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Plasma Perturbation by Cylindrical Probe and its Effect on Probe Diagnostics VALERY GODYAK, RF Plasma Consulting, NATALIA STERNBERG, Clark University — Different kinds of Langmuir (LP), magnetic (B-dot-P) and microwave (MWP) probes are widely used for plasma diagnostics. Any probe diagnostics implies that the plasma local parameters inferred from the probe measurements are not distorted by the presence of a probe. However, inserting a probe into plasma leads to local and sometime to global perturbation of the plasma parameters. This can produce erroneous diagnostic results. The criteria for undistorted probe measurement are well understood for the electron current collection by the classical Langmuir probe [1]. However, in all other types of probes, neglecting plasma perturbation caused the by probes may lead to essential errors. Here we present an analysis of plasma perturbations by a cylindrical probe, commonly found in practice, for arbitrary collisionality parameter $\beta = \rho/\lambda$i, where $\rho = $ a + s is the probe-sheath radius, a is the probe radius, s is the sheath width, and λi is the ion mean free path. Our results were obtained for cylindrical probes by solving numerically a set of fluid equations for neutral plasma with cold ions, taking into account ion inertia and a nonlinear ion friction force, similarly to for a spherical probe. An analytical solution for cylindrical probe in the collisionless case, $\beta = 0$, was also found. Plasma perturbation around a cylindrical probe appeared to be significantly larger than that for a spherical probe [2]. Effects of plasma depletion around cylindrical probes is discussed for different kinds of probe (LP, B-dot and MW) diagnostics.

[1] V. Godyak and V. Demidov, J. Phys. D: Appl. Phys. 44, 233001 (2011).
[2] N. Sternberg and V. Godyak, Phys. Plasmas 24, 093504 (2017).

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