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Mini Review

Inspiring Practitioners of Science (IPS)[$]

Part 01: John C. Mather, NL

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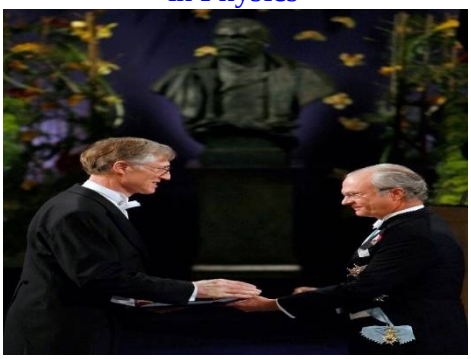
Dr. John C Mather(1946)

2006 Nobel Prize winner in Physics



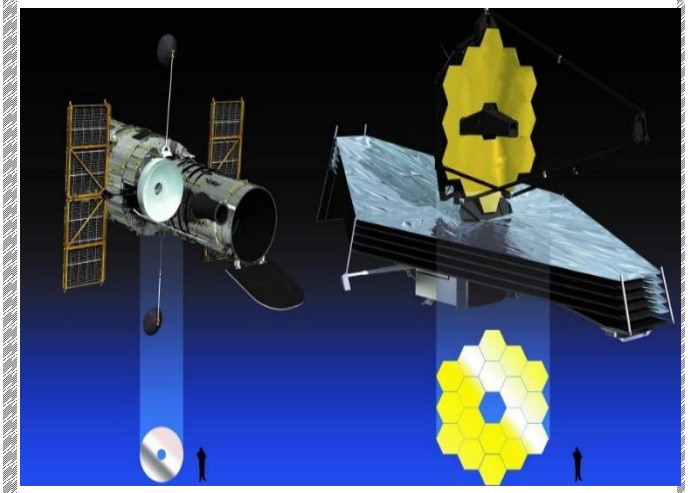
Webb senior project scientist, NASA Goddard

Senior Astrophysicist in the Observational Cosmology Laboratory located at NASA's Goddard Space Flight Center, Greenbelt, Md

[$]**Dedicated to "J. Applicable Chemistry" during Start of second decadal (2022-2031) publication era**

Single Sentence Summary (SSS): Dr. John C Mather was awarded Nobel Prize in Physics for his scientific contributions in COBE (Cosmic Background Explorer) research; His brain wave for next generation (post-Hubble era) space telescope culminated into JWST revolving in L2 orbit (one million miles from our earth) with quarter century effort of twenty thousand scientists, engineers, soft-hardware-experts (She) from twenty-nine countries with a budget of $10 billion to probe into getting small answers for big-questions (origin-evolution-of-universe; origin of life) asked repeatedly and those unasked (because they are not yet flashed in the human brain).

Graphic brief: JWST stood on shoulders of Yester years giant space telescopes (viz.Hubble and Spitzer) and thus able to see farther and farther in distance, closer and closer to Bing bang period with finer and finest details(Carina Nebula)
https://youtu.be/Mmc1Y_FTcWY?t=102



- ✓ Left: NASA/ESA Hubble Space Telescope
- ✓ Right: JWST

credit: Future/Adrian Mann

- Left : Hubble (How Carina Nebula appears to Hubble'seye.Vis)
- Right" Webb (How Webb sees the Carina Nebula with IR.eye)
  - ✓ Eye.Infrared Sees more stars (i.e. nearer to reality or truth)

Evolved eye perceives truth
https://youtu.be/Mmc1Y_FTcWY?t=7

Keywords: COBE research; JWST; John C Mather; NASA; universe; life; origin/evolution; biggest space telescope;

Layout

1	Childhood of John C. Mather	7	COBE
2	Formal Education	8	Nobel Prize
3	Extra-curricular Science flare	9	JWST
4	Higher Education	10	Science mission
5	Research studies	11	Future Telescopes
6	Employment		

	Appendices
Appendix I	Universe (nature) -- Riddles-to-Science yet-Unanswered
Appendix II	Awards, Prizes, Medals to John C. Mather
Appendix III	Books by John C. Mather
Appendix IV	Photo gallery – Nobel award 2006

1. Childhood of John C. Mather: John C. Mather was born to Robert E. Mather and Martha Cromwell Mather on 7th August, 1946 in Roanoke, Virginia, a small city near Blacksburg. Many of the members of the family on both sides were indulged in teaching or science practice.

His father was a PhD from the University of Wisconsin and worked as a research scientist with expertise in statistics anddairy cattle breeding/feeding(a sub-discipline of animal husbandry). When John was about a year and a half old, the family moved to the Rutgers Agricultural Experiment Station. The work station was also known as the Dairy Research Station, in Sussex County, New Jersey. Robert developed a test to measure the protein content of milk which led to re-optimization of the dairy industry to produce more protein and less butter. He was one of the early users of computers and managed milk production records of 10,000 cows on punched IBM cards.Robert was a young faculty member at the school also, later called Virginia Tech. John's mother, Martha Cromwell Mather, was teaching French in the high school. John's maternal grand-father, Hobart Cromwell, was a bacteriologist with Abbott Laboratories in suburban Chicago and had reputation as wise and gentle in his professional life.

Childhood of John C. Mather from age of 2 to 15 was spent in an abode at the top of a long hill on a farm country, far away from city lights. The obvious fortune was his closeness to his father's scientific equipment. He enjoyed the rare opportunity to perceive and understand the stars with the aid of the telescopes he assembled from mail order kits.

2. Formal Education

Elementary school: Mather started his formal learning at Wantage Consolidated Elementary School (with about 600 students) near Sussex, N.J. That school was established in 1930's. He is not among the athletes group, although most of the childrenwith formers' background excelled at baseball and wrestling. However, his attention always was towards nature and science. He used to read a book hiding it behind the desk while the other students learned from class.

At nine years itself, he was sure that his liking was around scientific and engineering things, including electronics.

High school: Mather's parents decided his studies after 8th grade at Newton High Schoolwhich was nearby their home. The choice was based on information that it was the best education centerthere. In

fact some excellent teachers taught classes in science, math, and English. He learntbiology in 9th grade, chemistry in 10th grade, and physics in 11th grade.

3. Extra-curricular Science flare

Parents' promotion of intellectual talent: His parents took him and his sister to American Museum of Natural History in New York,. Mars was very close to the Earthwhich seemed to himforever. His father bought a small telescope from Sears Roebuck. Mars was extremely small even with the telescope and also could not show the canals. He also bought a book *Astronomy Made Simple*. His family culture was that his parents enjoyed reading aloud biographies of Darwin and Galileo and various other science books.

Little John was fascinated with museum displays of the sequence of different kinds of skeletons of fishes, showing their changes through time. It stamped in his brain that evolution was natural and so obvious. He hunted for fossils in the roadside streams, He built little dams of mud and pebbles. His parents gave substantial research grant when he was only about 11 years old. The cumulative effect was that he had a lot of opportunity to learn science, even in the very rural back-ground.

He performed an experiment with eight baby rats to infer what diets they need. He kept cages with rats under a table in the kitchen. His mother showed enormous patience such chores. His father taught him how to design a Greco-Latin square for the experiment, and also procedure of analysis of variance of data. The information the little boy derived was corn flakes alone are inadequate and dog food and vitamins are good. This was experiment was for his science fair project.

Personal enthusiasm in science: At aroundsix yearsof age, Matherrealized thateven after filling an entire page with digits, one does not arrive at the largest possible number. So, he sawwhat could be infinity; not expressible with a paper and pencil tool in conceivable timeat the level of his mind.

He was fascinated in reading everything that came his way. He fed his mind with information in the books from the Sussex County bookmobile, a traveling library that visited the farms every couple of weeks.

In one summer, he studied calculus borrowing the textbook instead of attending an advanced science course in high school. This bestowed confidence in self-study and going ahead to normal schedule. The knowledge acquired was a good buffer when he later joined the college.

John made a beginning in optics and assembled small refractor telescopes ordering lenses from Edmund Scientific co with savings in his allowances. He built shortwave radio kits. Mather designed a robot with vacuum tubes and remote controls for another science fair project, but it never worked. Yet, that activity left a lot of experience with him. He received a one-tube radio kit as Christmas gift. Subsequnently, he upgraded to 5-tube shortwave Heathkit radio with the money from his savings.With thishe could listen to exotic languages and broadcasts from far-away places;really a rich experience. He never got very excited about dairy cattle science.

