WORK-IN-PROGRESS (OCTOBER 31, 2020) PARALLEL CHART FOR

Paper 41 — Physical Aspects of the Local Universe

Sources for Paper 41, in the order in which they first appear

(1) Sir James Jeans, M.A., D.Sc., F.R.S., *Through Space & Time* (New York: The Macmillan Company, 1934)

Note: This source is coded Jeans2.

(2) A. S. Eddington, M.A., D.Sc., LL.D., F.R.S., *Stars and Atoms* (Oxford: Clarendon Press, 1927)

(3) Sir James Jeans, M.A., D.Sc., L.L.D., F.R.S., *The Universe Around Us* (New York: The Macmillan Company, 1934)

Note: This source is coded Jeans1.

(4) Dr. G. Gamow, "Neutrinos vs. Supernovae," *The Scientific Monthly,* January 1942

(5) W. F. G. Swann, A.R.C.S., M.A., D.Sc., *The Architecture of the Universe* (New York: The Macmillan Company, 1934)

(6) Unidentified source for 41:7.11, re the temperature of the sun's corona

Key

(a) Green indicates where a source author first appears, or where he/she reappears.

(b) Yellow highlights most parallelisms.

(c) Tan highlights parallelisms not occurring on the same row, or parallelisms separated by yellowed parallelisms.

(d) An underlined word or words indicates where the source and the UB writer pointedly differ from each other.

(e) Blue indicates original (or "revealed") information, or UB-specific terminology and concepts. (What to highlight in this regard is debatable; the highlights are tentative.)

(f) Light green indicates Bible passages or fragments thereof, which are not paralleled in the source text.

(g) Red indicates where Sadler apparently misread or misinterpreted the source text, usually resulting in a statement whose erroneousness would have been recognized at the time the paper was written as well as now.

(h) Gold highlights a word or theme which will be discussed in a later analysis of the chapter.

APPENDIX A

highly condensed towards its centre. As the constitutions of actual astronomical bodies must lie somewhere between these two extremes, we might naturally expect such a body to follow a series of configurations intermediate between the

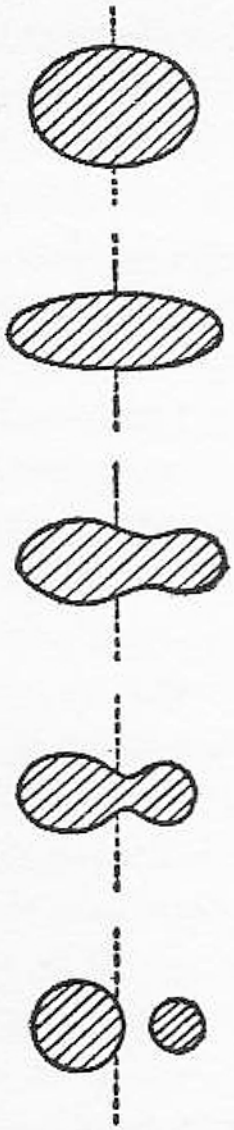

FIG. 11.—The sequence of configurations of a rotating mass of liquid.

FIG. 12.—The sequence of configurations of a rotating mass of gas.

two shewn in figs. 11 and 12. Theory shews that as a matter of fact it does not. All bodies having less than a certain critical degree of central condensation follow the sequence shewn in fig. 11, or a sequence differing only immaterially

Scientists Debunk Old Theories at Harvard Sun Conference

By LOUIS M. LYONS

Half a hundred of the star scientists of America, gathered at Harvard Observatory, turned their attention from the World War yesterday to examine a revolution that has swept the world of science in the last few weeks concerning science's own notion of the nature of the sun, source of all life on earth.

Their new ideas about the sun and sun spots and their relation to earth and radio and electrical storms stretched the imagination of listening laymen far more than the exploits of parachute troops or airplane torpedoes.

They trained the light of recent research on a new concept of the sun's explosive, seething rim, expressed in temperatures of more than 2,000,000 degrees, instead of the previously accepted top of 6000 degress of surface heat.

A Star in Gaseous Envelope

They had found in the sun's corona iron and nickel and calcium, heavy metals all, instead of only the light helium and hydrogen which had been assumed to be the only elements light enough to be exploded in the eruptions of solar geysers that make the fireworks of the blazing corona visible in eclipses.

This has led the astronomers and physicists to new conceptions of the nature of the sun itself. "The sun has sprung a leak," exclaimed Prof. Donald M. Menzel of Harvard Observatory in describing his notion of the cause of the tremendous eruptions that produce the phenomena of the coronal projections. Coronal material with temperatures up to 2,000,000 degrees is shot out of the hot interior of the sun "from a crack, or a pore or a whirlpool in the surface," Menzel explained. "A long tube of volcanic material from the depths of the sun is spouted out into space, where it spreads out in the form of the corona and prominences, sometimes in a volume hundreds of times the size of the earth."

Some of this gaseous material "rains back onto the sun," the astronomer explained, and some of it flies off from the sun.

He himself has come to believe, on the basis of the recent new conception of the nature of the stuff of the sun, he said, that the sun is a planetary nebulae, that is, a star enclosed in a gaseous envelope.

Points Way for New Study

These solar eruptions produce high velocity particles that may be found to cause such disturbances on earth as radio fadeouts and violent electric storms with their destructive effects on electric power systems, Menzel suggested.

"The new theory strengthens the view that magnetic storms and radio fadeouts are intimately connected with the sun's corona," Menzel said. "The X-ray energy associated with the coronal emission may prove to be the long-sought source of electrification of the ionosphere, the layer above the stratosphere that reflects radio waves. The way has been pointed for new techniques for studying these things."

Studies of the relation between sunspots and electrical disturbances on the earth, presented by Alvin G. McNish of Carnegie Institute, led Dr. Menzel to tell the conference that "we are rapidly debunking sun spots as phenomena of importance in themselves. We are coming to think of them more like the spots in measles, symptoms of a more fundamental deep-seated disturbance. It is probable than the sun spots correspond to such fundamental disturbances as the eruptions in the sun."

50,000 "Spittin' Images"

Prof. Manuel S. Vallarta of Massachusetts Institute of Technology described observations of the magnetic effect of the sun on the earth that led Prof. Henry Norris Russell of Princeton to say it was the first persuasive evidence he had heard that the sun is a magnet.

Stormy conditions on the earth are directly related to storminess in the sun's atmosphee, D. McNish reported. Magnetic storms are much more intense during the period when sunspots are most numerous, he found. It is not possible to make a direct relation to the appearance of any single sunspot and a single storm, he said, but the average storminess of a month or a year corresponds to the average intensity of sun spots. He had studied sun spots cycles for 18 years to reach his conclusions.

Dr. Leo Goldberg of Harvard Observatory saw "some evidence" of direct relation between sun spot intensity and electrical storms. He reported the results of four months

of observations in Zurich, during which seven intense electrical storms followed by a single day in each instance an intense coronal eruption on the sun.

Prof. Harlow Shapley, director of the Harvard Observatory, opening the two day sun conference, said that recent investigation reveals the sun as about 'an average star." Harvard studies have shown that nearly 50,000 stars are "the spittin' image of the sun," he said.

Problem an "Inter-Science Job"

The late Miss Annie Jump Cannon had classified all these stars, he said, and found many of the same class as the sun. "Class G" Harvard rates the sun.

Prof. Russell, in an address last night at the American Academy of Arts and Sciences, said that the astronomer's problem of working out the energy and light waves of atoms on the surface of the sun is "like working out a cross-word puzzle. Things key into each other the same way, and sometimes you get an unkeyed line and have to know whether what you fill it out with makes sense."

"We used to think we knew all about an atom and what was inside it," said the famous astronomer. "Now we feel that nature has given us no way to know. A dozen years ago a lecturer sharpened his chalk to draw his concept of an atom. Now he uses an eraser and makes a smudge. What we really have is the state of the atom showing the electrical charge at different times."

Theories Radically Revised

The key unlocking the new notions about the sun stuff was given science this Spring by a Swedish physicist, Bengt Edlen, who tortured atoms with hot electric sparks to discover that coronium, the substance of the sun's corona, is chiefly iron, partly nickel and calcium, but not ordinary metal, rather these metals vaporized and with half the outer cloak of their electrons torn away.

"Thus vanishes a 70-year mystery," Dr. Menzel said of the Edlen discovery. Edlen found that two of the 25 lines of the corona could be iron. This gave astronomers a new picture of the sun's corona, as a seething mass of excited atoms. It demanded radical revision of the accepted theories of the construction of stars. Dr. Menzel and Dr. Goldberg, following up Edlen with studies at Harvard, concluded that the great width of the coronal lines he found showed that the metallic atoms were moving at a speed that could be accounted for only by temperatures of 2,000,000 degrees. This does not change the concept of the surface temperature of the sun as 6000 degrees, but leads to the explanation that volcanic disturbances throw up geysers of superheated stuff from the sun's interior to form the corona.

"The coronal problem would have been solved long ago had we been able to study the X-ray regions of the solar spectrum," Dr. Menzel said. Last night, in a paper at the American Academy, Dr. Menzel reported for the first time an observation made at the Harvard station at Climax, Colo., of a coronal flare and its condensation to form a prominence which then rained its material down into the surface of the sun."

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PAPER 41 — PHYSICAL ASPECTS OF THE LOCAL UNIVERSE

41:0.1 The characteristic space phenomenon which sets off each local creation from all others is the presence of the Creative Spirit. All Nebadon is certainly pervaded by the space presence of the Divine Minister of Salvington, and such presence just as certainly terminates at the outer borders of our local universe. That which is pervaded by our local universe Mother Spirit is Nebadon; that which extends beyond her space presence is outside Nebadon, being the extra-Nebadon space regions of the super-universe of Orvonton—other local universes.

