“A Mote of Dust Suspended in a Sunbeam”

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Around 5 kilometres.

That is how far I daily ride on my bicycle from my room to my office in the morning, and then back home again in the evening.

So those add up to around a 10 kilometre journey every day. Gladly acceptable, is it not? Many of us are surely familiar with having to travel such distances day after day – whether to school, or college, or office, etc.

An easy amount.

Now look at this number: 19540000000. If we express it in words using a routine numerical standard, we will say this number is 19.54 billion.

How about we put a unit next to this meaningless number? It is a unit I have already used – kilometre.

Well, then that number begins to look a bit strange, even scary: 19.54 billion kilometres!

Ummm, just to get a hang of things, do we know how far the Sun is from our Earth?

Only around 0.15 billion kilometres. Hmmm, that’s not much of a help!

Let’s see – how far away is Pluto from the Sun? Most of us know the name of Pluto, don’t we? At one time we used to read about it in school textbooks as the ninth planet of our Solar System, because it was the most distant one from the Sun in that numerical order. But in 2006 scientists decided to mercilessly throw the poor thing out of this elite club, and categorised it as a dwarf planet for absolutely no fault of its own. Nevertheless, it is still a really long way away from our parent star. To be precise, Pluto’s most distant position from the Sun in its orbit is at about 7.4 billion kilometers.

7.4 billion is nowhere close to even half of 19.54 billion!

Not so easy a quantity this one.

But what does this length mean? Is it really a distance? Of what? From where? And why are we talking about it?

Before I reveal the answer, let me give you two more figures for comparison.

Around 20 minutes. That is how long it takes me to ride on my bicycle from home to office. So taking the round trip into account, it is a daily journey lasting somewhere around 40 minutes. Again, this is easily acceptable for most of us as the duration of a daily journey to and from home, right?

Ummm, how about 37 years and 2 months? For the duration of a journey that is – one where you haven't rested for a second and you don't know where exactly you will end up. But you do know two other things: first that the journey is not going to end anytime in the foreseeable future and second, you are never coming back home.

Now at last let me introduce you to the space probe named Voyager 1.

I presume you had already deduced that no living thing can travel non-stop for 37 years, so most probably somehow there was a machine involved!

Voyager 1 was launched by the National Aeronautics and Space Administration (NASA) from the United States in September 5, 1977, primarily to study the planetary systems of Jupiter and Saturn. After those two main missions were completed by November 1980, the probe was redirected by its operators to embark on a new assignment to first study the outer region of our Solar System, and later on to explore interstellar space.

Today on May 14, 2015, as I write these lines, the probe is in fact 37 years 8 months and 9 days into its voyage. That initial figure of 19.54 billion kilometres was its calculated distance from Earth as of December 6, 2014, or around 37 years and 2 months into its mission. Almost four months have passed since that date. And Voyager 1 has just kept on going at a velocity of 61,000 kilometres per hour. Perhaps it will go on like this as long as it exists. . . . . .

According to an announcement by NASA in September 2013, Voyager 1 had entered interstellar space roughly on August 25, 2012 – the craft was in "the space between the stars." Firing up its rockets for the first time on a date almost a decade before my birth, perhaps before some of your own as well, this machine is travelling "further than anyone, or anything, in history."

I am sure you are thinking at this point, "But how in the world can this machine go on travelling non-stop for almost four decades, and is also ready to do so for all the decades that are to come? Is it using some kind of magic power source that NASA does not want anyone else to find out?"

Well, not really! The spacecraft actually carries two types of fuel — one to power the thrusters, the other to keep the electricity humming. The propellant is hydrazine, a simple concoction of nitrogen and hydrogen that smells like weak ammonia. It was chosen — and remains favored today — because it's cheap and has a very low freezing point. Voyager 1's jets are used to orient the vessel; the boring term for the hydrazine is "attitude control propellant." (There's no need for constant propulsion, of course, because space is gravity-free, so the initial boost went a long way; the spacecraft additionally took advantage of the outer planets' gravitational fields, which act like slingshots to increase speed. For example: Voyager 1 used the enormous gravity field of Jupiter to be hurled on to Saturn, experiencing a Sun-relative speed increase of roughly 57,450

kilometres per hour.) NASA estimates that its fuel efficiency is upwards of 13,000 kilometres per litre of hydrazine. Now that is an impressive number!

Voyager 1 has enough hydrazine to keep going until 2040. The real limiting factor is the other fuel, plutonium-238 dioxide. This is what powers the onboard scientific instruments and communications equipment. Plutonium's chemical transformation is converted into electricity by onboard radioisotope thermoelectric generators (RTGs), which feed off the heat generated by the radioactive fuel's decay. The fuel spheres were encased in a special iridium alloy, to prevent contamination in the unlikely event that the space craft had crashed shortly after takeoff from Earth.

