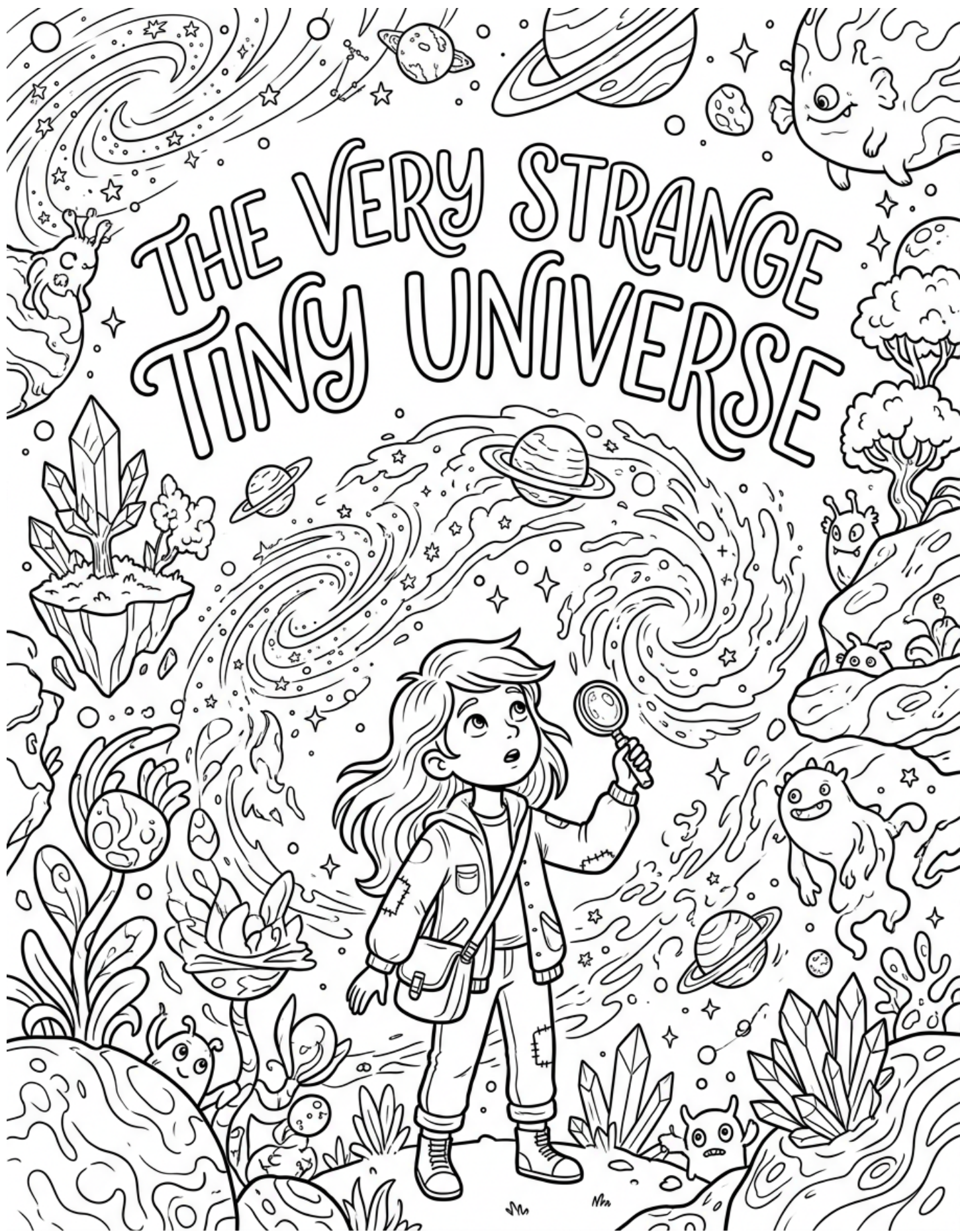
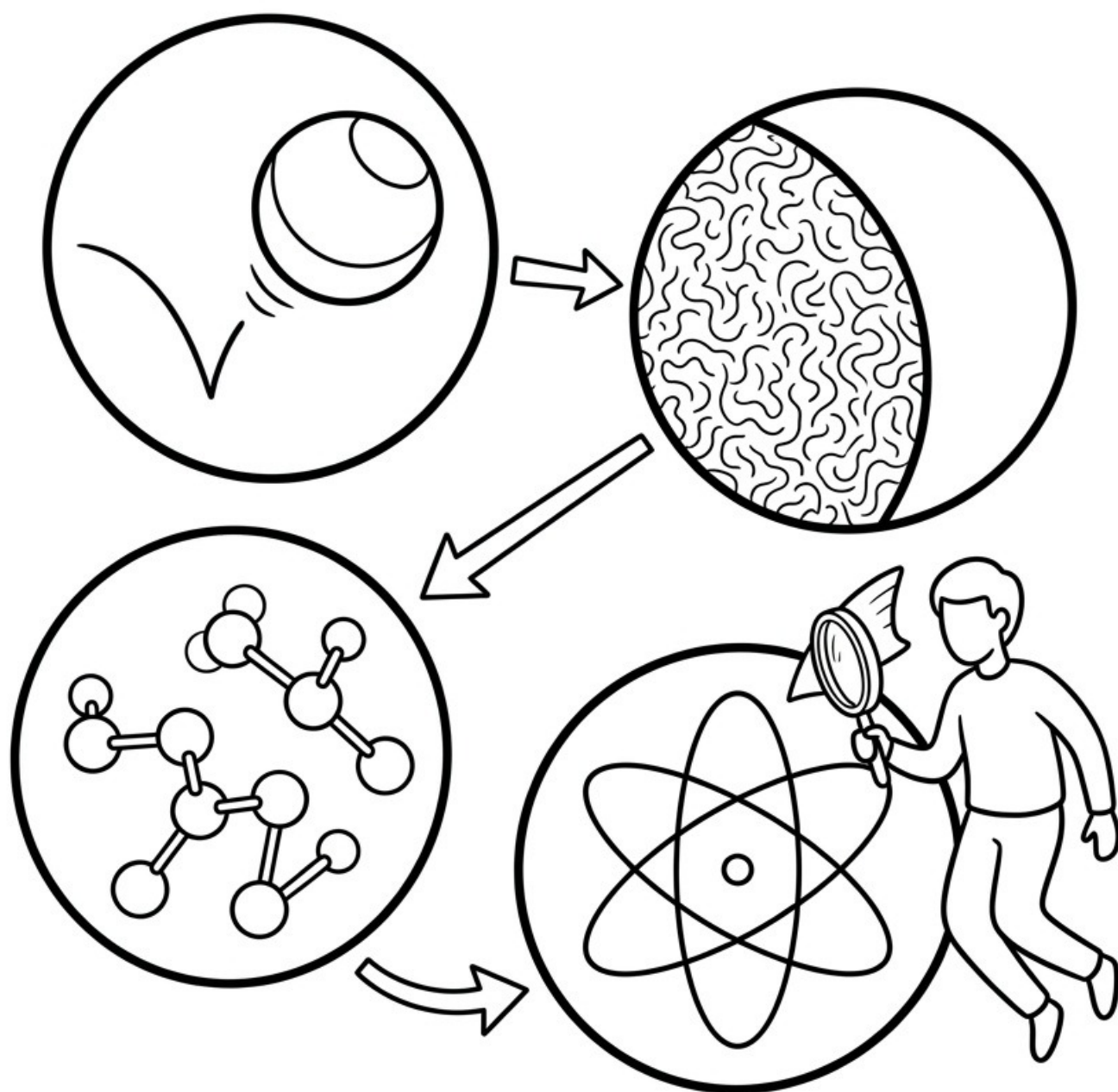
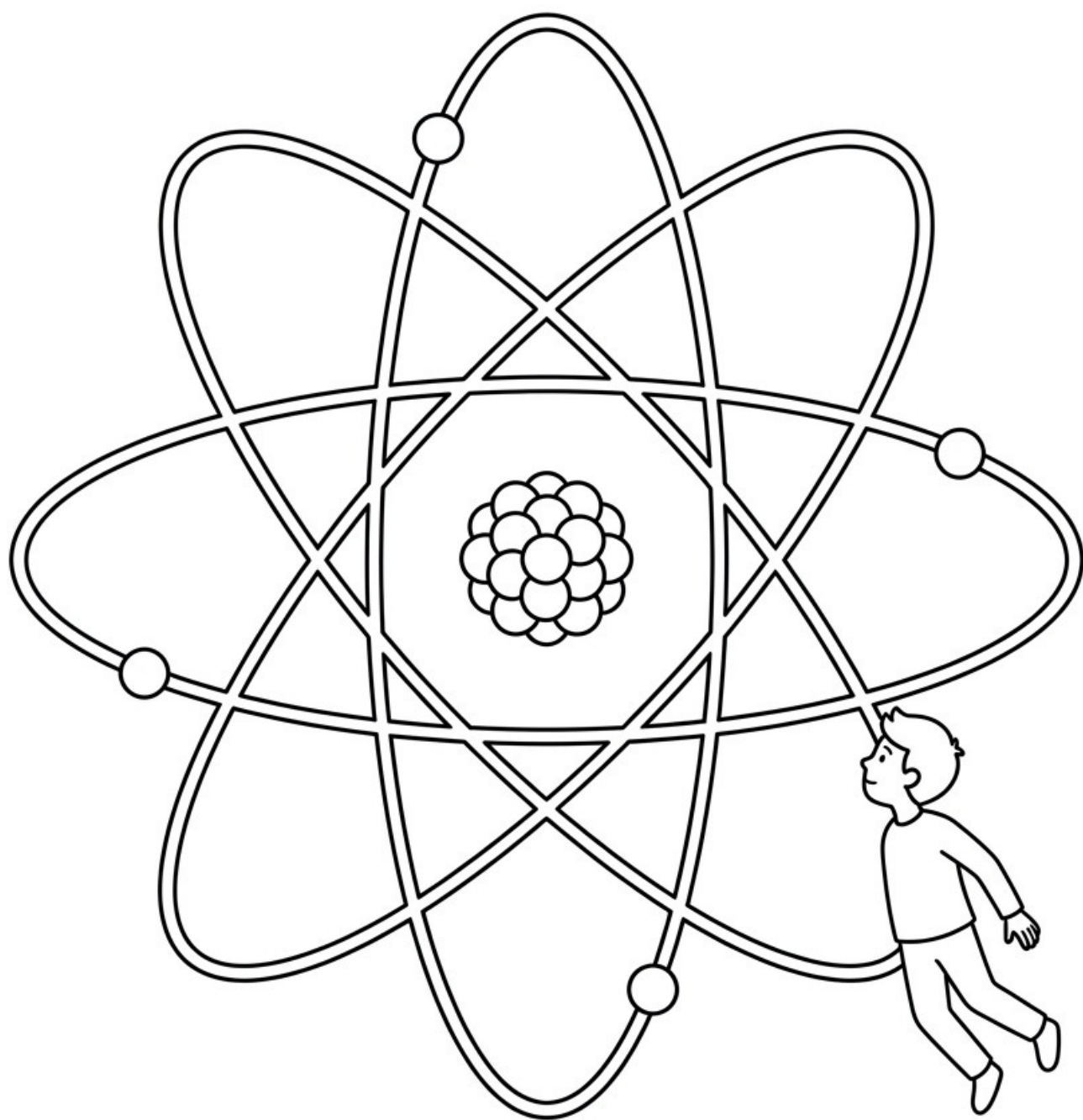


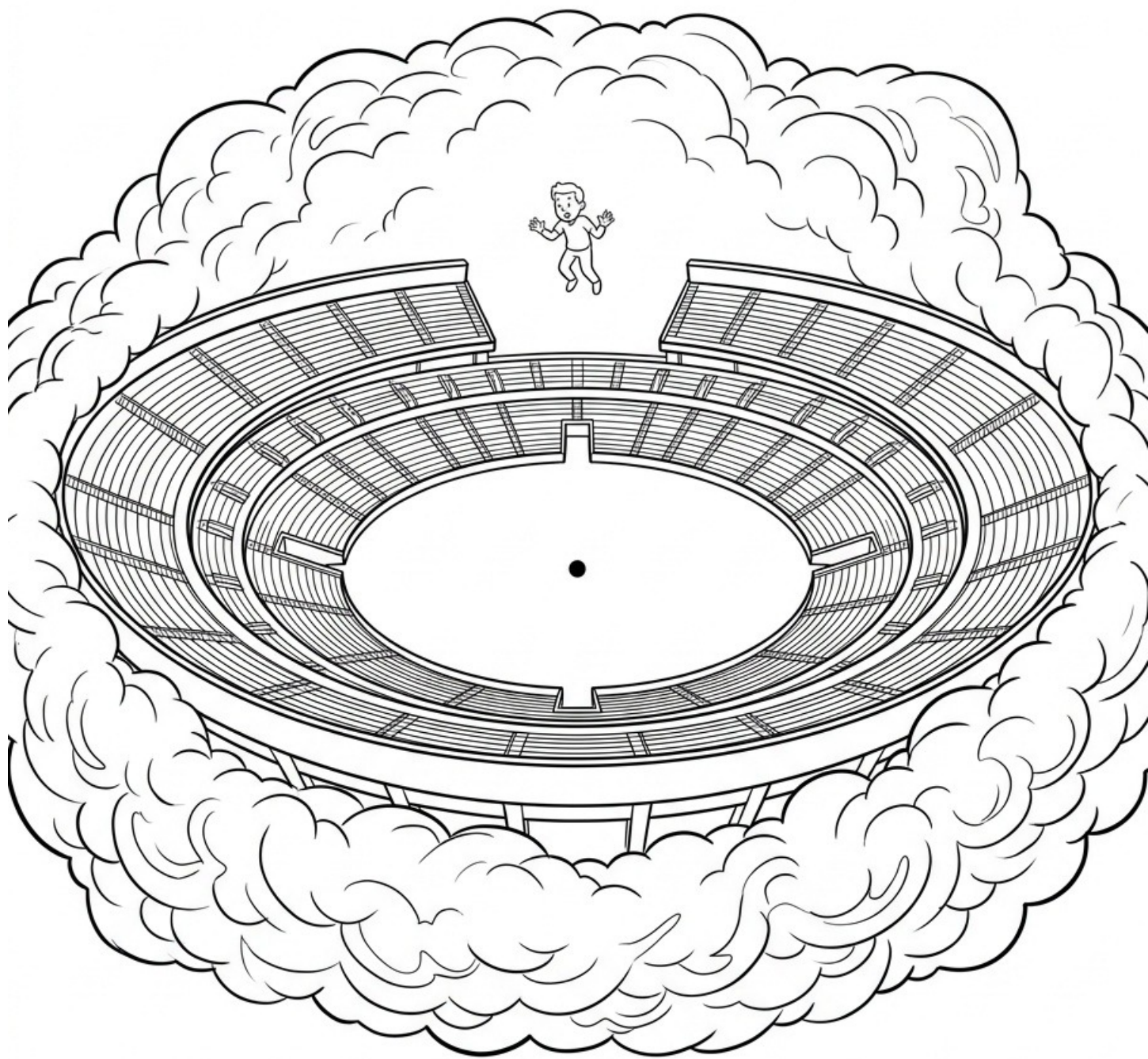


Everything around you is made
from things far too tiny for
your eyes to see.

