

Quoting from Alan Lightman's "A MODERN DAY YANKEE IN A CONNECTICUT COURT and other essays on Science".

Conversations with Papa Joe

The Second Evening

"The next evening, I hurried through dinner and, about eight o'clock, went to my study. I lit up my pipe and drew furiously, filling the room with great clouds of smoke, but nothing happened. Then, when I was starting to feel dizzy, Papa Joe appeared, just as he had the night before. He stood tall and erect for a moment and then sat down across from me, in his chosen chair.

For a while neither of us spoke. Papa Joe seemed to be enjoying the aromas wafting from the pipe, and I hated to interrupt his pleasure. I'd filled the pipe with my own blend of cavendish and burley, but, as happens with a fine old briar, all the tobaccos he'd ever smoked in it had left their own flavors inside the bowl and were now drifting through the room.

"I'm happy you came back," I finally said. "I hope our conversation last night didn't upset you."

"I must admit, your modern view of the heavens takes some getting used to. It strains me to picture a galaxy and its billions of suns. I have a much easier time picturing a house, with the plans and drawings all in front of me."

"Perhaps that's because you've put up a lot of houses with your own hands. You know how the marks on the drawings will turn into windows and doors."

"Just what I was getting at," said the old gentleman. "It seems that your astronomers want me to imagine an enormous building I've got no way of touching, and neither do they. All they've given me for blueprints are photographs of small white dots, and arguments. The reasoning is sound, I'll agree, but I keep remembering Aesop's astronomer, who walked outside

every night looking up at the sky, until one night he fell into a well."

"Don't worry. " I said laughing, "we won't have to venture from our chairs. We can continue last night's tour just fine from where we're sitting."

"Good, lets go on. You left off with the galaxies, far apart like little islands in space, except they're not little."

"Now you have to imagine that these galaxies are flying away from each other a great speed," I said. "That we learned about fifty years ago from Professor Hubble, who discovered that galaxies appear redder than they should be if they were standing still."

"Hold on, you've lost me."

"Let me try and explain with an analogy to sound. When something making a sound moves, the pitch of the sound changes. It goes up when the thing's coming toward you, and down when it's going away. The faster the speed, the greater the shift in pitch. You've probably noticed the effect with a passing train. When it's approaching, the pitch of its whistle rises, and when it's going away the pitch drops."

The old gentleman nodded. "I know trains pretty good. The L. and N. ran next to my quarry. Many times I heard that falling shriek as it passed, but I never thought much about it."

"Well, the same kind of thing happens with light," I went on. "In light, what corresponds to pitch is color. When a source of light is moving toward you, its color goes up in frequency, which means it becomes bluer. When it's moving away, it gets redder. At ordinary speeds, the change in color is so slight that your eyes can't see it, but certain very sensitive instruments can. Hubble had one of these fastened to his telescope while he was studying galaxies. When he found that their colors were shifted toward the red, he concluded the galaxies were traveling away from him

in all directions. What's happening, we believe, is that every galaxy is rushing away from every other galaxy, like dots painted on an expanding balloon. The whole universe is expanding."

"Hold on, young man. You understand this business of colors much better than I do, but it seems to me that if the galaxies are flying off, we should see them move in our telescopes. Shouldn't we?"

"Not if they're very far away, " I replied. "Motion at a great distance is hard to detect. Galaxies are so far away they seem to be standing still, even in telescopes. Fortunately, we have our spectrometers."

"I'm beginning to feel better and better about being anchored to this chair, with the universe flying apart all around me," said Papa Joe, "I never guessed so much commotion was going on out their."

"You're in with some good company," I replied. "Aristotle convinced everybody the universe was perfectly steady, and people believed him for two thousand years. He had some exhausting arguments, and there wasn't any evidence to the contrary--not until Professor Hubble."

"And if I understand you," said Papa Joe, "you're saying that after all those centuries of peaceful nights under the stars, your modern astronomers have decided that Creation is bursting apart, on the strength of some gadgets looking a little smudges of light through a telescope."

"That's what I'm saying. And I believe it, although I admit it goes against what I see when I look up at the sky." I got up and took out a pipe cleaner from my desk near the window. My great-grandfather sat working his moustache.

"I reckon common sense isn't worth much in this business," he mused.

