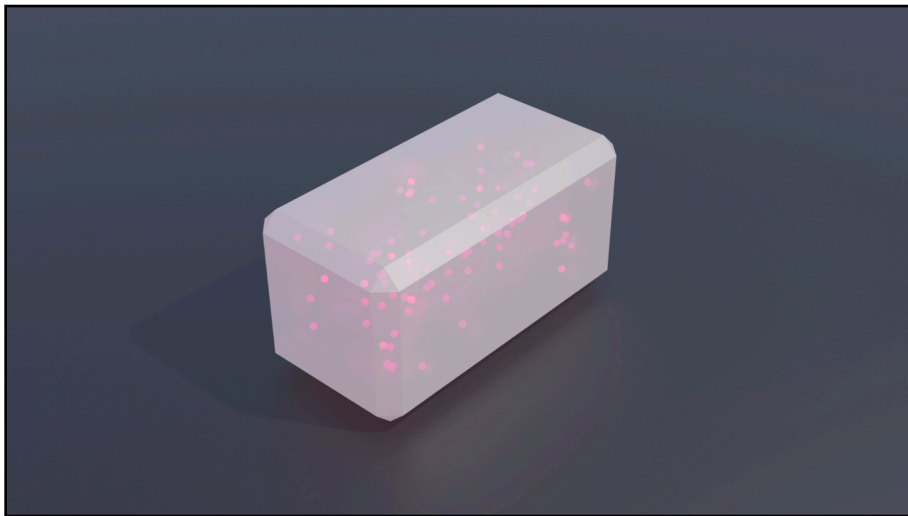


STORYBOARD

# NUCLEAR CLOCK ANIMATION

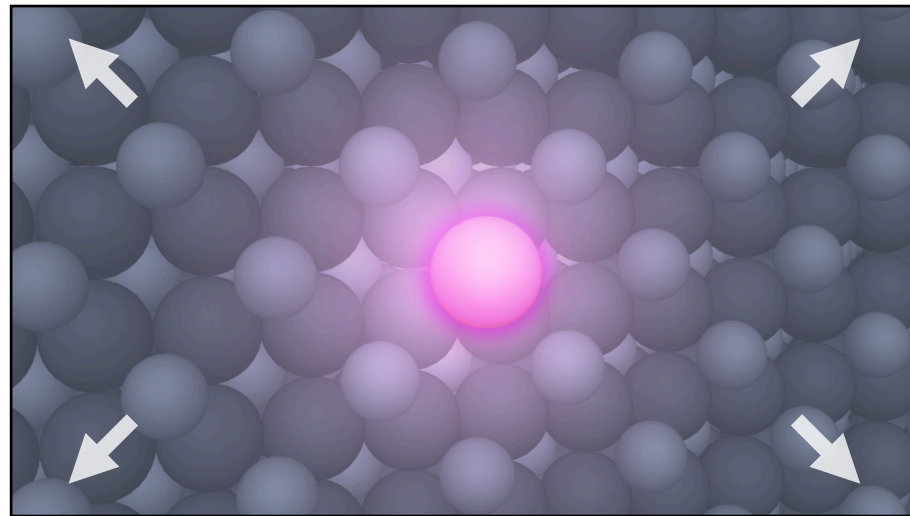
PANEL 01



**CAPTION** Within this crystal are embedded atoms of a metal called thorium.

**ACTION** We see a rectangular crystal on a surface, slow zoom in on crystal, glistening dots visible inside crystal

PANEL 02



**CAPTION** Scientists believe these thorium atoms could be the key to making a radically new timekeeper known as a nuclear clock.

