

THE FOUNDLING STARS

"All right—perfect. You're the most nearly motionless thing in the universe."

Hoey's words were figurative, of course; whether they were accurate or not depended entirely on point of view. Rocco Luisi and his *Ymyrgar* were indeed at rest with respect to Hoey and the *Anfforddus*, after more than four hours of maddening effort, but neither machine was motionless with respect to much else. Both were travelling at about four kilometers a second, roughly galactic northward, with respect to their home port on Rhyddid, seventy-five parsecs away. They were moving at a much greater velocity with respect to the far more distant Solar System. With respect to each other, however, velocity had been whittled down to somewhat less than five centimeters a year.

How long this would last was problematical. An automatic tracker was now on duty in Hoey's ship, trying to hold steady the fringe pattern produced by combining two ultraviolet laser beams, one originating in his own vessel and the other in Luisi's, in one of the most precise interferometers ever made. Since the crafts were about a light-hour apart, however, corrections tended to be late in time and, in spite of a computer's best efforts, erratic in amount and direction.

"Nineteen decimals" had been a proverbial standard of accuracy for well over a century; but achieving it on any but the atomic size and time scale was not yet standard art.

"That seems to be it," Hoey repeated. "That means that you and I stay strapped in our seats, with no more motion than we can help, for the next four hours or so. If either of the instrument platforms on our ships moves more than half a micron with respect to the other, a lot of time and money go down the drain."

"I know—I've had it hammered into me as often and as hard as you have." Luisi's voice was undistorted, and the responses instant, on the medium communicator.

"Sure you have," retorted Hoey, "only a lot of people wonder whether you really believe it."

"Well, it depends on what you mean by believe. I can figure as well as anyone where the center of mass of my ship would go if I stood up; I—"

"I know you can. Your trouble *is* that you can't believe it would make as much trouble as they say. Just remember that they were even concerned about tidal forces from Cinder over there"—he gestured, rather uselessly, at the grossly misnamed o6e star glaring at them from half a parsec away—"and even went to the trouble of finding a part of this neighborhood where the wind was steady—"

"Right there I break connection. Space is space. You only worry about wind when you're close to a sun, and then it's only a hard-radiation problem."

"True enough, as a rule. The trouble is that the usual run of stellar winds involves a mass density of around ten atoms to the cubic centimeter; here it's a couple of thousand. It turned out that even that much mass wouldn't accelerate the ships seriously unless the relative velocity were very high indeed, but it was something the planners had to check on. You see what I mean; so stay put. Let's cut the chatter. The sooner the folks in 'Big Boy' can get to work, the sooner we can breathe comfortably. I'll call 'em."

Hoey's finger tensed on a button, replacing the microscopic crystal in the activity field of his communicator with another, whose twin was aboard. "Big Boy"—more formally, the *Holiad*. He spoke without preamble, knowing that someone would be listening.

"We're in position, and my tracker says we're holding. Get the job going while the going's good."

"Right." The answer was terse, but not casual. The speaker, a heavy-set, middle-aged man with an almost fanatically intense stare in his blue eyes, leaned forward over the console in front of him and began punching buttons in an intricate sequence. He paused every second or two to interpret the patterns of light which winked at him from the board. After half a minute or so the pattern became fixed, and he leaned back, more relaxed.

"Program A is running." A younger man, seated at a similar console a few yards away, nodded at the words. At first he did not answer aloud; then he decided to speak, though for several seconds he was obviously trying to make up his mind what to say. It was easy to make the wrong remark to Elvin Toner.

"D'you think we'll get full time out of it?" he ventured at last. "Those pilots are good, but I still wish it had been possible to use robotships for the key stations. A man can't hold still forever."

"So do I." Toner answered without obvious irritation, and his eyes remained fixed on his console, to the younger man's relief. "I also wish," the director went on, "that it were possible to use the medium communicator system directly for automatic control of such things as distance, so as to get away from light-lag. But until some genius in your generation works out a way to measure the frequency, wavelength, and propagation velocity of medium waves—or at least, furnishes some evidence that a wave phenomenon is involved—we'll have to stick with electromagnetic radiation and, at times, with human beings. You may not like it, but by the time you reach my age you'll have learned to put up with it."

