ISAAC ASIMOV

# THIOTIMOLINE TO THE STARS

“Same speech, I suppose,” said Ensign Feet wearily.

“Why not?” said Lieutenant Frohorov, closing his eyes and carefully sitting down on the small of his back. “He's given it for fifteen years, once to each graduating class of the Astronautic Academy.”

“Word for word, I'll bet,” said Feet, who had heard it the year before for the first time.

“As far as I can tell. -What a pompous bore! Oh, for a pin that would puncture pretension.”

But the class was filing in now, uniformed and expectant, marching forward, breaking into rows with precision, each man and woman moving to his or her assigned seat to the rhythm of a subdued drumbeat, and then all sitting down to one loud boom.

At that moment Admiral Vernon entered and walked stiffly to the podium.

“Graduating class of '22, welcome! Your school days are over. Your education will now begin.

“You have learned all there is to know about the classic theory of space flight. You have been filled to overflowing with astrophysics and celestial relativistic mechanics. But you have not been told about thiotimoline.

“That's for a very good reason. Telling you about it in class will do you no good. You will have to learn to fly with thiotimoline. It is thiotimoline and that alone that will take you to the stars. With all your book learning, you may still never learn to handle thiotimoline. If so, there will yet be many posts you can fill in the astronautic way of life. Being a pilot will not, however, be one of them.

“I will start you off on this, your graduation day, with the only lecture you will get on the subject. After this, your dealings will thiotimoline will be in flight and we will find out quickly whether you have any talent for it at all.”

The admiral paused, and seemed to be looking from face toface as though he was trying to assay each man's talent to begin with. Then he barked:

“Thiotimoline! First mentioned in 1948, according to legend, by Azimuth or, possibly,

Asymptote, who may, very likely, never have existed. There is no record of the original article supposed to have been written by him; merely vague references to it, none earlier than the twenty-first century.

“Serious study began with Almirante, who either discovered thiotimoline, or rediscovered it, if the Azimuth/Asymptote tale is accepted. Almirante worked out the theory of hypersteric hindrance and showed that the molecule of thiotimoline is so distorted that one bond is forced into extension through the temporal dimension into the past; and another into the future.

“Because of the future-extension, thiotimoline can interact with an event that has not yet taken place. It can, for instance, to use the classic example, dissolve in water approximately one second before the water is added.

“Thiotimoline is, of course, a very simple compound, comparatively. It has, indeed, the simplest molecule capable of displaying endochronic properties-that is, the past-future extension. While this makes possible certain unique devices, the true applications of endochronicity had to await the development of more complicated molecules; polymers that combined endochronicity with firm structure.

“Pellagrini was the first to form endochronic resins and plastics, and, twenty years later, Cudahy demonstrated the technique for binding endochronic plastics to metal. It became possible to make large objects endochronic-entire spaceships, for instance.

“Now let us consider what happens when a large structure is endochronic. I will describe it qualitatively only; it is all that is necessary. The theoreticians have it all worked out mathematically, but I have never known a physics-johnny yet who could pilot a starship. Let them handle the theory, then, and you handle the ship.

“The small thiotimoline molecule is extraordinarily sensitive to the probabilistic states of the future. If you are certain you are going to add the water, it will dissolve before the water is added. If there is even the slightest doubt in your mind as to whether you will add the water, the thiotimoline will not dissolve until you actually add it.

“The larger the molecule possessing endochronicity, the less sensitive it is to the presence of doubt. It will dissolve, swell, change its electrical properties, or in some way interact with water, even if you are almost certain you may not add the water. But then what if you don't, in actual fact, add the water? The answer is simple. The endochronic structure will move into the future in search of water; not finding it, it will continue to move into the future.

“The effect is very much that of the donkey following the carrot fixed to a stick and held two feet in front of the donkey's nose; except that the endochronic structure is not as smart as the donkey, and never gets tired.

“If an entire ship is endochronic-that is, if endochronic groupings are fixed to the hull at frequent intervals-it is easy to set up a device that will deliver water to key spots in the structure, and yet so arrange that device that although it is always apparently on the point of delivering the water, it never actually does.

“In that case, the endochronic groupings move forward in time, carrying all the ship with it and all the objects on board the ship, including its personnel.

“Of course, there are no absolutes. The ship is moving forward in time relative to the universe; and this is precisely the same as saying that the universe is moving backward in time relative to the ship. The rate at which the ship is moving forward, or the universe is moving backward, in time, can be adjusted with great delicacy by the necessary modification of the device for adding water. The proper way of doing this can be taught, after a fashion; but it can be applied perfectly only by inborn talent. That is what we will find out about you all; whether you have that talent.”