41:0.2 While the administrative organization of the grand universe discloses a clear-cut division between the governments of the central, super-, and local universes, and while these divisions are astronomically paralleled in the space separation of Havona and the seven superuniverses, no such clear lines of physical demarcation set off the local creations. Even the major and minor sectors of Orvonton are (to us) clearly distinguishable, but it is not so easy to identify the physical boundaries of the local universes. This is because these local creations are administratively organized in accordance with certain creative principles governing the segmentation of the total energy charge of a superuniverse,[1]

[See 41:3.10, below.]

[See endnote.]

whereas their physical components, the spheres of space—suns, dark islands, planets, etc.—take origin primarily from nebulae, and these make their astronomical appearance in accordance with certain precreative (transcendental) plans of the Architects of the Master Universe.

41:0.3 One or more—even many—such nebulae may be encompassed within the domain of a single local universe even as Nebadon was physically assembled out of the stellar and planetary progeny of Andronover and other nebulae. The spheres of Nebadon are of diverse nebular ancestry, but they all had a certain minimum commonness of space motion which was so adjusted by the intelligent efforts of the power directors as to produce our present aggregation of space bodies, which travel along together as a contiguous unit over the orbits of the superuniverse.

[See Paper 29, "The Universe Power Directors".]

41:0.4 Such is the constitution of the local star cloud of Nebadon, which today swings in an increasingly settled orbit about the Sagittarius center of that minor sector of Orvonton to which our local creation belongs.

[See 15:3.11.]

1. THE NEBADON POWER CENTERS

[Paradise force organizers are nebulae originators ... (15:4.4).]

41:1.1 The spiral and other nebulae, the mother wheels of the spheres of space, are initiated by Paradise force organizers;

[When this energy attains gravity-responding levels,

and following nebular evolution of gravity response,

SOURCE OR PARALLEL	URANTIA PAPER 41
the power directors and their associates of the superuniverse regime appear upon the scene	they are superseded in superuniverse function by the power centers and physical controllers,
and begin their never-ending manipulations designed to establish the manifold power circuits and energy channels of the universes of time and space (15:4.2).]	who thereupon assume full responsibility for directing the physical evolution of the ensuing generations of stellar and planetary offspring.
	This physical supervision of the Nebadon preuniverse was, upon the arrival of our Creator Son, immediately co-ordinated with his plan for universe organization. Within the domain of this Paradise Son of God, the Supreme Power Centers and the Master Physical Controllers collaborated with the later appearing Morontia Power Supervisors and others to produce that vast complex of communication lines, energy circuits, and power lanes which firmly bind the manifold space bodies of Nebadon into one integrated administrative unit.
[4. *Local Universe Centers.* On the headquarters of each local universe are stationed one hundred power centers of the fourth order.	41:1.2 One hundred Supreme Power Centers of the fourth order are permanently assigned to our local universe.
They function to downstep and otherwise to modify the seven power circuits emanating from superuniverse headquarters, thus making them applicable to the services of the constellations and systems.	These beings receive the incoming lines of power from the third-order centers of Uversa and relay the down-stepped and modified circuits to the power centers of our constellations and systems.
	These power centers, in association, function to produce the living system of control and equalization which operates to maintain the balance and distribution of otherwise fluctuating and variable energies.

The local astronomical catastrophes of space are of passing concern to these power centers; they are engaged in the orderly dispatch of effective energy to the subsidiary constellations and systems (29:2.16).]

Power centers are not, however, concerned with transient and local energy upheavals, such as sun spots and system electric disturbances; light and electricity are not the basic energies of space; they are secondary and subsidiary manifestations.

41:1.3 The one hundred local universe centers are stationed on Salvington, where they function at the exact energy center of that sphere. Architectural spheres, such as Salvington, Edentia, and Jerusem, are lighted, heated, and energized by methods which make them quite independent of the suns of space. These spheres were constructed—made to order—by the power centers and physical controllers and were designed to exert a powerful influence over energy distribution. Basing their activities on such focal points of energy control, the power centers, by their living presences, directionize and channelize the physical energies of space. And these energy circuits are basic to all physical-material and morontia-spiritual phenomena.

[5. *Constellation Centers.* Ten of these living power centers are stationed in each constellation, functioning as energy projectors to the one hundred tributary local systems (29:2.17).]

41:1.4 Ten Supreme Power Centers of the fifth order are assigned to each of Nebadon's primary subdivisions, the one hundred constellations.

In Norlatiadek, your constellation, they are not stationed on the headquarters sphere but are situated at the center of the enormous stellar system which constitutes the physical core of the constellation. On Edentia there are ten associated mechanical controllers and ten frandalanks who are in perfect and constant liaison with the near-by power centers.

SOURCE OR PARALLEL

[6. *System Centers.* One Supreme Power Center is permanently assigned to each local system (29:2.18).]

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41:1.5 One Supreme Power Center of the sixth order is stationed at the exact gravity focus of each local system.

In the system of Satania the assigned power center occupies a dark island of space located at the astronomic center of the system. Many of these dark islands are vast dynamos which mobilize and directionize certain space-energies, and these natural circumstances are effectively utilized by the Satania Power Center, whose living mass functions as a liaison with the higher centers, directing the streams of more materialized power to the Master Physical Controllers on the evolutionary planets of space.

2. THE SATANIA PHYSICAL CONTROLLERS

41:2.1 While the Master Physical Controllers serve with the power centers throughout the grand universe, their functions in a local system, such as Satania, are more easy of comprehension. Satania is one of one hundred local systems which make up the administrative organization of the constellation of Norlatiadek, having as immediate neighbors the systems of Sandmatia, Assuntia, Porogia, Sortoria, Rantulia, and Glantonia. The Norlatiadek systems differ in many respects, but all are evolutionary and progressive, very much like Satania.

41:2.2 Satania itself is composed of over seven thousand astronomical groups, or physical systems, few of which had an origin similar to that of your solar system. The astronomic center of Satania is an enormous dark island of space which, with its attendant spheres, is situated not far from the headquarters of the system government.

41:2.3 Except for the presence of the assigned power center, the supervision of the entire physical-energy system of Satania is centered on Jerusem. A Master Physical Controller, stationed on this headquarters sphere, works in co-ordination with the system power center, serving as liaison chief of the power inspectors headquartered on Jerusem and functioning throughout the local system.

41:2.4 The circuitizing and channelizing of energy is supervised by the five hundred thousand living and intelligent energy manipulators scattered throughout Satania. Through the action of such physical controllers the supervising power centers are in complete and perfect control of a majority of the basic energies of space, including the emanations of highly heated orbs and the dark energy-charged spheres. This group of living entities can mobilize, transform, transmute, manipulate, and transmit nearly all of the physical energies of organized space.

[See 44:5, “The Energy Manipulators”.]

41:2.5 Life has inherent capacity for the mobilization and transmutation of universal energy. You are familiar with the action of vegetable life in transforming the material energy of light into the varied manifestations of the vegetable kingdom. You also know something of the method whereby this vegetative energy can be converted into the phenomena of animal activities, but you know practically nothing of the technique of the power directors and the physical controllers, who are endowed with ability to mobilize, transform, directionize, and concentrate the manifold energies of space.

41:2.6 These beings of the energy realms do not directly concern themselves with energy as a component factor of living creatures, not even with the domain of physiological chemistry. They are sometimes concerned with the physical preliminaries of life, with the elaboration of those energy systems which may serve as the physical vehicles for the living energies of elementary material organisms. In a way the physical controllers are related to the preliving manifestations of material energy as the adjutant mind-spirits are concerned with the prespiritual functions of material mind.

41:2.7 These intelligent creatures of power control and energy direction must adjust their technique on each sphere in accordance with the physical constitution and architecture of that planet. They unfailingly utilize the calculations and deductions of their respective staffs of physicists and other technical advisers regarding the local influence of highly heated suns and other types of supercharged stars.

Even the enormous cold and dark giants of space and the swarming clouds of star dust must be reckoned with; all of these material things are concerned in the practical problems of energy manipulation.

41:2.8 The power-energy supervision of the evolutionary inhabited worlds is the responsibility of the Master Physical Controllers, but these beings are not responsible for all energy misbehavior on Urantia. There are a number of reasons for such disturbances, some of which are beyond the domain and control of the physical custodians. Urantia is in the lines of tremendous energies, a small planet in the circuit of enormous masses, and the local controllers sometimes employ enormous numbers of their order in an effort to equalize these lines of energy. They do fairly well with regard to the physical circuits of Satania but have trouble insulating against the powerful Norlatiadek currents.

3. OUR STARRY ASSOCIATES

41:3.1 There are upward of two thousand brilliant suns pouring forth light and energy in Satania, and your own sun is an average blazing orb.

VII: THE STARS (Jeans2 173)

Of the thirty stars which are nearest to it in space, only three are more luminous than the sun, while most of the remaining twenty-seven are very much less luminous (J2 179).

Of the thirty suns nearest yours, only three are brighter.