Participation in Science fairs: His first entry in school science fair was with four little projects when he was in 4th grade. None else there had interest in science exhibitions at that time. Afterwards, he attended summer science programs sponsored by the National Science Foundation, including a summer physics program at Cornell University.

Summer schools: Mr. Mather got opportunity to attend NSF sponsored summer programs in Mathematics and Physics after his 10th and 11th grade curriculum. At Assumption College, he learnt foundations of Mathematics. The introduction to quantum mechanics, special relativity, optics, nuclear physics, and cosmology at Cornell University were extraordinary for high school students. This training ensured him to orient towards a career in science and strive for bright future.

State and National level talent contests: John Mather stood in 7th position in nationwide math contest and first in statewide physics competition.

4. Higher Education

Under graduate College: Mather had a pretty good feeling to further the studies at college. His parents were consciously cautious to advise him that he should work hard during under graduation programme. Also, he may carry the idiom that thitherto he was a big fish in a small pond. So, it is imperative to face the challenges which come in the real big world from then onwards. Mather opted Swarthmore College inspired by its excellent physics program. He continued to excel in physics as an undergraduate.

He was not good in humanities and the arts. But he tried piano lessons again with enjoyment but not to develop skill or talent. Mathers kipped the second half of freshman physics and dived right into sophomore physics. Being a honors student he should get through all four seminars in math, four in physics and two in astronomy. David, professor at Princeton put him a question about every day effects of relativity and Mather said that magnetism was a relativistic effect of electron motion. In the later years, David was chosen as a founding member of the COBE.

Fellowships to John C. Mather		
1964-1968	Swarthmore College	Open Scholarship (honorary)
1967	William Lowell Putnam Mathematical Competition	30th place nationwide
1968	Highest possible score (990)	Physics Grad Records
1968	Fellowship (1968-1970)	NSF Fellowship honorary Woodrow Wilson Fellowship
1970	Fellow(970-1974)	Hertz Foundation
1974	Postdoctoral Fellow (1974—1976)	NRC

1968	B.A. (Physics)	Highest Honor: Phi Beta Kappa	Swarthmore College

Military service: He suffered from extreme nearsightedness. So, he was not drafted as a soldier for military service during the Vietnam War.

Graduation at University of California at Berkeley: Mathur was the receipient of NSF fellowship for graduation study. Although he chose Princeton initially he shifted to Lawrence Berkeley Laboratory as the scholarship was transferable. He had a summer job there to work with Henry Frisch on control electronics for a spark chamber. Inspired by Richard Feynman, his hero, he wanted to becomean elementary particle physicist. But due to Vietnam War, he chose another path.

5. Research studies

Thesis project: The idea of developing nuclear fusion power for the good of humanity was felt by his professor as an extremely long and difficult goal with many obstacles and also with no sure end product. Mather joined the group of Charles Townes (1964 Nobel Prize awardee in Physics) and Paul Richards to pursue the research in newly discovered Cosmic Microwave Background Radiation (CMBR).

M WRCOBE satellite project: Microwave radiation has been dispersed throughout space all through the ages. It is a cool remnant of the first light released when the universe started its expansion 13.7 billion years ago with big bang. Thus, that was another exciting heavenly world compared to long indulged toil of assimilating from books, classes routine experiments. The deemed project of building a small far infrared spectrometer, taking it to the Barcroft station on White Mountain in eastern California was a success.

+ It resulted in a few research publications.
  - But the instrument was of limited accuracy mainly due to the interference of the Earth's atmosphere. Thus, the spectrometer failed to gather the intended data
➔ The next trial was to launch a spectrometer in upper atmosphere with a weather balloon
  - It also failed
• Yet, Paul, his adviser agreed for the successful part of the scheme and
  o Mather got his Ph D for ground-based work and design of the balloon instrument.
  ? But, his dream of exploration of cosmic origins had come to a dead end!!!

1974	Ph.D. (Physics)	4.0 GPA	Univ. of California at Berkeley

Post-Doctoral studies at Goddard Institute for Space Studies: In Jan1974, Dr. Mather joined National Research Council postdoctoral fellow at the Goddard Institute for Space Studieswith scientist, Pat Thaddeus. He performed theoretical and observational studies on naturally occurring SiO masers. The team observed the SiO emission at 43 GHz, which was never seen before in space.

Mather developed a giant Fortran program on the IBM 360 computer. But it never yielded anything worthwhile.
  - This added another defeat to the list

On advice of Pat, the group proposed a mission with four instruments, namely, far IR interferometer to measure the CMBR spectrum, two instruments to measure its anisotropy (difference in brightness in different directions), and an instrument to hunt for the diffuse IR background from the first galaxies in the universe. None of proposers have any prior experience with space missions.

! They were unaware that for this NASA project, there were around 150 proposals including those from JPL and Berkeley group.

However, NASA was interested and sanctioned a little money to see whether the spectrometer could be miniaturized if given a ride to space as some part of the IRAS (Infrared Astronomical Satellite).IRAS mission, contemplated a large helium cryostat. It is just like the one needed for the COBE.

Mather presented their concept to the IRAS science team meeting near Amsterdam. It went over with are sounding thud. Mather was very glad in getting an opportunity to build that of instrument, he conceived earlier.

+ In 1976, NASA decided formally to study their concept, but with extended team (Hauser,

Weiss, Wilkinson, Mather, George Smoot of UC Berkeley and Sam Gulkis of JPL for Mission Definition Science Team). Mather was asked to work with the engineering team and makethat project happen. It was the start of COBE satellite project

6. Employment

Led proposal efforts for	Cosmic Background Explorer mission	1974-76
Goddard Space Flight Center	Study Scientist GSFC	1976-88
	o Project Scientist o Principal Investigator for Far Infrared Absolute Spectrophotometer (FIRAS) on Cosmic Background Explorer (COBE)	1988-98
James Webb Space Telescope	Senior Project Scientist ➔ Leads the science team; Represents scientific interests within the project management	1995-

7. COBE research project: Mike Hauser employed Dr Mather at Goddard Space Flight Center in Greenbelt, Maryland, thus baptizing him to be a proper civil servant. Hauser was his mentor and exemplary hero all through and rescued Mather to surmount the hurdles in tough times. The report of their results on reducing the size of instrument went through the scrutiny and yielded a fabulous reward.

- + A larger team of the IUE (International Ultraviolet Explorer) with seasoned expert engineers(led by Jerry Longangecker) were assigned to COBE
- ✓ NASA decided to shift to Space Shuttles in all launches cancelling all rockets like the Deltas
  - The team of Mather argued but has no success
- ➔ As a consequence, COBE was redesigned to be compatible to go on the Space Shuttle

COBE satellite project: In1979, NASA decided to build the COBE satellite in-house at Goddard itself. This was an exception to earlier practices of NASA to get satellites for launching. It imparted a high thrust that engineers and scientists at Goddard; they would work together very closely with no barriers to learning, transferring science, technology except with a laser focus of the end goal of science looking back in time about evolution. That project was also essentially a training platform for new engineers and would be reservoir of talent. Further, the team should solve emergencies anywhere with its top talent human resource. With large number of such chores,

- o Mather expressed the frustration and fear for main target
  - o Yet, he had to accept all scheduled tasks

