

# SCIENCE FICTION QUARTERLY

ALL  
NEW  
STORIES

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*Cover by Emsb, from "Children Of Fortune"*

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# SCIENCE

## in Science Fiction

### *A Series of Special Articles*

## The Tie That Binds

by Richard H. Macklin, Ph.D.

I ALWAYS LIKE a good fight, and this series of articles certainly seems to have started one. Letters have come in both pro and con. The "pros"—like Victor Endersby, whose letter appeared in the November issue—are of the general opinion that science-fiction writers should have some kind of examination to make sure they know their science; the "cons" all want to know: "What the devil are you trying to do? Ruin our faith in science fiction?"

In order to clarify my position, I'll explain how this series came about.

Some time back, I wrote a letter to Mr. Lowndes, explaining what I thought was good and what I thought was bad in the field of science fiction, and *why* I thought so. Your editor rejected the letter, saying, in essence: "This isn't complete enough. Do a series of articles, and quote chapter and verse."

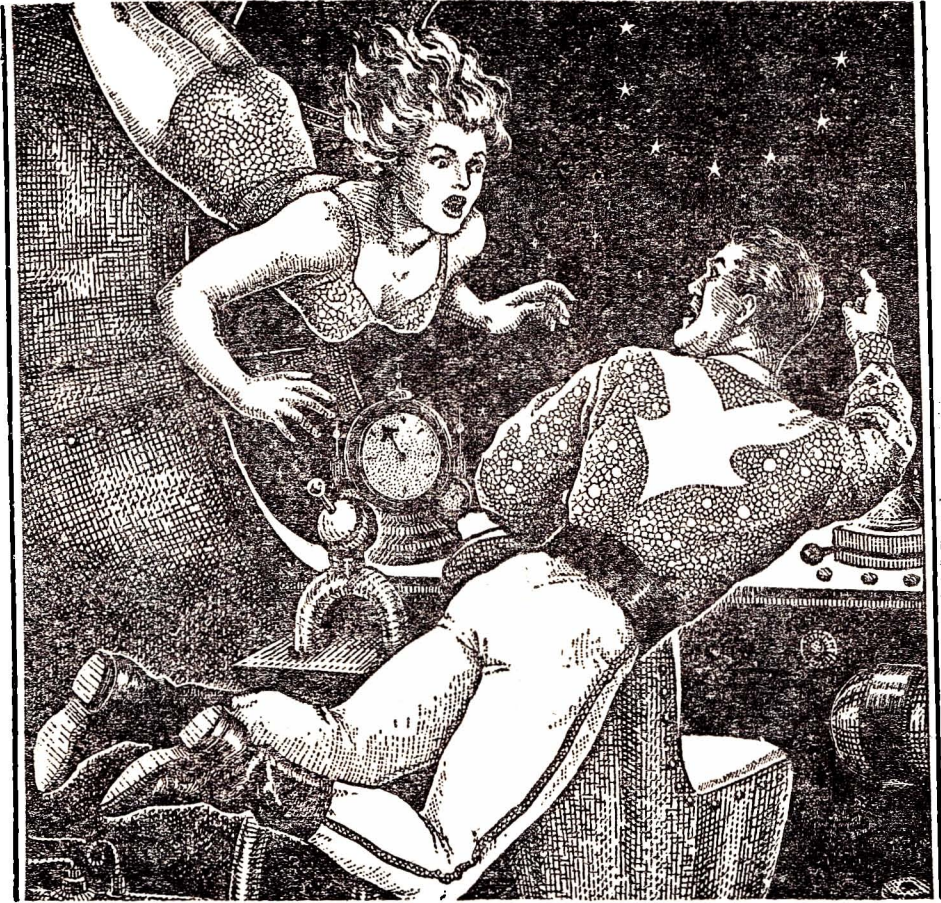
I was a little nervous about the idea at first; scientists are not primarily authors. But I tackled the job any-

way, because I did have something to say, which is this:

*Science fiction has done an excellent job in the past, in that it has interested a good many people in science. But it has erred in that it has attempted to teach people science.*

Self-contradictory? Not at all. As long as people who read speculative fiction realize that it *is* speculation, they won't be misled by an author's honest errors. But when it is claimed that science fiction *teaches science*, the author becomes an authority, and the reader begins to swallow pseudo-science along with the rest.

