Self-sustained oscillations in a reactive plasma-wall system

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Plasmas in laboratory devices are complex objects. This complexity manifests itself by different types of self-organization processes and, in particular, by macroscopic self-sustained oscillations seen in the time variation of local and global parameters such as plasma density, temperature, particle and energy content, radiation losses etc. Saw-tooth activity in the core and edge localized modes in tokamaks, breathing oscillations in stellarators are well known examples of such oscillations. Understanding of the nature of these phenomena is crucial for the determination of the most optimal operation mode of modern and future devices and can bring a deeper insight into the nature of complex systems.

In the present contribution a simple system with a strongly ionized hydrogen plasma confined by a magnetic field and bounded by a material wall parallel to the field lines will be considered. Electrons and ions diffuse out of the plasma volume perpendicular to the field and recombine on the wall. The generated neutral particles are released back into the plasma due to diverse processes, i.e., the so called particle recycling takes place. In a stationary state the influx of neutrals compensates the loss of ions and electrons from the plasma. The ionization of neutral particles by collisions with electrons provides the source of charged particles in the plasma. It will be demonstrated that macroscopic self-sustained oscillations is an universal feature of such a system when the plasma transport characteristics are sufficiently inhomogeneous through the plasma volume which is normally the case in real plasmas.