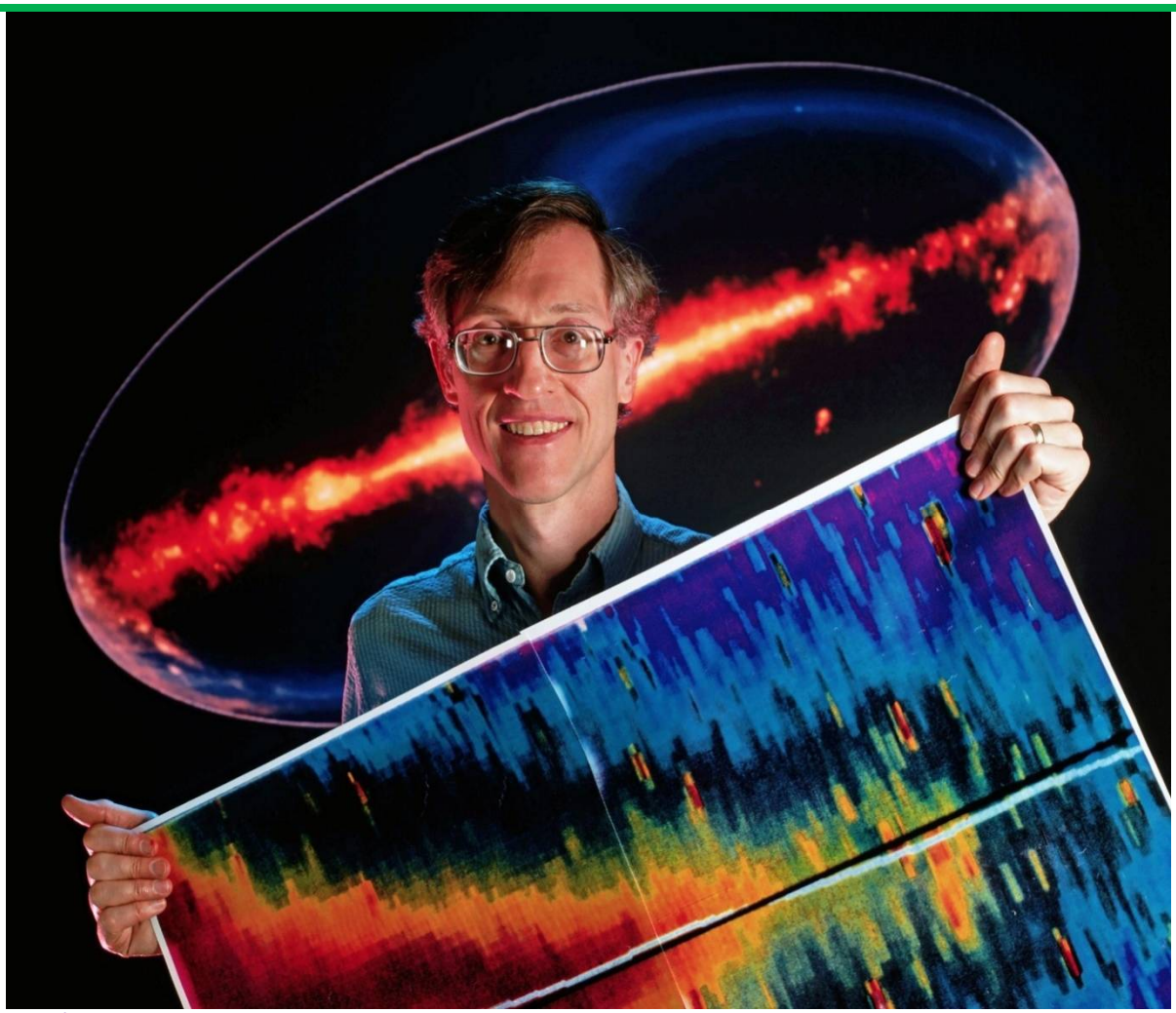
Launching of COBE: The 2,200-kg satellite (with COBE measurement tools) was launched by the National Aeronautics and Space Administration on Nov. 18, 1989. It carried three instruments DIRBE, FIRA, DMR housed inside a cryostat, cooled with 95.7 kg liquid helium.

The entire professional life of Mather was filled with the COBE saga from 1980 onwards. The mega mission was to take precise measurements of the diffuse radiation between 1 micrometer and 1 cm over the whole celestial sphere. Dr. Mather published a memoir of the COBE project entitled "The Very First Light: The Inside Story of the Scientific Journey Back to the Dawn of the Universe" in the year 1996.

Instrument		Function
FIRAS	➔ Far Infrared Absolute Spectrophotometer	o To compare the spectrum of the Cosmic microwave background radiation witha

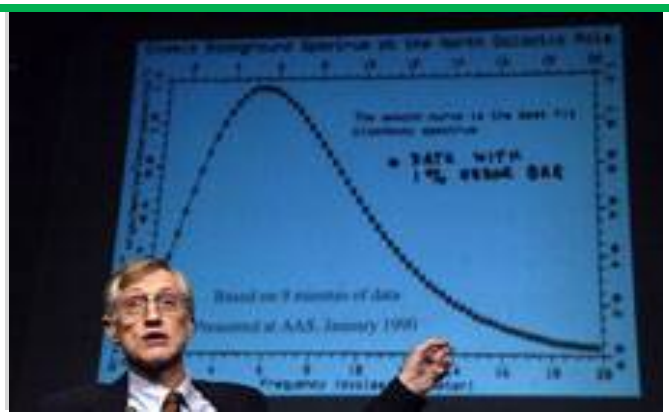
		precise blackbody
DMR	➔ Differential Microwave Radiometer	o To map the cosmic radiation sensitively
DIRBE	➔ Diffuse Infrared Background Experiment	o To search for the cosmic infrared background Radiation.

Functional objectives of COBE	
Measurements	Range
Spectrum of 3 K radiation	➔ 100 micrometers to 1 cm
Anisotropy of 3 K radiation	➔ 3 to 10 mm
Spectrum and angular distribution of diffuse infrared background radiation	➔ 1 to 300 micrometers of wavelengths

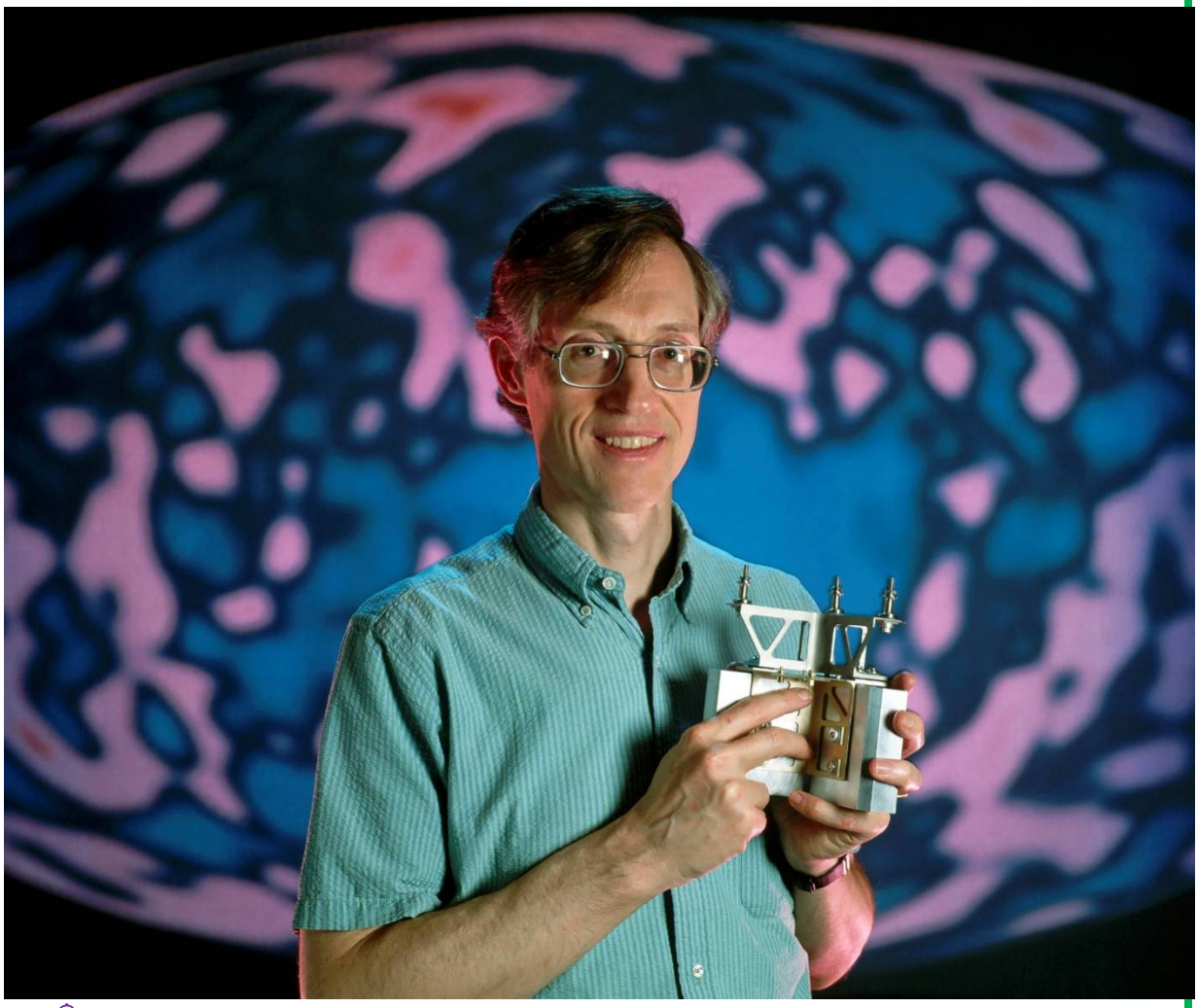


Display of radio maps made by the COBE satellite

variations in the universe's background radiation, helped to refine the Big Bang theory



