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# The Life and Pioneering Contributions of an African American Centenarian: Mathematician Katherine G. Johnson



Katherine G. Johnson, in her late nineties.

*Johnny L. Houston*

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I first met mathematician Katherine G. Johnson when I presented her with the National Association of Mathematicians (NAM) Distinguished Service Award at NAM's Regional Conference in Norfolk, Virginia in 1996. The award celebrated her more than 50 years as a productive mathematician, most of these years having been spent with the National Aeronautics and Space Administration (NASA).

Given her necessary security clearance, NAM did not probe Johnson about the nature of her work. For an African American mathematician to have worked at NASA from the 1950s well into the 1980s was itself historic.

The full and extraordinary story of her life and pioneering contributions was revealed to the world in the *New York Times* bestseller *Hidden Figures*, published in 2016 and written by Margot Lee Shetterly. However, Johnson's contributions became best known after the Oscar®-nominated movie *Hidden Figures* was released in December 2016. I was highly impressed with Johnson from what I learned from both the book and the movie. She was a pioneer extraordinary and a brilliant mathematician. Her work impacted the success of NASA's early space flight missions. I was extremely delighted that in her lifetime she has received the awards, honors, and recognitions that many pioneers never live long enough to witness and enjoy. I found her life story itself to be a fascinating one to know.

Katherine Coleman was born on August 26, 1918 in White Sulphur Springs (Greenbrier County), West Virginia as the fourth and youngest child of Joshua and Joylette Coleman. She had a brother Horace (b. 1912), a sister Margaret (b. 1913), and a brother Charles (b. 1915). Her mother was a schoolteacher and her father was a lumberman, farmer, and handyman who worked at the Greenbrier Hotel.

At an early age (her third birthday or younger) she began to speak very articulately and was very curious about knowing details of everyday things that she observed. Her father, with only a sixth-grade education, had an incredible ability for doing math problems. For Katherine, he was the smartest person she knew. She started to count everything she saw and attempted to emulate her father in solving math problems. For Katherine, counting things and constantly learning new information about things became her favorite daily activity. Her mother being a nurturing teacher and her father being a math whiz kept her motivated to learn. Katherine officially began attending elementary school at the age of five.

However, because of what she had learned prior to that age, she was placed into the second grade during her first year of school. When she was eight years old she should have entered the fifth grade but, being such an advanced student, she was placed in the sixth grade of a newly opened school for Blacks. With her advanced placement, she was now a grade ahead of her brother Charles who was three years older than she was. At age ten, Katherine was ready to enter high school. She was viewed by many as a child

prodigy. Her father instilled in her that she was as good as anyone and could achieve whatever she desired, but she was never to think that she was better than others.

White Sulphur Springs had no high school for Black children. Because the Coleman family valued education highly and was determined that their children should have a quality education through high school and college, her parents rented a house in Institute, Kanawha County, West Virginia where their children attended high school and college. Thus, every autumn for eight years, Katherine's mother moved with her children to the rented home. In the summer they would return some 125 miles back to White Sulphur Springs where her father lived in their *home house* and worked, primarily as a farmer and at a hotel, earning about \$100 per month. All four Coleman children completed high school and college under this arrangement of living in two different places during the year.

Katherine entered West Virginia State College High School before her teens and graduated at the age of 14. In high school, she excelled in mathematics, science, and English. In high school she also developed some affinity for astronomy. This was where she met another person who greatly influenced her love for math: Angie Turner King, who taught her geometry in high school. King later taught her math in college and continued to encourage her.

