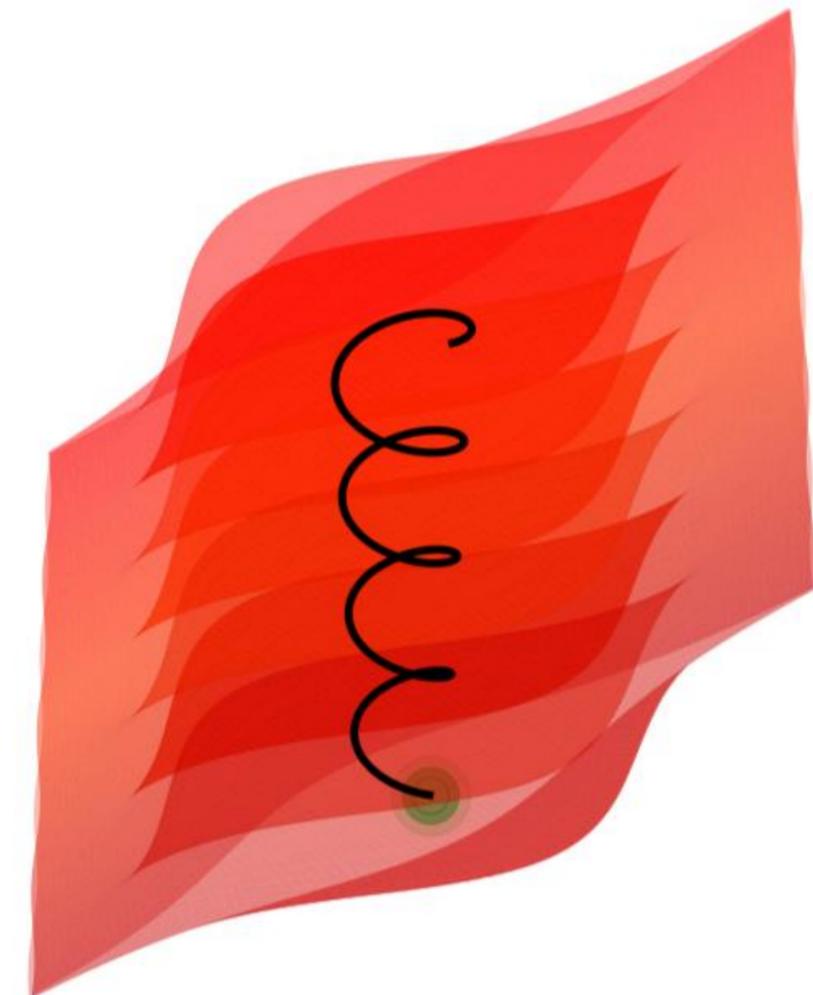


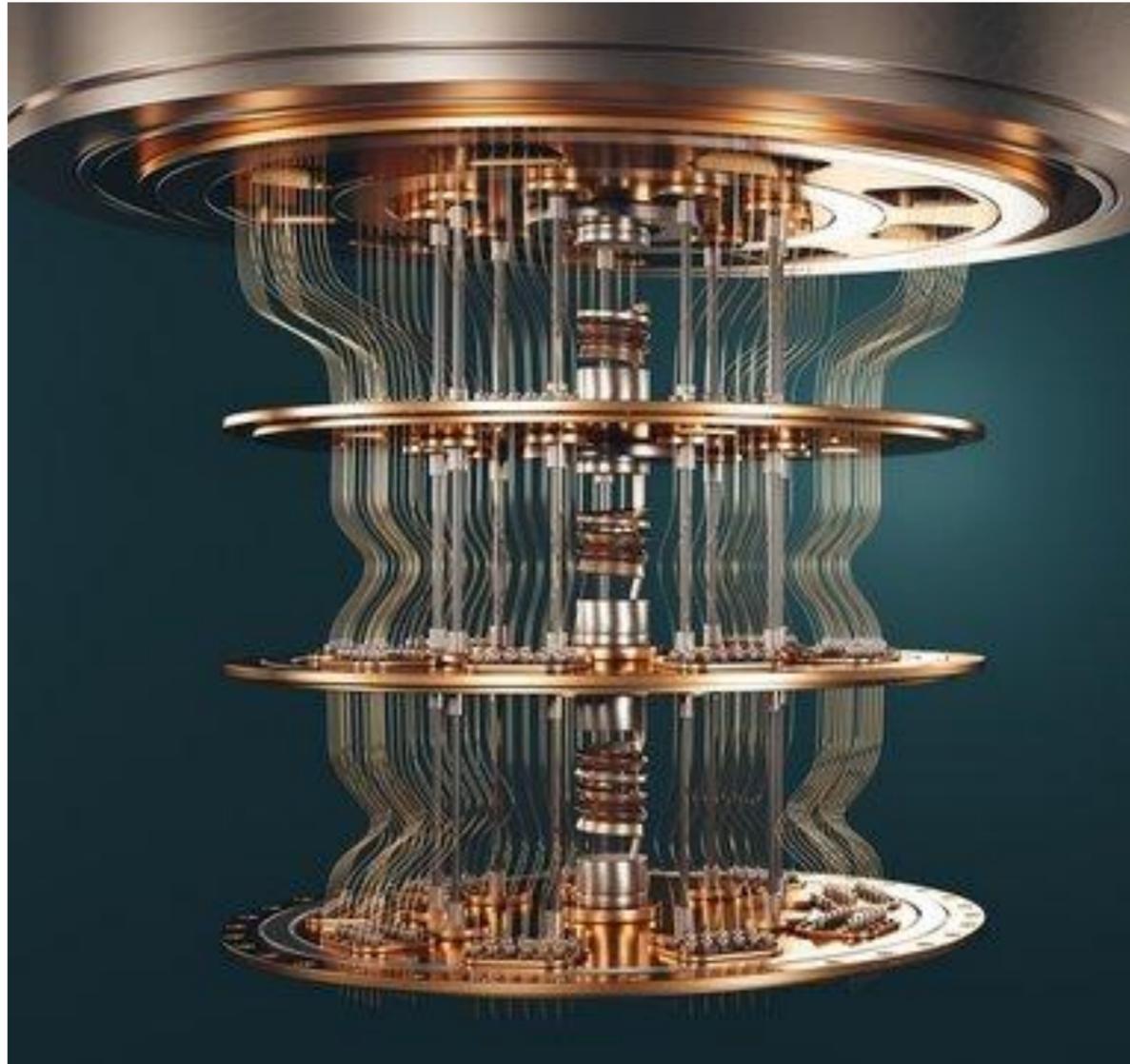
Quantum Simulation of Particles in External Fields

