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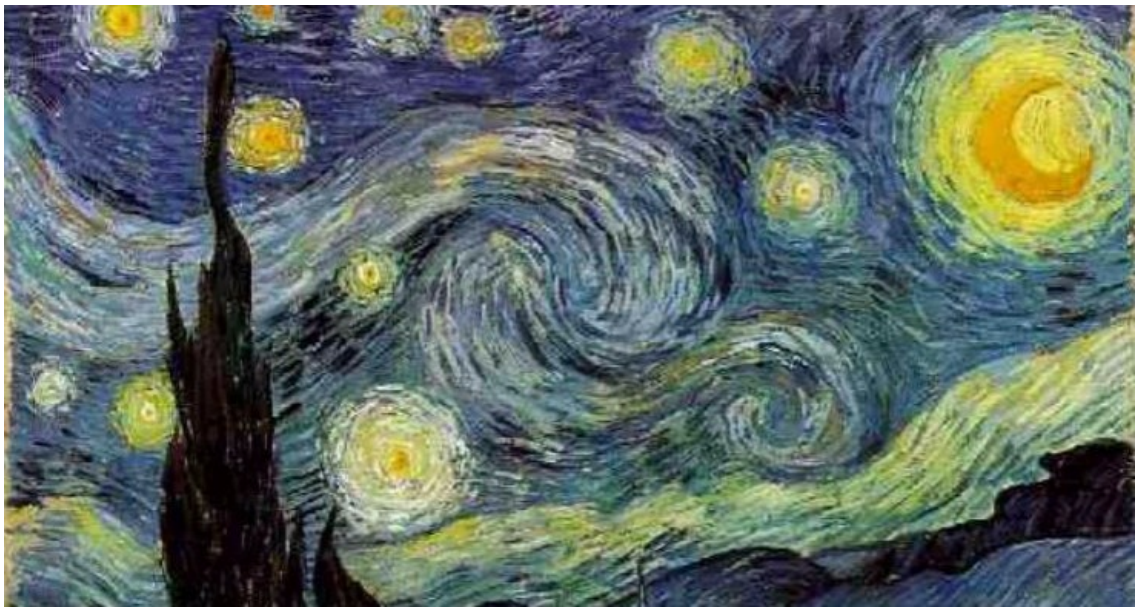

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Seeing Stars

We talk about the lifetime of a system as the time over which it works, between its beginning and its end, and for stars that shine this is a long time.

What does it mean to perceive something? It's not enough to see it without some understanding. It might be a small part of a big thing, or one aspect of several. If you don't understand, then you don't know what you're looking at. And if you don't know what you're looking at, you don't know what you're seeing.

Seeing tends to stop at the parts, but perception can extend to the whole. Seeing, perceiving, and understanding are a loop: as one grows, so do the others. How much more do you see in a person once you understand them? How does your seeing change as you understand the world?

We don't perceive things entirely, we see them as they appear in the moment. We say a bee

is a bug on flowers because that's what we see, but bees are not individuals. There is no bee without a hive, no hive without flowers, no flowers without fields, and no fields without air, water, soil, and sun. And soil requires an ecosystem, and water needs weather, and air clean wind, and sun a star.

At the limit of the whole we ask new questions: do all stars have ecosystems? Is there life around every star? No one can say but every star has planets, and a good fraction of them have a planet like earth. The sun is not a special star, and neither is our solar system. It's quite possible there is, was, or will be life on half the stars we see, as well as half the ones we don't.

There are a lot of stars, but they're far away and out of sight. On a clear night we can see 5,000 of the ten billion trillion out there, but there are few such nights, and there's little point, so we hardly look. A large tree has a million leaves. How many do you see standing in front of a forest? That's easy: none unless you look at them.

If we can't eat something, mate with it, profit from it, or get hurt by it, then we don't pay much attention to it. Smug in our imagined elevation above our animal nature, we usually aren't that much. Let's elevate. Let's try to feel in our hearts what our special brains can imagine.

