Chapter 32

COMPOSITION OF THE UNIVERSE

Lower-energy hydrogen, hydrinos, comprises the dark matter of the universe such that all matter is ordinary (baryonic) matter, and the mass of the Universe is sufficient for it to be closed [30, 31]. The standard theory of big bang nucleosynthesis explains the observed abundance of light elements (H, He, and Li) only if the present density of ordinary (baryonic) matter is less than 10 % of the critical value [43, 44] which is not the case. Recently, the missing mass has been showed to be baryonic rather than strange matter [45]. According to classical physics (CP), ***the abundance of hydrogen is determined by a hydrogen atom production/annihilation cycle and the abundance of heavier elements is determined by a nucleosynthesis/annihilation cycle that drive an expansion-contraction cycle of the universe***. Hydrogen atom and heavy elemental annihilation dominate during the expansion phase and hydrogen production and stellar nucleosynthesis dominate during the contraction phase. In the latter case, stellar and galaxy evolution occurred during the contraction phase as revealed by high-redshift radio galaxies and galaxies associated with extremely distant, luminous quasars that date back to the beginning of the expansion [46, 47]. The presence of metal lines in quasars demand a previous generation of stars (two generations for nitrogen) that is consistent with the stellar nucleosynthesis origin of the Li, He, and heavier elements [46]. Since H comprises essentially all of the mass of the universe, the abundance of hydrogen for any r-sphere can be determined from the power of the universe as a function of time (Eq. (32.161)) over the oscillatory cycle. The abundance of heavier elements may be determined from the nucleosynthesis rates in stars as a function of age.

As discussed previously in the Quantum Gravity of Fundamental Particles section, ordinarily, a photon gives rise to a particle and an antiparticle. The event must be spacelike or annihilation would occur. The event must also conserve energy, momentum, charge, and satisfy the condition that the speed of light is a constant maximum. Eqs. (32.14-32.17) give the relationship whereby matter causes relativistic corrections to spacetime that determines the curvature of spacetime and is the origin of gravity. To satisfy the boundary conditions, particle production from a single photon requires the production of an antimatter particle as well as a particle. The transition state from a photon to a particle and antiparticle comprises two concentric atomic orbitals called transition state atomic orbitals. The gravitational effect of a spherical shell on an object outside of the radius of the shell is equivalent to that of a point of equal mass at the origin. Thus, the proper time of the concentric atomic orbital with radius ${}^{+}r^{*}$ (the radius is infinitesimally greater than that of the inner transition state atomic orbital with radius r^{*}) is given by the Schwarzschild metric, Eq. (32.38). The proper time applies to each point on the atomic orbital. Therefore, consider a general point in the xy-plane having $r = \lambda\!\!\!{}^{-}_C$; $dr = 0$; $d\theta = 0$; $\sin^2\theta = 1$. Substitution of these parameters into Eq. (32.38) gives:

$$d\tau = dt\left(1 - \frac{2Gm_0}{c^2 r_\alpha^*} - \frac{v^2}{c^2}\right)^{\frac{1}{2}} \tag{32.169}$$

with $v^2 = c^2$, Eq. (32.169) becomes

$$\tau = ti\sqrt{\frac{2GM}{c^2 r_\alpha^*}} = ti\sqrt{\frac{2GM}{c^2 \lambda\!\!\!{}^{-}_c}} \tag{32.170}$$

The coordinate time is imaginary because particle/antiparticle production is spacelike. The left-hand side of Eq. (32.170) represents the proper time of the particle/antiparticle as the photon atomic orbital becomes matter. The right-hand side of Eq. (32.170) represents the correction to the laboratory coordinate metric for time corresponding to the curvature of spacetime by the particle production event and is the origin of gravity. Consider the special case that antimatter is not produced in a H atom annihilation and production cycle that drives the oscillatory expansion-contraction cycle of the universe.

H ATOM DECAY AND PRODUCTION CYCLE DRIVE THE OSCILLATORY SPACETIME EXPANSION-CONTRACTION CYCLE OF THE UNIVERSE

The recycling of matter and energy in the universe occurs in an oscillatory cycle wherein matter converts to energy primarily by hydrogen atom decay via a hydrino pathway [48], and energy to matter conversion occurs by hydrogen atom production during gamma ray bursts. The matter-energy cycle drives a dependent space-time expansion contraction cycle. The decaying dark matter signatures of power and 511 keV gamma, neutral pion, and neutron capture emission match those of hydrogen atom decay from the high-p-state hydrino inventory comprising the dark matter. The characteristics, composition, and high energetics of cosmic rays in the absence of neutrino emission overturn long-held theory but match the signatures of H atom production.