"I hope not," Ledermann couldn't help replying.

"Eh? Why not?" Toner's eyes almost flicked away from his instruments for a moment, but didn't quite.

"I mean that if I learn to put up with inconveniences, it'll be because I haven't been able to figure out anything else to do about them. Who wants to admit that?"

Toner grinned. "Nobody wants to, I suppose, but the honest people do anyway. Hold up; here comes the end of the first minute; any irregularities on your board?"

"Not so far. I don't know what that proves, though; all we are measuring is what's going into the generators. We can't touch what's coming out without changing it—"

"Of course." The older man made a gesture of impatience. It's some relief, though, to know that things are going in right. I don't know about you, Dick, but Program A is going to be the second longest couple of hours in my life."

"I know," replied Ledermann. It was the first time Toner had ever been so frank about his feelings—even though they were usually quite obvious from other evidence—and certainly the first time the assistant had felt much real sympathy for the director. Since the younger man was not a fast thinker, the remark left him once more unsure of what to say.

As a matter of fact, there was probably nothing to say which would have been just right. Toner, like most middle-aged men, had developed a pretty firm personal philosophy and a rather rigid set of fundamental beliefs. The present experiment involved very heavily one of those beliefs—one which Ledermann did not share.

Although, the assistant thought as he glanced through one of the *Holiad's* great view ports, this was a place where it was hard to feel sure and right about anything fundamental.

Space was not dark, though the nebular material which abounds in the Orion spur of the Milky Way system is never very bright even when no planetary atmosphere dims it. Getting closer to an extended light source, of course, doesn't make each square degree look any brighter; it merely increases the number of square degrees. From the *Holiad's* position, most of the sky is nebula-bright; and to a spaceman, anything resembling a cloud looks wrong in space. In some directions the stars blaze steadily, as they do from Earth's moon; other directions are blacked out by light-years of dust. Some of the dust itself is bright, for 41 Orionis, named "Cinder" by some humorist who had explored the region earlier, is only half a parsec away. Not only does its fierce ultraviolet radiation keep the nebular gases fluorescing, but its visible is quite enough to light up the dust for immense distances. Not counting its emission envelope, Cinder is only about five times the diameter of Sol, which means that it looks like a point from half a parsec away; but that point illuminated the *Holiad* almost as effectively as the full moon illuminates the earth. Several other O and B stars flame in the neighborhood; some look brighter than Venus as seen from Earth, some reveal themselves only by illuminating the surrounding dust clouds, some are invisible in the nebulosity. The Orion Spur is one of the cradles of the galaxy.

Unfortunately, the occupants of the cradle are foundlings. The general circumstances surrounding a star's birth are now fairly clear; ships prowling the cloudier regions of the spiral arms have found them in all stages of gestation, from gas and dust clouds half a light-year across and little denser than the interstellar background, through T Tauri variables hot enough to radiate visibly, to the vast population of main-sequence suns whose hydrogen fires are safely alight. Like foundlings, while an entire birth has

never been observed in any one case, we know enough to picture the circumstances with some confidence.

Also like foundlings, however, the precise details of a star's conception are somewhat obscure. It has been widely supposed for several decades that random variations in the density of the interstellar medium are the key factor—that the law of chance is the father. Dick Ledermann, young and conservative, had no trouble accepting this view. To him, it was obvious that the random "winds" of space must at times produce a gas concentration so dense that its gravity would override the disruptive tidal force of the rest of the galaxy—override it enough to produce a local potential well able to trap at least the lower energy particles of the cloud.

Elvin Toner, nearly twenty years older, had strong reservations about the potency of unaided statistics. Like anyone with even a modest grounding in physical science, he realized the basically statistical nature of many of the universe's laws; he admitted that a star *could* come into existence by the concatenations of chance which most people took for granted; but he doubted seriously that the random motions of interstellar gas could set up the appropriate conditions often enough to account for the number of observed stars, even allowing for the fairly impressive lifetime of a star. He felt sure—it was as much an article of faith as the normal scientific belief that there is a natural reason for everything—that some specific, widespread, underlying process was operating to improve the chance of protostar formation.

