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Experimental study of the electromagnetic fluctuations and energy confinement in the quasi-axisymmetric stellarator CFQS-T plasmas

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The Chinese First Quasi-axisymmetric Stellarator Test device (CFQS-T) has been successfully commissioned in August 2024 [1, 2], which is the first experimental phase of the Chinese First Quasi-axisymmetric Stellarator (CFQS) [3-5], operating at low magnetic field strength (< 0.1 T) and low heating power (< 30 kW) conditions. This work will introduce the initial experimental study of the electromagnetic fluctuations and plasma confinement at CFQS-T. Various working gases, such as argon, helium, and hydrogen, have been used in the initial CFQS-T experiments. Two kinds of electromagnetic fluctuations, i.e., harmonic fluctuations with the frequency of 1-5 kHz and broadband fluctuations with the frequency of 1-20 kHz, have been observed under different discharge conditions. The characteristics of these two kinds of fluctuations, including poloidal and toroidal mode number and propagating directions, and their parametric dependence on the heating power, magnetic field strength, and gas fueling, will be presented. Runaway discharges sometimes occur in the CFQS-T stellarator. The conditions to induce the runaway discharges and magnetic fluctuations driven by the runaway electrons are investigated. Finally, the statistical analysis of the energy confinement time in the CFQS-T discharges with different working gases, including argon, helium, hydrogen, and deuterium (to be used in the coming experimental campaign in 2025), will be presented.

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