**ACTION** Accelerate zoom to inside crystal, fade to molecular structure, stop on thorium atom

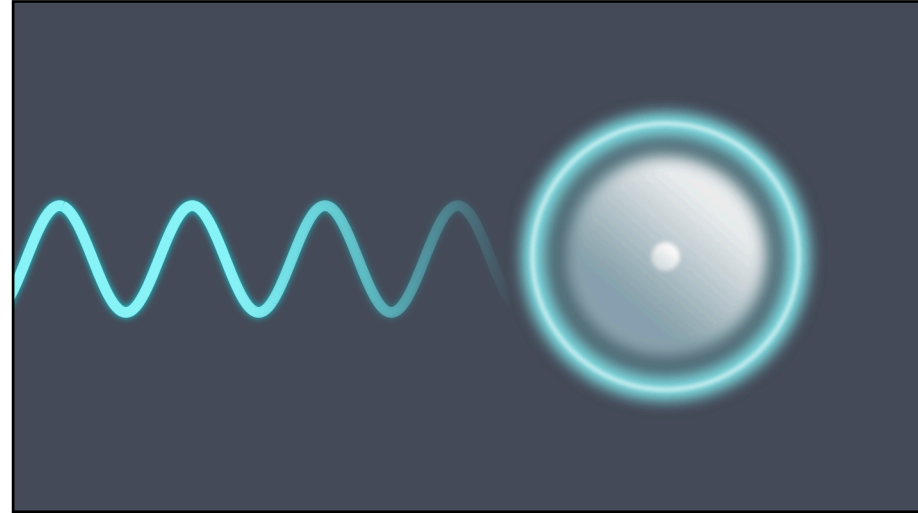
PANEL 03



**CAPTION** Today's atomic clocks keep time using electrons, tiny particles that form a cloud within the atom.

**ACTION** Fade out to single generic atom with outer electron "cloud"

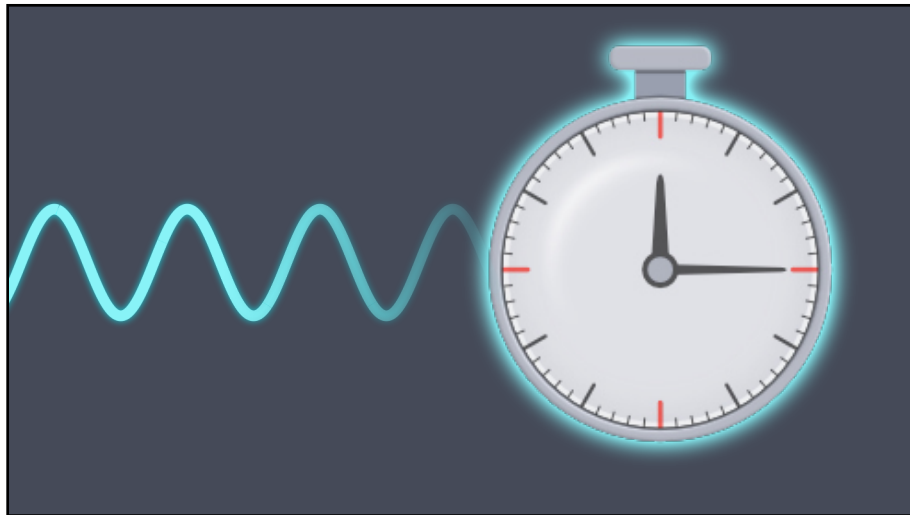
PANEL 04



**CAPTION** Microwaves or visible light with specific frequencies can make these electrons jump between energy levels.

**ACTION** Laser appears, cloud glows and expands slightly

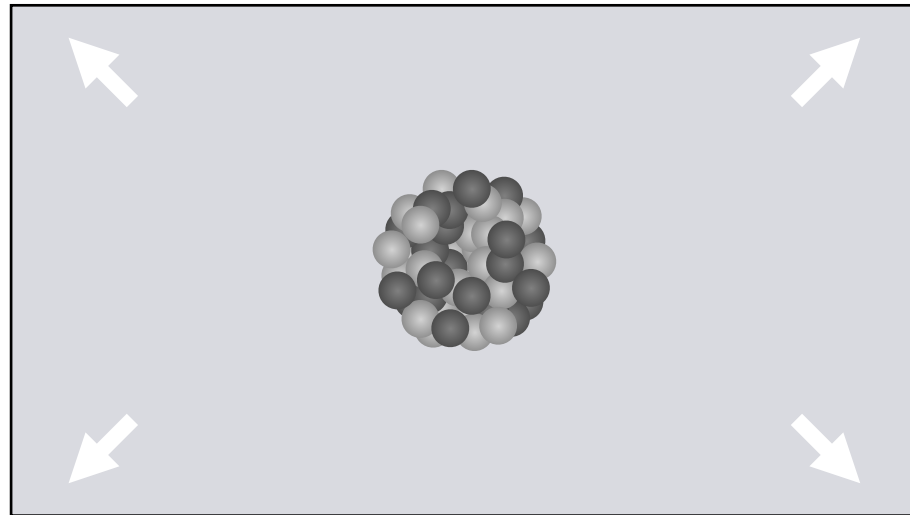
PANEL 05



**CAPTION** By measuring the frequencies of light that cause these energy jumps, scientists create the world's steadiest and most accurate clocks.

