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Gary Westfahl

## “The Closely Reasoned Technological Story”: The Critical History of Hard Science Fiction

As a way to begin a discussion of hard SF, it is surely useful to examine when and how the term emerged.

Throughout the 1950s and 1960s, there were several tentative efforts to establish a label for such a category. In 1955, C.S. Lewis called Jules Verne’s *Twenty Thousand Leagues under the Sea*, H.G. Wells’s “The Land Iron-clads,” and Arthur C. Clarke’s *Prelude to Space* “Engineers’ Stories” (#24 63). Gregory Benford recalled a conversation with Poul Anderson in the early 1960s when they employed the phrase “Campbellian science fiction” (personal communication), while Harlan Ellison used the similar “Campbell-esque science fiction,” as well as “the Campbell heavy-science story” and “the Campbell dull-science novel,” to condemn Frank Herbert’s *The Dragon in the Sea* in 1968 (#14 122, 123, 125). In the blurb to Clarke’s “The Wind from the Sun” [then called “Sunjammer”],<sup>1</sup> Donald A. Wollheim and Terry Carr observed, “Just as the mystery field has a sub-genre called ‘police procedural fiction’...a type of story so integrally concerned with how the future will work...might be called ‘procedural science fiction’—and Arthur C. Clarke, with tales like PRELUDE TO SPACE and A FALL OF MOONDUST, has shown that he is the master of the form” (#34 9).

There may be other claimants for the honor, but P. Schuyler Miller—the regular book reviewer for *Astounding/Analog*—seems to have originated the term. In the late 1950s and early 1960s, Miller was visibly searching for a way to describe SF which emphasized science. One term used was “‘straight’ science fiction”: he called Richard McKenna’s “Mine Own Ways” and Anderson’s “Martyr” the “only two stories [in one collection] that could be called ‘straight’ science fiction” (#26 10/61 166). Another was “‘real’ science fiction,” used to describe Isaac Asimov’s *Lucky Starr and the Rings of Saturn* and Gordon R. Dickson’s *Secret under the Sea* (2/59 140; 1/62 156); and he called Clarke’s *The Deep Range* “what engineers call the ‘real’ science fiction, almost documentary in its technical perfection” (6/62 159). “Documentary” SF, as in that statement, was another experiment, also applied to Rex Gordon’s *First on Mars* (2/58 146), Jeff Sutton’s *Spacehive* (7/61 158), and Clarke’s *The Deep Range* and *Prelude to Space* (7/59 158; 4/62 167). Once he italicized “science” to establish a category: George O. Smith writes “the kind of oldish-fashioned *science* fiction yarn he can do so well,” and Hal Clement’s *Mission of Gravity* is “one of the classics of recent

science fiction" (2/59 142, 149) He later tried "quantitative science fiction": Anderson's *Tales of the Flying Mountains* "shows his ability to combine 'quantitative' science fiction with action and human problems" (1/72 169), and *Mission of Gravity* is "the peak of 'quantitative' science fiction" (4/72 168).

"Hard science fiction" appears to be an adaptation of another Miller experiment: "'hard science' story." In August, 1959, he said James Blish's *The Triumph of Time* "is almost an anachronism: a 'hard science' story in the vein of E. E. Smith's 'Skylark' yarns, of John W. Campbell's 'Mightiest Machine' series of nearly twenty years ago.... one reader I know considered the discussion of the scientific problem so much technical double-talk" (151). In September, 1961, he described Blish's *Titan's Daughter* as "a 'hard science' story" (167). He called Clarke's "A Slight Case of Sunstroke" "gorgeous corn and 'hard' science at the same time" (1/63 172) and Larry Niven's "Neutron Star" "a 'hard science' short story" (8/71 166).<sup>2</sup>

Miller's first use of the exact term "'hard' science fiction" came as early as November, 1957, when he said that John W. Campbell, Jr.'s *Islands of Space* "is also very characteristic of the best 'hard' science fiction of its day" (143). In February, 1960, he said that George O. Smith "has written some of the best 'hard' science fiction we have—such as his 'Venus Equilateral'" (166). Two years later, he called *A Fall of Moondust* "'hard' science fiction—the kind that many scientists and engineers are thinking of when they complain that the current brand is no good, or isn't even science fiction" (2/62 163). The term kept coming up in the 1960s and 1970s: he said that Clifford D. Simak's "Limiting Factor" "is a puzzle story...perhaps the closest to 'hard' science fiction in [the anthology under review]" (9/62 155). He asked, "Are you an engineer who longs wistfully for the 'hard' technical science fiction of a generation ago....the engineers I know turned handsprings over 'A Fall of Moondust'" (1/63 170). In December, 1963, he referred to "'hard' science fiction—the technical kind" (86); in May, 1964, he said Fred and Geoffrey Hoyle's *Fifth Planet* was "to a degree a 'hard'-type story which might even stir some interest in Hal Clement, chief sculptor of that form" (87); in the same issue he commented, "Maybe we're short of the 'hard' technical science fiction of the early years" (89). He cited Clement's *Close to Critical* as "a prime example of 'hard' science fiction" (1/65 87), called Clement "the master of 'hard' science fiction," said "The best science-fiction writers create such Secondary Worlds.... They may do it, as Hal Clement has done in his best stories, Robert Heinlein in most of his, and Arthur C. Clarke and Frank Herbert with notable success, by building their worlds as carefully as an architect-builder would do his work" (9/65 147, 148), and, reviewing *Natives of Space*, said "Clement is the master of the meticulously worked out novel of 'hard' science fiction, in which worlds and beings are constructed out of chemistry, physics, and ingenuity" (10/65 151). After discussing Susan Sontag on SF, he commented that she "has—happily—not encountered 'hard' SF, and maybe she never will" (6/66 143). Dean McLaughlin's "The Permanent Implosion" and Anderson's "Sunjammer"

were “a pair of ‘hard’ science-fiction yarns” that “will take you back to the ‘Good Old Days’ of George O. Smith’s ‘Venus Equilateral’ and Jack Williamson’s ‘Seetee’ stories” (12/67 160-161); “Neutron Star” was “‘hard’ science fiction” (2/72 173); and Barrington Bayley’s “Escape from City 5” “combines ‘hard SF’ with the experimental techniques” (6/72 167). Even if Miller did not originate the term, he clearly helped to popularize it.