SOURCE OR PARALLEL	URANTIA PAPER 41
	The Universe Power Directors initiate the specialized currents of energy which play between the individual stars and their respective systems. These solar furnaces, together with the dark giants of space, serve the power centers and physical controllers as way stations for the effective concentrating and directionizing of the energy circuits of the material creations.
II: SOME RECENT INVESTIGATIONS (Eddington 42)	
Unknown Atoms and Interpretation of Spectra (Eddington 53)	
	41:3.2 The suns of Nebadon are not unlike those of other universes.
The rash prophecy that knowledge of the composition of the heavenly bodies must be for ever beyond our reach has long been disproved; and the familiar elements, hydrogen, carbon, calcium, titanium, iron, and many others, can be recognized in the most distant parts of the universe (E 56).	The material composition of all suns, dark islands, planets, and satellites, even meteors, is quite identical.[2]
I: THE INTERIOR OF A STAR (Eddington 9)	
[*Preamble*] (Eddington 9)	
[contd] The sun belongs to a system containing some 3,000 million stars. The stars are globes comparable in size with the sun, that is to say, of the order of a million miles in diameter (E 9).	These suns have an average diameter of about one million miles,
[*Note:* The sun has a diameter of 865,370 mi.]	that of your own solar orb being slightly less.

SOURCE OR PARALLEL	URANTIA PAPER 41
VII: THE STARS (Jeans2 173)	
Indeed the largest yet known (Antares) has a diameter 450 times that of the sun—or about 400 million miles.	The largest star in the universe, the stellar cloud Antares, is four hundred and fifty times the diameter of your sun
We could pack about 60 million suns inside it, and there would still be room to spare (J2 183).	and is sixty million times its volume.
[*Note:* Sadler copied Jeans' mistake, which was probably a typo. If Antares is 450 x the diameter of the sun, then it is approximately ninety million times its volume: 450 x 450 x 450 = 91,125,000. In Jeans' other source book, *The Universe Around Us,* he correctly stated: "Antares ... occupies 90,000,000 times as much space as the sun ..." (J1 257).]	
I: THE INTERIOR OF A STAR (Eddington 9)	
[*Preamble*] (Eddington 9)	
[contd from three rows above] The space for their accommodation is on the most lavish scale.	But there is abundant space to accommodate all of these enormous suns.
Imagine thirty cricket balls roaming the whole interior of the earth; the stars roaming the heavens are just as little crowded and run as little risk of collision as the cricket balls (E 9).	They have just as much comparative elbow room in space as one dozen oranges would have if they were circulating about throughout the interior of Urantia,
	and were the planet a hollow globe.
[*Note:* Neither Eddington nor Jeans suggests this, although Jeans does theorize that stars are thrown off a rotating nebula.]	41:3.3 When suns that are too large are thrown off a nebular mother wheel, they soon break up or form double stars.
V: STARS (Jeans1 238)	
THE HYPOTHESIS OF LIQUID STARS (Jeans1 279)	
	All suns are originally truly gaseous,

SOURCE OR PARALLEL

We have ... already found indications that the stars are not purely gaseous, since purely gaseous masses could not form close binary systems of the type observed in spectroscopic binaries (p. 211). Such systems can only be formed out of a mass which simulates the properties of a liquid rather than those of a gas; the mass need not be wholly in a liquid state, but there must be a considerable divergence from the state of a pure gas, at any rate in its central regions (J1 280).

IV: CARVING OUT THE UNIVERSE (Jeans1 184)

THE BIRTH OF BINARY SYSTEMS (Jeans1 206)

The Fission of Liquid Stars. (J1 208)

[*Note:* Jeans doesn't suggest that our sun was ever in such a state.]

[See Appendix A. It shows Fig. 11 (from J1 210), illustrating the fissioning of a hypothetical "liquid star".]

[*Note:* I have found no source for this. However, Sadler may have taken his cue from Eddington's remark that "there are very few stars with masses outside these limits" (*i.e.* with a mass less than about 1/6 x sun or greater than about 30 x sun). See E 34.]

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though they may later transiently exist in a semiliquid state.

When your sun attained this quasi-liquid state of supergas pressure, it was not sufficiently large to

split equatorially, this being one type of double star formation.

41:3.4 When less than one tenth the size of your sun, these fiery spheres rapidly contract, condense, and cool. When upwards of thirty times its size—rather thirty times the gross content of actual material—suns readily split into two separate bodies, either becoming the centers of new systems or else remaining in each other's gravity grasp and revolving about a common center as one type of double star.

SOURCE OR PARALLEL

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"NEUTRINOS VS. SUPERNOVAE" (Gamow 65)

STELLAR CATASTROPHES (Gamow 67)

The star observed by Tycho-Brahe in 1572 and visible in bright daylight, the star registered by Chinese astronomers in in the year 1054, and probably the Star of Bethlehem represent typical examples of such supernovae within our stellar system, the Milky Way (G 67).

41:3.5 The most recent of the major cosmic eruptions in Orvonton was the extraordinary double star explosion, the light of which reached Urantia in A.D. 1572.

This conflagration was so intense that the explosion was clearly visible in broad daylight.

[*Note:* A more recent supernova in the Milky Way galaxy is Kepler's Supernova (SN 1604), which occurred in the constellation Ophiuchus in 1604, twenty-two years after Tycho's Supernova (SN 1572). Both were Type 1a supernovae. (See Wikipedia: "History of supernova observation".)]

41:3.6 Not all stars are solid, but many of the older ones are.

[*Compare:* Not all the red stars are diffuse; there are many like Krueger 60 which have high density, and these we leave undisturbed as representing the last stage of evolution (E 107).] [*Note:* But according to Jeans, Krueger 60 *B*, a red dwarf (and therefore not "enormous"), has a density only 40 times greater than the sun, or approximately 216 lbs. per cubic inch.]

Some of the reddish, faintly glimmering stars have acquired a density at the center of their enormous masses which would be expressed by saying that one cubic inch of such a star, if on Urantia, would weigh six thousand pounds.[3]

The enormous pressure, accompanied by loss of heat and circulating energy, has resulted in bringing the orbits of the basic material units closer and closer together until they now closely approach the status of electronic condensation. This process of cooling and contraction may continue to the limiting and critical explosion point of ultimatonic condensation.

SOURCE OR PARALLEL	URANTIA PAPER 41
III: THE AGE OF THE STARS (Eddington 85)	
Evolution of the Stars (Eddington 106)	
The 'giant and dwarf' theory proposed by Hertzsprung and Russell ... recognized a series of *giant* stars, comparatively diffuse stars with temperature rising, and a series of *dwarf* or dense stars with temperature falling.... An individual star during its lifetime went up the giant series to its highest temperature	41:3.7 Most of the giant suns are relatively young;
and then the dwarf series (E 107).	most of the dwarf stars are old,
	but not all.
[*Note:* Modern astronomy holds that all white dwarfs are old stars. However, Sadler may have been referring to the chart on E 110, which indicates that Algol, a binary 'dwarf star' (*i.e.* a Main Series star, not a white dwarf, 4.3 x the mass of the sun), is a young star of white color, and 150 times more luminous than the sun.]	The collisional dwarfs may be very young and may glow with an intense white light, never having known an initial red stage of youthful shining.
On the former view [*i.e.* that stars evolve from high to low temperatures] all the cool red stars were old and dying. But a large number of them are now found to be extremely diffuse—stars like Betelgeuse, for instance. These must be set down as the very youngest of the stars ...	Both very young and very old suns usually shine with a reddish glow.
Both the first and last periods of a star's life are characterized by low temperature; in between whiles the temperature must have risen to a maximum and fallen again (E 107).	
[*Note:* Eddington, partially rejecting the above theories, suggests that stars in the Main Series begin as white, become yellow and end as red. See chart on E 110.]	The yellow tinge indicates moderate youth or approaching old age, but the brilliant white light signifies robust and extended adult life.

III: THE AGE OF THE STARS (Eddington 85)

Radiation of Mass (Eddington 113)

[S]tars in general do not pulsate—it is only the rare exceptions that behave in this way....

Cepheid pulsation is a kind of distemper which happens to stars at a certain youthful period; after passing through it they burn steadily (E 120).

41:3.8 While all adolescent suns do not pass through a pulsating stage, at least not visibly,

Pulsating Stars (Eddington 85)

when looking out into space you may observe

There are sixteen [testable] Cepheid variables ...; their periods range from 13 hours to 35 days ... (E 90).

many of these younger stars whose gigantic respiratory heaves require from two to seven days to complete a cycle.

[*Note:* Neither Eddington nor Jeans suggests that our sun had such a history.]

Your own sun still carries a diminishing legacy of the mighty upswellings of its younger days, but the period has lengthened from the former three and one-half day pulsations to

The number of sunspots fluctuates from a maximum to minimum and back to maximum in a period of about 11½ years; although we do not yet understand the reason for this fluctuation, we realize that this period is something characteristic of the sun in its present state and would change if any notable change happened to the sun (E 87).

the present eleven and one-half year sunspot cycles.

41:3.9 Stellar variables have numerous origins.

The star δ Cephei is one of the variable stars. Like [the double star] Algol, its fluctuating light sends us a message (E 85).

In some double stars the tides caused by rapidly changing distances as the two bodies swing around their orbits also occasion periodic fluctuations of light.

SOURCE OR PARALLEL	URANTIA PAPER 41
	These gravity variations produce regular and recurrent flares, just as the capture of meteors by the accretion of energy-material at the surface would result in a comparatively sudden flash of light which would speedily recede to normal brightness for that sun. Sometimes a sun will capture a stream of meteors in a line of lessened gravity opposition,
Radiation of Mass (Eddington 113)	
Why does δ Cephei pulsate? One possible answer is that the oscillation was started off by some accident (E 119).	and occasionally collisions cause stellar flare-ups,
It is much more likely that the pulsation arises spontaneously (E 119).	but the majority of such phenomena are wholly due to internal fluctuations.
I: EXPLORING THE SKY (Jeans1 16)	
VARIABLE STARS (Jeans1 53)	
[T]he observed relation between the period of fluctuation and the brightness of Cepheid variables—commonly known as the "period-luminosity" law—can be made to provide a scale on which the absolute luminosity, or candle-power, of a Cepheid can be read off directly from the observed period of its light-fluctuations.	41:3.10 In one group of variable stars the period of light fluctuation is directly dependent on luminosity,
	and knowledge of this fact enables astronomers to
The Cepheid variables may be regarded as lighthouses set up in distant parts of the universe (J1 57).	utilize such suns as universe lighthouses or accurate measuring points
Naturally the method is of most value for the exploration of the most distant parts of the universe; here it achieves triumphant success where other methods fail completely (J1 58).	for the further exploration of distant star clusters.

