

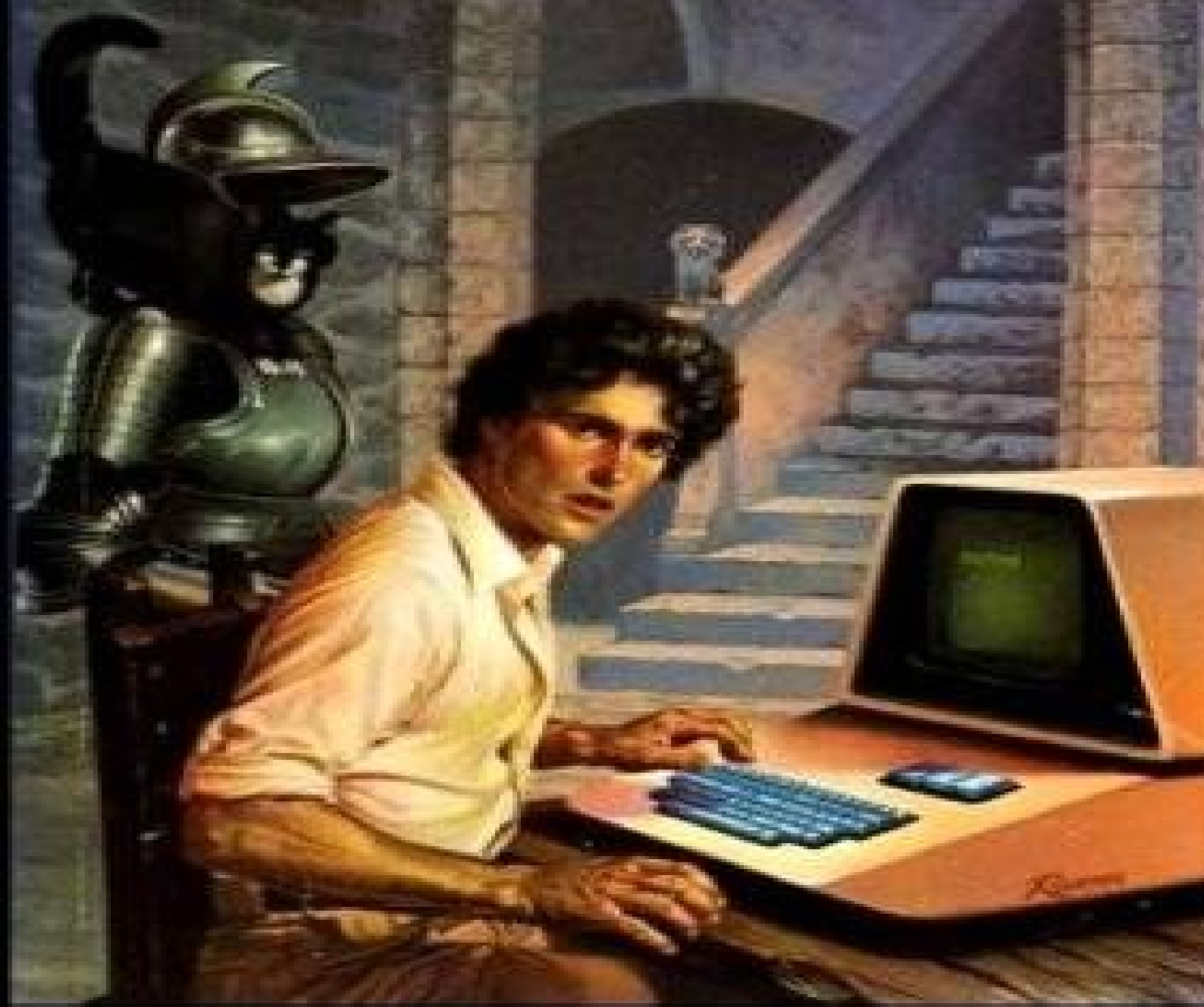
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TO SAVE THE FUTURE,  
THEY MUST CHANGE THE PAST—  
AND LOSE THE PRESENT!



# THRICE UPON A TIME

AN EXCITING NEW NOVEL BY  
**JAMES P. HOGAN**



# Thrice Upon a Time

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by James P. Hogan

## A HOLE EARTH CATASTROPHE

How does a man feel when he finds the end of the world staring him in the face?

The screen in front of him filled with mathematical expressions. Murdoch just stared numbly at the screen, unable to think, unable to move, unable to feel anything. But for him the shock was not total; he had been half prepared for it all along.

The microscopic black holes were not going to evaporate.

The loss of energy through tau radiation would sustain them until they became permanent. Then they would grow. As they lost orbital momentum, they would spiral toward the Earth's core, eventually coalescing into larger black holes... which would continue to draw in matter and grow even faster. There was insufficient information to determine exactly how quickly the process would accelerate or how long it would go on – maybe months, years, tens of years, or perhaps even longer – but the final result at the end of it would be inevitable:

Eventually they would consume the whole planet.

It was unstoppable and irreversible. There was no other way it could end.

Unless the past were somehow altered...

This is a work of fiction. All the characters and events portrayed in this book are fictional, and any resemblance to real people or incidents is purely coincidental.

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Del Rey / Ballantine

ISBN: 0-345-27518-7

Cover art by Rowena Morrill

First printing, March, 1980

These  ePub and Mobi  editions v1.0 by Dead^Man December, 2011

dmebooks at live dot ca

Retail edition, reformatted

Distributed by Simon & Schuster

1230 Avenue of the Americas

New York, NY 10020

Production by Windhaven Press, Auburn, NH

Printed in the United States of America

To all at Del Rey Books – the other half of the team who never get  
mentioned on the cover

*Inherit the Stars*  
*The Genesis Machine*  
*The Gentle Giants of Ganymede*  
*The Two Faces of Tomorrow*  
*Thrice Upon a Time*  
*Giants' Star*  
*Voyage from Yesteryear*  
*Code of the Lifemaker*  
*The Proteus Operation*  
*Endgame Enigma*  
*The Mirror Maze*  
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*The Immortality Option*  
*Paths to Otherwhere*  
*Bug Park*  
*Star Child*  
*Rockets, Redheads & Revolution*  
*Cradle of Saturn*  
*The Legend That Was Earth*

# Prologue

---

The digits, glowing bright red in the upper corner of the computer display screen, changed silently to count off the final seconds.

00:05... 00:04... 00:03... 00:02... 00:01... 00:00.

A symbol appeared below the clock-readout to confirm that the program had begun running. A moment later, the main area of the screen came alive to present the display:

30 DECEMBER 2009, 2325:00 HOURS.

TEMPORAL RETROTRANSMISSION TEST NUMBER 15 GROUP 4, SAMPLE 3. TRANSMISSION  
ADVANCE 60 SECONDS.

073681

END

The elderly man sitting in front of the console gazed expressionlessly at the display for a second and then tapped a pad on the touchboard array below the screen. A mild whine came from one of the racks of electronic equipment standing next to him; at the same time a hardcopy of the information on the screen slid smoothly from a slot and into the tray below. The screen went blank. The man took the hardcopy, ran his eye casually over it, then sat back in his chair to wait. In the upper corner of the screen, the clock-readout had reset to sixty seconds and begun counting down again.

The man's body was tall, and his shoulders still broad and straight, but the hair that had once glistened jet-black was now white, and the beard jutting stubbornly from his chin had faded to gray. Remnants of flames that had once blazed bright still smoldered in the eyes looking out over the rugged crags of his face, but the fire was beginning to give way to a fatigue accumulated over many long years of life.