Earliest data from the NASA Cosmic Background Explorer Satellite



Dr. John C. Mather stands before an COBE image of distribution of matter in the early universe

Mather holds a model of the COBE satellite in his hands 1993

	COBE Mission	
Boggess, N. W.	NASA, Goddard Space Flight Center, Greenbelt, MD	Meyer, S. S Moseley, S. H Murdock, T. L Shafer, R. A Silverberg, R.F Smoot, G. F Wilkinson, D.T Wright, E. L
Mather, J. C.	NASA, Goddard Space Flight Center, Greenbelt, MD	
Bennett, C. L.	NASA, Goddard Space Flight Center, Greenbelt, MD	
Cheng, E. S.	NASA, Goddard Space Flight Center, Greenbelt, MD	
Dwek, E.	NASA, Goddard Space Flight Center, Greenbelt, MD	
Hauser, M. G.	NASA, Goddard Space Flight Center, Greenbelt, MD	
Kelsall, T.	NASA, Goddard Space Flight Center, Greenbelt, MD	
Weiss, R.	MIT, Cambridge, MA	
Gulkis, S.	JPL, Pasadena, CA	
Janssen, M. A.	JPL, Pasadena, CA	

Expertise	Cosmolog, Far IR astronomy	Instrumentation Fourier transform spectroscopy Large space telescopes COBE JWST
	Interplanetary dust Diffuse background radiation	

Post COBE project: The successful launching of COBE in 1989 was a cumulative team as well as individual effort over a very long period of time. Then, the instruments started out pouring data just in the contemplated manner and also beyond plausible expectations.

In the post-COBE period, Mather turned his attention to look for the next challenging mission. His colleague, Harvey Moseley, was studying on the features of IRAC (Infrared Array Camera) for the Space Infrared Telescope Facility(SIRTF). That project was renamed later as Spitzer Space Telescope.

- The disadvantage of IRAC was its sensitivity resulting in numerous overlapping fuzzy images of distant galaxies leading to confusion.

He contemplated more angular resolution needed for the next telescope.

Seeds for next generation telescope with radical transport mode to space: Mather got convinced the need for a 2 meter-telescope which could be squeezed into an inexpensive launch vehicle. It could be unfolded after reaching destination in space. Then only it would meet cost-accuracy compromise.

His colleagues laughed when that concept was narrated at a colloquium one day and emphasized that NASA would never entertain a design with radical departures from tradition or with dead approaches. Around that time, Edison mission concept was rejected, based on inaccurate thermal calculations of some reviewer. Mather joined these two rejected ideas by stitching through marriage to get the offspring idea which is concept of space telescope, later called JWST. Subsequently, it became a major passion.

In the fall of 1995,Ed Weiler at NASA Headquarters sent a telephone message to Dr Mather asking him to submit a proposal the very next day for a study of the Next Generation Space Telescope. It was a great astonishment as he was not even aware of the topic or even knew that an entire conference had been held at the Space Telescope Science Institute to argue for such an observatory. Without any delay, Mather said 'yes' and looked out for back-ground information. At that time, a report was under preparation regarding "HST and beyond" by a committee under the chairmanship of Alan Dressler. It noted the necessity of an infrared-optimized telescope to study time-line-of-events from-early-universe to the formation of stars and planets near home land. The creative brain of Mather spurred a sparkle of wild theme. The biggest thrill was the mission to hunt for ways to go far beyond anything ever done before. His success in every venture, of course was because of his brain waves as well as intellect, patience and devotion of his team.

Alan briefed the mission to Dan Goldin, the then NASA Administrator and there was a perfect resonance. In the immediate American Astronomical Society meeting held in January, Golden announced that NASA would build a bigger telescope. The response was a standing ovation of attendees marking the new generation of space science in twenty first century.

In 1995, Mather was appointed to work on the next great space telescope after Hubble. Initially the contemplated largest space telescope ever deemed to orbit in space at about one million miles from our mother earth of our solar system was called Next generation space telescope (NGST).

Next generation space telescope (NGST) renamed as James Webb Space Telescope (JWST): James Webb was second administrator of NASA. He was the chief during 1961 to 1968. During that period, around 75 space science missions (concerned with sun, stars, galaxies and atmosphere-directly-above-Earth) were launched under his guidance and stewardship. Webb retired a few months before the human being stepped his foot on the surface of moon under Apollo-moon-program. Although, political scenario was under turmoil, Webb set NASA's science objectives in space programs. He spelled out launching large-space-telescopes should of highest priority in the list-of-key-goals of the space agency. Webb in his capacity insisted President Kennedy for implementation of scientific research programs at NASA and in universities for the good of the Nation (The-USA).

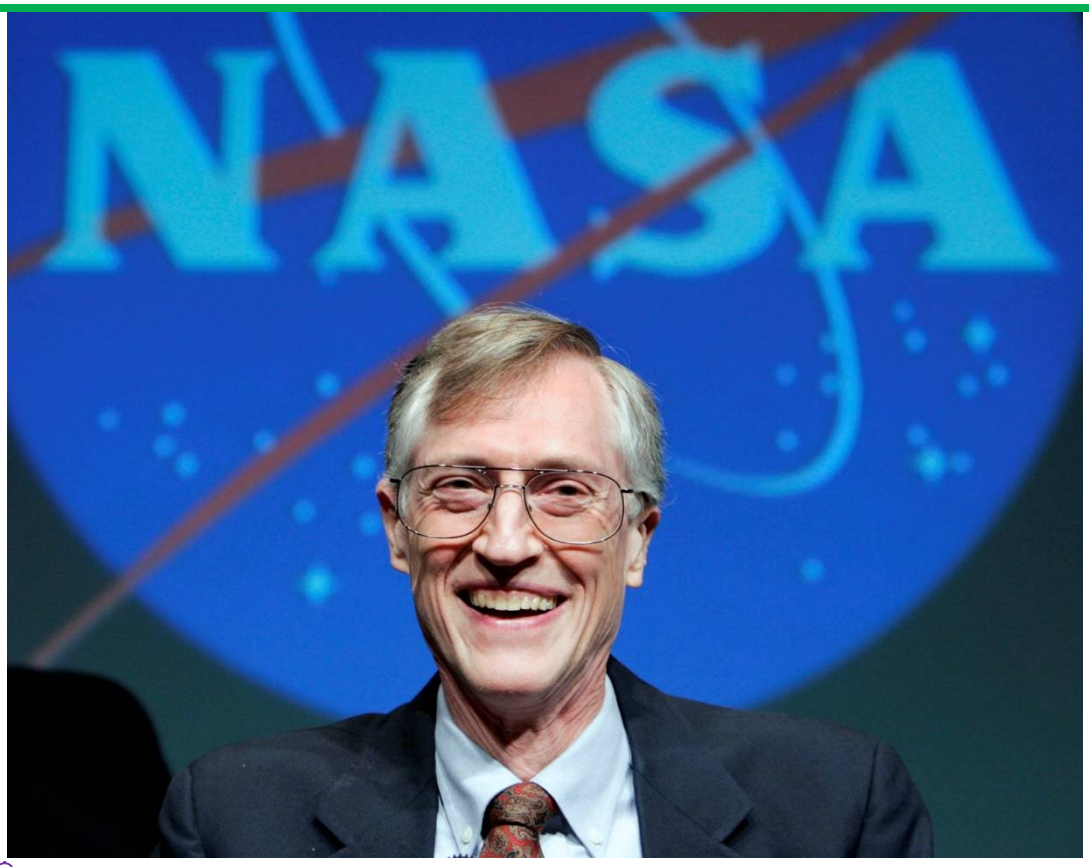
The next generation space telescope was renamed as JWST (James Webb Space Telescope) in September 2002 to honor James Webb. The decadal Survey of National Academy ranked the space telescope project as of top priority in 2000.

