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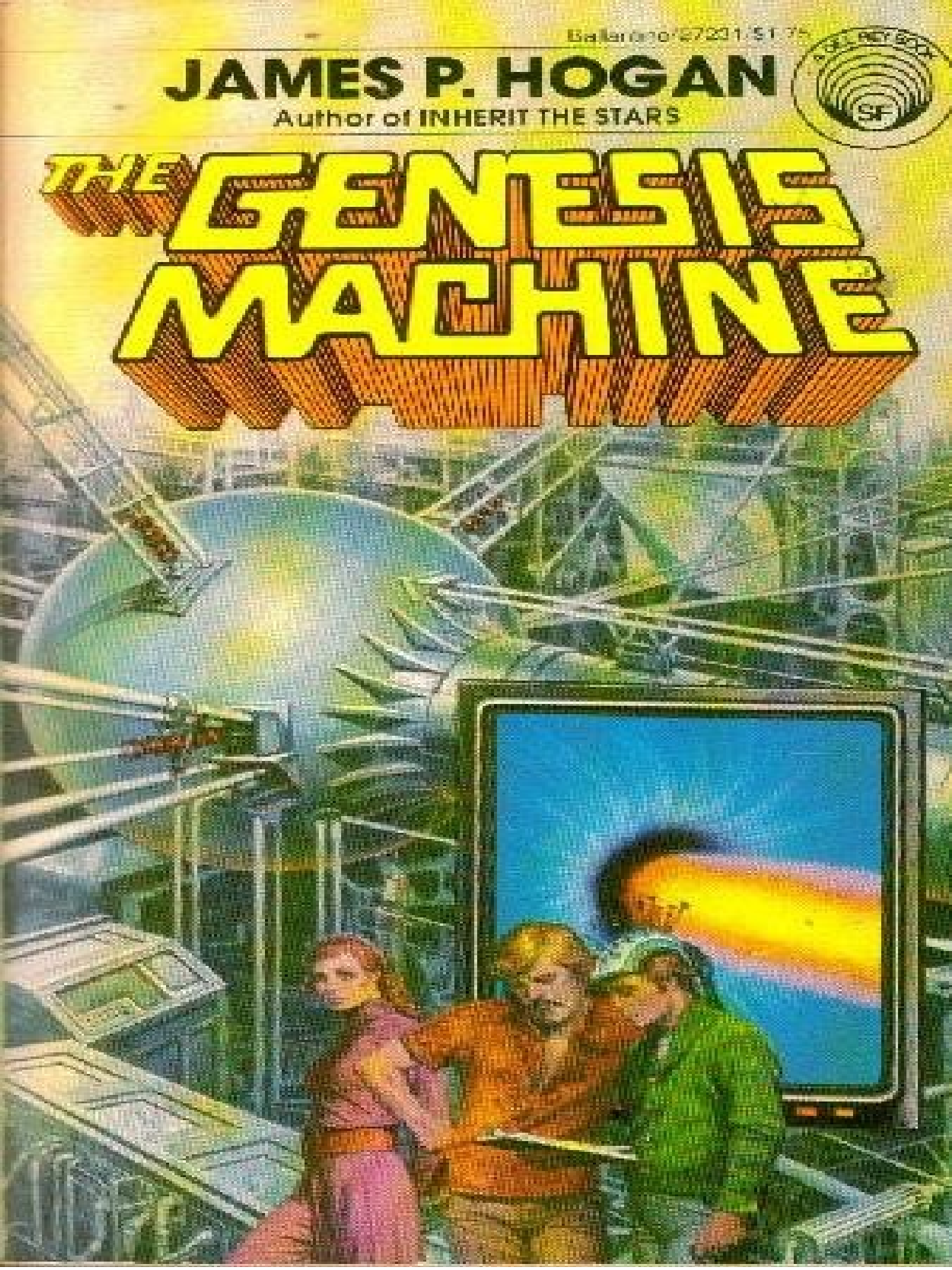
JAMES P. HOGAN

Author of INHERIT THE STARS

THE GENESIS MACHINE



The Genesis Machine

James P. Hogan

MACHINE POLITICS

“Once the coordinates have been computed,” Clifford stated, “they can be recalled instantly. As for the weapon itself....” He scanned the faces assembled before him, then continued. “We have succeeded in transporting energy from one place to another... and we can select precisely where in space that energy will be delivered. Destructive forces of unprecedented strength can be instantaneously directed and focused on any part of Earth’s surface or beyond.”

The stares of the Defense Secretary, service chiefs, presidential aides, and defense planners seated around the conference table had frozen into wide-eyed masks of stunned incredulity. The silence, when he paused, was absolute.

“Furthermore, there is no method by which the system I am describing could be interfered with or countered. Interception is impossible. The ICBM and the orbiting bomb are as outmoded as the battering ram.”

Hughes stared aghast at Morelli as the words came home to him. “What are we getting into?” he asked. “Has Brad gone mad?”

“First I knew about this,” Morelli said, shaking his head. “I knew it was something big... but this....”

On the plane back to Boston that night, Clifford’s mood was one of grim satisfaction. Aub, for once, seemed subdued and withdrawn.

“What’s the matter?” Clifford asked him. “It’s what you’ve always said you wanted, isn’t it – unlimited government funds and resources. Why doesn’t it taste so good now?”

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Every child is a born scientist.

This book is dedicated to DEBBIE, JANE, and TINA – the three young scientists who taught me to distinguish reality from illusion by asking always:
“Who says so?”
“Who’s he?”
and, “How does he know?”

Baen Books by JAMES P. HOGAN

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
The Infinity Gambit
Entoverse
The Multiplex Man
Realtime Interrupt
Minds, Machines & Evolution
The Immortality Option
Paths to Otherwhere
Bug Park
Star Child
Rockets, Redheads & Revolution
Cradle of Saturn
The Legend That Was Earth
Martian Knightlife

Chapter 1

The familiar sign that marked the turnoff from the main highway leading toward Albuquerque, som thirty or so miles farther north, read:

ADVANCED COMMUNICATIONS
RESEARCH ESTABLISHMENT
GOVERNMENT PROPERTY
ABSOLUTELY NO ADMITTANCE
TO
UNAUTHORIZED PERSONS
SHOW PASSES – 1½ MILES AHEAD

Accompanied by the falling note of a barely audible electric whine, the Ford Cougar decelerat smoothly across the right-hand traffic lane and entered the exit slipway. Without conscious registering the bleeped warning from the driver's panel, Dr. Bradley Clifford felt the vehicle beg responding to his touch as it slipped from computer control to manual drive. The slipway led into shallow bend that took him round behind a low sandy rise dotted with clumps of dried scrub and dus desert thorn, and out of sight of the main highway.

The road ahead, rolling lazily into the hood of the Cougar, lay draped around the side of a barre rock-strewn hill like a lizard sunbathing on a stone. In the shimmering haze beyond and to the right the hill, the rugged red-brown bastions that flanked the valley of the Rio Grande stood row behind ro in their ageless, immutable ranks, fading into layers of pale grays and blues that blended eventual with the sky on the distant horizon.

