States of Matter: Solids, Liquids, and Gases

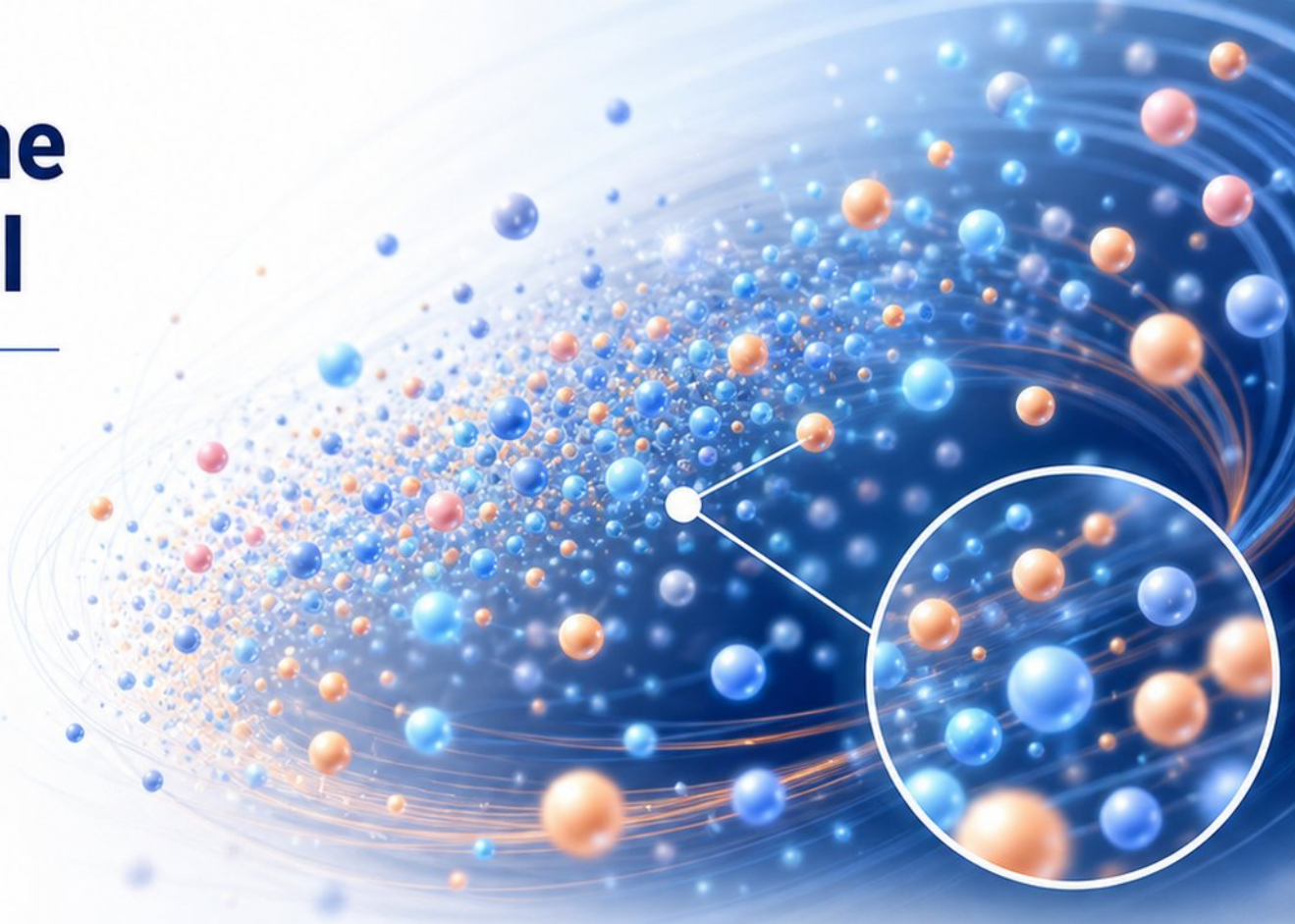
- Welcome—today we'll build a first particle-level model of matter.
- A particle model explains everyday solid, liquid, and gas behaviors.
- Gases are matter, even though they are invisible.
- Roadmap: matter → particle model → three states → compare → state changes → apply.