After a while he shifted his gaze to the fluffy black-and-white kitten lying curled up in the half-open, lower-most drawer of the desk that stood alongside his chair.

"Aye, it's a strange pair we are, Maxwell, and that's for sure," he murmured. "Still at work here an hour when any folks with a dram o' sense would long have been away to their beds. Enough, enough. We'll make this the last for tonight now."

Alerted by the man's voice, the kitten opened a sleepy eye to look at him, and then glimpsed the reflex twitching of his own tail. He awoke, pounced back into the depths of the drawer, and began whirling in futile circles amid sounds of swishing fur and crumpling paper. A yellow plastic pushpin flew out in the confusion, bounced on the floor with a hollow clatter, and rolled away in a drunken curve around the base of one of the equipment cubicles. Maxwell's head appeared peering from the opening with ears erect and eyes following the rolling button like twin tracking-radars. Then the kitten cleared the side of the drawer in a bound, rounded the corner of the desk in an uncontrolled skid with all four paws flailing ineffectively at the shiny floor, reengaged forward drive suddenly, and scampered away in pursuit.

A faint smile softened the corners of the man's mouth as he watched. Then he looked back at the screen in front of him. The countdown had almost reached zero.

00:01... 00:00.

A display similar to the previous one appeared. The man carefully compared the number contained

in it with the one in the hardcopy record that he was still holding. They matched. He nodded slowly himself. At that very moment, if the phrase retained any meaning at all in the strange realm of topsy-turvy logic that he had uncovered, a man was watching those same lines appear on that same screen for the first time – the gray-haired man who was sitting in that same chair, sixty seconds in the past.

He hardcopied the second display, attached the copy to the first, added the sheets to a pile lying on the desk, and entered the details in a notebook lying open beside him. Then he closed the book and turned back to the console to begin the brief routine for shutting down the system.

“Enough’s enough,” he repeated as he finished and rose from the chair. As he moved toward the door, the pushpin rattled back into sight from behind a part of the machine. The tip of a black-and-white nose poked round the base of a cubicle. Then, slowly, Maxwell’s face slid fully into view, closely followed by Maxwell, his body elongated low near the floor like a snake with legs. The kitten gathered himself to spring, then paused and looked up curiously as the man reached for the lightswitch.

“Och, come on now,” the man called. “There’ll be time enough for that kind o’ nonsense tomorrow. It’s nearly tomorrow already as it is.” Two saucer-eyes turned wistfully toward the pushpin and then up again before the kitten stood up and trotted for the doorway. “Aye, you’re no’ so bad for all your mischief, ye wee scallywag,” the man said gruffly. He turned out the light, waited for Maxwell to leave the lab, and closed the door behind.

The passage outside was bare, with plain, whitewashed walls rising up from a gray stone floor. At the end of the passage they came to a narrow wooden staircase leading up to a heavy oak door. The man waited again at the top of the stairs and held the door ajar while the kitten tackled the steps manfully, half leaping, half scrambling up one and then bunching himself for the next.

They emerged from the doorway into a large, paneled hall, gloomy in the feeble light of the single lamp that had been left burning halfway along a corridor opening off the far side. The floor here was covered by deep, rich carpet. Vague shadows of portraits stared down from the walls, and the furnishings, most of which dated from the early twentieth century or before, were solid, well-preserved, and dignified in keeping with their surroundings. A full suit of medieval armor stood impassively at the foot of a broad carved staircase that disappeared into deeper darkness above, where glints of reflected light traced ghostly outlines of Scottish claymores and battle axes mounted on the walls.

The man flipped a switch to illuminate the stairs and began climbing slowly. Two circles of mirror-brightness were already staring back at him from the darkness just above the top step. “You’re no’ be so nimble on your feet with seventy-two years on the wrong side o’ ye, Maxwell,” the man said. At the top of the flight he turned to follow the railed gallery that overlooked one side of the stairwell and stopped outside one of the doors opening off the short passageway beyond. A shaft of light lanced across the floor as he pushed the door open.

“We’ve done it, Maxwell,” he murmured. “There can be no doubt about it now. It works, all right. We’ll have to be telling Ted the good news first thing in the morning.” He paused for a second. “And Murdoch, of course.... It’s time we were involving Murdoch in what’s been going on.” He nodded to himself. “Aye. Murdoch will be very interested indeed if I’m not very much mistaken.”

The door swung shut and plunged the household once more into gloom.

# Chapter One

---

Kennedy International Airport had shrugged off the snow that fell after Christmas, and was again a bustling oasis of business-as-usual amid the white-blanketed suburbs stretching along the southern Long Island shoreline. Steady processions of groundcars and mono-cabs flowed between the airport complex and Manhattan to the west, while overhead swarms of airmobiles arrived and departed like bees on never-ending foraging missions. From within the perimeter, a succession of Boeing Lockheeds, and Douglasses sailed vertically upward on the first stages of their suborbital trajectories through the ionosphere; higher above, arriving dots from Europe, Japan, Australia, and elsewhere slowly acquired shape as they dropped from the flawless blue that had come with the first day of the new year.

In the Arrivals Concourse of the glass-fronted marble sculpture that constituted Terminal Three Murdoch Ross stood among a group of waiting people and divided his attention between scanning the faces of the passengers streaming from Flight 235, just in from San Francisco, and taking in a few more lines of an article on graviton wave-mechanics featured in the current issue of *Scientific American*. He was in his late twenties, on the lean side of average for his medium height, and clean-shaven to reveal a fresh and healthy complexion. His eyes were bright and alert as they glanced up every few seconds from the magazine in his hand, and almost as dark as the wavy black hair above the collar of his overcoat.

He saw the head of copper-colored hair protruding above the rest of the new arrivals at the same time as the head saw him. Its owner changed direction to wade obliquely through the river of humanity toward Murdoch. He was dressed in a dark-blue, open-necked shirt, navy windbreaker, and gray cords, and carrying a leather travel bag slung across one shoulder; he moved unhurriedly, but with a powerful, easy-going stride. Murdoch thrust the magazine into the pocket of his overcoat and grinned as they shook hands. It was like grasping a double-thick cut of spare rib that hadn't died yet.

"Lee, great to see you again! It seems like a lot more than five months. I'm sorry about the short notice, but that's all I had myself."

Lee Walker's mouth barely twitched, but his eyes came as near as they ever did to smiling. "Hi Doc. You're right – it seems a lot longer. I guess that's the way things go." He heaved his bag onto his other shoulder and produced a pack of cigarettes from his windbreaker. "What time is it here? How long have we got before the flight leaves?"

"It's on schedule – just over fifteen minutes."

"Get my ticket fixed okay?"

"You're all set."

"Thanks."

They began walking briskly toward the nearest escalator leading down to the automatic shuttle system that connected the airport terminals.

"So," Murdoch said. "How are things back west? Dynasco going okay?"

"Pretty good," Lee replied. "The checkout's finished, and the documentation's all done. I think they're pretty pleased with the whole deal."

"Good."

"In fact if you hadn't called, I'd have been coming on over to New York in a week or so anyway."

How's it been looking?"

"Promising. How about Tracey? Did you get her untangled at last?"

"Yeah. It's all... 'untangled.'"

An empty shuttle-car was waiting with doors open. They crossed the platform skirting the track the bottom of the escalator and stepped inside.

