On impact of neutrals on the tokamak edge plasma instabilities

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In many situations, the plasma in boundary regions of magnetic confinement devices contains significant amount of neutrals, which come either because of recycling from the walls or from plasma volumetric recombination. An interaction of neutrals with plasma through a number of collisional processes, plays an important role in establishing detached divertor regime [1]. In addition to that, neutrals can also play an vital role in edge plasma instabilities and turbulent processes. For example, an impact of neutrals can result in new type of instabilities [2], alter the strength of zonal flows in edge plasmas and, therefore, cause enhancement of turbulent transport [3]. On the other hand neutrals could reduce the growth rates of both interchange and resistive drift wave modes [4, 5]. Therefore, accounting for plasma-neutral interactions in modeling of edge plasma turbulence and transport seems to be irrefutable. However, given that the influence of neutrals on plasma dynamics is rather complex, the physics underlying an impact of neutrals on plasma instabilities and turbulent transport is not understood yet. One of the issues with incorporating neutrals into edge plasma turbulence codes is the fact that neutrals, unlike plasma charged particles, are not magnetized. As a result, accurate modeling of neutral-plasma interactions becomes rather complex since neutral dynamics, depending on both plasma and turbulence parameters, could vary from fluid-like (e.g. see [6]) to ballistic-like regimes.

In this work we investigate an impact of neutrals on both interchange and resistive drift wave instabilities and consider an impact of neutrals on nonlinear generation of zonal flow by turbulent eddies. We carefully assess an impact of neutrals on these instabilities and zonal flow generation examining both fluid and ballistic regimes of neutral dynamics. Finally we compare our results with existing theoretical predictions and numerical simulations.

References: