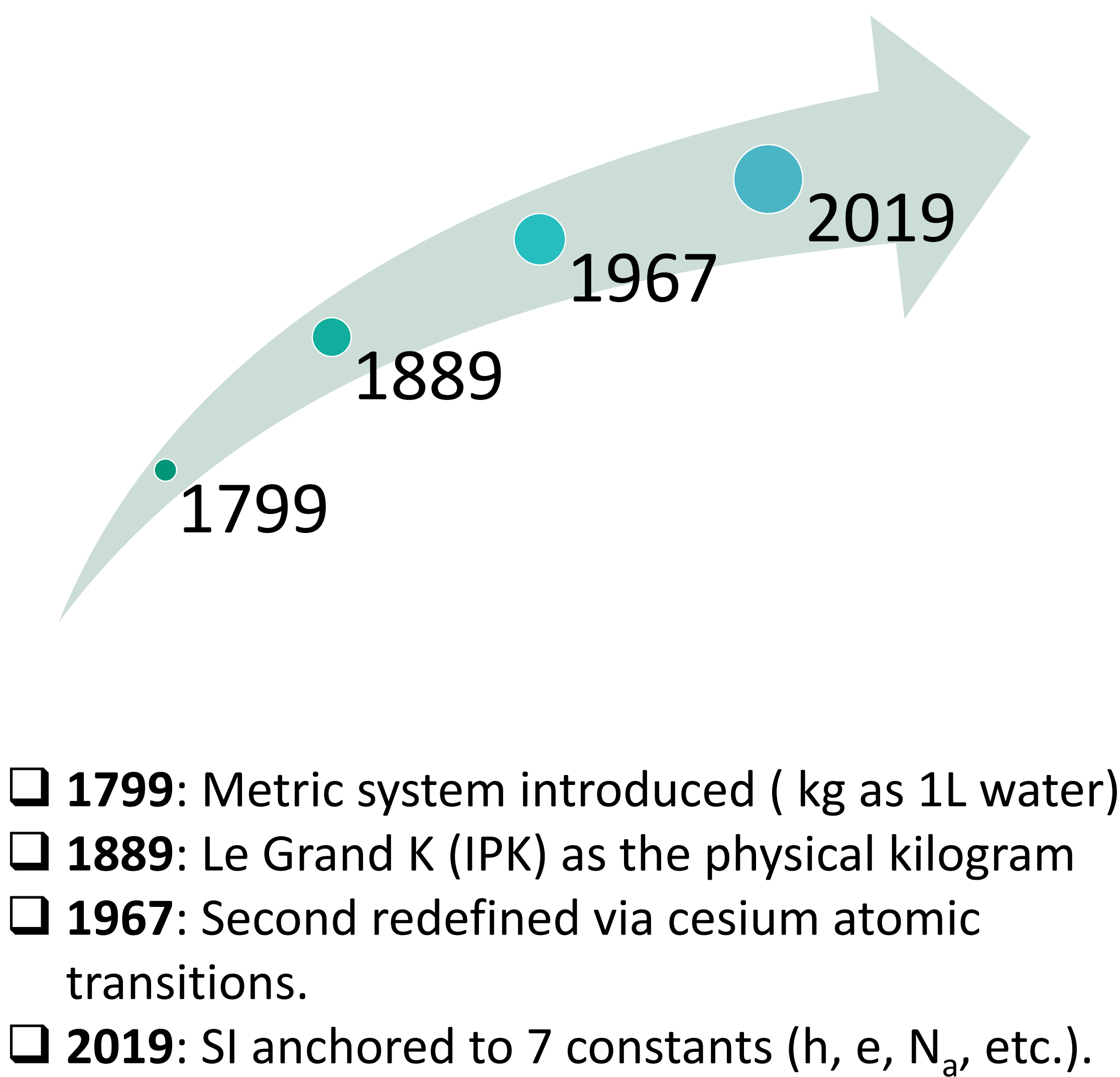




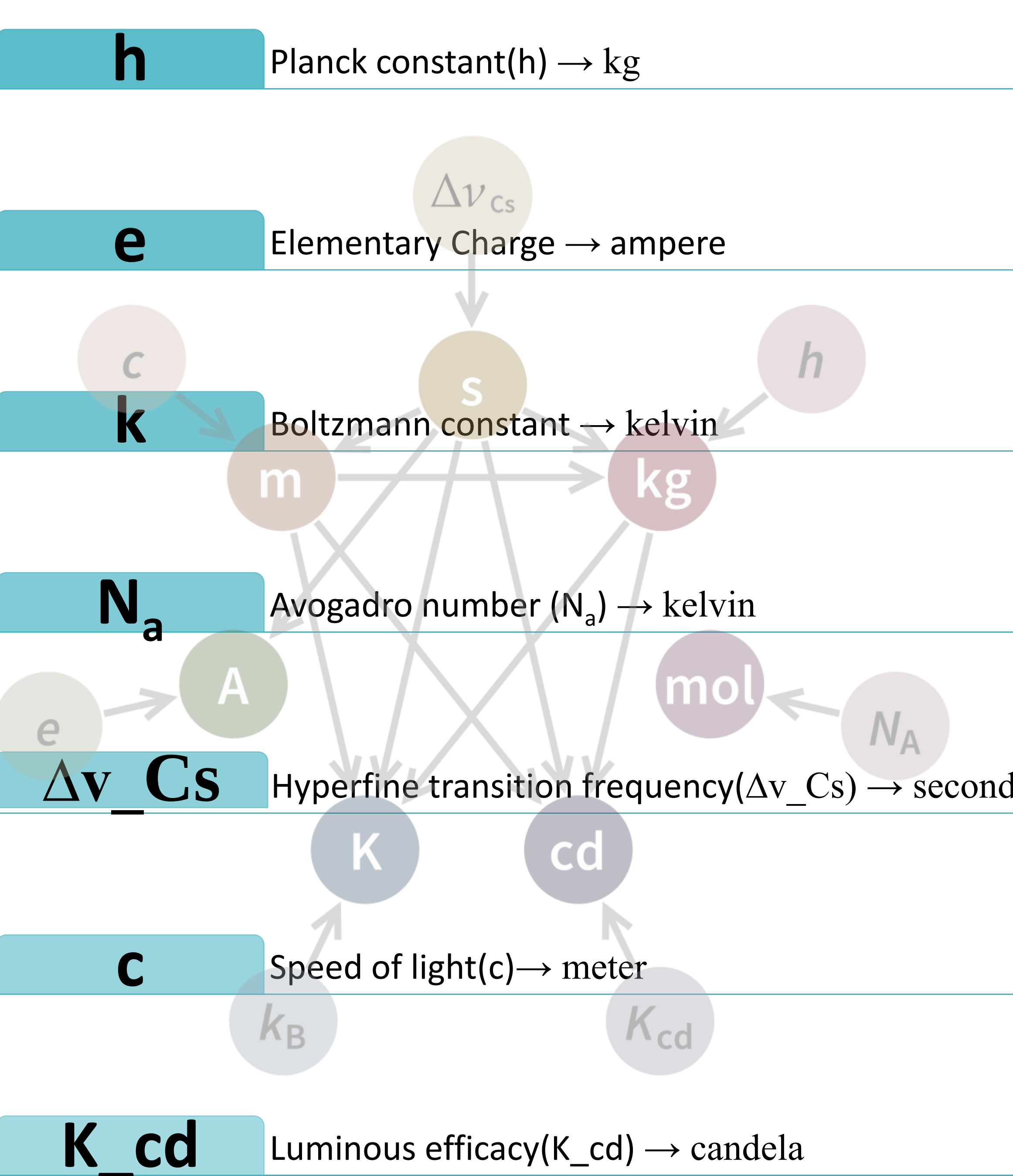
Importance of SI units and metrology: historical context

Name: **Anand Singh Chaurasiya**, Inspector Legal Metrology, Madhya Pradesh Govt., India
Email: anandschaurasiya@gmail.com