8. Nobel prize winner of 2006 Physics: Dr. John Mather and George F. Smoot shared Nobel Prize in Physics of the year 2006. In the 1980s Mather and Smoot were instrumental in developing the Cosmic Background Explorer (COBE) for NASA. The satellite was launched in 1989 and measured cosmic microwave background radiation formed during the early phases of creation of the universe confirming big-bang.

2006 Physics Nobel Laureates	**John C. Mather**	**George F. Smoot**

Affiliation at the time of the award	NASA Goddard Space Flight Center, Greenbelt, MD, USA	University of California Berkeley, CA, USA
Born on	7 August 1946	20 February 1945
Birth place	Roanoke, VA, USA	Yukon, FL, USA
Prize share	1/2	1/2
Noble scientific achievement	Influential cosmology work helping to confirm the Big Bang Discovery of the blackbody form and anisotropy of the cosmic microwave background radiation	

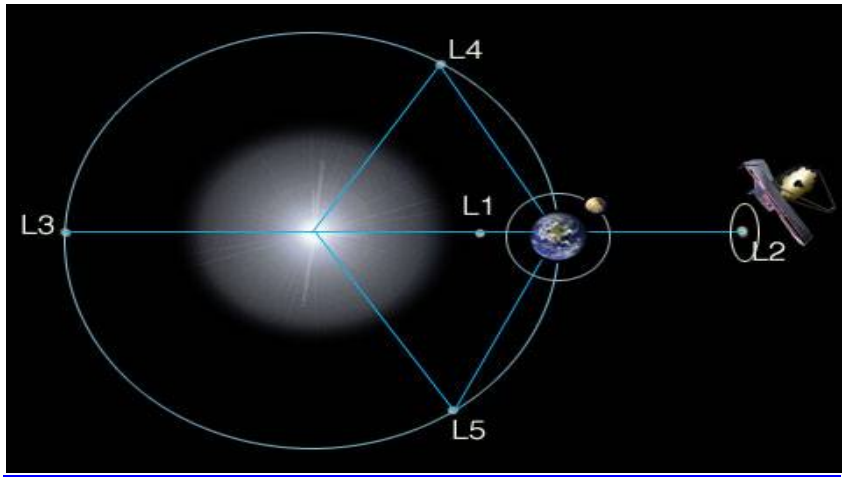
John C. Mather receiving Nobel Prize award from
His majesty King Carl XVI Gustaf of Sweden
at the Stockholm Concert Hall,
on 10th December, 2006



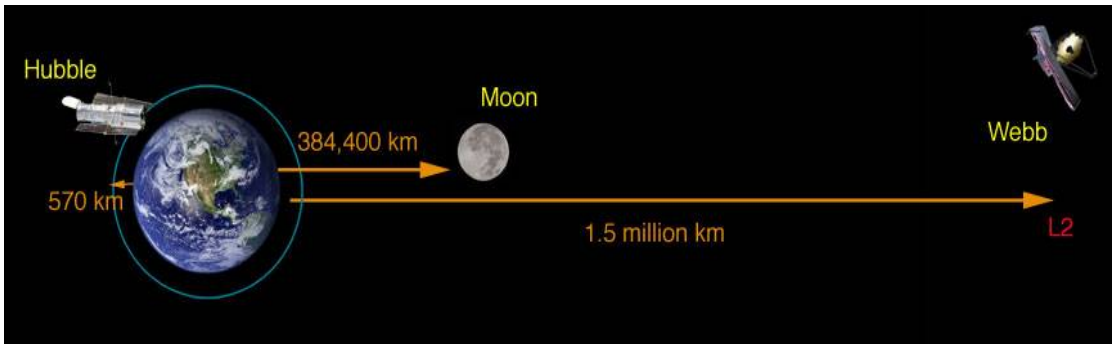
- Dr. John C. Mather takes questions from the press after receiving word he had won the 2006 Nobel Prize in Physics
- Mather's studies of cosmic radiation helped determine the age of the universe
- have added confirmation to the Big Bang theory of its origin.

9. Dr James Mather and JWST: He had been continuing in various key-official-roles (senior project scientist) in the unique space venture of JWST (which lifted on 25th December2021). He had been chairman-of- the-science-working group. The tricky-task is to ensure that the mission will meet the scientific requirements (amidst 10 Billion dollars budget, 20+ years of clock-time on our mother earth, 20,000+ scientists/engineers/computer programmers/technicians, grazy lines between achieved-to-not achievd-to-to_achieve, goals-to-dynamic_adaptive_sub_ goals, possible-plausible-impossible-borders etc. etc. etc.)

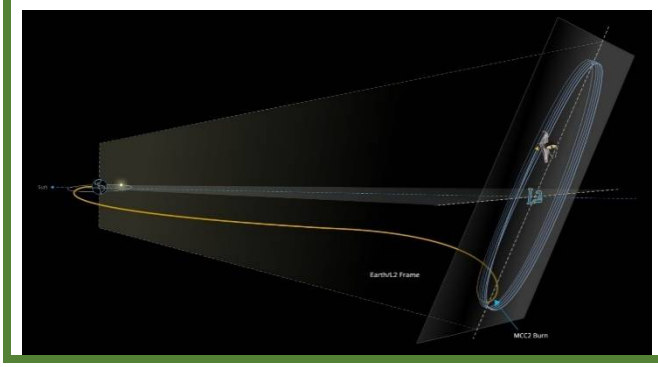
- Part of the Webb team in front of a full-scale model at NASA's Goddard Space Flight Center in Greenbelt, Maryland, in 2005. Credit: NASA



First Sun-Earth Lagrange point, L1: It is 1.5 million km from the Earth towards the Sun, solar observatories located L1: DSCOVR, WIND, SOHO, ACE.
L2,: WMAP, Herschel, Planck



