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# Chapter 1

# Introduction

## 1.1 Numerical Simulations

As there are several theoretical branches within the field of plasma physics, magnetohydrodynamics, kinetic theory (Note to self: Need better overview, and citations), that are suited to investigate plasma physics at different scales and different phenonema, there are also different approaches to conduct numerical plasma studies. Plasma simulation codes can be classified along the extent they are particle based or fluid based. Fluid based programs use the magnetohydrodynamical equations,

## 1.2 Particle-in-Cell

To investigate the mechanics involved in a wide variety of plasma phenomenens, computer simulation. Particle-in-Cell, PiC, is simulation model that takes a particle based approach, where each particle is simulated seperately, or a collection. If we naively would attempt to compute the electrical force between each particle, the necessary computational power would grow quickly as the number of particle increases, $\mathcal{O}((\#particles)^2)$. Since a large number of particles is often neccessary the PiC method seeks to the problem by computing the electrical field produces by the particles, and then compute the force on the particle directly from the field instead. From the charge distribution we can find the electric potential through the use of Poissons equation, **??**, and subsequently find the electrical field from the electrical potential. See **??** for an overview of the

$$\nabla^2\Phi = -\rho \qquad \text{in} \qquad \Omega \tag{1.1}$$

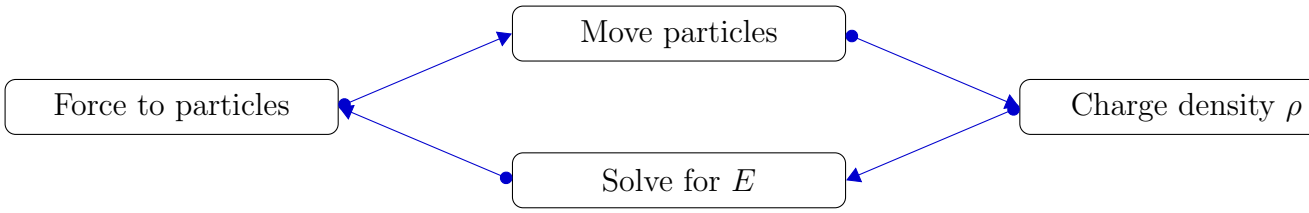


**Figure 1.1:** Schematic overview of the PIC method