

Quoting from Alan Lightman's, "A Modern Day Yankee In A Connecticut Court and other essays on Science".

Conversations with Papa Joe

The First Evening

"An extraordinary thing happened one night last winter. I was relaxing in my study after a long day at the university. As I sat reading, drawing on my great-grandfather's pipe, the old gentleman himself materialized in the curling gray smoke and seated himself in the comfortable wingback across from me. He seemed much less surprised than I and immediately occupied himself with dusting off his suit, as if he'd been on a long journey.

I should explain that I know little of Papa Joe. He came to this country from Hungary about 1880, in his early teens, and started a construction company in Nashville. According to my older relatives, he was not formally educated, but a capable man, with a good head on his shoulders and a strong curiosity about the world. His pipe, a fine old England briar with a solid bowl and a beautiful straight grain, had been tucked away in a drawer for years when my father found it and gave it to me. This was only the second time I had lit it.

After introducing ourselves, we settled into conversation. "I've been looking for that pipe," the old gentleman said, taking a deep whiff of the aromas filling the room.

"It's a wonderful pipe," I agreed. "It's always made me wonder what you were like."

Papa Joe was eager, of course, to learn what had happened in the last sixty years and began asking questions. We talked of how his various descendants had got on in life, the Great Depression, the Second World War, the landing of men on the moon.

All of a sudden, I realized I hadn't offered Papa Joe his own pipe. I wiped off the stem and held it out to him. He reached for it immediately, but then hesitated, and finally pulled back his hand.

"What's been has been," he said with a sigh, then walked over to the large window behind my desk and stood looking out. It was one of those crystal nights, with cold, clear skies. Even from my chair near the fire, I could easily make out Orion, with Betelgeuse at the hunter's shoulder and Rigel marking his left foot. Taurus the Bull was close by, glistening through the branches of my maple tree.

"I love the sky at night," said Papa Joe. "Never new much about the stars, but I always wanted to." He paused, in thought. "I used to tell your father that each star was a firefly."

"I suppose the nights you remember were clearer than this," I said. "Our streetlamps and city lights spoil a view a bit."

He nodded. "But you're not bad off here, on this little street. Not bad off at all. My pipe's found a good home." Just as the old gentleman uttered those words, he started to fade.

"Wait! Wait!" I cried out to him. "I can tell you some things about the sky, if you're interested. I'm actually an astronomer."

At that, my great-grandfather's figure grew firm once again. "I reckon I'll stay awhile then," he said, and returned his gaze to the window. "I trust the sky. Clothes and men change with the styles, but not the stars."

"If you don't look too long, or too far," I said.

"What do you mean?" he asked, turning back toward me.

"You can be pretty sure that each of those stars up there will eventually dim to a cinder or blow itself

apart. It's only a matter of time." Papa Joe had a stricken look on his face, like a man who'd suddenly lost an old friend. I felt a wave of embarrassment. I tried to change the subject, but he wouldn't let me. Instead, he pressed me to explain my remark. I didn't know exactly where to begin, so I put another log on the fire. Papa Joe returned to his chair.

"One thing I have to tell you about modern science," I finally said, "is that it has galloped off into territories far beyond where we can follow with our bodies. What we experience directly with our human senses is only a small fraction of the world around us. But we very badly want to see what our eyes cannot see, and hear what our ears cannot hear. We want to know about places beyond the stars and about happenings before the earth was formed. So we've built enormous machines that dissect the insides of atoms. We've built telescopes that peer out to unimaginable distances and instruments that record colors invisible to the human eye. Our theorists have worked out equations to describe the beginning of time".

"A lot of what we now believe about the world has come to us only by looking at the readings of our instruments and trusting the logic of our calculations. Of all people today, I think scientists have the deepest faith in the unseen world. The greater the scientist, the deeper his faith."

"That's a turn of events," exclaimed my great-grandfather. "I always thought of scientists as fellows who wouldn't forecast rain until they were drenched. This is pleasant news."

"It's a special brand of faith," I continued. "You might say that the scientist sees God as a mathematician. and with some justification, as far as I can tell. As our artificial eyes and ears have revealed each new patch of the invisible tapestry, it looks more and more precise. And our abstract equations and scribblings work remarkably well as predicting the patterns."

"You've whetted my appetite, young man. But please mind, I'm not much with philosophy. I like to have solid proof for what I believe."

"Do you believe the Earth spins on its axis, Papa Joe?"

"Yes."

"What solid proof do you have?" said I. "Do you feel yourself whipped around through space at several hundred miles per hour?" Papa Joe started to speak, twisted his thick moustache uneasily, and said nothing.

"If you set swinging a long heavy pendulum and watched it carefully, the way Monsieur Foucault first did in the last century, you'd notice that its plane of motion very slowly rotates. That plus some principles of physics prove that the Earth turns on its axis. But you'd never catch the tiny effect with your own senses."

The old gentleman chuckled. "All right, I get your point. I'm all ears to what you've learned with your modern devices, if ears are of use anymore. Now tell me about the heavens, misbehaving behind our backs."