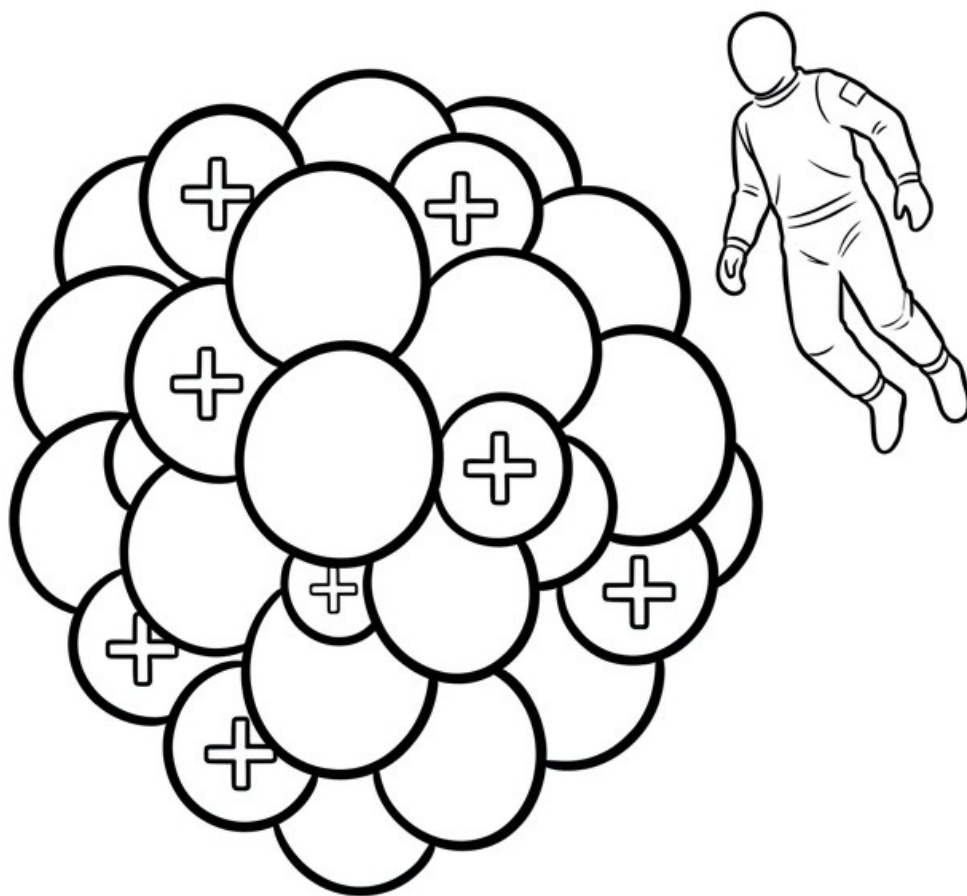




Almost everything you touch
is built from atoms. They are
tiny beyond imagination.



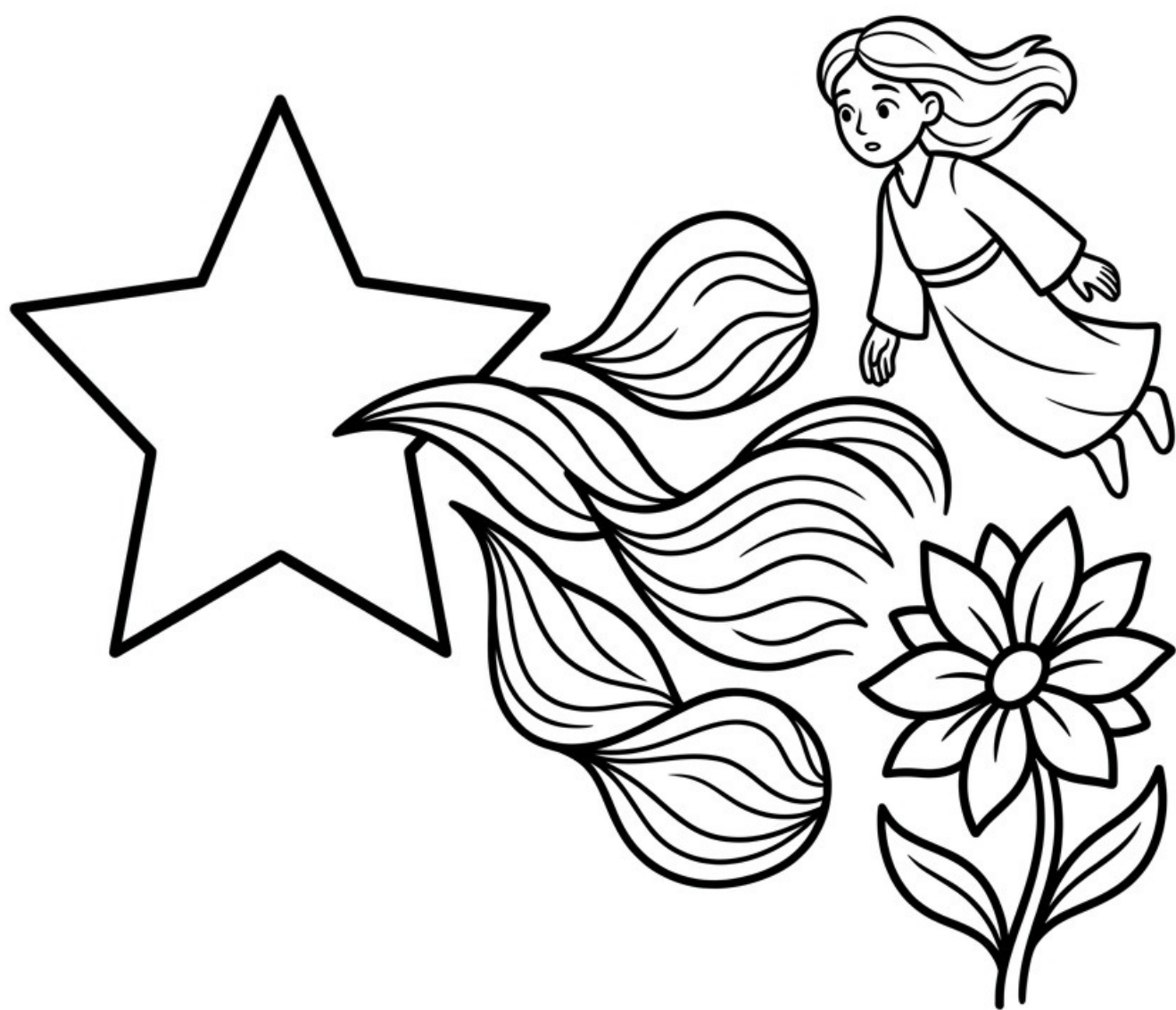
If an atom were as big as a stadium,
its nucleus would still be
surprisingly tiny.



At the center of an atom,
protons and neutrons crowd together
inside the nucleus.



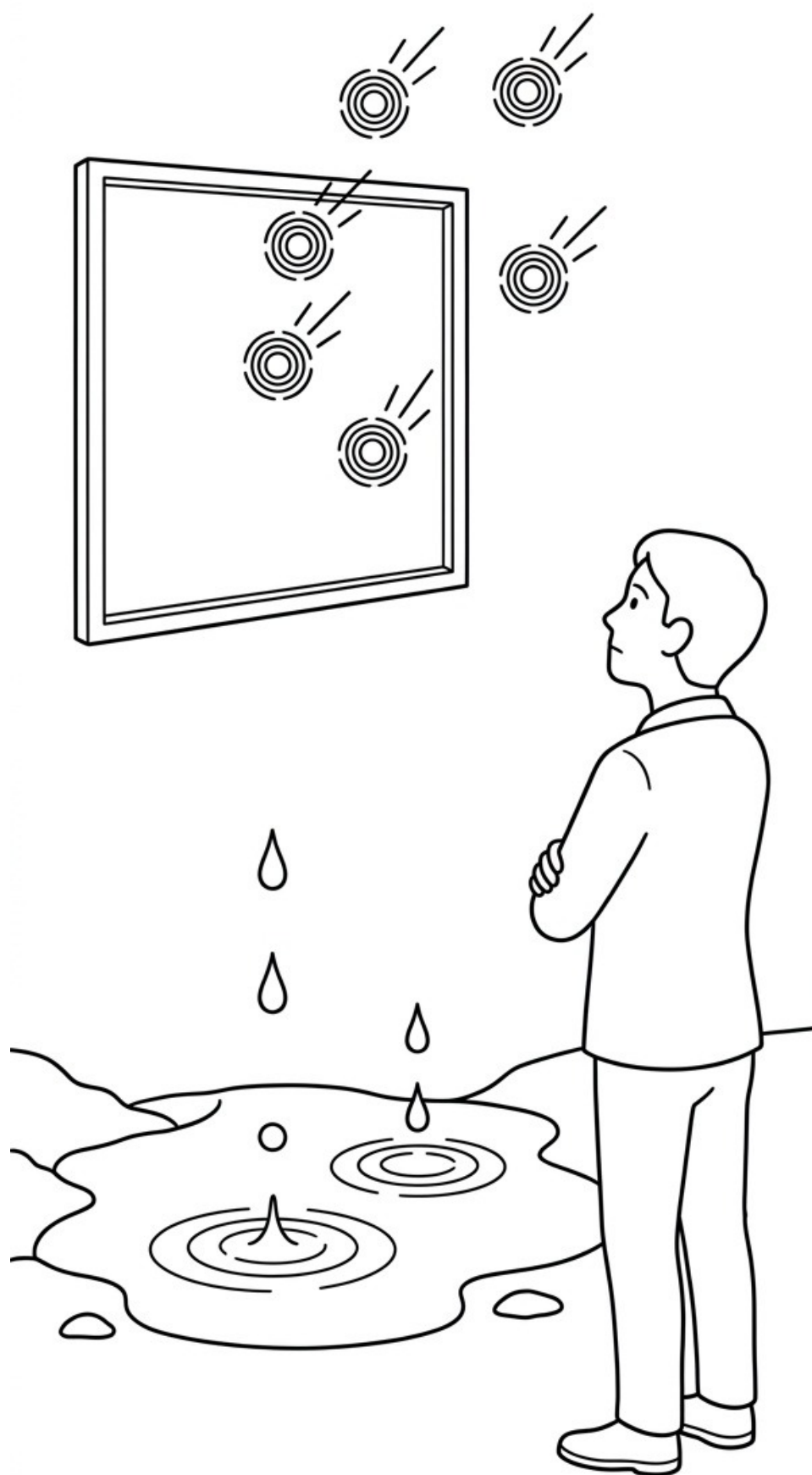
Look inside a proton and the tiny world
gets stranger again. Inside are
particles called quarks.



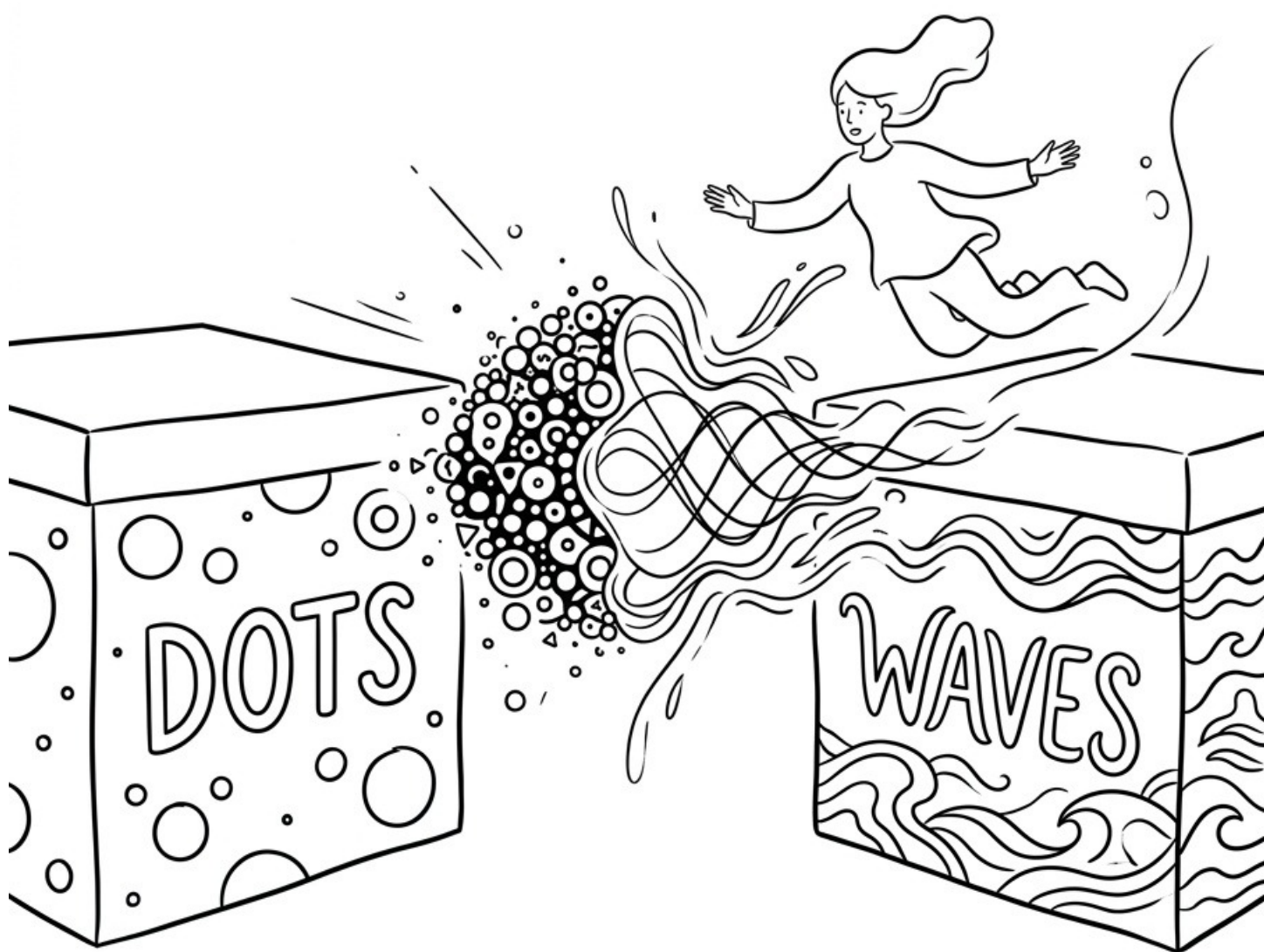
Light delivers energy in tiny packets.
We call those packets photons.

Sometimes light
behaves like waves
spreading across a
pond.