"It seems to me, " I replied, "that common sense is

what you learn from personal experience. But we're talking about things that you can't possibly experience, not with your human senses anyway. A good deal of science these days is beyond the senses, and it isn't at all common. The only way to get there is to start with what you're dead sure about, then climb out a bit, standing on solid logic, then climb a little further, inching your way along and making certain each step is firmly supported by the one below. Sometimes you take what you thought was a little step and find yourself hanging in thin air. Then you have to grab on and scramble back a few rungs. One way or another, you eventually get so far up you can't see where you started. That's when you need to have faith."

"I'll bet nothing compares to that feeling of being up in the clouds'" said Papa Joe, "with the ground out of sight, and knowing the strength of your ladder. That must be how Shapley felt. And Hubble. I wish I'd been there."

I nodded. "So do I. Those guys had faith--but well-grounded faith, I believe. Take Hubble's, for example. The same spectrometers we point at galaxies we also point at lightbulbs set up in the lab, where we're darn sure whether the lightbulbs are moving or not, and how fast. The theory checks out. So if galaxies aren't flying apart as we think, then the laws of nature in space are different from what they are on the ground. That would be illogical. If one and one makes two over here, one and one should make two over there. Or else all science would be in a terrible mess, and scientists would be out of work. Let's assume D. Hubble was right, " I continued, "and the universe is expanding. That means it was smaller and denser in the past."

Papa Joe nodded cautiously, like a man readying himself for the pinch of a used-buggy salesman.

"Then if you mentally go backward in time," I went on, "the galaxies get closer and closer together. Eventually, they touch and merge and become a single

mass, which gets denser and denser. Planets and stars lose their boundaries. Atoms get ripped apart and crushed together. Everything gets squeezed closer and closer together. Finally, there comes a definite time in the past when all the matter of the universe is compressed into a single point. Astronomers can estimate that time by measuring how fast the universe is expanding now. It's about 14 billion years ago. 14 billion years ago, according to the theory, the universe exploded from a point and was born. Scientists call that beginning the Big Bang."

The old gentleman was busily working his moustache again. Furthermore, he had abandoned the safety of his chair and was pacing the room, narrowly missing the logs piled by the fireplace. "On the strength of some gadgets looking at little smudges of light through a telescope," he muttered. "I used to think I had chutzpah."

"It comes with the profession these days, " I said. Just then, a church clock struck ten in the distance. Papa Joe produced from his vest pocket a beautiful gold watch, flipped open its cover, and nodded appreciatively. When he saw how taken I was with his watch, he handed it to me to look at more closely. The he began complaining again about the Big Bang.

"There's something else that adds weight to this ten billion years," I offered. "Stars and planets began forming soon after the universe began, so the earth has to be younger than the universe, but probably not a lot younger. At the beginning of the century, before people had any idea of a Big Bang, some chemists found a way to tell how old the earth is. Special kinds of atoms are continuously changing into other kinds of atoms, in a regular way. For example, uranium atoms change into lead atoms. If you start off with a rock of pure uranium, after a certain number of years half of it will be lead. After that number of years again, three quarters of it will be lead, and so on. So by measuring how much uranium and how much lead are in the rock at any point in time--and assuming the laws of nature don't change in time--you can figure how

long it's been since the rock was pure uranium. About twenty years before Hubble made his measurements on galaxies, some chemists dug up a few rocks, part uranium and part lead, and used them to estimate the age of the earth. It came out to about four and a half billion years, nearly a third the age of the universe, according to Hubble. In other words, the figure that astronomers get by looking at far-off galaxies through a telescope is roughly the same as what chemists and geologists get by looking at rocks under their feet. It amazes me how those two numbers agree."

"An interesting story," said my great-grandfather. "The faith of one scientist holds up the faith of another. That's good. But it's still faith, as you were saying before. You can measure you atoms and galaxies until hell freezes over, but I doubt if you're going to know for sure how old the universe is, or even if it has an age."

"Not by being there at the start," I had to admit. "the entire recorded history of human beings goes back only ten thousand years. Our whole species goes back only a hundred thousand."

I was getting drowsy, and the fire was low. As I lazily rose from my chair to put another log on the fire, I turned and noticed that Papa Joe was also beginning to fad. He was standing in front of a bookshelf, lost in thought, and various titles slowly started to appear through his dissolving form--WALDEN, THE DOUBLE HELIX, A CONNECTICUT YANKEE IN KING ARTHUR'S COURT. I hoped he would come back again.

To Be Continued