"Okay, so tell me more about it," Lee said. "You reckon your grandfather has actually done it – he can send information *backward* through time?" His face was creased into a frown and his tone skeptical.

Murdoch nodded. "That's what he says."

"But it's crazy. In principle it's crazy. What happens to causality?" Lee drew on his cigarette and blew a cloud of smoke toward the roof of the car. "What's he done exactly? How far has he sent it back?"

"You know just about as much as I do," Murdoch told him. "He wasn't exactly generous with details when he called me either. He just said it worked and told me to get over there right away. He knows I've talked to you about it a lot, and figured it was about time you two met. So I called you. The rest you know."

"But it's crazy," Lee insisted. "I never thought he'd get anywhere with it. If it's true, the whole of physics goes down the tubes. I mean —"

"Save it," Murdoch said. "There's company on the way. Let's talk about it on the plane." A trio of businessmen approached along the platform and stepped into the car talking loudly about some company's market share or something or other. They were followed a few seconds later by a couple shepherding two young, tousle-haired boys. The car doors beeped a warning and then closed, and the shuttle slid forward to rejoin the through-track, then accelerated smoothly into the tunnel that led to the next terminal on the circuit.

Twenty minutes later they were sixty miles up over the mid-Atlantic at the apex of a shallow parabola that joined Kennedy to an artificial island constructed a few miles off-shore from Edinburgh in the Firth of Forth. The seats on one side of them were occupied by two pleasant but inquisitive middle-aged English ladies who plied them continually with questions about the States; on their other side sat a Bostonian who maintained a steady monologue on football despite their repeated proclamation of total ignorance of, and disinterest in, the subject. At no time during the thirty-five minute flight did they get a chance to talk further about Murdoch's grandfather.



## Chapter Two

---

“Did you ever hear of Bannockburn?” Murdoch asked over the muted humming of the car engine.

“Some kind of Scotch baron?” Lee guessed.

“It’s a place, not far off down that road on the left there. They had a battle there in 1314. The Scots had kicked the English out of the whole of Scotland except the castle at Stirling, which is the town we’re just coming into. One of the English kings, Edward II, brought an army up to get them out, but he got wiped out by Bruce.”

“Scotch?”

“Yes, except that’s the stuff you drink. There was another battle here before that too, in 1297. That was when Edward I lost out. I guess the Edwards didn’t have much luck around here.”

“I didn’t know you went in for all this,” Lee said.

Murdoch shrugged. “Maybe it’s my grandpa coming out in me. You know, I wouldn’t mind moving over and living here somewhere one day. Look at the stonework in some of those buildings, but they were put up before anybody heard of California.”

They had decided not to use the local jet service from Edinburgh to the town of Inverness, just over one hundred miles to the north, since it would have made little difference to their total journey time. Instead they rented a groundcar at the island-airport and drove below the Firth to emerge on land some miles west of Edinburgh, heading toward the Scottish Central Lowlands. Since then, with the groundcar running automatically under remote guidance on the controlled main highway, they had turned northward to pass through Perth, the repeatedly besieged former capital, where they would cross the river Tay.

Lee draped his arm along the lower ledge of the window and surveyed the scenery for a while. “It’s a pretty country,” he conceded at last, which from Lee was as near a eulogy as one was likely to get.

Murdoch pursed his lips and nodded. “Now you know why I like coming over here whenever I can.”

“How come your father never talks all that much about it?” Lee asked. “I’d have thought that with a name like Malcom and being a generation nearer to it, he’d have been full of it. Are you the odd one out or something?”

“More like the other way around,” Murdoch replied, shaking his head. “He’s the odd one. Grandpa was – still is – a theoretical physicist. His father was a mathematician. I guess I’m mathematical. As far as I know, my pa was the only one in the whole line for way back who couldn’t balance a checkbook. Didn’t stop him making money though.”

“That’s probably the reason,” Lee said. “Buy at sixty, sell at a hundred and make ten percent. No wonder I know why I can’t read balance sheets. Ah well... I guess I’ll never be rich.” He fell silent for a moment, then went on, “Your father is definitely all-American. So if your grandfather’s different, what’s he like? Does he wear kilts and go around with daggers in his socks, and all that stuff?”

“Dirks,” Murdoch said, grinning. “No... not often anyway. Only on formal occasions. But you’re right – he is pretty traditional. I guess that kind of thing tends to run through the Rosses too. Maybe that’s why I like Scottish history.”

“And he’s still that way after – How many years was your grandfather in the States before he moved back to Scotland?”

---

“About forty, I think. But people like him don’t change very easily. You’ll see what I mean when you meet him.”

From Perth they followed the Tay valley into the Grampian Highlands, a fifty-mile-deep, storm-tossed giant’s sea of granite waves quick-frozen by the winter snow. At the town of Kingussie in the valley of Strath Spey, Murdoch switched to manual drive and turned off the main Perth-Inverness highway and into the mountains of Monadhliath for the last leg of the journey to Glenmoroch. Within minutes the few remaining signs of the space age had disappeared completely. The road became single track, winding its way carelessly among the feet of regiments of steep, boulder-strewn slopes that had fallen hopelessly out of step, and around frosty streams and rippling lochs, chattering and shivering with the winter cold. Woods of larch and Norwegian pine appeared at intervals, stretching from the roadsides in irregular patches to form ragged skirts along the lower parts of the hills. High up, they thinned away or huddled into narrow gorges where they cowered beneath steep slopes of pebble screes and brooding buttresses of naked rock. Only the occasional farmhouse, bridge, or run-dry-stone wall remained as a reminder that the human race existed.

They rounded a bend by one of the farms to find the road blocked by a miniature sea of sheep, which a dour farmer, a helper, and three tireless dogs were herding through a gate into one of the adjacent fields. Murdoch eased the car to a halt a few yards back from the scampering, bleating tide.

Lee shook his head incredulously. “This can’t be true,” he said. Murdoch grinned and sat back in his seat to wait. For a while he watched the dogs. On his previous visits to Scotland he had come to admire the uncanny ability of sheepdogs to coordinate their movements and anticipate every gesture and whistle of command. Trained dogs enjoyed working and soon grew restless if deprived of it; like many people, animals could become addicted to the habit. During one of Murdoch’s previous visits to Glenmoroch, a sheepdog belonging to Bob Ferguson, who owned a farm on the outskirts of the village, hurt a leg and was prescribed a week’s rest by the vet, which meant no going up onto the hills. The dog occupied itself by herding chickens around the farmyard instead.

Murdoch shifted his eyes to study the older of the two men, who was clad in a thick tweed jacket with trousers gathered into knee-length gumboots. He wore a flat peaked cap on top of graying, short-cropped hair. His face was the color of boiled lobster, lined and weathered, and below his bushy eyebrows his eyes burned keenly through slits narrowed by a lifetime’s exposure to mountain winds and rain. It was a face, Murdoch thought, that, like the granite crags, had been carved by elements that had ruled the Highlands since long before the ancestors of the Picts and Celts drifted northward from England, or migrated across the sea from the lower valley of the Rhine. It was a face that belonged here, he told himself – just as a part of him, somewhere deep down inside, belonged here.

The last few strays were rounded up and dispatched through the gate. The farmer raised his stick to acknowledge the driver’s patience, and Murdoch responded with a wave of his hand as he eased the car into motion again.

“I’d like to see that happen on the Frisco-L. A. freeway,” Lee said.

“Time waits for people here,” Murdoch told him.