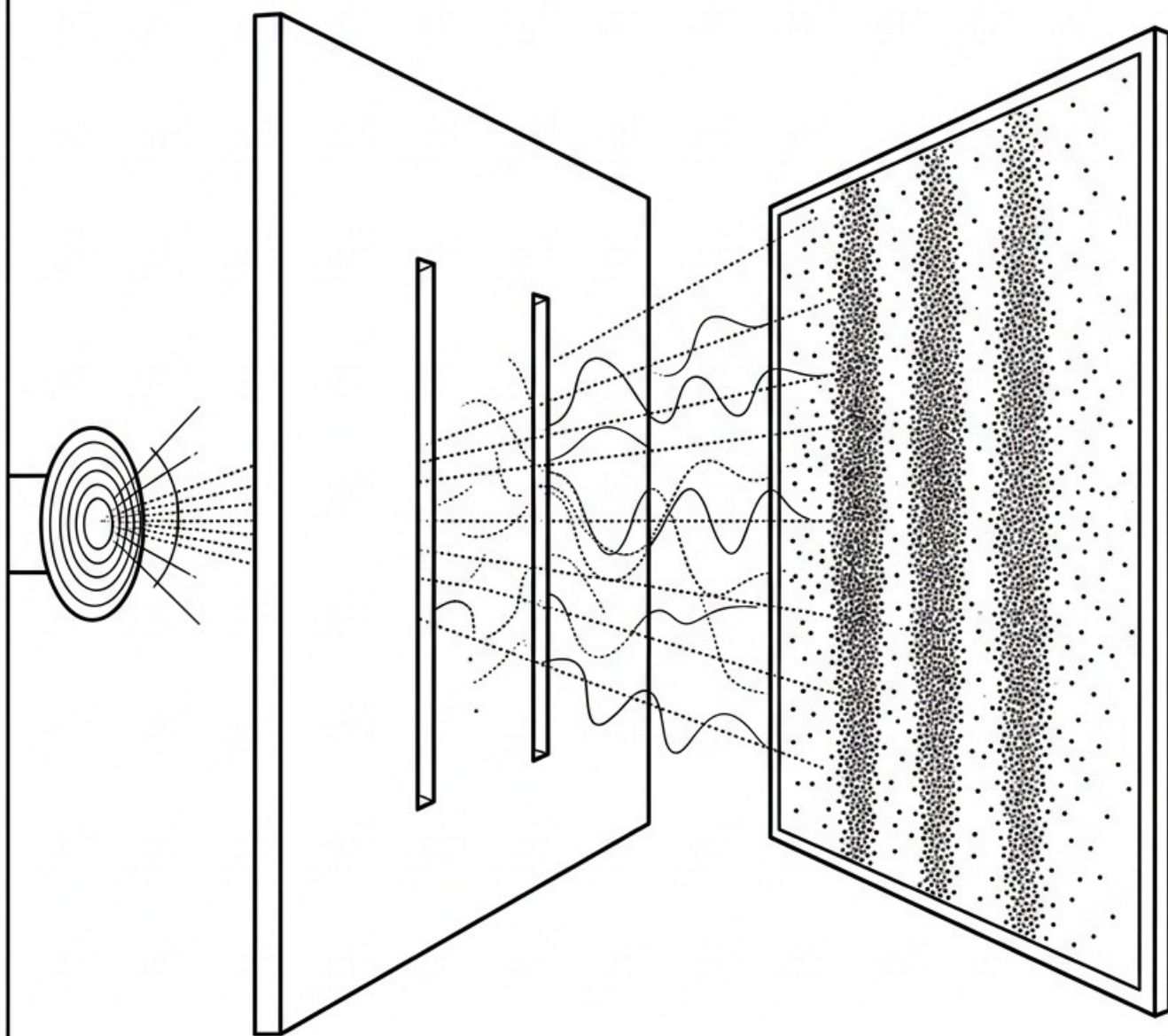


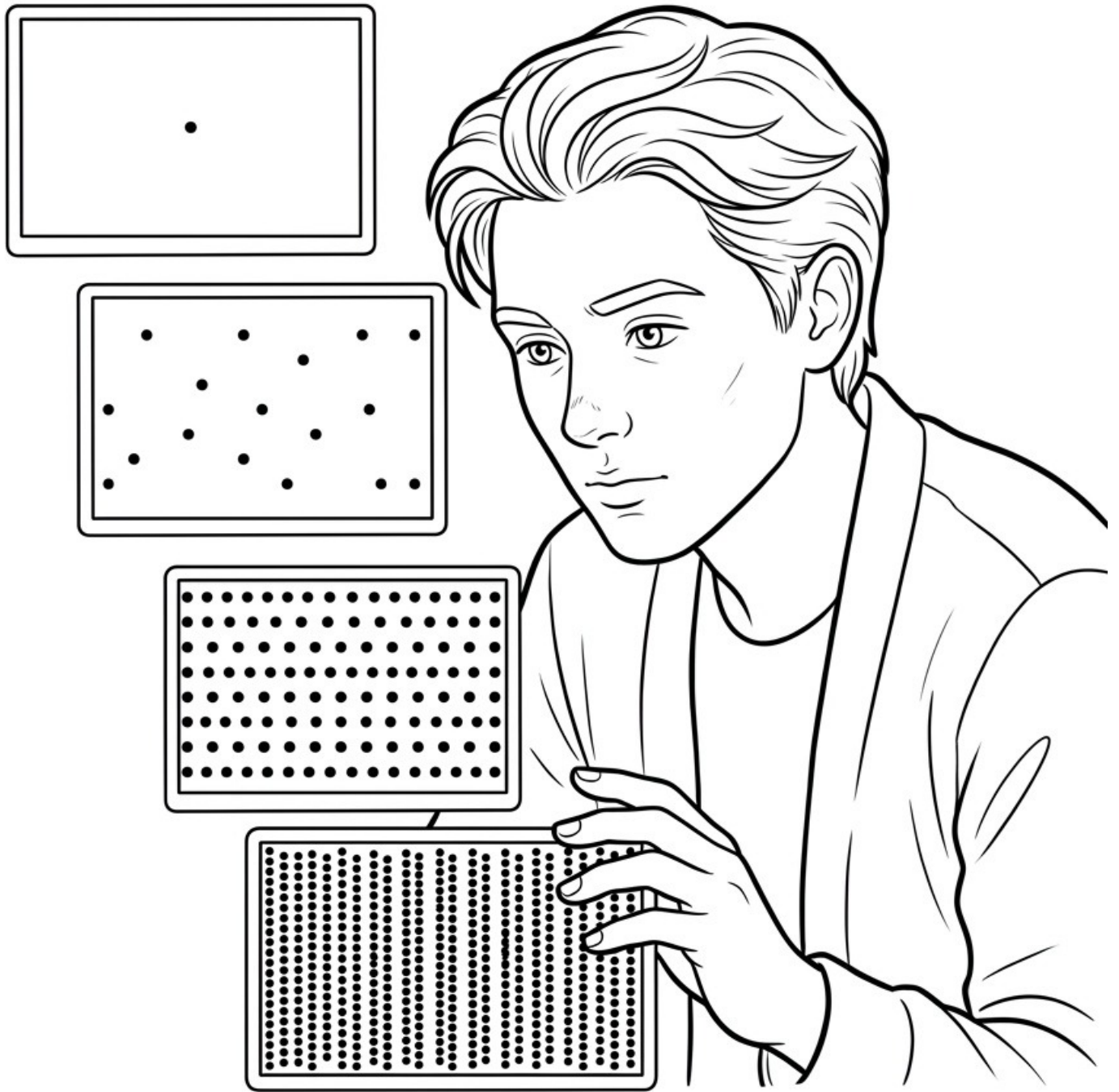
But light can also
arrive in individual
packets, almost like
drops of rain.



Tiny quantum things can show wave-like
behavior and particle-like behavior.
Nature does not have to fit our everyday boxes.

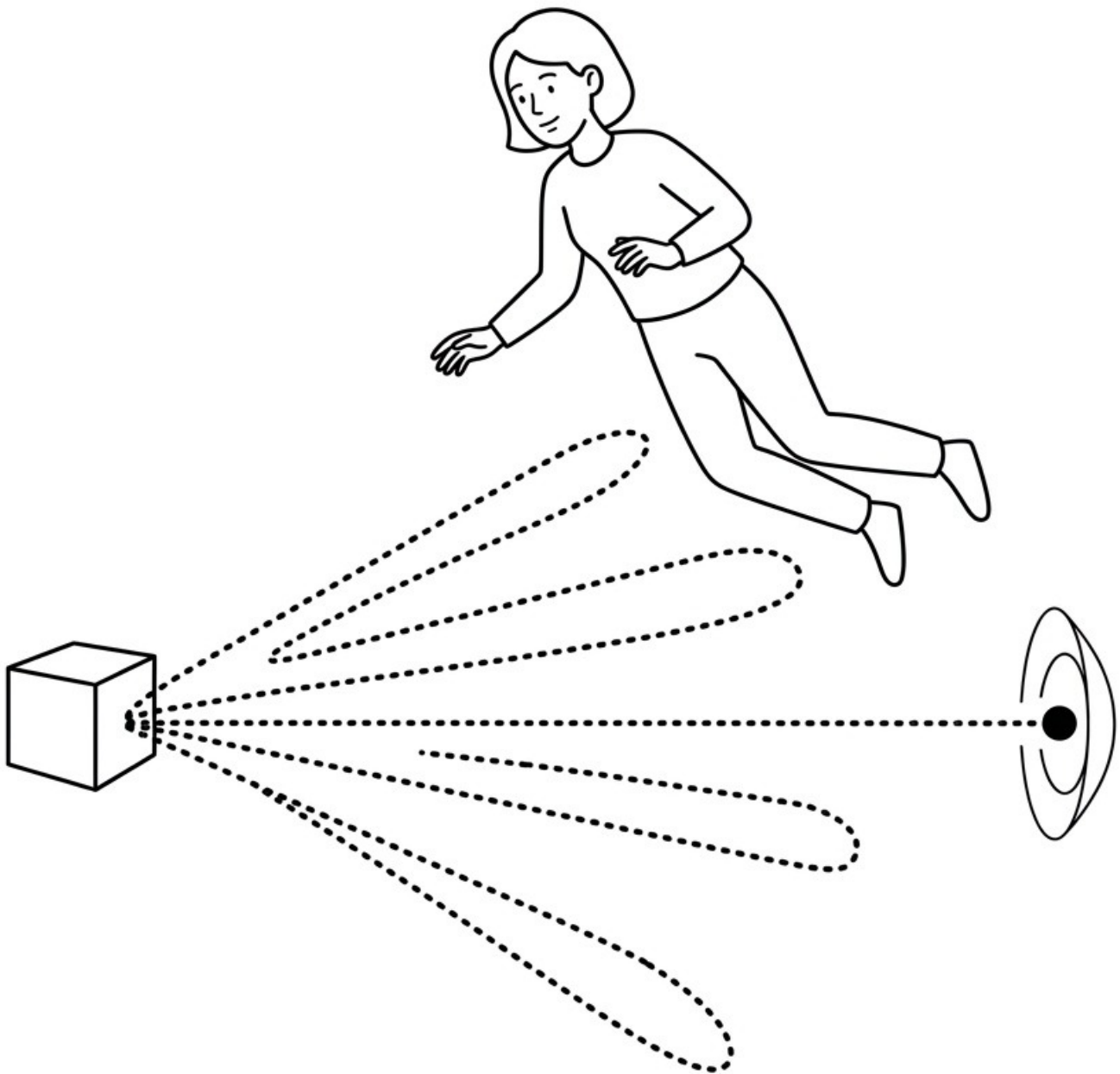
Send tiny quantum objects through two openings and something surprising appears: a wave-like pattern.

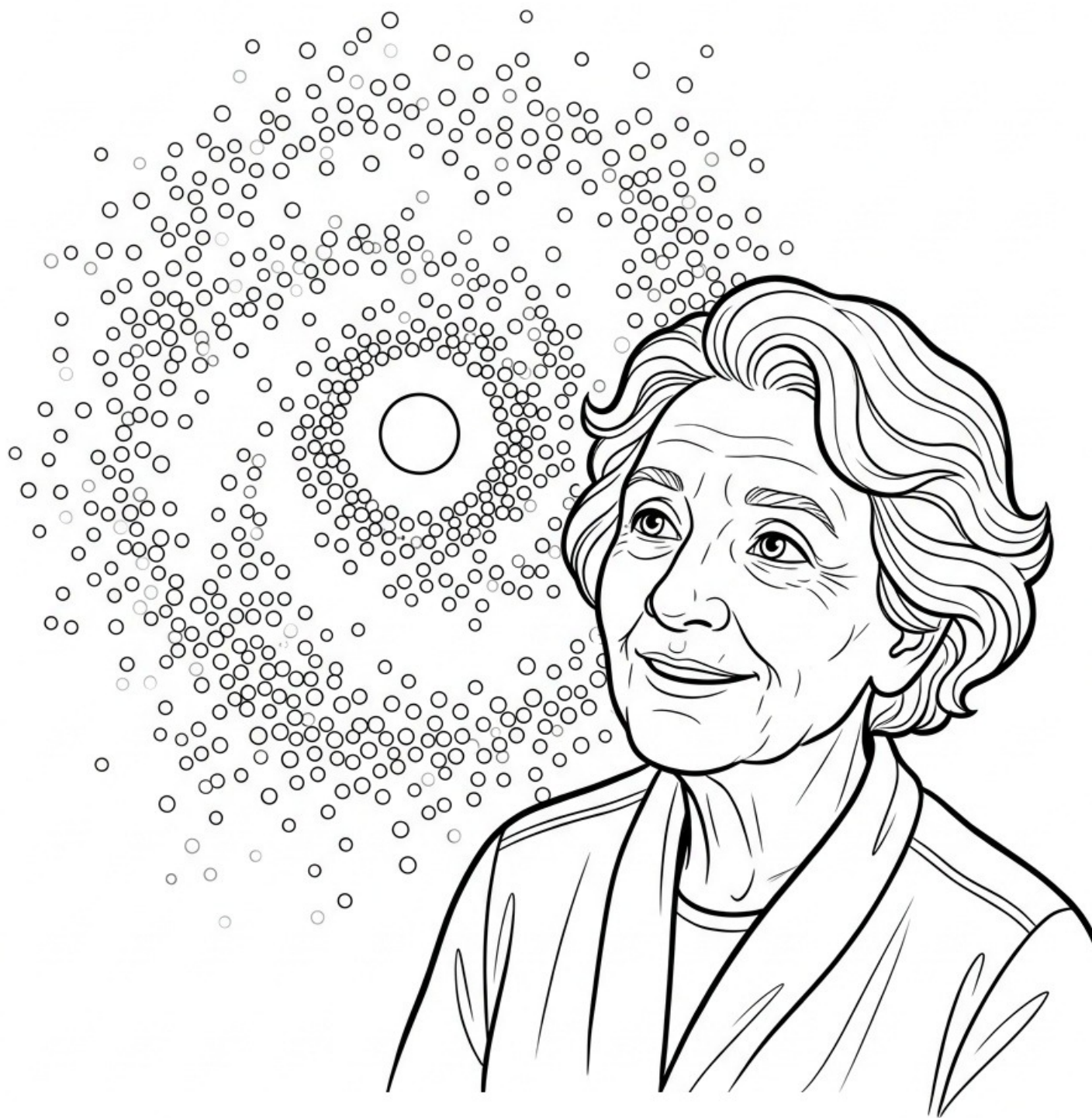




Even when they arrive one at a time,
many quantum events can slowly
build a wave-like pattern.

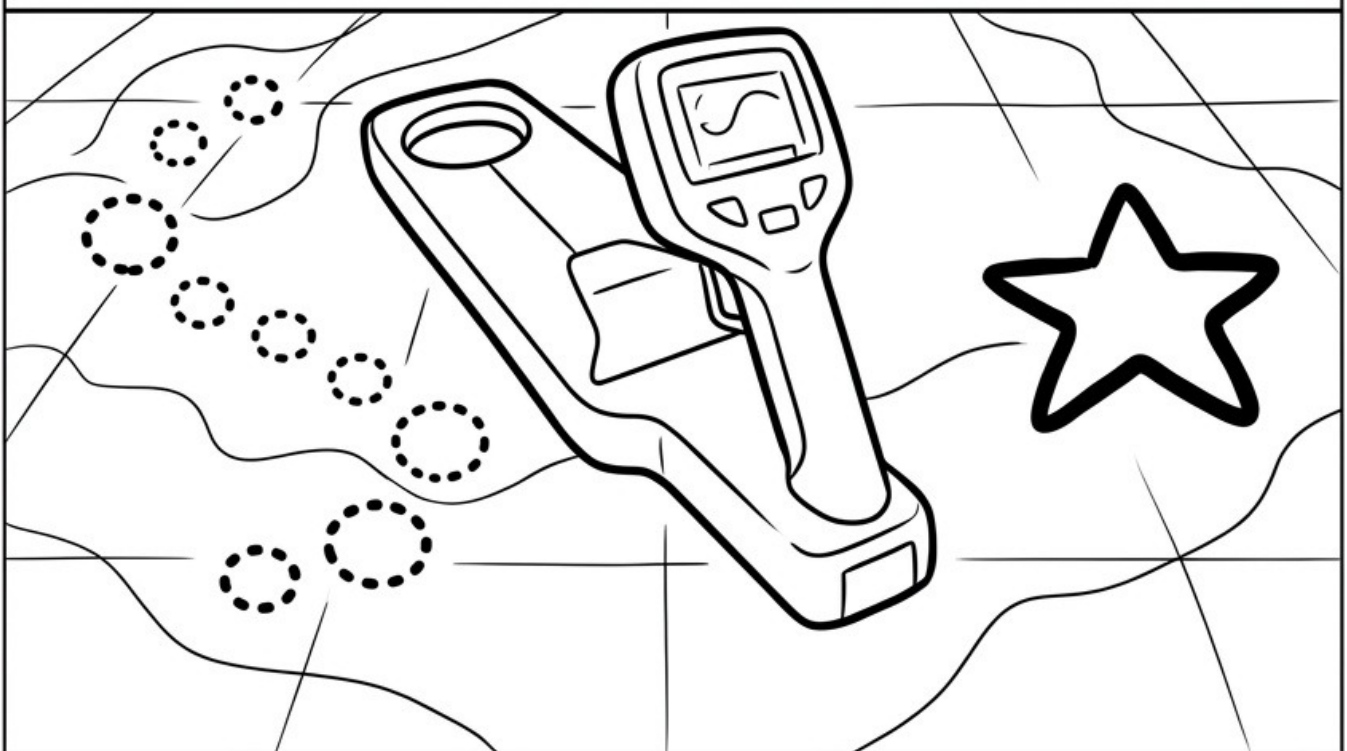
Before we measure, quantum physics tells us
the different results that might happen
and how likely they are.





An electron does not simply circle the nucleus like a tiny planet. Quantum physics gives us a cloud of where it may be found.