Webb will orbit the sun 1 million miles away from the Earth atb L2 point

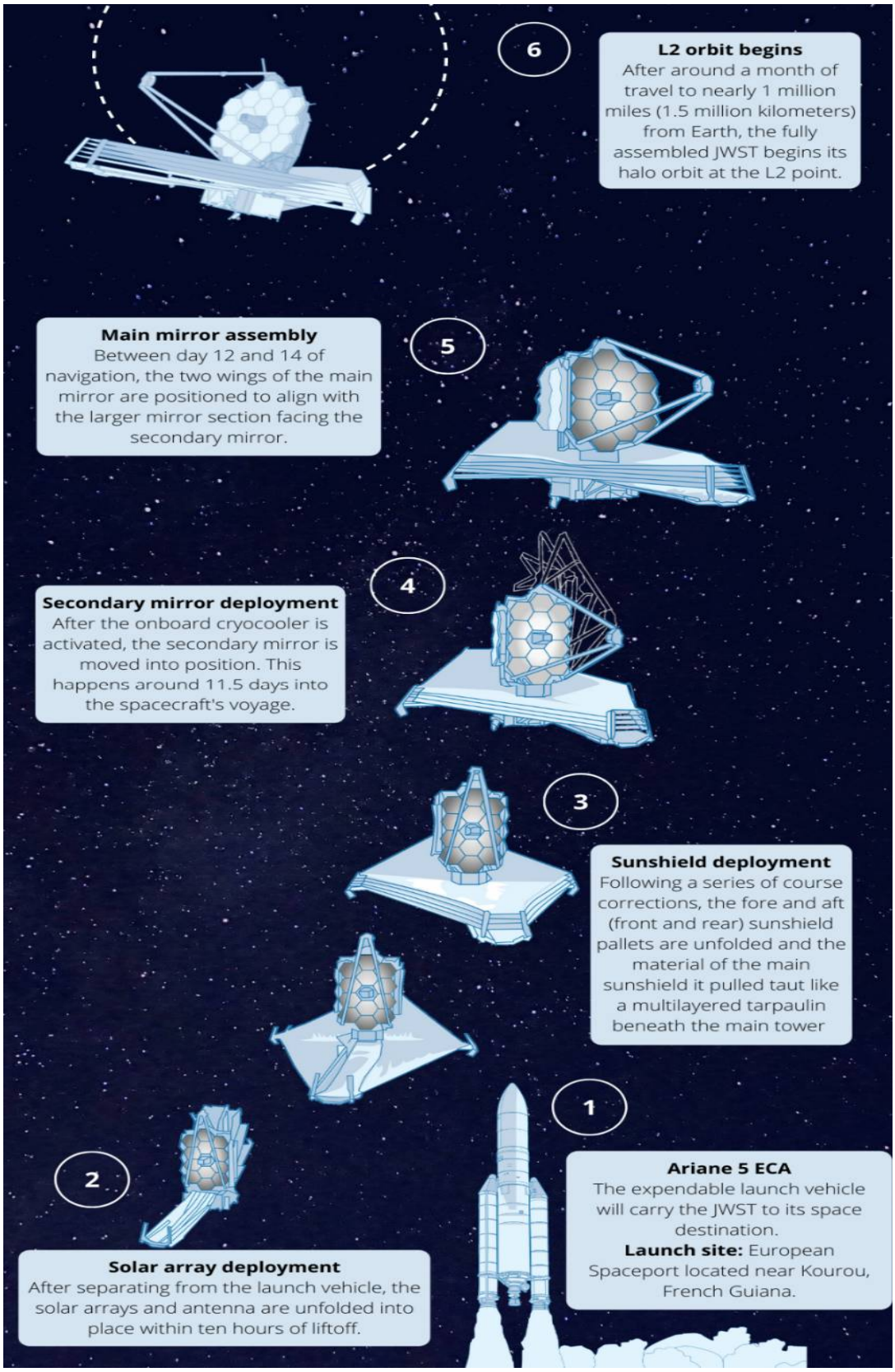


Credit: Steve Sabia/NASA Goddard

Launching -of JWST to- reach L2 orbit: The gestation period of JWST was over a quarter-century from brain wave to nurturing idea to launching. It is a unique collaborative effort between NASA, the European Space Agency and the Canadian Space Agency. This project was commenced when NASA was under the spell of "faster, better, cheaper' slogan. JWST, an infrared space observatory (I So), was launched on 25th Dec, 2021, from ESA's launch site at Kourou in French Guiana, at 7:20 a.m. EST (1220 GMT; 9:20 a.m. local time in Kourou), aboard an Arianespace Ariane 5 rocket.

- Lift off of NASA 's James Webb Space Telescope
- Riding on : Ariane 5 rocket
- From: European Space Agency's base in French Guiana
- Date :December 25, 2021:,
- Event : 'Christmas miracle'

From that instant it travelled nearly one million miles in 30 days and reached the permanent abode (for at least another two decades) L2on Jan. 24, 2022.



JWST travel from Kourou to L2

Travelling in L2 orbit allows the telescope to stay in line with Earth as it orbits the Sun.It is an advantage. This allows the satellite's large sunshield to protect the telescope from the light and heat of the Sun and Earth (and Moon).The precise and accurate launch has an unexpected saving of fuel and it would be sufficient for next twenty years rather than earlier expectation of ten years.

Herschel Space Telescope(60 to 500 microns)and the Planck Space Observatory (Wavelengths: 300 µm – 11.1 mm or30 to 857 gigahertz) also used this orbit in the last decade in their exploration studies.

Unveiling of first set of pictures from Space telescope: Joe Biden, President of The United State of America, unveiled the first science-quality image captured by the James Webb Space Telescope on 11th July of 2022 at the White House. Kamala Harris, Vice President, USA and Bill Nelson, NASA Administrator were also present in the gorgeous historic moment of scientific world.

Joe Biden, President of The United State of America

- Hailed the image for its representation of the nation and the power of science
- Praised NASA for its work that enabled the telescope (JWST) and the imagery it will produce
- This is the oldest documented light in the history of the universe from 13 billion — let me say that again, 13 billion — years ago

Kamala Harris, Vice President

- Today an exciting new chapter in the exploration of our universe started
- From the beginning of history, humans have looked up to the night sky with wonder
- Now onwards, we can look to the sky with new understanding
  - Thanks to dedicated people who have been working for decades in engineering and on scientific marvels

Nelson, NASA Administrator

- 100 years ago, we thought there was only one galaxy
- We know now the truth that the number of galaxies is unlimited
  - ? If you hold a grain of sand on the tip of your finger at arm's length, that is the part of the universe that you're seeing, just one little speck of the universe
- The First image is even more revolutionary when put in a longer historical context
- ! We are going to be able to answer questions that we don't even know what the questions are they
- The technology could determine whether other planets were habitable, Biden responded with a "Whoa."

John Mather, NL, Senior project scientist for Webb, astrophysicist at Goddard

- ✓ I'm thrilled and I'm relieved
- ✓ "When you start something this big, you know, there's always a possibility it might not work."
- ✓ It did work. We are so proud.

JWST first image unveiling function

President Joe Biden listens during a briefing from NASA officials
about the first images from the James Webb Space Telescope
South Court Auditorium on the White House complex, in Washington,
on Monday, July 11, 2022.

- Humanity got the first glimpse of what the observatory in space has been seeing: a cluster of early galaxies (Haiyun Jiang/The New York Times)
- Cosmic image, which was speckled with tiny dots of galaxies

NASA's Webb Delivers Deepest Infrared Image of Universe Yet

! First full-colour image from NASA's James Webb Space Telescope, shows the galaxy cluster SMACS 0723 ----

- Distant patch of sky in which fledgling galaxies were burning their way into visibility just 600 million years after the Big Bang

! Image known as Webb's First Deep Field, in a composite made from images at different wavelengths taken with a Near-Infrared Camera and released July 11, 2022.

Credit:NASA, ESA, CSA, STScI, Webb ERO Production Team/Handout via REUTERS

JWST's career as Space Observatory (So, JWST):

James Webb Space Telescope (also referred as JWST or Webb) is an infrared observatory (costing $10 billion) orbiting in L2 orbit around Sun. It is at a distance of 1 million miles from earth and will do science for at least next ten years. This is a joint venture of NASA, ESA, CSA, and STScI.It is the largest telescope ever sent in to space; Comparatively it is 100 times more powerful than Hubble, which researched the universe for abouttwo decades. The very large mirror demanded to fold inorigami-style to fit in the rocket. And so, it should be unfolded like a "Transformer" in space for doing science.

T

The NIRSpec thermal team from Airbus Germany of Taufkirchen and Immenstaad – Marc Maschmann (left), Martin Altenburg (right), and Ralf Ehrenwinkler (front) – at the Space Telescope Science Institute in Baltimore.

Credit: STScI

10. Science mission: On 11th July, 2022, NASA cleared instrument (Third eye) for full-fledged scientific explorative research of post (13.5 bYrs) big-bang universe. This auspicious moment was a few hours before President Biden unveiled the ultra deep field image in white house. This sanction was after all the seventeen modes of operation of Webb instruments meticulously passed through test protocols.

The Science and Operations for JWST will be performed from Space Telescope Science Institute (STScI) in Baltimore, USA. The ESA astronomers (a team of fifteen members) look after selecting, planning and carrying out all approved science observations, uplinking /down linking of data, generating calibrated data and monitoring the behaviour of the observatory all in near real time.

Wild ideas of Mather: The wildest idea of Mather (based on his experience even during doctoral work) was to send a miniature telescope to the outer solar system to see the cosmic infrared background light directly, without interference from interplanetary dust. JWST although deemed wild and infeasible when proposed, astonishingly it became operational with herculean effort, time, budget and mega team work of NASA augmented by international collaborative expertise. Dr Mather, NL, still enjoys in developing new mission concepts, and trying to persuade people to work on yet another way of hunting for planets around nearby stars.

Service to Science: Twenty Nobel Laureates in Physics, including Mather, urged President George W. Bush in May 2008 to "reverse the damage done to basic science research in the Fiscal Year 2008 Omnibus Appropriations Bill". They also requested additional emergency funding for the Department of Energy's Office of Science, the National Science Foundation, and the National Institute of Standards and Technology.

