Ask A Genius 62 - Space
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Scott: We were talking about a conversation you had a while ago about space. Someone asked you about space. We've talked about space. Space as an emergent property of the interactions of matter in the universe. When the person asked you about space, they asked, "What is it, and what is it expanding into?" in essence. What are some false assumptions behind that?

Rick: There are reasonable assumptions behind that. The traditional perspective of the Big Bang, to be visualized easily is the 2-dimensional surface on a 3-dimensional balloon. As the balloon is blown up, the entire balloon expands. Looking at the balloon, though it is a 2-dimensional surface, it is in 3-dimensional space.

So, it is reasonable to ask, "What is our universe, if our universe can be imagined as a 3-dimensional curved surface, embedded in?" The natural answer is that there is a 4-dimensional space that contains it. The real answer is the universe contains itself. It defines itself. It is, as you said, an emergent property of the arrangement of the universe, the relationships of information.

It is more efficiently or effectively visualized being a spatial relationship. In fact, that is such an effective visualization that we live our lives in what we consider 3-dimensional space. It works from the arrangement of information. It works so well spatially that we live in actual space. It does not mean that there is anything outside of this space.

In the same, or not quite the same, way as if you're a dungeon master in *Dungeons & Dragons*, you build your play area. You could imagine realms beyond the play area, but you don't need them in your world, I guess. It is a space that exists abstractly without needing a further space to be embedded in.

Similarly, as we've been talking about consciousness, if the information within an information-sharing system can be efficiently arranged spatially, that space defined by the information doesn't really need external space for it to be embedded in. The space is an abstract-ish space.

If there's enough information, and if it's an efficient enough arrangement, the space can be seen as something that is a functioning kind of thing. An emergent property of the arrangement of information that is helpful in seeing how the information within the space interacts, but it doesn't need a further space beyond the space that defines itself.

All through human history there is the saying that "no man is an island," but we do almost all of our computation, all of our sensory and mental computation, within our head and the computation and sensation external to us are very threadbare, slender, and weak compared to the mass of information processing that goes on within our individual awarenesses.

But in the future, as those tendrils and threads and communication and links to external computation are strengthened, and we become further and further embedded in what will be a worldwide computational sphere, then it becomes reasonable to imagine connected information spaces.

Say in science fiction, 120 years from now, people who are really into each other can do a literal marriage of the minds, where they can super-link their thoughts, so that they are actually sharing thoughts via some wireless dealy. I guess a literal jacking into each other via the year 2140 version of HDMI cable, or one partner wants to or is forced to abandon his or her body due to age has his/her thoughts/thinking/mental hardware literally embedded in the other person's head.

In each of these cases, where you have two minds super-linked, you could imagine that these two information spaces would have to expand into each other. But again, as long as those two people form their own island of two super-linked people, which they would because everybody is super-linked, except the technological Amish.

The information space describing their two minds is sufficient unto itself and doesn't require a further abstract space for their linked mind-space to be embedded in. Until, they open a bunch of links into other links and people. In which case, you have expansions into linked other information spaces, which kind of looks like Big Bangy physics.

If you merge two mind-spaces, it looks like a bunch of stuff looks like to you like the early universe. A whole bunch of early stuff becomes visible and ages along with your mental universe, so that it eases into older and older parts of the universe because the active center of consciousness is the information in your head that at least for the moment it is being processed is the oldest information, the information with the longest history, in your head.

The older or less relevant the information is, the more it is at the more distant, apparently younger, outskirts because the further away from the center you're looking then the younger the universe you're seeing.

Scott: The original assumption of space was an infinite void that things expand into. You're describing an information-based definition of space, where space is derivative of relationships developed through information processing. Time develops through that too. Time is changes in space states. Spaces with linked pasts and implied futures, right?

Rick: Yes, my buddy, Chris, talks about Liebnizian monads. Liebniz lived 3 centuries before information theory. A bunch of people have wrestled with atomic theories of existence, which is "what is the smallest little unit of stuff that could exist from which everything else could be built up from?" You either need an atomic theory with the smallest unit or some theory that says there is no smallest thing and that it is just an infinite ladder of things being built up from tinier and tinier particles and elements, or some other theory.

But those are your two big choices. Liebniz was trying to come up with the simplest building units. He came up with this monad deal, which I don't fully know is in terms of information. It is possible to imagine a universe made up of monads with monads being the simplest possible thing. A connection between one thing and another thing. It is the basic tinker toy. There's nothing simpler that does anything.

Scott: In other words, you have a unit, A, or a monad, A, a unit, B, and the relationship between them, C, but that's without information theory.

Rick: Basically, anything less than that is a tinker toy that is connected to nothing but itself, and you cannot build a universe that is made of stuff connected to nothing. So, you have a universe built on these one-on-one connections that you can start to catalogue in efficient ways, in ways that make sense of them, spatially and temporally.

So, you can argue that space and time originate from efficient and effective cataloguing of, not exactly random but not exactly not random, sets of monad-type connections. You start with your simplest building blocks, and then you classify via relationship, then the classifications naturally lead to spatial divisions and structures and temporal structure.

