# PRE-FLARE EVOLUTION AND THE BEGINNING OF FLARES

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## 1. Introduction

A solar flare is one of the most prominent phenomena of the active Sun, and is still not known why and how it occurs. A flare occurs mostly in an active region. An evolutionary change of an active region, persumably due to the effect of the magnetic field, convection and circulation of the Sun, may prepare an environment of flare occurrence, but the characteristics of the environment, which inevitably lead to flare occurrence, are not known.

The study of pre-flare state is important to understand the storage of the free energy necessary for a flare and the developments that lead to the energy release of the flash phase. If flare occurrence could be predictable, flare mechanisms would be thoroughly studied. The prediction, however, needs knowledge of the flare mechanisms. Lack of the knowledge forces us to do patient works on the pre-flare state.

## 2. Environment of pre-flare state

One of the pioneer works on the environment of flare occurrence was made by Martres et al. (1971, 1974, 1977a). They studied characteristics of an active region with and without flare activity. Almost no flare activity is seen in an active region where an $H_{//}=0$ line crosses area of the same sign of velocity field or a normal Evershed velocity is observed. If the magnetic configuration of an active region becomes complex due to the existence of a parasitic polarity, inclusion, or juxtaposition of two active centers, the probability of flare occurrence becomes high. Flares occur at locations where an $H_{//}=0$ line crosses a $V_{//}=0$ line, which points towards the disk center. Such velocity fields suggests a kind of vortex motion. Unno et al.(1980) have considered vortex motion as wake formation behind a spot group and studied on evolutionary change of an active region due to the dynamo action in the photosphere.

Harvey and Harvey (1980) also found that i) flaring level is high when

velocity pattern is complex, and ii) an $H_{//}=0$ line and a $V_{//}=0$ line cross in some events, but in most of flare events both lines are roughly parallel, each separating 3 to 8 arc seconds.

The free energy necessary for a flare is considered to be stored in stressed magnetic field in the corona, but the fields and currents are not yet observed. Tanaka (1980) tried to estimate pre-flare energy stored in stressed magnetic field from shear motion of spots in McMath 13043 active region on June 28-July 10 1974, and found a good relation between the stored energy due to the shear motions and the radiated energy of the flares.

3. Pre-flare enhancement

The pre-flare coronal enhancement of an active region commonly occurs (Svestka, 1975). The region of the gradual enhancement in the flaring region is not always in the same loop or loops which are later most enhanced during the flare (Sturrock, 1979).

Not all flare exhibit precursor phase in x-ray, but at least 80% of all flare-associated soft x-ray bursts have measurable precursors which begin about 2 min. earlier than the onset of a flare, on the average (Thomas and Teske, 1971).

From Skylab data Vorpahl et al. (1975) found that in many cases the flare core could be seen several minutes before the flare actually started, but Kahler and Buratti (1976) reported that the region of x-ray brightening prior to several minutes before the onset differed from that of the following flare. Gradual heating or energy release may occur before the more catastrophic event takes place, but the brightening loop may move during the course of flaring event.

Kundu (1965) reported that the gradual increase in intensity of 3cm radio sources of S-component, probably due to energy build-up in an active region, was observed prior to flare start. Kai (1980) has also observed pre-flare enhancements at 17GHz about 20 min. before bursts.

Filament activations such as darkening, slow outward expansion, or fragmentation are detected several min. to one hour before a flare starts (Martin and Ramsy, 1972). At least 82% of flares are preceeded by $H\alpha$ off-band pre-flare activity of filament (Martres et al., 1977b). Two ribbon flares are sometimes observed at disparitions brusques.

Velocity field associated with a flare was observed at and after its maximum phase (Yoshimura et al., 1971). The velocity is higher (1.5km/s) at the lower photosphere and zero at the chromosphere. If the velocity is horizontal, the velocity would be explained as a vortex motion around a bright point of the flare. Blue-shifted velocity changes in the photosphere of 0.3 to 1km/s were observed

in localized area adjacent to the flaring element (Harvey and Harvey, 1976). The change in velocity began about 10-15 min. prior to flare start, reached maximum near or at flare maximum folowed by a slow decrease. A similar but smaller change was observed in $H_{\alpha}$ velocity.

Data on magnetic and veloctiy fields with high time resolution and good spatial resolution are needed for understanding the environment of flare occurrence, and also data from both ground-based and space observations are needed for knowing the accumulation of free energy necessary for a flare.

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