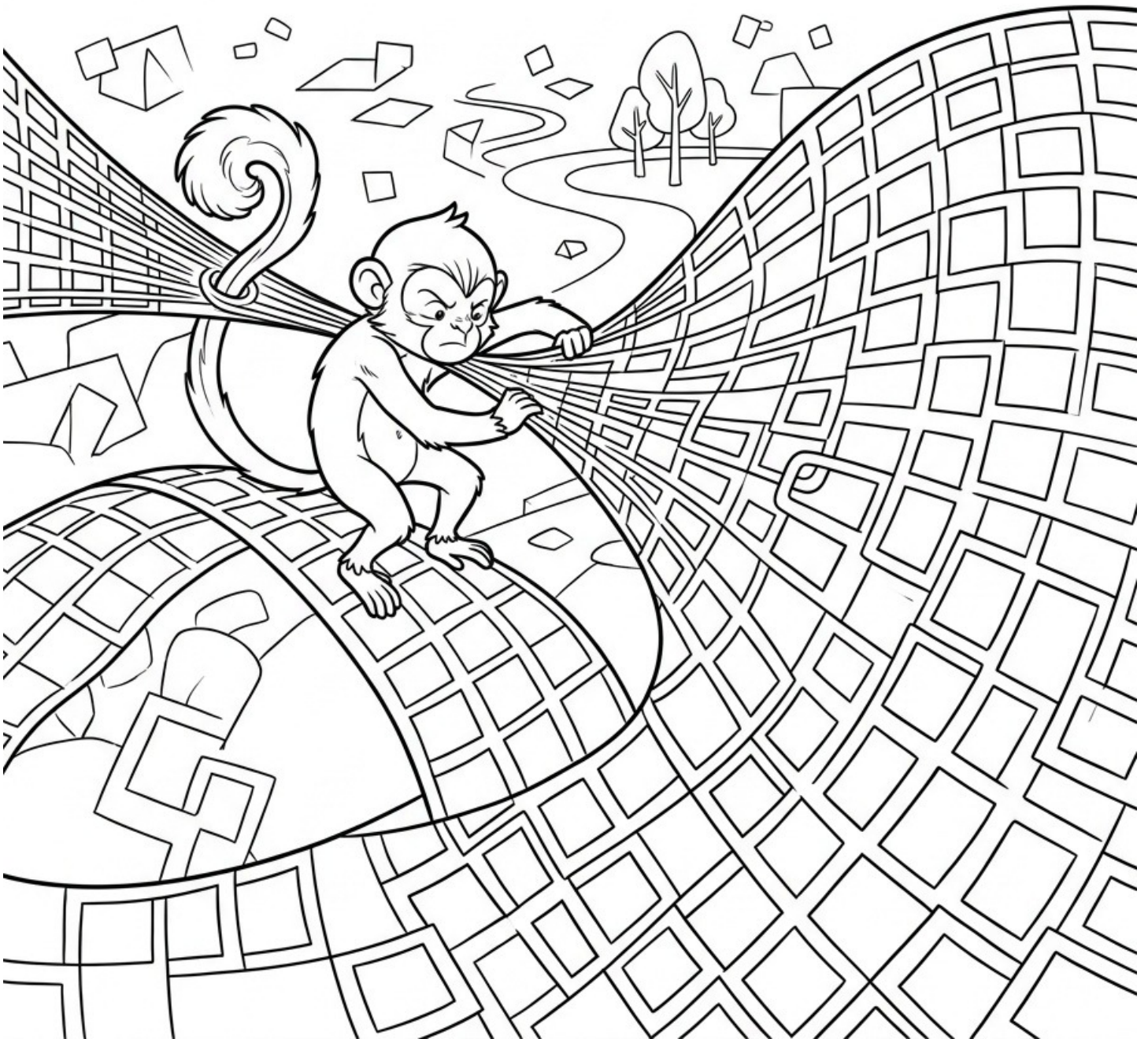
Quantum physics may describe many possible
results. A measurement gives us
one actual result.



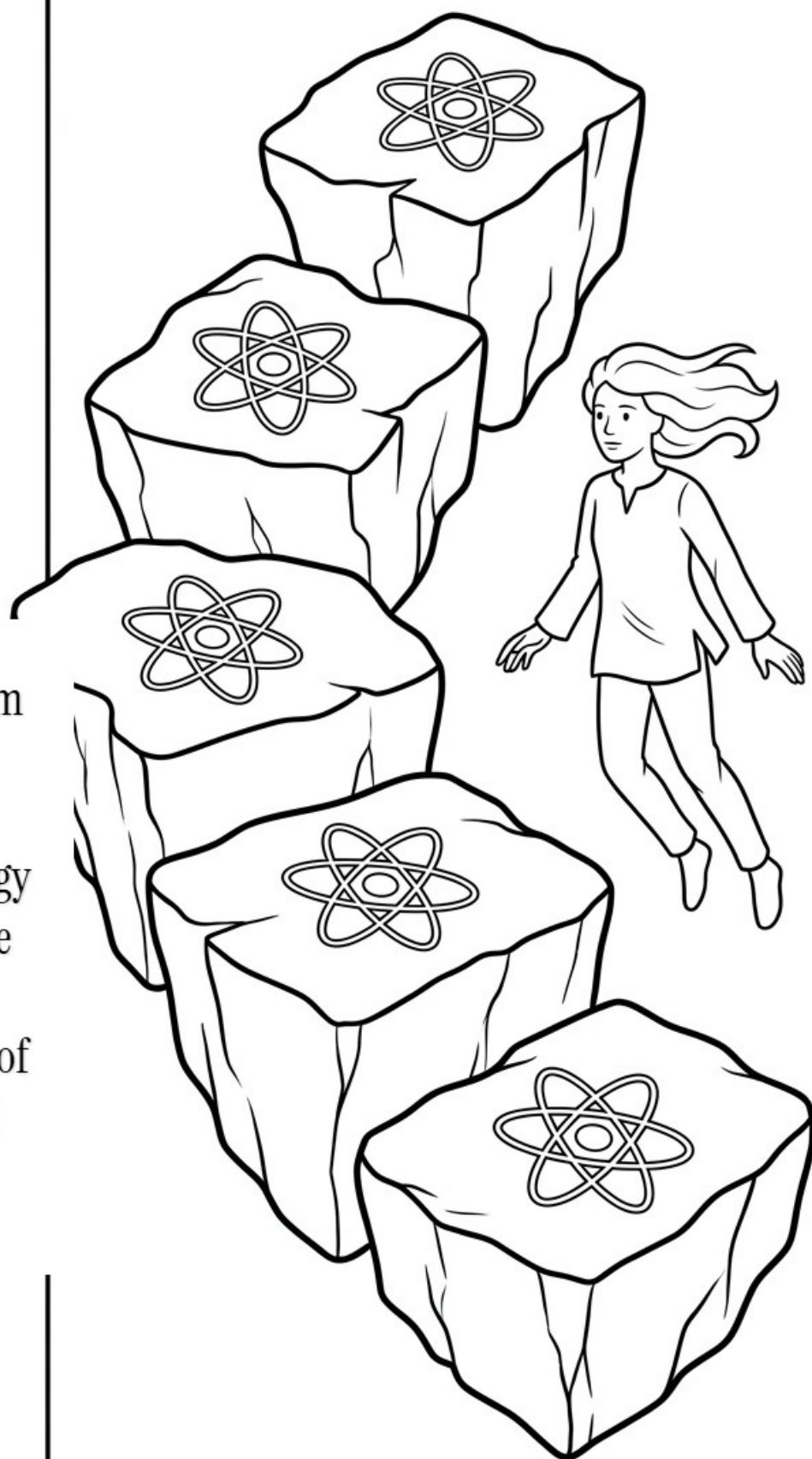


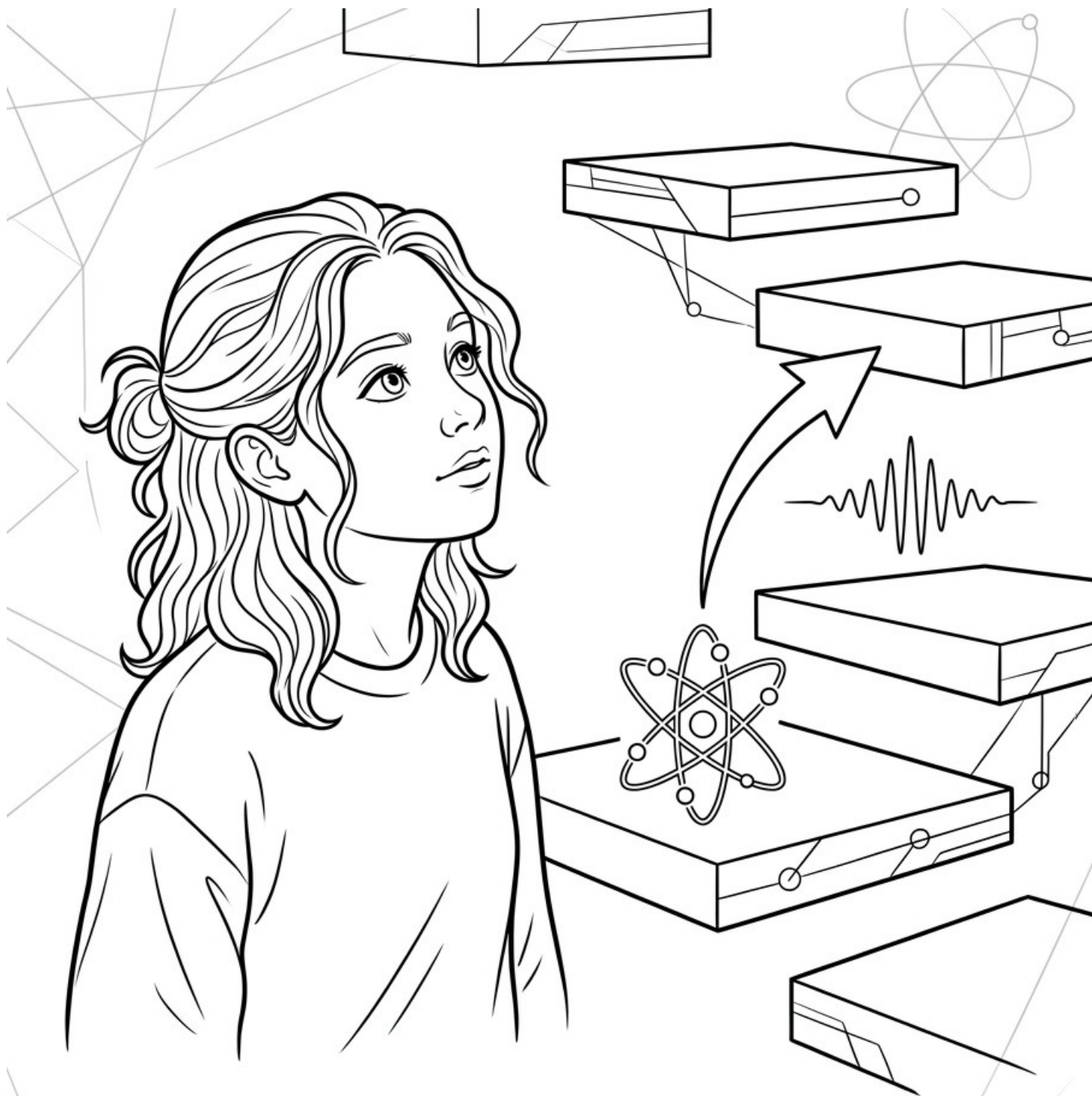
The more precisely we know some quantum properties, the less precisely we can know certain others.

Quantum uncertainty is not just a mistake
in our tools. It is built into how
the tiny world works.

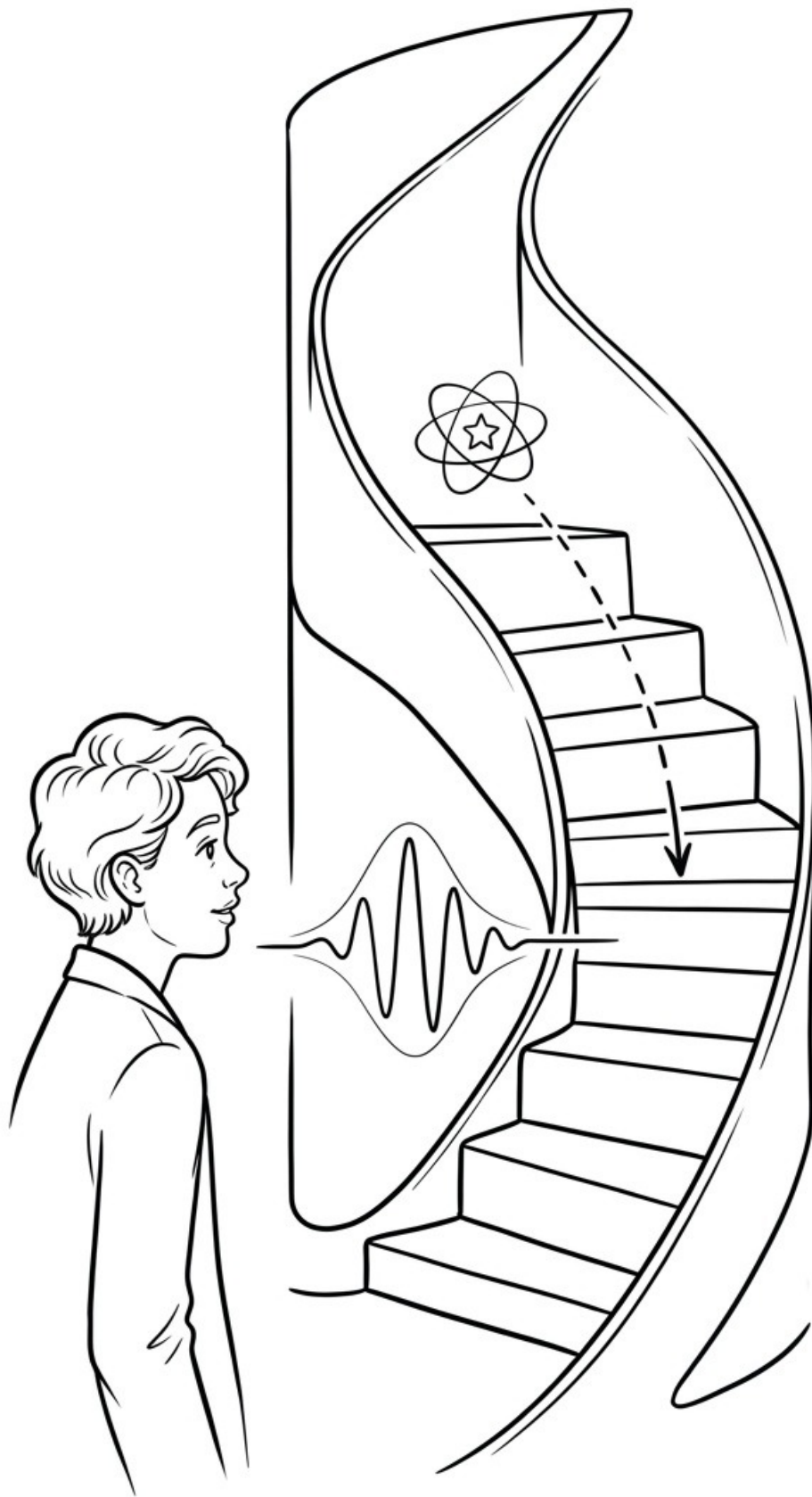


In some quantum systems, only certain amounts of energy are allowed, like standing on steps instead of anywhere on a ramp.