The mention of time sent Lee’s mind back to the things they had discussed briefly at Kennedy. They had covered another two miles when at last he spoke. “Suppose your grandfather’s right. What happens to free will? If you can send information backward through time, you can tell me what I do

even before I get around to doing it. So suppose I choose not to?" He half-turned in his seat and looked defiantly across at Murdoch. "What's there to make me? So I don't, and no information ever gets sent back to say I did. But I've already received it." He shrugged. "The whole thing's crazy."

"Serial universes," Murdoch suggested, keeping his eyes on the tortuous road ahead. Evidently Lee had been doing some thinking too.

"What about them?"

"Suppose that all the pasts that have ever existed, and all the futures that will ever exist, are all just as real as the present. The present only gives the illusion of being more real because we happen to be perceiving it... in the same kind of way that the frame of a movie that happens to be on the screen right now appears real, but that doesn't make all the other frames in the reel less real. Does that make sense?"

"Depends what you mean," Lee answered. "Are you saying that all those pasts exist exactly the way we remember them?"

"No. That's the whole point. They could be different. For instance, the 1939 that exists 'now' back up the timeline might not contain a Hitler at all. When it arrives at its own 1945, World War II won't have happened, and it will have evolved a history that doesn't read like ours at all. From there it will go on into its own future, fully consistent with its own past but different from ours." Murdoch cocked an eye and glanced at Lee.

Lee sat back and frowned into the distance through the windshield. "So that universe will eventually arrive in its own 2010, maybe with a Doc and Lee in it who aren't in Scotland at all... maybe without any Doc and Lee in it. By that time this universe that we're in will have gone forward to its, what would it be?... 2065... carrying an internal history that would be consistent with what it remembers. It wouldn't know anything about what's happening way back upstream. Is that what you're saying?"

"More or less. What do you think?"

"Mmm..." Lee turned the suggestion over in his mind. "Could be, I guess. But if it does work that way, I can't see much of a future for it."

"Oh. How come?"

"You could send information back to a past universe, but you could never be affected by anything that anybody in that universe did as a consequence. It might help them, but it can't help you. You could tell them not to do something that you did, but you're stuck with it. So why should you bother? Why should you want to put that effort into helping somebody else solve his problems, even if he does happen to be an earlier version of yourself, when it's not going to do anything to help you solve yours?"

"Curiosity," Murdoch offered with a shrug. "Or philanthropy maybe. There's all kinds of people in the world. Why save souls?"

"Because they count as tax credits on your own return," Lee said. He shook his head. "If it does work that way, I can't see it ever being more than an academic curiosity."

"Pretty sensational for a curiosity though, being able to talk to whole new universes that you didn't know existed. Isn't that exciting enough?"

"That's what bothers me. It's sensational, but you can't use it. Suppose you end up deciding it's all pointless talking to past universes because they can't do anything for you, and then you find that the future universes aren't taking calls because they've come to the same conclusion. Then what do you do?"

do? You're sitting on the biggest breakthrough in physics since electricity, and it's no good to you. It'd be like Robinson Crusoe inventing the telephone."

---

Murdoch thought about it, grunted, then fell silent. Lee had a habit of suddenly dumping whole new trains of thought by the shovelful for Murdoch's mind to sift through. Sometimes Murdoch wished that he would find a smaller shovel.

At last the road ahead of them unfolded into a two-mile straight leading across bleak, snow-covered grouse-moor textured by scattered rocks and clumps of gorse. Murdoch announced that they had only a few miles left to go. For some time they had been ascending toward a skyline formed by the crest of a vast ridge, and the surroundings had been growing more windswept and barren. The final slopes that led up to the ridgeline itself began on the far side of the moor; the road climbed across them in a series of tight hairpins to vanish at a notch of sky pinched in the snow. To the right the ridge rose steeply and swelled to become a bulging shoulder of the three-thousand-foot peak of Ben Moroch, the towering sentinel that kept watch over the pass leading through to the valley-head of the glen beyond.

The sun was soaking into the hills to the west by the time they reached the high point of the pass. To their left the southwest ridge of Ben Moroch marched away in a line of descending spurs before rising again to blend with a more distant peak, while on the right the mountain itself soared upward as a wall of glowering ramparts of rock and ice. In front of them and below, the ground fell away into a vast amphitheater formed by the meeting of the west and southwest ridges, which curved away on either side to become the arms that held the ribbon of Glenmoroch in between. For a minute or two they were able to look over the crestline of the west ridge at the Highlands stretching away like a sea of rose-tinted icebergs with glimpses of the sun-burnished waters of Loch Ness in between; then the road began meandering downward once more, gently at first and then more steeply, between the frozen peat bogs and shale slopes that formed the upper reaches of the glen.

Soon the whole of Glenmoroch was spread out in miniature beneath them, and Murdoch felt the exhilaration that always came when he saw the familiar landmarks again for the first time after a long absence. The road traced its way down the flanks of the ridge to leave the crest high on the left, and then converged on the valley floor with the wandering line of the brook where the streams flowing off Ben Moroch mustered for their long march to Loch Keld and onward en masse to the sea. He could make out the stone bridge where the road crossed the brook before disappearing into a small wood, and beside it the rectangular lines of walled fields that marked the beginning of Ferguson's farm. The road emerged from the far side of the wood into a scattering of houses, copses, and tracks that consolidated themselves lower down into the huddle of Glenmoroch village, already looking sleepy beneath faint plumes of chimney smoke and showing a few lights in the shadow advancing from the foot of the west ridge.

Below the village the road again plunged into trees, which fanned out on either side to form a rough crescent around the near end of Loch Keld. To the right of these trees, the land shelved gently upward for a distance from the shore of the loch, and then swept upward sharply to form the terminal spur of the west ridge. The shelf between the loch and the spur was thickly wooded, and through the trees a compact cluster of roofs and turrets protruded to catch the last rays of the dying sun.

"That's it," Murdoch said, pointing. "The place sticking up through the trees between the mountain and the water behind the village. That's the Storbannon estate."

"I thought it was supposed to be a castle," Lee said after a few seconds.

"Well, that's what people round here call it, but it isn't really. What did you expect – portcullise

guys in armor, and damsels in distress hanging out the windows?”

“I’d have settled for the damsels,” Lee replied. After a moment he added, “The dis-dressed ones.”  
Murdoch groaned.

The village was quiet as they drove through its main street between terraced stone cottages interspersed with an assortment of tiny shops and a few cosy-looking, warmly lit pubs, and past the ancient, iron-railed churchyard. A couple of figures outside the red-fronted Post Office, which also served as grocery and general store, turned to watch the unfamiliar car pass by, but otherwise there were no signs of life. Nothing had changed.

They left the village and entered the crescent-shaped wood that extended to the shore of the loch. A track took them off the main road and brought them out of the wood again, this time pointing toward Storbannon. Minutes later, Murdoch turned off the track between two large and imposing stone gateposts, and into a wide driveway that curved away upslope through the trees. Lee realized afterward while that the brief bird’s-eye view of the estate that he had seen from high up on the far side of the valley had been deceptive, for they had covered what must have been almost a mile before the light of the house itself became visible. And then the trees opened up suddenly before a large, oval-shaped area around which the driveway looped, widened, and then rejoined itself to form the forecourt “Storbannon Castle.” The main entrance was in the center of the building, set back on the far side of a small courtyard enclosed on three sides, which was formed by the main body of the house and its two projecting wings. Murdoch steered into the courtyard and stopped at the foot of the broad flight of shallow steps leading up to the doors.