The next critic who regularly employed the term was James Blish; indeed, Poul Anderson has attributed to him the claim that he coined the term.<sup>3</sup> In August 1962, he said, “[Dean] McLaughlin...is almost alone among the latest generation in being a writer of ‘hard’ science fiction. (In the preceding generation there are three—Budrys, Dickson, and Garrett—but of these, Budrys is a law unto himself, and Garrett has spent much of his career in what seems to me to be a deliberate campaign to throw away all his virtues except his industry)” (#4 109). Blish may be the first person to use the term without quotation marks, for he then said that “I can only pray that Dean will...get back to writing hard science fiction” (#4 112). A year later, he wrote:

Wells used [science-fantasy] originally to cover what we would today call “hard” science fiction, in which a conscientious attempt to be faithful to already known facts (as of the date of writing) was the substrate on which the story was to be built....

American science fiction [of the 1940s] was almost entirely “hard”; the best writers of that decade tried to be as respectful of the facts as Wells....

To hitch the word “science” to [fantasies] at best is claiming a cachet to which even the “hard” science-fiction writer has only the most dubious claims (because not one science-fiction story in several thousand involves anything closer to science than minor technological innovations). (#5 99, 103, 106-7)

In the 1960s and early 1970s, other commentators started using the term. Ellison’s 1966 “Introduction” to “The Jigsaw Man” in *Dangerous Visions* noted that Niven “writes what is called ‘hard’ science fiction—i.e., his scientific extrapolation is based solidly in what is known at the date of his writing” (#15 70). In October, 1967, Algis Budrys observed that “Clarke, educated and intelligent, is supposed to be one of the big guns in ‘hard’ science fiction.... he is in fact the author of a clutch of mystical novels and only one or two ‘hard’ ones” (#8 123). Wollheim and Carr’s 1969 blurb to “Kyrie” said, “Anderson is most generally regarded as the best practicing writer of ‘hard’ science fiction: stories built around careful extrapolation of scientific laws as we understand them today” (#35 33). In 1971, Asimov wrote,

For the last dozen years or so, what we might call “hard science fiction” has receded somewhat into the background. By hard science fiction, I mean those stories in which the details of science play an important role and in which the author is accurate about those details, too, and takes the trouble to explain them clearly.... I’m a hard science fiction man myself.... there are still hard science fiction writers among the younger generation. Ben Bova, for instance, writes hard science fiction, and so does Larry Niven. (#3 299)

In January 1971, Campbell called three Wells novels “the ‘hard’ science fiction of their day” and said “‘Dune’ was hard science-fiction worked out in meticulous detail.... Clement’s ‘Mission of Gravity’ and Asimov’s ‘Foundation’ and ‘Robot’ stories were hard science fiction” (#9 592-593).

In all cases, the writer does not claim to be originating the term; the term “hard” is with one exception in quotation marks, suggesting the writer sees the term as slang; and the writer usually defines the term while using it, indicating he does not expect readers to understand it without explanation. One could logically speculate that the term first came up in conversations between SF writers and fans and gradually entered written discourse. Also, the term probably stems from the expression “hard science,” although a related—and more prosaic—factor may simply be that stories of this type, filled with detailed scientific descriptions, were difficult to read, especially for readers who lacked a background in science.

Long after “hard science fiction” appeared, a variant term emerged: “hard-core science fiction.” In 1967, Judith Merrill said that “there does remain a discrete discipline—‘hard-core science fiction’—with specialized, and rather demanding parameters. It is no easier to define now than it was in the days of its glory, but it is readily recognizable—and dearly beloved—by those who, like myself, have identified most of their adult intellectual lives with it” (#25 135-136). On the cover of the original paperback edition of *Ringworld*, Niven is called “a hardcore science fiction writer.”

The term “hardcore” suggests an analogy not to the sciences but to pornography: that is, as sexual content is the primary attraction in pornography, science is the primary attraction in SF; and, as works with the most and most explicit sex are called “hardcore,” works with the most and most explicit science are called “hardcore science fiction.”<sup>4</sup> Unlike “hard science fiction,” “hardcore science fiction” thus has an argument embedded in it, one that could be either supportive—implying its emphasis on science makes it central to the genre—or critical—implying the form’s excessive interest in science is perverse or unsavory. Still, since the more neutral “hard science fiction” came first and “hardcore science fiction” was a later adaptation, the intent some later critics attribute to the subgenre—to seize control of the center or “core” of SF—was not the impulse behind the creation of the term; in fact, efforts to ascribe such an intent could be characterized as false etymology.

To summarize: hard SF is a term which emerged in the early 1960s preceded and accompanied by several equivalent terms. Works by some authors from earlier eras—such as Verne, Wells, Campbell, Heinlein, Asimov, George O. Smith, and Williamson—are occasionally included, but most references involve authors who emerged or became prominent in the 1950s and 1960s: Anderson, Blish, Budrys, Clarke, Clement, Dickson, Garrett, Gordon, Herbert, McLaughlin, Niven, Sutton, and, “to a degree,” Hoyle. Works first mentioned tend to involve cautious projections of near-future space adventures, though later references to Clement and “building ...worlds” signal an embrace of more imaginative stories. The form’s

characteristics include long scientific explanations and a creative process of scientific extrapolation.

In the late 1960s and 1970s, the meaning of hard SF expanded to include writers previously not associated with it. In 1968, Ellison said that in *Dragon-flight*, Anne McCaffrey took “as her tools the form and content of the most masculine specie of speculative fiction: the hard science adventure novel” (#14 138). In 1969, Budrys called Kate Wilhelm’s “The Mile-Long Spaceship” “a piece of hard science fiction” (#8 203). In 1974, Thomas M. Scortia said:

The closely reasoned technological story has come to be known as a “hard-core science fiction story.” Robert A. Heinlein and Dr. Isaac Asimov have long been the leading adepts of this difficult subspecies [the “hard-core science fiction story”]... Larry Niven in *Ringworld* and Frank Herbert in *Dragon in the Sea* and the monumental *Dune* have shown themselves masters of the difficult art of constructing a story line that adheres to an internally consistent technical or social structure. (#7 1974 139)

In 1976, discussing hard SF, Clement called Heinlein’s *Beyond This Horizon* “one of the best examples” (#6 1975 43-44). In the same book, Norman Spinrad said “Larry Niven, Hal Clement, Murray Leinster, John W. Campbell, Jr., among others, are generally considered hard science fiction writers ... certain works of writers like Poul Anderson, James Blish, Lester del Rey, Isaac Asimov, and Arthur C. Clarke are also considered hard science fiction” (#6 65).