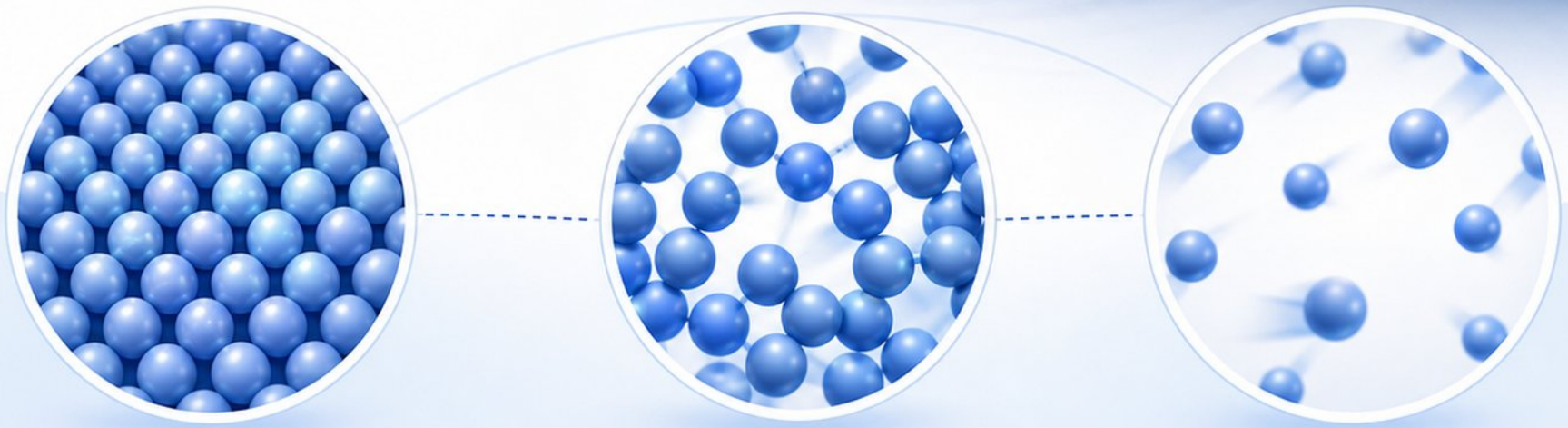
What Is Matter?

- Matter has mass and takes up space
- Light, sound, and energy are not matter
- Common examples: air, water, desk, your body
- Gases are matter, even when invisible

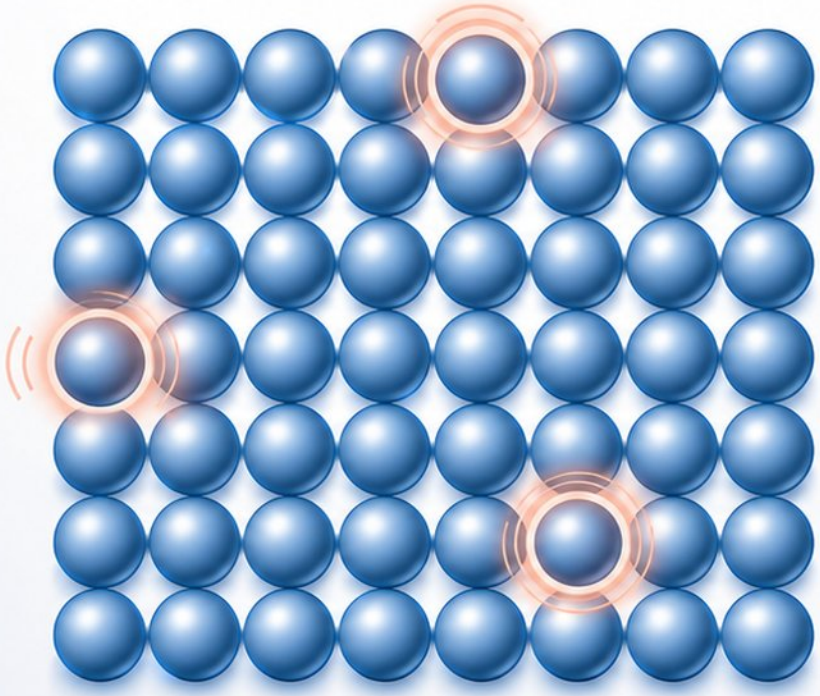
Introducing the Particle Model

- All matter is made of tiny particles too small to see
- Particles are always moving; this is kinetic energy
- There are spaces between particles
- Particles arrange differently to form solids, liquids, or gases