The road reached a high point about halfway up the shoulder of the hill, and from there wou down the other side to commence its long, shallow descent into the mouth of the valley beyond, at th far end of which was situated the sprawling complex of the Advanced Communications Researc Establishment. At this time of the morning, the sun shone from the far side of the Establishmen transforming the jumble of buildings, antenna towers, and radio dishes into stark silhouettes crouchi menacingly in front of the black, shadowy cliffs that marked the head of the valley. From a distanc the sight always reminded Clifford of a sinister collection of gigantic mutant insects guarding th entrance to some dark and cavernous lair. The shapes seemed to symbolize the ultimate mutation science – the harnessing of knowledge to unleash ever more potent forces of destruction upon tormented world.

About a mile farther on and halfway down to the valley floor, he came to the checkpoint where th road passed through the outer perimeter fence of ACRE. A black Army sergeant, in shirtsleeves bu armed and wearing a steel helmet, walked forward from the barrier as Clifford slowed to a halt besi a low column. Nodding his acknowledgment to the guard's perfunctory "'Morning," Clifford extracte the coded card from his pass folder, inserted it into a slot in the front of the box surmounting th column, and handed the folder to the guard. Then he pressed the ball of his thumb against the gla plate located adjacent to the slot. A computer deep beneath ACRE's Administration Block scanned th data fed in at the checkpoint, checked it against the records contained in its files, and flashed the resu

back to another soldier who was seated in front of a display console inside the guardhouse. Th sergeant returned the pass folder to Clifford's outstretched hand, cast a cursory glance around th inside of the vehicle, then stepped back and raised his arm. The Cougar moved through and the barri dropped into place behind.

Fifteen minutes later, Clifford arrived at his office on the third floor of the Applied Studie Department of the Mathematics & Computer Services Building. On the average, he spent probably n more than two days a week at ACRE, preferring to work at home and use his Infonet terminal, whic gave him access to the Establishment's data bank and computers. On this occasion he hadn't been for eight days, but when he checked the list of messages on his desk terminal, he found nothing th was especially pressing; all the urgent calls had already been routed on to his home number and dea with from there.

So no unexpected panics to worry about before his eleven-o'clock meeting.

No sooner had he thought it, when the chime sounded to announce an incoming call. He sighed an tapped a button to accept.

"Clifford."

The screen showed a momentary frenzy of color, which stabilized almost immediately into th features of a thin, pale-faced individual with thinning hair and a hawkish nose. He looked mea Clifford groaned inwardly as he recognized the expression of pained indignation. It was Wilbu Thompson, Deputy to the Deputy Financial Controller of Math-comps and self-appointed guardian protocol, red tape, and all things subject to proper procedures.

"You might have told me." The voice, shrill with outrage, grated on Clifford's ears like a hacksa on tungsten carbide. "There was absolutely no reason for you to keepquiet about it. I would hav thought that the least somebody with my responsibilities could expect would be some kind cooperation from you people. This kind of attitude doesn't help anybody at all."

"Told you what?"

"You know what. You requisitioned a whole list of category B equipment despite the fact that yo section is way over budget on capital procurement for the quarter, and without an SP6 clearanc When I queried it, you let me go ahead and cancel without telling me you'd gotten a priority approv from Edwards. Now the whole thing's a mess and I've got everybody screaming down my throa That's what."

"You didn't query it," Clifford corrected matter-of-factly. "You just told me I couldn't do i Period."

"But... You let me cancel."

"You said you had no alternative. I took your word for it."

"You knew damn well there'd be an exception approval on file." Thompson's eyes were bulging if he were about to become hysterical. "Why didn't you mention the fact, or give me an acce reference to it? How was I supposed to know that the project director had personally given it a priori 1 status? What are you trying to do, make me look like some kind of idiot or something?"

"You manage that okay without me."

"You listen to me, you smart-assed young bastard! Do you think this job isn't tough enoug already without you playing dummy? There was no reason why I should have checked for an exceptio approval against that requisition. Now I'm being bawled out because the whole project's bottlenecke What the hell made you think I'd want to check it out?"

“It’s your job,” Clifford said dryly, and cut off the screen.

He just had time to select some of the folders lying on his desk and to turn for the door, when th chime sounded again. He cursed aloud, turned back to the terminal, and pressed the *Interrogate* key obtain a preview of the caller without closing the circuit that completed the two-way channel. As h had guessed, it was Thompson again. He looked apoplectic. Clifford released the key and sauntere out into the corridor. He collected coffee from the automat area, then proceeded on to one of th graphical presentation rooms which he had already reserved for the next two hours. Since the meetin demanded his presence at ACRE that day, he thought he might as well make the most of th opportunity presented to him.

An hour later Clifford was still sitting at the operator’s console in the darkened room, frownin with concentration as he studied the array of multidimensional tensor equations that glowed at hi from the opposite wall. The room was one of several specifically built to facilitate the manipulatio and display of large volumes of graphical data from ACRE’s computer complex. The wall th Clifford was looking at was, in effect, one huge display screen. In levels deep below the building, th machines busied themselves with a thousand other tasks while Clifford pondered the subt implications contained in the patterns of symbols. At length, he turned his head slightly to direct h words at the microphone grille set into the console, but without taking his eyes off the display, an spoke slowly and clearly.

“Save current screen; name file *Delta Two.* Retain screen modules one, two, and three; era remainder. Rotate symmetric unit phi-zero-seven. Quantize derivative I-vector using isospin matri function. Accept I-coefficients from keyboard two; output on screen in normalized orthogon format.”

He watched as the machine’s interpretation of the commands appeared on one of the sma auxiliary screens built into the console, nodded his approval, then tapped a rapid series of numera into the keyboard.

“Continue.”

The lower part of the display went blank and a few seconds later began filling again with ne patterns of symbols. Clifford watched intently, his mind totally absorbed with trying to penetrate th hidden laws within which Nature had fashioned its strange inter-plays of space, time, energy an matter.

In the early 1990s, a German theoretical physicist by the name of Carl Maesanger had formulate the long-awaited mathematical theory of Unified Fields, combining into one interrelated set equations the phenomena of the “strong” and “weak” nuclear forces, the electromagnetic force, an gravity. According to this theory, all these familiar fields could be expressed as projections int Einsteinian spacetime of a complex wave function propagating through a higher-order, six dimensional continuum. Being German, Maesanger had chosen to call this continuum *ein sechsrechtwinkelkoordinatenraumkomplex*. The rest of the world preferred simply *sk-space,* whic later became shortened to just *k-space.*

Maesanger’s universe, therefore, was inhabited by *k-waves* – compound oscillations made up components that could vibrate about any of the six axes that defined the system. Each of the dimensional components was termed a “resonance mode,” and the properties of a given k-wav function were determined by the particular combination of resonances that came together to produc it.

The four low-order modes corresponded to the dimensions of relativistic spacetime, th corresponding k-functions being perceived at the observational level simply as *extension;* they define the structure of the empty universe. Space and time were seen not merely as providing a passive stag upon which the various particles and forces could act out their appointed roles, but as objectiv quantifiable realities in their own right. No longer could empty space be thought of as simply wh was left after everything tangible had been removed.

Addition of the high-order modes implied components of vibration occurring at right angles to a the coordinates of normal spacetime. Any effects that followed from these higher modes wer incapable, therefore, of occupying space in the universe accessible to man's senses or instrument They could impinge upon the observable universe only as dimensionless points, capable of interactin with each other in ways that depended on the particular k-functions involved; in other words, the appeared as the elementary particles.

