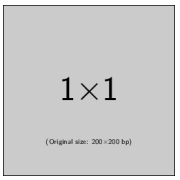

Vienna International School

Extended Essay

Predicting the breakdown probability for a plasma discharge in the GOLEM tokamak

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supervised by
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Abstract

This is my abstract

Contents

Introduction

It is very difficult to imagine a world without electricity. For over one hundred years we are using it to accomplish a wide range of tasks. Yet still our civilization does not possess a reliable and cheap source of this energy for wide use. Nuclear fission has proved to be a good candidate. However, as a side effect it produces large amounts of nuclear waste. Nevertheless, scientist are working on a better alternative - Fusion. Unlike in fission, where heavy atoms are split into smaller atoms and thereby releasing energy, the process of fusion is quite the opposite. Light elements are forced to combine into heavier elements releasing vast amounts of energy. Scientist have discovered this process together with fission. Yet it proved very difficult to duplicate the process in an efficient and controlled manner.

One of the key problem at reproducing fusion in an artificial environment are the extreme conditions required. The atoms naturally repel due to the coulomb force. Only after forcing the atoms close together does the strong nuclear force take over and fuse the atoms. In our sun, gravity is responsible for this. However on Earth, we are unable to create such enormous pressures. The only alternative are temperatures as high as millions of degrees where the kinetic energy of the atoms is high enough to bring the atoms close to one another. No element can withstand such temperatures. Therefore maintaining fusion over extensive periods of time requires finding a method of containing it safely in a reactor without touching the walls.

Tokamak is a technology used to contain plasma in a vacuum ring using electromagnetic coils. Most fusion reactions take place in the plasma state of matter. This makes a Tokamak an ideal device for containing fusion. However to make sure the fusion is safely contained in the reactor one must first understand the process of plasma formation in the tokamak chamber.

The plasma formation, also known as the plasma breakdown or the avalanche effect, is one of the strangest parts of plasma physics. It very much depends on the initial conditions of the experiment and thus it is difficult to simulate. However it is possible to estimate, based on previous experiments, if the breakdown of the plasma is going to be successful given some initial conditions. This essay will focus at investigating methods for **Predicting the breakdown probability for a plasma discharge in the GOLEM tokamak**

Background information

2.1 Tokamak background

Tokamak is an abbreviation for 'toroidal chamber with magnetic coils'. The history of the design reaches as far back as the 1950s when it was invented by the Soviet physicist Igor Tamm and Anrei Sakharov.

The GOLEM tokamak situated at the CVUT faculty in Prag is

2.2 Plasma creation process

A tokamak consist of a toroidal chamber which is surrounded by coils. When current flows through the coils a toroidal magnetic field is generated inside of the chamber. This can be used to attract the ionized gas inside of the chamber towards the center and away from the walls.

The chamber of the GOLEM tokamak is surrounded by an iron core of a transformer. It is positioned in such a way as to induce electric current in the area of the chamber. If partially ionized gas is present in the chamber, its loose electrons are accelerated resulting in further ionization and rapid heating of the gas.

This plasma breakdown process is sometimes called the avalanche effect because the entire volume of the gas ionizes initiated by a small number of initial ions in the gas.

Whether the plasma breakdown is successful or not depends very much on the initial conditions. This includes the strength of the toroidal magnetic field, strength of the electric field, gas type and pressure, type and duration of the pre-ionization and many more.

This experiment will focus at estimating the probability of a successful breakdown given initial conditions.

Conclusion

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[1] **Saussure1995**.

Appendix Title

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