FAST frequency sweeping EVEnts in the electron cyclotron emission of nonequilibrium plasma confined in a tabletop mirror trap

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The complex dynamics have been observed in the spectra of the electron cyclotron emission of a nonequilibrium plasma confined in a tabletop mirror trap [1]. The dynamic spectrum of the emission is a set of highly chirped radiation bursts with both increasing and decreasing frequencies which are repeated periodically. Such patterns are not described in the frame of a quasilinear approach which is standard for the description of a broadband plasma emission. From the other hand, the simultaneous observation of several chirping bursts in the same frequency range is typical for the formation of nonlinear phase-space structures in a proximity of the wave-particle resonances of a kinetically unstable plasma, also known as the “holes and clumps” mechanism (or Berk-Breizman model [2]).

Microwave emission is observed at a plasma decay stage with a delay of 0.1-1 ms after ECR heating switch-off. The microwave emission is observed only in a few frequency bands which are independent of the experimental conditions and the emission frequency is always less than electron cyclotron frequency in the trap center. Within every frequency band the emission spectrum is a set of fast narrowband chirping bursts (d*f*/d*t* ≈ 30 MHz/sec, Δ*f* ≈ 2×10-3 *f*ce0) with a duration up to 10 us, while the duration of a burst series can be up to 1 ms. Following the model [2], the frequency drift within each wave packet is proportional to the instability growth rate and has a predetermined time dependence. Resulting from the analysis of the microwave emission spectrum, the value of the growth rate is consistent with previous studies of excitation of extraordinary waves at the stage of plasma decay [3], which confirms the applicability of the discussed model.

Our data provide the first experimental evidence for spontaneous formation of self-consistent structures such as the Bernstein-Green-Kruskal waves near the wave-particle resonances in the ultra-high frequency domain in a laboratory mirror-confined plasma.

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References

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