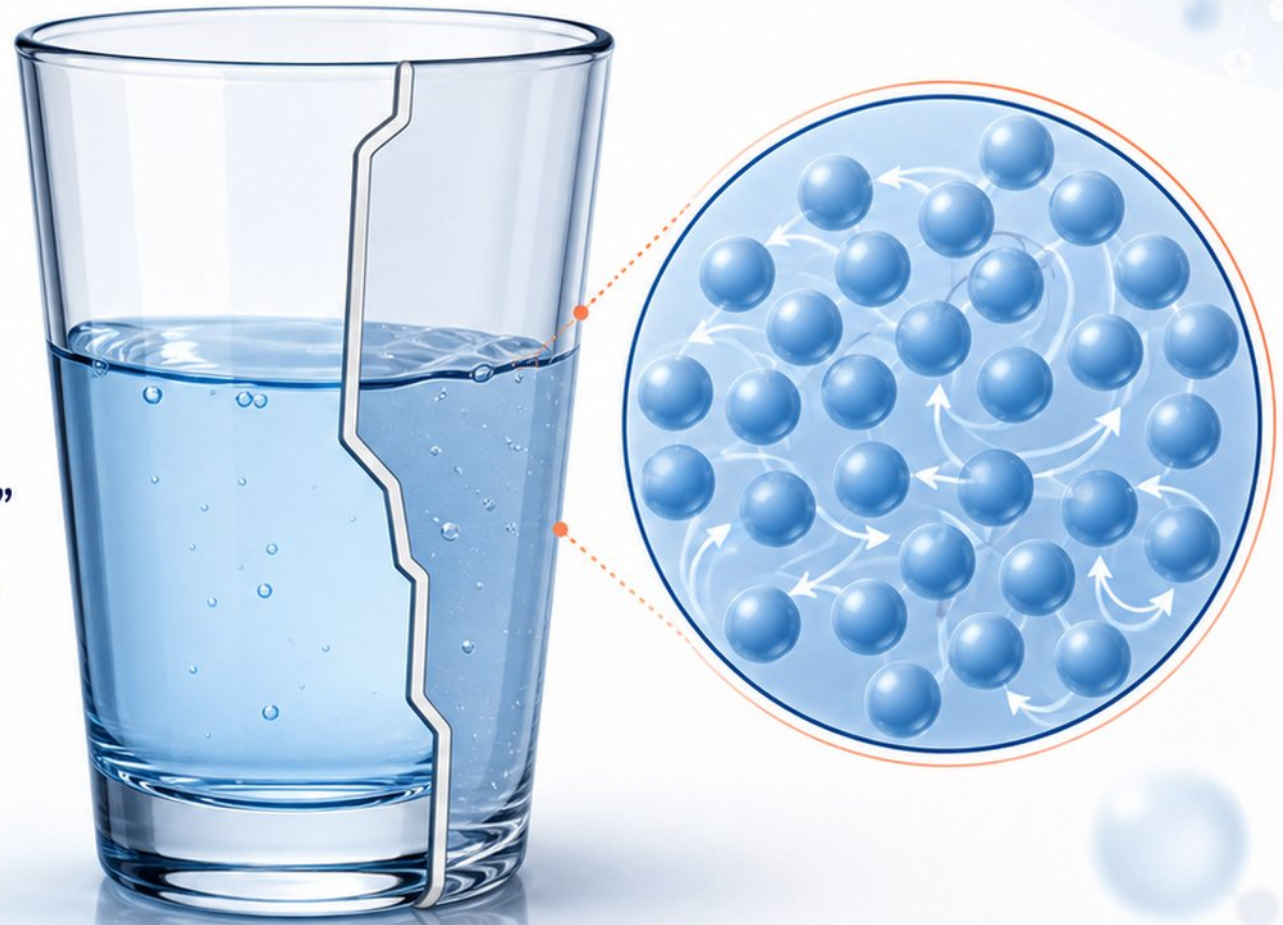
Solids: Fixed Shape and Volume



- Particles tightly packed in a regular, repeating pattern
- Particles vibrate in place; they do not move past each other
- Solids have a definite shape and a definite volume
- Everyday examples: ice, a coin, a chair