11. Future Telescopes

Space Telescopes at NASA: Nancy Grace Roman Space Telescope, will launched around 2027. It will scan vast areas of the sky for new fascinating targets for Webb and also be hunting for the effects of dark matter and dark energy. The Webb images will rewrite the textbooks with increased truth value, and new discoveries so important for the human viewers to feel how the universe emerged? Habitable Exoplanet Explorer (HabEx), the Lynx X-Ray telescope, Origins Space Telescope (OST), and the Large Ultraviolet Optical Infrared Explorer (LUVOIR) are possible space telescopes in the latter part of this decade.

Groundbased Telescopes: Thirty Meter Telescope (mirror of 30 meters across), Extremely Large Telescope (Thirty-nine Meter mirror diameter), Giant Magellan Telescope (seven main mirrors each with a diameter of more than 8 meters)and Legacy Survey of Space and Time (LSST, of 3.2 billion pixels resolution digital camera) are ground based instruments in the mega pursuit of secrets of astronomy in near future.

Appendixes

https://youtu.be/8qyb5Tvou_8?t=11	How The World's Most Valuable Object Was Transported 1,118,358 viewsJun 25, 2022
https://youtu.be/6cUe4oMk69E?t=3	Animation: The James Webb Space Telescope's Orbit 880,276 views Apr 13, 2021 James Webb Space Telescope orbit as seen from above the Sun's north pole and as seen from Earth's perspective.

Appendix I

Universe (nature) Riddles-to-Science yet-Unanswered

- ? Did Big Bang happened or not
- ? If not, what else happened
- ? If happened
- ? How did the Big Bang made you, meand the universe
- ? Why and how they are like they are?
- ? How galaxies, stars and planetsare made

- ? How dark matter and dark energy emerged, sustained??
- ? Is there evolution or not
- ? How black holes born
- ? How do they grow and what happens when they get old

- ? What are we?
- ? Where did we come from
- ? Where will we go from here
- ? Are we alone
- ? If not
- ? How close our neighbours

	? What happened before Big-bang	
Mather,NL	Short answer: We don't know We might never know! Long answer: Await for future observational and /or theoretical sciences →	https://youtu.be/jPm6RQHhV2Y?t=21 2,347 viewsAug 9, 2022 Quantum gravity; Theory-of-every-thing; QM of ordinary particles; More/different-understanding-of-space-time

https://youtu.be/H6nP8m4QRUA?list=PLF1A02E39EC712052&t=12

	What happened before Big-bang	
Mather,NL	Short answer: We don't know. We might never know! Long answer: Await for future observational and /or theoretical sciences	https://youtu.be/jPm6RQHhV2Y?t=21 2,347 viewsAug 9, 2022

https://youtu.be/H6nP8m4QRUA?list=PLF1A02E39EC712052&t=12

Adaptive-Objectives of next decade research with JWST

- ? How are **galaxies**/ assembly of galaxies born
- ? What is pattern of evolution/ transformation of first galaxies over time
- ? What happens when they get old

- ? How, when and where do **stars** form
- ? What determines their individual masses
- ? How do stars die
- ? How does their death impact the surrounding medium
- ? Why mammoth stars (which lit up the cosmic dark ages, changing the Universe forever) lived very bright, but with very short lives
- ? What are new details about places like Europa and Titan, which could harbour life

Predecessors of

- ? **Stars**
- ? Protoplanetary systems
- ? Planetary systems
- ? Exoplanets

- ? Next **interstellar comet**

- ? Where and how do **planet**ary systems form and evolve
- ? How do planets grow inside those beautiful clouds of gas and dust
- ? What happens when they get old
- ? Are there any planetary systems like in our solar system
- ? How planets are on the way forming today and in future
- ? Do the rocky planets we can observe with Webb have any atmosphere at all
  - ? Is there water

- ? What happens inside dust clouds
- ? How do stars grow inside those beautiful clouds of gas and dust

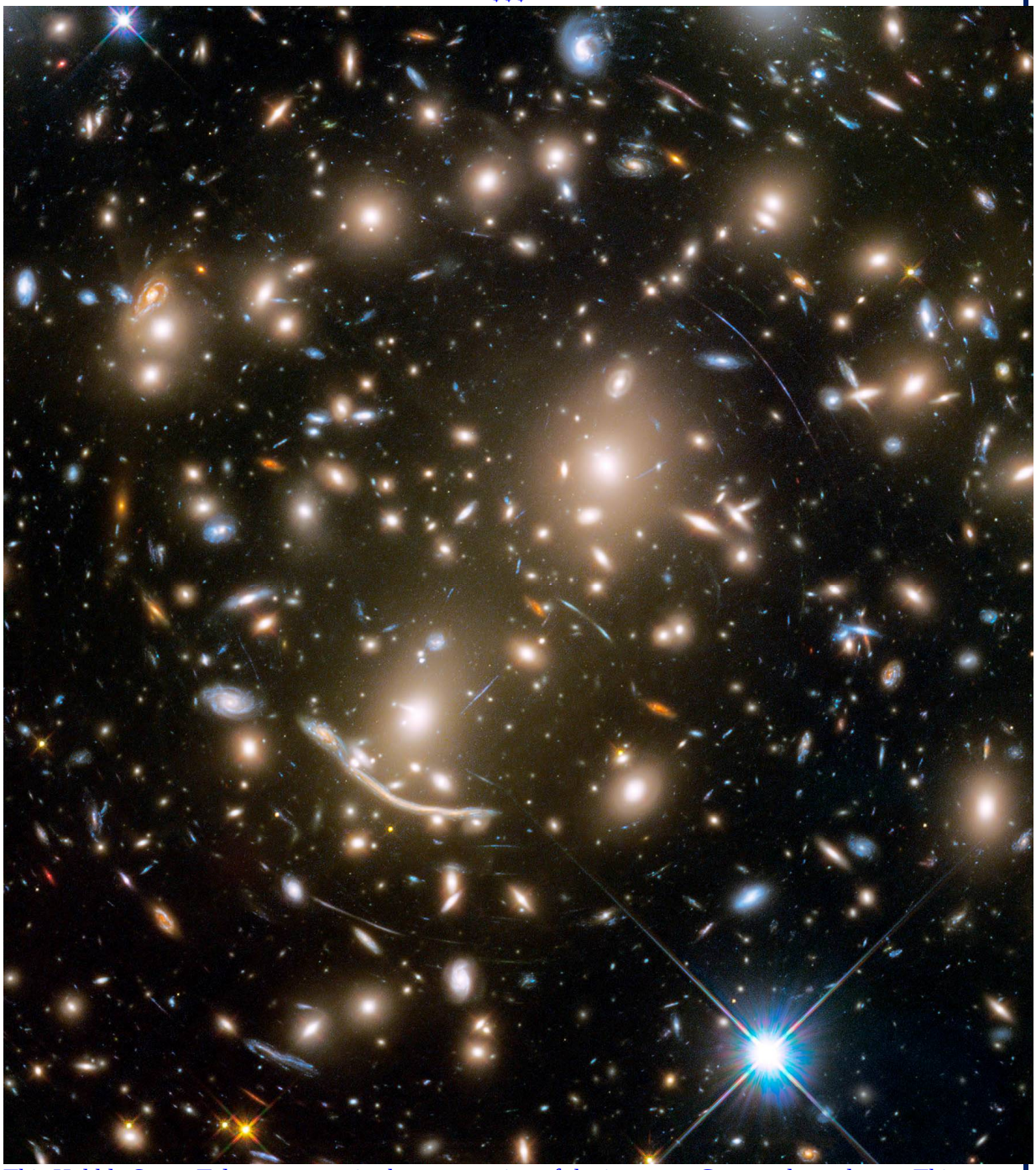
- ? **Exoplanets** that the Kepler Space Telescope found, or follow up on real-time observations from ground space telescopes
- ? What is Alien planet formation and beyond

- ? What could make **life**possible on other planets

- ? **Spectrum** of the planet
- ! Objects
  - ? **Chemical composition**
  - ? Physical and chemical properties
- ? Chemicals present in the **atmosphere** of the hot exoplanet
  - WASP-96 b

- ? Chemical traces of our solar system
- ? Mysteries like Jupiter's great red spot
- ? Composition of the ocean under the ice of Europa
- ? Atmosphere of Saturn's giant moon Titan

$$$



This Hubble Space Telescope mosaic shows a portion of the immense Coma galaxy cluster. This Hubble Space Telescope mosaic shows a portion of the immense Coma galaxy cluster — containing more than 1,000 galaxies — located 300 million light-years away. The rapid motion of its galaxies was the first clue that dark matter existed. Credits: NASA, ESA, J. Mack (STScI) and J. Madrid (Australian Telescope National Facility

Appendix 1I: Awards, Prizes, Medals to John C. Mather

2020	Fellow	Elected a Legacy Fellow of the American Astronomical Society
2010	Medal	India General President Gold Medal
2010	Fellow	Fellow of the Optical Society of America
2008	Prize	Robinson Prize
2008	Speaker	University of Maryland Winter Commencement Speaker
2007	Fellow	SPIE - The International Society for Optical Engineering

Dr. John C. Mather, astrophysicist and Nobel Prizewinner in Physics, receives the Golden Plate Award presented by Awards Council member Ralph Nader during the 2007 International Achievement Summit in Washington, D.C.