He was able to prove that some such process was needed to account for the observed star density. Ledermann was able to prove that it was not. Both "proofs" were statistical, using the same "laws" of chance. They differed, of course, in the basic conditions which were assumed. Both sets of conditions were reasonable; the two hypotheses continued to survive because neither could be checked adequately. Elvin Toner had spent thirty years acquiring a professional reputation impressive enough to interest a sufficiently wealthy foundation in doing the checking. And now he had the chance.

It had taken wealth—or its equivalent—and a vast amount of human effort.

The basic check required detailed measurements of the positions, velocities and accelerations of all the particles, as exactly as Heisenberg allowed and as nearly simultaneously as possible, along a range of more than five astronomical units. Since electromagnetic energy had to be used, this meant that the best part of two hours would be needed merely to set up the web of standing waves which was to serve as the "framework" of the battery of measuring instruments, which were themselves force fields.

The basic design, of the experiment was standard—even unimaginative. After setting up the wave pattern, a period would be spent measuring the initial vector quantities of the particles along the range. Fundamentally, the measuring process would be practically instantaneous, but scanning and recording would use up an hour as the chain of reading impulses travelled from the *Ymyrgar* along the wave web to the *Anfforddus*, from which the readings would be transferred by medium crystal to the mother ship.

This was "Program A" which was now in progress. Electromagnetic waves of almost five hundred different frequencies, ranging from the blue part of the visible spectrum to the output of a huge electromagnet fed by an alternating current source with a three-hundred-second period, were propagating away from the *Ymyrgar*, groping their way through the not-quite-empty billion kilometers or so which separated the little tender from her sister. Some of the frequencies had been selected for their ability to interact with the atoms and ions known to occupy the space, some for the fact that they would not. Some would be absorbed and analyzed by the apparatus aboard the *Anfforddus*, some would be reflected back toward their source to create the standing-wave patterns needed for Program B. All would represent a waste of energy if the two tiny ships changed their relative positions by one part in ten billion billion.

Lights on the control consoles aboard the *Holiad* recorded the behavior, microsecond by microsecond, of each separate frequency generator; but the one which Toner never let out of his sight was that which kept track of the interferometer on the *Anfforddus*. This light shone yellow as long as the original pattern of fringes remained unchanged; a one-fringe shift one way would carry it into the red; a similar change in the other would turn it violet. So far, while there had been at times a suspicion of green or orange in its tint, it had held within the English language limits of yellow.

"I think you can relax a little," remarked Ledermann. "All the general run of disturbances should have had their licks by now; A has been cooking for over half an hour. Unless Hoey or Luisi has a fit, their ships can hardly move enough to make trouble."

"They both had EEG checks before they were hired." Toner was not joining in any levity, yet. "I'm not worried about that possibility."

"Then why not take it easy? Surely you're not worrying about a meteor."

"Well—comet nuclei are found pretty far from suns, but I really wasn't thinking of anything specific. It's just that so little need go wrong to wreck the whole works. Program A isn't so bad, in spite of the precision we need; but when B gets going it will really mean something. I can't keep my mind off that."

Ledermann nodded. Program B was the experiment itself—the check on the Toner hypothesis. In assuming that non-statistical forces existed which tended to start interstellar matter drawing together into protostars, the astronomer had not fallen back on mysticism. He had computed many combinations of electric and magnetic fields which should have such an effect, and which might reasonably—or at least conceivably—exist along the arms of the Milky Way. The wave patterns of Program B had been designed from these computations. Naturally, phenomena as complex as, say, the human nervous system or even the circuitry of a television set or the measuring patterns of Program A would be no improvement on pure chance as an explanation for star formation; such things were too improbable by any standards. Toner's fields were simple enough so that, in his opinion, they were more probable than random gas and dust concentrations. They were also complex and extensive enough so that looking around for examples of them already in existence seemed impractical—so far. Of course, if Program B showed that such fields would, or could, produce the results Toner expected, he would have little trouble financing such a search.

If the program failed to give the results Toner hoped for, Ledermann was both unsure and uneasy about what to expect. Few men can abandon a favorite hypothesis abruptly and completely, and the need to do so can have painful effects.

