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Comparative analysis of theories of zebra-pattern in solar radio emission

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Strong and weak aspects of different theories of fine structure on solar radio emission dynamic spectra observed as several or numerous quasi- equidistant bands of enhanced and reduced radiation (zebra-pattern) are discussed.

Most of works proposing zebra-pattern interpretation is based on plasma mechanism of radio emission generation which consists of exciting plasma (electrostatic) waves and their succeeding transformation into electromagnetic emission. Plasma waves arise due to kinetic or hydrodynamic instability at the upper hybrid frequencies (at the levels of double plasma resonance in a distributed source) or at the electron gyrofrequency harmonics (Bernstein modes in a compact source with quasi-uniform magnetic field). The reason for the instability is occurrence of a number of electrons with nonequilibrium distribution over velocities perpendicular to magnetic field. Radio emission escaping from the source is a result of nonlinear coalescence of plasma waves with low frequency or high frequency waves which does not break the harmonic character of spectrum.

A significant number of works is devoted to considering whistlers as a main reason for occurring stripes in emission and absorption on dynamic spectra. Whistlers are also believed to be excited by a group of nonequilibrium electrons, and then some nonlinear processes including whistler interaction result in specific frequency spectrum with enhanced and reduced radiation stripes.

An alternative theory of zebra-pattern origin suggests the presence of a compact source with trapped plasma waves in the corona. The trapped waves in a confined space easily provide discrete spectrum. One more interpretation is based on special effects that

may occur when radio waves are propagating through non-uniform coronal plasma: the alternate bright and dark stripes on dynamic spectra are supposed to be a result of radio wave interference or diffraction on some periodical structure in the solar corona.

All suggested mechanisms are analyzed with relation to their capability to give the best fit for the observed fine structure features in the framework of the source model with reasonable physical parameters.