

= Pale Blue Dot =

Pale Blue Dot is a photograph of planet Earth taken on February 14 , 1990 , by the Voyager 1 space probe from a record distance of about 6 billion kilometers (3 @. @ 7 billion miles , 40 @. @ 5 AU) , as part of the Family Portrait series of images of the Solar System .

In the photograph , Earth 's apparent size is less than a pixel ; the planet appears as a tiny dot against the vastness of space , among bands of sunlight scattered by the camera 's optics .

Voyager 1 , which had completed its primary mission and was leaving the Solar System , was commanded by NASA to turn its camera around and take one last photograph of Earth across a great expanse of space , at the request of astronomer and author Carl Sagan .

= = Background = =

In September 1977 , NASA launched Voyager 1 , a 722 @- @ kilogram (1 @, @ 592 lb) robotic spacecraft on a mission to study the outer Solar System and eventually interstellar space . After encountering the Jovian system in 1979 and the Saturnian system in 1980 , the primary mission was declared complete in November of the same year . Voyager 1 was the first space probe to provide detailed images of the two largest planets and their major moons .

The spacecraft , travelling at 40 @, @ 000 miles per hour (64 @, @ 000 km / h) , is the farthest man @- @ made object from Earth and the first one to leave the Solar System . Its mission has been extended and continues to this day , with the aim of investigating the boundaries of the Solar system , including the Kuiper belt , the heliosphere and interstellar space . Operating for 38 years , 10 months and 17 days as of today (July 24 , 2016) , it receives routine commands and transmits data back to the Deep Space Network .

Voyager 1 was initially expected to work only through the Saturn encounter . When the spacecraft passed the planet in 1980 , Sagan proposed the idea of the space probe taking one last picture of Earth . He pointed out that such a picture would not have had much scientific value , as the Earth would appear too small for Voyager 's cameras to make out any detail , but it could have been meaningful nevertheless as a perspective on our place in the universe .

Although many in NASA 's Voyager program were supportive of the idea , there were doubts that taking a picture of Earth so close to the Sun risked damaging the spacecraft 's imaging system irreparably . It was not until 1989 that Sagan 's idea was put into practice , but then instrument calibrations delayed the process further , and the personnel who devised and transmitted the radio commands to Voyager 1 were also being laid off or transferred to other projects . Finally , NASA Administrator Richard Truly interceded to ensure that the photograph was taken .

= = Camera = =

Voyager 1 's Imaging Science Subsystem (ISS) , now disabled , consisted of two cameras : a 200 mm focal length , low @- @ resolution wide @- @ angle camera (WA) , used for spatially extended imaging , and a 1500 mm high @- @ resolution narrow @- @ angle camera (NA) ? the one that took Pale Blue Dot ? intended for detailed imaging of specific targets . Both cameras were of the slow @- @ scan vidicon tube type and were fitted with eight colored filters , mounted on a filter wheel placed in front of the tube .

The challenge for NASA 's imaging team was that , as the mission progressed , the objects being photographed were getting farther away from the spacecraft , therefore appearing fainter and requiring longer exposures and even slewing (panning) of the cameras to achieve good quality . The telecommunication capability also decreased with distance , limiting the number of data modes that could be used by the imaging system .

After taking the Family Portrait series of images , which included Pale Blue Dot , NASA mission managers commanded Voyager 1 to power its cameras down , as the spacecraft was not going to fly near anything else of significance for the rest of its mission , while other instruments that were still collecting data needed power for the long journey to interstellar space .

= = Photograph = =

The design of the command sequence to be relayed to the spacecraft and the calculations for each photograph 's exposure time were developed by space scientists Candy Hansen of NASA 's Jet Propulsion Laboratory (JPL) and Carolyn Porco of the University of Arizona . After the planned imaging sequence was taken on February 14 , 1990 , the data from the camera was stored initially in an on @-@ board tape recorder . Transmission to Earth was also delayed by the Magellan and Galileo missions being given priority over the use of the Deep Space Network . Then , between March and May 1990 , Voyager 1 returned 60 frames back to Earth , with the radio signal travelling at the speed of light for nearly five and a half hours to cover the distance .

Three of the frames received showed the Earth as a tiny point of light in empty space . Each frame had been taken using a different color filter : blue , green and violet , with exposure times of 0 @.@ 72 , 0 @.@ 48 and 0 @.@ 72 seconds respectively . The three frames were then recombined to produce the image that became Pale Blue Dot .

Of the 640 @, @ 000 individual pixels that compose each frame , Earth takes up less than one (0 @.@ 12 pixels , according to NASA) . The light bands across the photograph are an artifact , the result of sunlight scattering off parts of the camera and its sunshade , due to the relative proximity between the Sun and the Earth . Voyager 's point of view was approximately 32 ° above the ecliptic . Detailed analysis suggested that the camera also detected the Moon , although it is too faint to be visible without special processing .

The pale blue color of the dot is the result of polarization and scattering of the light reflected from Earth . The polarization in turn depends on various factors such as cloud cover , exposed areas of oceans , forests , deserts , snow fields etc .

Pale Blue Dot , which was taken with the narrow @-@ angle camera , was also published as part of a composite picture created from a wide @-@ angle camera photograph showing the Sun and the region of space containing the Earth and Venus . The wide @-@ angle image was inset with two narrow @-@ angle pictures : Pale Blue Dot and a similar photograph of Venus . The wide @-@ angle photograph was taken with the darkest filter (a methane absorption band) and the shortest possible exposure (5 milliseconds) , to avoid saturating the camera 's vidicon tube with scattered sunlight . Even so , the result was a bright burned @-@ out image with multiple reflections from the optics in the camera and the Sun that appears far larger than the actual dimension of the solar disk . The rays around the Sun are a diffraction pattern of the calibration lamp which is mounted in front of the wide @-@ angle lens .

= = Distance = =

According to NASA 's Jet Propulsion Laboratory 's HORIZONS tool , the distances between Voyager 1 and the Earth on February 14 and May 15 , 1990 , were as follows :

= = Reflections by Sagan = =

During a public lecture held at his Cornell University on October 13 , 1994 , Carl Sagan presented the image to the audience and shared his reflections on the deeper meaning behind the idea of the pale blue dot :

We succeeded in taking that picture , and , if you look at it , you see a dot . That 's here . That 's home . That 's us . On it , everyone you ever heard of , every human being who ever lived , lived out their lives . The aggregate of all our joys and sufferings , thousands of confident religions , ideologies and economic doctrines , every hunter and forager , every hero and coward , every creator and destroyer of civilizations , every king and peasant , every young couple in love , every hopeful child , every mother and father , every inventor and explorer , every teacher of morals , every corrupt politician , every superstar , every supreme leader , every saint and sinner in the history of our species , lived there ? on a mote of dust , suspended in a sunbeam .

The earth is a very small stage in a vast cosmic arena . Think of the rivers of blood spilled by all those generals and emperors so that in glory and in triumph they could become the momentary masters of a fraction of a dot . Think of the endless cruelties visited by the inhabitants of one corner of the dot on scarcely distinguishable inhabitants of some other corner of the dot . How frequent their misunderstandings , how eager they are to kill one another , how fervent their hatreds . Our posturings , our imagined self @-@ importance , the delusion that we have some privileged position in the universe , are challenged by this point of pale light .

[...] To my mind , there is perhaps no better demonstration of the folly of human conceits than this distant image of our tiny world . To me , it underscores our responsibility to deal more kindly and compassionately with one another and to preserve and cherish that pale blue dot , the only home we 've ever known .

Sagan also titled his 1994 book *Pale Blue Dot : A Vision of the Human Future in Space* after the photograph .