“We’re here,” he said needlessly, as Lee craned his neck to take in as much of the frontage as he could see in the light reflected by the snow from the two spotlamps above the entrance.

The building could have been an “E” shape without the middle bar, Lee thought, or maybe he was looking at one side of an “H.” The doors at the top of the half-dozen or so steps were heavy and solid with ornate hinges and hanging hand rings of wrought iron; they seemed in good repair, as did everything else that formed his first impressions. The arch framing the doors was formed from columns of round, recessed, stonework ribs, which flowed upward on either side like staggered bands of organ pipes before bowing into flattened curves that met in a point at the top. The walls, extending away into the shadowy corners formed by the wings, were faced in dressed gray stone etched by the battle scars of many long, harsh Scottish winters. Midway between the entrance arch and the wings the walls angled outward for a short distance to form two broad piers of double bay windows encased in florid masonry, which extended upward to join the parade of castellations that marked the roof line. At least it’s a change from high-rise glass and duroplastic, Lee thought to himself.

“I can see now why they call it a castle,” he said. “The tops of the walls up there are built like square-waves.”

“Recent additions,” Murdoch informed him. “They were part of renovations that were carried out by one of the Rosses in the nineteenth century. That was when the turrets were added too. I guess he put up the castellations to give the place a matching frontage.”

“And that’s recent?”

“Sure.”

“So how far back does this place go?” Lee asked as they climbed out of the car and walked around to begin lifting luggage out of the trunk.

Murdoch paused long enough to take in the South Wing with a gesture of his arm. “That’s the

oldest part of it. It used to be a nobleman's manor house somewhere around the middle of the fifteenth century, but there was something there before that; some of the stonework in the foundations thought to go back to the twelfth." He shrugged. "But so much alteration and rebuilding has gone on over the years that it's difficult to say exactly which part of what you can see now appeared when. That wing hasn't been lived in for a long time now, though... mainly storage and stuff. The front part is the garage, and the part that sticks out back is stables; the whole thing's laid out roughly like a T-aitch."

Lee closed the trunk and straightened up to survey the front of the central bar, facing them. "So what about this part?" he asked. "Did that come later?"

"In the 1650s," Murdoch answered. "Most of the character is in there. Look at the Tudor arch and the mullions across the windows." He nodded his head in the general direction of the North Window. "The rest of it appeared in bits and pieces over the last three hundred years or so. A lot of it was the late 1800s. The family had connections with the Clydeside steel industry, which was going through fairly good times, so they had plenty of cash to throw around on things like that." He made a face and added, "That part's typical of a lot of Victorian 'inspirations,' for want of a better word, though. Revived Gothic windows, Georgian portico around the other side, mock Doric columns, and baroque ornamentation. Goes together like ice cream and gravy."

Lee stared at the incongruous blend for a moment, and then shrugged. "I'll take your word for it, Doc," he said.

At that moment the doors swung open to release a flood of light onto the steps. A man with thinning hair and wearing a dark jacket and tie walked out, closely followed by a woman dressed in a plain gray dress and white apron, her dark hair tied back in a bun.

"You're here at last!" the woman called in a high-pitched, wailing voice. "We were beginning to wonder what had happened to ye."

"Morna, me fine lass!" Murdoch hugged her around the waist and spun her off her feet, ignoring her protesting scream. "We drove up the whole way. I don't trust those French things they fly up to Inverness." He put the woman down and turned to clasp the man's extended hand. "Hello again, Robert. You're looking great. How's it all been going?"

"'Tis grand to see you back so soon," the man replied warmly. "Sir Charles has been looking forward to today. And this must be the Lee that we've heard so much about."

Murdoch stepped back and clapped Lee on the shoulder. "This is Lee. Lee, this is Morna. She's got secret admirers all over Glenmoroch. And this is Robert. He's been here since before I can remember." Lee shook hands with both of them. "And how are Mrs. Paisley and Hamish?" Murdoch inquired.

"Both fine," Robert told him. "Hamish is all right when he isn't in some pub down in the village. Is this your first visit to Scotland, Lee?"

"First time ever," Lee said. "I think the place is starting to grow on me already, though. Having this guy in the car is like sitting next to a talking history book."

"He's always been one for anything to do wi' the Scots," Morna said. "Even when he was here for the summers as a boy. But enough o' this. Let's get the two o' ye inside and out o' the cold."

"Sir Charles is waiting for you in the library now," Robert told them. "Go on in. I'll take care of the bags and the car." He took Murdoch's keys and went on down the steps. Morna turned and walked back into the entrance hall with the new arrivals.

“Shall I ask Mrs. Paisley to find ye somethin’ t’eat?” she asked. Murdoch threw a quick sideways glance at Lee.

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Lee shook his head. “Later maybe,” he said.

“Just coffee,” Murdoch told her. “We only left New York less than an hour and a half ago.” He caught the surprised look on her face and stopped to gaze at the splendid paneling of the hall and the majestic main staircase, then added, “It seems like a thousand years already.”

## Chapter Three

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“So what’s happening with the consultancy in California?” Charles inquired. “Are you wrapping that up now?” They had been talking for almost half an hour. Charles was speaking from a large, red leather arm-chair to one side of the flickering log fire in the library. Lee was sprawled in the chair opposite, and Murdoch was on the settee between them, facing the hearth. Murdoch had given Charles the latest news regarding the family in Chicago, and the conversation had now drifted to the most immediate topic of Murdoch and Lee.

“We’ve been running it down for some time really,” Murdoch replied. “The last contract we had was for an outfit called Dynasco. They wanted a study on self-organizing energy vortices in plasma. Lee stayed on for a few months to tie up the loose ends on it while I was setting up things in New York.”

Charles took a sip from the brandy glass in his hand and smacked his lips approvingly. “Did it not work out then?” he asked. “I could have told you you’re not cut out to be a businessman like your father.”

“Oh hell, I know that,” Murdoch said. “The idea never was to start a multinational. It was just a way of working on things that were interesting without being owned by anybody, and to make enough to get by on for a year or two. That was all we ever meant to do, and that was what we did. It worked out fine.”

“So where to next?” Charles asked him. “What happens in New York?”

“It looks as if we’re all set for a commission with a consulting group called Wymess Associates. They’re looking for outside help on plasma dynamics. I’ve been talking to them since November and it’s looking pretty certain. Sounds interesting too; they’re working with General Atomic on nuplex designs for East Africa.”

Murdoch was referring to the integrated nuclear-based, agricultural-industrial package complexes, capable of supporting a tightly knit, autonomous community at full twenty-first-century living standards and life-styles that was being developed for export to the rapidly developing Third World. The “nuplexes” were part of an international program aimed at once and for all eliminating from the planet the most basic scourges that had plagued mankind as long as mankind had existed. Later on, the technologies perfected in developing the nuplexes would form the basis for designing self-sustaining colonies in space.

Charles nodded slowly. “Aye, that sounds as if it could suit you more. You’ve always had a wee bit o’ the idealist in you, I suspect, Murdoch... wanting to contribute something to making the world less of a mess and that kind of thing. You’ve got academic talent, but you’re no academic by nature. After CIT and Fusion Electric, you’ve probably seen as much of university campuses as you want to. He glanced across at Lee. “And you’re from the same mold if I’m not very much mistaken. And I’d warrant you don’t see yourself fitting in with the big corporations either.”

