§46. Alpha-Particle Confinement in l = 3 Reactor Sized Helical System

Motojima O., Sagara A., Shishkin O.(Kharkov State University, Ukraine), Shishkin A.(Kharkov Institute of Physics and Technology, Ukraine), , Yamazaki K., Watanabe K.Y.

The way to control the alpha-particle motion in l=3 helical reactor is considered. It is shown that the externally applied transverse magnetic field ($B_{\perp}$) can decrease the deviation of alpha-particles from the initial magnetic surface.

In the usual magnetic system schemes of the helical type reactor the aspect ratio R/a_h, where R and a_h are the large and the small radii of the helical coils winding, is taken from 4 to 8. The Force-Free-Helical Reactor (FFHR) in its reference version [1] has the following parameters: R=20 m, a_h=3.3 m, l=3, m=18 ; here l is the number of the helical winding poles and m is the number of the magnetic field periods on the torus length. The condition of the force-free-like helical windings $\gamma = ma_h/lR$=1 is satisfied. Here we consider the effect of $B_{\perp}$ on the alpha-particle confinement in FFHR in its reference version and in its more compact case [1], Depending on the sign and value $B_{\perp}$ shifts the magnetic axis of the configuration inside ($\Delta<0$) or outside the torus ($\Delta>0$) and changes the modulation of the magnetic field along the force line $B(\varphi)$. The magnetic flux surface function contains not only main helical harmonic with the "wave" numbers (l,m) but the satellite harmonics with (l+1,m) and (l-1,m) - so called sidebands. The drift velocity of the trapped and passing particles can be reduced when $\varepsilon_{l-1,m}/\varepsilon_l<0$ ($\Delta<0$) and $\varepsilon_{l+1,m}/\varepsilon_l<0$,where $\varepsilon_{n,m}$ are the Fourier coefficients in the magnetic field. Below there are shown the alpha-particle (W=3.5 MeV, B_0=12T) trajectories which are obtained with the numerical integration of the guiding center equations. The trajectories are shown on the background of the magnetic force line footprints which form closed magnetic surfaces.

Reference FFHR . In the case $\Delta<0$ the modulation of $B(\varphi)$ can be favourable to reduce the radial drift of the trapped particles and the passing particles . The deviation of the particle from the initial magnetic surface in the case $\Delta<0$ is smaller than in the cases $\Delta=0$ and $\Delta>0$ (Fig. 1).

FFHR Compact System.. The more compact systems are of great interest, for example, FFHR with the parameters R=13.2 m, a_h=3.3 m, l=3, m=12 [1], where the condition $\gamma=1$ is satisfied also. The deviation of the alpha-particle orbits from the initial magnetic surfaces is reduced in the case $\Delta<0$.

References

[1] O.Motojima et al., *in Controlled Fusion and Plasma Physics* (*Proc.23* rd *EPS Conf.* , Kiev,1996) Part II, p.551.

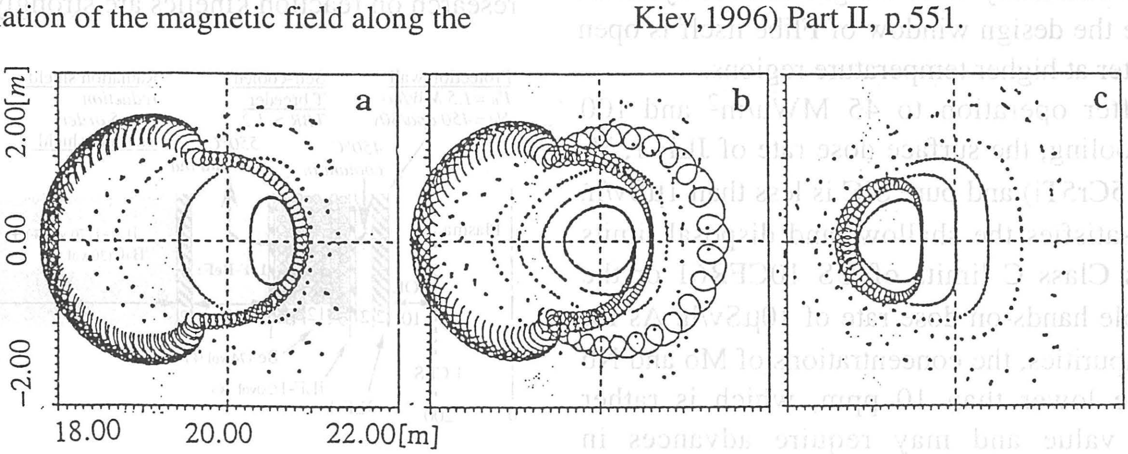

Fig.1 Projections of alpha-particle trajectories on the meridional cross-section in the FFHR reference case under $B_{\perp}/B_0$= -0.003 (a), 0.0 (b), 0.005 (c) for $V_{//}/V$=-0.3.