SOURCE OR PARALLEL

The "period-luminosity" law measures the distances of objects up to a million light-years away, with a smaller percentage of error than is to be expected in the parallactic measures of stars only a hundred light-years away (J1 58).

[*Note:* See 15:3.4, which says that these eight sectors have already been roughly identified.]

I: THE INTERIOR OF A STAR (Eddington 9)

Radiation Pressure and Mass (Eddington 9)

The mass of the sun is—

[*Note:* According to Wikipedia, the sun's mass is 2.192 x$10^{27.}$]

I will write it on the black-board—2000000000000000000000000000 tons (E 24).

III: THE AGE OF THE STARS (Eddington 85)

Evolution of the Stars (Eddington 106)

[*Note:* The chart on E 110 (referred to in 41:3.7) gives the statistics (mass, mean density, central temperature, surface temperature, colour and luminosity) of three typical stars of the Main Series: Algol, the sun, and Krueger 60. The mean density of Algol is 0.15 x that of water; the sun, 1.4 x; Krueger 60, 9.1.]

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By this technique it is possible to measure stellar distances most precisely up to more than one million light-years.

Better methods of space measurement and improved telescopic technique will sometime more fully disclose the ten grand divisions of the superuniverse of Orvonton; you will at least recognize eight of these immense sectors as enormous and fairly symmetrical star clusters.

4. SUN DENSITY

41:4.1 The mass of your sun is

slightly greater than the estimate of your physicists,

who have reckoned it as about two octillion (2 x 10^{27}) tons.

It now exists about halfway between the most dense and the most diffuse stars, having about one and one-half times the density of water.[4]

SOURCE OR PARALLEL	URANTIA PAPER 41
I: THE INTERIOR OF A STAR (Eddington 9)	
Dense Stars (Eddington 36)	
The sun's material, in spite of being denser than water, really is a perfect gas.	But your sun is neither a liquid nor a solid—it is gaseous—
It sounds incredible, but it must be so (E 38).	and this is true notwithstanding the difficulty of explaining how gaseous matter can attain this and even much greater densities.
[*Compare:* The feature of a true gas is that there is plenty of room between the separate particles—a gas contains very little substance and lots of emptiness. Consequently when you squeeze it you do not have to squeeze the substance; you just squeeze out some of the waste space (E 38).]	41:4.2 Gaseous, liquid, and solid states are matters of atomic-molecular relationships, but density is a relationship of space and mass. Density varies directly with the quantity of mass in space and inversely with the amount of space in mass, the space between the central cores of matter and the particles which whirl around these centers as well as the space within such material particles.
	41:4.3 Cooling stars can be physically gaseous and tremendously dense at the same time.
Careful investigation has shown that in the small stars on the extreme left of Fig. 7 the electric charges of the atoms and electrons bring about a slight deviation from the ordinary laws of a gas; it has been shown by R. H. Fowler that the effect is to make the gas not imperfect but *superperfect*—it is *more* easily compressed than an ordinary gas (E 40).	You are not familiar with the solar *supergases*,
	but these and other unusual forms of matter explain how
Is it impossible that a perfect gas should have the density of iron? The answer is rather surprising. There is no earthly reason why a perfect gas should not have a density far exceeding iron (E 38).	even nonsolid suns can attain a density equal to iron—

SOURCE OR PARALLEL	URANTIA PAPER 41
[Compare 58:5.5.]	about the same as Urantia—
	and yet be in a highly heated gaseous state and continue to function as suns.
The big terrestrial atoms which begin to jam at a density near that of the liquid state do not exist in the stars. The stellar atoms have been trimmed down by the breaking off of all their outer electrons. The lighter atoms are stripped to the bare nucleus—of quite insignificant size.	The atoms in these dense supergases are exceptionally small;
The heavier atoms retain a few of the closer electrons, but have not much more than a hundredth of the diameter of a fully arrayed atom (E 39).	they contain few electrons.
	Such suns have also largely lost their free ultimatonic stores of energy.
II: SOME RECENT INVESTIGATIONS (Eddington 42)	
The Story of the Companion of Sirius (Eddington 48)	
Working out the sum more accurately we find that the Companion of Sirius is a globe	41:4.4 One of your near-by suns,
	which started life with about the same mass as yours, has now contracted
intermediate in size between the earth and the next larger planet Uranus (E 50).	almost to the size of Urantia,
The actual density works out at 60,000 times that of water—	having become sixty thousand times as dense as your sun. [*Note:* Changed to 'forty thousand times' in second edition.]
	The weight of this hot-cold gaseous-solid
just about a ton to the cubic inch (E 50).	is about one ton per cubic inch.

SOURCE OR PARALLEL	URANTIA PAPER 41
[*Note:* The Companion of Sirius is a white dwarf.]	And still this sun shines with a faint reddish glow, the senile glimmer of a dying monarch of light.
	41:4.5 Most of the suns, however, are not so dense.
I: THE INTERIOR OF A STAR (Eddington 9)	
Opacity of Stellar Matter (Eddington 28)	
The mean density of Capella is nearly the same as the density of the air (E 29, footnote).	One of your nearer neighbors has a density exactly equal to that of your atmosphere at sea level.
The Relation of Brightness to Mass (Eddington 31)	
In many stars the material is so inflated that it is more tenuous than the air around us; for example, if you were inside Capella you would not notice the material of Capella any more than you notice the air in this room (E 31).	If you were in the interior of this sun, you would be unable to discern anything.
	And temperature permitting, you could penetrate the majority of the suns which twinkle in the night sky and notice no more matter than you perceive in the air of your earthly living rooms.
II: SOME RECENT INVESTIGATIONS (Eddington 42)	
The Cloud in Space (Eddington 63)	
Some of the stars of extremely rarefied. Betelgeuse, for example,	41:4.6 The massive sun of Veluntia,
	one of the largest in Orvonton,
has a density about a thousandth that of air.	has a density only one one-thousandth that of Urantia's atmosphere.

SOURCE OR PARALLEL	URANTIA PAPER 41
	Were it in composition similar to your atmosphere and not superheated,
We should call it a vacuum	it would be such a vacuum that human beings would speedily suffocate if they were in or on it.
were it not contrasted with the much greater vacuosity of surrounding space (E 64).	
The Story of Betelgeuse (Eddington 76)	
By spectroscopic analysis we know that Betelgeuse	41:4.7 Another of the Orvonton giants
has a surface temperature about 3,000º (E 78).	now has a surface temperature a trifle under three thousand degrees.[5]
The diameter is about 300 million miles.	Its diameter is over three hundred million miles—
Betelgeuse is large enough to contain the whole orbit of the earth inside it, perhaps even the orbit of Mars.	ample room to accommodate your sun and the present orbit of the earth.
Its volume is about fifty million times the volume of the sun (E 82).	And yet, for all this enormous size, over forty million times that of your sun,
[contd] There is no direct way of learning the mass of Betelgeuse because it has no companion near it whose motion it might influence. We can, however, deduce a mass from the mass-brightness relation in Fig. 7. This gives the mass equal to 35 x sun (E 82).	its mass is only about thirty times greater.
The Cloud in Space (Eddington 63)	
A nebula has no definite boundary and the density gradually fades off.... Before we pass entirely out of the sphere of one nebula we enter the sphere of another, so that there is always some residual density in interstellar space (E 64).	These enormous suns have an extending fringe that reaches almost from one to the other.

SOURCE OR PARALLEL

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5. SOLAR RADIATION

I: THE INTERIOR OF A STAR (Eddington 9)

Opacity of Stellar Matter (Eddington 28)

[Compare E 28-29, in which Eddington describes the material of stars as "decidedly opaque."]

41:5.1 That the suns of space are not very dense is proved by the steady streams of escaping light-energies. Too great a density would retain light by opacity until the light-energy pressure reached the explosion point.

There is a tremendous light or gas pressure within a sun to cause it to shoot forth such a stream of energy as to penetrate space for millions upon millions of miles to energize, light, and heat the distant planets.

A foot or two of the material [of Capella, whose mean density is nearly the same as the density of the atmosphere around us]

Fifteen feet of surface of the density of Urantia

would be practically a perfect screen [to X-rays, but not to light-waves] (E 29).

would effectually prevent the escape of all X rays and light-energies from a sun

until the rising internal pressure of accumulating energies resulting from atomic dismemberment overcame gravity with a tremendous outward explosion.

41:5.2 Light, in the presence of the propulsive gases, is highly explosive when confined at high temperatures by opaque retaining walls.

III: THE AGE OF THE STARS (Eddington 85)

The Contraction Hypothesis (Eddington 94)

Light is real.