Liquids: Fixed Volume, Changing Shape

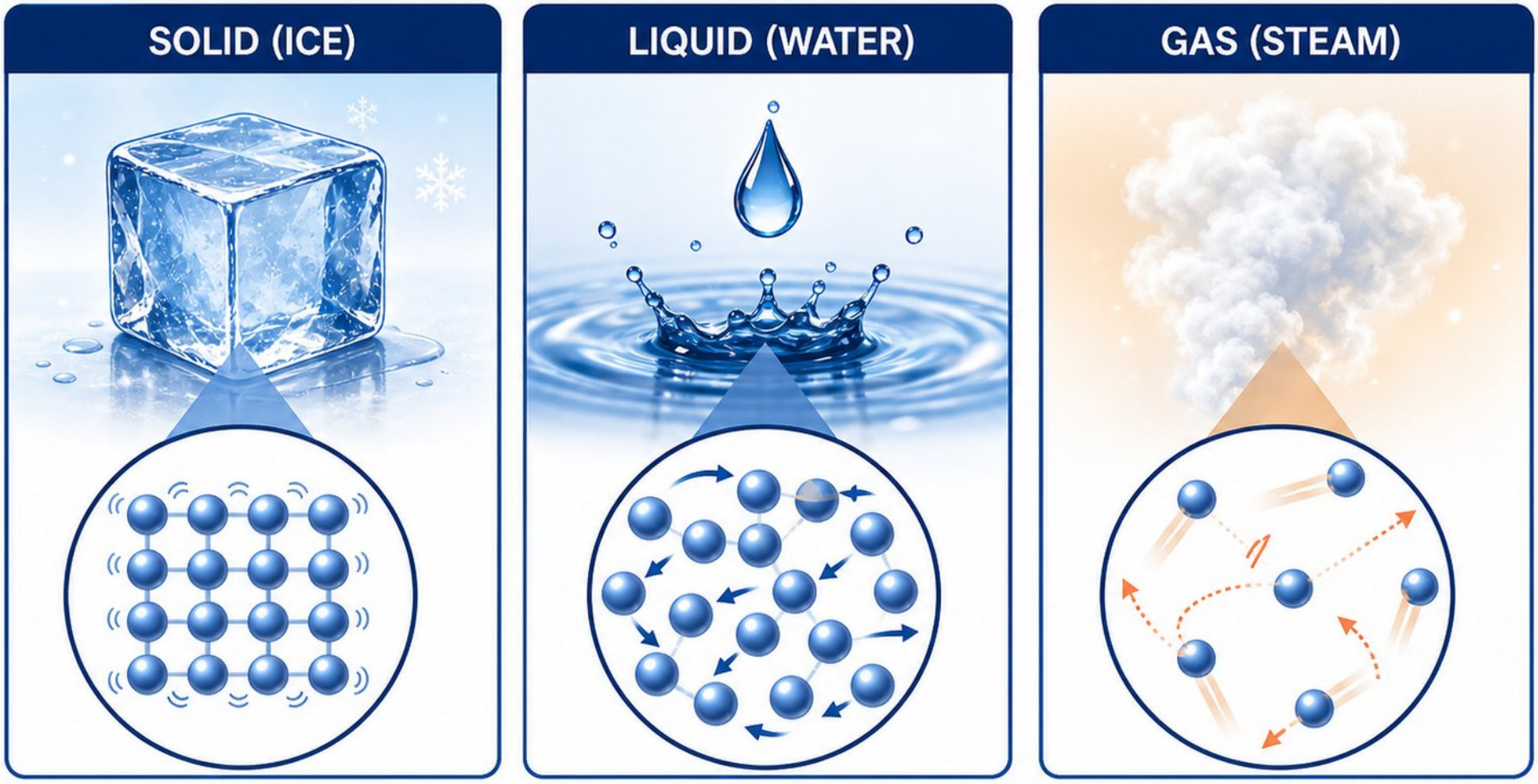
- “Particles close together but not in a fixed pattern”
- “Particles slide and flow past each other”
- “Definite volume, but no fixed shape”
- “Takes the shape of any container”
- “Examples: water, juice, and oil”



Gases: No Fixed Shape or Volume

- Particles are far apart and move rapidly in all directions
- No fixed shape, no fixed volume—gases expand to fill their container
- Particles collide constantly with each other and container walls
- Everyday examples: air, steam, helium in a balloon