Lee crossed a foot loosely over his knee, pursed his lips for a moment, then shook his head. “You’ve said it. They get things done, but you’ve got to fit. If you don’t fit the image or the image doesn’t fit you” – he spread his hands expressively — “what’s the point of wasting your time trying to prove something you’ve already made your mind up you’re not all that interested in proving?”

“Aye,” Charles conceded simply. He already knew enough not to press questions, and by nature he was not disposed to dispensing conventional wisdoms in the form of grandfatherly advice unless



was asked for.

By the early 2000s, a great deal of basic scientific research and many of the major research projects had come to be managed and funded by the larger multi-national corporations. This trend reflected the tendency of private industry to look more after itself and its basic needs as confidence in government initiative was eroded away by the effects of continual policy reversals, irresolution in the face of electoral whims, and stifling bureaucracy. To insure the supply of trained talent that these expanding ventures would demand, the corporations had become heavy investors in the education system by the closing decades of the twentieth century; some had gone further by opening their own colleges and awarding their own degrees, which in certain sectors of research and industry had already come to be considered more valuable than some of the traditional diplomas.

Murdoch had studied mathematical physics at CIT and then moved on to the university founded by the Fusion Electric Corporation, a California-based company engaged in the commercial generation and distribution of fusion-generated power, to gain further experience in plasma techniques. There he had met Lee, who, it turned out, was a son of the corporation's Vice President of Research. Despite the opportunities implied by virtue of his father's position, Lee's main interests there lay with the computers, an addiction he had been nurturing since an early age. He didn't find the executive image challenging or inspiring and, like Murdoch, was preparing to go his own way; again like Murdoch, he didn't know where to. After completing their courses at the university they had stayed for a while at the FEC, and then left to set up the consultancy at Palo Alto, on the bay shore a few miles south of San Francisco.

"So where are you from originally, Lee?" Charles asked. "Have you always lived on the West Coast?"

"I was born in Osaka, Japan," Lee replied. Charles's eyebrows rose in mild surprise. Lee explained, "My father was chief engineer on a joint U.S.-Japanese tokamak project out there for a number of years. He moved back to the States when they made him a V. P."

"You were very young while you were there, I take it," Charles said.

Lee shook his head. "He was there for quite a while. I was nearly fifteen when we moved back. As I got to see of the States before then was what I could squeeze into vacations."

"He was brought up on karate," Murdoch interjected. "I've seen him break concrete blocks with his fist."

"Good heavens!" Charles exclaimed. "You'll no doubt have a lot to talk about with Ted Cartlan when he gets back, Lee. Did Murdoch tell you about Ted?"

"Is that the English guy that lives here?" Lee asked. "Used to be in the Air Force... been all over."

"Aye, that's him," Charles confirmed. "He was born in Malaya. His father was major in the Army attached to the Australians. Ted's quite an interesting chappie."

"Where is he?" Murdoch asked.

"He's been away for a few days, working with one of the firms that we use for components," Charles replied. "He should be back tomorrow." The old man sat back in his chair and drained his glass. "Ah well, it sounds as if the two of you are still a solution waiting for the right problems to appear. But there's no rush. You know your own minds better than anyone. There's many a man in this world who's rushed headlong into the wrong thing without thinking, and then had to spend the next half of his life getting himself out of the mess he's made." He leaned forward to refill the glass from the decanter beside him. The other two watched in silence, wondering when he would get around to the

topic of their visit and the reason for it.

Charles leaned back and settled himself more comfortably into the chair with his glass. “So, Lee,” he said, as if reading their thoughts. “How much do you know about the background to what Ted and I have I been up to here?”

“Doc’s talked to me quite a bit about it off and on,” Lee replied, uncrossing his legs and straightening up in the chair. “I know you spent a lot of time in the States at places like MIT, Princeton, and Stanford... and after that at NASA and the Defense Department, before you came back here. I’ve read the papers you published on the isolation of free quarks. That was at Stanford, wasn’t it? I guess it must have started somewhere around there.”

“That was in the eighties,” Charles said, nodding. “But I suppose you’re right in a way: That did lay the foundation. But the really interesting things started happening about ten years ago. I was with NASA by then, but Stanford was still carrying out experiments involving quarks. Some of the experiments were giving anomalous results that nobody could explain, so they asked me to go down and have a look at them because of the work I’d been involved with there previously.”

“Something analogous to nuclear resonances, wasn’t it?” Lee said.

“Aye. They occurred in connection with nucleons decaying into three quarks. The specific cases were when a nucleon broke down first into two quarks plus an intermediate particle, and then the intermediate particle transformed into the third quark. The ‘quason,’ which was the name given to the intermediate particle that had been tentatively postulated, had never actually been detected or observed as such. As you say, it was like a nuclear resonance, but its lifetime was so many orders of magnitude shorter even than that of a resonance that some people were doubting it existed at all. It was simply an entity with certain mathematical attributes needed to account for the slight delay between the appearances of the first two quarks and the third one. The problem was that, in the light of the more accurate measurements that had been made by that time, it was impossible to assign a set of properties to the quason that were internally consistent. There was always something that contradicted the experimental data.”

“Yes, I remember reading about that in something that Doc showed me,” Lee said. “Didn’t you offer an interpretation that didn’t require quasons at all?”

“That’s right,” Charles replied. “But the alternative interpretation that I proposed called for a rather unusual assumption: that all three quarks were created simultaneously, but the data defining the first two had propagated *backward in time*. The magnitudes involved were of the order of ten-to-the-minus-thirty-second – about the time light would take to cross a quark – but real nevertheless.

“Results of other experiments from other places too involved the same kind of thing,” Charles went on. “To cut a long story short, it turned out that they could all be interpreted consistently on the basis of information propagating forward or backward through time, without quasons coming into it at all. So there were two explanations; one was testable but unsatisfactory, the other consistent but apparently nonsensical. As you can imagine, there was a lot of arguing going on around then.”

“That’s something I was meaning to ask about,” Lee said. “This would have been around when, ten years ago?”

“Aye. Around the turn of the century.”

“I checked through a lot of the papers and journals from around then, but I couldn’t find much mention of it. The only things I saw were the things that Doc showed me, which I guess he got from you. How come? And if you’ve proved now that the no-quason interpretation is correct, how come the

traditional version is still accepted practically everywhere?”

“Ah well...” Charles paused to sip his brandy. “There were two reasons. First there was the obvious thing: A lot of scientists opposed the theory on principle. I can’t say I blame them really. It conflicted with all the accepted notions of causality, and the overwhelming tendency among most of them was to stick with the choice that at least retained familiar concepts and made sense, even if it was giving ragged results. It wouldn’t have been the first time in the history of science that that had happened. So, I suppose, I was part of a very small minority... but then maybe I always was a bit of an awkward cuss.

“Then on top of that I was just in the process of moving from NASA to the Defense Department. There were all kinds of security regulations, classified information restrictions and all that kind of drivel to contend with, and some silly ass somewhere got it into his head that this particular topic might have defense implications. I can’t for the life of me imagine why, but that was enough to keep most of the story out of the limelight.

“Anyhow, I was convinced I was on the right track, never mind what the rest of them were saying, and through the work I was doing at the Department, I kept in touch with a few people at places like Los Alamos who thought the same way. You see, there were a few unofficial experiments going on here and there even though it was supposed to be restricted work. Eventually everything started coming out of the woodwork and the whole thing turned political. I got fed up with the whole damn business and came back here to be left alone. As Murdoch has told you, I’ve worked here ever since. Must be, oh... three years or thereabouts now.”

“And has this guy Ted Cartland been here that long too?” Lee asked.