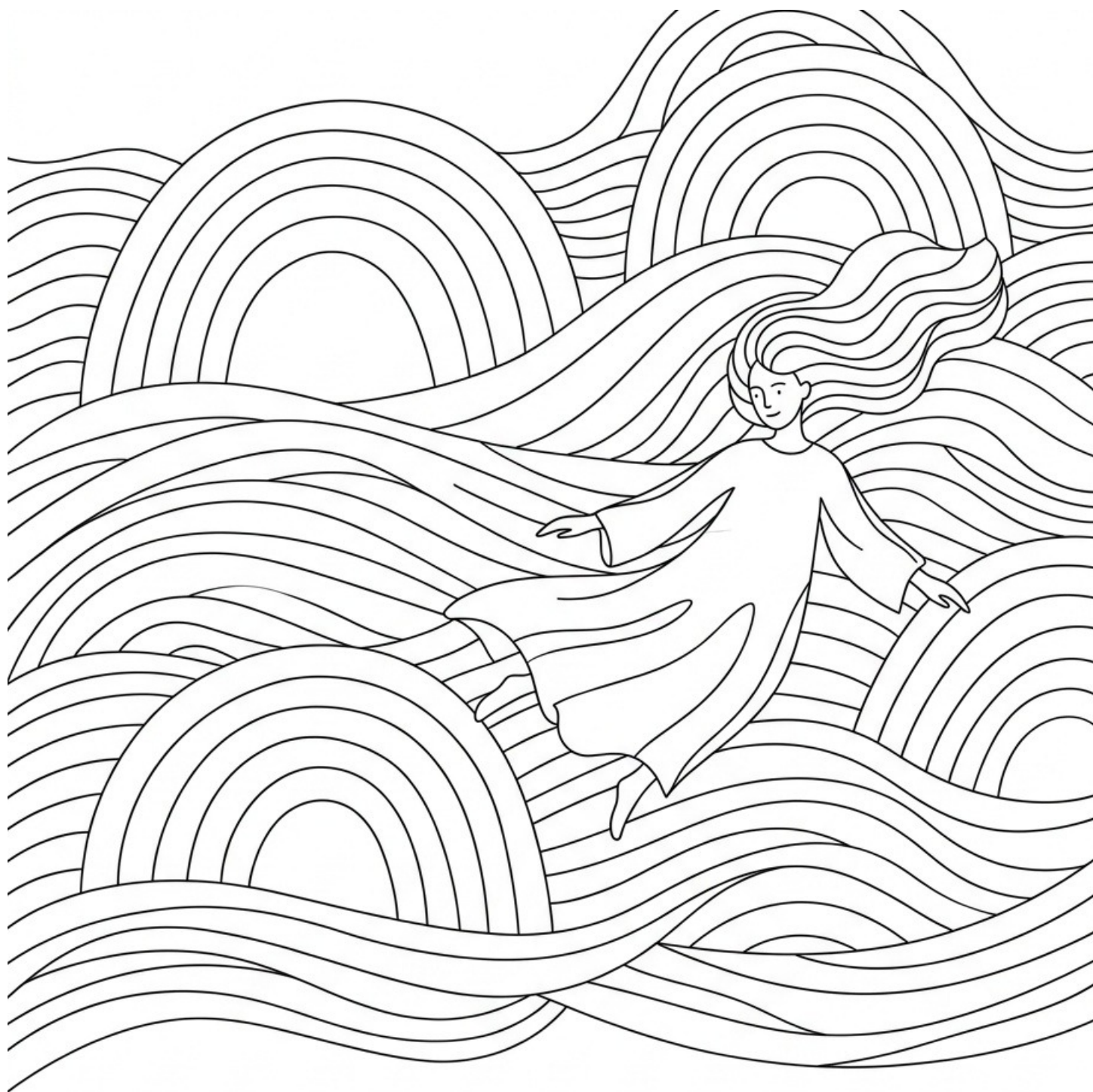




A quantum system can change from one allowed energy level to another. Physicists call this a quantum transition.

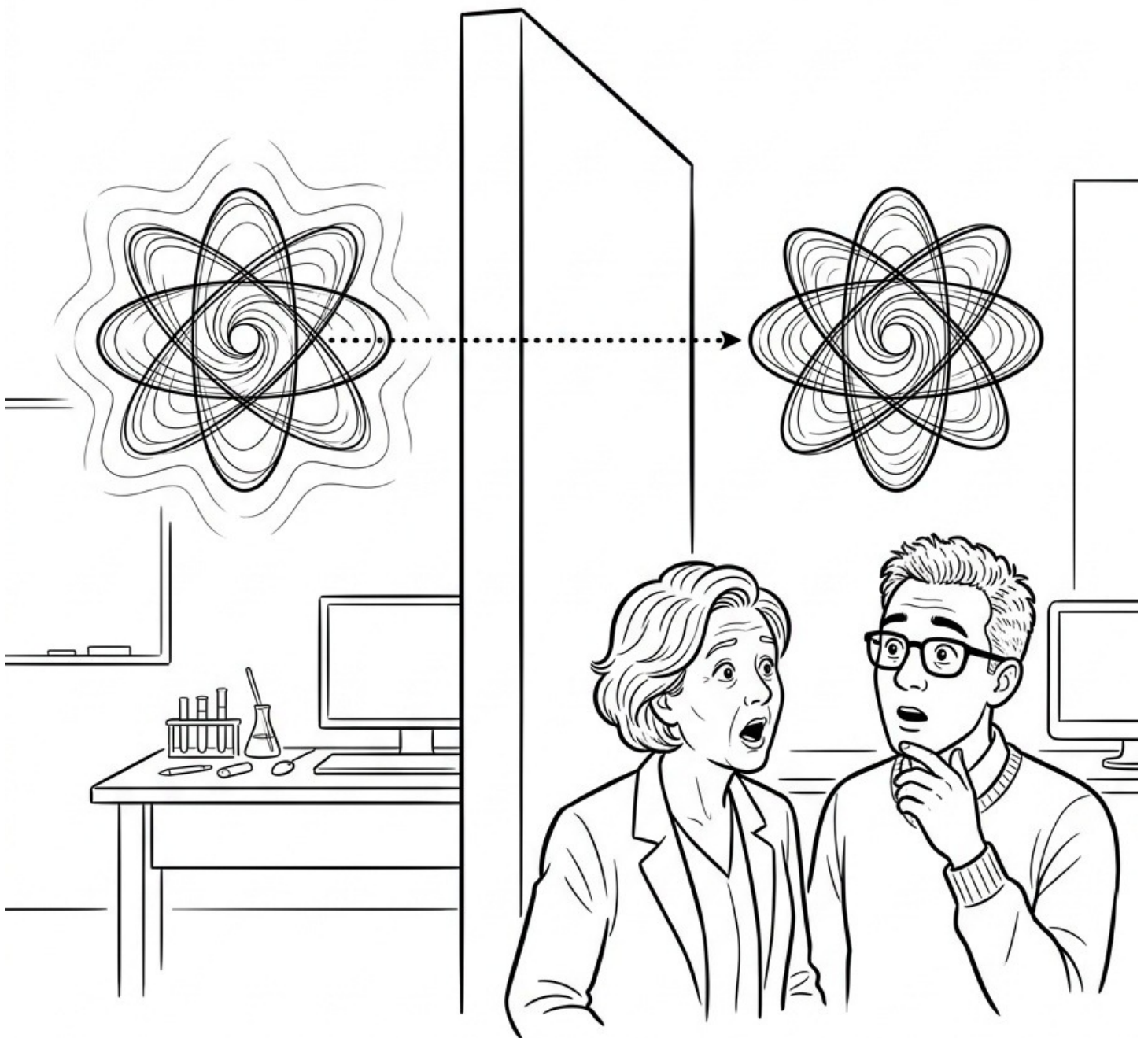


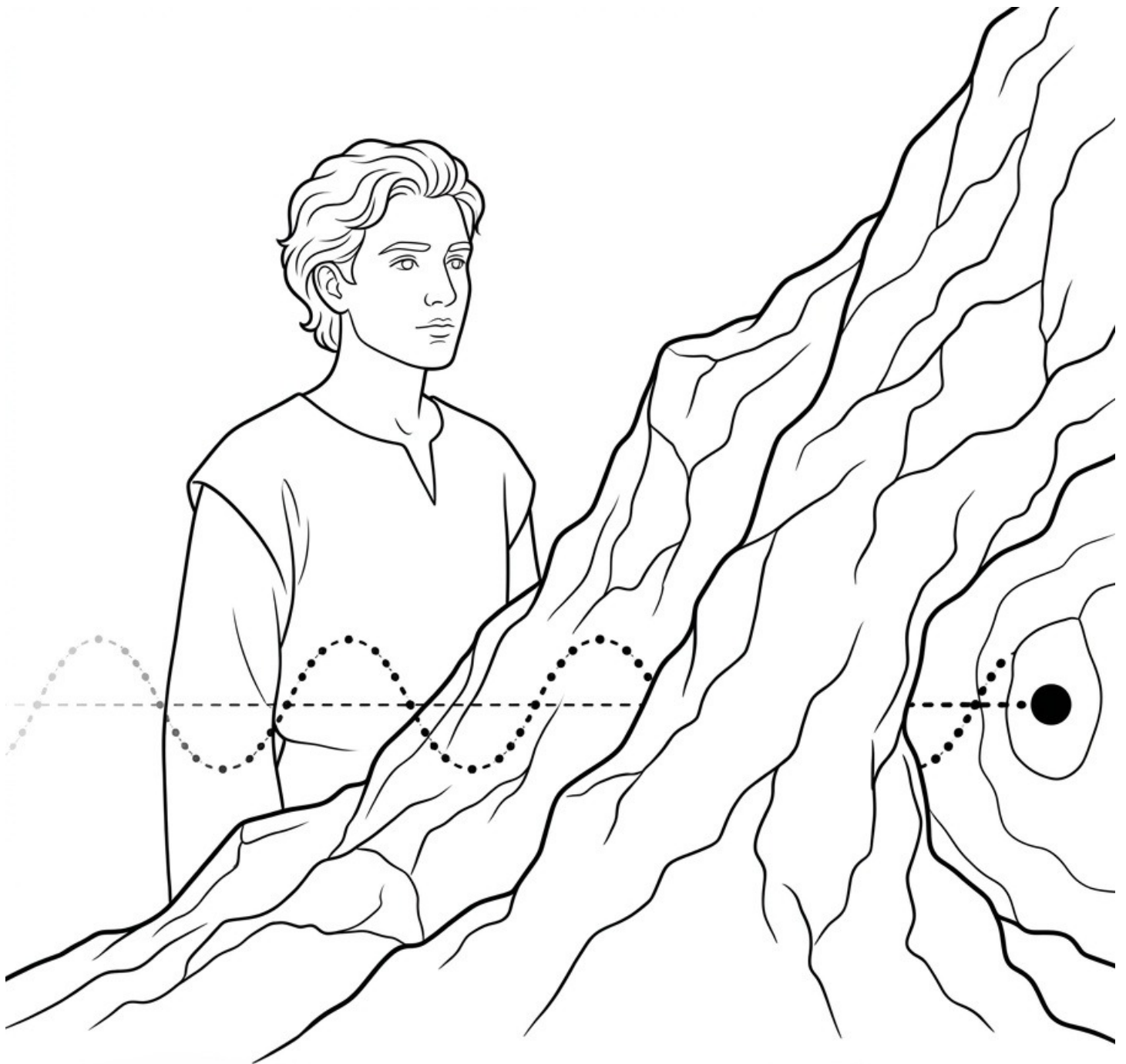
When an atom loses the right amount of energy, it can release that energy as a photon of light.



Different kinds of visible light carry different amounts of energy. That is part of why we see different colors.

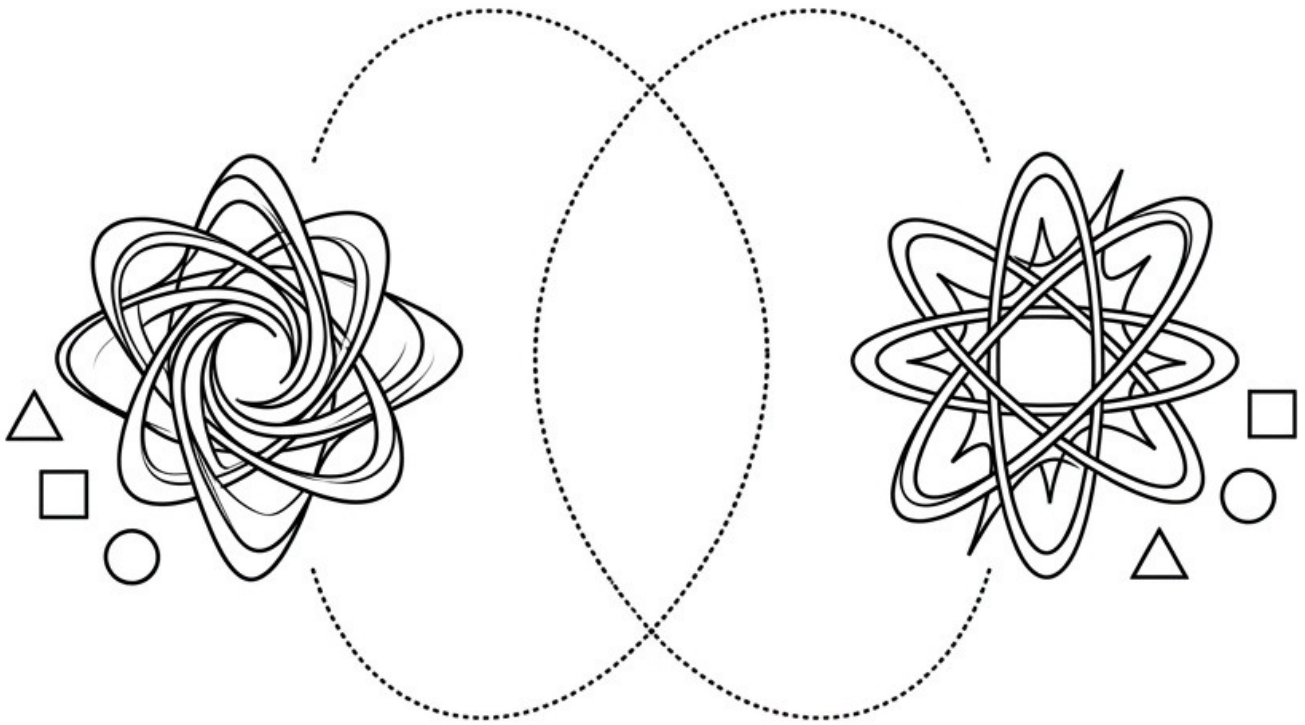
A quantum object can sometimes be found
on the other side of a barrier that
classical physics says it should not cross.





Nothing drills a hole through the wall.
The quantum description extends through
the barrier, making an outcome on the far side possible.

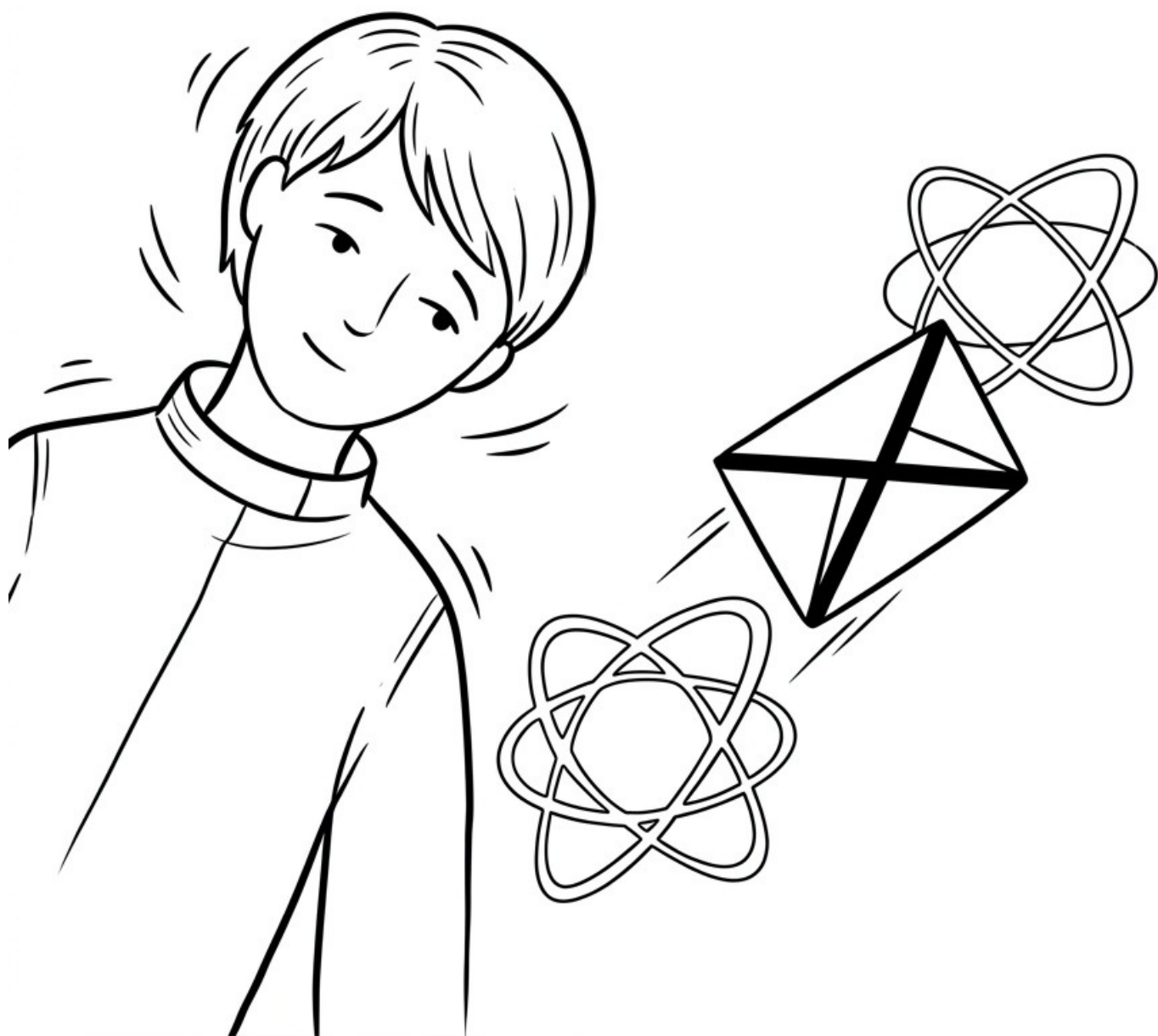
Two quantum systems can become entangled
so their measurement results are connected
in ways ordinary objects cannot copy.

