MESSENGERS OF TIME AND SPACE

WRITTEN BY

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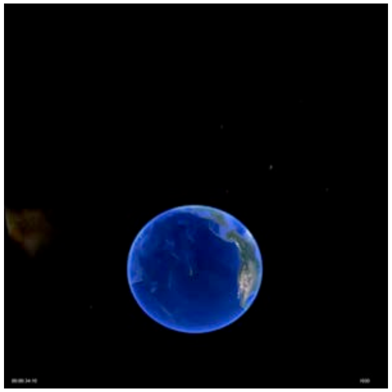
Time code	Narration	Visual description	Preview image
00:00	**SEGMENT 1: WELCOME TO GEMINI!**		
00:20	NARRATOR (V.O.) Among the billions of stars of the Milky Way galaxy, a small, blue, ocean world orbits a single Sun.	Zoom in on the Milky Way. Zoom in on Earth.	
00:34	And, rising from that world’s vast Pacific ocean: the island of Hawai‘i and its high peak, Maunakea, a mountain of profound significance to Native Hawaiians — and also to astronomy.	Zoom in on Maunakea in Hawai‘i.	

00:57	Stable air flows from the ocean across the mountain, creating exceptionally dry and clear skies.	Exterior view of the Gemini North telescope. "Gemini North telescope Maunakea, Hawai'i"	
01:09	As the Sun sets, the Gemini North telescope opens to the heavens, ready to capture light from across the Cosmos.	Interior view of the Gemini North telescope at sunset.	
01:30	Astronomy has come a long way since the days of the lone astronomer peering through a telescope.	FADE TO: A car approaching the Hilo Base Facility.	

01:37

The Gemini North telescope is controlled and monitored from a control room in the nearby coastal town of Hilo.

Exterior front entrance of the Hilo Base Facility.

"Hilo Base Facility
Hilo, Hawai'i"

01:48

CICERO (V.O.)
Every time I come in for night shifts, I feel pumped, I even get butterflies in my stomach. At most telescopes you just follow the plan, and okay, most nights it's like that here too. But with Gemini, there's always the chance you'll get to observe something completely unexpected and just… mindblowing.

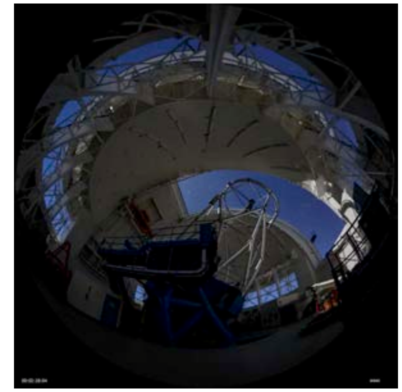
Interior front entrance of the Hilo Base Facility.

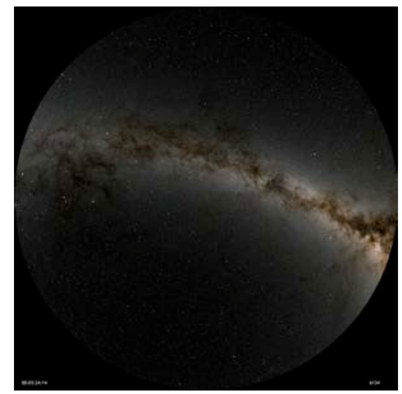
"Cicero Lu
International Gemini Observatory
NSF NOIRLab"

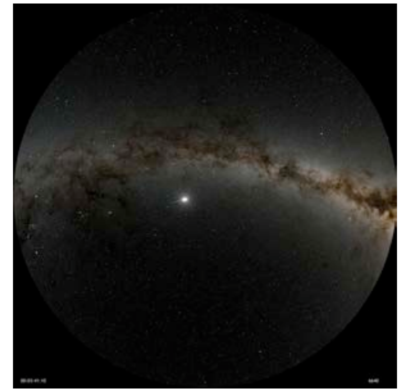
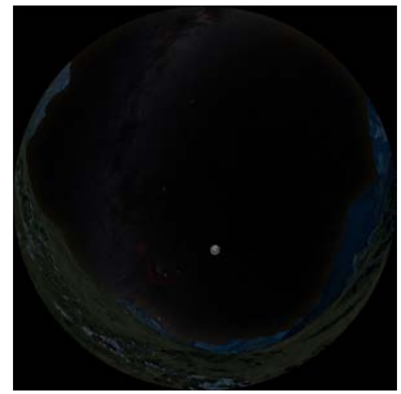
02:17

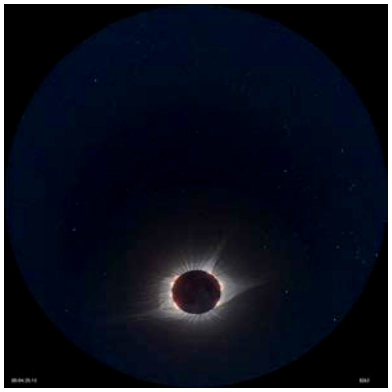
NARRATOR (V.O.)
Detailed observing plans are made in advance, with telescope time allocated to different targets.

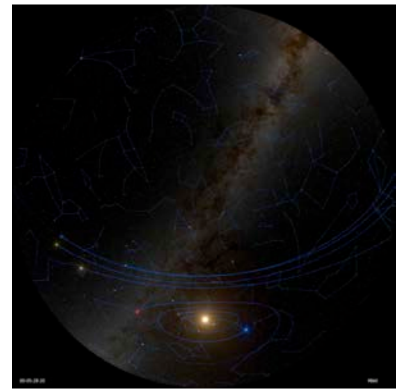
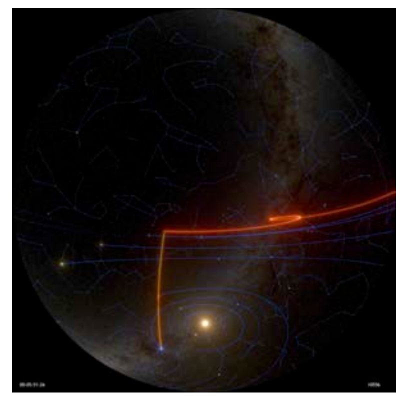
Interior view of the Gemini North control room.

