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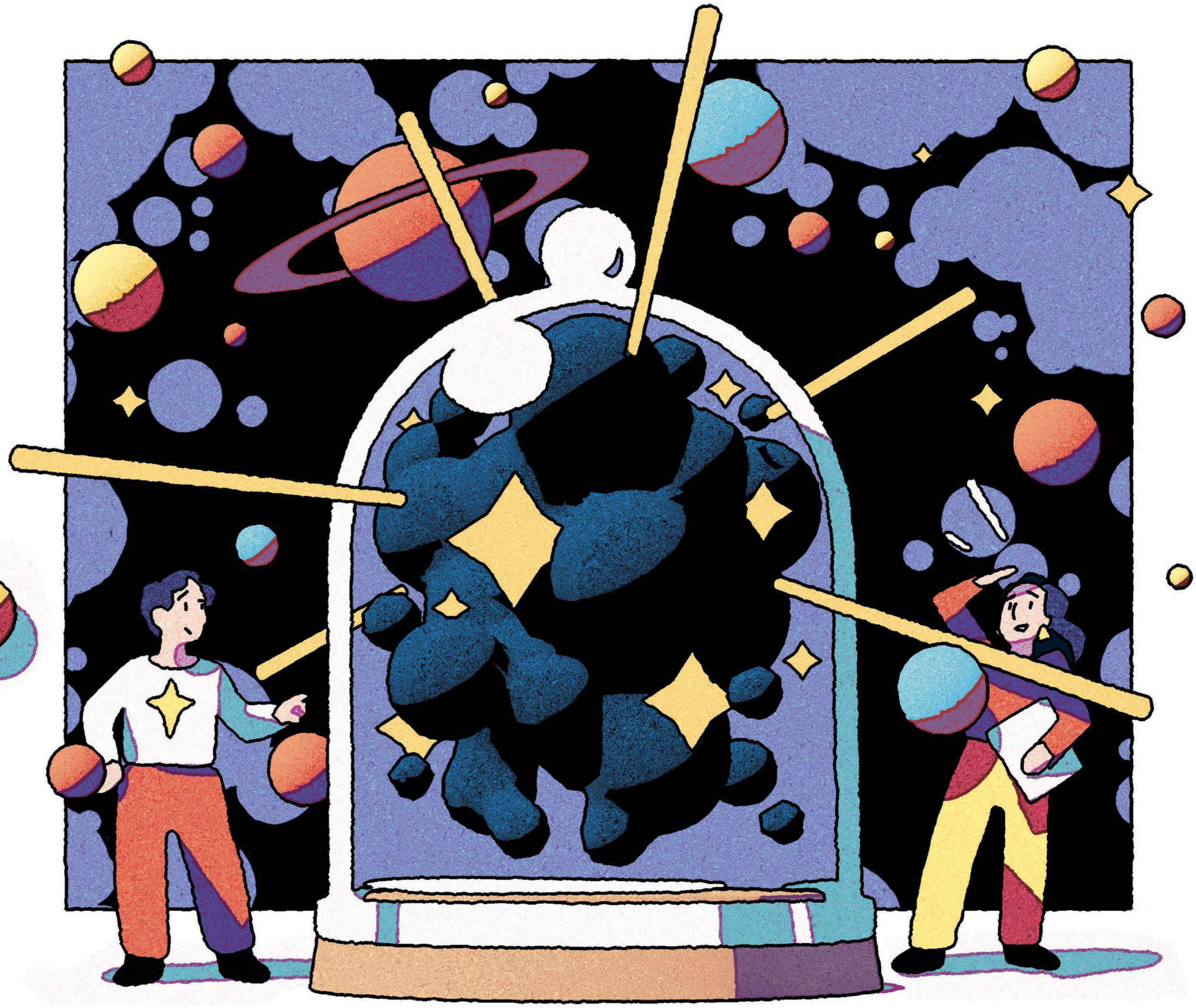

COMMENT

HOW THE FIRST STARS SPLIT THE UNIVERSE APART

Astronomers are delving into the dark period between the light from the Big Bang fading and the birth of the first stars

The light, in the beginning, didn't last.