When more formal works of criticism started to discuss the subgenre, however, the concept expanded more radically; one specifically notes efforts to identify hard SF with virtually all SF which predated the New Wave movement of the 1960s or with works reminiscent of those eras. Thus, in 1979, Peter Nicholls’s *The Science Fiction Encyclopedia* offered this broad definition of “hardcore SF”: “first...the kind of SF which repeats the themes and usually the style of genre SF written during the so-called Golden Age of SF; second, it is SF that deals with the so-called ‘hard’ sciences” (#28 273). In 1982, Donald M. Hassler’s *Comic Tones in Science Fiction* first equated “the pulp literature genre” with “hard science fiction” (#21 8) in the manner of Nicholls, then unhesitatingly labelled Frederik Pohl a hard SF writer, while acknowledging his lack of scientific training, on the grounds that both Clement and Pohl “stay close in their writing to the hard analysis of conditions and givens as modern science sees them” (#21 103), a rather loose standard.<sup>5</sup> Finally, as a possible harbinger of a larger expansion of the term, the 1986 critical anthology *Hard Science Fiction* (#30) included essays about 18th-century geologist Thomas Burnet, William Morris, C. S. Lewis, and Stanislaw Lem—incorporations that seem questionable in the context of the history and traditional meaning of the term.

As the idea grew that “hard science fiction” included all writers whose knowledge and use of science exceeded the puerile (bringing previously excluded writers like del Rey, Leinster, McCaffrey, and Lewis into the fold), some proposed the existence of an opposite category of “soft science fic-



tion,” which Nicholls noted was a “not very precise term...generally applied either to SF which deals with the soft sciences, or to SF which does not deal with recognizable science at all, but emphasizes human feelings” (#28 556). Hard SF, a term that once described a small category of SF, now seemed to become one of two broad categories encompassing the entire genre.

To further investigate the subgenre’s characteristics, one might examine how some of its major authors have described hard SF and the process of writing it.

The first article about a piece of writing firmly identified as hard SF is Clement’s “Whirligig World” (1953). He begins by describing the central preoccupation of the form:

The fun, and the material for this article, lies in treating the whole thing as a game. I’ve been playing the game since I was a child, so the rules must be quite simple. They are: for the reader of a science-fiction story, they consist of finding as many as possible of the author’s statements or implications which conflict with the fact as science currently understands them. For the author, the rule is to make as few such slips as he possibly can. (#13 102)

Years later, Robert F. Forward starts an essay on writing hard SF making essentially the same point: “When writing hardcore science fiction, the purpose is to have the science as accurate as possible and matched to the story.... There are lots of ways to make errors in science fiction stories. The goal is not to make any errors” (#30 1).

This principle, then, comes first: hard SF is committed to *avoiding scientific errors in stories*. There are four ways to achieve this: two are noted in “Whirligig World” but are sanctioned only as minor elements in the kind of SF writing he espouses. A third—implicit in some stories by Clement and others later identified as hard SF writers—and a fourth—the subject of Clement’s article—lead to the two forms commonly identified as hard SF.

The first way to avoid scientific errors is simply to employ jargon, impressive-sounding doubletalk that acknowledges the seeming implausibility of some device without trying to explain it—what Clement later called the “gobbledygook subclass” of SF (#6 51). In Clement’s case, facing the problem of Mesklin’s enormous gravity, he says, “Any science fiction author can get around that, of course. Simply invent a gravity screen. No one will mind little details like violation of the law of conservation of energy, or the difference of potential across the screen which will prevent the exchange of anything more concrete than visual signals.... No one but Astounding [sic] readers, that is; and there is my own conscience” (#13 106-107). Clement concedes the method has “obvious advantages”—“the scope of [a writer’s] story is not constrained by mere facts; and a vocabulary can serve in place of scientific knowledge” (#6 42).

Clement offers three reasons for avoiding this approach, each involving different SF readers. In “Whirligig World,” the problems is that terminology alone will not satisfy knowledgeable readers, who want more scientific substance in what they read. Twenty years later, Clement is more concerned about people who do not regularly read SF: gobbledygook “furnishes am-

munition to intellectual snobs who can't admit that science fiction is a legitimate branch of the storyteller's art." The major reason seems to involve only one reader—the writer—as indicated by Clement's reference to his "conscience": the author of hard SF regards the use of obfuscatory jargon as a type of cheating, not doing the work of SF; it does not provide what he later called the necessary "discipline" of the hard SF game (#6 42, 45).

The second way to avoid scientific errors is to speculate in areas where there is little scientific data. Writing *Mission of Gravity* in 1953, Clement said, "I don't have to describe the life processes [of Mesklinites] in rigorous detail. Anyone who wants me to will have to wait until someone can do the same with our own life form" (#13 113).<sup>6</sup> Still, while Clement would venture into vague or questionable science as a small part of his writing, he did not wish to focus a story in such areas: "There may be an afterlife. Telepathy and other psionic manifestations may be real and may some day come under orderly human control. There may be flaws in the laws of thermodynamics, even the first one. It is fun to read stories about such possibilities, but I seem to lack what it takes to write them" (#12 374). Writing about matters where one cannot make scientific errors, like inventing terms to cover scientific uncertainties, presumably does not involve much of a challenge.