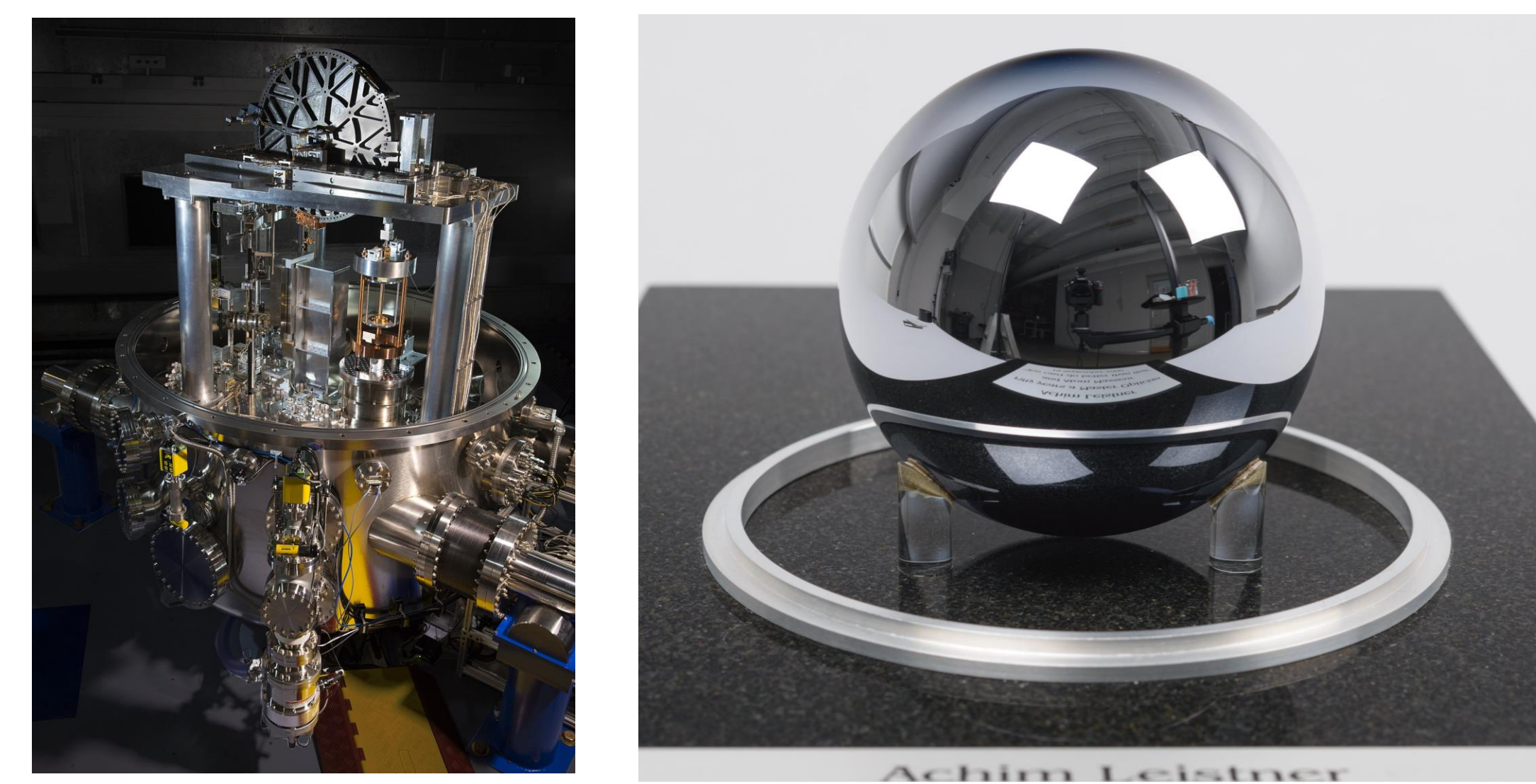
❖ From Artifacts to Constant: A Historical Shift