José Mariano

Supervisors: Prof. Marija Vranić
Dr. Lucas Ivan Iñigo Gamiz
Mr. Óscar Amaro

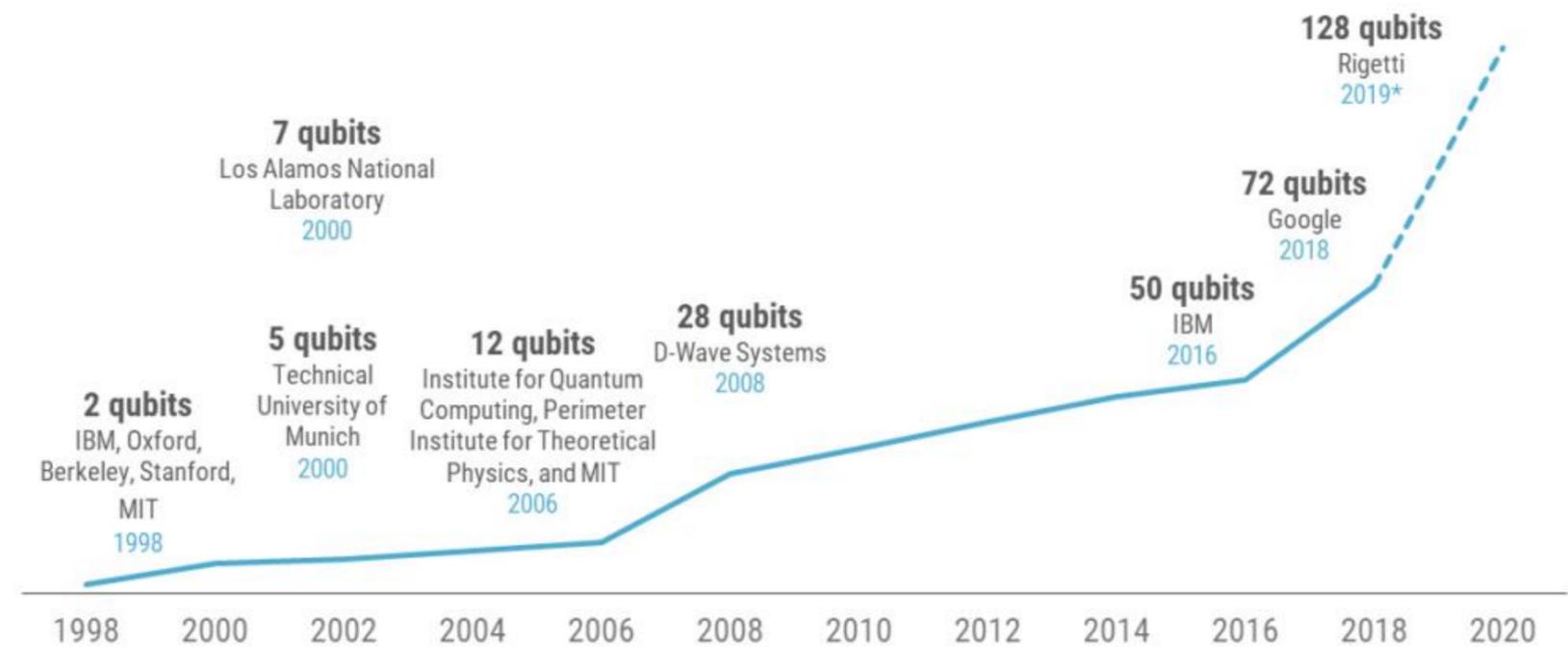


Another Way to do Simulations



Quantum computers are getting more powerful

Number of qubits achieved by date and organization 1998 – 2020*



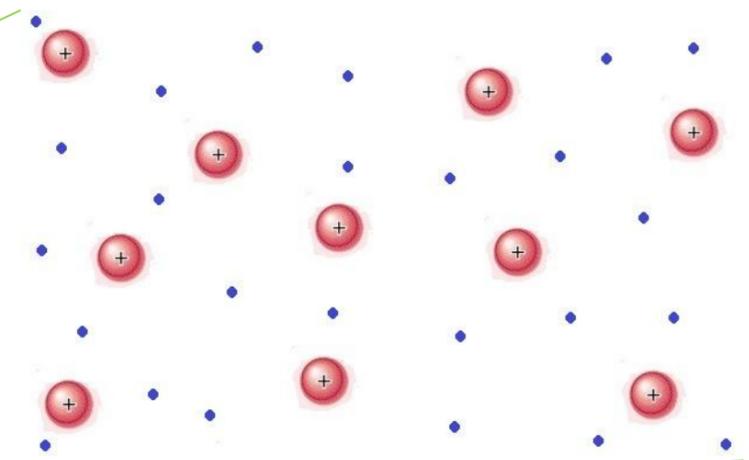