If you have some minimization principle, which is you want to arrange things so that things in your emerging space and time where the connections are minimized spatially, you're setting up a space where overall you're at a minimum. That if you total up the lengths of the connections of the monads, then you've got some kind of minimization going on.

For time, there's some other minimization or maximization principle, but the cataloguing with minimization or maximization naturally leads to a space arising. For instance, say that your real-world equivalent of monad-type relationships are photons, which are handshakes between two different points in space and time connected by this photon.

If you want to minimize the total paths of all photons in your universe, maybe, you would arrange stuff in stars and galaxies because in a star a photon travels, the average photon, about a millimetre before it runs into something. You've got massive fusion and masses around. You've got a zillion short-range photons coming into and out of existence.

Each of those photons considered as a monad is a little, teeny monad. Only the rare monad makes it off the surface of the Sun to travel light years across the universe. You want to minimize the number of super-long monad connections, which are these super long-distance photons, statistically, versus all of these short-range monads or photons where a photon is not able to travel more than the thickness of a piece of paper, or something which has got to be super small.

Most of the matter in the universe is in stars or in other gravitationally agglomerated collections of huge amounts of matter. Stars are further agglomerated into galaxies. Even if a photon manages to escape a star, if it is close to the center of the galaxy, its odds of running into something else before it makes it out of the galaxy are high.

Everything is agglomerated, which serves to make the universe more efficient in terms of minimizing the size of monads or connections, photon-mediated connections.

Scott: If you take Liebnizian monads, and if you take information theory to kind of give a number to it, and if you take the 10^85th or 10^80th particles in the universe…

Rick: …yea, the number I'm used to taking is 10^80, which is from 100 years ago…

Scott: …if you take that as the base number, and the base number of interactions without factorizations or higher-order combinatorial interactions, what would be the processing level of the universe? Only base-level amounts of processing.

Rick: There have to be, I think, many more photons than other massive particles, I guess. Maybe not, because each atom, each link between an electron and a nucleus, represents the emission of one or more photons. If you imagine that atoms, if you imagine the electron and the nucleus as initially being not linked, and then the electron becoming linked to that nucleus via emitting electromagnetic energy in the form of a photon, that, maybe not a one-to-one, relationship between the number electrons and the number of photons.

You've got background radiation consisting of like a zillion photons. Take 10^80th or 10^85th, to be fair, that is the number of active relationships mediated by current monads in the universe, say. So, that 10^85th, say that is correct within 10 orders of magnitude, that's some, I assume, measure of the information-processing capacity of the universe from moment-to-moment.

But you have to discuss the differences between moments. That there's the moment that is instantaneous, which is a slice through the universe, through the world line of the universe. How many monads does that slice intersect? Then there's the idea of a moment of the universe being, if the universe is thought of as a thinking thing, then a thought takes a certain amount of time and that time for a thought takes many tens of billions of years.

In that case, you're then encompassing a huge multiple more of monads that took part in the computation of that moment. An instantaneous moment intercepts much fewer number of monads than are contained in a 20-billion-year slice of the universe's timeline. Obviously, the universe, if a thought takes 20-billion-years for the universe think, will flesh out something much more complicated than the information contained in an instantaneous slice of the universe, which can be the thinking about the painting as you're watching it.

Your eyes are only designed to see half-a-dozen inches with any degree of detail. Your eyes run out of detail pretty fast. They've done studies, where they trace people's eyes as they look at the painting. It looks like a squiggle. It covers most of the painting. You develop an image of the painting over a second or two. Your built-up image of the painting interacts with your consciousness, then you have thoughts about the painting.

That is understood or contained, for a moment, in your awareness, which was well built up over a second or two. Where the instantaneous slice of the physics of your brain would contain much less information than the information contained your entire thought, which might take 2 or 3 seconds of squiggling around the painting, then having reactions to it, ditto for the universe.

The information capacity, the instantaneous information processing capacity of the universe might be way, way small compared to the effective, practical information processing in the universe because your information processes are able to stack up instantaneous processing to develop more complicated processing, more complicated thoughts in a tacit way mediated by long-distance photons tacitly sharing information with the universe as they traverse billions of light years with the information they contain being lost from the photon across billions of years and being encoded into the universe tacitly by reshaping the space of the universe.

Somebody, it might've been Bohm, who wrote a book called *The Implicate Universe*. Last time I looked at it was 30 years ago, but when I think about implicate, it implies, to me, that the universe does a lot of its business by implication, by indirect communication, via the structure of information within it.

That the universe acts as if it understands the information it contains via the physical structure of this abstract space that becomes more abstract in practical terms because of its precision and scope, and the sheer amount of information that defines that space, but with most information being understood or processable by the universe via tacit quantum Schrödinger-catty-type processes that don't necessarily involve the direct communication of information from one single point to another.

You have a bunch of different monads communicating from one point in space and time to another point in space and time, but that interaction affects the space around the interaction, so the universe understands that interaction as having happened without having directly communicated with the interaction via further particle exchange. Rather through a gravitational and spatial general relativistic slight reshaping of space, and encoding of information in space.

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