The popular notion of a particle as a tiny, smooth ball of "something" – a model that, because its reassuring familiarity, had been tenaciously clung to for decades despite the revelations quantum wave mechanics – was finally put to rest for good. "Solidness" was at last recognized being totally an illusion of the macroscopic world; even the measured radius of the proton wa reduced to no more than a manifestation of the spatial probability distribution of a point k-function.

When high-and low-order resonances occurred together, they resulted in a class of entities th exhibited a reluctance to alter their state of rest or steady motion as perceived in normal space, giving rise to the quantity called "mass." A 5-D resonance produced a small amount of mass and cou interact via the electromagnetic and weaker forces. A full 6-D resonance produced a large amount mass and added the ability to interact via the strong nuclear force as well.

The final possibility was for high-order modes to exist by themselves, without there being an component of vibration in normal spacetime at all. This yielded point-centers of interaction th offered no resistance whatsoever to motion in spacetime and therefore always moved at the maximu speed observable – the speed of light. These were the massless particles – the familiar photon an neutrino and the hypothetical graviton.

In one sweeping, all-embracing scheme, Maesanger's wave equations gave a common explanatio for the bewildering morass of facts that had been catalogued by thousands of experimenters in a sco of nations throughout the 1950s to the 1980s. They explained, for example, why it is that a partic that interacts strongly always interacts in all possible weaker ways as well, although the conver might not be true; clearly the 6-D resonance responsible for the strong nuclear force had, b definition, to include all possible lower modes as subsets of itself. If it didn't, it wouldn't be a 6- resonance. This picture also explained why heavy particles always interact strongly.

Theory predicted that 5-D resonance would produce particles of small mass, unable to participa in strong interactions; existence of the electron and muon proved it. Further considerations suggeste that any heavy particle ought to be capable of assuming three discrete states of electric charge, each which should be accompanied by just a small change in mass; sure enough, the proton and neutro provided prime examples.

If an interaction occurred between two resonances whose respective components on the time ax were moving in opposite directions – and there was nothing in the theory to say this couldn't happen the two temporal waves would cancel each other to produce a new entity that had no duration in tim To the human observer they would cease to exist, producing the effect of a particle-antiparti annihilation.

As a young graduate at CIT in the late 1990s, Bradley Clifford had shared in the excitement th
had reverberated around the scientific world after publication of Maesanger's first paper. K-theo
became his consuming passion, and soon uncovered his dormant talents; by the time he entered h
postdoctoral years, he had already contributed significantly to the further development of sever
aspects of the theory. Driven by the restless, boundless energy of youth, he thrust beyond the eve
widening frontier of human knowledge, and always the need to know what lay beyond the next hi
drew him onward. Those were his idyllic days; there were not enough hours in the day, days in th
year, or years in a lifetime to accomplish all the things he knew he had to do.

But gradually the realities of the lesser world of lesser men closed in. The global political an
economic situation continued to deteriorate and fields of pure academic research were increasing
subjected to more stringent controls and restraints. Funds that had once flowed freely dried to
trickle; vital equipment was denied; the pick of available talent was lured away by ever more temptin
salaries as military and defense requirements assumed priority. Eventually, under special legislatio
even the freedom of the nation's leading scientists to work where and how they chose became a luxu
that could no longer be allowed.

And so he had come to ACRE, virtually as a draftee... to find more effective methods
controlling satellite-borne antimissile lasers.

But though they had commandeered his body and his brain, they could never commandeer h
soul. The computers and facilities at ACRE surpassed anything he had ever dreamed of at CIT.

He could still let his mind fly free, to soar into the realm of Carl Maesanger's mysterious k-spac

It seemed to him that only minutes had passed when the reminder began flashing in the center
the wall screen, warning him that the meeting was due to commence in five minutes.

Chapter 2

Professor Richard Edwards, Principal Scientific Executive and second-in-command at ACR contemplated the document lying on the table in front of him. The wording on the title sheet read: *I Space Rotations and Gravity Impulses.* Seated around the corner of the table to the professor's le Walter Massey thumbed idly through his copy, making little of the pages of complex formula Opposite Massey, Miles Corrigan leaned back in his chair and regarded Clifford with a cool, predato stare, making no attempt to conceal the disdain that he felt toward all scientists.

"The rules of this Establishment are perfectly clear, Dr. Clifford," Edwards began, speaking ov the top of his interlaced fingers. "All scientific material produced by any person during the time he employed at ACRE, produced in the course of his duties or otherwise, automatically qualifies classified information. Precisely what are your grounds for requesting an exemption and permission publish this paper?"

Clifford returned his look expressionlessly, trying hard for once not to show the irritation he fe for the whole business. He didn't like the air of an Inquisition that had pervaded the room ever sin they sat down.

His reply was terse: "Purely scientific material of academic interest only. No security issu involved."

Edwards waited, apparently expecting more. After a few, dragging seconds, Massey shuffled h feet uncomfortably and cleared his throat.

Massey was Clifford's immediate boss in Mathcomps. He was every inch a practical, har applications engineer, fifteen years in the Army's Technical Services Corps having left him with n great inclination toward theoretical matters. When he was assigned a task, he did it witho questioning either the wisdom or the motives of his superiors, both of which he took for granted. was best not to think about such things; that always led to trouble. He represented the end-product the system, faithfully carrying out his side of a symbiotic existence in which he traded off individu freedom for collective security. He felt a part of ACRE and the institution that it symbolized, in th same way that he had felt a part of the Army; it provided him with the sense of belonging that h needed. He served the organization and the organization served him; it paid him, trained him, made a his major decisions for him, rapped his knuckles when he stepped out of line, and promoted him wh he didn't. If he had to, he would readily die fighting to defend all that it stood for.

But Clifford didn't find him really a bad guy for all that.

Right now, Massey wasn't too happy about the way in which Clifford was handling things. H didn't give a damn whether the paper ended up being published or not, but it bothered him th somebody from his section didn't seem to be putting up a good fight to speak his case. The name the platoon was at stake.

"What Brad means is, the subject matter of his paper relates purely to abstract theoretic concepts. There's nothing about it that could be thought of as having anything to do with nation security interests." Massey glanced from Edwards to Corrigan and back again. "You might say it kinda like a hobby... only Brad's hobby happens to involve a lot of mathematics."

"Mmm..." Edwards rubbed his thumbs against the point of his chin and considered the propositio Abstract theoretical concepts had a habit of turning into reality with frightening speed. Even the mo innocent-looking scraps of trivia could acquire immense significance when fitted together into

pattern with others. He had no idea of the things that were going on in other security-blanket research institutions of his own country, not to mention those of the other side. Only Washington hel the big picture, and if they went along with Clifford's request, it would mean getting mixed up in a the rigmarole of referring the matter back there for clearance... and Washington was never very happ over things like that. Far better if the whole thing could be killed off right at the beginning.

On the other hand, his image wouldn't benefit from too hasty a display of high-handedness... mu be seen as objective and impartial.

"I have been through the paper briefly, Dr. Clifford," he said. "Before we consider your reque specifically, I think it would help if you clarified some of the points that you make." He spread h hands and rested them palms-down on the table. "For example, you make some remarkable deductio concerning the nature of elementary particles and their connection with gravitational propagation... His look invited Clifford to take it from there.

Clifford sighed. At the best of times he detested lengthy dissertations; the feeling that he wa pressing an already lost cause only made it worse. But there was no way out.