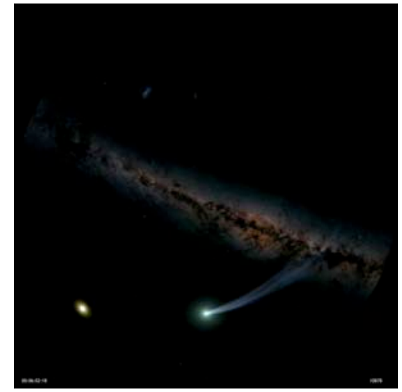
02:26	But, the Universe is dynamic and unpredictable. And at Gemini, everything can change in a moment if something goes bump in the night!	Timelapse of the interior of Gemini North at night.	
02:42	A revolution is unfolding in astronomy, driven by entirely new ways of understanding the cosmos.	FADE TO: Starry sky outside Gemini North.	
02:51	The Gemini North telescope and its southern twin in Chile are forerunners in a collaborative network that includes some of the most ambitious and innovative physics research facilities on Earth.	FADE TO: Starry sky over Gemini South “Gemini South telescope Cerro Pachón, Chile”	

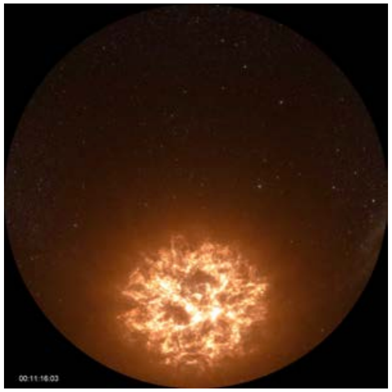
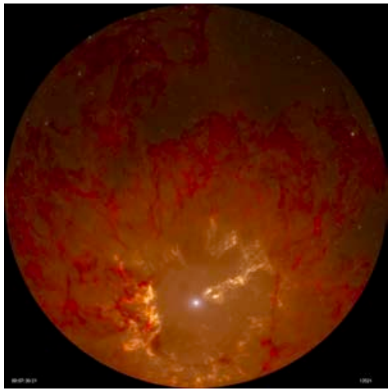
03:17		Title sequence. “Messengers of Time and Space”	
03:24	**SEGMENT 2: THE CHANGING UNIVERSE**		
03:24	NARRATOR (V.O.) Looking up at the dark night sky, the Universe appears calm and tranquil. We see the same stars as our ancestors; their long-traveled starlight delivering the message of their continued existence.	Dark night sky with slow daily motion.	

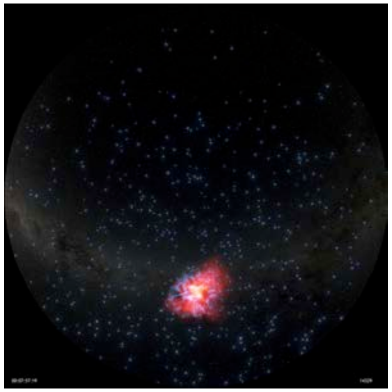
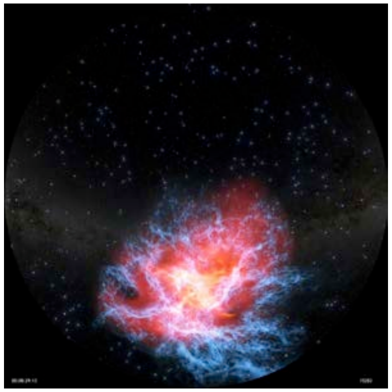
03:40	Yet we also know the Universe to be an active place, where dynamic events can be watched unfolding — even on human timescales. Some of the greatest discoveries in astronomy came from studying such phenomena. Astronomers call them "time-domain events".	Dark night sky showing time-domain events.	
04:05	The most obvious time-domain event is the Moon's changing appearance. Orbiting the Earth each month, it is lit from different angles by the Sun.	Two weeks of moon phases progressing from east to west.	

04:17	By charting the Moon's movements, early astronomers were able to predict its phases and also those rare occasions when the Moon passes directly between the Earth and Sun.	Solar eclipse.	
04:32	A total solar eclipse is an awesome spectacle. With the face of the Sun obscured, its dynamic outer atmosphere is visible, as are the distant stars.	Total solar eclipse with stars visible.	
04:55	In 1919, an eclipse inspired an expedition to west Africa, where stormy skies cleared just in time.	FADE TO: The 1919 total solar eclipse visible through a stormy sky.	

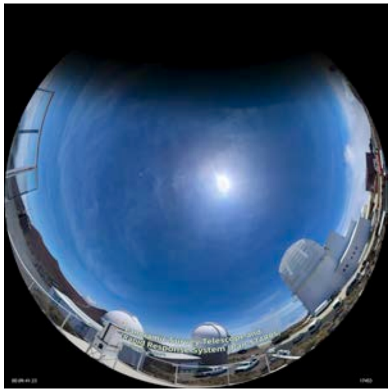
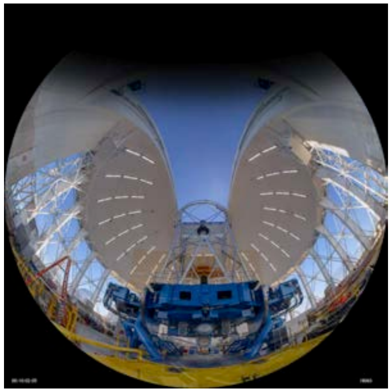
05:07	Photographing stars near the Sun during totality helped to confirm Einstein’s Theory of General Relativity. As predicted, the view of the stars was distorted as their light passed through the Sun’s gravitational field.	Stars visible during the 1919 total solar eclipse.	
05:26	Early astronomers also charted the slow movements of our Solar System’s planets, as seen from the changing viewpoint of our orbiting Earth.	The Moon fades down, the Solar System fades up, with annual motion trails shown in blue.	
05:39	The complex, but predictable, loops and progression of the planets’ positions against the background stars allowed astronomers to determine the structure of the Solar System — and our place within it.	Annual motion continues with the Mars retrograde motion shown in red.	