SOURCE OR PARALLEL	URANTIA PAPER 41
There is no real reason why you should not buy a pound of light from an electric light company—except that it is a larger quantity than you are likely to need and at current rates would cost you something over £100,000,000 (E 98).	As you value energy and power on your world, sunlight would be economical at a million dollars a pound.
V: STARS (Jeans1 238)	
STELLAR STRUCTURE (Jeans 288)	
A star is in effect nothing but a huge X-ray apparatus (J 293).	41:5.3 The interior of your sun is a vast X-ray generator.
	The suns are supported from within by the incessant bombardment of these mighty emanations.
I: THE INTERIOR OF A STAR (Eddington 9)	
The Interior of a Star (Eddington 26)	
There is no outward progress of the atoms and electrons; gravitation sees to that. But slowly the encaged ether-waves leak outwards as through a sieve. An ether-wave hurries from one atom to another, forwards, backwards, now absorbed, now flung out again in a new direction, losing its identity, but living again in its successor. With any luck it will in no unduly long time (ten thousand to ten million years according to the mass of the star)	41:5.4 It requires more than one-half million years for an X-ray-stimulated electron
find itself near the boundary.	to work its way from the very center of an average sun up to the solar surface,
It changes at the lower temperature from X-rays to light-rays, being altered a little at each re-birth. At last it is so near the boundary that it can dart outside and travel forward in peace for a few hundred years.	whence it starts out on its space adventure,

SOURCE OR PARALLEL	URANTIA PAPER 41
Perhaps it may in the end reach some distant world where an astronomer lies in wait to trap it in his telescope and extort from it the secrets of its birth-place (E 27-28).	maybe to warm an inhabited planet,
	to be captured by a meteor, to participate in the birth of an atom, to be attracted by a highly charged dark island of space, or to find its space flight terminated by a final plunge into the surface of a sun similar to the one of its origin.
[*Note:* By substituting "an electron" for Eddington's "ether-wave," Sadler creates the impossible scenario of an electron escaping from the interior of sun and being propelled to distant astronomic bodies, to "warm an inhabited planet," etc. In 41:5.5 (below), he continues to confuse electrons with light, equating electrons with a "sunbeam".]	
	41:5.5 The X rays of a sun's interior charge the highly heated and agitated electrons with sufficient energy to carry them out through space, past the hosts of detaining influences of intervening matter and, in spite of divergent gravity attractions, on to the distant spheres of the remote systems. The great energy of velocity required to escape the gravity clutch of a sun is sufficient to insure that the sunbeam will travel on with unabated velocity until it encounters considerable masses of matter; whereupon it is quickly transformed into heat with the liberation of other energies.
III: THE NATURE OF MATTER. DEVELOPMENT OF ATOMIC THEORY (Swann 44)	
Waves and Quanta. (Swann 100)	
[See 42:5.14.]	41:5.6 Energy, whether as light or in other forms, in its flight through space moves straight forward. The actual particles of material existence traverse space like a fusillade.

SOURCE OR PARALLEL	URANTIA PAPER 41
[I]t will always be possible ... to invent some complicated system of forces whose introduction will enable you to suppose that the particles [of light] really would like to have gone in straight lines had it not been for those mysterious forces which you have set up in space to guide them otherwise ... As a matter of fact, the light quanta do travel for the most part in straight lines,	They go in a straight and unbroken line or procession
except in the vicinities of atoms, diffracting surfaces and the like (S 115).	except as they are acted on by superior forces, and except as they ever obey the linear-gravity pull inherent in material mass and the circular-gravity presence of the Isle of Paradise.
	41:5.7 Solar energy may seem to be propelled in waves, but that is due to the action of coexistent and diverse influences. A given form of organized energy does not proceed in waves but in direct lines. The presence of a second or a third form of force-energy may cause the stream under observation to appear to travel in wavy formation, just as, in a blinding rainstorm accompanied by a heavy wind, the water sometimes appears to fall in sheets or to descend in waves. The raindrops are coming down in a direct line of unbroken procession, but the action of the wind is such as to give the visible appearance of sheets of water and waves of raindrops.
	41:5.8 The action of certain secondary and other undiscovered energies present in the space regions of your local universe is such that

[S]uch phenomena as the Compton effect, the photoelectric effect, and similar facts point as definitely to the suggestion that light and X-rays are corpuscles of small dimension and relatively large energy as the facts of interference of X-rays and light point to the belief that these agencies are really representative of a wave motion in space (S 110).

solar-light emanations appear to execute certain wavy phenomena as well as to be chopped up into infinitesimal portions of definite length and weight.

And, practically considered, that is exactly what happens.

You can hardly hope to arrive at a better understanding of the behavior of light until such a time as you acquire a clearer concept of the interaction and interrelationship of the various space-forces and solar energies operating in the space regions of Nebadon. Your present confusion is also due to your incomplete grasp of this problem as it involves the interassociated activities of the personal and nonpersonal control of the master universe—the presences, the performances, and the co-ordination of the Conjoint Actor and the Unqualified Absolute.

6. CALCIUM — THE WANDERER OF SPACE

II: SOME RECENT INVESTIGATIONS (Eddington 42)

The Cloud in Space (Eddington 63)

41:6.1 In deciphering spectral phenomena, it should be remembered that

SOURCE OR PARALLEL	URANTIA PAPER 41
An ordinary region [of space] where there is no observable nebulosity is the highest vacuum existing—within the limits of the stellar system at least—but there still remains about *one atom in every cubic inch* (E 64-65).	space is not empty;
Light has to pass one atom per cubic inch all the way from the star to the earth,	that light, in traversing space,
and it will pass quite enough atoms during its journey of many hundred billion miles to imprint these dark lines on its spectrum (E 66).	is sometimes slightly modified by the various forms of energy and matter which circulate in all organized space.
[?]	Some of the lines indicating unknown matter which appear in the spectra of your sun are due to modifications of well-known elements which are floating throughout space in shattered form, the atomic casualties of the fierce encounters of the solar elemental battles.
There seems to be no doubt that the medium containing the sodium and ionized calcium—and no doubt many other elements which do not show themselves—is separate from the earth and the star. It is the 'fullness' of interstellar space already mentioned (E 66).	Space is pervaded by these wandering derelicts, especially sodium and calcium.
[*Note:* Hydrogen is the most abundant element in the universe; helium is second. See "Abundance of the chemical elements" in Wikipedia.]	41:6.2 Calcium is, in fact, the chief element of the matter-permeation of space throughout Orvonton. Our whole super-universe is sprinkled with minutely pulverized stone. Stone is literally the basic building matter for the planets and spheres of space.

SOURCE OR PARALLEL

Plaskett ... showed that whereas the stars themselves had all sorts of individual velocities, the material of the fixed [calcium and sodium] lines had the same or nearly the same velocity in all parts of the sky, as though it were one continuous medium throughout interstellar space. I think there can be no doubt that this research demonstrates the existence of a cosmic cloud pervading the stellar system (E 67).

[Compare E 67-69. Eddington finds nothing remarkable about the ability of calcium atoms to persist in an ionized state in interstellar space.]

[!]

The Sun's Chromosphere (Eddington 70)

[*Note:* Eddington never suggests that solar calcium escapes into space by riding light beams. He says that the ionized calcium atoms are held to the sun's chromosphere.]

[*Note:* The atomic number of sodium is 11; the atomic number of calcium is 20.]

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The cosmic cloud, the great space blanket, consists for the most part of the modified atoms of calcium.

The stone atom is one of the most prevalent and persistent of the elements.

It not only endures solar ionization—splitting—but persists in an associative identity even after it has been battered by the destructive X rays and shattered by the high solar temperatures.

Calcium possesses an individuality and a longevity excelling all of the more common forms of matter.

41:6.3 As your physicists have suspected, these mutilated remnants of solar calcium literally ride the light beams for varied distances, and thus their widespread dissemination throughout space is tremendously facilitated.

The sodium atom, under certain modifications, is also capable of light and energy locomotion.

The calcium feat is all the more remarkable since this element has almost twice the mass of sodium.

SOURCE OR PARALLEL	URANTIA PAPER 41
	Local space-permeation by calcium is due to the fact that it escapes from the solar photosphere, in modified form, by
The ordinary atmosphere of the sun terminates rather abruptly, but above it there is a deep though very rarefied layer called the chromosphere consisting of a few selected elements which are able to float—float, not on the top of the sun's atmosphere, but on the *sunbeams*. The art of riding a sunbeam is evidently rather difficult, because only a few of the elements have the necessary skill.	literally riding the outgoing sunbeams.
The most expert is calcium (E 70).	Of all the solar elements, calcium, notwithstanding its comparative bulk—containing as it does twenty revolving electrons—is the most successful
	in escaping from the solar interior to the realms of space.
	This explains why there is
The layer of calcium suspended on the sunlight is at least 5,000 miles thick (E 70).	a calcium layer, a gaseous stone surface, on the sun six thousand miles thick;
[It has always seemed odd that a rather heavy element (No. 20 in order of atomic weight) should be found in these uppermost regions where one would expect only the lightest atoms (E 72).]	and this despite the fact that nineteen lighter elements, and numerous heavier ones, are underneath.
	41:6.4 Calcium is an active and versatile element at solar temperatures.
The ordinary calcium atom has two rather loose electrons in its attendant system; the chemists express this by saying that it is a divalent element, the two loose electrons being especially important in determining the chemical behaviour (E 71).	The stone atom has two agile and loosely attached electrons in the two outer electronic circuits,
	which are very close together.