"All the known particles of physics," he began, "can be described in terms of Maesanger functions. Every particle is a combination of high-order and low-order k-resonances. Theory sugges that it's possible for an entity to exist purely in the high-order domain, without any physical attribut in the dimensions of the observable universe. It couldn't be detected by any known experiment technique."

"This isn't part of Maesanger's original theory," Edwards checked.

"No. It's new."

"This is your own contribution?"

"Yes."

"I see. Carry on." Edwards scribbled a brief note on his pad.

"I've termed such an unobservable entity a 'hi-particle,' and the domain that it exists in, 'h space' – the unobservable subset of k-space. The remaining portion of k-space – the spacetime that v perceive – is then termed 'lo-space.'

"Interactions are possible between hi-particles. Most of them result in new hi-particles. Son classes of interaction, however, can produce complete k-functions as end-products – that is, combine hi-and lo-order resonances that are observable. In other words, you'd be able to detect them in norm space." Clifford paused and waited for a response. It came from Massey.

"You mean that as far as anybody can tell, first there's no particle there – just nothing at all – the suddenly – *poof!* – there is."

Clifford nodded. "Exactly so."

"Mmm... I see. Spontaneous creation of matter... in our universe anyway. Interesting." Edward began stroking his chin again and nodded to Clifford to continue.

"Since all conventional particles can be thought of as extending into hi-space, they can intera with hi-particles too. When they do, the result can be one of two things.

"First off, the interaction products can include k-resonances – in other words, particles that a observable. What you'd see would be the observable part of the k-particle that was there to begin wit and then the observable part of the k-products that came later. What you wouldn't see is the pure h particle that caused the change to take place."

Massey was beginning to look intrigued. He raised a hand to stop Clifford from racing ahead ar
further for the moment.

"Just a sec, Brad, let's get this straight. A k-particle is something that has bits you can see and bi
you can't. Right?"

"Right."

"All the particles that we know are k-particles."

"Right."

"But you figure there are things that nobody can see at all... these things you've called 'h
particles.'"

"Right."

"And two hi's can come together to make a k, and since you can see k's, you'd see a partic
suddenly pop outa nowhere. Is that right?"

"Right."

"Okay..." Massey inclined his head and collected his thoughts for a moment. "Now – in idi
language – just go over that last bit again, willya?" He wasn't being deliberately sarcastic; it was ju
his way of speaking.

"A hi can interact with a k to produce another k, or maybe several k's. When that happens, wh
you see is a sudden change taking place in an observable particle, without any apparent cause."

"A spontaneous event," Edwards commented, nodding slowly. "An explanation for the decay
radioactive nuclei and the like, perhaps."

Clifford began warming slightly. Maybe he wasn't wasting his time after all.

"Precisely so," he replied. "The statistics that come out of it fit perfectly with the observe
frequencies of quantum mechanical tunneling effects, energy-level transitions of the electron, and
whole list of other probabilistic phenomena at the atomistic scale. It gives us a common explanatio
for all of them. They're not inexplicable any more; they only look that way in lo-order spacetime."

"Mmm..." Edwards looked down again at the paper lying in front of him. The administrator in hi
still wanted to put a swift end to the whole business, but the scientist in him was becoming intrigue
If only this discussion could have taken place at some other time, a time free of the dictates of harsh
realities. He looked up at Clifford and noted for the first time the pleading earnestness burning fro
those bright, youthful eyes. Clifford could be no more than in his mid to late twenties – the age
which Newton and Einstein had been at their peak. This generation would have much to answer f
when the day finally came to count the cost of it all.

"You said that there is a second possible way in which hi-and k-particles can interact."

"Yes," Clifford confirmed. "They can also interact to produce hi-order entities only." He looked
Massey. "That means that a hi plus a k can make just hi's. You'd see the k to start with, then suddenl
you wouldn't see anything at all."

"Spontaneous particle extinction," Edwards supplied.

"I'll be damned," said Massey.

"The two effects of creation and extinction are symmetrical," Clifford offered. "In loose tern
you could say that a particle exists only for a finite time in the observable universe. It appears out
nowhere, persists for a while, then either vanishes, or decays into other particles, which eventual
vanish anyway. The length of time that any one particle will exist is indeterminate, but the statistic

average for large numbers of them can be calculated accurately. For some, such as those involved familiar high-energy decay processes, lifetimes can be very short; for radioactive decays, seconds millions of years; for the so-called stable particles, like the proton and electron, billions of years."

"You mean the stable particles aren't truly stable at all?" Edwards raised his eyebrows in surpris "Not permanently?"

"Right."

Silence reigned for a short while as the room digested the flow of information. Edwards look pensive. Miles Corrigan continued to remain silent, but his sharp eyes missed nothing. He smoothed wrinkle in his expensively tailored suit and glanced at his watch, giving the impression of being bor and impatient. Massey spoke next.

"You see, like I said, it's all pure academic stuff. Harmless." He shrugged and showed his empt palms. "Maybe this once there's no reason for us not to have Washington check it out. I vote we clea it."

"Maybe isn't good enough, Walt," Edwards cautioned. "We have to be sure. For one thing, I nee to be certain of the scientific accuracy of it all first. Wouldn't do to go wasting Washington's tim with a theory that turned out to be only half worked out; that wouldn't do ACRE's image any good all. There are a couple of points that bother me already."

Massey retreated abruptly.

"Sure – whatever you say. It was just a thought."

Clifford noted with no surprise that Massey had been simply testing to see which way the wi was blowing. He would go along with whatever the other two decided.

"Dr. Clifford," Edwards resumed. "You state that even the stable particles possess only a finit duration in normal spacetime."

"Yes."

"You've proved it... rigorously...?"

"Yes."

"I see..." A pause. "But tell me, how do you reconcile that statement with some of the fundament laws of physics, some of which have stood unchallenged for decades or even for centuries? It is we known, is it not, that decay of the proton would violate the law of conservation of baryon numbe decay of the electron would violate conservation of charge. And what about the conservation laws mass-energy and momentum, for example? What happens to those if stable particles are simp allowed to appear and vanish?"

Clifford recognized the tone. The professor's attitude was negative. He was out to uncover t flaws – anything that would justify going no further for the present and sending Clifford back to t drawing board. The mildly challenging note was calculated to invoke an emotive response, th carrying the whole discussion from the purely rational level to the irrational and opening the way for choice of counterproductive continuations.

Clifford was on his guard. "Violation of many conservation laws is well known already. Althoug the strong nuclear interactions do obey all the laws listed, electromagnetic interactions do n conserve isotopic spin. Furthermore, the weak nuclear interactions don't conserve strangeness, nor they conserve charge or parity discretely but only as a combined product of C and P. As a gener principle, the stronger the force, the greater the number of laws it has to obey. This has been known

an experimental fact for a long time. In recent years we've known that it follows automatically fro
Maesanger wave functions. Each conservation principle is related to a particular order of resonanc
Since stronger interactions involve more orders, they obey more conservation laws. As you reduce th
number of orders involved, you lose the necessity to obey the laws that go with the higher orders.

"What I'm saying here..." he gestured toward the paper "is that the same pattern holds true rig
on through to the weakest force of all – gravity. When you get down to the level of the gravitation
interaction – determined by lo-order resonances only – you lose more of the conservation laws th
come with the hi-orders. In fact, as it turns out, you lose all of them."