Charles nodded. “I got to know Ted while I was still at NASA. He was at Cornell, involved with designing orbiting detectors for X-ray astronomy. He’d been mixed up with shuttle and satellite design and testing while he was in the RAF... a lot of liaison with other countries and that kind of thing. He’d worked with the people at Cornell in the past, knew them all, and moved there when he left the RAF. They were doing work for NASA, and that was how we got to know each other.

“When I decided to move back to Scotland, I had the feeling that I wasn’t far from the point of producing a device to test the theory I’d been working on. Now I’m not much of a practical man when it comes to putting together gadgets and electronics and such, but Ted is. So I invited him to come back as well to take care of that side of things.”

With that, Charles emptied his glass for the second time, set it down on the edge of the hearth, and stood up. “Anyhow, enough of all this witterin’ on like three old women,” he said. “You must be wondering if I’m ever going to show you the machine itself. Let’s get along downstairs to the lab.”

## Chapter Four

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The lab was much as Murdoch remembered it from his last visit, although it seemed to have sprouted a few additional items of equipment. One side of the room was taken up by a large workbench running almost the full length of the wall, littered with tools and unidentifiable electronic assemblies in all stages of confusion. Along the back of the bench stood a line of stacked waveform analyzers, synthesizers, power supplies, and other instruments studded with buttons and covered with screens, and interconnected by unraveled rainbows of tangled wire. A section of ceiling-high storage racks, crammed with books, boxes, and components, occupied the space between the bench and the door; the wall opposite supported a large blackboard, covered with formulas and calculations, above a long metal table sagging beneath a load of charts and papers.

The machine itself stood along the wall facing the door. It consisted of a main display and control console; a DEC PDP-22/30, obtained secondhand through one of Charles's friends who worked for British Admiralty research and complete with its own high-density memory subsystem, plus some options from other sources; an auxiliary terminal connected to the national datagrid; a trio of enclosed, four-foot-high cubicles; and a jumble of electronics strung together in open racks. A cluttered desk beside the operator's chair at the main console and a set of heavy cables running through the wall to the generators in the next room completed the scene.

Saying nothing, Charles walked to the console and brought the system to life with a few rapid taps of his fingers. He glanced at the main screen, issued another command-string, and cut off the display. A few winking lights on the main panel were all that was left to show that the system was active. Then a sheet of glossy, plasticized paper slid from the hardcopy slot and into the tray beneath. Charles picked it up, ran his eye quickly over whatever was printed on it, folded it in two with the printed side inward, and then looked up.

"Now, Murdoch," he said. "Would you be so kind as to sit yourself down there at the console?" Murdoch obliged. Lee moved forward to watch over his shoulder. "There's a clock-readout counting down seconds at the top of the screen there," Charles went on. "When it gets to zero, I want you to type in a string of numbers and letters, up to a maximum of six characters."

Murdoch frowned up at him. "What, anything? No particular length?"

"It does not matter. Anything you like."

Murdoch shrugged. "Okay." He waited for the zero to appear, and then rattled in a random sequence. The main screen in front of him displayed:

2H7VI9

"That it?" he inquired.

"That'll do," Charles said. He unfolded the sheet of hardcopy that he had been holding and passed it to Murdoch without saying anything. Murdoch looked at it; Lee gasped audibly behind him. The sheet read:

1 JANUARY 2010, 2038.00 HOURS.

TEMPORAL RETROTRANSMISSION TEST. NO FILE REFERENCE.

MANUAL INPUT SEQUENCE. TRANSMISSION ADVANCE 60 SECONDS.

Although they had been more or less prepared for what to expect, Murdoch and Lee were stunned for the moment to say anything. Talking about this kind of thing in the car from Edinburgh was one thing; seeing it demonstrated was quite another.

“It works with computer-transmitted numbers too,” Charles commented matter-of-factly after a few seconds. Murdoch continued to stare with disbelieving eyes at the sheet of paper in his hand.

Lee looked slowly up at Charles, his brows knotted in bemusement. His lips moved soundlessly for a second or two. Then he whispered, “That... that was printed before Doc even knew what you were going to ask him to do. This really isn’t some kind of conjuring trick? Are you saying those characters were sent backward through time?”

“Aye. Sixty seconds, to be exact.” Charles looked back at him impassively.

“They exist!” Murdoch breathed, finding his voice at last. “The tau waves that you’ve always predicted – they really do exist!”

“So it would appear,” Charles agreed.

As Murdoch slumped back in the chair and began turning over in his mind what it all meant, Lee gazed with new respect at the array of equipment surrounding him. It didn’t look particularly spectacular; in fact, as far as external appearances were concerned, it could have been any one of a hundred lab lash-ups that he had seen before in all kinds of places. And yet what he had just observed had shaken him more than anything he could remember in his twenty-eight years. Murdoch had told him enough about Charles’s work for him to have a general idea of how the machine worked, but inwardly he had never believed that anything would come of it.

The influence that propagated through time originated with the annihilation of matter, that is, the conversion of mass into energy. The mass-energy equivalence relationship became nonlinear at high energy densities; under extreme conditions, less energy appeared for a given amount of mass than traditional theory said ought to. The hadron decay into quarks that Charles had mentioned had been the first instance to be noticed; at the high energy density prevailing inside the infinitesimally small volume of the interaction, less gluon binding energy had been measured than had been predicted. Where did the rest go? According to the theory developed by Charles and his colleagues, it had propagated away as tau waves and rematerialized as mass-energy at another instant in time. Because of the small scale of the events, the resulting time shifts had been of the minute order that Charles had described. But at higher energy densities they promised to be more.

Charles’s machine achieved high energy densities by focusing an intense beam of positrons onto a magnetically confined concentration of electrons. It employed a laserlike pumping technique perfected in the USSR about fifteen years before to generate energetic gamma photons, which in turn bred electron-positron pairs. The positrons were channeled by tuned fields and directed at a confined negative space-charge to produce the sustained annihilations that the process demanded. Unlike the giant particle accelerators, which were designed to produce a few isolated events but at enormous energies, this machine produced many events at moderate energies within a tiny volume of space; it was the energy *density* that mattered. That was why the machine didn’t need to be as large as the whole Storbannon estate; it also explained why the discrepancies attributable to the tau waves had remained undetected through the earlier decades of particle physics.

The result of the annihilation process was a burst of conventional energy, which was absorbed by a cooling arrangement, and a pulse of tau radiation that would reappear in detectable form elsewhere along the time line. The energy of the gamma photons could be varied, enabling the point in the future or in the past at which the tau pulse would materialize to be adjusted with a high degree of precision. The machine therefore functioned more like a telephone than a radio; the sender could “aim” a pulse at a selected instant, in the past for example, but a receiver in the past, or future, had no means of “tuning in.” A receiver could do nothing but wait for incoming calls.

Lee was unable to identify which of the cubicles and racks contained which components, but he would have ample time in the days ahead to become familiar with such details. For the time being he just wanted to know more about the basic principles.

“How is the character information modulated onto the positron beam?” he asked Charles. “Do you interrupt it somehow to get a serial code?”

“That would introduce too many complications, as you’ll appreciate later on,” Charles replied, shaking his head. “It sends one data-frame in parallel code. The beam is split forty-eight ways to give forty-eight simultaneous tau pulses. Thirty-six of them are used to encode six-bit characters, which is why we’re restricted to a six-character message at the moment. The other twelve bits are for control and timing signals.”