The rates of production and annihilation of matter and energy match those required to the complete the cycle over the period of oscillation of the universe. The H(1/p) annihilation reaction dominates over the H matter production reaction during the expansion phase wherein the power and temperature of the universe at the beginning of the expansion is at a maximum. Conversely, the H matter production reaction dominates over the H(1/p) annihilation reaction the during the contraction phase wherein the power and temperature of the universe at the beginning of the contraction are at a minimum.

Consider H decay. When the energy in the electric field of the proton is exhausted in the transition of the electron to hydrino states H(1/p) of higher p quantum number, the electron orbit at the reduced radius cannot be maintained, the hydrogen atom collapses, and annihilates as gamma rays through a positron and neutral pion decay pathway. High-p-state H atom decay reaction given by Eq. (5.118) is

$$\begin{array}{cccc} H\left(1/p\right)\rightarrow & e^{+}+e^{-}+ & \pi^{0} \\ & \downarrow & \downarrow \\ & 2\gamma & 2\gamma \end{array} \tag{32.171}$$

wherein e^{+} is the positron, e^{-} is the electron, π^{0} is the neutral pion, and γ is a gamma ray. Collision of the positron with the electron produces the characteristic 511 keV annihilation energy emission. 511 keV radiation produced according to Eq. (32.171) is observed as a distinct peak in the cosmic gamma ray spectrum (Figure 5.4) wherein the forerunner explanation of the diffuse 511keV positron annihilation emission [49-54] with no point source [50] and a narrow linewidth [53-54] is decaying dark matter [49-54]. Specifically, decay of H(1/p), hydrino as the identity of dark matter as given in the Dark Matter section, Refs.[48,55] is the ubiquitous 511 keV gamma source. Further support of this dark matter decay assignment is that the neutral pion π^{0} decay energy is also observed as a maximum intensity broad peak in the cosmic gamma ray spectrum [56]. Concerted H(1/p) decay may also give rise to gamma ray bursts consistent with the gamma ray spectrum recorded on a burst [57] showing a characteristic "π0-decay bump" [56]. These are likely, the long duration, lower energy type gamma ray bursts. In addition to 511 keV gamma ray emission, neutral pion π^{0}, gamma and X-ray, and neutron capture emission observed from a broad array of astrophysical environments such as interstellar medium, supernova remnants (SNRs), molecular clouds, galaxy clusters, and other sources [56] as well as solar flares [58] and thunderstorms [59], the subsequent photoneutron production (Eq. (5.119)), and neutron capture emission are assigned to H(1/p) decay as given in the Hydrino Catalyzed Fusion (HCF) and Proton Decay section.

Consider H production. Gamma ray bursts (GRBs) are a mechanism of both matter to energy conversion and energy to matter conversion to recycle protons and electrons from heavy nuclei, photons, and neutrinos accumulated by black holes during the oscillatory expansion-contraction cycle of the universe. Proton and electron decay and production occur in both the expansion and contraction phases with decay dominating during expansion and production dominating during contraction. Astrophysical observations discussed *infra* and the Hydrino Catalyzed Fusion (HCF) and Proton Decay section confirm that hydrino H(1/p) and H_2(1/p) are the dark matter of the universe which currently comprises the total mass of the universe except for a few percent non-hydrino hydrogen and traces of other elements. Decay of the high-state-p H(1/p) inventory is ubiquitous throughout the cosmos wherein H(1/p) decay is the mechanism of conversion protons and electrons into energy predominantly during the expansion phase. As shown in the Hydrino Catalyzed Fusion (HCF) and Proton Decay section the rate is commensurate with that required to recycle protons during the oscillatory cycle. Consider the fate of heavy nuclei and the particle production mechanism for protons and electrons. When the mass density of a black hole reaches the threshold of the Planck mass density a gamma ray burst occurs further contributing to the energy production portion of the pathway of recycling of protons. Concerted H(1/p) decay may also give rise to lower-energy gamma ray bursts consistent with the gamma ray spectrum recorded on a burst [57] showing a characteristic "π^0-decay bump" [56]. GRBs driven by H(1/p) decay are likely, the long duration, lower energy type GRBs; whereas GRBs drive by matter to energy conversion at the Planck mass density are likely, the short duration, high energy type GRBs.

