

INTRODUCTION

Do you know the theory of everything?

?
the ultimate mathematical
description of all physics

No me neither.

But how do you play chess if you don't know
the rules?

How can you get out of bed if you don't
know the theory of everything?

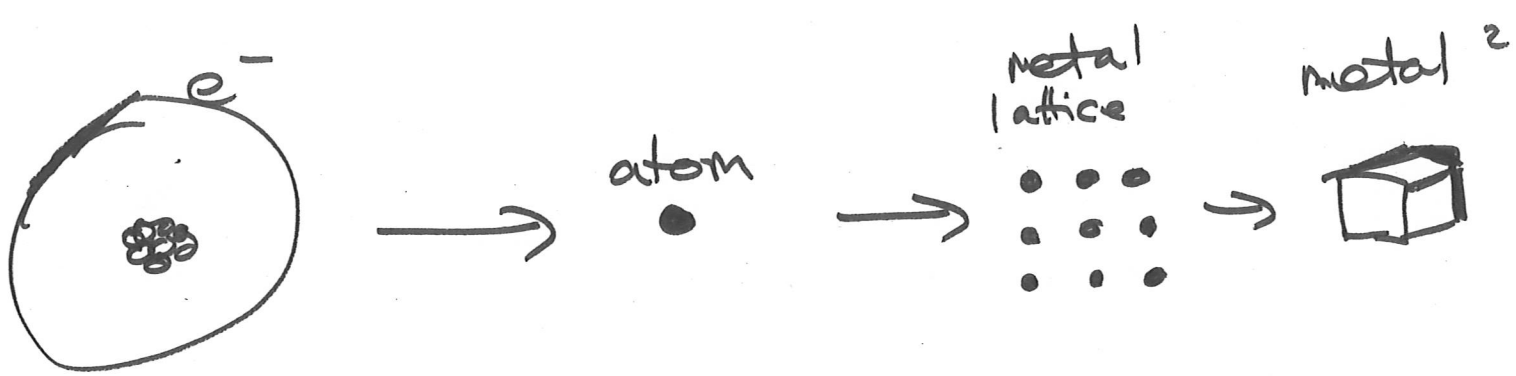
The reason is QUANTUM MECHANICS

$$E = h \nu = \frac{hc}{\lambda}$$

At low energy you can only make long
wavelength matter waves.... and they can't
probe small objects

☆ ~ thing!

This means physics divides into effective theories
relevant at different energy scales



As we look at smaller and smaller scales
new effective theories emerge.

An EFFECTIVE THEORY has
"degrees of freedom"

electrons m_e, v_e
atoms
~~specific~~ gas P, V, T

"with properties that are
inherited from shorter
distance scales"

m_e, q
 Z, A
density, conductivity

"laws of physics that
determine evolution"

Schroedinger Eq'n
 $F = ma$
 $PV = nRT$

Given we don't know the TOE - any physics is
an effective theory - they are all rather
interesting & can be quite different from each
other.

Hardest problem: transitions between effective
theories - but here startling predictions are
possible eg nucleus + e^- model explains
properties of 100s of atoms!

This course is about the first effective theory ³

solid; liquid; gases: $P, T, \text{Work} \dots$

& how it emerges from the next layer - atoms

It's a beautiful & illuminating piece of physics...

It contains unique important insights e.g. for cosmology & black holes...

The top layer effective theory is also the most useful for day to day life

- heating your home

- understanding the weather

etc

We won't totally reverse history though - you don't want to work with hydrogen & chlorine as different fundamental objects... so we'll start with how kinetic theory provides material properties then look at the laws of those properties...