So—am I trying to ruin your faith in science fiction? Well, if your faith is such that you think your favorite magazine will teach you as much as a good textbook, the answer is a resounding *Yes!* I am trying to ruin it. On the other hand, if you believe that science fiction is a method of speculative prophecy in some cases and sheer entertainment in others, then my answer is an equally resounding *No!*



They float through the air with the greatest of ease — but how solid is the scientific basis for it?

That's my position, and I'm attempting to prove it.

**E**VER SINCE Man developed his forebrain, he has realized that if he dropped something, it fell. Man thought about this phenomenon for a long time, but not until the advent of Sir Isaac Newton in the seventeenth century did anyone find a method of predicting how fast and how far it would fall.

Newton's Law of Gravitation is—or should be—familiar to all:

Between any two bodies in the universe, there is an attractive force which is directly proportional to the product of their masses, and inversely proportional to the square of the distance between the two.

Albert Einstein, in the early part of this century, formulated field equations which, although more complicated, give almost the same answer under ordinary conditions.

Of course, one thing must be pointed out: Neither these men, nor anyone else, has attempted to say what gravity *is*; they have merely formulated what it *does*.

But, alas, all too many authors of science fiction have shown themselves to be totally unfamiliar with the laws of gravity and inertia, and their relationship to mass and energy.

Jules Verne, rightly called the Father of Science Fiction, made some horrible errors in that direction. In his *Journey To The Center Of The*

*Earth*, (Ace Books, 1956) he puts his heroes in a cavern so far underground that gravitational effects on the rock above them would produce enough pressure to make rock actually flow; no such cavern could exist. The same thing holds true for the Pellucidar of Edgar Rice Burroughs: a hollow in the center of the Earth would long ago have collapsed in upon itself.

Verne pulled another gravitational blooper in his "Off On A Comet, or Hector Servadac", in which a comet brushes Earth, scoops off a small chunk of north Africa, and heads back into space—and the hero, who is on the lifted section of real estate, doesn't even know it! When it was reprinted in the April 1926 (Vol. 1, No. 1) issue of *Amazing Stories*, Hugo Gernsback had to apologize for the error, admitting that

If . . . the comet had even a hundredth part of the size and solidity and weight which Verne confers upon his monster so as to give his travelers a home—in that case the collision would be unspeakably disastrous—especially to the unlucky individuals who occupied the exact point of contact.

But T. O'Connor Sloane, who succeeded Gernsback, made no such apologies for "The Laughing Death" (*Amazing Stories*, April 1931), and its sequel, "Worlds Adrift" (*Amazing Stories*, May 1932) by Stephen G. Hale. In fact, he said that the latter was "scientifically plausible and very convincingly told".

The idea was this: an atomic-driven machine designed for drilling holes in the Earth goes wild and starts chewing around and around the Earth and finally cuts it in half and the two halves drift apart..

*Drift apart!* By all that's holy, I do not see how anyone could imagine that two masses a few hundred feet apart and having a total mass of six thousand million million million metric tons could drift apart! Even supposing that they could be cut apart in the first

place, they would fall toward each other immediately with a roar heard round the world.

It seems to be the magnitude of the thing that blinds everyone. Since it's difficult to visualize the Earth being sliced in two, one tends to reduce it to imaginable proportions and think of an apple being cut in two. But suppose that Mount Everest were sliced off at its base with some sort of disintegrator ray. Do you think it would go drifting off into the sky, never to be seen again? Do you?

George O. Smith, in his "Two Worlds For One" (*Future Combined With Science Fiction Stories*, July-August 1950), tried the same stunt. He has the mad genius scientist cut the moon in half, but at least he used a "gravity screen" between the halves, which kept them apart. We'll go into gravity screens another time.

**A**ND THEN there are the orbit jugglers. As a prize of this type, I submit for your consideration "Warriors of Space" by James P. Marshall (*Science Wonder Stories*, June 1929).