❖ The Seven Pillars of SI

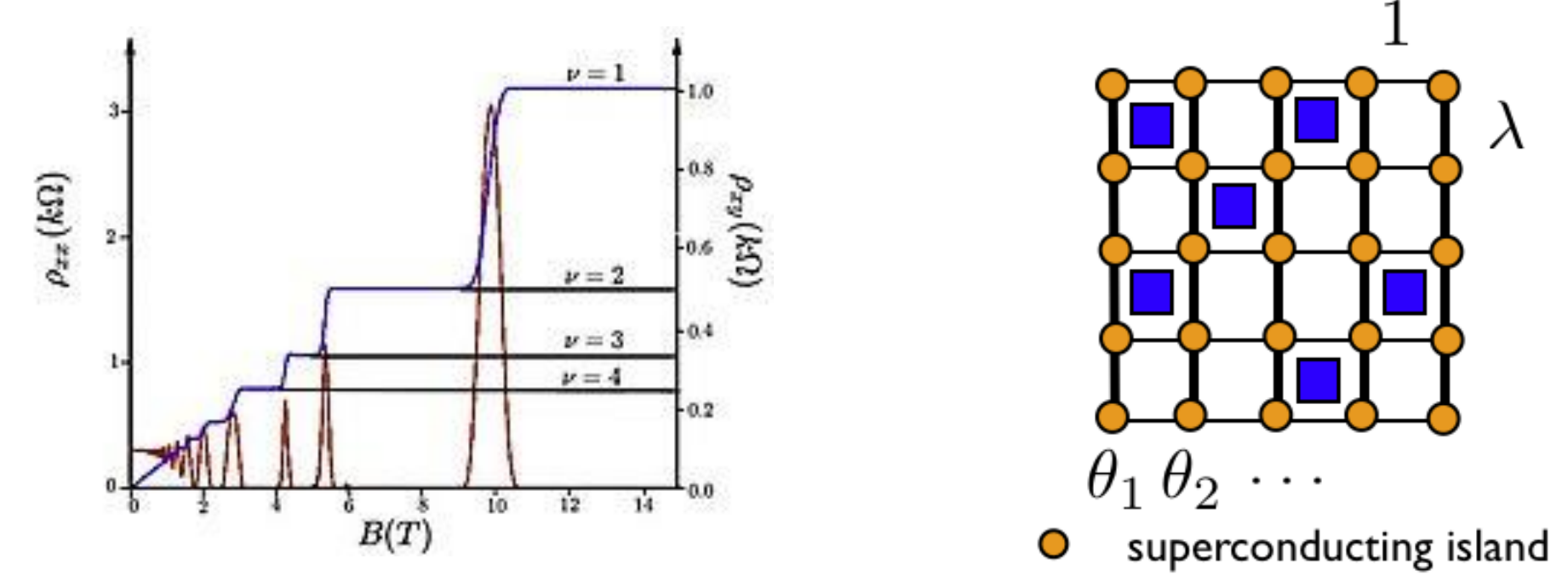


❖ Redefining the kilogram: Kibble Balance vs Avogadro Project



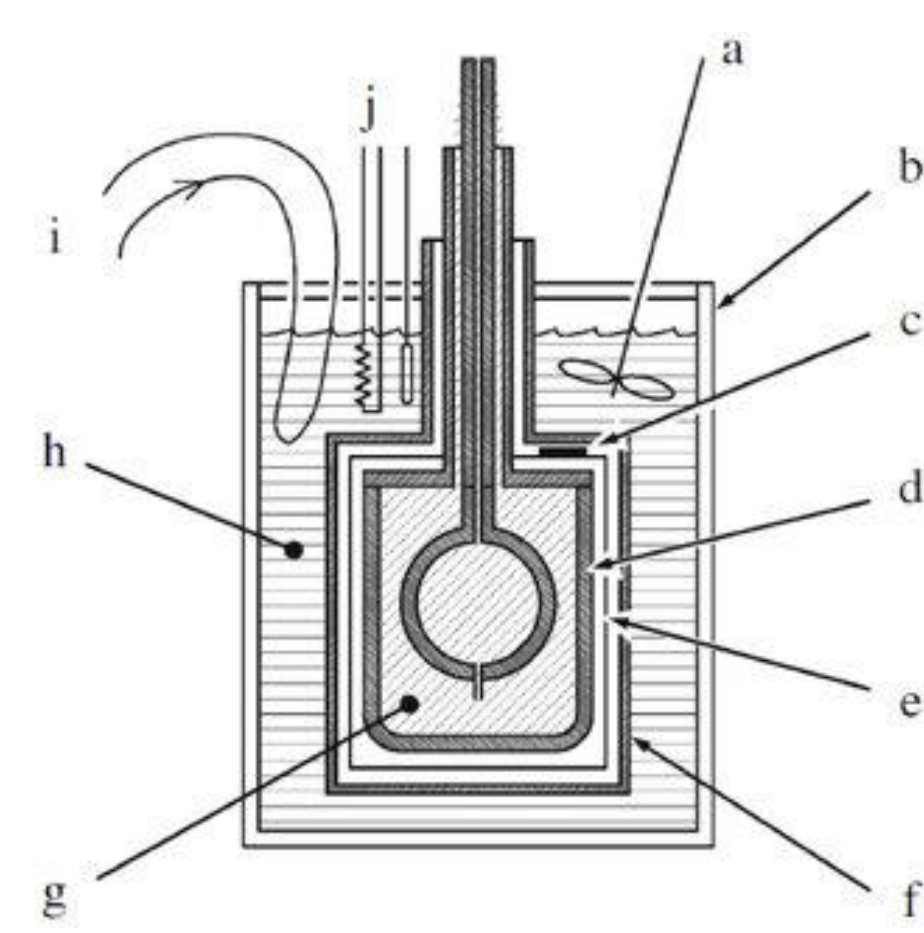
- Kibble Balance: Electromagnetic force vs gravitational force
 $h = 6.62607015 \times 10^{-34} \text{ J.s}$ (Planck constant)
 $m = h.f/(g.v)$ (kibble balance formula)
- Avogadro Project: Perfect Silicon sphere atom counting