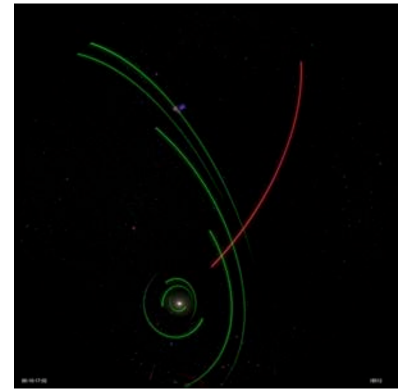
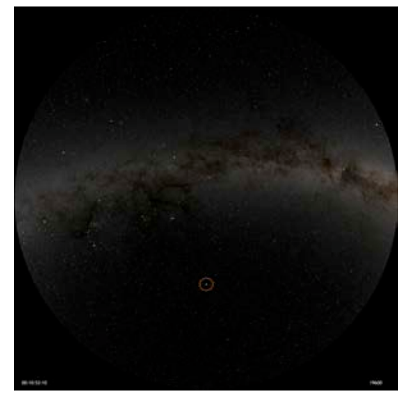
05:58	Later, the more extreme orbits of periodic comets were used to confirm Newton’s Theory of Gravitation. These icy visitors make only fleeting visits from the dark, outer Solar System, shedding tails of dust and gas in the Sun’s warmth. The predicted reappearance of Halley’s Comet in 1758 confirmed the theory’s ability to explain their motion.	Comet orbiting the Sun.	
6:30	**SEGMENT 3: HISTORIC SUPERNOVAS**		
06:30	NARRATOR (V.O.) But the most dramatic time-domain events visible to early astronomers were stellar explosions. These are, however, rare — only a handful were recorded before the invention of the telescope. In China, astronomers noted them as “guest stars”. Records from 1054 describe one particular guest star that grew so bright that it was visible in broad daylight.	FADE TO: A Chinese-style Building with a visible supernova in the sky.	

07:09	We now understand these events as supernovas; the explosive death throes of massive stars.	FADE TO: Supernova explosion.	
07:18	Modern telescopes reveal the aftermath of these violent events. The outer layers of the dying star are ejected across vast distances, forming intricate clouds of gas and dust called nebulae.	Red supernova ejecta.	
07:36	These ethereal structures are enriched by rare elements forged in the ferocity of the explosion. Carbon, oxygen, and iron — the building blocks of life.	Blue supernova ejecta.	

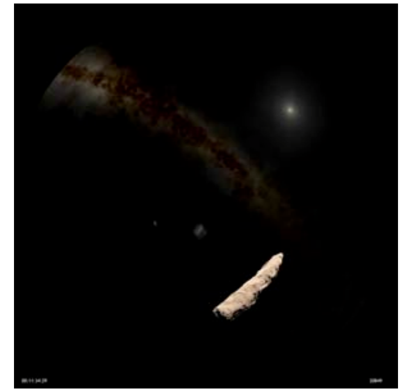
07:54	The remnant of the 1054 supernova is known as the Crab Nebula — a popular target for backyard telescopes. Buried deep within the nebula, only the core of the original star remains — now a neutron star. Crushed to incredible densities by its own gravity, just one tablespoon would weigh as much as a cruise ship.	FADE TO: Crab Nebula.	
08:26	Studying time-domain events allowed astronomers of the past to revolutionize our understanding of the cosmos.	Zoom in on the Crab Nebula.	
08:36	Studying time-domain events allowed astronomers of the past to revolutionize our understanding of the cosmos. But even today the Universe brings us unexpected surprises. The Gemini telescopes are at the forefront of studying such events.	FADE TO: Time lapse of the night sky over Gemini.	

08:51	**SEGMENT 4: GEMINI & ʻOUMUAMUA**		
08:51	CICERO (V.O.) So, you have a plan for the night, but you never know when you might get an alert — that means that another observatory has spotted something weird.	Interior view of the Gemini North control room.	
09:00	Gemini can react super fast, so we are often the first to follow up on these things.	Interior view of the Gemini North dome.	

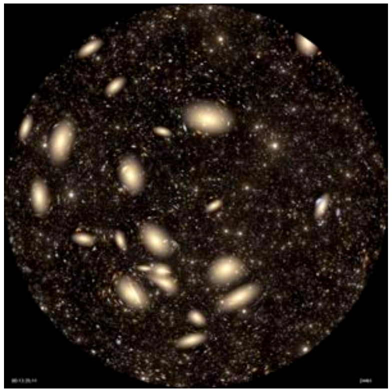
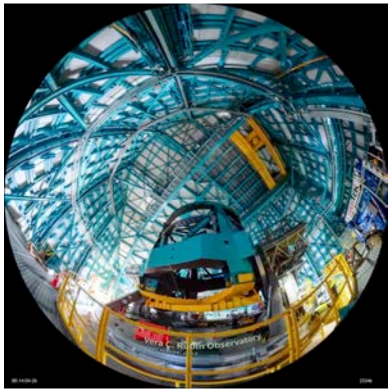
09:15	NARRATOR (V.O.) The Solar System is peppered with small bodies of rock and ice. Telescopes pick them up as tiny dots moving against the background stars. But some aren’t like the others…	FADE TO: Close up of an asteroid.	
09:37	On October 19th, 2017, astronomers using the Pan-STARRS survey telescopes on Maui’s Haleakalā noticed a small object moving against the background stars. But they realized something was strange — given its path, it was going fast, very fast.	The Pan-STARRS survey telescopes on Haleakalā “Panoramic Survey Telescope and Rapid Response System (Pan-STARRS) Haleakalā, Hawaii”	
10:00	They sent out an alert, and Gemini stopped what it was doing to focus on the dot (as did dozens of other telescopes).	Interior view of the Gemini North dome. The telescope slews to a new target.	