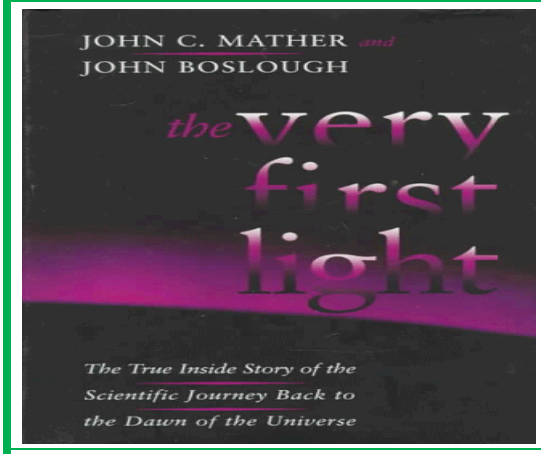
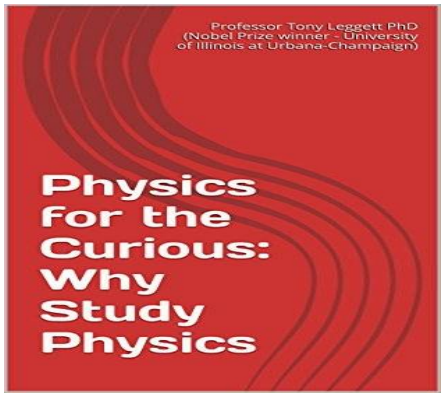
2006	Prize	Peter and Patricia Gruber Foundation Prize in Cosmology
2006	NP	Nobel Prize in Physics
2005	Award	Society of Photo-Optical Instrumentation Engineers George W. Goddard Award
1999	Medal	Franklin Institute Benjamin Franklin Medal in Physics
1998	Prize	Marc Aaronson Memorial Prize
1998	Member	American Academy of Arts and Sciences
1997	Member	National Academy of Sciences
1996	Prize	American Academy of Arts and Sciences Rumford Prize
1996	Fellow	American Physical Society
1995	Award	City of Philadelphia John Scott Award
1994	Fellow	Goddard Space Flight Center
1993	Award	Discover Magazine Technology Award finalist
1993	Award	American Institute of Aeronautics and Astronautics Space Science Award
1993	Prize	American Astronomical Society and American Institute of Physics Dannie Heineman Prize for Astrophysics
1992	Laurels	Aviation Week and Space Technology Laurels for Space/Missiles
1991	Award	Rotary National Space Achievement Award
1991	Trophy	National Air and Space Museum Trophy
1990	Award	NASA GSFCJohn C. Lindsay Memorial Award

	Honorary Degrees to **John C. Mather**	
2011	Doctor of Science	honoris causa University of Notre Dame[7]
2008	Doctor of Science	honoris causa University of Maryland
1994	Doctor of Science	honoris causa Swarthmore College

Typical projects -- **John C. Mather**		
✓ JWST	James Webb Space Telescope	
✓ COBE	Cosmic Background Explorer	
✓ WISE	Wide-field Infrared Survey Explorer	
✓ MPF	Microlensing Planet Finder	- Did not fly + But science incorporated in WFIRST
✓ SAFIR	Single Aperture	- Did not fly

	Far InfraRed telescope	? But may become origins space telescope
✓ SPECS	Submillimeter Probe Evolution of Cosmic Structure	- Did not fly ! An ambitious idea to follow SPECS

Appendix 1II: Books by John C. Mather

	
o The Very First Light: The True Inside Story of the Scientific Journey Back to the Dawn of the Universe o John C. Mather, John Boslough, o 10 December 1996 — 7 editions	o Physics for the Curious: Why Study Physics o Tony Leggett, Adam Riess, John C. Mather, David Wineland

Appendix 1V: Photo gallery –
Nobel award 2006 to John C. Mather

Nobel diploma to John C. Mather

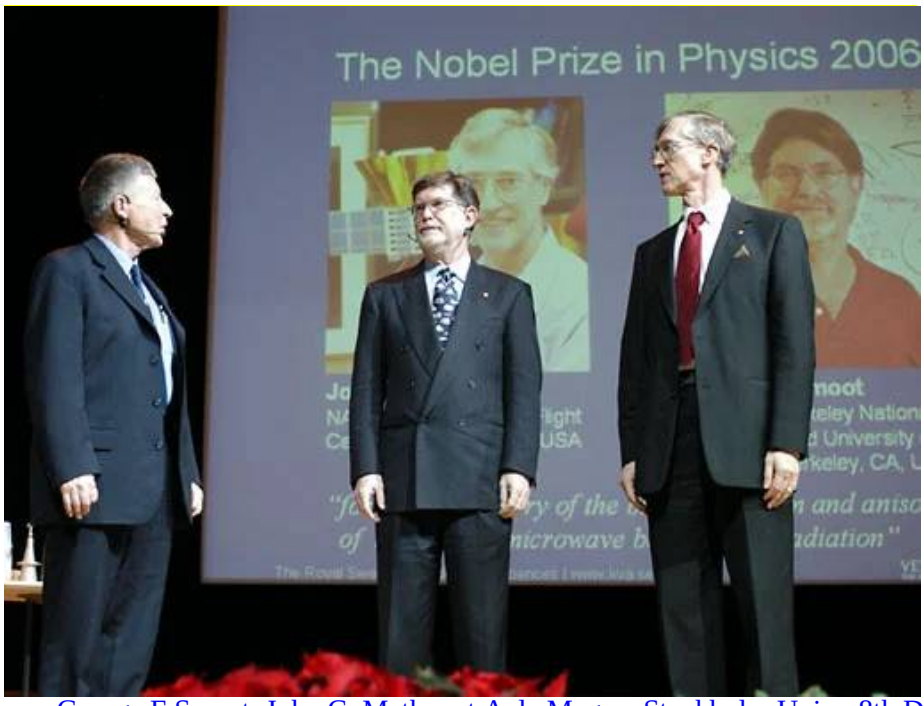
Photo reproduction: Fredrika Berghult

Artist: Jordi Arkö	Calligrapher: Annika Rücker

https://nobel-videocdn01.azureedge.net/video/award_2006_phy_mather_01_496.mp4	🕮 video clip of the 2006 Nobel Laureate in Physics, John C. Mather 🔔 Receiving his Nobel Prize medal and diploma ! During the Nobel Prize Award Ceremony at the Concert Hall in Stockholm, Sweden, on 10 December 2006

Mrs. John C Mather and John C. Mather with Gold medal;

Mather delivering banquet speech



Per Carlson, George F Smoot, John C. Mather at Aula Magna, Stockholm Univ., 8th Dec,2006

Their majesties Queen Silvia and King Carl XVI Gustaf of Sweden (Middle)
John C. Mather and his wife Jane Mather (left)
George F Smoot and his wife Christina Skube 9(right)

John C. Mather (left), George F Smoot, Adam Smith

A. How much
B. An Ultra-modern scientist
C. Perceives
D. A to Z of universe in time and space
E. with state-of-knowledge-probes