Having been invaded by Evil Beings from Saturn's satellite Dione, the Intrepid Earthmen decide that the war must be carried to the Awful Things' home. By anchoring a tractor beam—which is what it amounts to—the sun, and another to Saturn, they are going to pull Saturn into Sol. A government bigshot objects that there isn't enough power to do the job. The hero replies:

"You have seen scales delicately balance, with perhaps a huge weight on either side. It takes but a fraction of an ounce to disturb that balance. The universe is like that, each member nicely balance by opposing forces. We have but to strengthen one of those forces on one member and the balance of that member will be destroyed, making it move as the stronger force directs."

(The peculiar use of the word "balance" is the author's doing, not mine.)

They don't even think of just tossing Dione into the sun; evidently that's too simple for Great Minds. Of course, there's the matter of getting there, and, if I may digress a moment from the subject of gravity, I'd like to quote again:

"You have eight hundred million miles between you and your objective, a distance so great that with light traveling at one hundred and eighty-six thousand miles per second it takes over seventy hours for a beam to travel from that planet to us."

And, later on:

"Remember...we cannot see movement of that planet until nearly three whole days after it has actually moved. It will take that long for its light rays to reach us."

*Brother!* Actually, at their greatest distance from each other, during conjunction, when Earth is on one side of Sol and Saturn is on the other, light takes approximately one hour and twenty minutes to make the trip. But go ahead and figure it out for yourself.

And when they finally do drag Saturn to its doom, it takes them several days to get there at *infinite speed!* As Roosevelt remarked, "I do not see how even Herr Goebbels could have thought up that one."

But let's get back to the gravitational aspects of the story; there's almost enough to make Immanuel Velikovsky cringe.

Since the actual relative position of the two planets aren't stated in the story, it's a little difficult to figure out what's happening; but evidently the hero was so stupid that he actually dragged Saturn within a short distance of Earth—a million miles or so. The moon begins to spin faster on its axis, and storms of tidal waves rage over the Earth.

"The earth is sinking; the moon is turning; the whole universe is changing!"

But that doesn't last long, only a few days.

Then one day as they were standing fearfully at the telescope watching, fascinated, the brilliant electrical display of the sky, the strange motion of the earth to which they had almost become accustomed, ceased. The moon, too, became still, a new face shining down on the awe-struck world.

All this, if you please, in *Volume One, Number One of Science Wonder Stories*, in which Hugo Gernsback states editorially:

There has been altogether too much pseudo-science fiction of a questionable quality in the past. Over-enthusiastic authors with little scientific training have rushed into print and unconsciously misled the reader by the distortion of scientific facts to achieve results that are clearly impossible....

It is a guarantee to our readers that they will not get a false scientific education through the perusal of these stories.

**N**OW LET'S get one thing straight. The Solar System is *not* a delicate mechanism like a watch; it is *not* a structure like a Roman arch. The removal of any of the planets, or indeed all of them (with the obvious exception of Earth), wouldn't permanently disturb anybody but the astronomers.

On the other hand, if a planet like Saturn were to be pulled close enough to Earth to disturb it in the way described, Earth would then follow it into the sun or be put into such an eccentric orbit that life could no longer exist on it.

And the moon, once it started rotating more rapidly, would *not* slow down again—unless another force were brought to play upon it. The energy required to change a dynamically stable system has to come from outside that system. It is just as illogical for a planet to low down of its own accord as it is for it to speed up.

(By the way, when I say "outside the system", I mean energy not in use *within* the system. If the sun were to explode, the energy would certainly

change the Solar System, but the locked-up atomic energy in the heart of the sun is "outside the system".)

As an example, take "Ten Million Miles Sunward" by Geoffrey Hewelcke (*Amazing Stories*, March 1928).

A comet several hundred times the size of Earth is hurtling through space toward our planet. It isn't the collision that worries people, though; it seems that a comet is

... a thing composed of flaming gases, the heat from which will kill everything on earth, weeks before it hits, and when that happens, the earth will simply dissolve into its component solids and gases and will be incorporated into the comet.

Of course, a comet is *not* composed of flaming gases; Earth passed right through the tail of Halley's comet in 1910, and the luminous partial vacuum didn't bother us a bit. And no comet is even as big as the moon, much less a hundred times as big as the Earth—but let that pass, too.