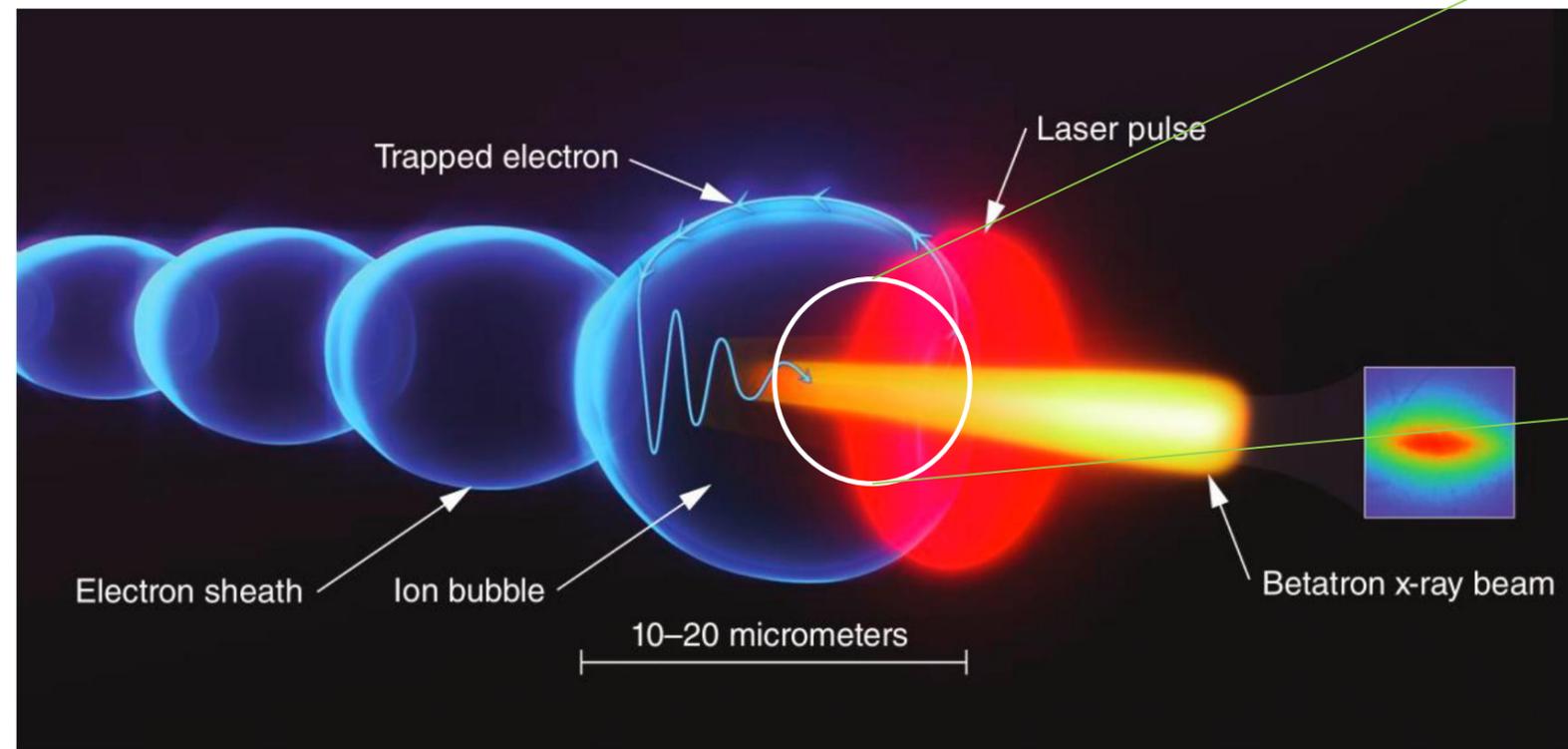
Source: MIT, Qubit Counter. *Rigetti quantum computer expected by late 2019.

Using Simplicity to Achieve Complexity

Currently in the early stages
quantum algorithms.



Start simple, reach
complex: simulate a single
particle in a laser field.