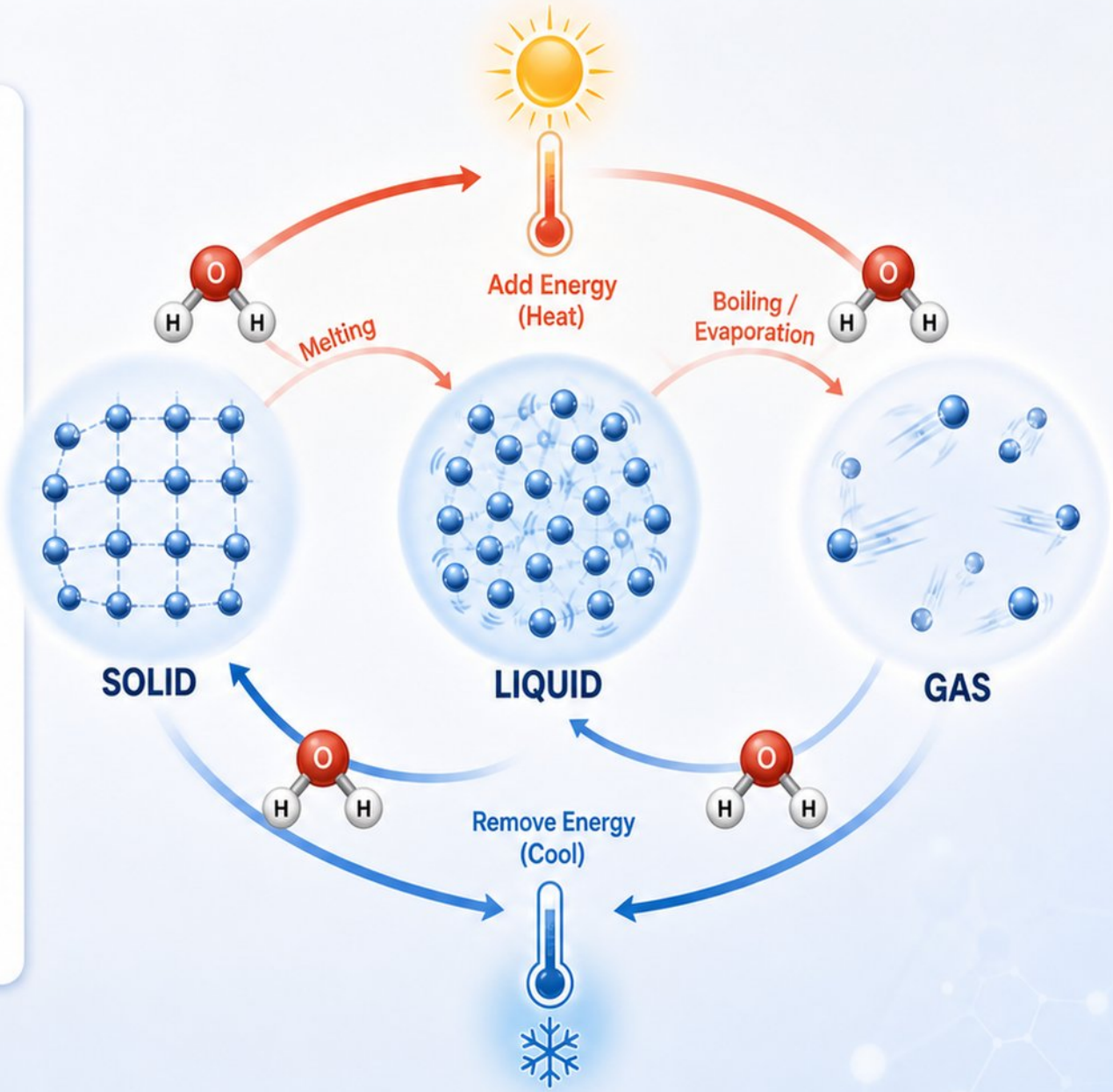
Comparing the Three States Side-by-Side



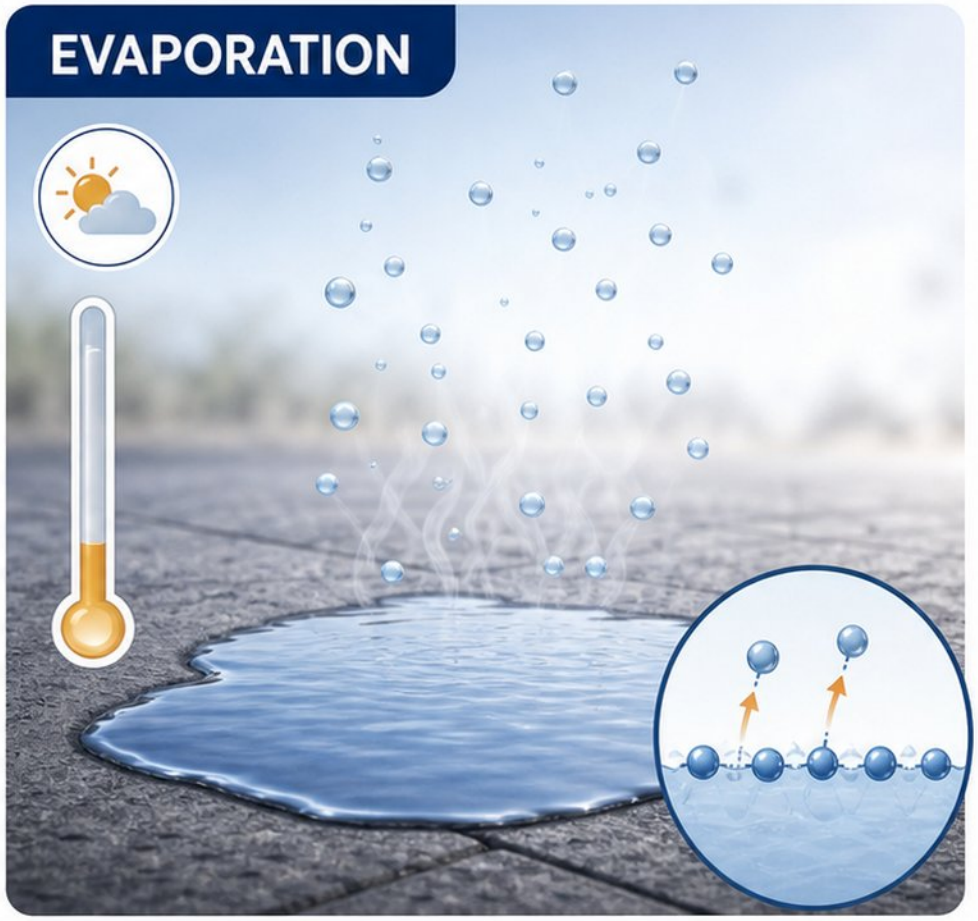
- - Solids: Tightly packed, fixed pattern, particles vibrate in place
- - Liquids: Close together, no pattern, particles slide past each other
- - Gases: Far apart, random motion, particles move rapidly in all directions
- - Same substance, different states (e.g., H_2O as ice, water, or steam)