"I see," said Edwards. "But if that's so, why hasn't anybody ever found out about it? Why haven
centuries of experiments revealed it? On the contrary, they would appear to demonstrate the reverse
what you're saying."

Clifford knew fully that Edwards was not that naive. The possibility that conservation principl
might not be universal was something that scientists had speculated about for a long time. But forcin
somebody to adopt a defensive posture was always a first step toward weakening his cas
Nevertheless, Clifford had no option but to go along with it.

"Because, as I mentioned earlier, the so-called stable particles have extremely long averag
lifetimes. Matter is created and extinguished at an infinitesimally small rate – on the everyday sca
anyway; it would be utterly immeasurable by any laboratory experiment. For matter at ordina
density, it works out at about one extinction per ten billion particles present per year. No experime
ever devised could detect anything like that. You could only detect it on the cosmological scale – an
nobody has performed experiments with whole galaxies yet."

"Mmm..." Edwards paused to collect his thoughts. Massey sensed that things could go either wa
and opted to stay out.

Clifford decided to move ahead. "All interactions can be represented as rotations in k-space. Th
accounts for the symmetries of quantum mechanics and the family-number conservation laws. In fac
all the conservation laws come out as simply different projections of one basic set of k-conservatio
relationships.

"Every rotation results in a redistribution of energy about the various k-axes, which we see
forces of one kind or another. The particular set of rotations that correspond to transitions of a partic
between hi-space and normal space – events of creation and extinction – produces an expanding wav
front in k-space that projects as a gravitational pulse. In other words, every particle creation
extinction generates a pulse of gravity."

There were no questions at that point, so Clifford continued. "A particle can appear spontaneousl
anywhere in the universe with equal probability. When it does, it will emanate a minute gravity puls
The figures indicate something like one particle creation in a volume of millions of cubic meters p
year; utterly immeasurable – that's why nobody has ever found out about it.

"On the other hand, a particle can vanish only from where it already is – obviously. So, whe
large numbers of particles are concentrated together, you will get a larger number of extinctions ov
a given period of time. Thus you'll get a higher rate of production of gravity pulses. The mo
particles there are and the more closely they're packed together, the greater the total additive effect
all the pulses. That's why you get a gravity field around large masses of matter; it isn't a stat
phenomenon at all – just the additive effect of a large number of gravity quanta. It appears 'smoot
only at the macroscopic level.

“Gravity isn’t something that’s simply associated with mass per se; it’s just that mass defines volume of space inside which a large number of extinctions can happen. It’s the extinctions th produce the gravity.”

“I thought you said the creations do so, too,” Massey queried.

“They do, but their contribution is negligible. As I said, creations take place all through th universe with equal probability anywhere – inside a piece of matter or way outside the galaxy. In region occupied by matter, the effect due to extinctions would dominate overwhelmingly.”

“Mmm...” Edwards frowned at his knuckles while considering another angle.

“That suggests that mass ought to decay away to nothing. Why doesn’t it?”

“It does. Again, the numbers we’re talking about are much too small to be measurable on th small scale or over short time periods. As an example, a gram of water contains about ten to the pow twenty-three atoms. If those atoms vanished at the rate of three million every second, it would tal about ten billion years for all traces of the original gram to disappear. Is it any wonder the decay never been detected experimentally? Is it any wonder that the gravity field of a planet appea smooth? We have no way of even detecting the gravity due to one gram of water, let alone measure to see if it’s quantized. You could only detect it at the cosmological level. At that level, totall dominated by gravity, conservation laws that hold good in laboratories might well break dow Certainly we have no experimental data to say they don’t.”

“That means all the bodies in the universe ought to decay away to nothing in time,” Edward pointed out. “They’ve had plenty of time, but there still seem to be plenty of them around.”

“Maybe they do decay away to nothing,” Clifford said. “Don’t forget that spontaneous creation going on all the time all over the universe as well. That’s an a awful lot of volume and it implies a awful lot of creation.”

“You mean a continuous process in which new bodies are formed out of interstellar matter by th known sequences of galactic and planetary evolution; the newly created particles provide a source replenish the interstellar matter in turn.”

“Could be,” Clifford agreed.

At last Edwards had drawn Clifford into an area in which he was unable to give definite answer He pressed the advantage.

“But surely that requires some resurrection of the Continuous Creation Theory of cosmology. A we all know, that notion has been defunct for many years. The overwhelming weight of evidenc unquestionably favors the Big Bang.”

Clifford spread his arms wide in an attitude of helplessness.

“I know that. All I can say is, the mathematics works. I’m not an astronomer or a cosmologist. I’ not even an experimental scientist. I’m a theoretician. I don’t know how conclusive the evidence f Big Bang is, or if there are alternative explanations for some parts. That’s why I need to publish th paper. I need to attract the attention of specialists in other areas.”

The string of admissions gave Edwards the moment he was looking for, a moment of weakne that could be exploited. It was time to move in the hatchet man. He half-turned toward Corrigan.

“What do you have to say, Miles?”

Miles Corrigan’s official title at ACRE was that of Liaison Director, a euphemism for watchdo Aloof from the hierarchy of line managers who reported to Edwards, Corrigan took his orders direct

from the Technical Coordination Bureau in Washington, an office of the Pentagon that provided rationalizing interface between the Defense Department and the various centers of governmen directed scientific research. Through the Bureau, the activities of practically all the nation's scientis were controlled and coordinated, both among themselves and with the activities of the other allies the Western Democracies. The payer of pipers was firmly calling the tune.

Corrigan's job was to make sure that the right things got done and got done on time; that was th publicized part anyway. The unpublicized part involved simply maintaining a political presence – constant reminder that whatever things went on in the day-to-day world of ACRE, they were alway part of and subordinate to the grand design of loftier and more distant architects. His brief was watch for, track down, and exorcise "counterproductive influences," which meant wrong attitude uninformed opinions, and anything else of that nature that threatened to affect adversely or undermi the smooth attainment of the Establishment's assigned objectives. Corrigan could track a subversiv rumor back to its source with all the skill and tenacity of an epidemiologist tracing an outbreak typhoid to its prime carrier. To avoid any witch hunts, it was safer just to say the kind of things yo were supposed to say, or at best, not to say the kind of things you weren't. The scientists at ACR called him the Commissar.

By temperament and background he was well qualified for the job. After walking through a firs class honors degree in law at Harvard, he had set up a lucrative practice in Washington, specializing defending the cases of errant politicians – at which he had demonstrated a prodigious skill. In th course of a few years he had incurred the lifelong indebtedness of a long list of fixers and strin pullers – the only kind of friends that meant anything on his scale of values – and their tokens gratitude soon added up to a permanent end to all of life's potential financial problems.

He married the daughter of a senator who had made his first million in a series of clandestine arm deals that had involved the offloading of whole ship-loads of substandard ammunition unsuspecting recipients in Burma and Malaysia – or so it was said. The allegations of the senator involvement were never proved after becoming bogged down over a legal technicality. Miles Corriga had seen to that.

Through the influence of his father-in-law and the goodwill of a number of friends with the rig contacts, he entered government service at the right level to further his ambitions. His assignment ACRE represented the final stage of his grooming before he made his debut on the internation political scene. He had made it while still in his prime and was all set to fly high.