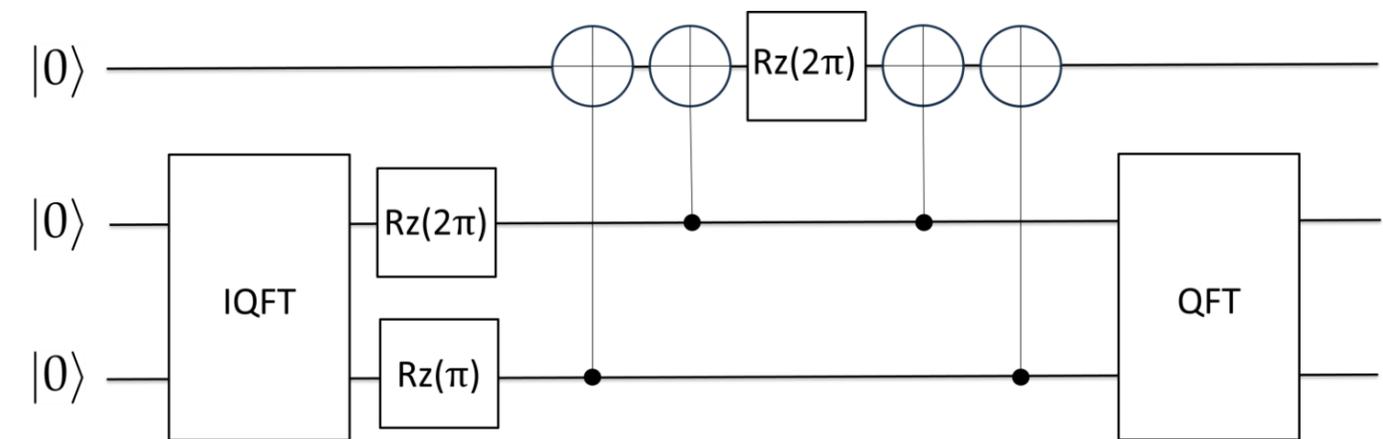


- **Reformulate Physical Models:** Translate typical particle Hamiltonians into formulations compatible with quantum simulation;

$$F^{-1} e^{-\frac{i}{\hbar} \frac{\vec{p}^2}{2m} \epsilon} F$$

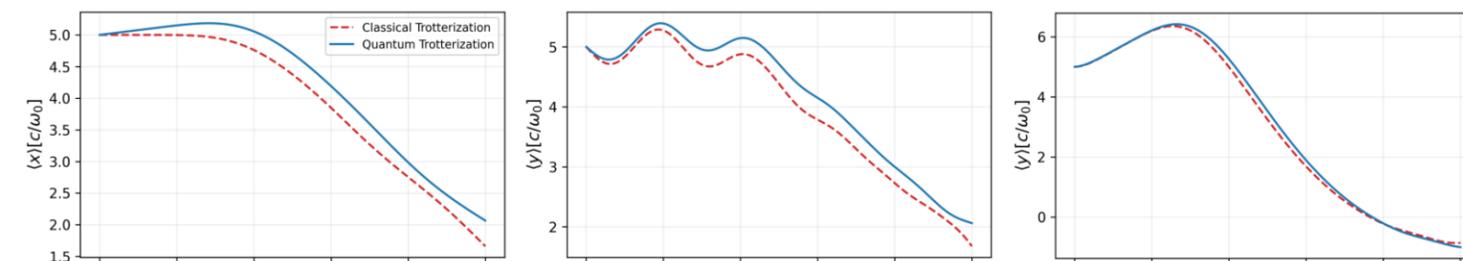
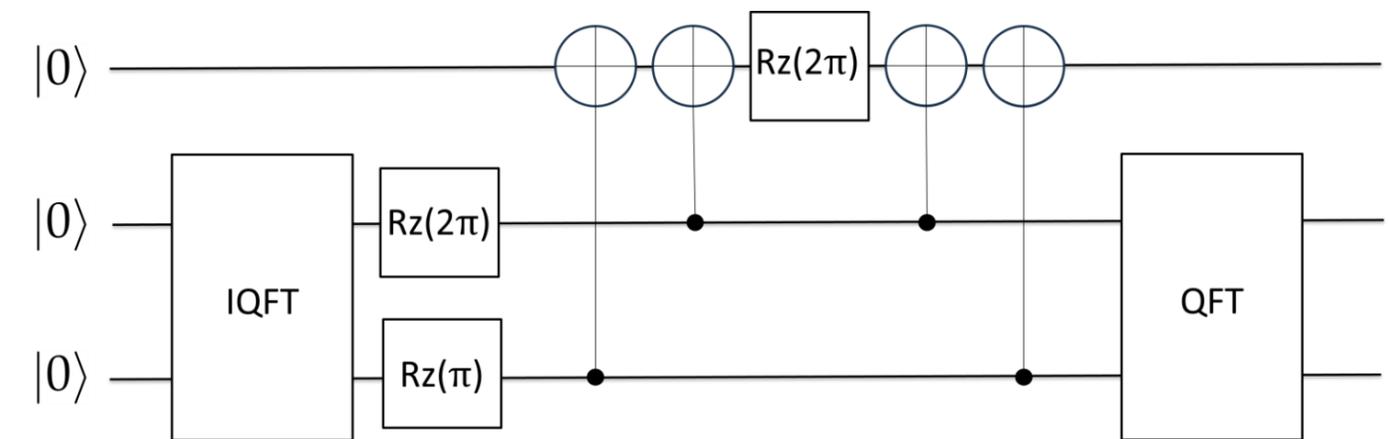
- **Reformulate Physical Models:** Translate typical particle Hamiltonians into formulations compatible with quantum simulation;
- **Design Quantum Circuits:** Develop the specific techniques to simulate the mentioned equations in a digital quantum computer;