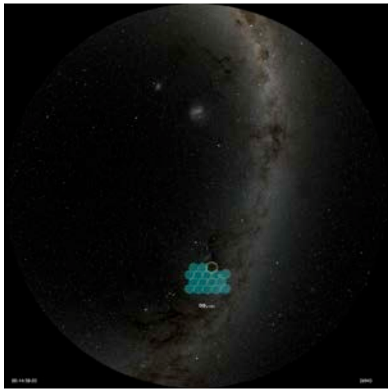
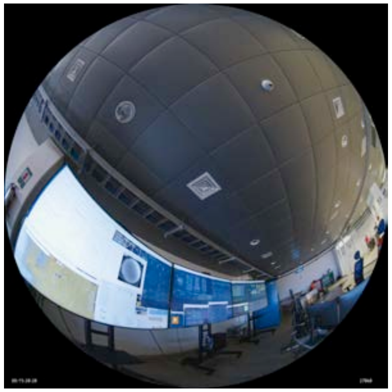
10:15	Asteroids and comets orbit the Sun. But astronomers quickly realised that this new object was not held by the Sun's gravity… rather it was an interstellar visitor passing through the Solar System. Nothing like this had ever been seen before. And there was only a short time to make observations before it departed back into deep space.	‘Oumuamua passing through the Solar System. ‘Oumuamua’s motion trail is shown in red, and the planets’ motion trails are shown in green.	
10:42	Karen Meech, an astronomer at the University of Hawaii’s Institute for Astronomy, was one of the first to study the object. She noticed something else unusual. It was winking!	The telescope view of ‘Oumuamua. The asteroid appears as a dot in the sky changing in brightness. It is circled in orange.	

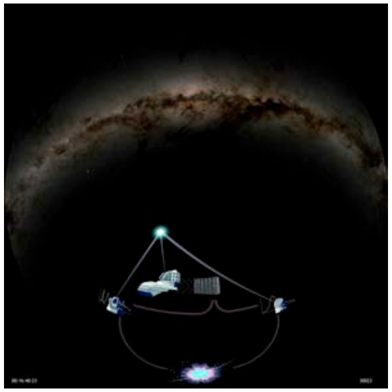
10:55	KAREN (V.O.) There was a brightness range of a factor of 10 to 1, which was remarkable because we'd never seen anything in the Solar System with a brightness range this big.	The light curve of 'Oumuamua showing its brightness over time. The graph is accompanied by a picture of Karen Meech. "Karen Meech University of Hawaii Institute for Astronomy"	
11:07	NARRATOR (V.O.) Brightness variations of small objects like asteroids offer clues to their surface composition, shape, and rotation. As they spin, they reflect different amounts of light. KAREN (V.O.) Taken at face value, this implies that one side is about ten times longer than the other side.	Three more light curves appear under the light curve of 'Oumuamua. Each light curve is accompanied by a rotating 3D model of the asteroid shape it represents.	

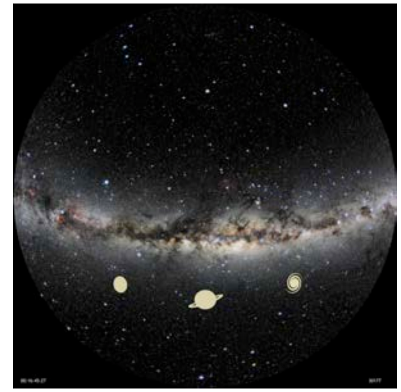
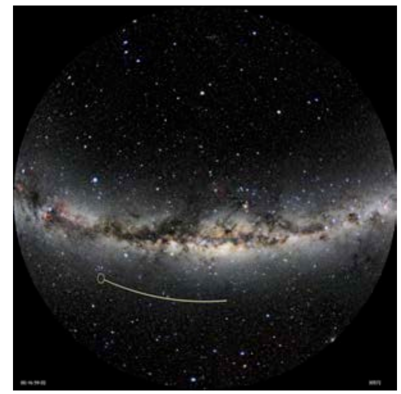
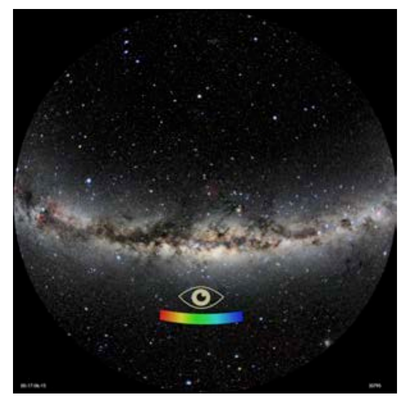
11:36	The interstellar visitor was calculated to be about a quarter-mile long.	FADE TO: Close up of ‘Oumuamua.	
11:49	Later, it would be given a Hawaiian name, to honor the place where it was discovered. The name, ‘Oumuamua, carries the meaning, “a messenger that reaches out from the distant past.”	Pan around ‘Oumuamua.	
12:38	**SEGMENT 5: RUBIN OBSERVATORY**		

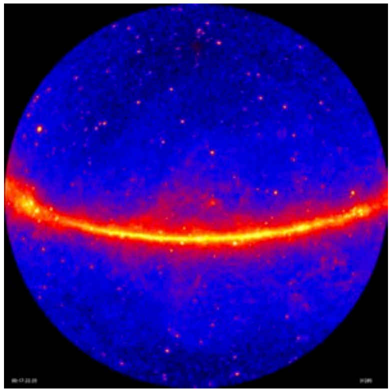
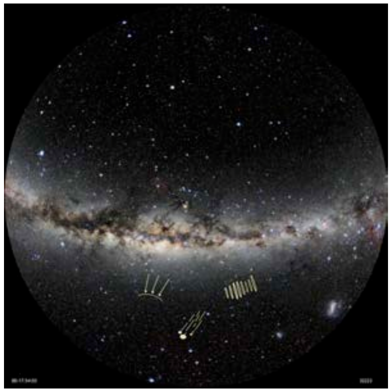
12:38	NARRATOR (V.O.) The ability to react quickly to unusual time-domain events is key to being able to study unusual, fleeting objects. But first… you have to spot them. High on the mountain of Cerro Pachón in Chile, the Gemini South telescope has a new neighbor. An entirely new type of telescope: the U.S. National Science Foundation and Department of Energy’s Vera C. Rubin Observatory.	Aerial view of NSF-DOE Vera C. Rubin Observatory on Cerro Pachón in Chile.	
13:00	Rubin Observatory is named in honor of the American astronomer, who laid the foundation for key areas of modern astronomy. Most notably, by providing the first convincing evidence of the existence of dark matter.	FADE TO: An image of Vera Rubin looking through the eyepiece of a telescope.	

