DANIEL M SOREF PLANETARIUM
Milwaukee Public Museum 800 West Wells Street Milwaukee WI 53233-1478

Stellar Women of Astronomy

FINAL SCRIPT

Introduction

Narrator: Looking back along the cosmic road—we discover amazing women in astronomy! Though opportunities were few, they broke barriers, made discoveries, and changed our understanding of the universe. Their accomplishments are stellar!

Scene 1: Hypatia

One of the first was Hypatia. She lived in Alexandria Egypt and worked at the magnificent library there. She studied many of the Greek astronomical texts and taught her students how to use an astrolabe, a tool to measure the position of the moon, planets and stars.

In Hypatia's time—science was on the decline--and seen as a threat. Sadly, Hypatia was killed and the great Library destroyed.

Over many years, science and astronomy remained in the shadows.
Slowly, the renaissance once again turned human eyes toward the stars above.

Scene 2: Caroline Herschel

Narrator: Working with her brother William, Caroline Herschel discovered eight comets and several nebulae—charting all that she saw.

Back then, the distant objects appeared faint and fuzzy, nothing like the fabulous images we have today.

Caroline and her brother built telescopes too—the largest of their day.

Herschel: *The study of astronomy has taught me to look at the world in a different way and has given me a deeper appreciation for the beauty and wonder of the universe*

Narrator: Caroline was overlooked for years, but today an asteroid and a crater on the moon bear her name.

Scene 3: Maria Mitchell

Narrator: As astronomy grew, more and more women were able to add their voice to how the universe worked.

In 1847, a comet was discovered by America's first female astronomer—Maria Mitchell. But Maria Mitchell accomplished much more than finding a comet.

She became a professor and director of the observatory at Vassar College in New York. And a fearless champion of science education for women.

Maria always encouraged her students to excel and know what science was all about.

Mitchell: *We especially need imagination in science. It is NOT all mathematics, nor all logic, but it is somewhat beauty and poetry.*

Scene 4: Henrietta Leavitt, Annie Jump Cannon & Williamina Fleming

Narrator: Our next stop takes us to Harvard University with three famous astronomers--Henrietta Leavitt, Annie Jump Cannon, and Williamina Fleming. They are a small sampling of the 80 women who worked there.

A theater play called *Silent Sky* reveals huge discoveries by these famous astronomers. Let's drop in.

WILLIAMINA: *She outdid me with those letters.*

ANNIE: *I did no such thing –*

WILLIAMINA: *The star classifications were her idea.*

ANNIE: *A collective effort, I assure you.*

HENRIETTA: *Star classifications? That was your work?*

WILLIAMINA: *Oh yes indeed, the sky was a riot until Miss Cannon coded it. I wanted to give every star a number based on color – but she insisted on labeling stars with letters based on temperature…*

ANNIE: *Ladies.*

WILLIAMINA & HENRIETTA*: O-B-A-F-G-K-M. Yes.*

HENRIETTA: *Oh, you created a . . . standard, Miss Cannon. My goodness. I'm honored. You'll find this funny, but my professor had me memorize the letters by this ridiculous phrase…*

Narrator: Annie Jump Canon's seven letters define star temperatures, gave us the life cycles of stars. The hot stars live in the fast lane and can end in ferocious ways—like supernovae—and maybe a black hole.

Let's see what Henrietta Leavitt reveals about variable stars and their connection to the vast distances of space.

HENRIETTA: *The pulsing is the answer.*

MARGARET: *And somehow musical?*

HENRIETTA: Yes. If you think of the notes as the star's brightness.
If this is the dimmest the star gets. And this is the brightest.
Then the time it takes to get from here - to here - could tell us how bright it actually is, which we could compare to how it appears, which could tell us how far away it is, which we could compare to other stars, which could tell us how far away they are, and if we know that we can, we can skip from star to star across the deepest space until we know…

MARGARET: *What?*

HENRIETTA: *Exactly where we are.*

Narrator: Henrietta Leavitt unlocked the relationship between Cepheid variable stars and the distances to these stars.

She gave us a 3-D map of the universe!

These women were way more than the so-called *Harvard Computers*. They helped build the framework for modern astrophysics.

HENRIETTA: *It's got to be important.*

Scene 5: Cecelia Payne-Gaposchkin

Narrator: Another huge, stellar secret was unveiled by the brilliant mind of young astronomer over 100 years ago.