Actually, Toner would not be forced to such an extreme at first; many more variations on the original theme would have to fail before the whole idea would have to be abandoned. What bothered Ledermann was the doubt that the foundation would go along with any such extension of the project and how Toner would react if it refused.

Actually he needn't have worried. The director was philosophical enough to take such a problem in his stride. Since the younger man had no way of knowing this, he watched his console with even more anxiety than his director—in spite of what they had both been saying.

But the green lights stared unwinkingly back at them, as the waves spread across space. No news, with the proverbial implication. The clock was the only instrument which showed change; the clock, that is, and two human nervous systems.

"Stuff coming in from Hoey's receivers," Ledermann reported abruptly. Toner nodded.

"On time," was his only answer. Neither bothered to ask, or to say, what sort of stuff was coming in; the data was no more meaningful to human senses than were the photons which carried the first Mariner pictures from Mars. The main thing was that news was coming in; it was being recorded; it could, in due time, be decoded; and—Program B was due to start.

Both men sat up a little straighter and stared more tensely at their consoles as the light patterns began to change.

Simultaneously—the word was as nearly truthful as it had ever been in human history—sets of electromagnetic fields began to grow around both the *Ymyrgar* and the *Anffordclus*.

Neither set was complete by itself, but this interference would produce something which Ledermann thought of as a huge lens. The analogy was a poor one geometrically, but has some excuse from a functional viewpoint. Drifting slowly with respect to the surrounding gases, many of whose atoms were ionized, it should—if Toner was right—tend to deflect their relative motions toward its own "optical axis." To that extent, Toner's idea was a simple one. The precise pattern of fields which should have the

desired effect was somewhat less so, as any engineer who has been involved with an electron microscope would expect.

Each lens" of the series making up the program was to be followed by a set of reading patterns similar to those of Program A, so that its individual effect on the motion of the nebular particles could be measured. In principle, the whole thing was easy ...

"Intervals seem to be right." Ledermann dredged a little good news out of his light pattern. "Four seconds, plus or minus ten to the minus tenth. Interlens distances are within tolerance, I'd say."

"If we haven't been too grossly off in computing the refractive index of the nebula—"

"Which is handled automatically by the original A measures, *as* I understood the plan. Calm down, boss."

"All right. You're talking a little louder than usual yourself. I still wish you'd invent a method for using the communicator medium for direct viewing; we could *see* whether these things are building right, instead of having to infer from generator behavior—"

"*Maybe* we could. I'm a conservative; I still buy the Uncertainty Principle. Even if we could do anything with the medium which would make it react to something besides a communicator crystal, I bet it would affect the thing we were trying to measure."

"It doesn't affect the crystals—just the space around them."

"Not measurably. Has anyone tried to check on them, to within fifteen figures of what we're doing now?"

"Not as far as I know. I—Dick! What happened then?"

Ledermann didn't know either. At least, he didn't know in the sense that Toner wanted to. Like the director, he had seen every light on his console except the one indicating tender separation turn a solemn red for a full second, and then switch back to green. If they had been looking away for that second, the men would not have known that anything had ever been wrong; after the event, the lights stared back at them, apparently unchanged.

The first thought to occur to both men was that something had happened to the console circuits; the second, that something had happened to their own nervous systems. Three seconds of checking with test switches seemed to dispose of the first possibility; and since they had both seen the same thing, the second was very low on the probability list.

Toner frowned, and spoke very slowly.

"If that is to be taken at face value, everything in both tenders which was putting out program radiation stopped for about a second and then started up again—all together. That would cause a gap of about three hundred thousand kilometers in the wave pattern—at each end—with the gaps due to meet in half an hour; let's see—what would that do to the lenses?"

"If you can work that out in your head, especially with only estimated time data, you didn't need to set up this experiment at all. You must have put the universe together in the first place," retorted Ledermann. "There's no more chance of telling that than of telling which of my next half million coin tosses is going to be heads."

"True." For a man whose work was taking such a blow, Toner seemed remarkably detached. "That would suggest that we should cut off our generators, let the present set of patterns radiate out of the area, and start over."

