Theoretical model of the diamagnetic confinement mode in GDMT with fast ion injection [[1]](#footnote-1)\*)

DOI: 10.34854/ICPAF.2022.49.1.057

1,2Khristo M.S., 1,2Beklemishev A.D.

1Budker Institute of Nuclear Physics, Novosibirsk, Russia, khristo.mikhail@gmail.com
2Novosibirsk State University, Novosibirsk, Russia

The diamagnetic confinement, or the diamagnetic bubble, is a new mode of plasma confinement in open traps, proposed by Beklemishev A.D. theoretically in 2016 [1]. The main idea is to create a region in the center of an open trap where the plasma pressure reaches its limiting value , and the magnetic field, respectively, is close to zero, since being almost completely displaced by the diamagnetic plasma. Theoretical estimates carried out within the framework of MHD [1, 2] predict a significant improvement in plasma confinement in this regime due to an increase in the particle lifetime. Investigation of the regimes close to the diamagnetic confinement is scheduled for GDT [3] and CAT [4], and the diamagnetic mode is also the part of the GDMT project [5].

Recently, MHD models of the diamagnetic bubble equilibrium have been constructed [1, 2]; however, significant magnetic field gradients, as well as the presence of a region where the magnetic field is close to zero, strictly speaking, do not allow the use of MHD and require a kinetic approach. The collisionless dynamics of particles in the diamagnetic bubble is studied in [6], and a completely kinetic model of the bubble equilibrium is presented in [7]. Nevertheless, the equilibrium in the diamagnetic confinement mode is essentially determined by the transport processes.

This work is devoted to a theoretical study of plasma equilibrium in the diamagnetic confinement mode in GDMT with injection of hot ions. We assume the plasma to consist of two fractions: hot ions being the result of neutral injection, a kinetic approach is used to describe them, and warm background plasma, which we consider in the framework of MHD. The neutral injection is assumed to be carried out into the region of absolute confinement [8, 9], we also take into account that the beam stopping has finite efficiency [10]. The energy of hot ions is assumed to be large enough to take into account collisions only with electrons, neglecting ion-ion collisions. To describe the warm plasma, the equations of energy and matter transport are used, which also take into account collisionless loss specific to the diamagnetic mode [6]. Numerical equilibria of the diamagnetic bubble in GDMT with neutral injection are constructed. The analysis of the obtained solutions allows us to determine the optimal parameters of the device in the diamagnetic confinement mode.

References

1. Beklemishev A. D. (2016). Physics of Plasmas, 23(8), 082506.
2. Khristo M. S., & Beklemishev A. D. (2019). Plasma Fusion Res., 14, 2403007–2403007.
3. Ivanov A. A., & Prikhodko V. V. (2017). Physics-Uspekhi, 60(5), 509–533.
4. Bagryansky P. A., et al. (2016). AIP Conference Proceedings, 1771, 030015.
5. Beklemishev A., et al. (2013). Fusion Science and Technology, 63(1T), 46–51.
6. Chernoshtanov I. (2020). arXiv preprint arXiv:2002.03535.
7. Kotelnikov I. (2020). Plasma Physics and Controlled Fusion, 62(7), 075002.
8. Morozov A., Solov'yev L. S. (1963) Voprosy teorii plazmy, 2, 177.
9. Hsiao M.-Y., Miley G. H. (1985). Physics of Fluids, 28(5), 1440.
10. Janev, R. K., et al. (1989). Nuclear Fusion, 29(12), 2125–2140.
1. \*) [abstracts of this report in Russian](http://www.fpl.gpi.ru/Zvenigorod/XLIX/Mu/ru/BI-Khristo.docx) [↑](#footnote-ref-1)