

# A Supercomputer Rebuilds the Young Universe

The Lumina simulation shows how astronomy now depends on code, chips, data, and teams that can test a model against the sky.



A supercomputer room is shown with a glowing cube of simulated stars and cosmic gas above a workstation.

**R**esearchers have built Lumina, a huge computer **simulation** of the universe's first 2 billion years, to help explain what new space telescopes are seeing. According to reporting by Phys.org on research published in *Monthly Notices of the Royal Astronomical Society*, the model was developed by researchers at the Center for Astrophysics | Harvard & Smithsonian and is designed to compare **telescope** observations with detailed predictions about how the early universe evolved.

That matters because the James Webb Space Telescope and the Nancy Roman Space Telescope are giving astronomers sharper views of the universe's earliest chapters. A telescope can collect light from faraway **galaxies**, but scientists still need a way to test what that light means. Lumina models ordinary matter, dark matter, and **radiation**. Dark matter is matter that does not give off light but can be detected because its **gravity** affects visible matter. Radiation, in this context, means energy traveling through space, including light. If the real sky matches the model, scientists gain confidence in their theories. If it does not, the mismatch can point toward something missing in the science.

Lumina is described as one of the largest and most detailed early-universe simulations ever created. It covers a cube of space about 1.5 billion light-years on each side, meaning light would take 1.5 billion

years to cross one edge of the modeled region. Phys.org reports that this is more than 100 times the volume of previous comparable simulations. The point is not just to make a bigger digital universe. The point is to keep enough detail inside that enormous volume to follow how galaxies, stars, black holes, gas, and light affected one another over time.

The trade vocabulary here is computational, not construction or automotive, but it is still about tools, materials, and workflow. Lumina is a cosmological radiation-hydrodynamics simulation. Cosmological means it deals with the large-scale universe. Hydrodynamics is the study of how fluids move; in this case, the fluid is mostly gas spread through space. Radiation-hydrodynamics means the program calculates both gas motion and energy from light or other radiation, including how they change each other. This is not an animation made after the fact. It is a working model that follows rules and produces results that can be checked against telescope data.

The simulation also follows **hydrogen** and **helium** reionization. Reionization is the process in which atoms that had electrons attached later had electrons stripped away again by energetic radiation. Hydrogen and helium are the two lightest chemical elements, and they filled much of the early uni-

verse. The article says Lumina is the first simulation to capture helium reionization as it happened while also letting its effects immediately influence the rest of the evolving model. That detail is important because early stars, galaxies, and black holes did not develop in empty space; they developed inside gas that was being heated, ionized, pushed, and reshaped.

For a career and technical education classroom, the job story is that modern **astronomy** is not only done by people looking through telescopes. It is also done by people who write code, maintain high-performance computing systems, manage large data sets, test **software**, and understand enough physics to know whether a result makes sense. Creating Lumina required more than 15,000 graphics processing units, or GPUs, running on Frontier, a supercomputer at Oak Ridge National Laboratory in Tennessee. A GPU is a computer chip designed to handle many calculations at the same time, which makes it useful for graphics, artificial intelligence, and scientific modeling. A supercomputer is a system built from many **processors** working together on problems too large for a normal computer.

The people behind a project like this include astrophysicists, computational scientists, software de-

velopers, data specialists, and supercomputing staff. Some are doctoral researchers building theories about the universe. Others focus on making code run efficiently across thousands of chips without crashing or wasting machine time. The source article does not list job requirements, but the work points to skills employers in technical fields recognize: programming, math, troubleshooting, documentation, teamwork, and the ability to compare a digital output with real-world measurements. In this workplace, a bad assumption in the code can matter as much as a bad measurement in a lab.

Lumina is also a reminder that a model is not the same as proof. It is a tool for asking sharper questions. Future studies will use it to investigate how gas moves between galaxies, how radiation from the big bang shaped cosmic evolution, and how regions of intense star formation developed. The next step is comparison: telescope teams gather observations, simulation teams produce predictions, and researchers look for agreement or tension between them. The work is slow, technical, and collaborative. It shows a version of science where the shop floor is a server room, the instrument is software, and the finished product is a better test of how the universe came to look the way it does.

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Written from reporting by Phys.org.

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## THINK IT THROUGH

1. When should scientists trust a computer simulation enough to use it as evidence, and what limits should they keep in mind?

**A strong answer:** A strong answer should weigh model quality, real-world observations, assumptions in the code, and the difference between prediction and proof.

2. If a school wanted to prepare students for work connected to projects like Lumina, which skills should it prioritize and why?