The third way to avoid scientific errors is to play it safe: set the story in the near future and feature scientific advances that are either already planned or plausible in light of current scientific and technological knowledge. Such stories, which usually occur in outer space, have always been accepted as hard SF: one of the first works ever associated with the term was *A Fall of Moondust*, and all writers later identified with hard SF have sometimes written in this vein: Clement, "Fireproof"; Clarke, *Islands in the Sky*; Anderson, "Sunjammer"; and Niven, "The Coldest Place." One could call this *microcosmic hard SF*—involving small steps into the future to predict small advances; in his own classification of two types of hard SF, writer David Brin calls it "engineering SF" (#30 9). Such works are rarely offered as noteworthy examples of hard SF, and few would argue for the superiority of those works over *Mission of Gravity*, *Rendezvous with Rama*, *Tau Zero*, or *Ringworld*. Still, since persons known as hard SF writers produce these works, and since these works have been called hard SF, they must be considered part of the subgenre.

The fourth way to avoid scientific errors is to deliberately create the most spectacular and implausible environment or development possible while adhering to all known scientific facts. I call this "world-building" *macrocosmic hard SF*—involving large leaps into the future to envision large advances and new worlds: Brin's term for it is "scientific SF" (#30 9). This seems the most interesting form and can produce impressive results, like Mesklin and *Ringworld*. In terms of Clement's game, though, it is a high-risk strategy; in Niven's case, knowledgeable readers noted that a structure like *Ringworld* could not maintain its position, which required Niven to awkwardly add stabilizing rockets in a sequel, *Ringworld Engineers*. "Whirligig World" is the first description of the process: writers accumulate and absorb all available



scientific information—in this case, information regarding the unseen companion to 61 Cygni—and based on that data carefully develop a detailed picture of the imagined environment, using equations when possible or informed guesswork. Clement says “Whirligig World” is not a “text” on how to create such worlds, “since if the subject is teachable I’d be creating competition and if it isn’t I’d be wasting time” (#13 102), but texts later appeared: Anderson’s “The Creation of Imaginary Worlds: The World Builder’s Handbook and Pocket Companion” and Clement’s “The Creation of Imaginary Beings” (both in #7).

“Whirligig World” is also striking not because of what it discusses—the careful creation of a strange but scientifically possible world—but what it does not discuss—how and why Clement developed a story to take place on that world. Clement fails to explain why Mesklinites were presented as businesslike traders or why the novel had humans recruiting them to retrieve a fallen space probe. In Bretnor’s *Science Fiction: Today and Tomorrow*, Clement explained how world-building and story-building were related:

there would seem to be two basic lines of procedure for the storyteller who needs nonhuman characters and other extraterrestrial life forms.... In the first case, the qualities of the various life forms have to a considerable extent already been determined...by the story events.... [In] the second line, which is my favored technique.... I get most of the fun out of working out the physical and chemical nature of a planet or solar system, and then dreaming up life forms which might reasonably evolve under such conditions. The story (obviously, as some critics have been known to remark) comes afterward. (#7 260-262)

In other words, the process of world-building is sometimes undertaken to support a particular story, and is sometimes undertaken for its own sake, with a story tacked on later.

Forward argues that the scientific background one develops effectively “writes the fiction.” As examples, he notes that the astronomical setting he necessarily provided for the dwarf star in *Dragon’s Egg* inspired interesting details about his aliens’ religious beliefs, and the strange characteristics of the magnetic field near its equator led to one plot development. Forward thus offers a third model for the relationship between background and story: world-building not only motivates the story, but actually creates the story (#30 1-7).

Both explanations, however, seem disingenuous. First, despite attempts to minimize the notion of a preconceived story, these writers did have vague conceptions of their stories before building their worlds. Why did Clement make Mesklin whirl rapidly to reduce its surface gravity to 3 Gs? Obviously—as implied by his statement that its originally calculated surface gravity was “over three hundred times what we’re used to”—Clement wanted a world which humans could land on and survive on. Why did he give Mesklin oceans of liquid methane? Obviously—as Clement said—he “want[ed] a native life form” (#13 106, 110). While the particulars of *Mission of Gravity’s* plot may well have developed at a later date, Clement from the very beginning was attempting to create a world where visiting humans could

contact native aliens. Forward is forthright about how the demands of his story influenced how he made his world: “I knew I wanted the action to take place on a neutron star, and I knew that I wanted humans in the story, at least as bystanders” (#30 4). Thus, while the process of world-building is constrained and shaped by scientific principles, it is also somewhat constrained by the demands of storytelling, whether the proposed story is vague or detailed— though one must grant Forward’s point that a scientifically created environment can direct and influence the story in significant ways.<sup>7</sup>

Understanding the two forms of hard SF offers an answer to a recurring puzzle: apparent inconsistencies in the use of the term. In Bretnor’s *The Craft of Science Fiction*, for example, after defining the subgenre as “science fiction written around known scientific facts,” Spinrad raises these questions:

Niven, for example, is generally considered a writer of “hard science fiction.” J. G. Ballard is not. Niven’s stories [have] two-headed aliens, telepathic powers, various flavors of time-travel, galactic cataclysms, hyper-drives, tractor beams, and so forth. Most of Ballard’s novels have been rather tight extrapolations of a world drastically altered by one reasonably plausible meteorological change, and even his later more stylistically dense works don’t ask the reader to swallow... scientific improbabilities whole. Hal Clement’s alien creatures are part of the hard science fiction canon, but Cordwainer Smith’s Underpeople are not. Aficionados of hard science fiction accept Poul Anderson’s medieval space cultures without a murmur but eschew the future worlds of Mack Reynolds which are worked out with a much more sophisticated and rigorous knowledge of economics and politics. (#6 54, 55)

The implication is that the term is being applied to certain writers in an arbitrary and illogical manner.

Part of the answer no doubt lies in what could be called the sociology of the field: that is, authors identify themselves as hard SF writers by announcing that fact and by associating with other hard SF writers; authors who do not do these things escape the appellation. Still, since Clement and Clarke were included in the subgenre without making efforts of this kind, there must be another explanation.