“So the sequence that Doc keyed in was stored first, then transmitted all in one block.”

“That is correct,” Charles said.

Lee nodded slowly and rubbed his chin while he looked at the equipment again. The shock was wearing off, and he was beginning to think more coherently. “So what’s its... its range?” he asked. “How far back can it send?”

“That’s determined by three factors,” Charles answered. “The magnitude of the pulse sent, the sensitivity of the receiving detector, and the absolute velocity of the Earth through space. You see, the tau pulse reappears as detectable energy at the same point in space as it was generated. Theoretically the profile of the reappearing energy wave forms a spherical surface that expands at light-speed about that point with increasing distances back along the timeline. After one second back in time it would occupy a volume one hundred and eighty-six thousand miles in radius, after two seconds one of twice that radius, and so on.”

“It can’t be,” Lee protested. “The machine’s not big enough to pack that much power. How could one pulse from it fill a volume that big?”

“Ah, I only said that was theoretically,” Charles reminded him. “That’s the mathematical limit. Inside that volume, the intensity falls off exponentially from the center-point. The signal exists everywhere inside that expanding volume. However, to receive it, the receiver can only be up to a certain distance from the center of the wave pattern, depending on how sensitive it is.”

“So that’s where the velocity of the Earth comes into it,” Lee said. “The Earth will have moved between the time of sending and the time of receiving. You can only send as far back as corresponds to moving the receiver to its limit of sensitivity.”

“Exactly,” Charles confirmed. “According to the data from Doppler shifting of big-bang background radiation, the Earth moves about twenty-one million miles in a day. The detectors in the machine will operate reliably up to approximately one hundred and forty-five thousand miles from the center-point of the wave pattern produced by the level of tau pulse that this machine sends. If you work that out, it gives you a range of just about ten minutes.”

Lee shook his head in wonder and stared at the characters still preserved on the screen in front of Murdoch. "So how long have you had it working now?" he asked.

"Only since two days ago," Charles told him. "I got it to work for the first time the day before I called Murdoch. Even Ted Cartland hasn't seen it yet. I called him a few minutes before I called you, Murdoch, but he's stuck in Manchester and won't be able to get away until tomorrow morning." Charles cackled wheezily. "The poor fellow was becoming frantic when I talked to him again, earlier today."

Murdoch was only half listening. He was still staring at the console, mentally replaying each step of the demonstration that Charles had given. The question going through his mind was obvious. Finally he looked up at Charles. "When you set this machine up a few minutes ago, you got the hardcopy first. Then you started up a program that would time-out after sixty seconds and send back whatever I typed in. Is that right?"

"Yes," Charles said simply.

Murdoch thought for a moment longer. "Okay. Let's ask the hundred-thousand-dollar question. What would have happened if I'd simply decided not to key in anything at all after the sixty seconds? What would have happened to the characters that were already on this sheet? How could they have gotten there?"

Charles nodded as if he had been waiting for Murdoch or Lee to ask that, and moved forward to reinitiate the system. Then he stepped back. "Try it and see," he invited.

Murdoch looked at the hardcopy slot expectantly and waited. Behind him, Lee moved closer and watched intently.

Nothing happened.

Murdoch's face knitted into a puzzled frown. After a while he looked up at Charles, but there was no surprise in Charles's expression. They waited.

"I don't believe this," Lee murmured at last. "It's no different than last time. Surely an intention inside somebody's head can't make any difference to what the machine does. That's for ESP freaks."

"Wait," Charles told them.

They waited.

Suddenly the slot ejected a sheet of paper. Lee leaped forward and snatched it up.

"It says MURDOC," he announced.

"When was it sent?" Murdoch demanded.

Lee checked the time printed on the sheet and glanced at the time-of-day readout on the console. "It's still set up for sixty seconds," he said. The countdown display had appeared at the top of the screen to confirm his words.

"Right," Murdoch declared. "We'll just see." He sat back in the chair and folded his arms in determination. Clearly he had no intention of doing anything when the zero arrived. Charles watched but said nothing. The final seconds ticked by; Murdoch and Lee became visibly tense. Then the zero appeared.

And that was that. The paper with its printed record remained in Lee's hand, and time marched on past the deadline regardless. Two faces jerked round toward Charles, demanding an explanation.

"I don't know," Charles said quietly. "I don't know who sent that, or where from, either." The other two gaped at him incredulously. They were too confused for a moment to say anything. Charles

stepped forward again and used the touchboard to bring up a color display on the screen. It showed a horizontal line across the bottom, annotated with numbers like the X-axis of a graph with zero at the center; above the line, the main area of the screen was divided vertically into three broad bands: a central white one separating two of gray.

“This is a graphical representation of the machine’s window of range,” Charles explained. “The horizontal axis is time, with the present instant corresponding to the zero in the middle. The white zone is twenty minutes wide; that’s the window of the machine’s current range, extending ten minutes forward and back. The gray areas on either side are the edges of the future and the past lying outside the ten-minute range.”

To the left of center inside the white area, they could see a short red bar standing up from the scale at the point denoted by -6 – six minutes into the past, and a similar, but dotted, red bar at -5 minutes. There was a second pair of bars, this time blue; the solid one was at -11/2 minutes, the dotted one at -1/2 minute.

“Those two solid lines represent signals that the machine has received and logged,” Charles explained. “The red one at minus six minutes is the random sequence of characters that Murdoch sent back a little while ago. Some of the control bits sent with every signal denote the time of transmission so the computer can plot on the display when the signal was sent, which it does by adding a dotted line of matching color in the appropriate place. You can see that the dotted red line is a minute ahead of the solid one in time. If you watch closely, you should just be able to make out that the whole pattern is creeping slowly to the left as time advances. Thus the zero in the center always corresponds to the current instant.” Charles paused and took a long breath, as if he were being forced to say something that he didn’t really believe. He raised his arm and pointed at the second, blue pair of bars. “The solid blue line, now at minus two minutes, represents the reception of the signal that Lee read out two minutes ago. And the corresponding dotted line” – he pointed with his finger — “is the machine’s reconstruction of where it was sent from – a point in time that is now one minute behind where we are right now.” He stopped speaking and waited for the protests that he knew would come.

“That’s crazy!” Murdoch exclaimed. “I didn’t send anything one minute ago. You were both watching me. Nobody sent anything one minute ago. There has to be something screwy with the system. How could – What the...?” He sat forward abruptly and stared wide-eyed at the screen. A solid green bar had appeared right on the zero-point of the scale, indicating that another signal had been received at that very instant. At the same time a dotted green bar had appeared sixty seconds ahead of it – sixty seconds in the future. The hardcopy slot disgorged another sheet.

“It says ‘CRAZY,’” Lee told them in a bewildered voice. “What in hell’s going on?”

A solid yellow bar appeared at zero to the right of the green one, which had already moved a few seconds leftward into the past. Its dotted yellow companion was well over to the right of the white area, denoting that something had come in from about eight minutes in the future. Charles touched the touchpad to deactivate the hardcopy unit.

“We can look at what the signals actually say later,” he said. “I don’t think it matters all that much for now.” It was almost as if he knew what was going to happen next. The display suddenly went wild. Bars of every shade and color added themselves at the zero-point as fast as the ones already there could shuffle out of the way, producing a solid, rectangular, rainbow spectrum that steadily extended itself relentlessly toward the left. At the same time the right-hand half of the white area, representing the future ten minutes of the machine’s range, filled haphazardly with matching dotted bars to complete each pair.



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