**A strong answer:** A strong answer should connect technical skills such as coding, math, data handling, and troubleshooting with teamwork and scientific judgment.

3. Does building larger simulations automatically make science better, or can size create new problems?

**A strong answer:** A strong answer should consider benefits of scale alongside cost, complexity, verification, access to supercomputers, and possible hidden errors.

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L E E C F P U S X S P H S T N A E N  
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ASTRONOMY

GALAXIES

GRAVITY

HELIUM

HYDROGEN

PROCESSORS

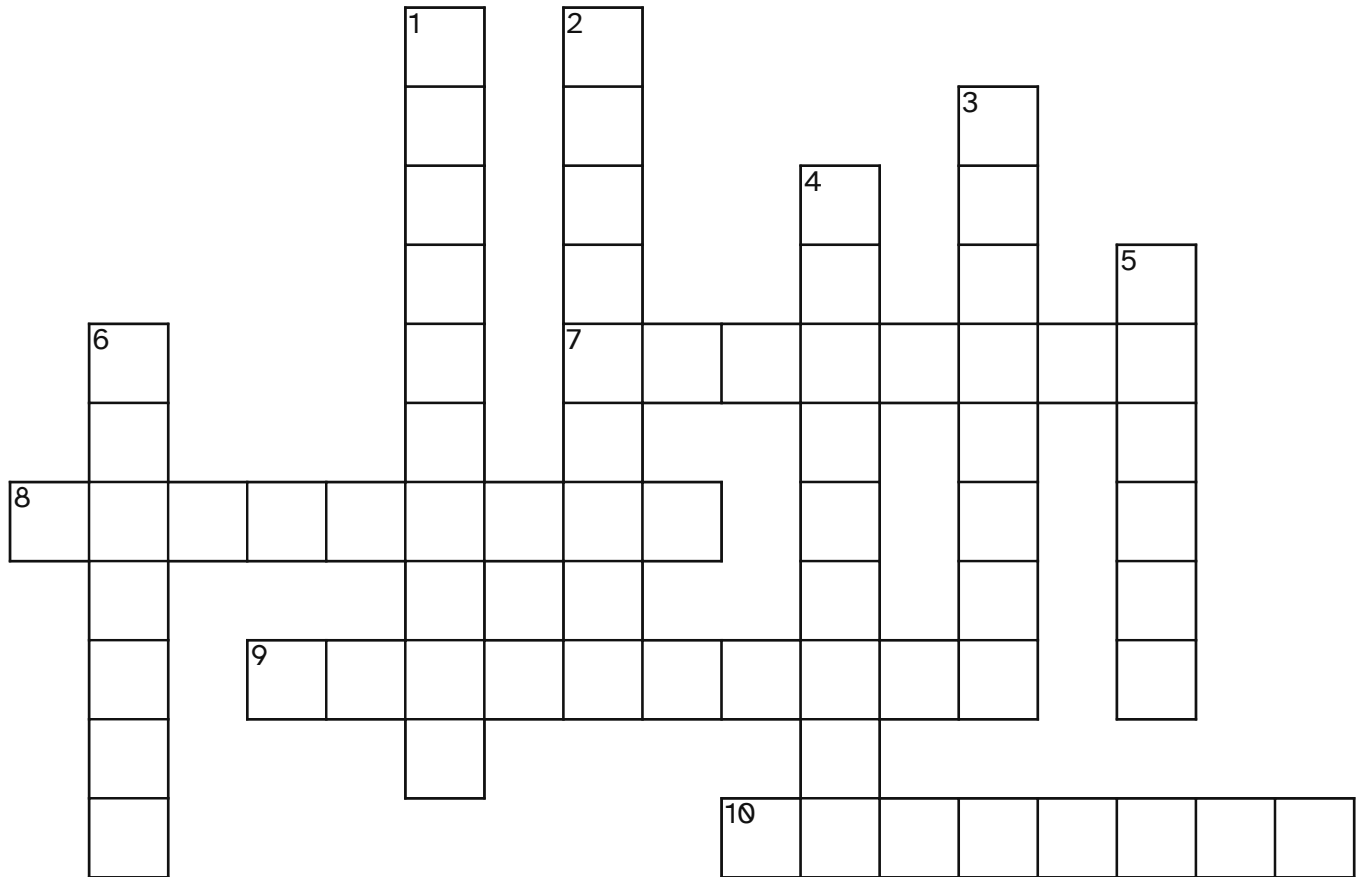
RADIATION