Again he paused and appraised them. Then he went on, amid perfect silence:

“But what good is it all? Let's consider starflights and review some of the things you have learned in school.

“Stars are incredibly far apart and to travel from one to another, considering the light-speed limit on velocity, takes years; centuries; millennia. One way of doing it is to set up a huge ship with a closed ecology; a tiny, self-contained universe. A group of people will set out and the tenth generation thereafter reaches a distant star. No one man makes the journey, and even if the ship eventually returns home, many centuries may have passed.

“To take the original crew to the stars in their own lifetime, freezing techniques may keep them in suspended animation for virtually all the trip. But freezing is a very uncertain procedure, and even if the crew survives and returns home, they will find that many centuries have passed on Earth.

“To take the original crew to the stars in their own lifetime, without freezing them, it is only necessary to accelerate to near-light velocities. Subjective time slows, and it will seem to the crew that it will have taken them only months to make the trip. But time travels at the normal rate for the rest of the universe, and when the crew returns they will find that although they, themselves, haveaged and experienced no more than two months of time, perhaps, the Earth itself will have experienced many centuries.

“In every case, star travel involves enormous duration of time on Earth, even if not to the crew. One must return to Earth, if one returns at all, far into the Earth's future, and this means interstellar travel is not psychologically practical.

“But- But, graduates-”

He peered piercingly at them and said in a low, tense voice, “ If we use an endochronic ship, we can match the time-dilatation effect exactly with the endochronic effect. While the ship travels through space at enormous velocity, and experiences a large slowdown in rate of experienced time, the endochronic effect is moving the universe back in time with respect to the ship. Properly handled, when the ship returns to Earth, with the crew having experienced, say, only two months of duration, the entire universe will have likewise experienced only two months' duration. At last, interstellar travel became practical.

“But only if very delicately handled.

“If the endochronic effect lags a little behind the timedilatation effect, the ship will return after two months to find an Earth four months older. This is not much, perhaps; it can be lived with, you might think; but not so. The crew members are out of phase. They feel everything about them to have aged two months with respect to themselves. Worse yet, the general population feels that the crew members are two months younger than they ought to be. It creates hard feelings and discomforts.

“Similarly, if the endochronic effect races a little ahead of the time-dilatation effect, the ship may return after two months to find an Earth that has not experienced any time duration at all. The ship returns, just as it is rising into the sky. The hard feelings and discomforts will still exist.

“No, graduates, no interstellar flight will be considered successful in this star fleet unless the duration to the crew and the duration to Earth match minute for minute. A sixty-second deviation is a sloppy job that will gain you no merit. A hundred-twenty-second deviation will not be tolerated.

“I know, graduates, very well what questions are going through your minds. They went through mine when I graduated. Do we not in the endochronic ship have the equivalent of a time machine? Can we not, by proper adjustment of our endochronic device, deliberately travel a century into the future, make our observations, then travel a century into the past to return to our starting point? Or vice versa, can we not travel a century into the past and then back into the future to the starting point? Or a thousand years, or a billion? Could we not witness the Earth being born, life evolving, the sun dying?

“Graduates, the mathematical-johnnies tell us that this sort of thing creates paradoxes and requires too much energy to be practical. But 1 tell you the hen with paradoxes. We can't do it for a very simple reason. The endochronic properties are unstable. Molecules that are puckered into the time dimension are sensitive indeed. Relatively

small effects will cause them to undergo chemical changes that will allow unpuckering. Even if there are no effects at all, random vibrations will produce the changes that will unpucker them.

“In short, an endochronic ship will slowly go isochronic and become ordinary matter without temporal extension. Modem technology has reduced the rate of unpuckering enormously and may reduce it further still, but nothing we do, theory tells us, will ever create a truly stable endochronic molecule.

“This means that your starship has only a limited life as a starship. It must get back to Earth while its endochronicity still holds, and that endochronicity must be restored before the next trip.

“Now, then, what happens if you return out-of-time? If you are not very nearly in your own time, you will have no assurance that the state of the technology will be such as to enable you to re-endochronicize your ship. You may be lucky if you are in the future; you will certainly be unlucky in the past. If, through carelessness on your part, or simply through lack of talent, you come back a substantial distance into the past, you will be certain to be stuck there because there will be no way of treating your ship in such a fashion as to bring it back into what will then be your future.

“And I want you to understand, graduates,” here he slapped one hand against the other, as though to emphasize his words, “there is no time in the past where a civilized astronautic officer would care to spend his life. You might, for instance, be stranded in sixth-century France or, worse still, twentieth-century America.

“Refrain, then, from any temptation to experiment with time.

