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Influence of neutral-plasma interactions on 3D scrape-off layer filaments

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Filaments are field aligned, non-linear density perturbations, which have been observed in most plasmas. In tokamaks they can carry a significant amount of particles and heat from the last closed flux surface to the far scrape-off layer (SOL). This highly non diffusive transport mechanism can cause a significant heat load onto first wall materials. It is important to understand the motion of filaments, particularly in regard to the design of future fusion devices.

Recent experiments on several machines have shown that the plasma density of the SOL can have a significant influence on the dynamics of filaments.

We have carried out non-linear, 3D seeded filament simulations, with the focus on neutral-plasma interactions, using the BOUT++ library. The model is an extension of the STORM code, which is a two fluid model, including thermal electrons. In order to study the influence of neutrals, 1D background profiles are computed. By varying particle and heat influx, different profiles are generated. The filaments of critical size showed an increasing radial velocity with increasing upstream temperature, as expected from scaling laws. The filament further showed a decreasing radial velocity with increasing plasma density. In these conditions, the neutrals interaction resulted in a reduced radial velocity. It was further observed that the filaments radial velocity had a strong dependency on the target temperature, resulting in an increasing radial motion for an increasing target temperature.

As higher neutral densities could affect the strong sheath currents, studying the neutrals filament interaction at higher densities is of interest. In the current study the density was further increased, as the previous simulations showed an increasing influence of the neutrals on the filaments with increasing background plasma density and temperature on the filament. The purely diffusive neutral model in STORM was extended to enable the modelling of higher density conditions towards detachment. This has been validated against other neutral simulation codes.

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