# TWO CLASSES OF FAST SOLAR WIND STREAMS: THEIR ORIGIN AND INFLUENCE ON THE GALACTIC COSMIC RAY INTENSITY

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The analysis of solar wind ( bulk velocity v, proton density n, proton temperature T ) and magnetic field ( $\vec{B}$ ) data in the years 1964-1974 makes possible to identify two main classes of high-speed streams ($\Delta V = (vm - vo) \geqslant 100$ km/sec, vm being the maximum daily mean speed and vo the mean value between the speeds immediately preceding and following the stream; duration $\Delta t \geqslant 2$ days):

a) Regular high-speed streams (RHSS's) with the following behaviours in the interplanetary parameters: n shows a peak immediately before the increase in v, sharp decrease towards low values during the v increase phase, recovery towards normal values during the v decrease phase; field magnitude B shows a peak terminating at the end of the v increase where it decreases rapidly towards a level which remains almost constant, constant field polarity except for minor fluctuations lasting a few hours; T increases with v, decreases slightly during the B descent phase and subsequently tends to follow the v behaviour. The initial phase of these streams is consistent with a stream interface (e.g. Burlaga, 1974) and the behaviours of the various parameters during the stream are consistent with a solar wind from a quiet solar region with unipolar diverging magnetic field.

b) Complex high-speed streams (CHSS's) showing at least one of the following features differentiating them from the RHSS's: simultaneous increases in v, n, B and T (radially outmoving shocks), large fluctuations in v, n, B and T in the high-speed period, fluctuations in field polarity lasting more than 3-4 hours, T behaviour departing from v behaviour, periods of very low T denoting flare ejecta pistons (e.g. Gosling et al., 1973).

The period during which the solar wind was emitted from the Sun is computed for each stream, by using speeds measured at the Earth assuming a constant Sun-Earth solar wind speed. The following features are obtained: nearly all (96%) the RHSS's are emitted during periods in which no "strong active regions" (AR's) exist at the central meridian and no solar flares accompanied by type IV radioemission fairly well extended in time and frequency (type IV SF's) occur; nearly all (92%) the CHSS's are associable with AR's and with type IV SF's;



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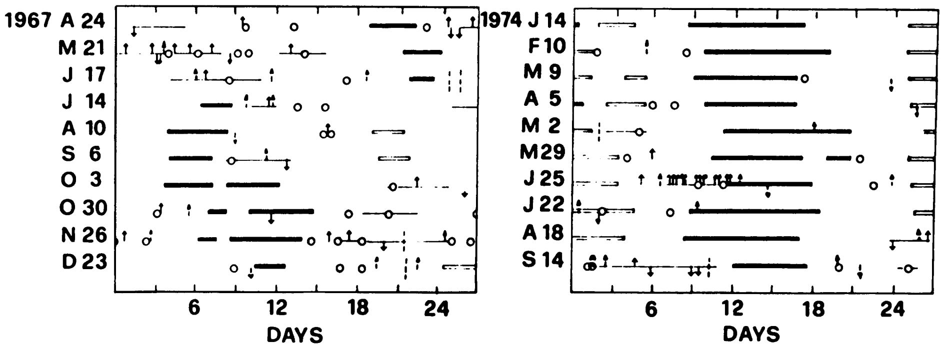
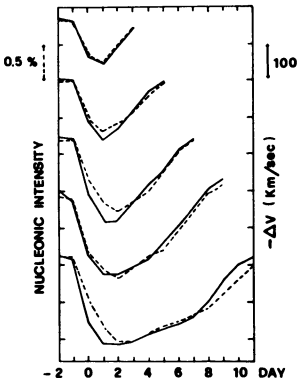



Fig. 1. Bartels display of dates of emission of RHSS's (▭ : positive polarity; ▬ : negative polarity) and CHSS's (—); central meridian passage of strong AR's (o) and occurrence of type IV SF's (↑ between E55-W55; ↓ E55-E90, W55-W90; | undefined longitude; ↑↓¦ idem for type IV SF's either in decametric waves only or lasting <10 minutes).

the RHSS's tend to recur several times. On the other hand only 60% of CHSS's recur 3-4 times at the most; the RHSS's tend to be longer and more frequent during the years 1973-1974; the CHSS frequency tends to follow the solar activity cycle. Moreover, practically all the observed near equatorial coronal holes (Nolte et al., 1976; Sheeley et al., 1976; Broussard et al., 1978) correspond to RHSS's even in respect of magnetic field polarity; the few instances of disagreement generally occur for small streams or to small coronal holes. Therefore we deem it plausible that the RHSS's are an almost stationary emission from coronal holes, while the CHSS's are generally emitted from the vicinities of AR's producing type IV SF's. See in Fig. 1 examples of such periods.

In order to study the cosmic ray (CR) modulation during the RHSS's, superposed epoch analyses of neutron monitor intensity (I) and v are performed; the events happening during the recovery of Forbush decreases (FD's) or followed by FD's and those with gaps longer than one day in the v data are not taken into account. The 88 RHSS's are divided into 5 groups according to duration as shown in Fig. 2; for each group the CR intensity follows the sign-changed v behaviour: $\Delta I/I \approx - K.\Delta v$, where K = 0.00005 sec/km. The factors causing such small CR modulation might be the following: increase of CR convection and decrease of diffusion in the stream interaction region which at great distances from the Sun may cover all magnetic field lines contained in the RHSS; due to magnetic field regularity in RHSS, CR's can diffuse freely parallel to the field lines, thus CR's with particularly small pitch angle can be absorbed by the Sun atmosphere. A glance at the CR intensity during CHSS's shows that most FD's with amplitude $\geqslant$1.5% occur during such periods. It also appears that for most individual events, v and I behaviours are not correlated; in Figure 3 the correlation plot between



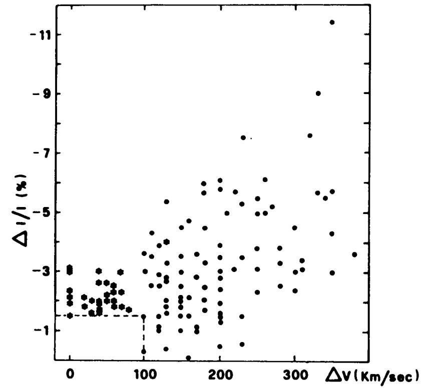




Fig. 2 (to the left). Superposed epoch analyses of high-latitude nucleonic intensity (dashed lines) and sign-changed solar wind speed (full lines) for 88 RHSS's divided in 5 groups according to their duration.

Fig. 3 (to the right). Nucleonic intensity maximum depression versus the maximum speed increase for 88 CHSS's (•) and for 29 FD's without CHSS's (*).

the maximum CR depression and $\Delta V$ is shown; besides the FD's associated with CHSS's there are 29 FD's where either $\Delta V < 100$ km/sec or $\Delta t < 2$ days. Out of these 29 FD's, 26 are associated with type IV SF's occurring near the Eastern limb (E50-E90) or are not flare-associated, i.e. are probably produced by type IV SF's occurring behind the East limb (Iucci et al., 1979), that is when the Earth enters into the modulated region from the Western edge where the speed increase is likely to be lower than in the radially advancing front. Therefore it can be stated that the CHSS's coming from the vicinities of AR's generating type IV SF's are generally associated with FD's whose time behaviours and maximum amplitudes are little correlated with the v at the Earth.

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