Katherine entered West Virginia State College (WVSC), a Historically Black College (HBCU), in her early teens. As a student at WVSC, she took every math course offered by the college. Several professors mentored her math studies, including chemist and mathematician Angie Turner King, who had also taught her in high school. Katherine said that King was "...a wonderful teacher—bright, caring, and very rigorous." James Carmichael Evans, who had BS and MS degrees from the Massachusetts Institute of Technology, also nurtured Katherine in her study of math. He was a very talented and encouraging teacher who insisted that she must major in mathematics, even though he knew of her strong interests and mentoring in French and English by others. And there was W. W. Schieffelin Claytor, the third African American to receive a PhD degree in math who took Katherine "under his wing." He was a brilliant teacher and researcher. Claytor not only taught her many of her math classes, but he also added new math courses to the curriculum just for Katherine. She recalled that Claytor told her, "You would make a good research mathematician" (after her sophomore year), and he continued, "I am going to prepare you for that career." According to a videotaped interview with Katherine, one of the courses Claytor created for her was analytic geometry, which was invaluable to her in her work at NASA. She was very fortunate to have had Claytor as a teacher. He only taught at West Virginia State College from 1934 to 1937. Katherine graduated from WVSC summa cum laude at the age of 18 in 1937 with degrees in mathematics and French; she had joined Alpha Kappa Alpha sorority while a student.

After graduation from college, she took a teaching job at a Black public school in Marion, Virginia. She was offered the job in Marion because she could teach math, teach French, and play the piano. In 1939, Katherine married James Francis Goble, who was called "Jimmy" by his friends. He worked as a high school chemistry teacher in Marion. This marriage produced three daughters: Constance, Joylette, and Katherine. All three became mathematicians and teachers.

In 1940 (before having children), Katherine enrolled in a graduate math program. She entered the graduate program at West Virginia University in Morgantown, West Virginia, the flagship university for the state of West Virginia that had been reserved for White students only. She was the first African American woman to attend the university's graduate school. This was facilitated with the courage of and assistance from WVSC's president, Dr. John W. Davis. He selected her as one of three African American students (she was the only female) to integrate the graduate school after the United States Supreme Court ruling *Missouri ex rel. Gaines v. Canada* (1938). The court ruled that states that provided public higher education for White students also had to provide it for Black students, to be satisfied either by establishing Black colleges and universities or by admitting Black students to previously White-only universities. Katherine spent a term at the University but left the program after she became pregnant. She chose to give priority, at that time, to raising a family. Jimmy and her parents supported her decision.

Katherine returned to teaching when her three daughters grew older. She taught in Morgantown and Bluefield, West Virginia. However, it was not until 1952 when a relative told

her about open positions in mathematics at the all-Black West Area Computing Section at the National Advisory Committee for Aeronautics (NACA), Langley Laboratory, Hampton, Virginia that she desired a different use of her mathematical talent. The program was headed by Dorothy Vaughan, whom she had met some years earlier in West Virginia. Katherine and her husband, Jimmy, decided to move the family to Newport News, Virginia to pursue this opportunity. The NACA had stopped hiring in 1952 when they arrived and she worked as a substitute teacher for a year. Katherine was hired by Langley the next year and began work there in the summer of 1953. Just two weeks into Katherine's tenure in the office, Dorothy Vaughan assigned her to a project in the Maneuver Loads Branch of the Flight Research Division. Katherine's temporary position with the previously all White research team soon became permanent. She spent the next four years analyzing data from flight tests and worked on the investigation of a plane crash caused by wake turbulence. As she was completing this work, her husband Jimmy died from a serious medical challenge in December 1956.

Katherine sang in the choir at Carver Memorial Presbyterian Church in Newport News, Virginia for 50 years. The minister there introduced James A. Johnson to her. He had been commissioned in 1951 as a Second Lieutenant in the United States Army and was a veteran of the Korean War. In 1959, the two married. Katherine had no additional children with her second husband.

Both in the West Area Computing Section and in the Flight Research Division, Katherine worked as a "human computer," doing the complex math calculations for airplanes and space flights. NACA disbanded the "Colored



Katherine G. Johnson working at NASA in the 1960s as a "human computer," physicist, and aerospace technologist in an all-White research division of engineers.

Human Computers Group” in 1958 when it was superseded by NASA, which adopted digital computers. In the Research Flight Division, where she was the only Black, all the Whites were hired as engineers and Katherine was considered a “human computer,” a mathematician, a physicist, and an aerospace technologist. During the NACA era, Katherine had to leave the Research Flight Division and go back to the West Area Colored Section to use the restroom, eat, or retrieve something out of her locker. Her questions about her daily inconveniences had a great impact on persuading NASA to eradicate its segregated facilities in the early 1960s. At NASA, she fulfilled Claytor’s prophecy and vision. She became a world-class research mathematician on the stage of the largest grand challenge problem of the time: successfully conquering the frontier of space flights to other celestial bodies in space. Katherine G. Johnson made many pioneering contributions on this grand challenge stage. For the sake of brevity of this document, only 15 will be listed.