Cecilia Payne-Gaposchkin discovered what is the Sun made of—hydrogen and helium. From careful analysis of these spectral lines, she deduced the Sun's primary elements.

At the time, her idea was rebellious! It was thought that the Sun was like Earth—made of heavier elements like iron and silicon.

Cecilia Payne-Gaposchkin discovery was dismissed at first. But truth—like starlight—may take time to be seen. But it always shines through.

Scene 6: Katherine Johnson, Dorothy Vaughan and Mary Jackson

Narrator: Our winding timeline pauses to take a closer look at three prominent women who helped America reach space—and walk on the Moon!

Katherine Johnson, Dorothy Vaughan and Mary Jackson—and many other African American women--played a crucial part in helping NASA achieve its lofty space missions in space in the 1960's.

To orbit the Earth safely, as Katherine Johnson figured out,

Johnson: *"Mathematics is the basis of the whole thing."*

Narrator: These *"hidden figures"* loved numbers. Their math expertise calculated the precise trajectories for the rockets and spaceships.

Without them, space flight might have stalled before it ever left the pad.

Johnson: *"Leaving the Moon, going back. That was the part that I worried about. They should be exactly correct on that . And I was sitting there hoping I was right too!"*

Scene 7: Jocelyn Bell Burnell

Narrator: Moving forward, we explore a curious pulsing signal first detected by an aspiring young astronomer in England.

Using a new, strange looking radio telescope, Joceyln Bell Burnell found an unusual, rapid, pulsing pattern in the data that she had collected.

Bell: *"And when that beam shines in your eyes—so to speak—or on a radio telescope, you pick up a pulse. So, it's going… pulse, pulse, pulse, pulse, pulse….*

Narrator: News spread of her discovery, and wild speculation that the signal could be LGM—or Little Green Men, aka aliens.

The radio pulse turned out to be a fast-spinning neutron star, the dense, dead core of a massive star that had gone supernova. It quickly became known as a pulsar. And Jocelyn Bell Burnell discovered the first!

She became a powerful advocate for underrepresented groups in science.

Scene 8: Vera Rubin

Narrator: Another stellar discovery led to a very dark mystery—still waiting to be solved.

Vera Rubin studied the motion of galaxies. By precisely plotting star movements far from the galactic core, she found they moved faster than predicted. Vera Rubin had discovered dark matter—an invisible substance whose gravity keeps galaxies from flying apart.

Vera's described her surprising discovery in these words:

Rubin: *"In a spiral galaxy, the ratio of dark-to-light matter is about a factor of ten. That's probably a good number for the ratio of our ignorance-to-knowledge. We're out of kindergarten, but only in about third grade."*

Narrator: Absolutely. We know so little and the universe is so enormous. And we're just beginning to understand all its workings.

This amazing telescope is called—you guessed it—the Vera Rubin Observatory, located in the dark skies of Chile. It will discover new galaxies, new supernovae, and new asteroids and comets. And may even solve the mystery of dark matter.

Scene 9: Katie Bouman

Narrator: Evidence for black holes has been accumulating for decades—but we never had a picture—until recently, when an amazing engineer and computer scientist…. meet Doctor Katie Bouman.

She helped create this—the first picture of black hole. It is a supermassive black hole at the center of the mega galaxy M87—over 50 million light years away.

Black Holes have strong gravity—but—thankfully—they are very far away. Their distance makes them appear very small—like an orange on the moon's surface.

Bouman: *"In order to see smaller and smaller, we need to make our telescope bigger and bigger. But even with the most powerful optical telescopes here on Earth, we can't even get close to the resolution necessary to image on the surface of the moon. "*

Narrator: So, an incredibly huge telescope was needed. Say hello to the EHT—or Event Horizon Telescope—a collection of telescopes across our planet. They collect massive amounts of data—where Katie—and many others—calculate the algorithms to convert the data into a picture!

She was one of 300 researchers from 80 institutions around the world. As she noted with much humility:

Bouman: *"So everyone knows from the beginning… this was the effort of lots and lots of people for many years."*

Ending

Narrator: Today, the number of women astronomers and physicists today is increasing, but still less than one in four.

Learning about the accomplishments of these women—all they observed, measured, calculated and discovered--provides inspiration for the young women of today. So they might seek careers in astronomy—and other sciences. So, they too might become trailblazers—and stellar women in astronomy!