BEHAVIOUR OF WHISTLERS IN CORONAL MAGNETIC TRAPS AND ITS RELEVANCE TO A NEW FINE STRUCTURE IN SOLAR TYPE IV RADIO BURSTS

G.P.CHERNOV
IZMIRAN, 142092 Moscow region, Troitsk, USSR

A possible contribution of whistlers to fine structure production due to the coalescence process with plasma waves l + w --> t at frequencies $\omega^{l} \pm \omega^{w} = \omega^{t}$ is estimated. A whistler ray tracing in the solar corona with the twice Newkirk density model and with a dipole magnetic field using a standard numerical integration of the Haselgrove two-dimensional equations is performed.

In the corona whistlers can canalize along density and magnetic field inhomogenieties (ducts) with a width $\lesssim 2 \cdot 10^{8}$ cm. Sufficiently narrowband whistlers (obliquely propagating) can undergo numerical reflections (Maltseva and Chernov, 1989a). Local kinetic increments, decrements by thermal plasma (cyclotron and Landau) and integral growth rates along trajectories of whistlers propagating under arbitrary angles to the magnetic field are computed for the distribution function of a beam of hot electrons with a loss-cone and temperature anisotropies. Predominant Landau damping at frequencies $f^{w}/f_{He} \lesssim 0.1$ with a maximum at moderate angles to the magnetic field 40-50 is discovered (Maltseva and Chernov, 1989b).

A consideration of whistler scattering by thermal ions and electrons and ion-sound wave coalesence for whistlers (s + s`--> w) permits us to distinguish the following whistler manifestations.

A whistler spectrum formed by means of coupling processes with s-waves in a pulsating regime can yield millisecond radioemission pulsations and spike-bursts in dm- and metric ranges. It is proposed to distinguish pulsations by whistlers from an MHD-model with FMS-waves and a plasma model with the aid of a modulation depth dependence versus a pulsation period (Chernov, 1989).

A whistler cyclotron instability at the normal Doppler frequency shift and whistler upward duct propagation along a magnetic trap causes fiber bursts with intermediate frequency drift. Periodic whistler wave packets generated with the anomalous Doppler cyclotron resonance (due to bounce-movements of hot electrons at magnetic loop tops) yields zebra-pattern stripes.

A periodic loss-cone instability during the annigilation of magnetic islands after a flare in reconnection regions inside a small trap between fast shock fronts (the model of Forbes and Priest, 1983 and Hick and Priest, 1989) explains the formation of a new fine structure, namely narrow band ropes of fiber-bursts (see Fig.1a and Aurass et al., 1987).

E. R. Priest and V. Krishan (eds.), Basic Plasma Processes on the Sun, 515–516.

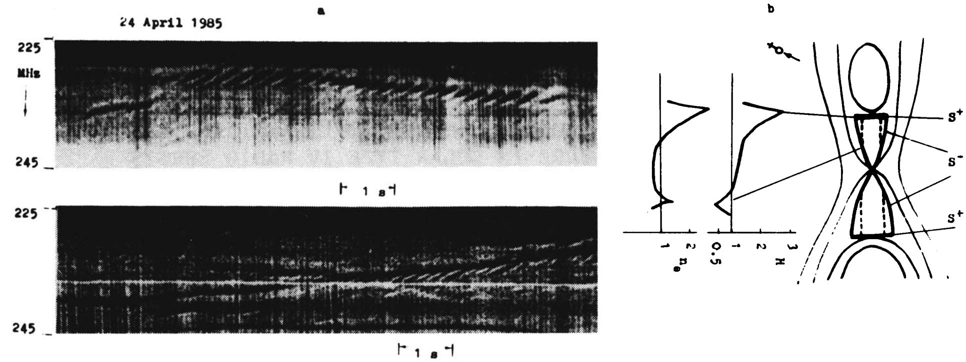

Fig.1. Rope-like chains of fiber bursts in the range 225-245 MHz (a); b- qualitative scheme of a quasistationary reconnection during the magnetic loop restoration after a flare (Forbes and Priest, 1983) and approximate variation of density (n_e) and magnetic field (H) in a reconnection region (see Sidneva and Semenov, 1985).

During a quasistationary reconnection with a neutral point of type X two pair of slow shocks and two fast shocks are formed. Between fast shock fronts (S^+) a new magnetic trap produces (Fig.1b). Near a fast shock front the magnetic field grows more than twice, maximal whistler increments may achieve enough high values $\gamma/\omega_{He} \sim 10^{-2}$ and the periodic whistler instability develops due to the bounce motions of fast electrons between shock fronts (S^+) distant at about 10^9 cm. Hence it follows the more high periodicity of fibers in a single rope $\sim$5-6 s^{-1} , than usual one $\sim$1-2 s^{-1} . Whistler wave packets can propagate from the fast fronts up to the slow shock fronts (S^-) where the magnetic field strength decrease in some times (see Sidneva and Semenov, 1985) and whistlers decay by the cyclotron damping. This distance ($\sim$2-3$\cdot 10^8$ cm) defines the bandwidth of rope-like chains ($\sim$2-3 MHz).

The proposed scheme explains not only rope-like fibers but also other accompanying fine structures, namely slow drifting fibers in absorption only due to the screening of the emission from rarefaction regions by the slow shock fronts and millisecond pulsations according to the model of a pulsating regime of whistlers and ion-sound waves in a reconnection region (Chernov, 1989).

References

Aurass H., Chernov G.P., Karlicky M., Kurths J. and Mann G. (1987) Sol. Phys., 112, 347-357.
Chernov G.P. (1989) Astronomichesky J., 66, N.6, 1258-1270 (in Russian).
Forbes T.G. and Priest E.R. (1983) Sol. Phys., 84, 169-188.
Hick P. and Priest E.R. (1989) Sol. Phys., 122, 111-129.
Maltseva O.A. and Chernov G.P.(1989) a- Kinematic. Physic. nebesnyh tel, 5, N.5, 32-43; b- ibid, 44-54.
Sidneva M.V. and Semenov V.S. (1985) Geomagnetism i aeronomija, 25, N.5, 806-811 (in Russian).