**ACTION** "Clock" fades in, ticking in time with the laser (same sequence as in trapped ion clock animation)

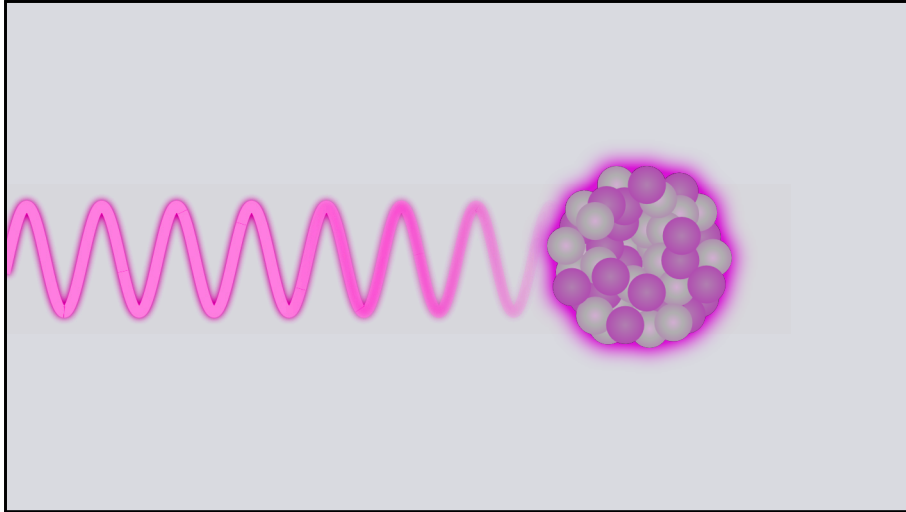
PANEL 06



**CAPTION** But nuclear clocks could be far more precise still. They would keep time using energy jumps inside the nucleus, a dense cluster of particles at the atom's core.

**ACTION** Fade back to atom and zoom in, revealing nucleus at center

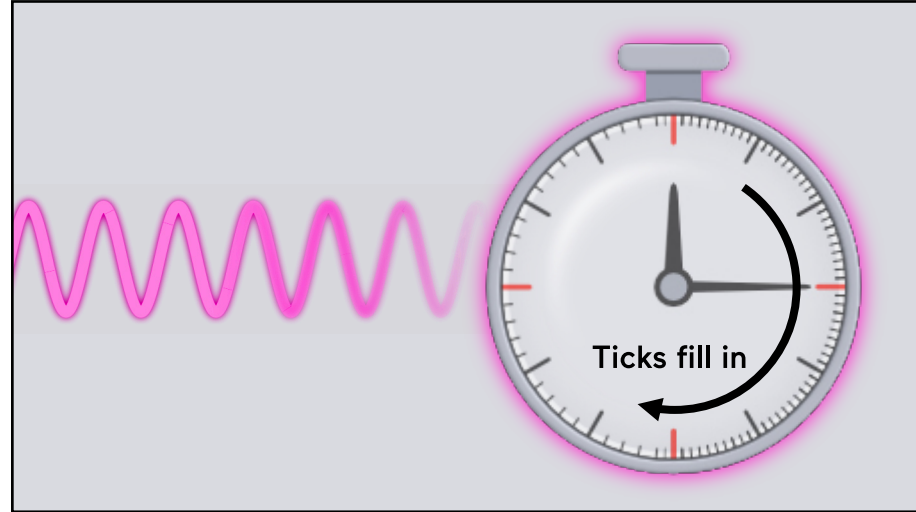
PANEL 07



**CAPTION** A nuclear energy jump in a type of atom called thorium-229 can be triggered by ultraviolet light with a frequency much higher than that used by today's best atomic clocks.