Katherine G. Johnson’s primary contributions at NASA were in computational science and research. In 2017 NASA opened and named in Johnson’s honor the above state-of-the-art 40,000 square-foot Computational Research Facility at NASA Langley in Hampton, Virginia.

### Fifteen of Katherine G. Johnson’s Major Pioneering Contributions to Space Flight History:

- A. Katherine Johnson was the first African American and the first woman to work in NASA’s Research Flight Division.
- B. She was the first African American and the first woman to attend NASA’s Research Test Flight Briefings where the fundamental problems of a space flight mission were presented, discussed, and analyzed; she specifically requested to be able attend, and they honored her requests.
- C. She was the first African American and first woman to have her name placed on a Scientific Report at NASA; however, she actually did major work on many earlier

reports for which she received no written credit or recognition in the report itself. The first report with Katherine’s name on it was major for NASA [8]. It contained the theory necessary for launching, tracking, and returning space vehicles and was used for the famous space flight by Alan Shepard in May 1961 and the flight of John Glenn in February 1962.

- D. Currently, there are more than twenty five scientific reports in the NASA archive in space flight history that Katherine authored or co-authored, the largest number by any African American or woman.
- E. From 1958 until her retirement in 1986, Johnson worked as an aerospace technologist in the Spacecraft Controls Branch where all final decisions were made for space travel; she served as NASA’s premier research mathematician at the time.
- F. She calculated the trajectory for the May 5, 1961 flight of Alan Shepard, the first American to travel in space.
- G. She also calculated the launch window for Shepard’s 1961 Mercury mission.
- H. She plotted backup navigation charts for astronauts in case of electronic failures.
- I. When NASA used electronic computers for the first time to calculate John Glenn’s orbit around the Earth, NASA’s officials called on Johnson to verify the computer’s numbers. Glenn specifically asked for Johnson’s verifications, and he refused to fly unless she verified the calculations. These were very difficult calculations; they had to account for the gravitational pulls of celestial bodies.
- J. As NASA began relying heavily on digital computers, they used Johnson’s calculations to help them check the accuracy of the computers; her validations caused NASA to establish confidence in the new digital computer technology.
- K. In 1961, NASA used Johnson’s calculations of trajectories to help to ensure that Alan Shepard’s Freedom 7 Mercury capsule would be found quickly after landing.
- L. Johnson also helped to calculate the trajectory for the 1969 Apollo 11 flight to the Moon.
- M. In 1970, Johnson worked on the Apollo 13 moon mission; her work on backup procedures and charts helped set a safe path for the crew’s return to Earth.
- N. In case of malfunctioning, Johnson had helped to create a one-star observation system that would allow astronauts to determine their location with accuracy.
- O. Later in her career, Johnson worked on the Space Shuttle Program, the Earth Resources Satellite, and on plans for a mission to Mars.

In recognition of her life and contributions as a role model, a scholar, an educator, and her pioneering career as a research mathematician with NASA in space travel, Johnson has received many awards, honors, and recognitions. For the sake of brevity, only 20 will be listed.