"First," I said, "we need to get some idea of the distances. But that's not easy. The prickliest problems in astronomy has been finding the distances to the stars. When we look into the sky, we perceive length and width, but not depth. From our vantage, stars are just white dots on the night sky, like distant ships on the night sea, visible only by their running lights. Some are certainly closer than others, but which ones? How can we measure the size and shape of space itself, stretching all around us? Astronomers puzzled over this problem for thousands of years, knowing that it held the answer to so many other celestial mysteries."

"I'm surprised you can't figure depths with your telescopes."

"Look at any star thorough the most powerful telescope," I said, "and it will appear as a mere point of light. How do you gauge something like that? And all you've got for reference are other points of light."

"I guess that must mean that the stars are very small, or else very far away," said Papa Joe.

"They're not small, " I replied, "but you're right about the distance. If the stars were nearby, then we'd see their locations shift back and forth as the Earth moves from one side of the Sun to the other, changing our angle of view. In fact, we do see a slight yearly shift in the closest stars and can measure their distances by the amount of the shift. The nearest star is several thousand times farther away than Pluto. But the great majority of stars are so distant that they appear fixed while we go back and forth around the Sun."

"Surely," spoke the old gentleman, "the nearer ships must look brighter and the old ones farther away must look dimmer. Couldn't their distances be judged in such a way?"

"Aha," I answered, "you're on the right track. But you're assuming that all of the ships carry the same lights on board. Some of the ships, the grander ones, will have stronger beacons, so at a great distance they will appear just as bright as the closer but less luminous ones."

"I should have guessed that the stars, like everything else, would have their own privates and captains," said Papa Joe. "I reckon the first step might be to group the stars by kind somehow, although I can't see how to do it. Then the dimness and brightness trick could be used on stars of the same kind." Papa Joe smiled faintly, as if pleased with his comments.

"That's in fact very close to what Professor Shapley did several decades ago," I said. "Astronomers had

noticed that certain stars change brightness in a rhythmic and regular fashion, with some running through their light cycles rapidly and others more slowly. Shapley put these pulsating stars into groups, according to the length of their cycles. Then he used the assumption that every star in the same group was identical, with the same luminosity. For example, every star with a light cycle between ten hours and eleven hours would be in one group; every star with a cycle between eleven and twelve hours would be in another, and so on. With this clever way of identifying what kind of star he was looking at, Shapley could then use the dimness and brightness method to figure its distance. So the pulsating stars became points of reference, at known distances. Find a pulsating star lodged within a group of other stars and you know the distance to them too. Little by little, Shapley began mapping out the heavens and placing many of the points of light at their proper depths, with better accuracy than anyone had managed before. It was immensely tedious work, requiring the scrutiny of thousands of telescopic photographs over time, in order to see which stars changed brightness and how quickly."

"I'm pleased to hear," said Papa Joe, "that you Professor Shapley had put in some hard work at his job. That makes me believe him all the more. From what you said before, I had the notion that modern scientists simply had to turn on their machines and lie back while new knowledge was cranked out and charted. If you'll pardon me, it sometimes seems that progress breeds laziness. For years, I had a fellow running my stone quarry outside Nashville. Once the telephone lines came in, he started calling me up with every damn fleabite, instead of thinking them out like he used to do. But I've carried us off the point. What did Shapley's labors turn up?"

"For one thing," I answered, "the heavens extend much farther than astronomers previously thought. For another, we're not at the center, and more than our planet is at the center of our solar system. Our sun seems to be casually dropped at the outskirts of an

enormous, disk-shaped gathering of stars, called a galaxy, containing every star our eyes can see and a hundred billion more. Before Shapley, astronomers thought our sun was at the center of this galaxy. But the center is far off, in the direction of Sagittarius. The dimensions of the whole this are fantastic. If our solar system were the size of a dime, then the galaxy would be the size of Tennessee."

My great-grandfather let out a whistle. "I can't imagine anything that large. But being off center could have its advantages," he offered. "It might keep us from getting too stuffed with ourselves. And what's out past the galaxy?"

"Other galaxies, with a lot of mostly empty space in between. As far as our telescopes can see, there are galaxies. Picture yourself gliding through the depths of the universe. You come to a flotilla of stars, all huddled together. That's a galaxy. After you've left the first galaxy far behind, so it's a tiny white patch of fuzz in the dark, you come to another huddling of stars. That's another galaxy. You pass one galaxy after another, some shaped like pinwheels, some like spheres, some like nothing in particular. Then you come to your own galaxy, the Milky Way. you quickly search for your own sun and can hardly find it, a single speck lost in the billions of other specks. The Earth is invisible. Then you are gone and your galaxy dwindles behind you, becomes nothing. More galaxies come and go, come and go."

Papa Joe had walked to the window and was looking out at the sky again. He stood there a long while. "And Professor Shapley," he said softly, "worked it out in a office somewhere, with his photographs and his good head. He sure was small compared to what he was thinking about. That's powerful faith. powerful faith."

As Papa Joe whispered these last words, his figure grew misty and began to dissolve. I noticed my pipe had gone out. "Don't go," I called out. "There's much more I haven't told you."

"All right. I'll be back tomorrow night," came a wisp of a voice. "Tomorrow night," I repeated, and then he was gone.

To Be Continued