Noting that the focus of attention in early uses of the term involved what I call microcosmic hard SF, I offer a tentative explanation (without defending it): writing microcosmic hard SF defines a hard SF writer. More extravagant works are accepted as part of the form, but one shows membership in the tribe by writing realistic, near-future space adventures, or by including such projections as part of more extravagant stories of constructed worlds. That is, Clarke is accepted as a hard SF writer because he can write stories like *A Fall of Moondust*, not just stories like *Childhood’s End*; Clement because he can write stories like “Fireproof,” not just stories like *Mission of Gravity*; Anderson because he can write stories like “Sunjammer,” not just stories like *Tau Zero*; and so on. On the other hand, if writers do not write stories of this kind, or apparently cannot write them, they will not be accepted as hard SF writers. That would explain why Ballard, Cordwainer Smith, and Reynolds are rarely associated with the

form. This attitude—based on an incomplete knowledge of recent commentaries—seems to survive to the present: thus, recent writers like Benford, Forward, and James P. Hogan have each written examples of both forms of hard SF and hence are labelled as hard SF authors; but Ian Watson, who can be every bit as careful with his science as those writers, has not been so labelled, because he has not produced stories of microcosmic hard SF. The lesson for writers, then, is that if you wish to be called a hard SF writer, building worlds may not enough; you also must show that you can build spaceships.

What unites these two apparently disparate forms of hard SF is an obsessive concern with complete accuracy<sup>8</sup> and thorough development of all ideas—suggesting another point: contrary to recent patterns in usage, not all SF stories which significantly involve science have been accepted as hard SF. Consider Hoyle. As a prominent astronomer who regularly employs his knowledge in writing novels, Hoyle would seem an obvious example of hard SF; yet he is rarely so identified—Miller's one mention of his work as hard SF is conditional. An answer lies in the "Preface" to Hoyle and Geoffrey Hoyle's *Fifth Planet*, where they announce, "The very nature of the plot has forced us to set this story in the more distant future than we would otherwise have preferred. It is hardly possible to foresee the shape of society a century or more ahead of one's own time, and we have not attempted to do so" (#22 v). Despite attentiveness to the scientific accuracy of his central idea, then, Hoyle lacks the compulsion to comprehensively develop all aspects of his story. Thus, if a story does not work out its scientific concepts completely, or if it intermingles its scientific concepts with large doses of gobbledygook and fuzzy science, it may not qualify as hard SF.

Adding together what commentators like Miller and Ellison, and practitioners like Clement, Forward, and Brin, have to say about hard SF, the following picture emerges: hard SF is a subgenre obsessed with total scientific accuracy which characteristically takes two forms—near-future space adventures and extravagant world-building; to be accepted as a hard SF writer, it is necessary to write hard SF of the first type, and it is necessary to be thorough, not selective, in scientific development in stories; and, noting that writers with scientific concerns who do not fulfill those two criteria have usually not been accepted as hard SF writers, one finds more logic and consistency in the typical use of the term than critics have noticed.

Having shown that the term, and the concept, of hard SF emerged with writers of the 1950s and 1960s, the next question to explore is exactly when this kind of writing emerged. Does hard SF in fact have a long and distinguished history, or is it actually a relatively recent development?

A recurring theme in comments about hard SF, both laudatory and critical, is that it represents an old, traditional type of SF: Miller called Blish's "'hard science' story" *The Triumph of Time* "almost an anachronism" (8/59 151), said *A Fall of Moondust* "is the kind of book that proves that 'old-fashioned' science fiction isn't dead" (2/62 164), spoke of "the 'hard' technical science fiction of a generation ago" (1/63 170) and "of the early

years" (5/64 89), and said "The Permanent Implosion" and "Sunjammer" "will take you back to the 'Good Old Days'" of George O. Smith and Jack Williamson (12/67 160-161). Lambasting "The Campbell heavy-science story" as represented by Frank Herbert's *The Dragon in the Sea*, Ellison declared, "What began as a New Wave in the Forties with Campbell's rejection of the Crustacean Period in speculative fiction.... now represents something like a return to the T. O'Connor Sloane [sic] image of what a good science fiction story should be" (#14 125, 122-123). Miller and Ellison thus envision Clement, Clarke and Herbert as lonely survivors of an earlier form of SF; but is this characterization accurate?

To be sure, the ideas that drive hard SF can be traced to earlier commentators. Hugo Gernsback was the first to emphasize that SF must "contain correct scientific facts" (#17 773); and recognizing the importance of that principle, del Rey begins a discussion of Clement's career by saying, "When Hugo Gernsback started the first science-fiction magazine back in 1926, he didn't refer to hard science fiction; but he did claim that his stories were scientifically accurate" (#12 xi). Readers quickly accepted the idea, and one complained about stories with "such obvious scientific mistakes in them that they seem more like fairy tales" (cited in #19 675). Since readers enjoyed finding errors in stories, Gernsback made a contest of it: publishing Geoffrey Hewelcke's "Ten Million Miles Sunward," he announced, "Frankly, though, there is something wrong with the story" and challenged readers to "See if you can find out what that 'something' is" (#16 1127). This seems to anticipate "the game" Clement would later see at the heart of hard SF.

One can also find stories from this era that resemble microcosmic hard SF. Consider Gernsback's "The Magnetic Storm" (1917), a story set in the near future during World War I involving a logical application of then-current technology: a large-scale effort to generate magnetic fields to disable enemy equipment, endorsed as feasible by Nicolas Tesla. Liking such cautious visions, Gernsback once proposed them as a new category of SF in "Science Fiction vs. Science Faction":

In time to come, also, our authors will make a marked distinction between science fiction and science *faction*, if I may coin such a term.... In science fiction the author may fairly let his imagination run wild and, as long as he does not turn the story into an obvious fairy tale, he will still remain within the bounds of pure science fiction.... In sharp counter-distinction to science fiction, we also have science *faction*. By this term I mean science fiction in which there are so many scientific facts that the story, as far as the scientific part is concerned, is no longer fiction but becomes more or less a recounting of fact.

For instance, if one spoke of rocket-propelled fliers a few years ago, such machines obviously would have come under the heading of science fiction. Today such fliers properly come under the term science *faction*; because the rocket is a fact today. (#20 5)

While only a description of one of its forms, Gernsback's editorial could be read as the first manifesto on behalf of hard SF, in that Gernsback isolates, defines, and defends a type of SF where scientific accuracy is central.