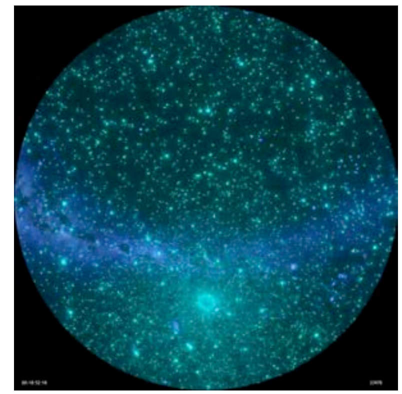
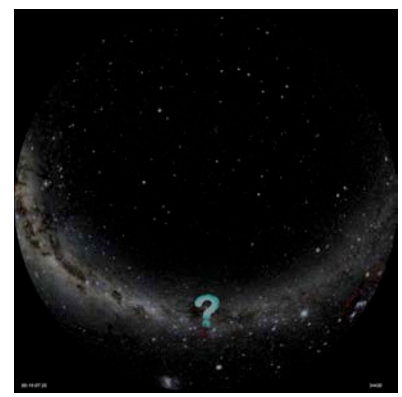
13:35	Dark matter remains one of the greatest mysteries in astronomy. We don't know what it is, but we see the effects of its gravity, in the lens-like distortion of light from distant galaxies, and in the motions of their stars.	Galaxies that appear warped due to gravitational lensing.	
13:59	The Rubin Telescope has a wide eye and nimble grace. In just one glance, it captures light from an area the size of 45 full Moons… giving it the largest field of view of any telescope of its size. By directing light into the world's largest astronomical camera, Rubin is recording the cosmos in incredible detail. One single image would fill 400 ultra-HD TVs.	Interior view of the Rubin Observatory dome. "Vera C. Rubin Observatory Cerro Pachón, Chile"	

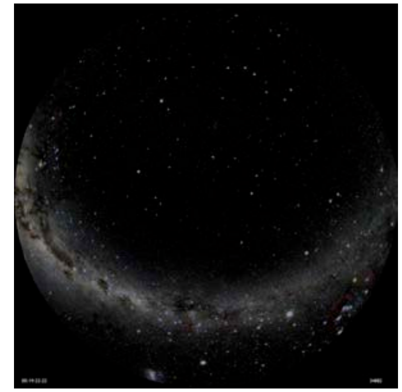
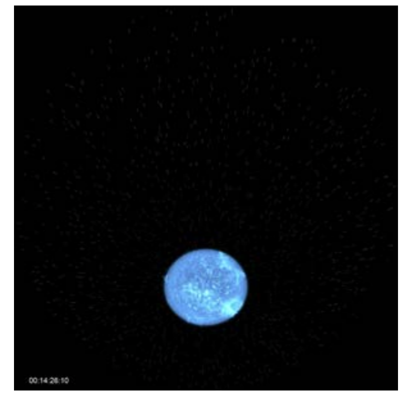
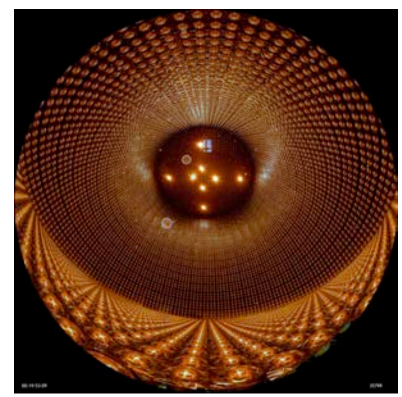
14:44	Despite its size, Rubin is remarkably agile, rotating quickly enough to capture a new image every 30 seconds. At this speed, it can survey the constellation of Orion in just 21 minutes, and the whole sky every two or three nights. By repeatedly scanning the sky over a ten-year period, Rubin is slowly creating the ultimate time-lapse movie, where cosmic time-domain events are the star actors.	FADE TO: Sky showing constellation outlines with Rubin's field of view moving across Orion.	
15:27	A powerful data center compares the rapidly incoming images, spotting even the tiniest of changes from earlier nights. This process generates a flood of new discoveries: from asteroids and comets, to supernova explosions, and events stretching to the extremes of the observable Universe.	Interior view of the Rubin control room.	

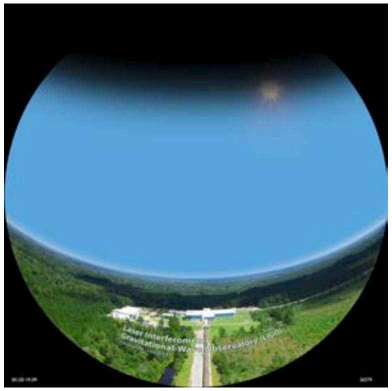
15:52	Where such events were once rare-and-startling for astronomers, Rubin can pick out as many as 10 million every night. This changes everything!	Exterior view of Rubin Observatory at night.	
16:11	The sheer number of new discoveries is overwhelming. Sophisticated computer systems are required to sort out the mundane from the unique, and select the best targets for other observatories around the world to investigate. As Rubin and the global network of observatories scurry to capture light from the dynamic sky, other facilities offer an entirely different perspective on the cosmos.	A diagram of the telescopes in the Astronomical Event Observatory Network (AEON).	
16:43	**SEGMENT 6: LIGHT AND OTHER MESSENGERS**		