"We'd have to do more than that. The gas in the area has probably been affected by the part of B which has already gone out. We'd have to move the tenders to a different area altogether and set up the whole works again. Wouldn't it be better to let this program run itself through? We don't really know that the generators did stop; test circuits or no test circuits, I find it easier to believe that something messed up the indicators than that the whole set of generators went out and came back on again at once. If we let things run, the worst that can happen will be the loss of a couple of hours—and we *might* not have to start over, if this run is really all right."

"You're partly right. Letting it run won't cost us much time. But we will have to do it over anyway; we won't be able to tell if the first run was really okay until we get the data reduced, which we can't do here. We'll just have to do the whole thing twice."

And Ledermann slowly nodded his head.

Hoey's reaction, some hours later, was more impressive. He and Luisi were celebrating their release, to the accompaniment of an improvised song whose burden was the supreme difficulty of doing nothing at all, when Toner broke the news as gently as possible that the whole thing would have to be done over.

He wrapped the information in flattery, lubricated it with all the soft soap he could bring himself to use and sweetened it with a respectable bonus offer; but neither pilot accepted the word at all philosophically. They were still visibly nettled sixty hours later when the tenders once more pulled away from the *Holiad*. This *may* have had something to do with the results.

They did calm down again, just a little, during the setup of the measuring line, however. Earlier practice may have helped, for it took them less than ninety minutes this time to get their little vessels "fixed" relative to each other.

"That's it, Doc!" Hoey's voice was almost jubilant. Toner, who had pretty well convinced himself by this time that the first run had really been all right, was able to answer in similar mood.

"Good going—that was very quick work. I'm starting the A tapes now. About how far are you from where the other run was made?"

"A couple of flight-hours, I'd say; we didn't try to check it exactly. You didn't say it was necessary." "It isn't Relax. And I do mean *relax*."

"I know, boss. We're getting used to it. Let things roll."

"They're rolling."

Even in the calmer atmosphere of the second run, tension built up a little during Program A. Even though this part had gone without a visible hitch the first time, there was no way of knowing whether the unknown interference had a preference for Program B.

Of course, it might have. The programs *were* different—and the word "unknown" certainly was a key one. No one is quite sure, yet.

Toner and Ledermann of course knew to the second just when the Program B interruption, if it had really been one, had occurred; Hoey and Luisi knew almost as well from the physicists' account of the affair. All four were watching clocks; and perhaps it was the tension wound up by the whirling clock hands which caused the trouble; perhaps not. No one was ever sure. Whatever the cause, six seconds before the critical moment, when both scientists were gripping their chair arms and staring frozenly at their consoles, Hoey sneezed.

It was quite a sneeze, and the fact that Toner heard it clearly through the medium communicator did not operate to lessen its effects. The pilot's head had been resting in the padded support which formed part of his seat—the support in which it was supposed to remain through the experiment. The muscular convulsion of the sneeze snapped that head some twenty centimeters forward and down.

The *Anfforddus* had, roughly, a million times the mass of Hoey's head, so its center of mass moved only about a millionth as far. This amounted to about a fifth of a micron. The fact that this was within the set tolerances for the experiment did not at once dawn on Toner—for one thing, it would have taken him a moment to figure it out under any circumstances, and for another his reaction was reflexive rather than rational. He was like a confirmed anti-vivisectionist reacting to an account of a mechanical heart's being tested on a dog; he exploded. He jumped—much farther than Hoey, though fortunately it didn't matter how much the *Holiad* moved. He also began to talk, though just what he said is uncertain—Ledermann charitably wiped that part of the monitor tape, later. It took the younger man some thirty seconds to calm his superior down enough to listen to reason, and perhaps fifteen more to supply the reason. Another five seconds passed while Toner actually recovered control of himself, and started to apologize to Hoey.

But Hoey did not hear the apology—we think.

In the fifty seconds or so since his sneeze, radiation from his ship travelled some fifteen million kilometers. This is easy to compute; it is pretty certainly a fact. It may possibly be a useful one, though no one so far has put it to any real use.

The trouble is, of course, that there is no way to be sure whether the sneeze put any significant

alteration into the radiation pattern which the *Anfforddus* was broadcasting. This, equally of course, is because no one can be sure just how big a change must be in order to be significant.