As for macrocosmic hard SF, the idea behind this type of writing—at

least the process of writing it—can be traced to Campbell, who said that “Science-Fiction, being largely an attempt to forecast the future, on the basis of the present, represents a type of extrapolation” (#11 5), and “Mapping out a civilization of the future is an essential background to a convincing story of the future” (#10 6). By publishing Heinlein’s “Future History” chart in 1941, displaying a carefully worked-out background for many Heinlein stories, he offered an example of the system and its benefits. Another Campbell author, Isaac Asimov, with his Foundation and Robot stories, also illustrated a process of careful extrapolation and development of future societies.

However, there are problems involved in seeing Gernsback, Campbell, and their writers as the prototypes of hard SF. First, despite his announced theories, Gernsback in practice was willing to publish stories with dubious or fuzzy science and sometimes admitted as much. Introducing Verne’s “Off on a Comet” in the first issue of *Amazing Stories*, he frankly discusses several scientific lapses which “all belong to the realm of fairyland” (#18 4-5). Defending errors in Leinster’s “The Runaway Skyscraper,” he claimed, “a writer of scientifiction is privileged to use poetic license, the same as is the writer of any other story.... sometimes disregarding the scientific facts, although still retaining enough scientific accuracy to make the plot or story seem probably and at the same time interesting” (#19 675). Campbell could also be inattentive to scientific errors: he published A. E. van Vogt’s “Concealment” without bothering to correct its obvious blunder—a “meteorite station” in space.<sup>9</sup> The example of van Vogt also shows he was not especially demanding about careful extrapolative thinking: as Damon Knight argues, the Earth of *The World of Null-A* “would be a plausible, if sketchy, background for a story laid from 50 to 100 years in the future. For a story which takes place 600 years from now, it is as bad as no background at all ...van Vogt has not bothered to integrate the gadgets into the technological background of his story” (#23 55-56).

Also, in keeping with this tacit atmosphere of scientific laxity, few works of the 1930s and 1940s completely fulfill the criteria of hard SF. Gernsback liked plausible stories of “science faction,” but readers did not: they clamored for “interplanetary stories,” and with the knowledge then available, such adventures could not be written as “science faction.” Some writers tried: presenting its space station, J. M. Walsh’s “Vandals from the Void” (1930) cited Hermann von Noordung’s *The Problems of Space Flying*: “The plans...were actually based on designs drawn up so long ago as the year 1929 by Captain Hermann Noordung, a German engineer and authority on mechanics, who was perhaps the first of all Earth-men to deal with the problem of space navigation seriously” (#32 482). However, the station’s design is really not presented in much detail—necessarily, since it was envisioned as larger and more elaborate than von Noordung’s station—and there is little scientific substance in the rest of the novel, a routine space opera.

The author before World War II who came the closest to writing micro-cosmic hard SF was undoubtedly George O. Smith, so that there is justice



in the fact that he was one of the first authors to be given the label. That is, in his early Venus Equilateral stories, Smith attempted to address and intelligently resolve some of the problems involved in space communication (though he sometimes overcomplicated matters—one story concerns the incredible difficulty of sending a radio message to a spaceship). His space station was thought out and presented with unusual care and thoroughness; in depicting the odd camaraderie that developed among its residents, Smith was also attempting to develop his station into a detailed, convincing environment. The problem was that there were only so many stories in this vein Smith could write, so he was driven to the realm of pseudoscience by later having his scientists design and perfect a method of matter transmission, with various fanciful results.

Another point about Smith: his works were usually seen as “scientific problem stories,” an accepted subgenre of SF also practiced by Ross Rocklynne, Asimov, and Williamson; and some Miller comments suggest that he saw these stories as hard SF: he called Simak’s “Limiting Factor” both “a puzzle story” and “‘hard’ science fiction.” Also, without using the term, Sam Moskowitz’s *Seekers of Tomorrow* argues that hard SF is an outgrowth of this form, calling *Mission of Gravity* “the epic of the scientific problem story in science fiction,” and citing Rocklynne as the first “popularizer” of the subgenre (#27 415-6). Still, except for Smith, these authors may not be true practitioners of hard SF. Sometimes they make scientific errors, Rocklynne’s “At the Center of Gravity” being a major example—as readers noted, a large hollow sphere would attract objects to its surface, not its center as Rocklynne indicated. Also, writers may be so focussed on their problem that they do not explore other aspects of their imagined worlds. Asimov’s comments on “The Talking Stone” are revelatory:

After the story first appeared, I received quite a bit of mail expressing interest in the silicony [a silicon creature living in the asteroid belt] and, in some cases, finding fault with me for allowing it to die in so cold-blooded a fashion.... I must admit.... I showed a lack of sensitivity to the silicony’s rather pathetic death because I was concentrating on his mysterious last words. (#2 53-54)

Focussing on presenting and resolving their mysteries, writers of scientific problem stories (like Asimov in this particular case) may not fully explore details generated by their stories—and Forward would later define an exploratory attitude as one attribute of the hard SF writer.

Only after World War II, when the United States actually developed a space program, and concrete proposals for spaceships, space stations, and space missions were widely promulgated, could space become a fit subject for “science fiction.” In fact, this type of story—set in the near future, with apparently realistic and predictable space technology employed to explore and inhabit nearby worlds—became widespread in the 1950s: it was the major form of juvenile SF, and many stories of this type were produced for the adult market. When the exciting environment of space entered the realm of foreseeable, practical science, then, microcosmic hard SF truly emerged.

Before 1950, there were also few if any examples of macrocosmic hard



SF—spectacular world-building following scientific principles. While Miller did call Campbell's *Islands of Space* "characteristic of the best 'hard' science fiction of its day," the qualifying phrase "of its day" cannot be ignored: despite his detailed scientific explanations, Campbell was not engaged in building a thorough and logical future world—and admitted as much in a 1953 letter to Hal Clement: "Precise, jig-saw-puzzle interlocking of details wasn't a forte of mine; the highly pleasing results you've produced by doing so has taught me that it's a satisfying thing to do, instead of being merely a damn nuisance" (#9 151).