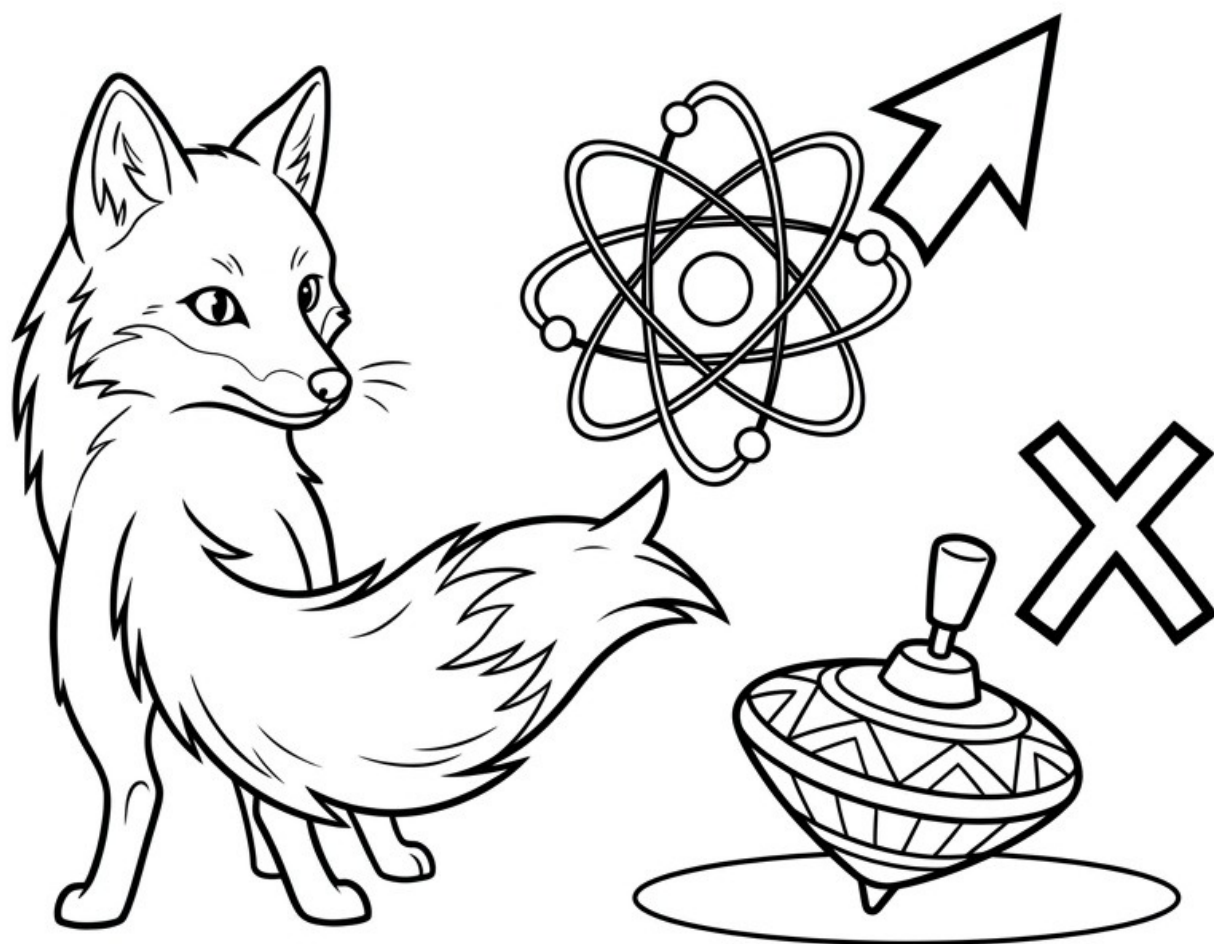




Entangled quantum systems can show connected results even when they are very far apart.

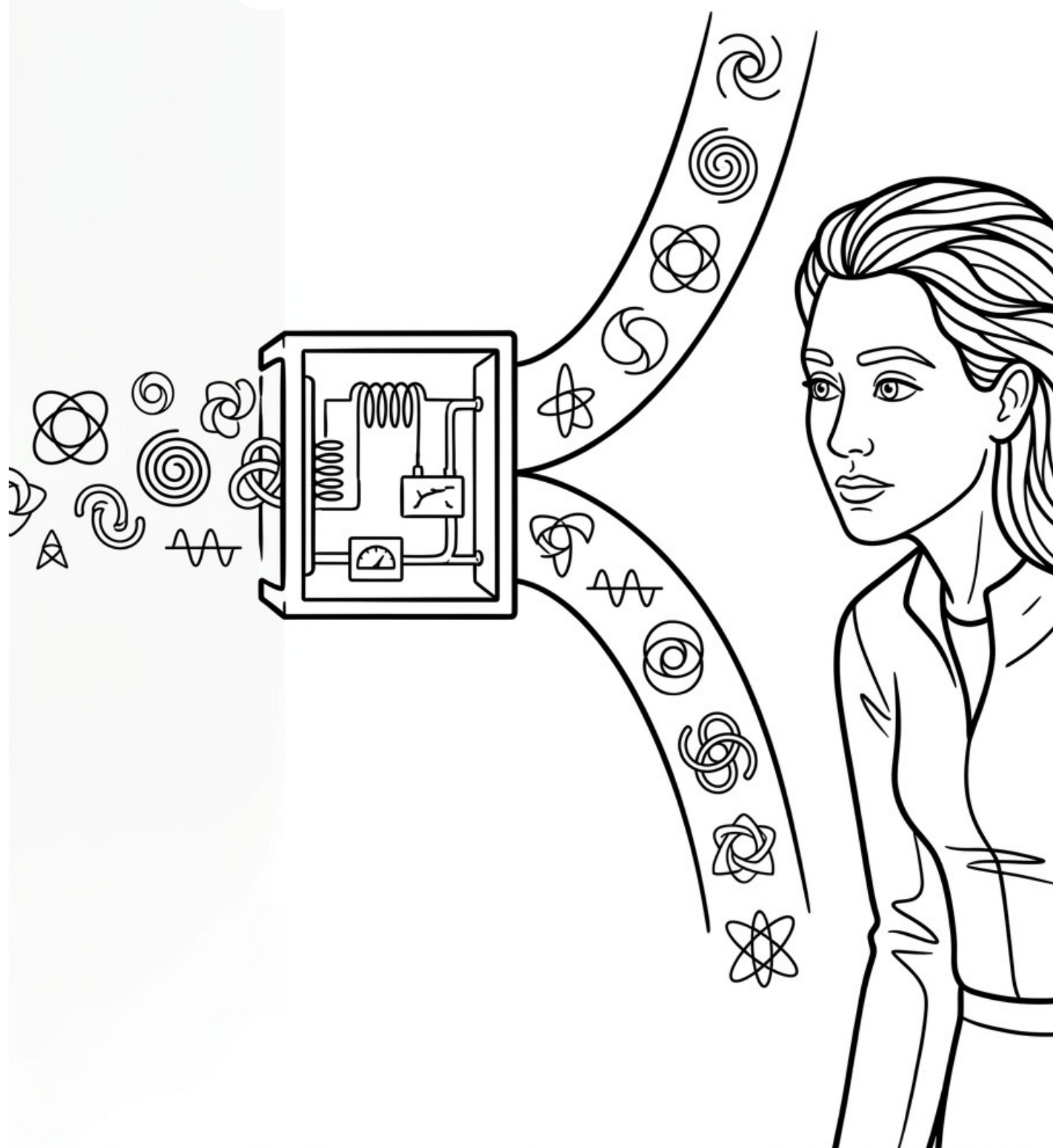
Entanglement is strange, but it does not
let us send ordinary messages
faster than light.

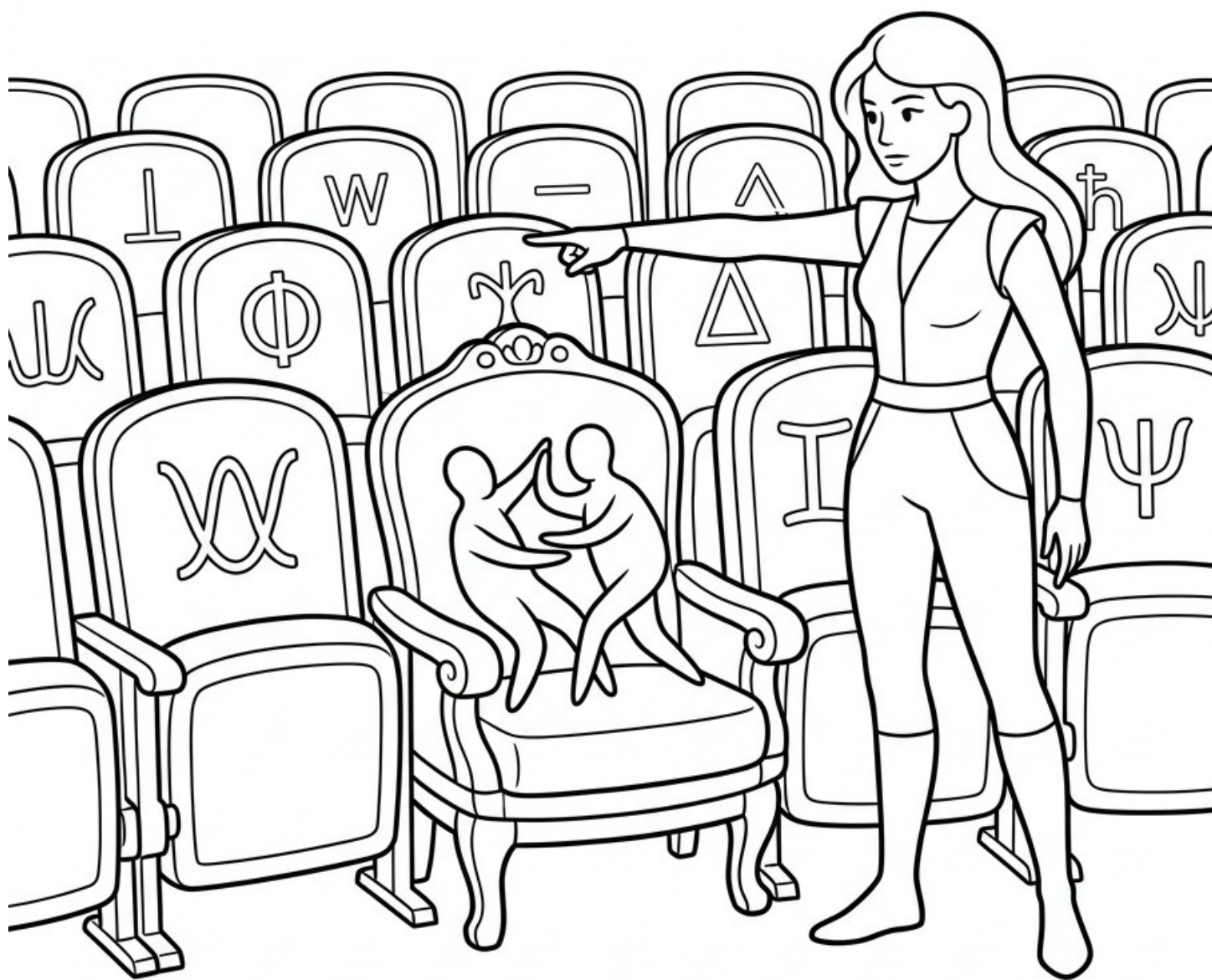




Particles have a quantum property called spin.
The name sounds familiar, but they are not
simply tiny balls spinning like tops.

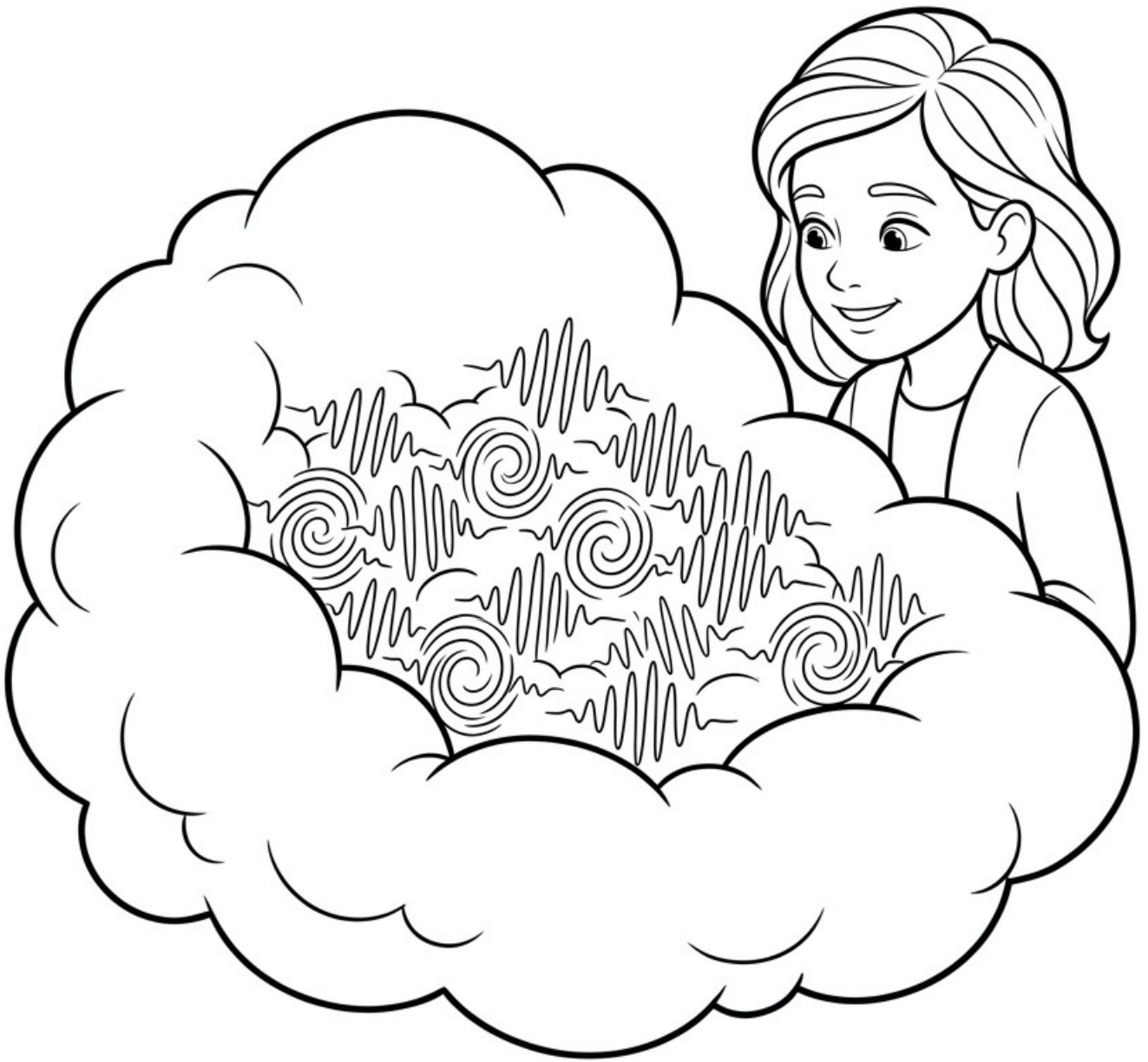
When we measure certain kinds of spin,
nature gives us specific allowed results.