The plan is to shift the Earth from its orbit, and thus dodge the oncoming horror, and is to be carried out by digging a canal from the Black Sea to the Caspian Sea, allowing water to pour into the Caspian, which is below sea level. This would move several million tons of water, which "would be enough to alter the orbit of the Earth".

Gernsback noted that the story had a flaw, and in the April 1928 issue, W. J. Luyten of Harvard Observatory pointed out the flaw.

Astronomically speaking, the thing is totally unsound; it is entirely impossible to change the course of the Earth... by doing anything from the Earth itself.

He goes on to say that if the water were moved rapidly enough, it might slow down the earth's rotation a little and make the day a few seconds longer, but after the Caspian had been filled, the error would correct itself.

Personally, I doubt it; after all, the tides shift much greater masses of water completely around the Earth every day, and the length of our rotational period is slowed only by fractions of second per century.

But, in the story, it works. The comet narrowly misses Earth—somehow doing so without disturbing our planet too much, in spite of its mass—and goes shooting off toward the sun. But the worst is yet to come, scientifically speaking.

Its speed was so great, that, although it actually passed through some of the sun's gaseous emanations, it never swerved aside from its course and continued on, and out of the solar system, unregretted by the world.

Anything that can pass through the sun's corona without being diverted from its course is just a hallucination and not worth worrying about in the first place. I *knew* there was something funny about that comet!

**A**NOTHER orbit juggler is A. W. Bernal's "Cosmic Menace" (*Amazing Stories Quarterly*, Summer 1931). The Solar System is about to be engulfed by a gigantic interstellar dust cloud. Where it came from is unexplained; any dust collection of the density of this one would have been collapsed into a stellar mass very quickly due to its own internal gravitation. And it can't be very large, because it was invisible to the Terrestrial telescopes until six years before the story starts, and is only moving at a relative velocity of about four thousand million miles per year, or about a hundred miles per second—which isn't very fast when you're trying to cover interstellar space. That cloud couldn't have been as dangerous as it seemed, but the boys are afraid of it, anyway.

Their solution is to dig a pit in Brazil, load it full of atomic fuel, and blast the Earth out of its orbit, thus escaping the Cosmic Menace.

Now it happens that the "parabolic



velocity," or escape velocity, of the Earth's orbit is 26.1 miles per second. To achieve this velocity would require an acceleration of 32 ft/sec<sup>2</sup> for a little less than an hour and twelve minutes. That's one gravity of acceleration, which would tear the Earth to smithereens if applied in so small an area as the story described. But Mr. Bernall applied the force in a single gigantic explosion! Let's give the author plenty of leeway and say that the explosion took one minute. That's an acceleration of *seventy-two gravities!*

What do you think *that* would do to poor old beat-up Terra?

There are other orbit-shifting stories which pull the same sort of thing. Arthur J. Burks' "Earth the Marauder" (*Astounding Stories Of Super-Science*, July, August, September 1930) has a magical gimmick which swishes the Earth off into space by shifting the internal balance of the planet; in "The Comet Doom" by Edmond Hamilton (*Amazing Stories*, January 1928), some fiends inhabiting another one of those comets attempt to pull Earth into the comet. It doesn't sound as though that would be too healthy for the cometeers, but that's their business.

"Wandl, the Invader" by Ray Cummings (*Astounding Stories* February, March, April, May, 1932) and E. E. Smith's "Gray Lensman" (*Astounding Science Fiction*, October, November, December, 1939, January 1940) and several others, use machines of such superscientific power and scope that they can be classed as "magic"; they can't be attacked on scientific grounds.

**O**NE OF THE things that has never ceased to confuse people is the difference between the terms *mass* and *weight*; so let's get them straight.

*Weight* is a measure of the gravitational attraction between two bodies. Your weight is the measure of the force of attraction between your body and the

Earth. When I stand on a scale, the pointer will register about 160 pounds; that means that the Earth and I are pulling each other with a force of 160 pounds. Naturally, the amount of pull depends on the mass of both bodies. If either one is changed, the force changes. Thus, my five-year-old son, having less mass than I, has a mutual attraction with the Earth of fifty pounds; if I were on the moon, the force would be around 27 pounds, because the moon is less massive than the Earth.