SOURCE OR PARALLEL	URANTIA PAPER 41
But under the conditions prevailing in the chromosphere one of the electrons is broken away, and the calcium atoms are in the same smashed state that gives rise to the 'fixed lines' in the interstellar cloud (E 71).	Early in the atomic struggle it loses its outer electron;
Calcium scores because it possesses a possible orbit of excitation only a little way above the normal orbit so that it can juggle the electron between these two orbits without serious risk (E 73).	whereupon it engages in a masterful act of juggling the nineteenth electron back and forth between the nineteenth and twentieth circuits of electronic revolution.
We now see that the special skill demanded is to be able to toss up an electron 20,000 times a second without ever making the fatal blunder of dropping it (E 72).	By tossing this nineteenth electron back and forth between its own orbit and that of its lost companion more than twenty-five thousand times a second,
	a mutilated stone atom is able partially to defy gravity and thus successfully to ride the emerging streams of light and energy, the sunbeams, to liberty and adventure.
The atoms in the chromosphere are kept floating above the sun like tiny shuttlecocks, dropping a little and then ascending again from the impulse of the light (E 71).	This calcium atom moves outward by alternate jerks of forward propulsion, grasping and letting go the sunbeam
	about twenty-five thousand times each second.
	And this is why stone is the chief component of the worlds of space. Calcium is the most expert solar-prison escaper.
	41:6.5 The agility of this acrobatic calcium electron is indicated by the fact that,
Milne's result is that an electron tossed into the higher solar orbit	when tossed by the temperature-X-ray solar forces to the circle of the higher orbit,

SOURCE OR PARALLEL	URANTIA PAPER 41
remains there for an average time of a hundred-millionth of a second before it spontaneously drops back again.	it only remains in that orbit for about one one-millionth of a second;
I may add that during this brief time	but before the electric-gravity power of the atomic nucleus pulls it back into its old orbit,
it makes something like a million revolutions in the upper orbit (E 73-74).	it is able to complete one million revolutions about the atomic center.
[Contrast E 75-76. Eddington speculates that calcium would escape into outer space in connection with the explosion of 'new stars' or novae, a position currently held by astronomers. Here is a case of the UB rejecting a correct speculation in favor of an unsupported scenario.]	41:6.6 Your sun has parted with an enormous quantity of its calcium, having lost tremendous amounts during the times of its convulsive eruptions in connection with the formation of the solar system.
By Milne's theory we can calculate the whole weight of the sun's calcium chromosphere. Its mass is about 300 million tons. One scarcely expects to meet with such a trifling figure in astronomy (E 76).	Much of the solar calcium is now in the outer crust of the sun.
Unknown Atoms and Interpretation of Spectra (Eddington 53)	
	41:6.7 It should be remembered that spectral analyses show only sun-surface compositions.
In the spectrum of Sirius the lines of hydrogen are exceedingly prominent and overwhelm everything else. We do not infer that Sirius is composed mainly of hydrogen; we infer instead that its surface is at a temperature near 10,000º, because it can be calculated that that is a temperature most favourable for a great development of these hydrogen lines. In the sun the most prominent spectrum is iron.	For example: Solar spectra exhibit many iron lines,
We do not infer that the sun is unusually rich in iron;	but iron is not the chief element in the sun.

SOURCE OR PARALLEL

we infer that it is at a comparatively low temperature near 6000º

favourable for the production of the iron spectrum (E 58).

[*Note:* The currently accepted figure is 9941º F., or 5505º C. Sadler apparently forgot that Eddington used Centigrade not Fahrenheit.]

I: THE INTERIOR OF A STAR (Eddington 9)

Ionization of Atoms (Eddington 17)

[*Contrast:* It is sometimes thought that the exceedingly high temperature assigned to the interior of a star is a modern sensationalism. That is not so. The early investigators, who neglected both ionization and radiation pressure, assigned much higher temperatures than those now accepted (E 24).]

[contd] At the high temperature inside a star

the battering of the particles by one another, and more especially the collision of the ether waves (X-rays) with atoms, cause electrons to be broken off and set free.... The breaking away of electrons from atoms is called *ionization* ... (E 17).

By means of the spectroscope we can find out a great deal about the chemical composition of the sun's atmosphere;

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This phenomenon is almost wholly due to

the present temperature of the sun's surface, a little less than 6,000 degrees,

this temperature being very favorable to the registry of the iron spectrum.

7. SOURCES OF SOLAR ENERGY

41:7.1 The internal temperature of many of the suns, even your own, is much higher than is commonly believed.

In the interior of a sun

practically no whole atoms exist;

they are all more or less shattered by the intensive X-ray bombardment which is indigenous to such high temperatures.

Regardless of what material elements may appear in the outer layers of a sun,

SOURCE OR PARALLEL	URANTIA PAPER 41
but it would not be fair to take this as a sample of the composition of the sun as a whole. It would be very risky to make a guess at the elements preponderating in the deep interior. Thus we seem to have reached a deadlock. But now it turns out that when the atoms are thoroughly smashed up, they all behave nearly alike ... (E 21-22).	those in the interior are rendered very similar by the dissociative action of the disruptive X rays. X ray is the great leveler of atomic existence.
Temperature in the Interior (Eddington 11) I mentioned just now a temperature of 6,000º [10832 F.]; that was the temperature near the surface—the region which we actually see (E 14).	41:7.2 The surface temperature of your sun is almost 6,000 degrees,
Going down into the interior the temperature rises rapidly to above a million degrees, and goes on increasing	but it rapidly increases as the interior is penetrated
until at the sun's centre it is about 40,000,000º [72,000,032 F.] (E 14).	until it attains the unbelievable height of about 35,000,000 degrees[6] in the central regions.
PREFACE (Eddington 5) Temperatures are expressed throughout in degrees Centigrade (E 6).	(All of these temperatures refer to your Fahrenheit scale.)
	41:7.3 All of these phenomena are indicative of enormous energy expenditure, and the sources of solar energy, named in the order of their importance, are:

SOURCE OR PARALLEL

III: THE AGE OF THE STARS (Eddington 85)

Subatomic Energy (Eddington 99)

[contd] This store of energy is, with insignificant exception, energy of constitution of atoms and electrons; that is to say, subatomic energy.... The main store of energy in a star cannot be used for radiation unless the matter composing the star is being annihilated (E 99).

[contd] It is possible that the star may have a long enough life without raiding the main energy store. A small part of the store can be released by a process less drastic than annihilation of matter, and this might be sufficient to keep the sun burning for 10,000,000,000 years or so, which is perhaps as long as we can reasonably require. The less drastic process is transmutation of the elements (E 99).

Transmutation of the elements—so long the dream of the alchemist—is realized in the transformation of radioactive substances (E 100).

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41:7.4 1. Annihilation of atoms and, eventually, of electrons.

41:7.5 2. Transmutation of elements,

including the radioactive group of energies thus liberated.[7]

41:7.6 3. The accumulation and transmission of certain universal space-energies.

SOURCE OR PARALLEL

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III: EXPLORING IN TIME (Jeans1 141)

THE SUN'S RADIATION (Jeans1 165)

In 1849, Robert Mayer suggested that the energy which the sun emitted as radiation might accrue to it from a continuous fall of shooting-stars or similar bodies into the solar atmosphere. The suggestion is untenable ... Mayer's hypothesis has to be abandoned (J1 166-67).

41:7.7 4. Space matter and meteors which are incessantly diving into the blazing suns.

III: THE AGE OF THE STARS (Eddington 85)

The Contraction Hypothesis (Eddington 94)

Contraction involves an approach or fall of the matter of the matter towards the centre;

41:7.8 5. Solar contraction;

gravitational potential energy is thus converted and made available as heat (E 94).

the cooling and consequent contraction of a sun yields energy and heat

sometimes greater than that supplied by space matter.

41:7.9 6. Gravity action at high temperatures transforms certain circuitized power into radiative energies.

41:7.10 7. Recaptive light and other matter which are drawn back into the sun after having left it, together with other energies having extrasolar origin.

[*Note:* I have not identified Sadler's source for this. In 1941 newspapers and magazines began reporting new findings into the temperature and composition of the sun's corona. See Appendix B for one such newspaper article.]

41:7.11 There exists a regulating blanket of hot gases (sometimes millions of degrees in temperature) which envelops the suns, and which acts to stabilize heat loss and otherwise prevent hazardous fluctuations of heat dissipation.

SOURCE OR PARALLEL

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III: THE AGE OF THE STARS (Eddington 85)

Evolution of the Stars (Eddington 106)

To outward view the star cools from 12,000° to 3,000° in passing down the [main] series, but there is no such change in its internal heat. The central temperature remains surprisingly steady....

It is very remarkable that all stars of the main series have a central temperature of about 40 million degrees as nearly as we can calculate (E 110-11).

Radiation of Mass (Eddington 113)

The strange thing is that the condition of balance is reached when the central temperature is near 40 million degrees—the same whether the star is at the top, middle, or bottom of the main series.... We can scarcely believe that there is a kind of boiling-point (independent of pressure) at which matter boils off into energy. The whole phenomenon is most perplexing (E 118).

[See 42:4.8.]

During the active life of a sun the internal temperature of 35,000,000 degrees remains about the same quite regardless of the progressive fall of the external temperature.

41:7.12 You might try to visualize 35,000,000 degrees of heat, in association with certain gravity pressures, as the electronic boiling point.

Under such pressure and at such temperature all atoms are degraded and broken up into their electronic and other ancestral components; even the electrons and other associations of ultimatons may be broken up, but the suns are not able to degrade the ultimatons.

41:7.13 These solar temperatures operate to enormously speed up the ultimatons and the electrons, at least such of the latter as continue to maintain their existence under these conditions.