Toner had just started to talk in a normal tone when Ledermann gave an astonished yelp; and the director, whose attention had shifted entirely to the screen of the medium communicator, looked back to his console.

Its lights were out. It was blank. So, when he turned back to it, was the medium screen. And so was Ledermann's console.

One hundred seconds later, after repeated calls to the tenders had proven futile, the *Holiad's* captain snapped her into irrelevance drive. Between four and five seconds later still, a hundredth of a parsec from where she had been lying, the research vessel halted again. Presumably she was within a few tens of thousands of kilometers of Hoey's tender, but no sign of the little ship could be detected by eye or instrument.

Calls continued to go unanswered. Searchers went out with detection and rescue equipment; the former gave no response, the latter went unused. Not a particle of solid matter could be found within light-minutes of either tender's former position; and it was not until much later, when the routine sample-bottles were being checked back on Rhyddid, that the slightly high count of aluminum atoms in that particular volume of space was noticed.

Of course, this may not be a significant fact, either.

"And just who was that?" The query came in the growl which seems to be a distinguishing property of sergeants, whether their linear dimensions be two meters or two hundred astronomical units. It received no immediate answer. "Well? Who was it? It came from just about where you should be, VA741. Was it you?"

"I—I guess so."

"You *guess* so? A soldier lets out a yelp that can be heard halfway across the spiral, and he only *guesses* that he did it?"

"I did it, I—I—"

"You did. Never mind the guessing. Why did you do it? You know why we're here?"

"Yes, Sergeant."

"You know what we're doing here?"

"Yes, Sergeant."

"In fact, up to now you've been helping to do it."

"Yes, Sergeant."

"And you know why we've been sweeping this stuff together."

"Yes, Sergeant. To clear a path for—"

"Shut up. How much use will the path be if the Flickers find it before our boys have a chance to come through?"

"Not much, I suppose, Sergeant."

"You suppose. Well, I suppose I should be glad it even occurred to you. Now that you've squealed like a stuck baby, how long do you suppose it will be before Flicker scouts are poking around this cloud?"

"I don't know, Sergeant."

"I don't know either, but I'll be very surprised if we drift a hundredth of the way around the spiral. If it were possible to travel faster than radiation, they'd be spearing you before you cleared another cubic parsec."

"They may show up anyway; we can't tell yet."

"That, soldier—I use the term loosely—is the only reason you're not under formal charges right now. If we're spotted in the next little while—say, before the cloud you're sweeping up right now starts to radiate—I'll assume it wasn't your fault. But if we're found after that, when that squeal of yours has spread out a few hundred parsecs, you're in for it. What I ever did to be saddled with a—"

"But, Sergeant, I couldn't help it. Something bit me."

"So something bit you. Let it bite! Since when—"

"But I really couldn't help it. It did something to my muscles, and I twitched so I thought someone might spot me anyway; but I relaxed and even damped out the spot with dope. I know how important it is not to make a disturbance. The sensation quit for a moment, but then it came back stronger than before, and before I could take another tranquilizer I cramped up tight all over. I couldn't help giving a little yelp—"

"Little? It was loud enough to—never mind. I hope you can produce whatever bit you; it may help in court. After all, I suppose anything which can interfere with even a sloppy soldier's self-control might be usable as a weapon. If we could breed more of 'em—that's an idea. See if you can catch it, without making too much noise."

"I'm afraid I didn't think of that in time, Same. We'll never catch that one. The whole business was just reflex, and I'm very sorry, but I swatted it without thinking."

In addition to their voice qualities, sergeants are sometimes known for a certain gift of rhetoric. This one, DA-6641, of the 44th Company, 6261st Field Engineering Battalion, Army of the Republic of Whilth, was no exception.

If he had not been careful to use only short radiation in his remarks, they would have been audible back in Whilth, in the spiral arm of the Milky Way next outward from Sol's. Even with the short waves, he might possibly have made an impression on the *Holiad's* instruments; but of course the *Holiad* was no longer there.

Long before he had really made himself clear about just what sort of poor excuse for a soldier the unfortunate VA741 was, both Elvin Toner and Dick Ledermann were dead of old age.