Weight, then, requires two bodies attracting each other gravitationally. This force will depend entirely on the masses of the two bodies and how far apart they are. Remember Newton's Law?

*Mass* is the amount of matter in something, and is measured by the resistance a body has to moving. Mass is totally indifferent to weight; it doesn't require another body anywhere near it. No matter where you go, your mass remains the same; no matter where it may be, a given mass has the same resistance to change of motion. This resistance is called *inertia*.

Let's take an example. Suppose you have a railroad freight car, equipped with well-lubricated roller bearings on a smooth, level track. With a little effort, a reasonably healthy man can get it started moving—slowly at first, then picking up speed as he keeps pushing. Pretty soon, it's going along as fast as he can keep it going with very little effort.

It's easy to move, once he gets it started, but *first he had to overcome the inertia*.

Now, suppose he wants to stop it. He runs up to the front of the car, and holds out his hand. It knocks him down and runs over him. Why? Because he will have to apply as much energy to stop the car as he did to start it! Again, inertia. Was it the weight that knocked him down? No; the *weight* of the car is

pressing down on the rails. it was the *mass* that did the dirty work.

So, how does this apply in science fiction?

On the cover of the July 1929 *Science Wonder Stories*, there is a picture of a man in a seaman's uniform holding up the transatlantic liner *Leviathan*—at that time the largest ocean liner afloat, with a displacement of some sixty thousand tons. The cover illustrates the editorial by Mr. Gernsback, in which he shows that if one could transport the *Leviathan* out to some asteroid made of ordinary rock, and with a diameter of 116 feet, the gravitational pull would be so little that the *Leviathan* would only weigh 200 pounds, and if the rock were still smaller, the ship could be lifted with one hand, as the cover shows.

Well, that's all right, as far as it goes, but remember that railroad car? Suppose you strapped your feet to the asteroid and started trying to lift the *Leviathan*. On the scale, it only weighs a few pounds; if you had it on your shoulders, you could stand there all day. But overcoming its inertia is an entirely different matter because the mass hasn't changed.

After much strenuous pushing, you might get it over your head—and then it would just keep on going! You don't think a ship is easier to stop than a boxcar, do you?

So you wave goodbye to the *Leviathan* as your ship sinks slowly in the sun.

And that's exactly what would have happened to Mason, in Laurence Manning's "The Wreck of the *Asteroid*" (*Wonder Stories*, February 1933), when he attempted to carry the spaceship *Asteroid* around Phobos, the inner moon of Mars. Granted, the ship might only weigh ten pounds, but its mass would be just as great as ever.

Stories which contain scenes taking place under the influence of little or no



gravitational pull will suffer from the mass-weight confusion to a greater or lesser extent. "The Shot Into Infinity" by Willi Gail (*Science Wonder Quarterly*, Fall 1929) is surprisingly good for its time; on the other hand, Hugo Gernsback's "Ralph 124C41+" (*Amazing Stories Quarterly*, Winter 1929) ignores the mass of things entirely. H. G. Wells, in his "First Men in the Moon" (*Amazing Stories*, December 1926, January and February 1927) merely seems a little confused at times.

**O**NE HATES to bite the hand that feeds one, so it is with great trepidation that I make any statements about a novel called *Mystery Of The Third Mine* by Robert W. Lowndes (John C. Winston Company, 1953, \$2.00); but, after all, we mustn't be chauvinistic, must we?

The action takes place in the asteroid belt, and throughout the book the author paid special attention to the mass-weight problem. In several places, a huge mass moves slowly, but inexorably.

One of the most striking of these is



the scene where a heavy piece of machinery with a mass of several tons is dropping on a man's head. It is

... drifting the way anything drifted from a height here, floating straight down, slowly, soundlessly, toward the two talking on the sidewalk.