SOURCE OR PARALLEL	URANTIA PAPER 41
I: THE INTERIOR OF A STAR (Eddington 9)	
[*Preamble*] (Eddington 9)	
	You will realize what high temperature means by way of the acceleration of ultimatonic and electronic activities when you pause to consider that
A drop of water contains several thousand million million million atoms (E 9).	one drop of ordinary water contains over one billion trillions of atoms.
III: THE AGE OF THE STARS (Eddington 85)	
Subatomic Energy (Eddington 99)	
The amount of this energy is amazingly large; by annihilating a single drop of water we should be supplied with 200 horsepower for a year (E 102-03).	This is the energy of more than one hundred horsepower exerted continuously for two years.
VI: THE FATE OF THE UNIVERSE (Swann 232)	
The heat sent out by the sun,	The total heat now given out by the solar system sun each second
if poured into the oceans of the earth, would cause them to boil in one second (S 237-38).	is sufficient to boil all the water in all the oceans on Urantia in just one second of time.
	41:7.14 Only those suns which function in the direct channels of the main streams of universe energy can shine on forever. Such solar furnaces blaze on indefinitely, being able to replenish their material losses by the intake of space-force and analogous circulating energy. But stars far removed from these chief channels of recharging are destined to undergo energy depletion—gradually cool off and eventually burn out.

SOURCE OR PARALLEL	URANTIA PAPER 41
[[*Compare:*] *Burned-out Suns.* Some of the dark islands of space are burned-out isolated suns, all available space-energy having been emitted. The organized units of matter approximate full condensation, virtual complete consolidation; and it requires ages upon ages for such enormous masses of highly condensed matter to be recharged in the circuits of space and thus to be prepared for new cycles of universe function following a collision or some equally revivifying cosmic happening (15:5.11).]	41:7.15 Such dead or dying suns can be rejuvenated by collisional impact or can be recharged by certain non-luminous energy islands of space or through gravity-robbery of near-by smaller suns or systems. The majority of dead suns will experience revivification by these or other evolutionary techniques.[8]
	Those which are not thus eventually recharged are destined to undergo disruption by mass explosion when the gravity condensation attains the critical level of ultimatonic condensation of energy pressure.
[*Note:* See 15:8.6 re "the rarest form of energy" (*i.e.* puissant energy).]	Such disappearing suns thus become energy of the rarest form, admirably adapted to energize other more favorably situated suns.

SOURCE OR PARALLEL

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8. SOLAR-ENERGY REACTIONS

"NEUTRINOS VS. SUPERNOVAE" (Gamow 65)

STELLAR EVOLUTION (Gamow 65)

But, although it was already clear at that time [1929] that the thermonuclear reaction responsible for the energy supply of stars must be taking place between hydrogen nuclei (protons) and the nuclei of some other light element, the insufficient knowledge of various nuclear processes prevented the discovery of the reaction itself. And it was only recently (1939) that the particular nuclear reaction, or rather chain of reactions, responsible for the energy production in the sun and all other stars of the main sequence was found by Bethe.

41:8.1 In those suns which are encircuited in the space-energy channels, solar energy is liberated by various complex nuclear-reaction chains,

the most common of which is the hydrogen-carbon-helium reaction.

[*Note:* Only stars with a mass of at least 1.3 solar masses produce most of their energy by the hydrogen-carbon-helium reaction (today known as the CNO cycle). A different process—the proton-proton chain reaction—is dominant in our sun and other smaller stars. Only 1.7% of our sun's helium nuclei are born in the CNO cycle.]

[See six rows down.]

In this metamorphosis, carbon acts as an energy catalyst since it is in no way actually changed by this process of converting hydrogen into helium.

According to Bethe, the light element which reacts with hydrogen (in the nuclear sense) at the high temperatures of the stellar interior is ordinary carbon. Penetrating into the interior of carbon nuclei, protons emit their surplus energy in the form of hard γ-rays, and remain in the bound state, thus giving rise to somewhat heavier nuclei.

Under certain conditions of high temperature the hydrogen penetrates the carbon nuclei.

SOURCE OR PARALLEL	URANTIA PAPER 41
However, the nucleus of carbon can not hold more than four protons	Since the carbon cannot hold more than four such protons,
and, as soon as the saturation point is reached,	when this saturation state is attained,
	it begins to emit protons as fast as new ones arrive.
it "spits them out" in the form of a single α-particle, or the nucleus of a helium atom.	In this reaction the ingoing hydrogen particles come forth as a helium atom.
The carbon nucleus emerging from this process in its original form is ready again to capture new protons and to unite them into a new α-particle. Thus we see that the carbon plays only the role of what the chemists would call a catalizer, and the net result of nuclear reaction is the transformation of hydrogen into helium (G 66).	
Since the nuclear reactions, transforming hydrogen into helium, cause definite changes in the physical properties of stellar matter, one should expect that they must result in certain changes of the observed characteristics of the star itself. This question was studied in some detail by the author of this article, and it was found that the steady decrease of the hydrogen content in the star must lead to a quite considerable increase of its luminosity (G 66).	41:8.2 Reduction of hydrogen content increases the luminosity of a sun.
	In the suns destined to burn out,
After the star, following the path of its evolution, reaches this state of maximum luminosity, the hydrogen content in its body will be entirely exhausted (G 66).	the height of luminosity is attained at the point of hydrogen exhaustion.

SOURCE OR PARALLEL	URANTIA PAPER 41
During these late stages of stellar evolution,	Subsequent to this point,
the radiation of the star is supported by the gravitational energy liberated in contraction, and the luminosity of the aging star is gradually dropping down.	brilliance is maintained by the resultant process of gravity contraction.
The final stage of the contraction must be represented by a very dense star, which might be, however, still quite hot. Examples of such dying stars are given by the so-called "white dwarfs" possessing very low luminosities,	Eventually, such a star will become a so-called white dwarf,
and the estimated density exceeding the density of water by a factor of several hundred thousand (G 66-67).	a highly condensed sphere.
THE CAUSE OF SUDDEN COLLAPSE (Gamow 68)	
[*Note:* Gamow doesn't confine novae or supernovae to large suns, let alone "small circular nebulae".]	41:8.3 In large suns—small circular nebulae—
As soon, however, as the hydrogen content is completely exhausted, no more subatomic energy is available	when hydrogen is exhausted
and the star must begin to contract, thus turning into radiation its potential energy of gravity. The process of such gravitational contraction will, however, go very slowly, since, because of the high opacity of stellar material, the heat transport from the interior to the surface is very slow (G 68).	and gravity contraction ensues,

SOURCE OR PARALLEL	URANTIA PAPER 41
[T]he only way to accelerate the contraction of a star and to turn it into a rapid collapse as observed in the case of the novae and supernovae, would be devise some mechanism which would remove from the interior the energy liberated in the contraction. If, for example, the opacity of stellar matter could be reduced by a factor of several billions,	if such a body is not sufficiently opaque to retain the internal pressure of support for the outer gas regions,
the contraction would be accelerated in the same proportion, and a contracting star would collapse within a few days.	then a sudden collapse occurs.
This possibility is, however, quite excluded, since the present theory of radiation definitely shows that the opacity of stellar matter is quite definitely a function of its density and temperature, and can hardly be reduced even by so much as a factor of ten or hundred (G 68).	
[*Note:* Gamow suggests that neutrinos are produced only at very high temperatures, during the star's contraction following the complete consumption of hydrogen. See G 70.]	The gravity-electric changes give origin to vast quantities of
It was recently proposed by the author of this article and his colleague, Dr. Sch[o]enberg, that the real cause of stellar collapses is due to certain tiny particles, which were but recently introduced in physics and are known under the name of neutrinos (G 69).	tiny particles
It was first suggested by Pauli that these run-away particles, which he called "neutrinos," can account for all observed discrepancies [of measured energy losses in radioactive decay] if one supposes that they carry no electric charge and possess a mass considerably smaller than the mass of the electron (G 69).	devoid of electric potential,

SOURCE OR PARALLEL

It is clear from the above description of the new particle that it is just the right agent to remove the surplus energy from the interior of a contracting star, since the entire body of the star is just as transparent for neutrinos as a window pane is for ordinary light (G 69).

STELLAR CATASTROPHES (Gamow 67)

The first extragalactic supernova was observed in 1885 in the neighboring stellar system known as The Great Andromeda Nebula, its luminosity exceeding by a factor of one thousand the luminosities of all other novae ever seen in this system (G 67).

[*Compare:* In the case of oxygen (where the unstable product is radioactive nitrogen with the decay period of 9 seconds) the star can lose even as much as 10^{17} ergs per second per each gram of its material. The energy losses in this ... case are so high that the complete collapse of the star takes place in only twenty-five minutes (G 70).]

As in the case of ordinary novae, a supernova explosion gives rise to a rapidly expanding gas shell, which, however, takes a considerably larger fraction of the stellar mass. In fact, whereas the gas shells emitted by novae become thinner and thinner and dissolve themselves rapidly in the surrounding space, the gas masses emitted by supernovae form extensive luminous nebulae involving the place of explosion.

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and such particles readily escape from the solar interior,

thus bringing about the collapse of a gigantic sun within a few days.

It was such an emigration of these "runaway particles" that occasioned

the collapse of the giant nova of the Andromeda nebula about fifty years ago.

This vast stellar body collapsed in forty minutes of Urantia time.

41:8.4 As a rule, the vast extrusion of matter continues to exist about the residual cooling sun as extensive clouds of nebular gases.

It can be, for example, considered as definitely established that the so-called "Crab Nebula," seen at the place of the supernova of the year 1054, was formed by gases expelled during that explosion.

In fact, in the very center of the Crab Nebula, observations show the presence of a faint star which, according to its observed properties, must be classified as a very dense white dwarf (G 68).

And all this explains the origin of many types of irregular nebulae,

such as the Crab nebula, which had its origin about nine hundred years ago,

and which still exhibits the mother sphere as a lone star near the center of this irregular nebular mass.

9. SUN STABILITY

[!]