SIMULATION

SOFTWARE

TELESCOPE

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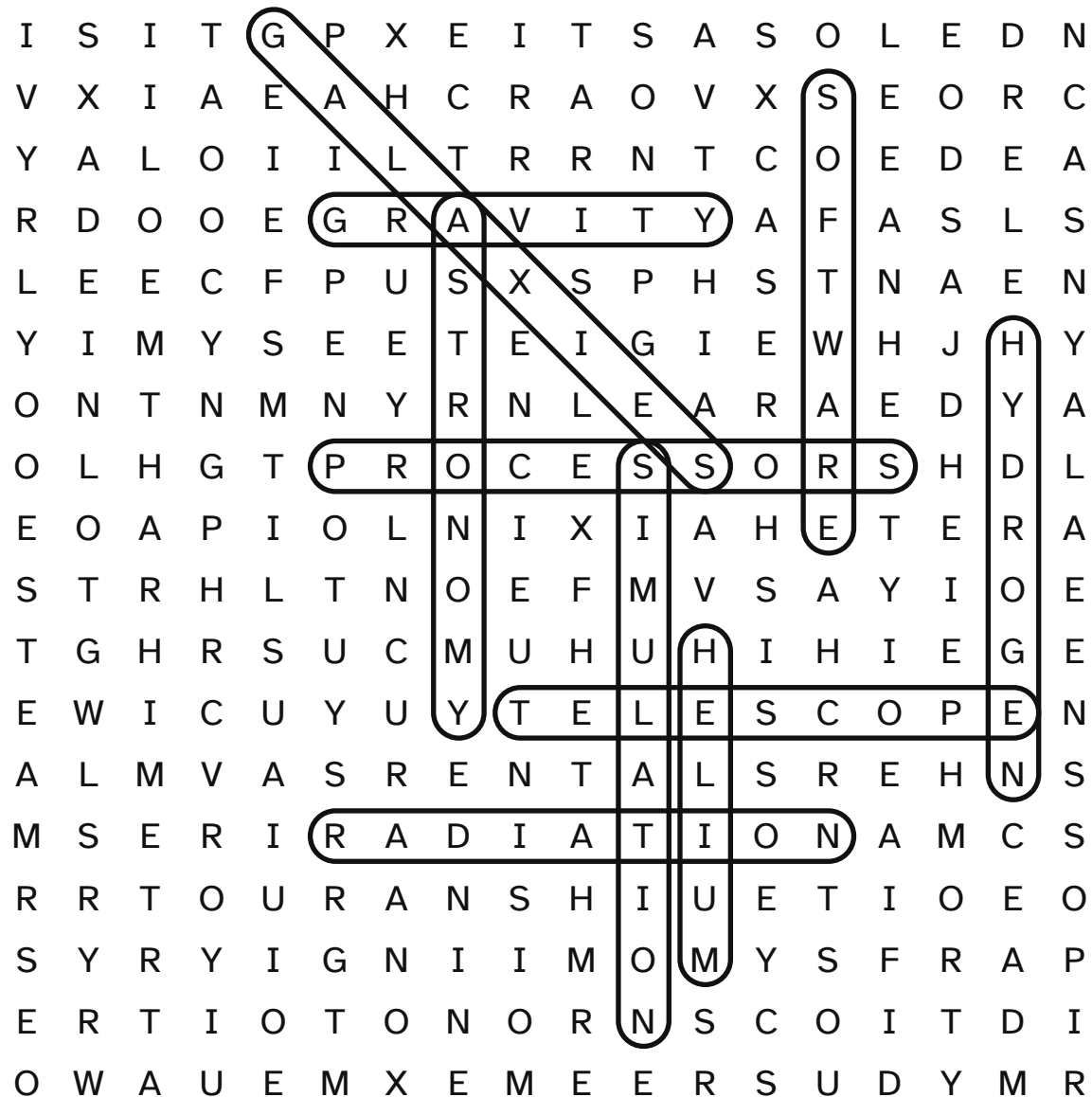
## ACROSS

- 7 Programs that direct a computer's tasks
- 8 Energy moving through space, such as starlight
- 9 Computer parts that execute calculations and commands
- 10 Lightest element, abundant in early-universe gas

## DOWN

- 1 Rule-based computer model of a changing real-world system
- 2 Light-gathering instrument for studying distant objects
- 3 Vast gravity-bound collections of stars, gas, and dust
- 4 Science of objects and events beyond Earth's atmosphere
- 5 Light element common in the young universe
- 6 Attractive force between objects with mass