Everything started out so hot. Pure radiation, at first: drawn from some primeval impulse now lost to the obscurity of over-stretched space-time, hidden behind the wall of fire that seared through every femtometre of an incipient cosmos. There was no source of the light, no ignition point to spread from; it was everything, everywhere, and that everywhere was growing. The cosmos was swelling, space escaping from itself, spreading light across the face of creation until droplets formed: matter was born hot and screaming. The first particles tore through searing plasma in waves, acoustic vibrations spreading and colliding. The Universe was a sea of ions – unpaired protons and electrons, with a sprinkling of helium and other light nuclei – born nuclear-hot from the all-encompassing furnace. The Universe exhaled fire that slowly turned to atomic ash. Positively charged protons and negative electrons spiralled together to form neutral atoms – the first in the Universe – mostly hydrogen, no longer plasma, not ions, but gas. The gas cooled. It became quiet. The Universe rested for 100 million years.

We call the next phase the Dark Ages. (We astronomers are a literal species.) The light from the Big Bang was fading, stretching out toward the radio spectrum; the first stars had yet to ignite. For eons, the cosmos was filled with a dark hydrogen fog, diffusing with the expansion of the Universe, its residual heat fading.

And yet…

The fog could feel its own weight. When the roiling plasma waves cooled, they left their wave crests behind, imprinted in the gas as tiny imperfections. A few more atoms here; a slightly thinner collection there. The mass of an atom is minuscule, but give it time and it'll find its neighbours. The thickest fog formed clouds; the densest clouds formed knots. The knots grew heavier, pulling gas into orbit around them, spinning and crashing together with such force that the gas was compressed into ignition. The same gas that sat dormant for countless ages was, in the centre of the tightest cloud, converted back into a nuclear furnace blazing with heat. The first star was born: Cosmic Dawn.

Amid the thick haze of the cosmos, stars sparked to life: tiny points of blinding light, shining in the darkness. They clustered together where the largest clumps had gathered: the age of the galaxies had begun. Each galaxy was born into a shallow pool of its own light, shrouded from view by the dark, dense clouds that formed it, like a city light smothered by fog. The vagaries of atomic physics make hydrogen an effective star shield: give a hydrogen atom a photon of visible light and it'll consume it entirely, bumping its electron to a higher energy state, only to burp the light out later in a random direction. But this shield is a self-limiting thing. The light from the first galaxies carried harder radiation too: ultraviolet light, so energetic that an incautious hydrogen atom could have its electron not excited, but zapped away entirely. Bubbles of hydrogen-ripping galaxy light began to grow, carving holes in the cold, quiet bulk of the intergalactic gas. Over a billion years, the bubbles filled the cosmos and nearly every hydrogen atom was torn in two, leaving protons and electrons to wander the Universe separately again – not a fire this time, but a diffuse, dissipating haze of once-again ionised gas.

NERISSA ESCANLAR ILLUSTRATION: KYLE SMART

"As we look across the Universe, to galaxies whose ancient light comes to us from farther back in time, we can begin to see the quenching of that light, as though watching a cosmic film in reverse"

We're still learning the story of how the first stars split the Universe apart. We call it 'reionisation', and our knowledge of it comes primarily from its ending. An ionised cosmos is one that is transparent to visible light; as we look across the Universe, to galaxies whose ancient light comes to us from farther back in time, we can begin to see the quenching of that light, as though watching the cosmic film in reverse – the thick neutral gas spreads out and shrouds the galaxies until they're almost entirely hidden from view.

We're fortunate, though, to have ways to cut through the fog. Visible light may be consumed, but longer wavelengths of radiation – infrared, microwave, and radio – can travel unimpeded, and starlight is full-spectrum. With new telescopes like the James Webb Space Telescope, we can peer into the epoch of reionisation by capturing the infrared part of the galaxies' light. With new radio telescopes we may do even better, tuning in to low frequencies of radio light emitted or absorbed by neutral hydrogen itself.

To understand reionisation is to know the first stars and galaxies. Perhaps someday we'll watch them carve away their own natal shrouds, tiny sparks stretching out across a sea of darkness to change it, fundamentally, forever.

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