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Preliminary study on the phase space instability of fusion reactors

Xiandong Zeng[1], Xiaoyi Yang[1], Xiaogang Wang[2], Yao Wang[3], Chang Liu[4]
[1]Harbin Institute of Technology
e-mail (speaker): 2021110459@stu.hit.edu.cn

The age of burning is coming after series of excellent progress in recent years [1-4]. How to consist stable plasma and continuously output the fusion energy becomes one of the most important physical issue of the fusion reactor. As is shown in Figure 1, a new physical modeling is proposed inducing a two-dimension phase space to describe the dynamic of burning plasma, with nuclear reaction, feeding and ash discharge considered. By study the topology of the traces in the phase space, three important results are got:

Firstly, a critical feeding exist, above which stable burning equilibrium can be achieved. The equilibrium is just near the ignition condition.

Secondly, the equilibrium should place in the descending edge of the reaction rate, which means the temperature of the actor should be higher.

Finally, it is proved that even the ignition condition dis-satisfied when the temperature is high enough, the plasma system will still evolve to the burning equilibrium spontaneously.

More details about the physical modelling, burning behaviors and critical conditions will be shown in the poster. It will make deeper understanding of the future fusion reactor and give suggestion for the fusion studying route.

References

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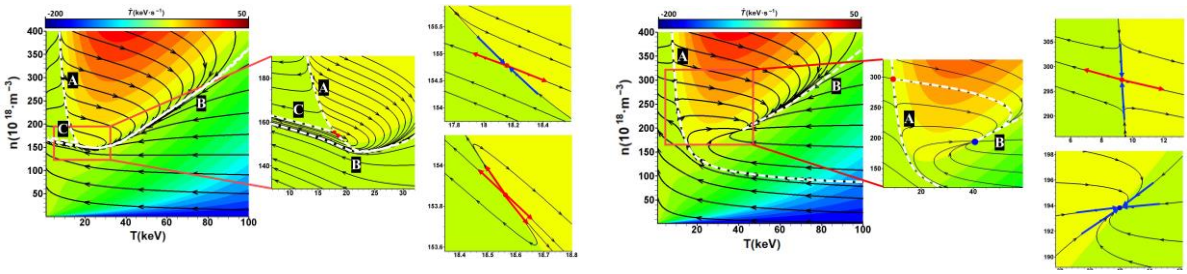

Figure 1. When the feed is less than the critical feed (left), there is no stable fixed point in the phase space, which means that the burning equilibrium cannot be stable; When the feeding is greater than the critical feeding (right), the fixed point with higher temperature in the phase space is stable, indicating that the corresponding burning equilibrium is stable. At this time, as long as the plasma density and temperature reach the curve C, the plasma can spontaneously evolve to burning equilibrium.