He took the cue, sensing a turkey being set up for the kill. When he spoke, his voice was icy an menacing, like the hiss of a cobra measuring its distance. "I'm not interested in k-spaces, hi-spaces, any of the other buzz-phrases. If all this boils down to saying that you've got something that serv the national interest, then tell us about it. If you haven't, then why are you wasting our time?"

He confronted Clifford with the sneering, unblinking stare that had destroyed innumerab confused and hostile witnesses. His eyes were mocking, inviting the scientist to court disaster if h dared; at the same time they were insistent, demanding an immediate reply. He caught Cliffo completely unprepared.

"But... that's not the point. This is..." Clifford was surprised to hear himself stumbling for th right word. Even as he spoke he realized he was on the wrong foot and walking straight into the tra but it was too late. "We're talking about fundamental knowl —"

"Will it help us kill Commies?" Corrigan cut him short.

"No, but..."

"Will it help stop Commies from killing us?"

"No... I don't know... Maybe, someday..."

"Then why are you fooling around with it? How much time and resources has all this stuff take up? What effect has all this had on the work you're paid to be doing? Massey describes it as a hobb but I don't believe it's quite as simple as that. I've checked the amount of computer usage you've logged over the past six months and I've checked the current status of the projects you're supposed be working on. They're all way behind schedule. So, where's all the computer time going?"

"I don't suppose Einstein had the A-bomb in mind when he developed special relativity," Cliffor retorted, ducking the feint and walking straight into the uppercut.

"Einstein!" Corrigan repeated the word for the benefit of the jury. "He's telling us he's anothe Einstein. Is that right, Dr. Clifford – you consider yourself to be on a par with Einstein?"

"I didn't say anything of the kind, and you damn well know I didn't." Clifford had recovere sufficiently to return Corrigan's look with a glare that could only be described as murderous. He kne that he was being drawn on to Corrigan's home ground. Somehow he didn't really care much an more.

"You're saying that we ought to allow you to dabble around with anything that takes your fanc and at whatever expense, simply in case you happen to hit upon something useful. Is that how we' supposed to preserve the security of the West? Doesn't the concept of organized profession objectivity mean anything to you people? How long do we have to protect you and the freedom th you're always talking about before you wake up to reality?"

Edwards stared uncomfortably at the table, having joined Massey in abdication. It was all up Corrigan now.

"This isn't some kind of philosopher's utopia where anybody is owed the right to any living l chooses," Corrigan continued. "It's a dog-eat-dog jungle; the strong survive and the weak go to th wall. To stay strong we have to get our priorities straight. Your priorities are all screwed up. Nov you're asking us to follow suit and compound the offense by approving it."

He took a long, deep breath for effect. "No way. There's no way I'm going to tell Professo Edwards to give a carte blanche for even more time-wasting and misuse of funds and resources."

Actually, Corrigan couldn't tell Edwards to do anything. His use of the word was deliberat however, serving as a gentle reminder of his own power, if not authority, at ACRE. Edwards didn argue the point. He knew that Corrigan's reports back to the Bureau would have a lot to do wi whether he ever moved on to become chief at ACRE or something similar, or whether he ended u running a backwater missile test range on the northern coast of Baffin Island.

When the victim has been battered to a pulp and stripped of every shred of dignity, he become highly suggestible and will respond eagerly to even a slight gesture of friendship. Prison guards ha been well versed in the technique throughout history. And Corrigan understood psychology well; h knew what made people tick all right.

His tone softened a fraction. "Everyone's out of step except you, Dr. Clifford. We're all a tean here, trying to do a good job. Why make it difficult? Once you make the effort to fit in, you might fin that life's not really that bad.

"Don't you feel you owe it to this country and all it stands for – the way of life we all believe in Isn't it worth a few sacrifices to protect all that? Right now half the world out there is sitting an

waiting for us to ease up for just one second so they can blow us all off the face of this planet. Are yo just going to sit there and let it happen? Do you want them to come walking in here without having lift a finger?" Corrigan finished on a note that oozed all-in-it-togetherness. "Or are you gonna join th team, do your share, and help us go out there and zap those bastards?"

Clifford had turned white. Corrigan and his propaganda epitomized everything abhorrent in world that was going insane. And now he was expecting to enlist Clifford in the ranks of th brainwashed millions who had toiled and bled and died believing that line ever since the world bega There would always be Corrigans to ride on the backs of the masses – for as long as there were willi backs to carry them. Clifford's voice fell to a whisper as he fought to control the anger that boile inside, churning his stomach and bubbling up into the back of his throat like waves of nausea.

"I'm not interested in zapping anybody, mister... not for you or for whatever you represent. You system put me here; don't you tell me I'm screwed up now because I don't belong. Don't you tell me owe anything to your system to help straighten out its mess. Save your garbage for the morons Without waiting for a reply he got up and strode toward the door. Edwards and Massey remaine silent, staring fixedly at the table. If Brad was flushing himself down the tubes, they weren't going get caught in any of the backsplash.

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Clifford, still shaking when he slammed the door of his office behind him five minutes later, bega hammering a brief code into the keyboard of the desk terminal. At least he had tried the offici channel. The outcome hadn't really been a surprise; that was why he had already prepared a long fi in the data bank, ready for immediate transmission.

A woman's face appeared on the screen. "Message Center. Can I help you?"

"I need an immediate outgoing channel. The destination code is 090909-73785-21318."

"Triple-09 prefix is extraterrestrial, sir – for the lunar bases."

"I know."

"I'm sorry, but those channels need special authorization from grade 5 or over. Do you have clearance reference?"

All the frustrations of the last half-hour boiled over. "Listen, damn it, and store this on file. This absolutely top priority. I take full responsibility. I don't care if you need clearance from the Presiden the Pope, or God Almighty himself. GET ME THAT DAMN CHANNEL!"

Chapter 3

"... Proxima Centauri, 4.3 light-years away from us, has at least three planets of significant size, t largest of them having a mass of 0.0018 times that of the sun and an orbital period of 137 yea Slightly farther away, at 6.0 light-years, Barnard's Star again has at least three planetary companion B1, B2, and B3, of masses 0.0011, 0.0008, and 0.0003, periods 26, 12, and 14.3 years respectively; v strongly suspect others as well. Beyond these systems, the stars Lalande 2115A, 61Cygni, and Krug 60A, to name just three, also possess planets that have been positively observed and whose ma properties have been accurately measured. In fact, more than thirty planets of stars other than our ov sun are known to exist within a radius of twenty light-years from us."

Professor Heinrich Zimmermann pointed out the last item on the list and then turned away fro the three-dimensional model of the local regions of the galaxy to look directly into the camera. Th camera trolley rolled noiselessly forward to close in on his tall, immaculately dressed figure, dignifi by a lean, angular build and a crown of silvery hair.

"Thus some of our work here at the Joliot-Curie Observatories on Lunar Farside has adde immensely to our knowledge of the Sun's neighboring planetary systems. If these statistics a extrapolated to cover the whole galaxy, they indicate the existence of billions of planets. If only one every thousand were to be similar to Earth in temperature and surface chemistry, we are still left wi millions of worlds on which life as we know it could emerge. Furthermore, as you saw earlier, th emergence of life is not, as was once supposed, a billion-to-one freak occurrence; as the experimen of such scientists as Okoyaku and Skovensen have shown, it is virtually a certainty once the rig conditions are established." He stepped aside to allow a zoom-in for a close-up of the model while h delivered his final words. "I will leave you to draw your own conclusions as to the implications these statements. Despite the exciting things that we have seen in this program, it could be that th real excitement is yet to come."