Asimov and Heinlein may be better candidates for examples of early world-builders, but they were not all that attentive in developing the backgrounds of the Foundation and Future History series. Asimov admitted in *Asimov on Science Fiction* that he more or less made up the Foundation universe as he went along (#1 281-5), and later novels like *Robots and Empire* devote much energy to explaining and rationalizing aspects of that series that should have been resolved long ago. Heinlein was a bit more careful; and, as Smith represents the closest early approach to microcosmic hard SF, Heinlein represents the closest early approach to macrocosmic hard SF. Still, he also had conspicuous lapses; for years, he included "We Also Walk Dogs—" in his Future History although it contradicted details in other stories, and after introducing an orbital power plant in "Blowups Happen," he failed to mention it in later stories, and only in his last novel, *To Sail beyond the Sunset*, did he explain its conspicuous absence. The environments offered by Asimov and Heinlein may also be perfunctory: their future cities in *The Caves of Steel* and *Beyond This Horizon* are impressive, but their alien worlds are nothing like Mesklin or Ringworld. Thus, neither writer fully anticipates the process and possibilities of hard SF that Clement and Niven later demonstrated.

To explain the rise of macrocosmic hard SF in the 1950s, one might note that at this time of new developments in space technology there were also less dramatic but equally impressive gains in astronomical knowledge about other planets. *Mission of Gravity* is noteworthy not only as an impressive piece of planet-building, but as the first SF novel built on actual observational data involving another possible solar system; and improved knowledge about nearby planets naturally led to novels like Clarke's *Sands of Mars*, arguably the first Mars story built on an accurate scientific view of Martian conditions.

It seems best, then, to see hard SF as a development of the 1950s and 1960s, when writers emerged who were determined to practice what Gernsback and Campbell had preached, who elevated scientific accuracy and extrapolative thinking to central positions in the writing process that they had previously enjoyed only in theory; and this suggests a possible shift in the ways the modern history of SF is characterized.

The conventional picture is that the literature of the 1930s and 1940s was dominated by science and technology; then, in the 1950s and 1960s, writers

began to shift away from science to other priorities, a trend that led to the New Wave movement.<sup>10</sup> Then, as a violent reaction to the excesses of the New Wave, a counter-revolution in favor of older, more scientific SF was launched in the name of “hard science fiction.”

Here is my hypothesis: despite public pronouncements SF was in fact largely indifferent to science before 1950 and tolerated lapses in scientific fact and thinking. After 1950, writers emerged who made announced scientific priorities into rules of SF and developed two forms of SF following those rules. This led to an increase in science-based stories in the 1950s and 1960s, largely not noted by critics because it involved marginal texts and authors, like juvenile SF and lesser *Astounding* writers.

By the early 1960s, it might have seemed to some, this form of writing was dominating the genre: several writers practicing and preaching a scientific style had appeared and were increasing in prominence; the minor magazines that had been open to a wider variety of SF largely vanished; *Astounding* became *Analog* and placed more emphasis on science and technology; *Galaxy* and *If* were now edited by Pohl, who was more concerned about science than H.L. Gold; even *The Magazine of Fantasy and Science Fiction* seemed to be shifting to a greater emphasis on science under Robert P. Mills, with science articles by Asimov, among other things. In the context of this apparent shift to more science in SF, the New Wave—at least its American version—may have in part been a counter-revolution, an effort to again shift the genre back to an attitude of scientific laxity.

Of course, one would have to thoroughly survey the comments of various New Wave writers to confirm this hypothesis, but one atom of evidence is in Ellison’s assault on Herbert. Amidst criticism of the novel’s characterization and style, Ellison lambastes its emphasis on scientific discussions:

the sole reason for the existence of this novel is the gleeful and meticulous explication of the minutiae of hardware aboard the *Fenian Ram*. This is a gear-and-grommet story. It is an engineer’s daydream....

It is not a novel, nor a study of people, nor an attempt to point a moral, or tell a story, or entertain a reader; it is shop talk....

*Analog* has not even been in the running [for the Best Magazine Hugo Award] for half a dozen years. This, for the magazine which allegedly sells the most copies in America, seems highly unusual, until one considers that those copies are being sold to the other members of the bull session—other engineers and scientists. (#14 121, 124)

Ellison finds the conversation of SF he once enjoyed increasingly dominated by “engineers and scientists” and “shop talk” which he is not interested in and cannot participate in; and his call for “a new definition...of the form” is an effort to shift the conversation back to a style and subjects he is more comfortable with (#14 123).<sup>11</sup>

Though hard SF, then, was already established when the New Wave emerged, that movement did engender a new spirit of advocacy in its writers and fans; and the New Wave no doubt contributed to the trend in the 1970s to employ the term hard SF to describe all SF which was not part of the

New Wave. Thus, while the term for hard SF appeared in the 1960s, the 1970s certainly brought it to the forefront. My point is that writers like Jerry Pournelle, James P. Hogan, Charles Sheffield, and Forward do not represent a new outburst of interest in science, but rather a continuation of a commitment to hard SF that began much earlier.

I have argued in "On *The True History of Science Fiction*" that a study of the critical commentaries surrounding modern SF constitutes the best starting point for studies of the genre; I argue here that the same is true of hard SF. The term cannot be allowed to mean whatever a given critic wants it to mean; and to challenge, for example, Michael Collings's characterization of C.S. Lewis as a hard SF writer (#30 131-140), one may not be convincing in saying, "In my opinion, he is not a hard science fiction writer," since Collings can reply, "In my opinion, he is." Knowing the critical history of hard SF, however, one can say, "Lewis is not a hard science fiction writer because: in the first twenty years when the term was regularly employed, he was never called a hard science fiction writer, even by commentators like Miller who were well aware of his work; Lewis's novels do not fulfill all traits usually announced as characteristic of the form, such as extreme attentiveness to scientific fact and extrapolation; and in his own remarks on hard science fiction ('Engineers' stories') Lewis expressed disdain for the form, thus distancing himself from it." That, I submit, is a more powerful rebuttal.

## NOTES

1. In 1964, both Anderson and Clarke published stories called "Sunjammer" (Anderson's story is mentioned below), so Clarke renamed his story "The Wind from the Sun" in later publications.

2. Another related term—used once without explanation—came when he termed Philip K. Dick's *Time Out of Joint* "good, hard-shell science fiction" (1/60 174).

