5 Transport phenomena

Jas not in equilibrium => distribution fct. different

from Plaxwell - Boltzmann

distribution

temperature, density,
and average velocity are
not constant throughout
the Sas

Reaching equilibrium implies: transport of energy,
mass, and momentum
from one part of
the gas to another

Average distance over
which molecular properties can be transported
in one collision is the
mean free path.

Mean free path: average distance traveled by an atom/molecule between successive collisions.

Solve Boltzmann transport equation for some initial conditions => f (+, p, t) as a fet.

in general non-trivial

Some dynamical quantities are rigorously conserved. We will look at mass, momentum, and energy.

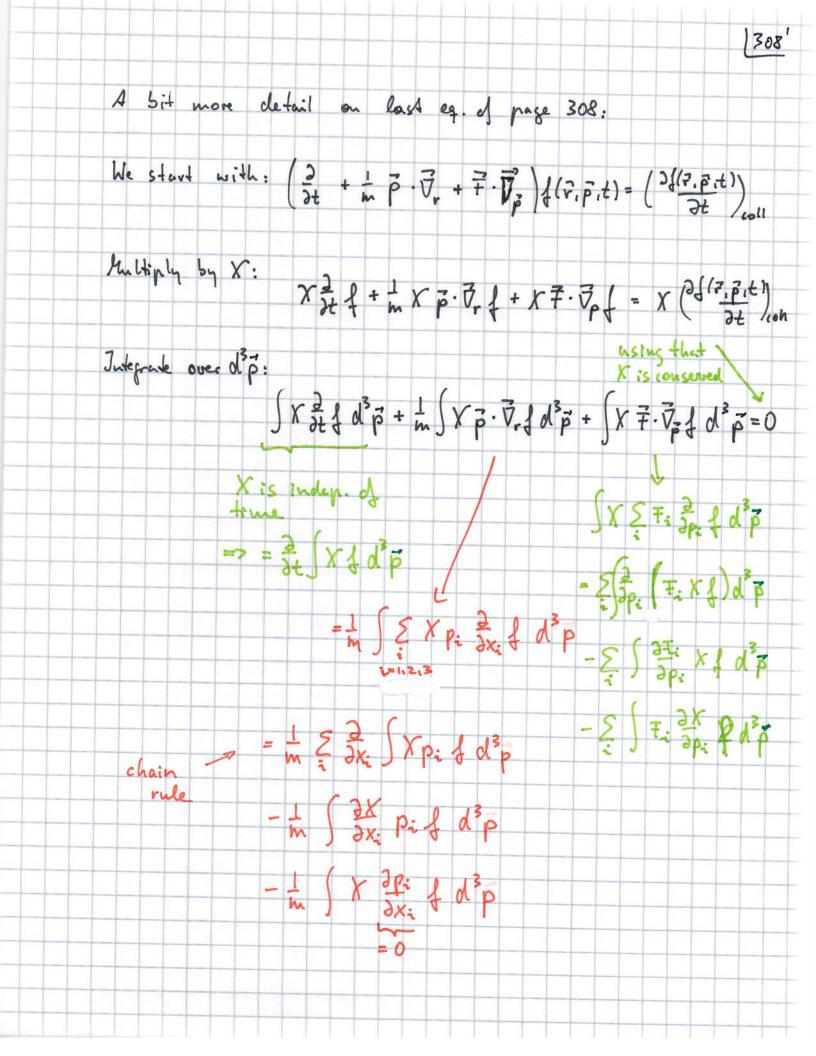
See text (not in notes)

Set three conservation theorems

Ly the idea is that some equations

related to the conservation theorems

are easier to solve than the Boltz
mann transport equation



Recall:

Boltzmann transport

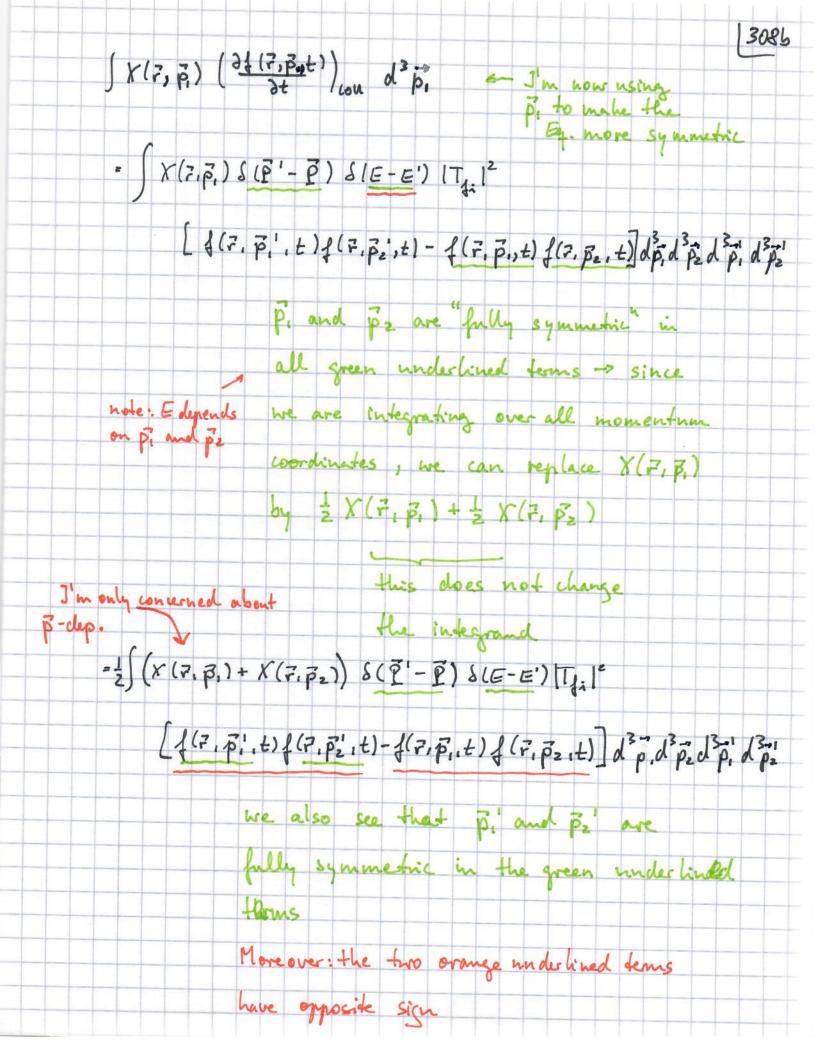
$$\left(\frac{\partial}{\partial t} + \frac{1}{m} \vec{p} \cdot \vec{\nabla}_{z} + \vec{T} \cdot \vec{\nabla}_{p}\right) f(\vec{r}, \vec{p}, t) = \left(\frac{\partial}{\partial t}\right)_{coll}$$
 equation