"Okay. Cut it there." The floor director's voice sounded from the wall of darkness behind the a lights. "That was fine. Take a short break, but be ready for another take of the first part of sequence in five minutes. Harry and Mike, don't go rushing off anyplace – I need to talk to you for a second."

The lights dimmed and a hubbub of voices broke out on all sides. The floor around Zimmerman was transformed into an arena of bustling technicians. He paused to allow his eyes to readjust to th comparative gloom of normal lighting, acknowledged the thanks from the film team, and moved awa from all the activity to stand by one of the dome's viewing ports. While he dabbed his forehead light with a pocket handkerchief, he stared silently out at the harsh, bleak landscape of the lunar surface.

Beyond the litter of assorted engineering and latticework that marked the environs of th observatory complex and base, the soft, rolling dunes of ash-gray dust lay seared beneath the dire rays of lunar noon, pitted here and there by the ink-black shadow of the occasional crag or boulde Above the featureless horizon, a million blazing jewels lay scattered on a carpet of velvet infinit Joliot-Curie was without exception the loneliest center of human habitation in the universe. Her shielded by the body of the Moon itself from Earth's incessant outpouring of electronic caterwaulin gigantic radio dishes listened for the whisperings that brought the secrets of the cosmos; unhampere by any atmosphere and all but free of the weight-induced distortions that had crippled their Eart bound predecessors, enormous optical telescopes probed the very limits of the observable univers The Joliot-Curie observatory complex was distant; it was isolated, but it was free – a surviving outpo of unfettered science where the pursuit of knowledge constituted its own ends.

A shadow from behind him darkened the wall by the side of the viewing port. Zimmermann turne to find Gus Craymer standing there; Craymer was Assistant Producer of *Exploding Horizons* – th documentary they were making. Craymer peered past the professor to take in the scene from th outside and pulled a face.

"How come you guys don't go nuts in this place?" he asked. Zimmermann followed his gaze, an then turned back smiling faintly.

"Oh, you would be surprised, Mr. Craymer. The solitude and peace can be quite stimulating. really depends on what you see when you look out there. Remember the rhyme about the two men an the prison bars? I wonder sometimes that you don't all go nuts on Earth."

"You see stars, huh," Craymer grinned. "Literally." He indicated the far side of the room with nod of his head. "There's coffee going over there if you'd like some." Zimmermann folded th handkerchief and replaced it in his breast pocket.

"Thank you, no. I'll enjoy some in comfort when we have completely finished. How near the en are we?"

Craymer consulted the typed schedule that he was holding.

"Well, there's some outside shooting to be done now that the Sun's at the right angle... som close-ups of instruments to go with the commentary we recorded yesterday. Lemme see now, when are your parts...? Here we are – there's only one more shot that involves you and that's coming u right now. That'll be a retake of the beginning of sequence 5... the one where you talk about radiatio from black holes."

"Ah, yes. Very good."

Craymer closed the folder and turned to look out across the floor with Zimmermann.

"I guess you'll be glad to get back to your work without this bedlam going on all the time," h said. "You've been very patient and cooperative while we've been here. I'd like you to know that a the people on the team appreciate it."

"Quite the contrary, Mr. Craymer," Zimmermann replied. "It has been my pleasure. The publi has paid for everything here, including my salary; they have a right to be kept informed of what we a doing and why. Besides, anything that popularizes the true nature of science is worth a little time an trouble, don't you think?"

Craymer smiled ruefully as he recalled the problems that they had encountered with pet bureaucrats in Washington six months before, when they had tried to put a documentary together o spacecraft navigation and propulsion systems. In the end they'd had to abandon the project, since wh was left after the censoring wouldn't have made a lesson fit for elementary-school students.

"I wish more people thought that way these days," he said. "They're all going paranoid bac home."

"I can well imagine," Zimmermann replied, moving aside to make room for a technician who wa positioning a spotlight according to directions being shouted from across the room.

As they began threading their way toward the area where the next shooting sequence would tak place, Craymer asked: "How long have you been up here now?"

"Oh, eighteen months or more, I suppose... although I do visit Earth from time to time. It ma sound strange but I really miss very little. My work is here and, as I said a moment ago, th environment is stimulating. We have no interruptions and are largely left free of interference of an

kind."

"Must be nice to be able to do your own thing," Craymer agreed. "You steer clear of all the sordi political stuff then, huh?"

"Yes, I suppose we do... but it has not always been so. I have held a number of governme scientific positions, over several years... in Germany you understand, before the formation of U. Europe. However..." Zimmermann sighed, "when it became apparent that official support would b progressively restricted to activities of the kind in which neither my conscience nor my interests mad me wish to participate, I resigned and joined the International Scientific Foundation. It is complete autonomous, you see, being funded entirely from private and voluntary sources."

"Yeah, I know. I'm surprised the USE government didn't try and make things difficult... or mayb you don't push around easy?"

Zimmermann smiled and scratched an eyebrow.

"I think it was more a question of persuading them that neither I nor my particular kind knowledge would have been of very much use to them," he said.

Craymer reflected that the more he saw of life, the more he became convinced that the quality modesty was the preserve solely of the truly great men that he happened to meet. The amplified voi of the floor director boomed around the room, curtailing their conversation.

"All right, everybody. In your places for the sequence 5 retake now. This will be the last on today. Let's make it good." The murmuring died away and the arc lights came on to flood a backdro set up against one wall. To the right of the backdrop, banks of instrument panels and consoles carrie a colorful array of blinking lights and display screens. Zimmermann moved forward from the jumb of cameras, microphone booms, chairs, and figures, to stand in the semicircle of light in front of th consoles. A short distance to his right, Martin Borel, compere of the documentary, took his position i front of the backdrop.

The floor director's voice came again. "Mart – this time, start moving to your left as soon as yo say '... the most perplexing phenomena known to man.' Take it at the same speed as last time – tha way the professor will appear on camera just as you introduce him. Okay?"

"Sure thing," Borel acknowledged.

"Professor?"

"Yes?"

"When you refer to the equipment behind you for the first time, do you think you could move bac for about five seconds so that we can pan in on it, please? Then close back in with Mart and resum the dialogue."

"Certainly."

"Thank you. Okay – roll it." Borel straightened up and assumed a posture with his hands high, ne his shoulders. The clapperboard echoed. "Action."

"The black hole," Borel began, speaking in the firm, resonant tones of the professional. "Strang regions of space where matter and energy are lost forever without trace, and time itself stands sti We have traced the history of black holes through from early speculations all the way to the confirme realities of the present day. Scientists can now draw for us an incredible picture of the bewilderin laws of an unfamiliar physics, that dominate these mysterious bodies. But despite all this ne knowledge, unexpected riddles continue to emerge. The black hole is still, and will continue for a lon

time to be, one of the most perplexing phenomena known to man."

Borel began walking slowly across the front of the backdrop toward Zimmermann.

"To give you an idea of the kinds of riddle that investigators into black-hole physics are meetin today, let me introduce Professor Heinrich Zimmermann of ISF, Director of Joliot-Curie and perhap one of the most distinguished physical astronomers of our time.