# A Supercomputer Rebuilds the Young Universe — answer key



ASTRONOMY

GALAXIES

GRAVITY

HELIUM

HYDROGEN

PROCESSORS

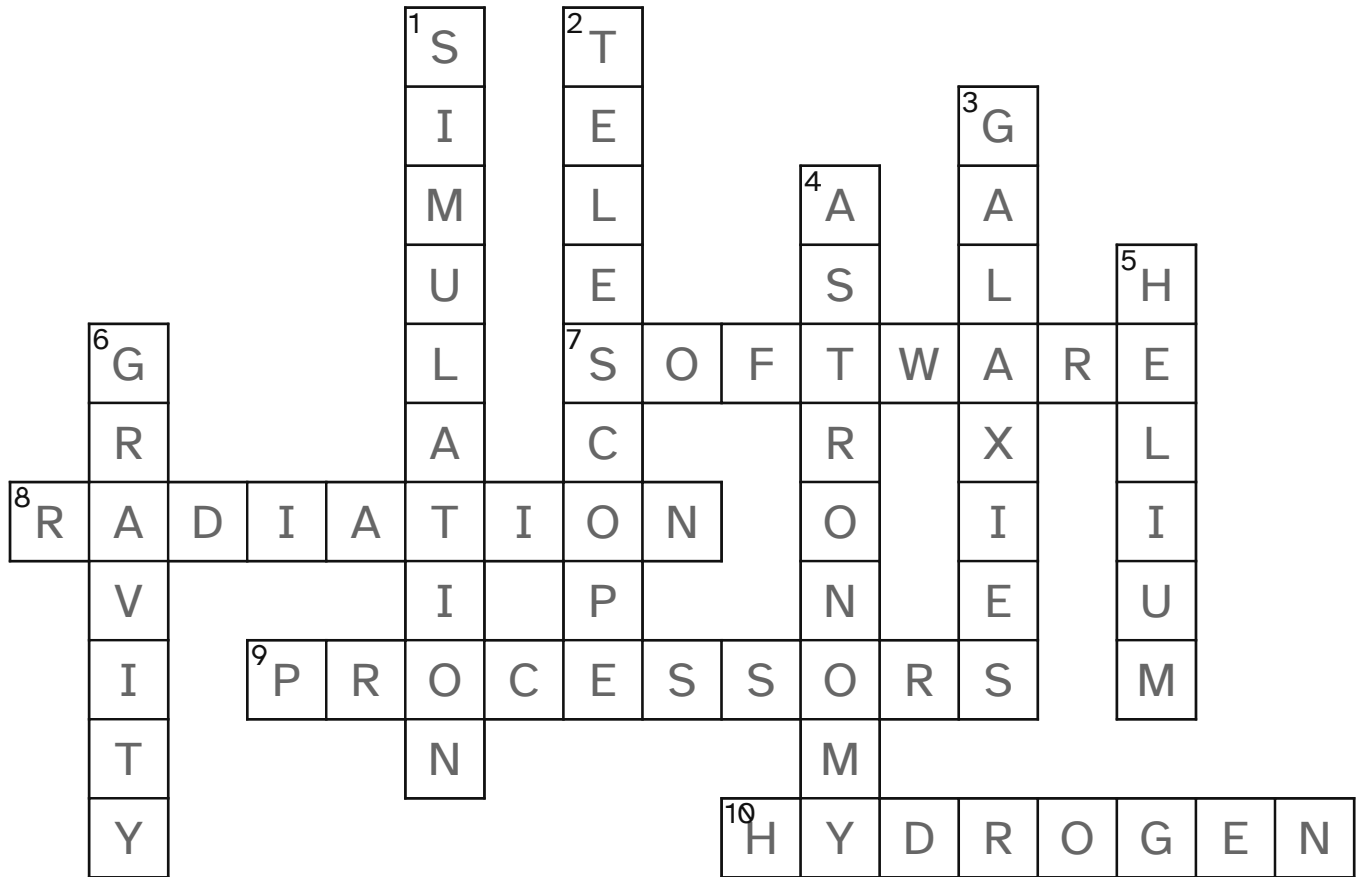
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## Where this came from

This article was written for 3andB from the reporting below. It is not a reprint — the wording is ours and the facts are theirs.

### Phys.org

“Lumina simulation brings the early universe to life on a record-breaking scale”

Published Sunday, October 25, 2026

Read by us on Monday, October 26, 2026

<https://phys.org/news/2026-10-lumina-simulation-early-universe-life.html>

### WHAT IS IN THIS PACKET

The article with a note on each question, a word search, a crossword, and the answer key to both.

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