Effect of the vertical magnetic field on the shape of the vacuum magnetic surface in a stellarator [[1]](#footnote-1)\*)

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Vertical (normal to a torus plane) magnetic field is often used in stellarators to change both the shape of magnetic surfaces and size and phase of magnetic islands. It is not obvious what parameters of the initial configuration determine response of the magnetic configuration to the change of external vertical field. An attempt to solve this problem is made in this report. It is assumed that initial vacuum magnetic configuration has a resonant surface close to the edge of plasma column, but islands are not formed, so it is possible to find magnetic configuration with enclosed magnetic surfaces and to determine its metric (the metric of the Boozer flux coordinate system) using VMEC code [1].

Vertical field and magnetic configuration variation are assumed to be small. The equation of magnetic surfaces $B∇a=0$ ($B=B\_{0}+B\_{⊥}, a=a\_{0}+δ$) with uniform vertical field $B\_{⊥}=С∇Z$ takes the following form (a cylindrical coordinate system R, Z, φ is used as the initial one):

 $Φ^{'}\left(μ\frac{∂δ}{∂θ}+\frac{∂δ}{∂ζ}\right)=-CR\left(φ\_{θ}^{'}R\_{ζ}^{'}-φ\_{ζ}^{'}R\_{θ}^{'}\right)$

The right side of this expression determines the magnitude of the vacuum surfaces variation δ (a,$θ$,$ζ$). If a flux system with straight field lines and unchanged toroidal angle is used, φ ≡ $ζ$, $φ\_{ζ}^{'}$ = 1, $φ\_{θ}^{'}$=0, the equation takes the form:

 $Φ^{'}\left(μ\frac{∂δ}{∂θ}+\frac{∂δ}{∂ζ}\right)=CRR\_{θ}^{'}$

This equation can be extended for the more general case of two-dimensional potential of vacuum vertical magnetic field.

As it is seen from above, the resonance harmonic in $R^{2}$ is important for islands formation by vertical magnetic field, in contrast to the self-healing of magnetic islands during plasma pressure change [2].

References

1. S.P. Hirschman. [Phys. Fluids, 1983, 26, 3553](http://dx.doi.org/10.1063/1.864116).
2. T. Hayashi, T. Sato, P. Merkel, J. Nührenberg, U. Schwenn. Physics of Plasmas, 1994, 1, 3262.
1. \*) [abstracts of this report in Russian](http://www.fpl.gpi.ru/Zvenigorod/L/Mu/ru/BS-Khanaeva.docx) [↑](#footnote-ref-1)