The plutonium's radioactive decay means that the fuel is generating less and less heat as the years go by, and consequently the RTGs are producing less and less power. NASA is trying to combat the problem by shutting down non-critical systems, and alternating which instruments are on and off. Still these solutions are just not good enough. By 7 October 2011 the power generated by Voyager 1 had dropped to 267.9 watts, about 57% of the power at launch, which was approximately 470 watts.

Thankfully, there is no friction out there in space to stop the probe from moving even after its hydrazine load runs out and the engine shuts down. So Voyager 1 will be travelling for decades, centuries, perhaps even millenniums after my death and that of each and every being alive on this planet right at this moment as well. After those who had made it and launched it and ordered it to finally take up a path which would ensure it was destined "perhaps eternally – to wander the Milky Way" are dead.

But there is an astonishing twist to this tale. Let me explain.

You see, in truth Voyager 1 has a couple of good friends for company. The probe itself was part of the Voyager programme of NASA, which was all about sending into space two similarly designed robotic probes – Voyager 1 and Voyager 2. In reality it was Voyager 2 who left its mother planet first, on August 20, 1977. In addition to studying Jupiter and Saturn, it was also meant to take a look at Uranus and Neptune, and till date remains the only space probe to have visited these two gas giants. Although eventually overtaken by its faster twin, Voyager 2 remains as one of the most distant human-made objects – on December 11, 2014, the craft was at a distance of 15.95 billion kilometres from Earth.

Amusingly enough though, the Voyagers are not the actual pioneers when it comes to attempting to leave the Solar System forever. That honour goes to another twin pair of space probes, the original pioneers – Pioneer 10 and Pioneer 11. Launched by NASA in their numeric sequence at about a year's gap in March 1972 and April 1973 respectively, these two were the first human-made objects to have gained escape velocity from the Solar System sometime near the mid-80s. Eventually Voyager 1 overtook Pioneer 10, the faster of the two, in February 1998.

In September 2012, Pioneer 10 and 11 were estimated to be somewhere around 15.96 and 12.86 billion kilometres away from the Earth, but going away from each other in almost exactly opposite directions! Yes, you may be surprised to know that Pioneer 10 is in fact heading in the

opposite route as compared to the general heading of the other three. However, if truth be told, these four brave hearts are never going to meet each other in any case for all practical purposes. Nonetheless, I think Pioneer 10 would definitely feel sad to know of this cruel plan to separate it so cold-bloodedly from the rest of this unique group.

Even so, none of this sounds anywhere close to a twist, does it? So let me get to that first, and to a bit more towards the end.

One sad truth is that we have lost contact with both of the Pioneers for a long time by now – for more than 12 years with number 10 and for nearly two decades with 11. And you most probably realised that this is the inevitable future scenario for the Voyagers as well when we were talking about their power source a little while ago. Yes, so sometime around 2025 both will run out of all electrical power supplied by the RTGs to support science data return and spacecraft operations. Thankfully though, their original designers were ingeniously creative when it came to passing on a message across enormous distances – they had put in a type of intergalactic notes in all the four probes for anyone to get a hold of, read, even listen to in some cases, as long as the machines were physically intact!

That's right; that's what the sentence just said: ". . . . for anyone to get a hold of, read, even listen to. . . ."!

In case you are wondering who that "anyone" may actually be, feel absolutely free to immediately substitute it with the much more attractive word "aliens".

Actually there are these two sets of "notes" – one is called the Pioneer Plaques, and the other is called the Voyager Golden Records. The first are attached to Pioneer 10 and 11, the second are attached to Voyager 1 and 2. Weighing just about 120 grams, the plaques are made of gold-plated aluminium and contain a pictorial message engraved on the metal. Those engravings show the nude figures of a human male and female along with several symbols (depicting for example, the structure of a hydrogen atom, the Solar System, etc.) that are designed to provide information about the origin of the spacecraft. On the other hand, the objects attached to the Voyagers are phonograph records which contain 116 images related to our Earth and ourselves, and a variety of natural sounds, such as those made by surf, wind, and thunder, and animal sounds, including the songs of birds and whales. The record additionally features musical selections from different cultures and eras, and spoken greetings in fifty-nine languages, which include the following Indian ones: Bengali, Gujarati, Hindi, Kannada, Marathi, Oriya, Punjabi, Rajasthani, Telugu and Urdu. In the eclectic 90-minutes long musical collection, we have the three and a half minutes long "Jaat Kahan Ho" in Raga Bhairavi by Kesarbai Kerkar!