**ACTION** Laser appears, nucleus starts glowing (particles shift?)

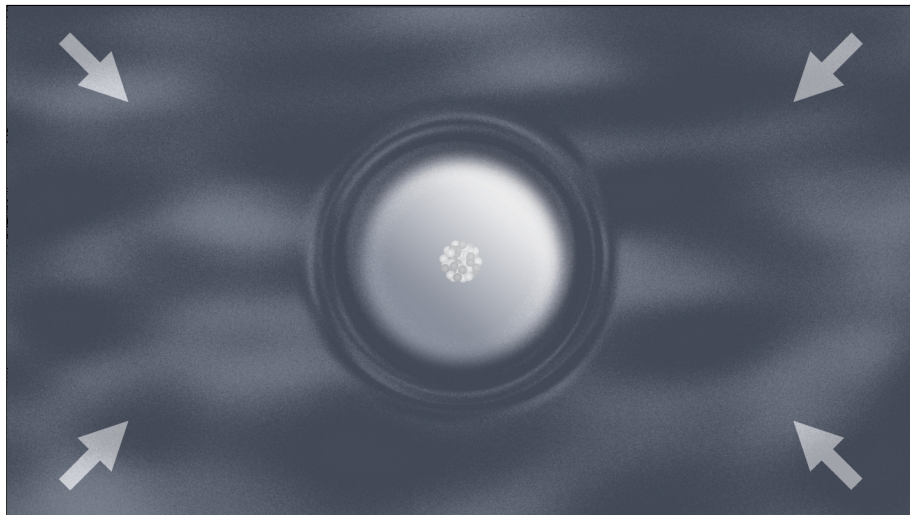
PANEL 08



**CAPTION** A clock based on this frequency could, in theory, tick more precisely and accurately than any existing clock. It would tick more than 2 million billion times per second.

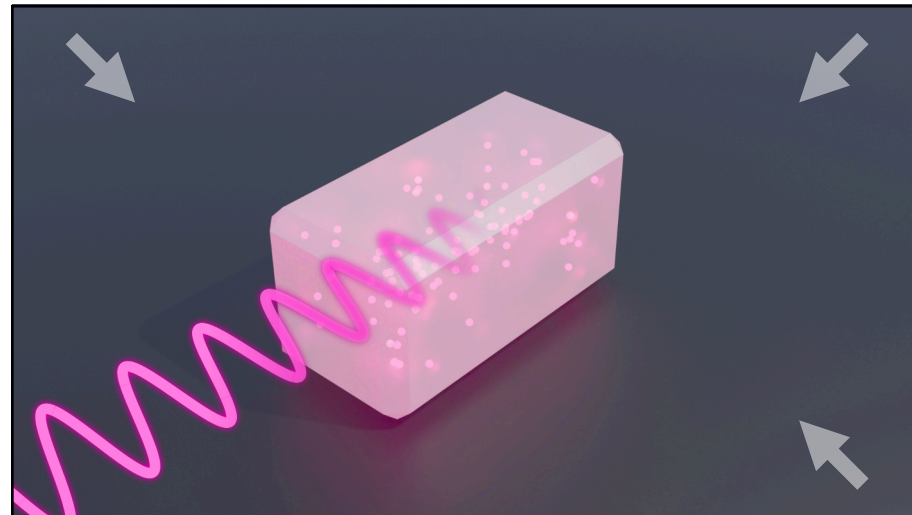
**ACTION** Clock appears, more tick marks fill in around edges

## PANEL 09



**CAPTION** In addition, the atomic nucleus is naturally shielded from the environment by its electrons,

**ACTION** Fade back to nucleus as we zoom out, electron cloud appears around nucleus, noise appears, cloud shields nucleus from noise



**CAPTION** making its ticks of time extremely stable and regular.

**ACTION** Zoom back out to crystal, this time with laser and crystal glowing

(maybe crystal is sitting on a "circuit board"?)

PANEL 11



CAPTION Cntd.

ACTION Continue zooming out to see that the crystal is powering a clock on a satellite

PANEL 12



CAPTION Scientists hope to use nuclear clocks to probe the fundamental nature of reality and shed light on some of the universe's deepest mysteries.

ACTION Zoom way out to show some cosmic scene?