3. Anderson's comment: "The term itself, 'hard' science fiction, originated with the late James Blish, who, afterward, remarked that his original intention had been greatly misinterpreted" (Interview with Jeffrey M. Elliot, *Science Fiction Voices* #2 42). Because Blish did not specify original places of publication for all the reviews he later incorporated into *The Issue at Hand* and *More Issues at Hand*, and because those pieces were often, as he acknowledged, extensively rewritten for book publication, it is difficult to establish exactly when Blish first used the term without sorting through all of the old fanzines where Blish first published. Concerning the quotations I cite, Blish states that the comments on McLaughlin originally appeared in August 1962, and that the second discussion was a combination of pieces from 1960 and 1963; the passages about hard science fiction in the second piece certainly involve the later date, however, since they begin with a reference to an August 1962 issue of *The Magazine of Fantasy and Science Fiction* and immediately proceed to an attack on Brian W. Aldiss's "Hothouse" stories, published in 1961. Even if Blish's use of the term does date to 1960, Miller used it much earlier. Of course, exact dates for the first *published* use of the term are not conclusive in themselves: it remains possible that Blish started using the word when speaking at the science fiction conventions both he and Miller attended, and that Miller picked up the term from him. It is also possible that each man developed the term independently.

4. In March 1971, Algis Budrys noted the phrase on the cover of *Ringworld* and made the connection explicit: "Inasmuch as Ballantine originally popularized the term 'hard-core pornography,' we don't even have to ask what the term 'hard-core science fiction' may be intended to mean" (#8 296).

6. Another passage from Hassler's book links Theodore Sturgeon with hard SF: "Clement and Pohl have survived (along with Asimov, Sturgeon, and some others) and are still creating this effect forty years after Campbell took over *Astounding* when 'softer' writers have moved on to other things" (#21 103-04).

6. The traditional focus of hard SF on engineering and hard sciences thus reflects only the fact that when the form emerged, not enough was known about biology to construct alien life in any detail. When this was longer the case, Clement could write an article on "The Creation of Imaginary Beings"; and recent stories like Michael E. Flynn's "The Washer at the Ford" (*Analog*, June and July 1989) follow the hard SF pattern but emphasizing biological, not mechanical, engineering.

7. Reading about two forms of hard SF, some may feel I am really defining two extremes of the hard SF continuum—*Prelude to Space* at the near end and *Ringworld* at the far end. The concept is good in theory but not realized in practice, since almost all works associated with hard SF fall unambiguously into one of the categories. Consider Clarke's novels. Works of microcosmic hard SF are *Prelude to Space*, *Islands in the Sky*, *Sands of Mars*, *Earthlight*, *A Fall of Moondust*, *Dolphin Island*, *Imperial Earth*, *The Fountains of Paradise*, and *The Ghost from the Grand Banks*. Works of macrocosmic hard SF are *Against the Fall of Night*, *Childhood's End*, *The City and the Stars*, *Rendezvous with Rama*, and *The Songs of Distant Earth*. The 2001 novels juxtapose—without blending—the two types, devoting most of their energy to a near-future space adventure with a stunning cosmic vision at the end—as seen in the codas to *The Fountains of Paradise* and *The Ghost from the Grand Banks*. Other hard SF writers begin in the near-future then lurch forward to more extravagant environments: Forward's *The Flight of the Dragonfly* begins by describing the building of a laser-powered starship, then uses that ship to reach and explore an alien planet; Charles Sheffield's *Between the Strokes of Night* begins with experiments in a near-future space station and moves onward to an expansive adventure of galactic space exploration and revelation.

8. Although authors realize that complete accuracy may be impossible; Benford has said "There are no cheat-free stories, including my own" (#30 50).

9. A meteorite is a large rock that lands on Earth, a meteor is a rock that burns up while falling towards Earth, a meteoroid is a rock in space, and an asteroid is a large rock in space; thus, what van Vogt described should be called a "meteoroid station" or "asteroid station." Other critics note the error.

10. It is interesting to note that Miller may also be the first person who used that term: in 1961, discussing recent British writers, he spoke of "the 'new wave'—Tubb, Aldiss, and to get to my point, Kenneth Bulmer and John Brunner" (11/61 167).

11. More evidence for this hypothesis would be Anderson's essay for *Nebula Award Stories Seven* (ed. Lloyd Biggle, Jr. [NY: Harper & Row, 1973], 263-273). Using an idiosyncratic classification system of "hard science," "imaginary science," "quasiscience," and "counter-science," he surveyed and classified novels and stories that either were nominated for or won Nebula Awards, concluding that "hard science and technophilia are flourishing—maybe more than ever!" A survey of winners of Hugo Awards and International Fantasy Awards produced a similar result: "Evidently readers continue to go for 'traditional' SF" (272, 273). A further survey of run-of-the-mill stories from the 1960s might also show a preponderance of highly scientific works.

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**Abstract.**—Several commentators in the 1950s visibly searched for a way to describe SF that was especially attentive to science. P. Schuyler Miller, book reviewer for *Astounding/Analog*, first used the term "hard science fiction" in November 1957 and used it more frequently in the 1960s. By the mid-1960s, other commentators were also using the term. Early references involved a relatively small number of writers who emphasized scientific accuracy and explanation, but in the 1970s and 1980s, the term expanded to include numerous writers not originally associated with hard SF. Hal Clement's "Whirligig World" states that the primary goal of hard science fiction is avoiding scientific errors and suggests four strategies for doing so. Two of these—using "gobbledygook" and speculating in areas where scientific knowledge is limited—are rejected; the other two lead to forms of hard SF: microcosmic hard SF, cautious predictions of near-future technology like Arthur C. Clarke's *A Fall of Moondust*, and macrocosmic hard sf, extravagant visions of alien environments like Larry Niven's *Ringworld*. When the characteristics of hard SF are understood, it is clear that while the principles behind hard SF were first articulated by Hugo Gernsback and John W. Campbell Jr, few if any writers before 1950 meet the standards of hard SF. Instead, hard SF should be seen as a development of the 1950s and 1960s, suggesting that versions of science-fiction history treating the 1930s and 1940s as eras of science-dominated SF may need to be rethought. Overall, examining the critical history of hard SF is valuable because it provides solid grounds for firmly and usefully establishing the parameters of hard SF. (GW)