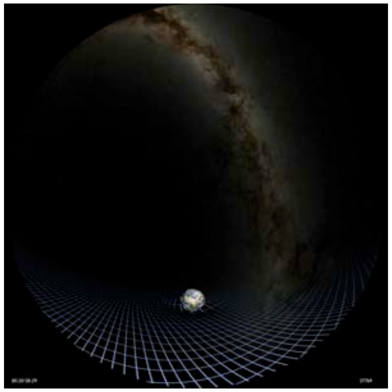
16:43	NARRATOR (V.O.) Astronomers of the past could detect exploding stars, planets, and galaxies because these objects either emit or reflect light toward us.	Graphic of an exploding star, a planet, and a galaxy against a starry sky. Another graphic depicts light being emitted and reflected.	
16:55	Light acts as an untiring messenger, carrying information across the vast void of space.	A graphic depicting a beam of light.	
17:04	Beyond the colors we can see, light exists in other forms, which carry different information. Together, these make up the electromagnetic spectrum, which includes…	A graphic depicting the electromagnetic spectrum and icons to represent each wavelength range.	

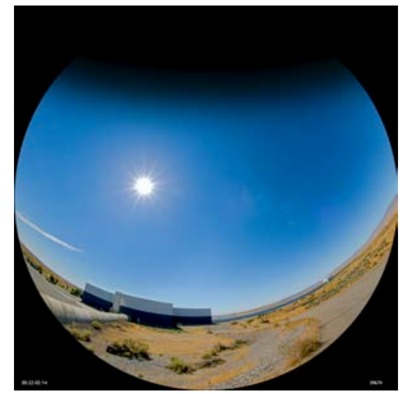
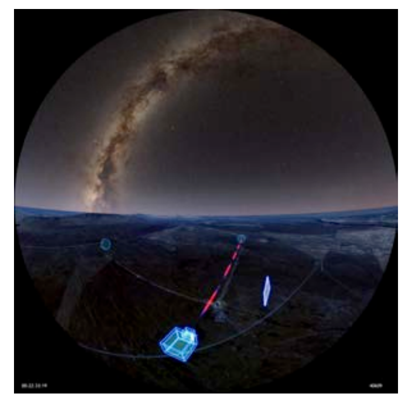
17:17	High-energy gamma rays… Visible light… Infrared… Microwaves… And low-energy radio waves. But we can now go so much further — by going beyond light, to welcome previously unseen messengers, with new stories to tell.	Images of the Milky Way taken at different wavelengths.	
17:47	Messengers like cosmic rays, neutrinos, and gravitational waves. These travelers are invisible and can't be seen. However, they do sometimes reveal their presence…	Graphic depicting cosmic rays, neutrinos, and gravitational waves.	

18:17	The beautiful auroras of the northern and southern skies have entranced sky-watchers for millenia. We now know their light is created when cosmic rays from storms on the Sun collide with the gases of our atmosphere.	FADE TO: Green and purple aurora.	
18:38	Cosmic rays are a mix of particles flung at high speed from stars, supernovas, and the discs surrounding black holes. They hurtle through space at close to the speed of light.	Graphic depicting cosmic ray sources followed by an animation of cosmic rays.	
18:54	In recent years, rare detections of ultra-high energy cosmic rays have also revealed previously unknown sources, which have yet to be explained.	A question mark appears containing the cosmic rays.	

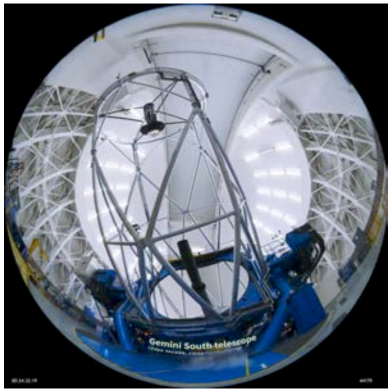
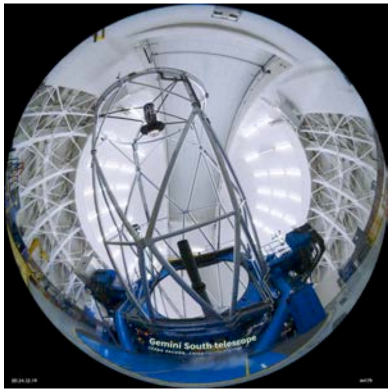
19:08	Cosmic rays often arrive accompanied by more-ghostly companions: neutrinos, which pass quietly — not only through our atmosphere but through our bodies, and the Earth itself.	Night sky with daily motion.	
19:30	Neutrinos move through matter almost entirely unimpeded. Unlike light, they can escape a star’s core directly, bringing information from deep inside our Sun and also early warning of distant supernovas.	Neutrinos leaving a star.	
19:53	Slippery as they may be, neutrinos can be detected. Within vast, subterranean tanks of special fluids, their rare interactions are revealed by tiny flashes of light.	FADE TO: Interior view of the neutrino detector, Super-Kamiokande under Mount Ikeno in Japan.	

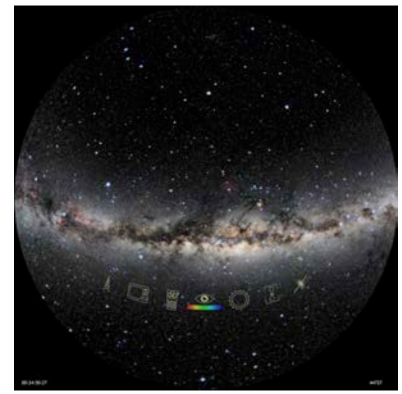
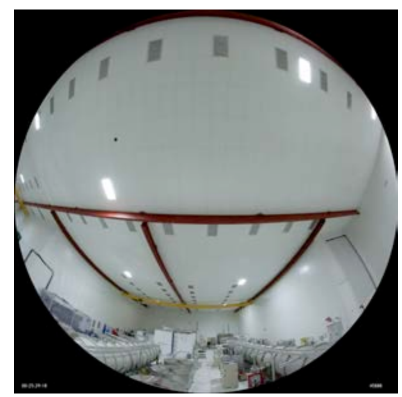
20:19	**SEGMENT 7: LIGO**		
20:00	NARRATOR (V.O.) But, even more elusive than neutrinos are the messages carried across the cosmos in the subtle rippling of the very fabric of the Universe.	Aerial view of LIGO in Louisiana. "Laser Interferometer Gravitational-Wave Observatory (LIGO) Livingston, Louisiana"	
20:32	Located in remote regions of Louisiana and Washington State, the LIGO Observatory's twin detectors are part of a global network of instruments that detect gravitational waves.	Exterior of the LIGO facility in Washington. "Laser Interferometer Gravitational-Wave Observatory (LIGO) Hanford, Washington"	