❖ Quantum Electrical Standards



- The ampere is now defined by fixing $e = 1.602176634 \times 10^{-19} \text{ C}$, measured via single-electron pumps and quantum tunneling.

❖ Thermodynamic temperature: Acoustic Gas Thermometry



- $k = 1.380649 \times 10^{-23} \text{ J/K}$ (Boltzmann constant)

❖ Global Applications

- Semiconductors: Atomic-layer etching in chip fabrication requires SI-traceable mass and current standards.
- Pharmaceuticals: Nanogram drug dosing calibrated via Kibble balance-derived scales.
- Climate Science: CO_2 mole fraction measurements in ppm (parts per million) rely on revised SI definitions.
- Quantum Computing: Qubit control demands picoampere precision enabled by redefined ampere.

❖ Challenges in Implementation

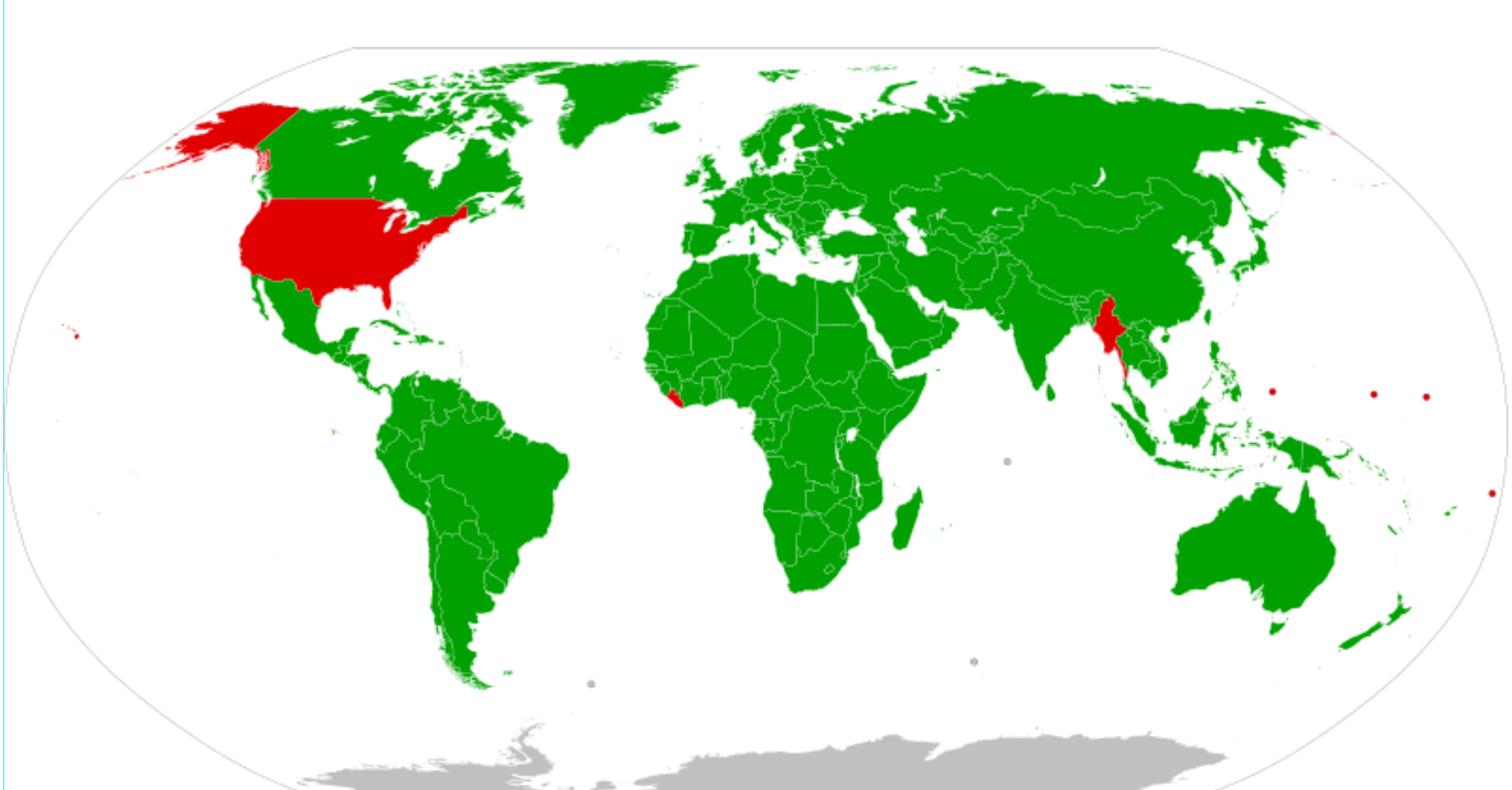
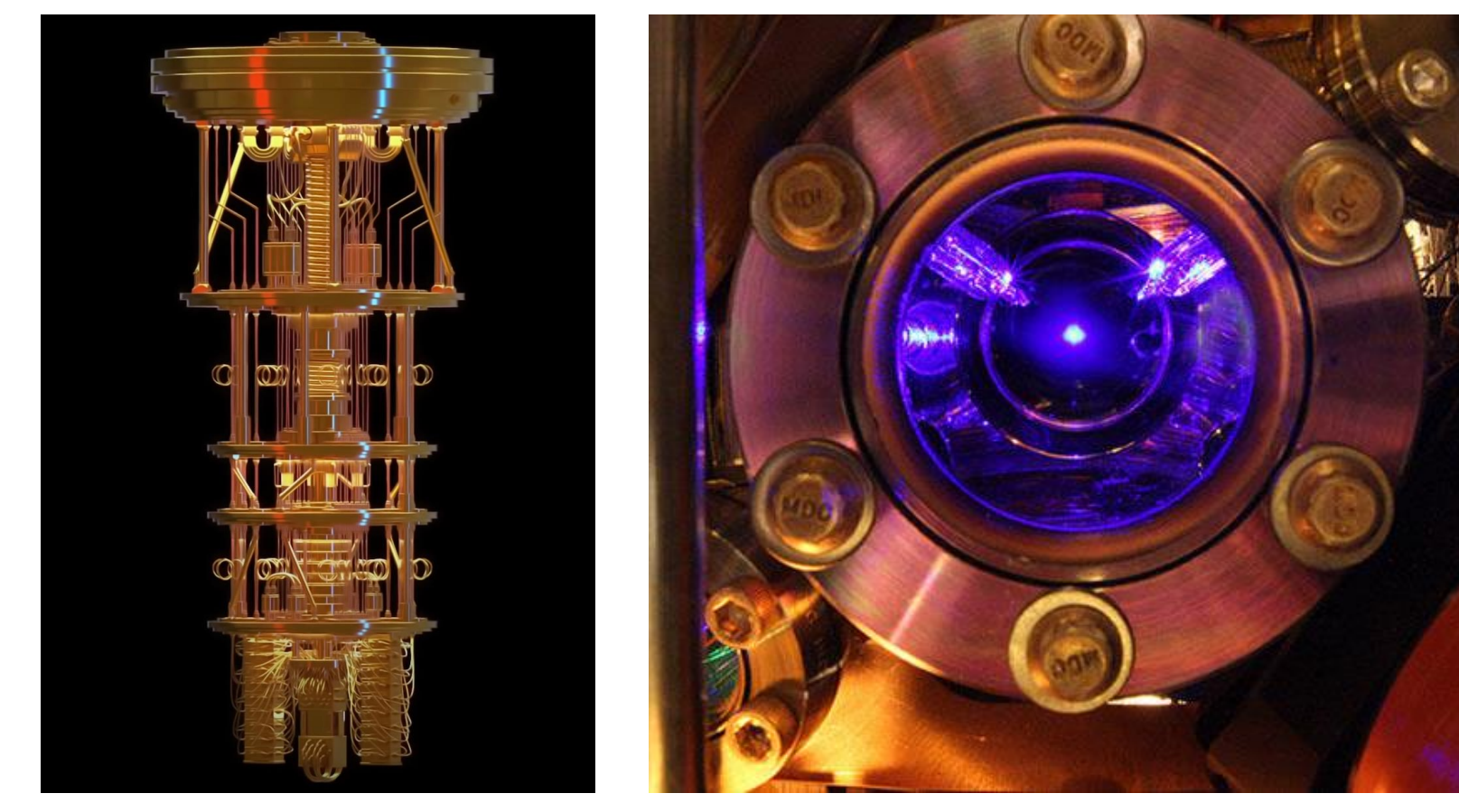