$$F^{-1} e^{-\frac{i}{\hbar} \frac{\vec{p}^2}{2m} \epsilon} F$$



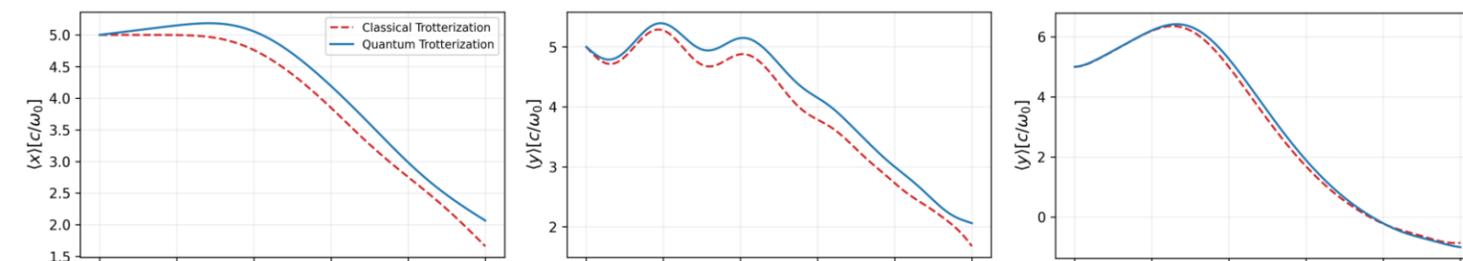
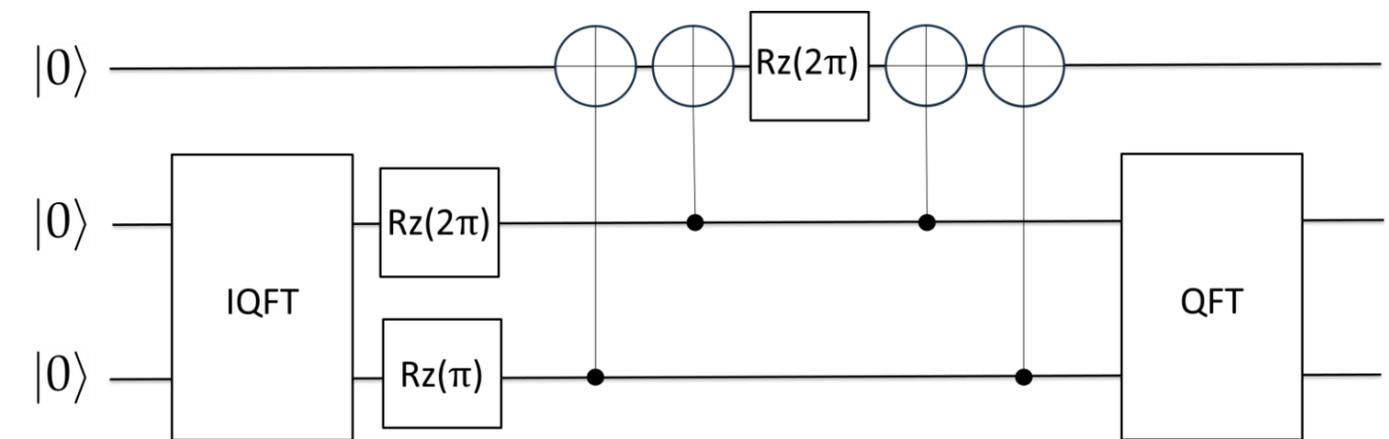
- **Reformulate Physical Models:** Translate typical particle Hamiltonians into formulations compatible with quantum simulation;
- **Design Quantum Circuits:** Develop the specific techniques to simulate the mentioned equations in a digital quantum computer;
- **Validate Performance:** Benchmark the simulation results against established classical methods;