Well then, have you now begun to sense the twist in the tale? Let me help a bit more by quoting a part of the printed message from the then US President Jimmy Carter included in the Voyager Golden Records:

"This is a present from a small, distant world, a token of our sounds, our science, our images, our music, our thoughts and our feelings. We are attempting to survive our time so we may live into yours."

This is it then, this is the twist – that if even after we lose all contact and control and whereabouts of those four spacecrafts, that if even after one day we forget all about ever having launched such missions into deep space, and indeed, that even after if one day all of human race is wiped out from the face of this world for good, those two plaques and those two records will continue to silently drift in the immortal cosmic ocean, ready to tell for all time any existing and competent sentient entity who picks them up as to who we once were.

One of the main driving forces behind the creation of these two sets of amazing items, the popular American astronomer, science writer and science communicator Carl Sagan had actually said about the Voyager Golden Records:

"The spacecraft will be encountered and the record played only if there are advanced space-faring civilizations in interstellar space. But the launching of this 'bottle' into the cosmic 'ocean' says something very hopeful about life on this planet."

And it is after taking inspiration from a magnificent passage related to the Voyager 1 mission written by Carl Sagan that I want to leave a few morsels behind, hopefully as food for your thoughts. . . . . .

You see, as Voyager 1 was leaving the Solar System in February 1990 marking the beginning of its epic expedition towards deep space, it was commanded by NASA at the request of Sagan to turn its camera around and take one last photograph of Earth across a great expanse of space. So on February 14 the probe took a photograph of planet Earth from a record distance of about 6 billion kilometres which subsequently became famous as the 'Pale Blue Dot'. 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, and if somebody does not direct your eyes to right at that spot in the picture where our home is, I personally think at least an hour with a high quality magnifying glass in hand may let you spot her – may that is!

Then in 1994 Carl Sagan published one of his books titled *Pale Blue Dot: A Vision of the Human Future in Space*. In it he penned down his own thoughts regarding the true meaning of that apparently featureless piece of hazy image, and here is a part thereof which I can't help but quote directly:

"Consider again that dot. That's here. That's home. That's us. On it everyone you love, everyone you know, everyone you ever heard of, every human being who ever was, lived out their lives. The aggregate of our joy and suffering, thousands of confident religions, ideologies, and economic doctrines, every hunter and forager, every hero and coward, every creator and destroyer of civilization, every king and peasant, every young couple in love, every mother and father, hopeful child, 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."

This past January I had heard firsthand one of the most prominent young Indian writers of the fast-growing genre of mythological fictions say that their generation, which grew up during the era of the popularisation of science and technology in India, was so badly robbed of imaginative

freedom in schools and colleges as a result, that many of the current writers who belong to that group straight away turn to our mythological tales nowadays to draw inspiration for their own stories and novels. As a student of science myself and being somewhat close in age to the author's generation, I had first felt disbelief, then anger and ultimately sadness at hearing such an intelligent and gifted man blatantly blaming science and technology education for destroying the imaginative thoughts of young people. As a product of the old-school of Indian education system, I am sufficiently aware of how monotonously science subjects are taught in our schools and colleges in most cases. But to straightaway label this bad teaching of science in educational institutions as a sort of ultimate truth proclaiming that science is really bad for the development of imaginative powers is a truly unreasonable act.

You want proof for this last statement? Take help of the Internet and have a look at the Pale Blue Dot, after that go through those lines by Sagan, and if it is night time then go to the roof to simply gaze at the sky for some minutes. And while doing so do try to remember that as you go through your daily routine for weeks after weeks, months after months, four spacecrafts are out there hurtling further away from their origin every second and towards that unimaginable vastness of space, so alone that it sends a shiver down one's spine just trying to imagine it, with no chance of ever coming back, with no knowledge of where they may end up, yet faithfully carrying our civilisation's messages with them all the time.

I tried to imagine all of this last night myself while standing on my roof, but it proved to be just too mind-boggling a scenario for my puny bunch of neurons to visualise. Thus I gave up after a few frustrating minutes.

Science and technology had not failed at all to inspire my imagination; it was my imaginative capability which had failed to make sense of the incredible reality science and technology had to show to my mind's eye.

One can of course say that spending billions of dollars to send some robot into space and take flimsy photos of the Earth that are difficult to comprehend with the naked eye and to carry images and songs and voices of humans for some alleged alien beings is an irresponsible and unforgivable wastage of money and time and energy. The only way I will reply to such an accusation is that the continuation of the fact that even after all these so-called unjustifiable efforts we as a species have mostly not yet appreciated and respected either the sheer delicateness and importance of our home, of our birthplace, of this "mote of dust suspended in a sunbeam", of this Pale Blue Dot, or our own true place in the grand scheme of the cosmos, is the actual example of both the failure of our imaginative abilities and also of our unforgivable sin.