Time

We measure time in hours, but let's stretch it out to years. Recall the year: spring, summer, fall, and winter. Recall a snapshot from each: spring… summer… fall… winter. What important events fit in your purposeful life? In a year, the earth makes one circle around the sun.

Now, if you can, recall the last decade. Life doesn't come in 10-year pieces, so what has a decade's duration, more or less? Perhaps a job… relationship… or place you lived. Perhaps the time since someone was last seen. A decade is the scope of our recollection, during which Jupiter makes one circle around the sun.

Imagine you'll live to be 100. Maybe you're young and just starting, or middle-aged and halfway there, or old -- how did that happen? -- and you may hear that life is behind you. Consider a life of 100 years. Ten decades fashioned from circumstance, serendipity, struggle, or skill. Our oldest second-hand memories, the family history of 100 years.

If we shrink a star's lifetime to 100 years, then what is 100 years to us will shrink to one second. That's something to consider: if stars held conversations, your centenarian life would be a moment. In 100 years the planet Uranus makes one circle around the sun.

Imagine a series of ten ancestors each living to be 100, born to the great-grandchild on the day of their centenarian ancestor's passing. Ten such ancestors span one thousand years, each living in a different age, each carrying a different legacy. Hildegard chanting in the 11th century, Dylan rocking in the 21st.

Ten centuries is a millennium, the memory of a culture. Times change, but a people take a thousand years. Attitudes that we pass on, untaught and untraceable. A millennium is the span of oral history, genetic personality, cultural attitudes and affinities: antiquity, the Middle Ages, modern history. In one thousand years the comet Hill (C2006 S5) makes one circle around the sun.

Ten times longer is ten millennia; 10,000 years completes recorded history. People are migrating across the Bearing Strait. Things hadn't changed much for us up until then, but now we start forging metal. The Bronze Age and the pace of progress becomes blistering!

We emerge from cave painting and start agriculture, and civilization as we know it. And since this time Sedna, the most distant object in the solar system, the size of Pluto but twice as far from us, makes one circle around the sun. One Sedna year for our 10,000.

And that's as far back as our history goes -- about an hour in the lifetime of a star -- so we go back further: 100,000 years. We're still human, but smaller and we don't speak much, maybe we say "hunt," or "food," or "happy." We've been making the same stone, bone, and wood tools for a long time. Clothes are the big thing: we start wearing them.

There are Neanderthals, too; and we might be friends, but I doubt it. They live far north and use the same tools. And while just as able, they're provincial, stubborn, ... and they look funny. In 100,000 years our deepest space comet, Lovejoy (C2007 E2), makes half a circle around the sun.

Ten times older again, a million years, the earliest genetic memory of homo sapiens. We were bashing things with dull rocks and now we're inventing stone tools. Our world is Africa, nature is awesome, and we are on the menu. The nights are beautiful, the same stars shine above us, and we've found fire. Lights, warmth, cooking! We don't have to hide in trees, and the world won't be the same. A million years is a week in the life of a star.

Five million years ago. We're starting to walk on two legs, we're a new kind of ape. Our brains are changing. We're starting to reflect, and new habits are forming: lift with your knees, protect your head, throw things when angry. No people in Africa -- or anywhere -- but we can now walk there as the Atlantic is closed and the continents are connected. In five million years Catalina (C1999 F1), our slowest orbiting comet, completes one revolution around the sun.

20 million years ago. Climate change, currents change, ice caps grow, and the oceans fall 200 feet. Mammals replace lizards. Grasslands flourish: bear, deer, and herds of grazers. We have most of our birds, and there are snakes. Lots of snakes.

Since this time, the last 20 million years, we've made one excursion out and back to the plane of our galaxy, as we've done 100 times before. It's another one of our seasons, but in this winter it's not only the leaves that fall, but most everything else, too. It's the cycle of mass extinctions.

