

Robust control strategies for magnetically confined fusion plasma.

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The study of the problem of plasma confinement in huge devices, such as for example Tokamaks and Stellarators, has attracted a lot of attention in recent years. Strong magnetic fields in these systems can lead to instabilities, resulting in vortex formation. Due to the extremely high temperatures in plasma fusion, physical materials cannot be used for confinement, necessitating the use of external magnetic fields to control plasma density. This approach involves studying the evolution of plasma, made up of numerous particles, using the Vlasov-Poisson equations. In the first part of the talk, the case without uncertainty is explored. Particle dynamics are simulated using the Particle-in-Cell (PIC) method, known for its ability to capture kinetic effects and self-consistent interactions. The goal is to derive an instantaneous feedback control that forces the plasma density to achieve a desired distribution. Various numerical experiments are presented to validate the results. In the second part, uncertainty and collisions are introduced into the system, leading to the development of a different control strategy. This method is designed to steer the plasma towards a desired configuration even in the presence of uncertainty. The presentation concludes by outlining a future perspective focused on developing a robust control strategy based on neural networks.

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