"Professor, the receiver that we saw outside is collecting radiation from the vicinity of a blac hole in space. Down here you are analyzing the information that the computers have extracted fro that radiation. Could you summarize for us, please, what you are finding and what new questions yo are being forced to ask?"

By now Zimmermann had been through this routine three times.

"The receiver is at this moment trained on a binary system known as Cygnus X-1," he replied. " binary system is one in which two stars are formed very close to one another and orbit about common center of mass under their mutual gravitational coupling. Most binary systems comprise tw ordinary stars, each of which conforms to one of the standard classifications. Some binaries, howeve contain only one normal, visible star, the second body being invisible. The so-called dark companio emits no light but can be detected by its gravitational influence on the visible star. In many cases, the are known to be neutron stars as described earlier in the program. In a number of confirmed instance however, collapse of the companion body has continued beyond the point at which a neutron star formed, which results in the condition of ultimate degeneracy of matter – a black hole. Cygnus X-1 an example of precisely this."

"In other words, you have an ordinary star and a black hole orbiting each other as a stable system Borel interjected.

"That is so. However, the system is not quite permanently stable. You see, the gravitationa attraction of the black hole is strong enough for it to draw off gaseous material from the surface of th star. The system thus comprises three parts essentially: the visible star, the black hole, and a filamen of stellar material that flows out of the former into the latter, connecting them rather like an umbilic cord. The filament spirals around the black hole as the particles contained in it acquire energy an accelerate down the gravitational gradient. In a somewhat simplified way, you might picture it a bathwater spiraling down into the drain." He paused, allowing Borel to pose the next question.

"But straightforward as this might sound, it is producing results that you are having difficulty explaining. Isn't that so?"

"Very true," Zimmermann agreed. "You see, the matter that is being drawn off of the visible sta is extremely hot and therefore in a highly ionized state. In other words, it is made up of strong charged particles. Now, charged particles in motion give rise to electromagnetic radiation calculations predict that a characteristic spectrum of broad-band radiation, extending up into the x-ra frequencies, should be observable as a halo around the black hole. Indeed, we do observe radiation the general nature that we would expect. Precise analysis of the spectrum and energy distribution however, reveals a pattern that is not at all in accordance with theory."

Zimmermann moved to one side and gestured toward the instrumentation panels behind them "The equipment that you see here is being used for this kind of investigation. From here we ca monitor and control the receiving equipment, direct the computers, and observe what they are doing.

"Many years of observations and measurements have enabled us to determine the characteristi of several black-hole binaries with sufficient accuracy for us to compute precisely a mathematic

model that should give us the pattern of radiation that each should produce." He moved forward indicate one of the monitor screens on the console. "In fact, this is a picture of the theoretic distribution pattern computed for Cygnus X-l." The screen showed a wavy green line, annotated wi captions and symbols; it rose and fell in a series of peaks, valleys, and plateaus, like a cross-section view of a mountain range.

"This is what we should expect to see. But when we analyze the data actually received fro Cygnus X1..." he touched a button to conjure up a second, red curve, "we see that there is a significa discrepancy." The screen confirmed his words. The red curve was of a different shape and la displaced above the green curve; only in one or two places did the green rise high enough for the tv to nearly touch.

"Both curves are to the same scale and plotted from the same origin," Zimmermann commente "If our model were correct, they would be approximately the same. It means that the amount radiation actually measured is much greater than that which can be accounted for by theory."

"Actual measurement shows more radiation than predicted," Borel repeated. "Where does th excess radiation come from?"

"That, of course, is what intrigues us," Zimmermann replied. "You see, there are only thre objects in the vicinity – the star, the filament, and the black hole. We are quite confident that we kno enough about the physics of ordinary matter – as exemplified by the star and the filament – to exclu them as possible sources. That leaves only the black hole itself. But how can a black hole produ radiation? That is the problem confronting us. You see, all our theories of physics, based on genera relativity, tell us that nothing – matter, energy, radiation, information, or any kind of influence – ca escape from a black hole. So how can the black hole be responsible for the extra energy that we dete as radiation? But there is nothing else there for it to come from.

"The answer to this question could have very far-reaching consequences." The camera pulled for a close-up. "Let us ask the question: What happens to matter when it falls into a black hole? W know that it disappears completely from the universe of which we have any knowledge. Logically, on must conclude that it exists thereafter either in some other part of our own universe or in som entirely different universe. There would appear to be no other possibility. If you reflect for a mome on the implications of what I have just said, you will realize why it is that we get excited at th discovery of what could turn out to be a process operating in the reverse direction. Something th contemporary theory declares impossible is being observed to happen. Behind it, we see hints of whole new realm of physical phenomena and laws, of which we must at present admit an almost tot ignorance. And yet we have strong reasons to suspect that within this mysterious realm, things that w consider to be impossible could turn out to be commonplace."

Borel waited a few seconds to allow the professor's words time to take effect.

"I find this absolutely fascinating, and I'm sure the viewers do too," he finally said. "There a one or two questions about what you've said that I'd like to come back to in a moment. But before w do that, for the benefit of the more technically minded among those watching, I wonder if you wou describe in a little more detail the exact function of each of the pieces of equipment that you hav assembled behind us here."

"Okay. Cut." The director's voice called again. "That was good. We'll splice the rest of take 2 o from there to complete that sequence. That's all for today, everybody. I'd like all the people who ar involved in tomorrow's outside shooting to stay on for a schedule update. Everyone else is free t enjoy the J-C nightlife. Thanks. See you all at dinner."

The arc lights went out and Zimmermann spent a few minutes discussing technical details with th direction team. Then he left the room, traced his way through to the door that gave access to one of th interdome connecting tubes, and followed the tube through to Maindome, which stood adjacent. Fro there he descended by elevator to emerge four levels below ground in the corridor that led to his offi suite. His secretary was watering the plants in the outer office when he entered.

"Hi," she greeted with a freckled grin over her shoulder. "All through?"

"Hello, Marianne. Yes. I must confess I'm not terribly sorry either." He looked at what she wa doing. "My goodness, look at the size of those plants already. I'm sure that even your fingers can't b that green. It must be the gravity." Casting a casual eye over the notes and papers on her desk, h inquired, "Anything interesting?" She turned and creased her face into a frown of concentration.

"Mellows called and said that the replacement photomultiplier has been fitted in C dome – he sa you'd know what it was all about. Pierre's come down with a bug and is in sickbay; he won't be ab to make the meeting tomorrow."

"Oh, dear. Nothing serious, I hope."

"I don't think so. I think it was something he ate. Doc said he looked distinctly hydroponic."

"Uh huh."

"And there was this long message that came in, addressed to you by name... from a Dr. Clifford some place in New Mexico."

"Clifford...? Clifford...?" Zimmermann shook his head slowly. "Who is he?"

"Oh." Marianne looked surprised. "I assumed you knew him. I took a hard copy of it... here." Sh lifted a thick wad of pages out of a tray and passed them across. "Came in about an hour or more ago

Zimmermann ruffled curiously through the sheets of mathematical equations and formulae, the turned back to the top sheet to study the heading.

"Dr. Bradley Clifford," he read aloud. "No. I'm sure I have never heard of him. I'll take it thoug and have a look at it later. In the meantime, would you get Sam Carson at Tycho on the screen for m please. I'd like to check the schedule for incoming flights from Earth."

"Will do," she replied as the professor disappeared through the door into the inner office.