41:9.1 The larger suns maintain such a gravity control over their electrons that light escapes only with the aid of the powerful X rays. These helper rays penetrate all space and are concerned in the maintenance of the basic ultimatonic associations of energy. The great energy losses in the early days of a sun, subsequent to its attainment of maximum temperature—upwards of 35,000,000 degrees—are not so much due to light escape as to ultimatonic leakage. These ultimaton energies escape out into space, to engage in the adventure of electronic association and energy materialization, as a veritable energy blast during adolescent solar times.

41:9.2 Atoms and electrons are subject to gravity. The ultimatons are not subject to local gravity, the interplay of material attraction, but they are fully obedient to absolute or Paradise gravity, to the trend, the swing, of the universal and eternal circle of the universe of universes.

SOURCE OR PARALLEL	URANTIA PAPER 41
	Ultimatonic energy does not obey the linear or direct gravity attraction of near-by or remote material masses, but it does ever swing true to the circuit of the great ellipse of the far-flung creation.
III: THE AGE OF THE STARS (Eddington 85)	
Evolution of the Stars (Eddington 106)	
The sun is losing 120 billion [*i.e.* trillion] tons annually whether its radiation comes from annihilation of matter or any other internal source (E 111).	41:9.3 Your own solar center radiates almost one hundred billion tons of actual matter annually,
[*Note:* Jeans also made clear that the amount of weight loss in tonnage was in the trillions not the billions: "It appears that the sun as a whole is losing weight at the rate of rather over 4 million tons a second, or about 250 million tons a minute ... Two hundred and fifty million tons a minute is 360,000 million tons a day.... And 360,000 million tons a day is 131 million million tons a year" (J1 168).]	
Radiation of Mass (Eddington 113)	
A star of greater mass than Algol squanders its mass very rapidly,	while the giant suns lose matter at a prodigious rate during their earlier growth, the first billion years.
so that we do not increase the age of the Sun appreciably by supposing it to have started with greater mass than Algol (E 114).	

SOURCE OR PARALLEL	URANTIA PAPER 41
After a change of mass the star has to resolve the problem of the internal conditions necessary for its equilibrium. So far as mechanical conditions are concerned (supporting the weight of the upper layers) it can choose any one of a series of states of different density provided it has the internal temperature appropriate to that density. But such equilibrium is only temporary, and the star will not really settle down until the tap of subatomic energy is opened	A sun's life becomes stable after the maximum of internal temperature is reached, and the subatomic energies begin to be released.
to the right extent to balance the rate of radiation which, as we have already seen, is practically fixed by the mass (E 117).	
[*Note:* Eddington begins on E 118-19 to discuss the question why δ Cephei pulsates. He maintains that pulsating stars are a rare exception.]	And it is just at this critical point that the larger suns are given to convulsive pulsations.
I: THE INTERIOR OF A STAR (Eddington 9)	
Temperature in the Interior (Eddington 11)	
	41:9.4 Sun stability is wholly dependent on the equilibrium between gravity-heat contention—tremendous pressures counterbalanced by unimagined temperatures.
Now imagine yourself at some point deep down in the star where you can look upwards towards the surface or downwards towards the centre. Wherever you are, a certain condition of balance must be reached; on the one hand there is the weight of all the layers above you pressing downwards and trying to squeeze closer the gas beneath; on the other hand there is the elasticity of the gas below you trying to expand and force the superincumbent layers outwards.	The interior gas elasticity of the suns upholds the overlying layers of varied materials,

SOURCE OR PARALLEL	URANTIA PAPER 41
Since neither one thing nor the other happens and the star remains practically unchanged for hundreds of years, we must infer that the two tendencies just balance.	and when gravity and heat are in equilibrium,
At each point the elasticity of the gas must be just enough to balance the weight of the layers above ... (E 12).	the weight of the outer materials exactly equals the temperature pressure of the underlying and interior gases.
[*Note:* Neither Eddington nor Jeans says this.]	In many of the younger stars continued gravity condensation produces ever-heightening internal temperatures, and as internal heat increases, the interior X-ray pressure of supergas winds becomes so great that, in connection with the centrifugal motion, a sun begins to throw its exterior layers off into space, thus redressing the imbalance between gravity and heat.
	41:9.5 Your own sun has long since attained relative equilibrium between its expansion and contraction cycles, those disturbances which produce the gigantic pulsations of many of the younger stars.
III: THE AGE OF THE STARS (Eddington 85)	
Radiation of Mass (Eddington 113)	
The upper limit to the present age of the Sun is 5.2 billion [trillion] years however great its initial mass (E 114).	Your sun is now passing out of its six billionth year.
	At the present time it is functioning through the period of greatest economy.

SOURCE OR PARALLEL

Energy of 1.8 . 10^54 ergs has a mass 2 . 10^33 grammes which is the mass of the sun; consequently that is the sum total of the energy which the sun contains—the energy which has to last it all the rest of its life. We do not know how much of this is capable of being converted into heat and radiation; if it is all convertible there is enough to maintain the sun's radiation at the present rate for 15 billion [trillion] years (E 98).

[See 57:5.]

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It will shine on as of present efficiency for more than twenty-five billion years.

It will probably experience a partially efficient period of decline as long as the combined periods of its youth and stabilized function.

10. ORIGIN OF INHABITED WORLDS

41:10.1 Some of the variable stars, in or near the state of maximum pulsation, are in process of giving origin to subsidiary systems, many of which will eventually be much like your own sun and its revolving planets. Your sun was in just such a state of mighty pulsation when the massive Angona system swung into near approach, and the outer surface of the sun began to erupt veritable streams—continuous sheets—of matter. This kept up with ever-increasing violence until nearest apposition, when the limits of solar cohesion were reached and a vast pinnacle of matter, the ancestor of the solar system, was disgorged.

In similar circumstances the closest approach of the attracting body sometimes draws off whole planets, even a quarter or third of a sun. These major extrusions form certain peculiar cloud-bound types of worlds, spheres much like Jupiter and Saturn.

41:10.2 The majority of solar systems, however, had an origin entirely different from yours, and this is true even of those which were produced by gravity-tidal technique. But no matter what technique of world building obtains, gravity always produces the solar system type of creation; that is, a central sun or dark island with planets, satellites, subsatellites, and meteors.

41:10.3 The physical aspects of the individual worlds are largely determined by mode of origin, astronomical situation, and physical environment. Age, size, rate of revolution, and velocity through space are also determining factors. Both the gas-contraction and the solid-accretion worlds are characterized by mountains and, during their earlier life, when not too small, by water and air. The molten-split and collisional worlds are sometimes without extensive mountain ranges.

[?]

41:10.4 During the earlier ages of all these new worlds, earthquakes are frequent, and they are all characterized by great physical disturbances; especially is this true of the gas-contraction spheres, the worlds born of the immense nebular rings which are left behind in the wake of the early condensation and contraction of certain individual suns.

[See 15:5.3.]

Planets having a dual origin like Urantia pass through a less violent and stormy youthful career. Even so, your world experienced an early phase of mighty upheavals, characterized by volcanoes, earthquakes, floods, and terrific storms.

SOURCE OR PARALLEL	URANTIA PAPER 41
	41:10.5 Urantia is comparatively isolated on the outskirts of Satania, your solar system, with one exception, being the farthest removed from Jerusem, while Satania itself is next to the outermost system of Norlatiadek, and this constellation is now traversing the outer fringe of Nebadon. You were truly among the least of all creation until Michael's bestowal elevated your planet to a position of honor and great universe interest.
[So the last shall be first, and the first last: for many be called, but few chosen (Matt. 20:16).]	Sometimes the last is first, while truly the least becomes greatest.
	41:10.6 [Presented by an Archangel in collaboration with the Chief of Nebadon Power Centers.]

1. Nebulae are not directly related to any of the administrative units, such as minor sectors or local universes, although some local universes have been organized from the products of a single nebula. Each local universe embraces exactly one one-hundred-thousandth part of the total energy charge of a superuniverse irrespective of nebular relationship, for energy is not organized by nebulae--it is universally distributed (15:4.6).

The energy charge of a local universe is approximately one one-hundred-thousandth of the force endowment of its superuniverse. In the case of Nebadon, your local universe, the mass materialization is a trifle less (32:1.4).

2. We may say with confidence that, throughout the galactic universe, matter is everywhere composed of the same kinds of atoms and that their behaviour is everywhere governed by the same laws (Ernest William Barnes, *Scientific Theory and Religion* (1933), p. 341).

3. Jeans mentions that Sirius B, a white dwarf, contains on average one ton of matter per cubic inch (J1 250), and that Van Maanen's star, another white dwarf, has a density amounting to ten tons or so to the cubic inch.

4. [The sun's] density of 1½ times that of water is still very far indeed from the maximum density of stellar matter; and it is therefore entirely reasonable that we should find it behaving like a perfect gas (E 52-53).

5. Betelgeuse's surface temperature in Fahrenheit is about 5840º. Sadler again neglected to convert Eddington's Centigrade to Fahrenheit.

6. The currently accepted figure is 27,000,000º F.

7. Are any radioactive elements involved in solar thermonuclear fusion?

8. *Compare:* The next stars in line are all faint and deep red in color. They are the carbon stars. Their cycle is about over. They will ride mutely at terrible rates across the far meadows of the universe awaiting life, a reviving crash perhaps, collision, heat, new love, rejuvenation (Baker Brownell, *The New Universe: An Outline of the Worlds in which We Live* (1926), p. 43).

Compare: In the days when it was thought that the whole of space was filled with stars moving at random, novae were thought to result from chance collisions between neighbouring stars. New stars were thus supposed to be born to replace those whose light had faded away: cold planets in this way became hot stars.... But the idea that planets or stars which have lost their heat are thus again brought to incandescence and start a new lease of life finds no confirmation in modern investigation (Ernest William Barnes, *Scientific Theory and Religion* (1933), p. 369).