$$F^{-1} e^{-\frac{i}{\hbar} \frac{\vec{p}^2}{2m} \epsilon} F$$

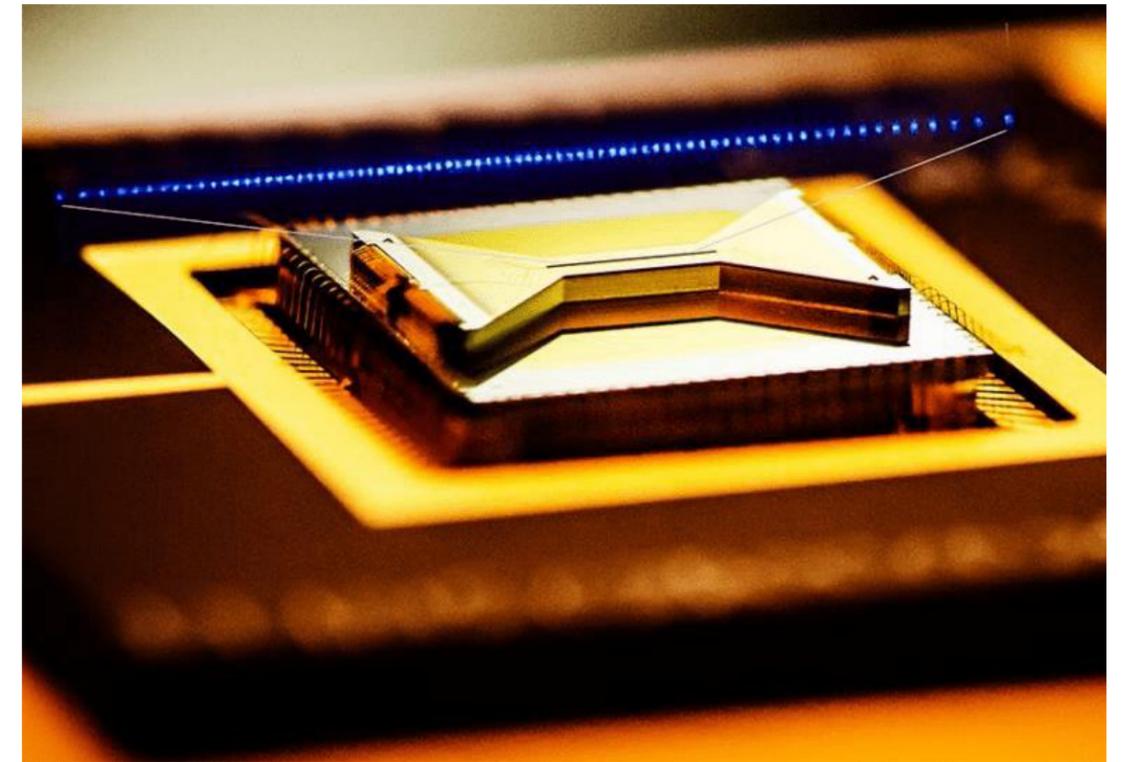


- **Reformulate Physical Models:** Translate typical particle Hamiltonians into formulations compatible with quantum simulation;
- **Design Quantum Circuits:** Develop the specific techniques to simulate the mentioned equations in a digital quantum computer;
- **Validate Performance:** Benchmark the simulation results against established classical methods;
- **Optimize for Hardware:** Adapt the circuits to ensure feasibility on current physical quantum devices.

$$F^{-1} e^{-\frac{i}{\hbar} \frac{\vec{p}^2}{2m} \epsilon} F$$



Finish Line Objective



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