Fig: A comprehensive map of countries that use the metric system

- Cost: Cryogenic quantum instruments exceed \$1M.
- Knowledge gap: Only 30% of nations have quantum metrology capabilities.
- BIPM's Response: Virtual training labs + collaborative robot remote calibrations.
- Training: Bridging the gap between physicists and industry.

❖ Future-Proofing Metrology:

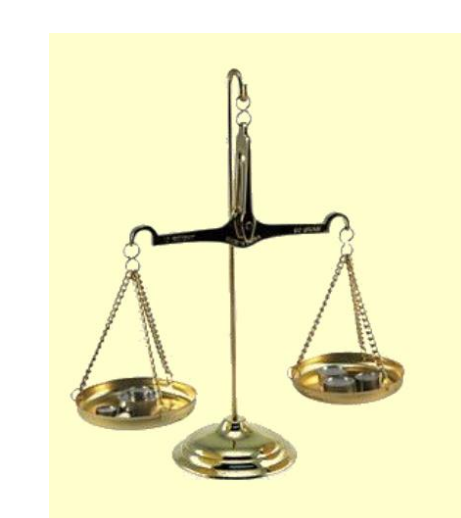
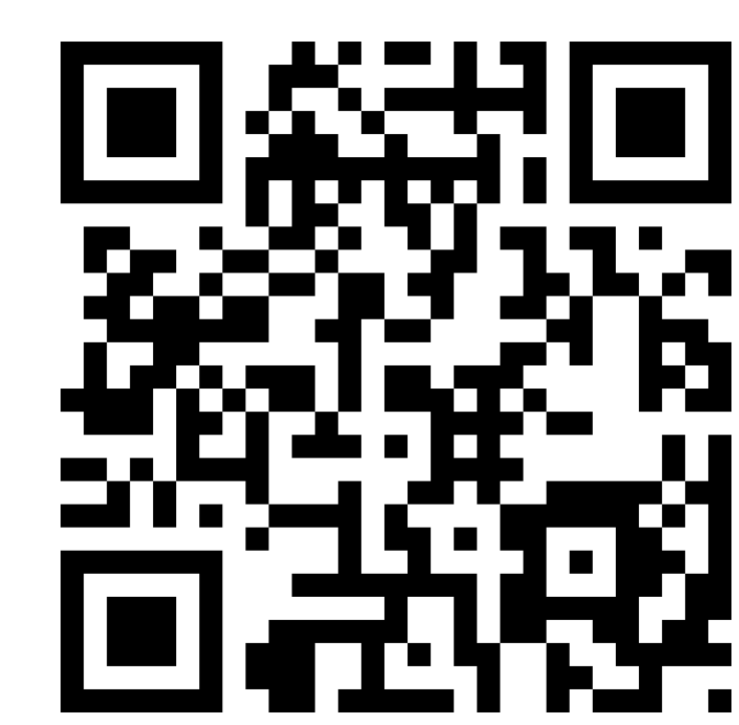


- Optical Clocks: Redefining the second with strontium lattice transitions (10^{-18} uncertainty).
- Quantum Sensors: Gravimeters for mineral exploration via SI-traceable acceleration standards.

❖ Ethical and Economic Implications:

- Will quantum metrology widen the gap between advanced and developing economies?
- Open-Source Solutions: Community-driven calibration tools (e.g., Arduino-based Kibble Prototypes.).

○ Scan the below QR to read full abstract in PDF format:



"उपभोक्ता की यही मांग"
'सही तौल व सही दाम'