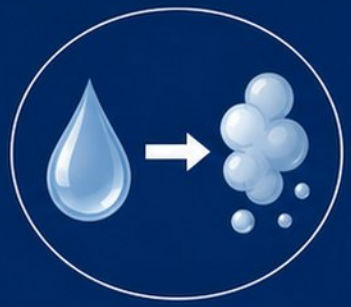
Changing State: Adding and Removing Energy

- State changes are physical: particles rearrange, not new substances
- Adding energy (heating): solid → liquid → gas
- Removing energy (cooling): gas → liquid → solid
- Key terms: melting, freezing, boiling, evaporation, condensation



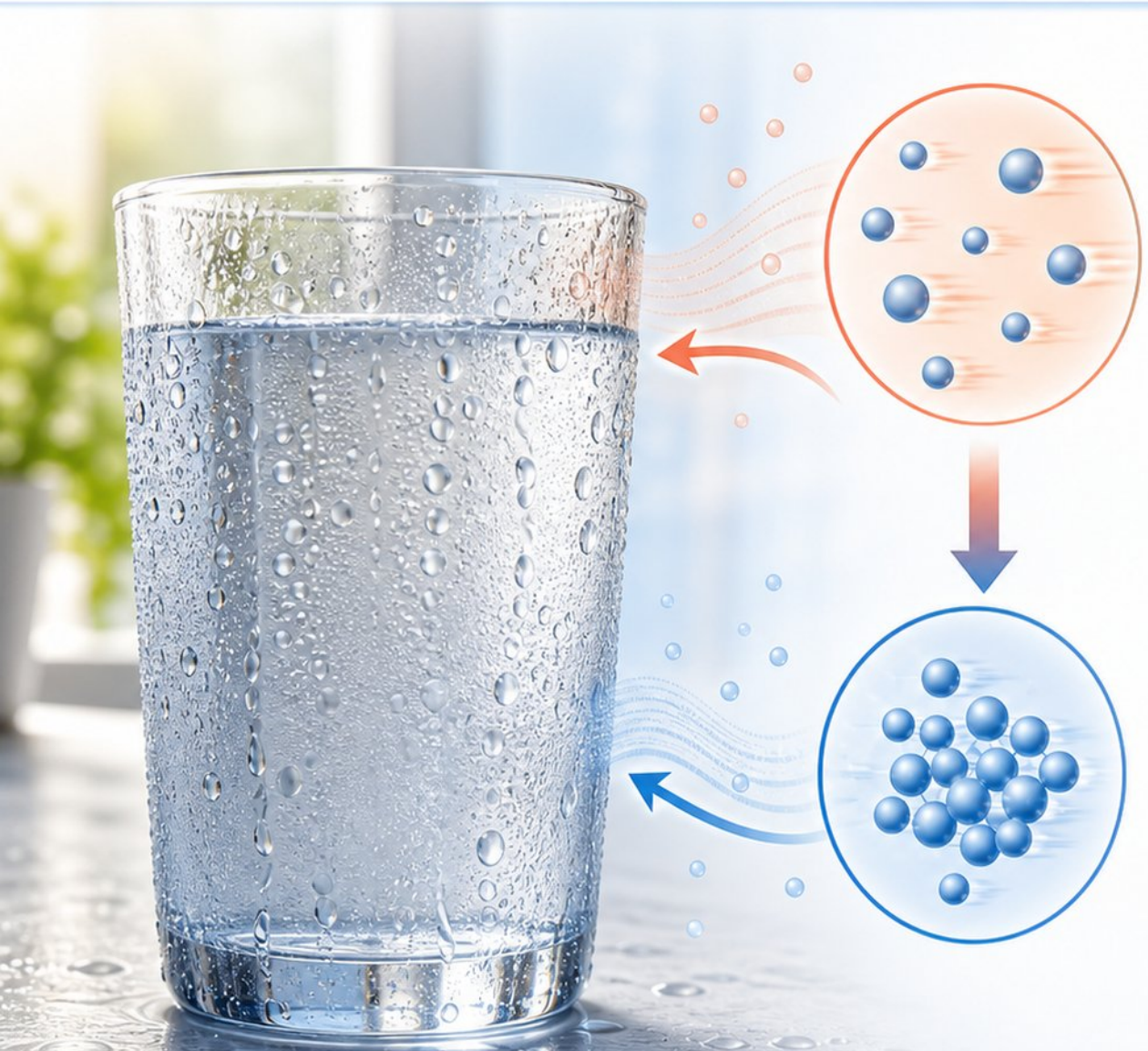
Boiling and Evaporation: What's the Difference?





