

A first look at 2nd quantization

Additional reading

- Sakurai, chapter 7
- Feynman, Statistical mechanics, chapter 6
- Brues and Flenberg, chapter 1
- Altland and Simons, chapters 1 and 2.

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additional reading

A first look at second quantization

The name "second quantization" stands for a different way of writing down the rules of quantum mechanics, that is ideally suited for dealing with a large number of identical particles. In quantum mechanics we usually say "which particle is in which state". But for many identical particles, that is too messy. Instead, in second quantization we only specify "how many particles are in each state". This is what we call the occupation number representation.

Second quantization is the basis of most modern theories in physics, from condensed matter to quantum field theory. It is still quantum mechanics, so everything you learned before continues to hold. What really changes is the way we think about the problem.

Introducing second quantization to a student for the first time is always a bit tricky. I could always try to show you in detail where it all comes from. But that is usually too abstract and not very productive. I therefore propose we do this in 2 steps. In these notes I will give you only the general idea, without rigorous proofs. This will allow us to jump straight to applications. Maybe this introduction will already satisfy you. But maybe it will leave you feeling that the theory is rather mystical. It is not. Second quantization is quantum mechanics and can be constructed using only the rules you already know.