**Twenty of Katherine G. Johnson's Awards, Honors, and Recognitions:**

- A. 2019 (January 18) the National Association of Mathematicians, NAM's Centenarian Award
- B. 2018 (August 25) West Virginia University, Morgantown, unveiled a life-size bronze statue of Katherine Johnson on campus and established a STEM scholarship in her name
- C. 2018 (May 12) College of William and Mary awarded her an Honorary Doctorate Degree
- D. 2017 (September 22) The Katherine G. Johnson Computational Research Facility at NASA Langley in Hampton, Virginia opened and was named in her honor (40,000 sq. feet)
- E. 2017 received Daughters of the American Revolution Medal of Honor
- F. 2016 Oscar®-nominated movie *Hidden Figures* profiled her life as a "colored human computer" and a research mathematician at NASA
- G. 2016 received Presidential Honorary Doctorate of Humane Letters from West Virginia University, Morgantown
- H. 2016 *New York Times* bestseller *Hidden Figures*, by Margot Lee Shetterly, profiled her life as a scholar, an educator, a "colored human computer," and a research mathematician at NASA
- I. 2016 received the Space Flight Industry Silver Snoopy Award from Leland Melvin
- J. 2016 received the Astronomical Society of the Pacific's Arthur B. C. Walker II Award
- K. 2016 listed as one of the 100 most influential women worldwide by the BBC
- L. 2015 received National Center for Women and Information Technology's Pioneer in Tech Award
- M. 2015 received the Presidential Medal of Freedom from then president Barack Obama
- N. 2014 received the De Pinza Honor from National Women History's Museum



Having recently celebrated her centennial birthday, Katherine Coleman Goble Johnson has lived to receive many awards, honors, and recognitions for her pioneering work. One such award was the Presidential Medal of Freedom from President Barack Obama in 2015.

- O. 2012 selected as a Science History Maker (now archived in the Library of Congress)
- P. 2010 received an Honorary Doctor of Science from Old Dominion University, Norfolk, Virginia
- Q. 2006 received an Honorary Doctor of Science from Capitol University, Laurel, Maryland
- R. 1999 selected as West Virginia State College Outstanding Alumnus of the Year
- S. 1998 received an Honorary Doctor of Law from SUNY, Farmingdale, New York
- T. 1996 received the National Association of Mathematicians Distinguished Service Award
- U. 1971, 1980, 1984, 1985, and 1986 received NASA Langley Research Center Special Achievement Award

**In Her Own Words: Quotes from Katherine G. Johnson**

- A. I like to learn. That's an art and a science.
- B. Let me do it. You tell me when you want it and where you want it to land, and I'll do it backwards and tell you when to take off.
- C. Girls are capable of doing everything men are capable of doing. Sometimes they have more imagination than men.
- D. We will always have STEM with us. Some things will drop out of the public eye and will go away, but there will always be science, engineering, and technology. And there will always be mathematics.
- E. I don't have a feeling of inferiority. I never had one. I'm as good as anybody, but not better.
- F. Like what you do, and then you will do your best.

On August 26, 2018, Katherine Coleman Goble Johnson completed her 100th trip around the Sun, becoming a highly distinguished centenarian African American mathematician. Katherine G. Johnson lives in Hampton, Virginia. She continues to encourage her grandchildren and students to pursue careers in science, technology, engineering, and mathematics (STEM).

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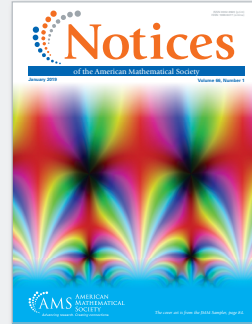
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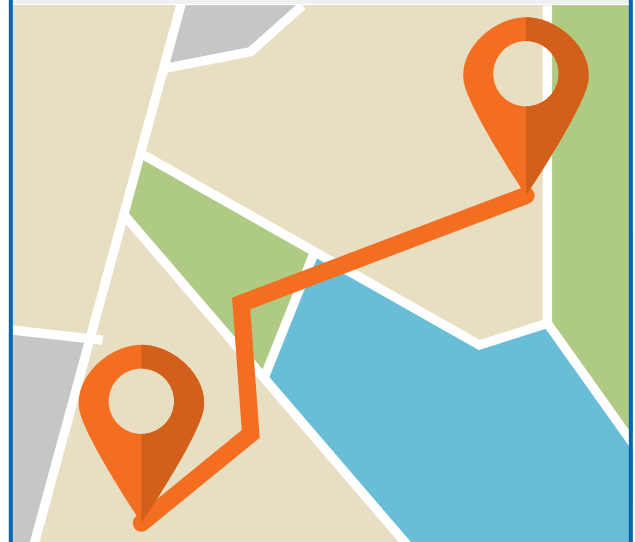
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