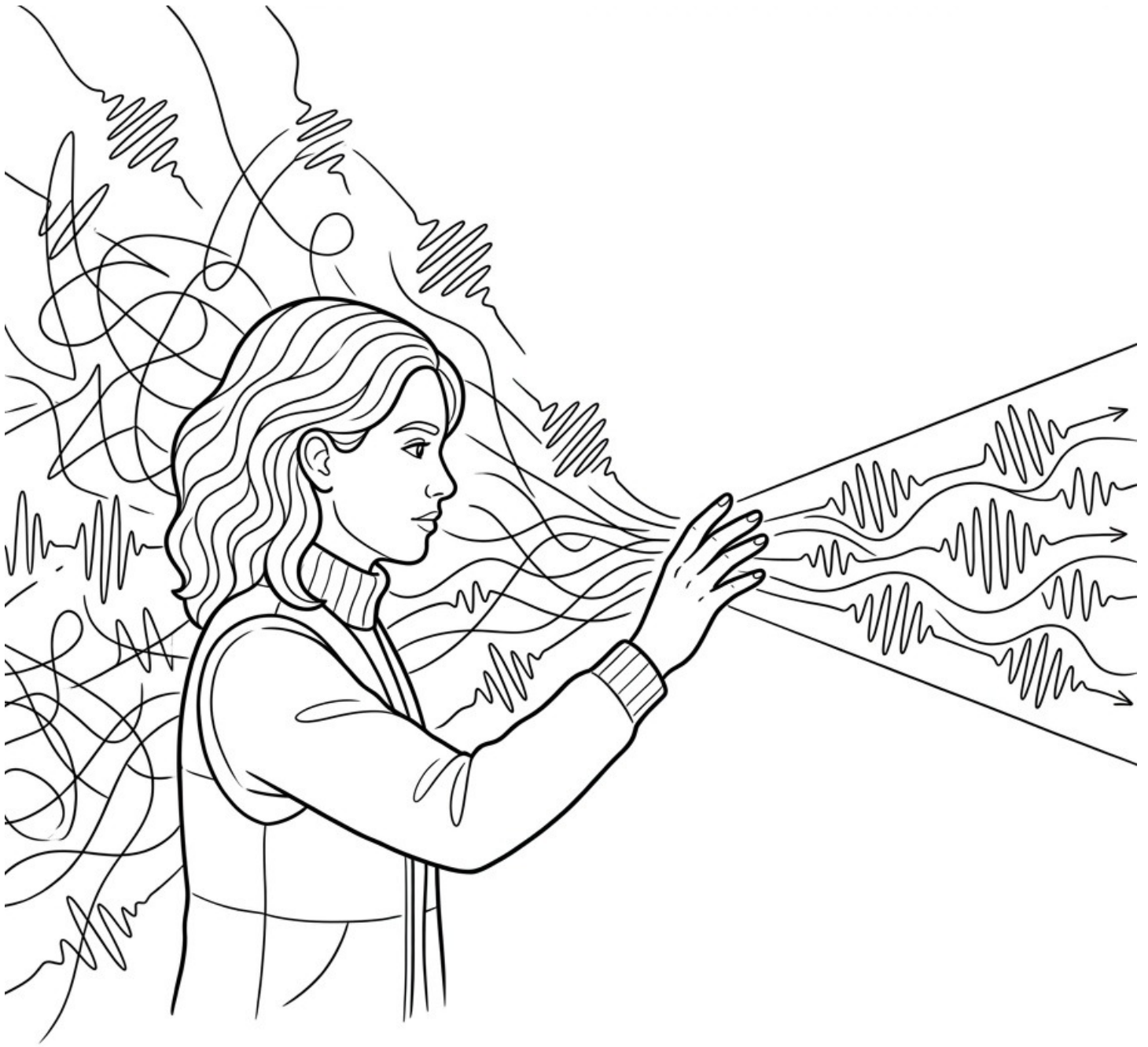




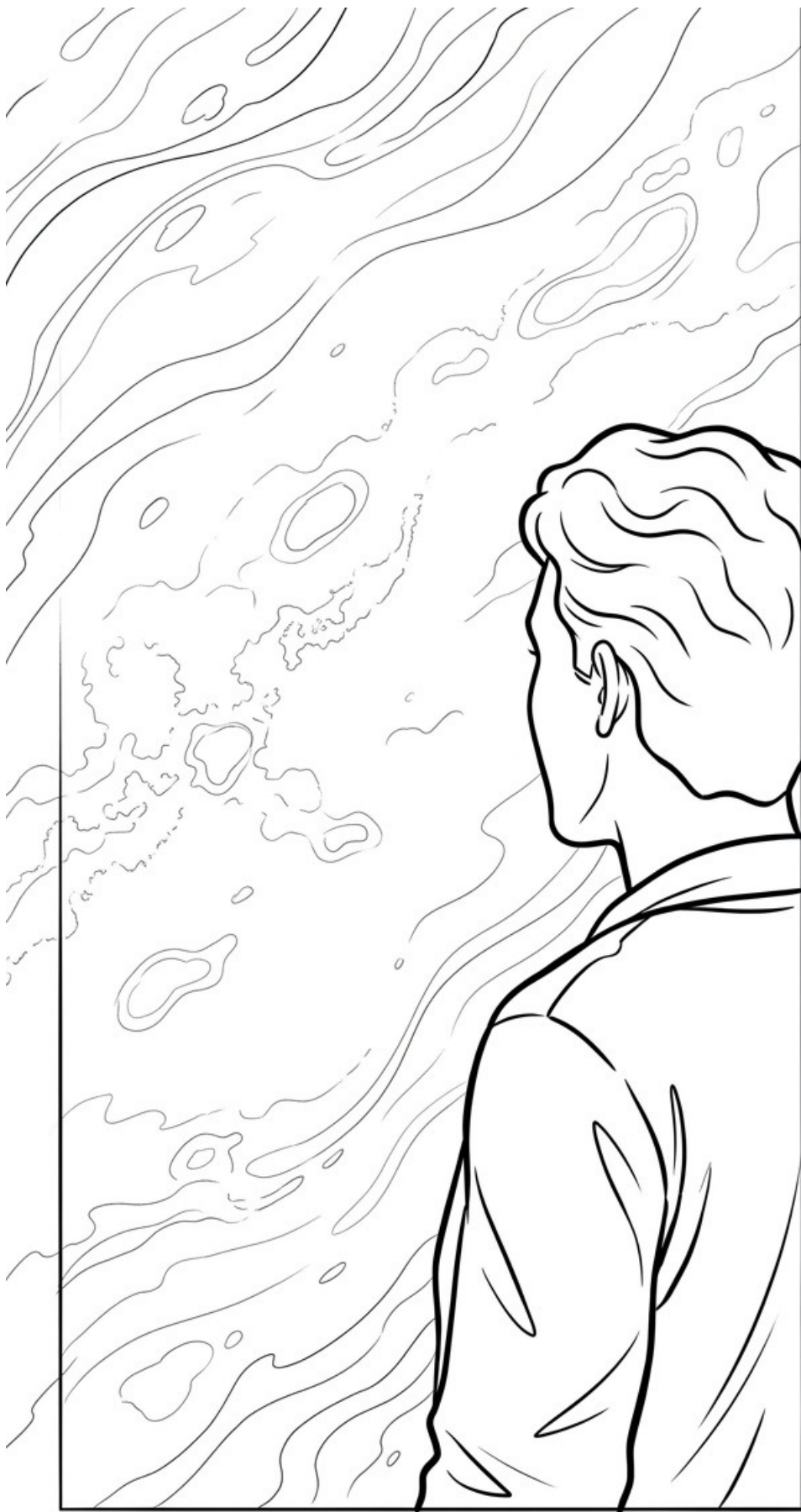
Some kinds of particles cannot share
exactly the same quantum state.
It is like having very strict seating rules.

Other particles, called bosons,
can happily share the same
quantum state.



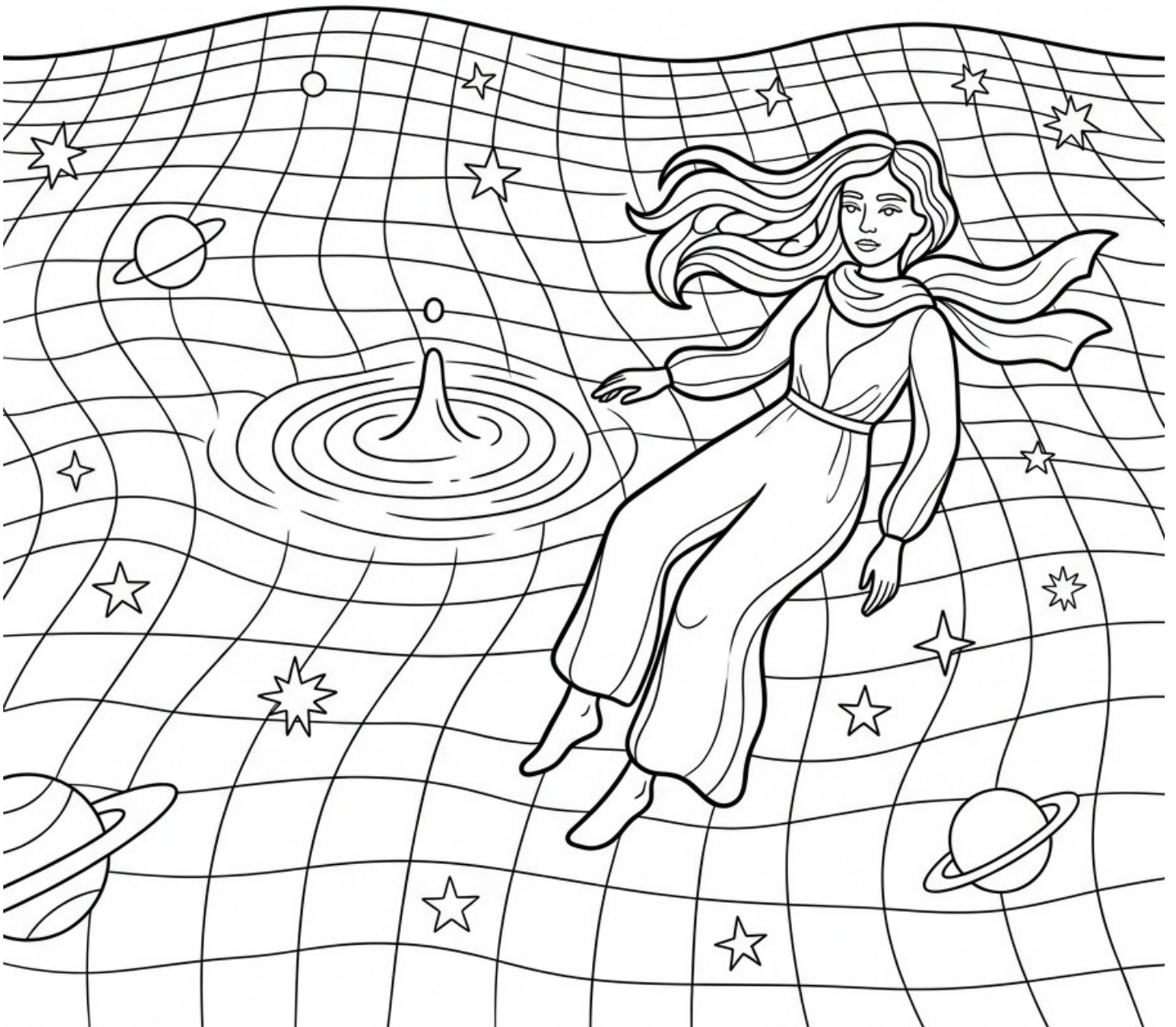


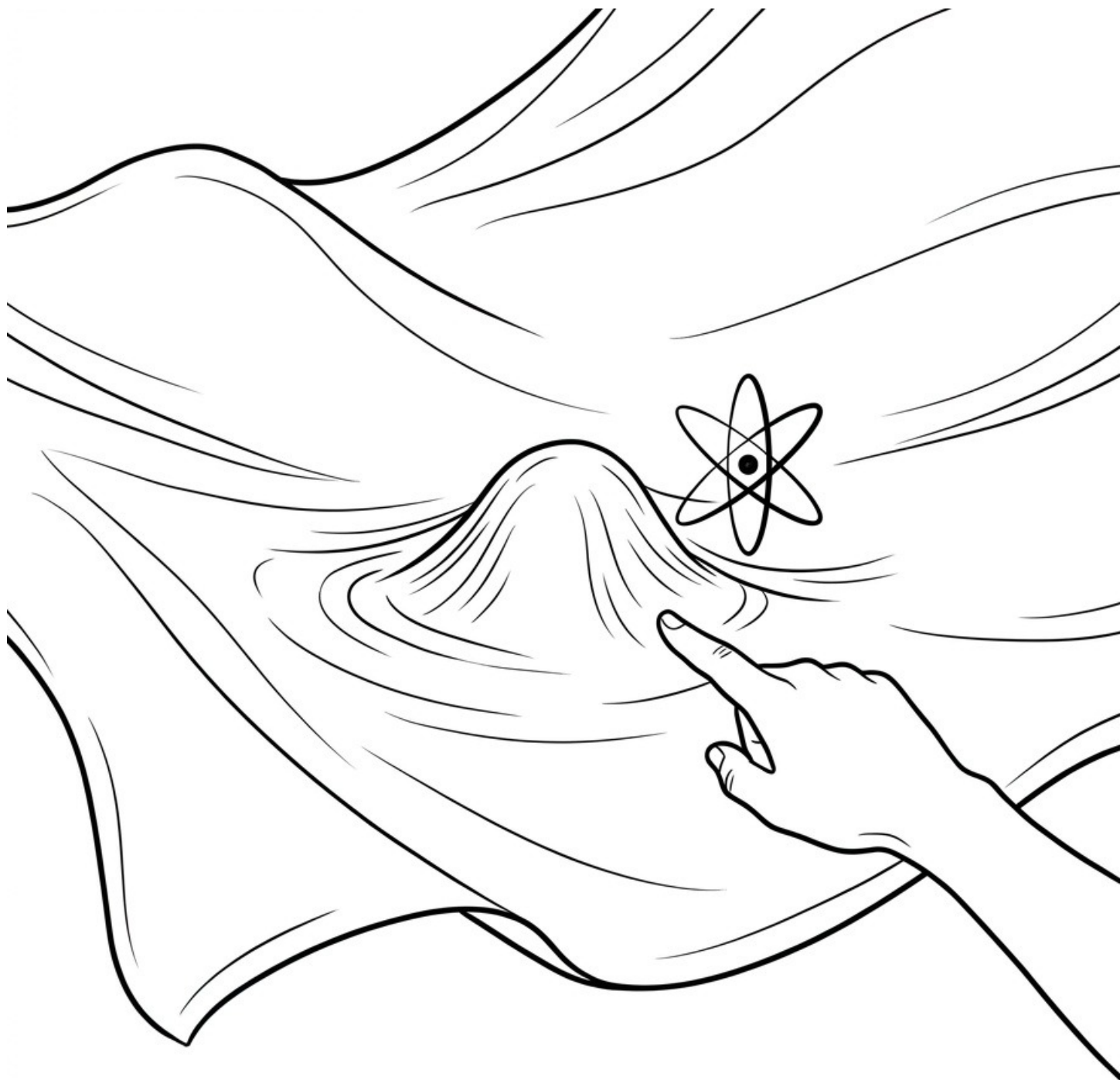
A laser organizes light so many photons
travel together in a remarkably
orderly beam.