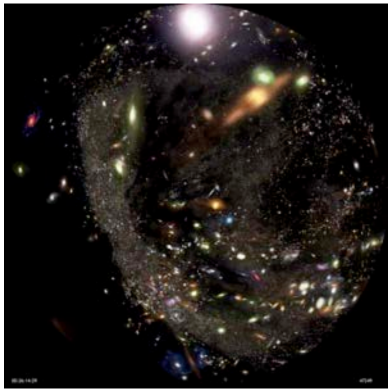
20:48	Gravitational waves are predicted by Einstein's General Theory of Relativity. Einstein showed that gravity is caused by massive objects like Earth distorting spacetime, a four-dimensional continuum of space and time.	2D spacetime grid distorted by gravity.	
21:06	Gravitational waves are formed when moving-objects create distortions in spacetime that ripple outward through the universe at the speed of light. But how do you detect these ripples? The answer is in how they affect the path of light. Only the most powerful gravitational waves can be detected, and even then the measured effect is tiny.	Gravitational waves from binary stars.	

20:43	To achieve this, LIGO and similar observatories must create two perfectly matched beams of laser light.	Interior view of the LIGO facilities.	
21:54	LIGO beams its lasers through a vacuum, down two tunnels set at right angles to each other. Each tunnel is four kilometers long — about two and a half miles. But even that’s not long enough to detect an effect. The light must be reflected some 300 times back and forth along each tunnel.	Exterior view of a laser tunnel at LIGO.	
22:36	If a gravitational wave passes, the space through which the beams travel is distorted, causing the beams to travel slightly different distances, so they are no longer perfectly matched. Even after magnifying the effect by reflecting the beams hundreds of times, the difference is smaller than the nucleus of an atom. But it can be enough to make a detection.	Animation of lasers reflecting back and forth. Close up view of the distance difference and wave pattern.	

23:08	On August 17, 2017, LIGO detected a strong gravitational wave event, confirmed by another detector in Italy.	Interior view of the LIGO control room.	
23:21	Astronomers around the globe scrambled to locate the culprit, and found a rapidly fading light source within a distant, nondescript galaxy known only as NGC 4993.	Zoom in on NGC 4993. Light source circled in orange.	
23:42	An event of this magnitude could only have been caused by the collision of exceptionally massive objects. In this case, the collision of two neutron stars: a rare phenomenon known as a kilonova.	Neutron stars collide and emit gravitational waves.	

24:25	Kilonovas had long been predicted but never before seen.	Kilonova remnant.	
24:30	Dozens of telescopes including Gemini South, SOAR, and the Víctor M. Blanco Telescope worked together to observe the kilonova's changing light.	Interior view of the Gemini South dome and telescope. Followed by an interior view of the SOAR dome and telescope. Followed by an interior view of the Víctor M. Blanco dome and telescope. "Gemini South telescope Cerro Pachón, Chile" "Southern Astrophysical	

		Research (SOAR) telescope Cerro Pachón, Chile” “Víctor M. Blanco Telescope Cerro Tololo, Chile”	
24:26	Light from different parts of the spectrum brought different information. Gamma rays, ultraviolet, x-rays and radio waves. But perhaps the most important story was that told by infrared light. Here, astronomers found evidence of the creation of gold and platinum – an extraordinary discovery that finally solved the mystery of how these heavy elements came to exist in the Universe.	A graphic depicting the electromagnetic spectrum and icons to represent each wavelength range. This is followed by a graphic depicting the elements Platinum and Gold.	
25:24	Without LIGO, the kilonova would have passed unnoticed. And without the quick response of telescopes like Gemini, its significance would have remained unknown.	Interior view of the LIGO facilities.	

25:38	**SEGMENT 8: RETURN TO THE CONTROL ROOM**		
25:38	CICERO (V.O.) It really feels like we're at the brink of something. The question isn't "if" we'll make a world-changing discovery, but "when" or even "how often." It's a privilege to be part of this huge community of astronomers, data scientists, engineers, and everyone else who works to make this possible.	Interior view of the Gemini North control room.	
26:13	**SEGMENT 9: WHAT'S IN STORE?**		
26:13	NARRATOR (V.O.) Time-domain astronomy is coming of age. We are living through a profound transformation in how we study the cosmos. From our small, blue planet, we witness massive cosmic collisions, track interstellar visitors, and chronicle the history of the Universe. This revolution in astronomy is revealing once-hidden wonders and uncovering entirely new mysteries. What new discoveries are waiting to be made? We need only to listen to the whispering Messengers of Time and Space.	Flying through galaxies.	

