going up into the visible photosphere of chromosphere which has its driving energy input or the storage below the surface. Then both the fields involved and the energy output are much stronger.

Spicer: I had intended to point this out but felt that there not enough time during my talk. There are two possible scenarios for magnetic energy storage. Firstly, the total energy for the flare may be stored in an equivalent inductor. Secondly, a much larger energy may be stored and only a small fraction released in the flare. This is possible for certain types of circuit. One of the nice things about this is that it allows you to explain homologous flares. Such flares occur at intervals of hours; whereas large flares in an active region generally occur after 1 or 2 days of quiescence. So the 2 days may be the time necessary for sufficient energy storage. If, however, the stoarge time is of the order 2 days then it is difficult to explain homologous flares except by having more energy than is needed for the flare there to start with.

Mullan: I wonder if you would like to say anything about the connection between coronal heating and flares. Do you believe that there is a fundamental difference between the processes needed for quiescent coronal heating and for triggering a flare? Could such a difference be explained in terms of equivalent circuits?

Spicer: A lot of workers have proved that the two mechanisms are identical, including such processes as anomolous Joule heating and reconnection. I have my doubts about both these for coronal heating. To other suggestions for explaining coronal heating are Alfvèn wave heating or some variation on this. One can show mathematically rigorously that Alfvèn waves are always associated with any system of parallel currents. In talking about flares one generally speaks of very low frequency Alfvèn waves, while for coronal heating higher frequencies are invoked. Maybe this is the difference. I must admit that I have not studied the problem myself. I think however that the question is related to that of flare energy storage in the corona. If you cannot store the energy there then it must come from below. This would clearly distinguish flare mechanisms from coronal heating mechanisms.

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