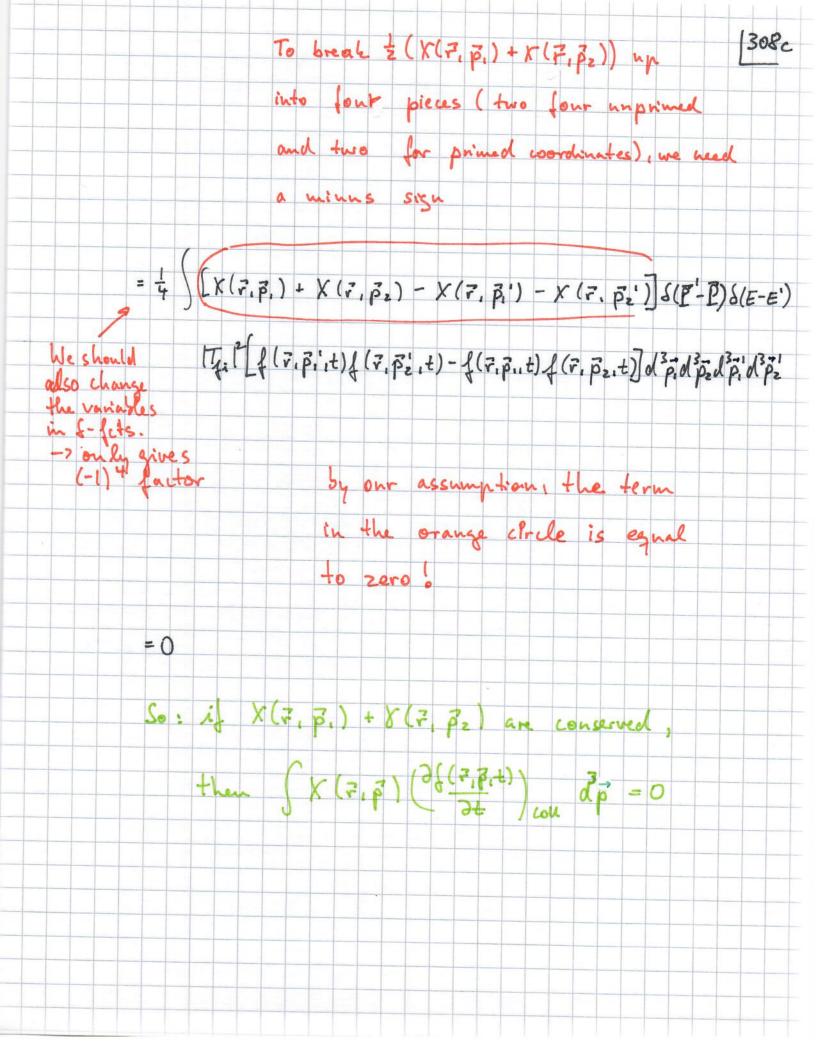
[(F, p', t) (F, p', t) - (F, p, t) (F, p, t) dpdpdpdp

Let's look at an example:

$$\chi'(\vec{r}_2,\vec{p}_2) = \vec{p}_2^2$$

Let's write it out:





Let's define: $(A) = \frac{\int A \{d^3p\}}{\int \{d^3p\}} = \frac{1}{h} \int A \{d^3p\}$ $\{-\{(\vec{r},\vec{p},t)\}$

n (7,t)- [{[,p,t)d}]

With this notation, we have

3+ (nk) + 2 3 (nv; x) - 5 n(v; 3x)

- in Ext. Dr. > - in Ext. X = 0

Conservation theorem

Let X=m:

m is constant $\frac{\partial}{\partial t}$ (m n) + $\frac{\partial}{\partial t}$ (m n $\frac{\partial}{\partial t}$ (m n $\frac{\partial}{\partial t}$) = 0

(pull out of

integral) -> only
the first two terms or: g(7,t) = mn(7,t) = mass density
contribute

=> \frac{2g(7,t)}{2t} + \frac{7}{7} \cdot (g(7,t) \vec{u}(7,t)) = 0

Continuity eq

where il(7, +) = < i>>