- **Boiling:** occurs at a specific temperature, forming vapor bubbles throughout the liquid
- **Evaporation:** slow process happening only at the liquid's surface
- **Evaporation** can occur at any temperature, not just when heated
- Both processes turn liquid into gas, but under different conditions

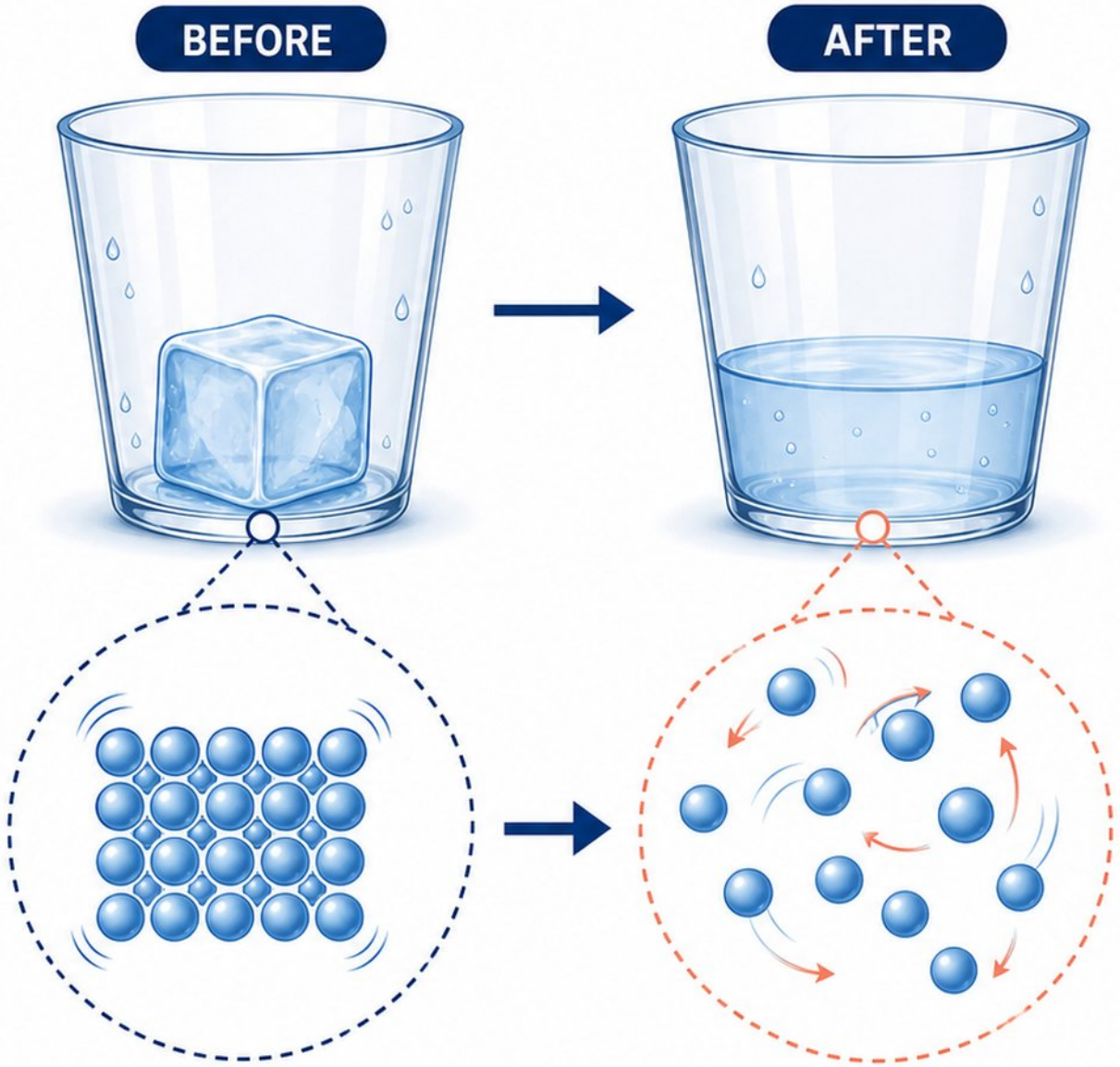
Condensation: From Gas to Liquid



- Water vapor in air cools and becomes liquid water
- Moisture on a cold glass comes from the surrounding air
- The glass itself does not create or leak water
- Cooling removes energy, so vapor particles slow and clump together