100 million year ago, now we're talking! The first flowers appear to create new landscapes. Ants begin their growth to the world's most massive family, and dinosaurs grow feathers. There are few mammals, most are the size of your thumb except for the largest, weighing a pound, Castoro-cauda lutra-similis, a beaver.

The middle, limbic brain is on the drawing board, bringing with it the first emotions: happiness, sadness, fear, and anger. And with them new behaviors: struggle for power, fear injury, mourn the dead, seek pleasure. In this time galaxies rotate, and in 100 million years ours makes half a turn, two percent in the life of a star, and perhaps they take notice.

Ten times older still, and we reach our first billionth birthday backward in time. It's quite a party; sex has been invented! Thank the protozoa, now one billion years old, starting their second billion. And they're about to roll out the next great invention: multi-celled animals. Big news, staggering consequences.

Life remains oceanic and nothing's on land. Air is still being created, and the result will be an entirely frozen planet before it will return to life-supporting. Snowball earth, the first of two. It will be a long time yet before anything rubs two sticks together. By this time, a billion years ago, our once aqueous neighbor Mars has lost most of its water, along with whatever life it had.

Being

History is a funny thing. If there's no one around, it doesn't get recorded. A lot has happened in the last billion years, but no one says much about the billion before that. We don't have much of a biological record; most of what we have is inorganic. Even the astronomical record is rather blank.

Go back two billion years. Mostly the same stars in the sky, though they've moved. There's life on earth, but the cells lack a nucleus and other structures. The bacteria have DNA and they've been busy: they've oxygenated our atmosphere. This is our third and final atmosphere, at least so far. There have been huge advances in the development of life, we just don't know how to measure it.

Go back another to three billion years ago. Bacteria are widespread in the water, still here today, doing what they did then. Photosynthesis starts, the rocks tell us. Here lay down the primordial inclinations, genetic memory that supports us still, our fundamental urges: maintain life, avoid death, ... eat!

Mars has oceans and probably as much life. Three billion years is middle age for a star. Stars born then are now seeing their kids off to college.

Go back another billion years to four billion years past. Self-replicating molecules: DNA, RNA, prions, and viruses are just loose bits, not part of any system, and considered non-living.

The sun is 30% cooler, but we keep warm under a blanket of methane. Vapors condense, squeezed from rocks like a sponge, liquids pool and, for the first time, it rains. Water, with us from before the start, bathes our surface and we became a ocean planet, as we are still.

Something else make its appearance along with water, shortly after the earth itself turns half a billion. It has a beginning and an end, it's contained in a membrane, and it maintains itself. We call it a cell and say it's alive. The race begins.

We have our moon and solar system. The terrestrial planets might have atmospheres. The outer ones, made of lighter stuff, are much the same as today. There is a lot of debris in the sun's orbit, and big rocks fall from the sky. It's safer underwater.

Shortly before this -- by half a billion years -- from a lot of dust and vapor, the sun formed, and so, too, the solar system with its planets, from the point two percent that escaped. The

heavy stuff clumped into orbits and then, when the sun ignited, the dust was blown away.

Did you know that all stars are about the same age? Humanity has lived 5,000 generations, but the stars in the universe have lived only 3 or 4. They come and go, but the lifetime of a star is half the age of the universe, and equal to that of life itself.

Star-time is orders beyond our lifespan, but not beyond everything that's human. Star-time measures life itself, between the time life is excinerated and incinerated. And since life must have a star, it's more than coincidence that connects us. The sun is four and a half billion years old, and will live for another two. We are four billion years old and will survive another one before everything dries up.

Now

What do you see in the sky on a clear, dark night? Small, faint things that seem indifferent, but are the measure of life itself. Reach back to your oldest memory when you were but a strand of DNA and learned the primordial choice: life or death. Somewhere in that is everything that is, was, or will be you.

Who are your real parents? Who let there be light? The stars. Sit at their feet and see if you can feel them tell you the facts of life. Relax ... and listen.

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