Even the
lowest-energy
quantum state
is not quite the same
as ordinary
empty nothingness.

Modern quantum physics describes fields that exist throughout space. What we call particles can be excitations of those fields.

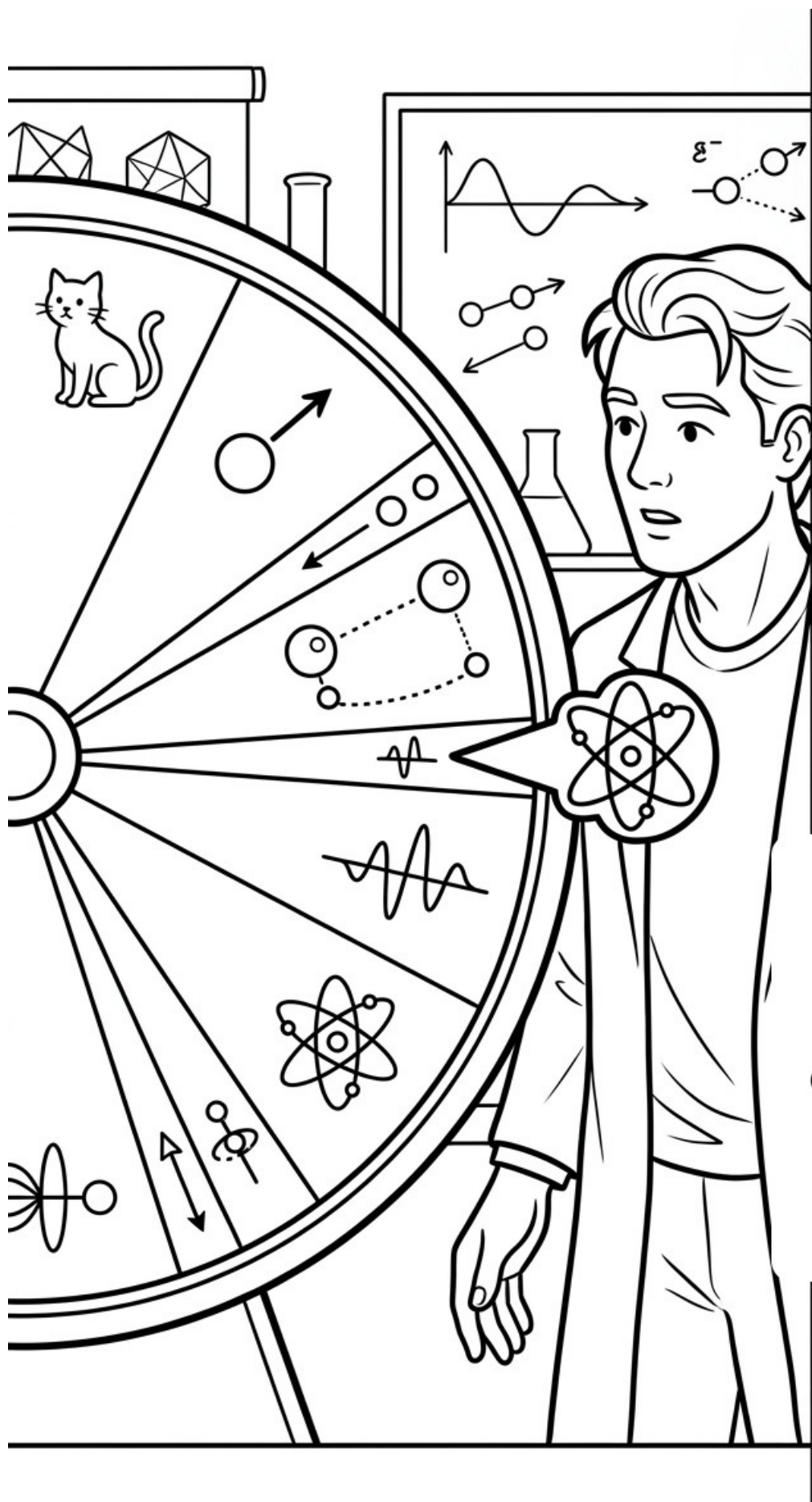




One way to picture a particle is as a little packet of excitement in a quantum field.

Quantum physics is strange, but it is not random nonsense. It follows precise rules that make astonishingly accurate predictions.



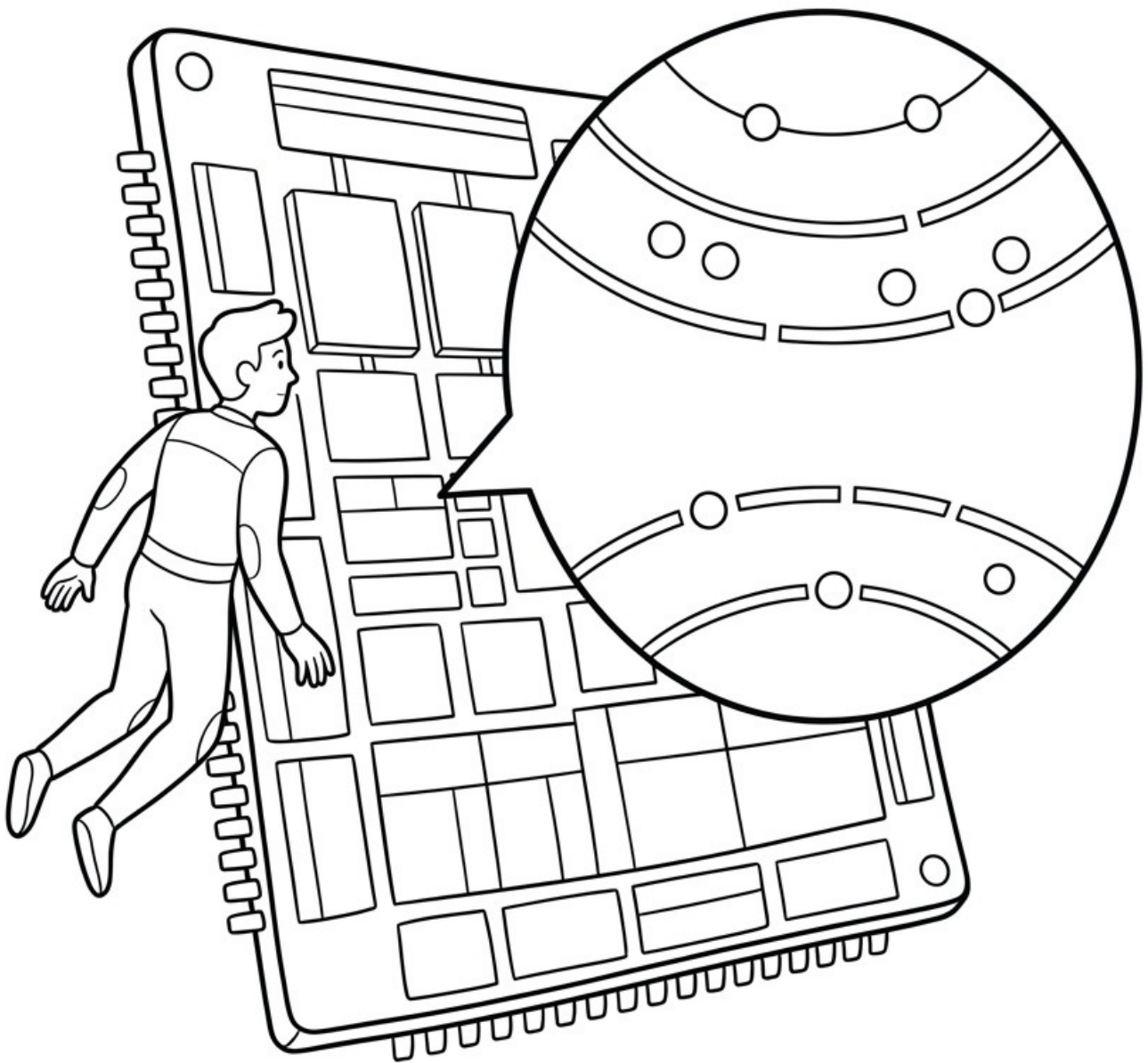


Quantum physics
uses probability,
but different
outcomes can have
very different
chances.

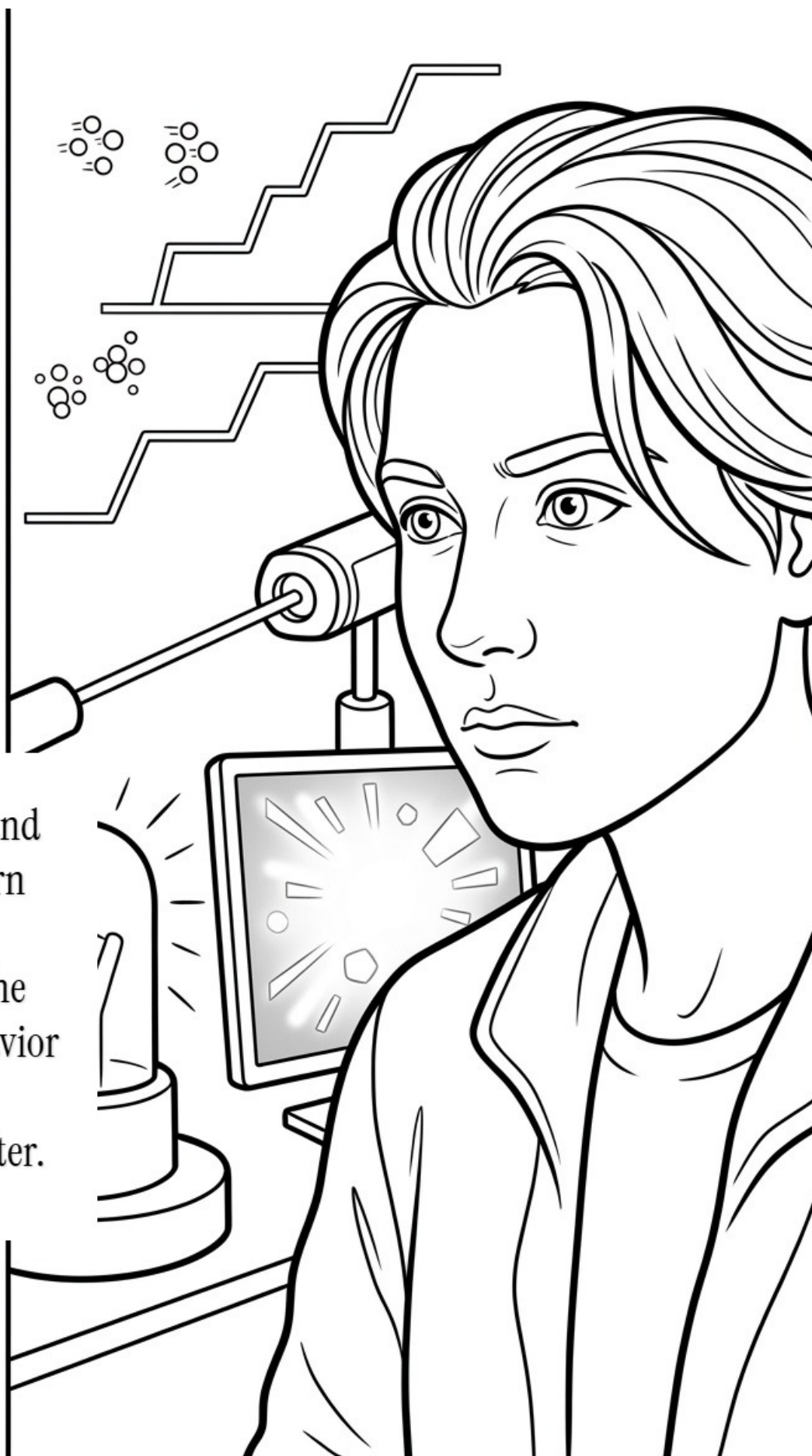


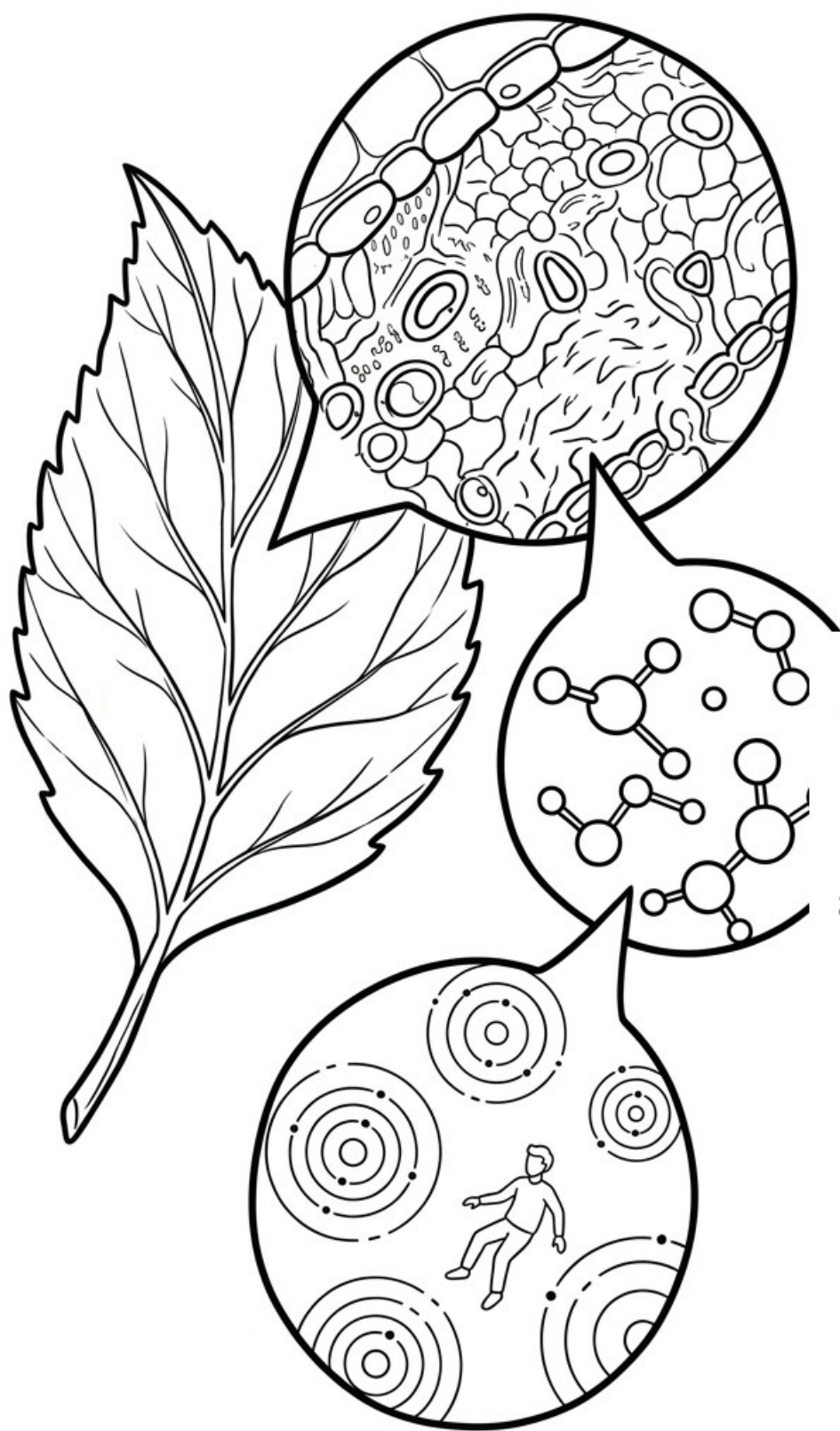
The strange quantum rules never disappear,
but huge numbers of particles together
create the ordinary world we know.

Computers and phones work because engineers understand how electrons behave inside materials.



LEDs, lasers and
many modern
displays
depend on the
quantum behavior
of
light and matter.





Quantum rules help
atoms form
molecules,
and molecules make
chemistry possible.
That means the
quantum world is
part of every living
thing.



Quantum physics teaches us something wonderful:
nature does not have to make sense in the
way we expect. We have to learn how nature actually works.



Draw something that could only happen
in The Very Strange Tiny Universe.
There are no wrong colors in a quantum imagination.

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