NSF NOIRLab presents

Messengers of Time and Space

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Animation and Photography

Milky Way Zoom to Maunakea
NOIRLab/NSF/AURA/T. Matsopoulos/Space Engine/Google Maps

Gemini North at Dusk
NOIRLab/NSF/AURA/T. Matsopoulos

Gemini North Interior
NOIRLab/NSF/AURA/T. Matsopoulos

Car Approaching Hilo Base Facility
NOIRLab/NSF/AURA/T. Matsopoulos

Entering Hilo Base Facility Control Room

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Gemini North Interior and Exterior at Night
NOIRLab/NSF/AURA/T. Matsopoulos

Logo and Title Sequence
NOIRLab/NSF/AURA/P. Marenfeld/M. Garrison

Changing Night Sky
NOIRLab/NSF/AURA/R. Proctor

Solar Eclipse
NOIRLab/NSF/AURA/R. Proctor

1919 Solar Eclipse
NOIRLab/NSF/AURA/Double Dome Films

Retrograde Motion
NOIRLab/NSF/AURA/R. Proctor

Comet
Caltech-IPAC/RubinObs/NOIRLab/SLAC/NSF/DOE/AURA

1054 Supernova as Seen from China
NOIRLab/NSF/AURA/T. Matsopoulos/Sketchfab/NASA

Supernova Explosion
ESO/Space Engine/L. Calçada

Supernova Ejecta
ESO/Space Engine/L. Calçada

M1 Crab Nebula
NOIRLab/NSF/AURA/R. Proctor

Gemini North Exterior at Night
NOIRLab/NSF/AURA/T. Matsopoulos

Hilo Base Facility Control Room
NOIRLab/NSF/AURA/T. Matsopoulos

Asteroid
Caltech-IPAC/RubinObs/NOIRLab/SLAC/NSF/DOE/AURA

Pan-STAARS1 Survey Telescope and ‘Oumuamua Time Series
Haleakala Observatory and ESO/K. Meech, et al.

Gemini North Telescope Action
NOIRLab/NSF/AURA/T. Matsopoulos

‘Oumuamua Orbit
T. Matsopoulos/NASA/ESO/M. Kornmesser

Karen Meech Segment
NOIRLab/NSF/AURA/P. Michaud/R. Proctor

‘Oumuamua Flyby
NOIRLab/NSF/AURA/T. Matsopoulos/Space Engine

‘Oumuamua Flyby
NOIRLab/NSF/AURA/T. Matsopoulos/Space Engine

Rubin Observatory Aerial Shot
NOIRLab/NSF/AURA/T. Matsopoulos

Vera Rubin Photo
Archives & Special Collections, Vassar College Library

Galaxy
ESO/L. Calçada/T. Matsopoulos

Dark Matter Lenses in Galaxy Cluster
Dark Energy Survey/DOE/FNAL/DECam/CTIO/NOIRLab/NSF/AURA
NOIRLab/NSF/AURA/R. Proctor

Rubin Observatory Interior
RubinObs/NOIRLab/SLAC/NSF/DOE/AURA/T. Matsopoulos

LSST Camera Footprint with Full Moon
NOIRLab/NSF/AURA/T. Matsopoulos

Rubin Camera Lab
RubinObs/NOIRLab/SLAC/NSF/DOE/AURA/T. Matsopoulos

Rubin Observing Orion in 21 Minutes
NOIRLab/NSF/AURA/R. Proctor

Rubin Observatory Exterior at Night
NOIRLab/NSF/AURA/T. Matsopoulos

Rubin Control Room
RubinObs/NOIRLab/SLAC/NSF/DOE/AURA/T. Matsopoulos

Rubin Control Room
RubinObs/NOIRLab/SLAC/NSF/DOE/AURA/T. Matsopoulos

Telescope Alert Network
NOIRLab/NSF/AURA/P. Marenfeld

Multi-Wavelength Sky and Infographics
NASA/NOIRLab/NSF/AURA/M. Garrison/R. Proctor
NASA/Fermi Gamma-Ray Space Telescope

NASA/IRAS
ESA/Planck
HI4PI Collaboration

Aurora VR Video
Kwon O Chul

Cosmic Rays and Neutrinos Infographics
NOIRLab/NSF/AURA/M. Garrison

Neutrinos from Star
NOIRLab/NSF/AURA/T. Matsopoulos

Super-Kamiokande
Kamioka Observatory, ICRR, the University of Tokyo/NHK Enterprises, INC.
NOIRLab/NSF/AURA/R. Proctor

LIGO Aerial
NOIRLab/NSF/AURA/LIGO/T. Matsopoulos

LIGO Exterior
NOIRLab/NSF/AURA/T. Matsopoulos

Spacetime Grid Distortion
NOIRLab/NSF/AURA/T. Matsopoulos/NASA

Neutron star merger Gravity Waves
ESO/L. Calçada/T. Matsopoulos

LIGO Lab
NOIRLab/NSF/AURA/T. Matsopoulos

LIGO Exterior
NOIRLab/NSF/AURA/T. Matsopoulos

LIGO Laser Arm Drive By
NOIRLab/NSF/AURA/T. Matsopoulos

LIGO Visualization
NOIRLab/NSF/AURA/Double Dome Films

LIGO Control Room
NOIRLab/NSF/AURA/T. Matsopoulos

NGC 4993
NASA/ESA Hubble Space Telescope/NOIRLab/NSF/AURA/T. Matsopoulos

Telescope Montage
NOIRLab/NSF/AURA/T. Matsopoulos

Gold and Platinum
NOIRLab/NSF/AURA/R. Proctor/M. Garrison

LIGO Vacuum area
NOIRLab/NSF/AURA/LIGO/T. Matsopoulos

Blanco Telescope Control Room
NOIRLab/NSF/AURA/T. Matsopoulos

NSF NOIRLab Machine Shop
NOIRLab/NSF/AURA/T. Matsopoulos

View from Blanco Telescope
NOIRLab/NSF/AURA/T. Matsopoulos

Hilo Base Facility Control Room
NOIRLab/NSF/AURA/T. Matsopoulos

Kilonova
NOIRLab/NSF/AURA/Double Dome Films

DESI Galaxies
Fiske Planetarium/DESI Collaboration

Star Map
NASA/Goddard Space Flight Center Scientific Visualization Studio.
Gaia DR2: ESA/Gaia/DPAC Constellation figures based on those developed for the IAU by Alan MacRobert of Sky and Telescope magazine (Roger Sinnott and Rick Fienberg).

Photographic Star Map
NOIRLab/NSF/AURA/E. Slawik/M. Zamani

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2025

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