NUMERICAL MODELING OF the current drive GENERATION IN THE TOKAMAK USING SLOW AND FAST ELECTROMAGNETIC WAVES OF THE INTERMEDIATE FREQUENCY RANGE. METHODS FOR SOLVING THE FOKKER-PLANCK EQUATION [[1]](#footnote-1)\*)

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One of the most effective non-inductive current drive methods is the LHCD. However, the latter has a density limit, which does not allow to penetrate deep into the fusion plasma. Therefore, it was proposed [1] to support the current with fast waves of the intermediate frequency range, often called helicons. These waves are in the region of frequencies well above the ion-cyclotron, but less than the bottom-hybrid (LH) $(Ω\_{ci}\ll ω<Ω\_{LH})$. For this wave, the absorption improves with increasing density. In addition, helicons propagate predominantly along magnetic field lines with a small radial component, which allows the wave to slowly and spirally penetrate deep into the plasma, where it is effectively absorbed. And the much lower frequency compared to the LH wave allows to solve the problem of antenna-plasma coupling for large machines, such as ITER. Recently it has been demonstrated [3] that for the case of a helicon, just as in the case of a LH wave, the quasi-linear diffusion coefficient can be found from the analysis of the energy release of the wave beam without calculating the spatial distribution of electric fields. This circumstance allows us to consider the behavior of ray trajectories of waves using nonstationary modeling of current drive using the ASTRA transport code [4] and the FRTC code [5,6] and to solve the one-dimensional Fokker-Planck equation.

In this paper, we present the results of unsteady modelling of the current drive in tokamaks FT-2 and Globus-M2 using slow (LH) and fast (helicon) waves of the intermediate frequency range. The current drive was calculated using the one-dimensional distribution function obtained by solving the Fokker-Planck equation with the constant electric field. The numerical solution of the latter was performed using a scheme that uses weighting coefficients to prevent the appearance of negative values of the distribution function. This approach is justified in this case. That is because the quasilinear diffusion coefficient, which only carries information about the wave-plasma interaction, is a piecewise linear function whose derivative may create jumps, unacceptable for a numerical solution. There are also considerations about the necessity of using the two-dimensional Fokker-Planck equation. This is necessary primarily to account for relativistic effects, which cannot be included in the one-dimensional model because of computational complexity. Grill3D [7] was used to calculate the refractive index spectrum of the LH wave.

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