Naturally, because of the tendency to leave the ground on the planetoid Ceres, the hero, who is trying to warn the man and woman standing beneath the falling mass, can't move very fast; also, the air beneath the dome is thin and carries sound poorly. So, by the time he warns them, the machine is almost on top of them. The girl manages to get away, but the man is crushed to death beneath the calculator unit.

Now it happens that the surface gravity of Ceres is approximately one thirty-second that of Earth. The acceleration of a falling body is thus about one foot per second per second. That means that an object weighing 3200 pounds on Earth would weigh 100 pounds on Ceres—but remember, the *mass* remains the same.

The author said "several tons"; that means more than two, obviously, so let's call it 6400 pounds for easy figuring, and let's drop it and find out what happens.

Suppose the Empire State Building were on Ceres, and the machine were dumped off the top of it. By the time it reached the level of the head of a man standing on the sidewalk below, it would be moving at only thirty miles an hour, and it would have taken around three-quarters of a minute to fall that distance. On Earth, neglecting air resistance, it would be moving at nearly two hundred miles an hour, and would have taken only a little over eight seconds to make the trip.

However, we don't have buildings like that on Ceres. Internal evidence indicates that the average building is about eleven stories high—around 112 feet. If dropped from such a structure on Ceres, the machine would be mov-

ing at around ten miles an hour when it hit and would require fifteen seconds to fall that distance.

If it were weight alone that determined the damage done, this would still be the equivalent of dropping a two hundred pound weight on a man from a point three feet above his head. I don't think I'd care to be under it.

But it isn't weight that counts here; it's mass. And that means that it's the equivalent of 6400 pounds of machinery coming down on your head at ten miles an hour. I know good and well I don't want to try *that*.

All very fine, but, alas, there's a flaw here nonetheless. The author apparently forgot that a falling body *accelerates*, whether the gravity is low or high, and wrote this scene as if the unit fell at a uniform rate from start to finish. Now the length of time for the unit to fall from the eleventh story would be about 15 seconds. At the start of its fall it would, indeed, seem to be "drifting" down; it would fall one foot in the first second. *But it would fall 14 feet in the last second*, and would be coming down at about ten miles an hour.

Thus (a) if the object was nearly on top of Menotti and the girl when Pete saw it, from across the street, they'd have been squashed before he could possibly attract their attention; (b) if the unit was "drifting", in appearance, then it would still be pretty near the top of the building. You can have it either way, but not both.

**T**HERE'S a lovely little scene in the book where the local cops are tossed up into the air so that the hero and his pals can get away. Naturally, once the police are off the floor, they're helpless; they can't do anything until they touch the floor again. And with a good, hefty shove, they'd be up in the air, literally, for about half a minute—plenty of time for the boys to scam—providing that the

ceiling was about 112 feet high. Internal evidence indicates that the auditorium could have had that high a ceiling.

One other gravitational error in the book. In chapter 14, the hero and his friends lift and carry a rocketship *a la* "Wreck of the Asteroid." Could be, in both cases, but not as described in either. Well, none of us is perfect, and most of the gravitational thought is sound.

Another flub can be found in *Revolt on Alpha C* by Robert Silverberg (Thomas Y. Crowell Co., 1955, \$2.00). One of the characters is talking about Alpha Centauri VII, which is described as a "sort of super-Jupiter"; in other words, a heavy planet with a high-density gravitational field.

"Two exploratory ships landed on VII about twenty years ago, but the pull of gravity was so strong they couldn't lift the

Sorry; no good. The energy re-ship up once it landed."  
 quired to land a ship on a planet is ex-

actly equal to the energy required to take it off. In other words, if they had the power to land, they had the power to get off. If they couldn't take off it was because they didn't have the energy, and therefore didn't land—they crashed! But if they didn't crack up, then they could have taken off.

Again, you can have it either way, but not both.

One other gravitational errors in the scientific thought—without error—behind it is Hal Clement's "Mission of Gravity" (*Astounding Science Fiction*, April, May, June, July 1953). There's no need for me to comment on it; just read Clement's own article on the subject, 'Whirligig World,' in the June 1953 *Astounding*.

If more people would write like that, maybe the field would be justified in claiming the title "science-fiction;" so far, all we have is a few lights in a murky fog. It's a situation to be viewed with utmost gravity.