“Let us now pass on to one more point which may not have been more than hinted at in your formal school days, but which is something you will be experiencing.

“You may wonder how it is that a relatively few endochronic atomic bonds placed here and there among matter which is overwhelmingly isochronic can drag an with it. Why should one endochronic bond, racing toward water, drag with it a quadrillion atoms with isochronic, bonds? We feel this should not happen, because of our lifelong experience with inertia.

“There is, however, no inertia in the movement toward past or future. If one part of an object moves toward the past or future, the rest of the object does so as well, and at precisely the same speed. There is no mass-factor at all. That is why it is as easy for the entire universe to move backward in time as for this single ship to move forward-and at the same rate.

“But there is even more to it than that. The time-dilatation effect is the result of your

acceleration with respect to the universe generally. You learned that in grade school, when you took up elementary relativistic physics. It is part of the inertial effect of acceleration.

“But by using the endochronic effect, we wipe out the time-dilatation effect. If we wipe out the time-dilatation effect, then we are, so to speak, wiping out that which produces it. In short, when the endochronic effect exactly balances the time-dilatation effect, the inertial effect of acceleration is canceled out.

“You cannot cancel out one inertial effect without canceling them all. Inertia is therefore wiped out altogether and you can accelerate at any rate without feeling it. Once the endochronic effect is well-adjusted, you can accelerate from rest relative to Earth, to 186,000 miles per second relative to Earth in anywhere from a few hours to a few minutes. The more talented and skillful you are at handling the endochronic effect, the more rapidly you can accelerate.

“You are experiencing that now, gentlemen. It seems to you that you are sitting in an auditorium on the surface of the planet Earth, and I'm sure that none of you has had any reason or occasion to doubt the truth of that impression. But it's wrong just the same.

“You are in an auditorium, I admit, but it is not on the surface of the planet, Earth; not anymore. You-I-all of us-are in a large starship, which took off the moment I began this speech and which accelerated at an enormous rate. We reached the outskirts of the solar system while I've been talking, and we are now returning.

“ At no time have any of you felt any acceleration, either through change in speed, change in direction of travel, or both, and therefore you have all assumed that you have remained at rest with respect to the surface of the Earth.

“Not at all, graduates. You have been out in space all the time I was talking, and have passed, according to calculations, within two million miles of the planet Saturn.”

He seemed grimly pleased at the distinct stir in the audience.

“You needn't worry, graduates. Since we experience no inertial effects, we experience no gravitational effects either (the two are essentially the same), so that our course has not been affected by Saturn. We will be back on Earth's surface any moment now. As a special treat we will be coming down in the United Nations Port in Lincoln, Nebraska, and you will all be free to enjoy the pleasures of the metropolis for the weekend.

“Incidentally, the mere fact that we have experienced no inertial effects at all shows how well the endochronic effect matched the time-dilatation. Had there been any

mismatch, even a small one, you would have felt the effects of acceleration-another reason for making no effort to experiment with time.

“Remember, graduates, a sixty-second mismatch is sloppy and a hundred-twenty-second mismatch is intolerable. We are about to land now; Lieutenant Prohorov, will you take over in the conning tower and oversee the actual landing?”

Prohorov said briskly, “Yes, sir,” and went up the ladder in the rear of the assembly hall, where he had been sitting.

Admiral Vernon smiled. “You will all keep your seats. We are exactly on course. My ships are always exactly on course.”

But then Prohorov descended again and came running up the aisle to the admiral. He reached him and spoke in a whisper. “Admiral, if this is Lincoln, Nebraska, something is wrong. All I can see are Indians; hordes of Indians. Indians in Nebraska, now, Admiral?”

Admiral Vernon turned pale and made a rattling sound in his throat. He crumpled and collapsed, while the graduating class rose to its feet uncertainly. Ensign Peet hadfollowed Prohorov onto the platform and had caught his words and now stood there thunderstruck.

Prohorov raised his arms. “All's well, ladies and gentlemen. Take it easy. The admiral has just had a momentary attack of vertigo. It happens on landing, sometimes, to older men.”

Peet whispered harshly, “But we're stuck in the past, Prohorov.”

Prohorov raised his eyebrows. “Of course not. You didn't feel any inertial effects, did you? We can't even be an hour off. If the admiral had any brains to go with his uniform, he would have realized it, too. He had just said it, for God's sake.”

“Then why did you say there was something wrong? Why did you say there are Indians out there?”

“Because there was and there are. When Admiral Sap comes to, he won't be able to do a thing to me. We didn't land in Lincoln, Nebraska, so there was something wrong all right. And as for the Indians-well, if I read the traffic signs correctly, we've come down on the outskirts of Calcutta.”