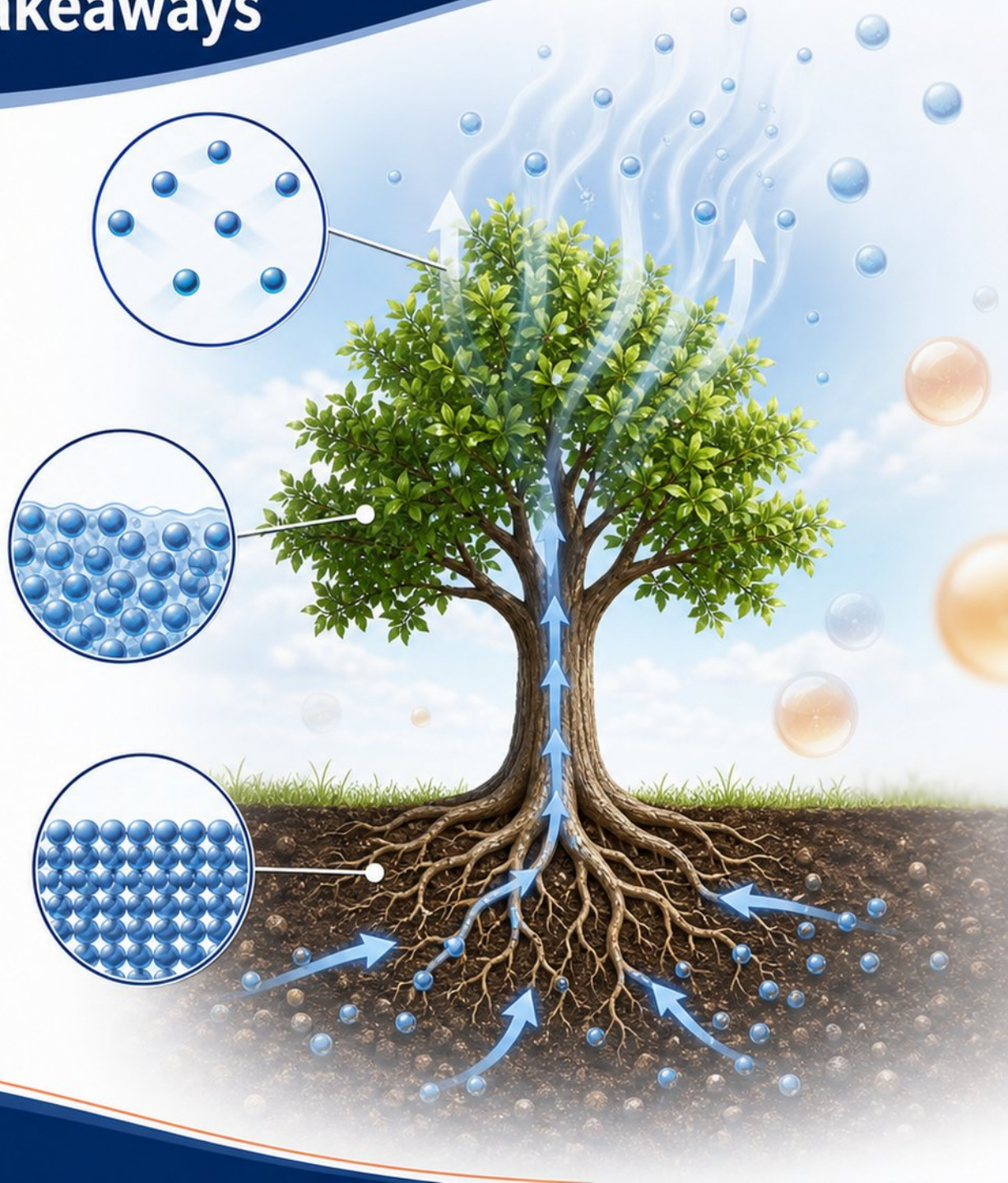
Activity: Explaining State Changes with Particles

- Guided exploration: an ice cube melting in a cup
- Draw or describe particle arrangement before and after the change
- Discuss why shape or volume changed using the particle model
- Guiding questions: What happened to the spaces between particles? How did their motion change?



Summary and Key Takeaways

- Particle arrangement and motion define solids, liquids, and gases
- A particle model explains shape, volume, and state changes
- Particles themselves do not change size or identity during changes
- Apply the model to everyday examples like dew or drying puddles



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