collisionless particle dynamic in diamagnetic trap [[1]](#footnote-1)\*)

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Mechanisms of particles confinement and lifetimes of unconfined particles in axisymmetric diamagnetic trap are discussed in this report. The idea of diamagnetic confinement is formation and sustainment of plasma with extremely high pressure, which is equal to pressure of magnetic field of mirror machine [1]. The region occupied by hot dense plasma (so-called diamagnetic “bubble”) is formed in regime of diamagnetic confinement. The magnetic field is extruded fully from the “bubble” due to plasma diamagnetism. MHD models [1, 2] predict dramatic increasing of confinement time of particles and energy after transition to the regime of diamagnetic confinement in comparison with time of gas-dynamic outflow.

Investigation of particle dynamic in the diamagnetic trap is needed for development of kinetic models of diamagnetic confinement. Full energy  and azimuthal component of angular momentum  conserves due to stationarity and axial symmetry of magnetic field. But particle magnetic moment  not conserves because of smallness of magnetic field inside the “bubble”. It changes essentially particle dynamic and can leads to chaotic behavior.

The two mechanisms can provide particle confinement for unlimited time when collision scattering absent and system is fully axisymmetric and stationary. First, particle can be confined if it rotates quickly around the trap axis in direction coinciding with direction of cyclotron rotation (so called absolute confinement [3]). Criterion of the absolute confinement can be written in the form, here  is vacuum mirror ratio and  is the cyclotron frequency counted by the vacuum magnetic field in center. Second, radial adiabatic invariant can conserves if the magnetic field varies smoothly in longitudinal direction.

The analytical criteria of adiabaticity of particle motion in the diamagnetic trap with smooth and corrugated (due to discrete structure of magnetic system of the trap) magnetic field are discussed. Analytical estimation of lifetime of untrapped particles is found. It is shown that plasma confinement time in the diamagnetic trap in regime of gas-dynamic outflow (particle lifetime exceeds lifetime of collisional scattering) exceeds more that  times the time of gas-dynamic outflow from vacuum magnetic field, here  and  are radius of the diamagnetic “bubble” and ion Larmor radius counted by the vacuum field.

References

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1. \*) [abstracts of this report in Russian](http://www.fpl.gpi.ru/Zvenigorod/XLVII/Mu/ru/AG-Chernoshtanov.docx) [↑](#footnote-ref-1)