Hydrogen atoms are recycled by proton and electron production following the reverse pathway of hydrogen atom decay (Eq. (32.171)). The conversion of matter into energy during a GRB causes spacetime to expand such that gamma rays escape. The production mass of a proton given by the mass of the neutron (Eq. (37.42)) less the mass energy of neutron decay reaction given in the Weak Nuclear Force: Beta Decay of the Neutron section is $1.672648\ X\ 10^{-27}\ kg$. The experimental proton mass is $1.672648\ X\ 10^{-27}\ kg$ corresponding to a 938 MeV gamma ray photon. The production mass each of the electron and positron are given by Eq. (36.3) corresponding to a 511 keV gamma ray energy photon. The energy of the production gamma ray incident the particle that supports the production event must be greater than the sum of the energy of each particle corresponding to 939 MeV. When the emitted gamma rays of energy in excess of the production energy pass the event horizon of the black hole source of the GRB event, gamma photons undergo collisions with matter particles such as protons H atom particles may be produced. With the collision of a gamma ray photon with a particle under the extreme local conditions of a high-energy black-hole gamma ray burst, a positron, a neutral pion, and an electron form. The positron and neutral pion combine to form a proton. The proton may capture the electron to form a hydrogen atom to complete the cycle of H atom recycling.

$$\begin{array}{ccc} \gamma \xrightarrow{p^{+}} & e^{-} + & e^{+} + \pi^{0} \\ & \downarrow & \downarrow \\ & e^{-} & p^{+} \\ & \multicolumn{2}{c}{\downarrow} \\ & \multicolumn{2}{c}{H} \end{array} \tag{32.172}$$

wherein γ is a gamma ray, e^{-} is the electron, e^{+} is the positron, π^{0} is the neutral pion, p^{+} is the proton, and H is the hydrogen atom. ***From Eq. (32.172), the number of electrons exactly balances the number of protons. Thus, the Universe is electrically neutral.*** Typically, antimatter and matter are created in the laboratory in equal amounts; yet ***celestial antimatter is not observed***. An alternative pathway is the production of a proton and an antiproton through a collision of a gamma ray with a proton. However, this pathway is unproductive. ***No antimatter is produced due to it being annihilated in the reverse of the production reaction wherein the antiproton annihilates the incident proton with the condition of the universe comprising matter such as protons and photons only***.

As in case of H decay, the H production rate is commensurate with that required to recycle protons during the oscillatory cycle. Gamma-ray bursts (GRBs), considered the most powerful explosions known in the universe, are hundreds of times brighter than a typical supernova and essentially the brightest source of light in the observable universe when they erupt. GRB release immense amounts of energy is a short burst, often brighter than a billion trillion suns and capable of emitting more energy in a few seconds than the Sun will produce in its entire lifetime of 10B years. A GRB is detected roughly once per day; however, most of these bursts occur at very distant galaxies, far beyond our own Milky Way, or the burst axis is oriented in a direction away from the view of Earth. The actual rate of occurrence across the universe is much higher, with many bursts simply too far away or out of view to detect. There are estimated to be 100M black holes in the Milky Way galaxy. Neutron stars and pulsars, supernova explosions, and regions around black holes emit gamma rays that give rise to cosmic rays. The energy to matter conversion rate is a maximum at the beginning of the contraction phase and is a minimum at the beginning of the expansion phase, wherein the Earth is about 10B years into the expansion phase of a 1T year cycle. As an estimate of the magnitude of the GRB matter production yield consider that the one event that we observe per day at Earth within our narrow, non-axial view angle and single position in the universe is only 0.1% of the actual event rate. Black holes can be millions to billions of times the mass of the Sun. ***The equivalent mass/energy of a black hole GRB of 10^{6} Suns corrected for viewing limitations over the period of the universe of 1T years is equivalent to the mass of the universe of about 10^{54} kg such that the time of the decay of total H inventory of 10^{54} kg matches the time of the production of the total H inventory of 10^{54} kg over the period of the matter-energy/spacetime expansion-contraction cycle of the universe.***

Gamma ray bursts are also the source of cosmic rays discussed *infra*. Consider that H atom production follows the reverse path of decay. Proton and electron production occur with the collision of a gamma ray with a particle such as a proton of a gamma ray burst wherein the relativistic velocities of the particles exceed the gravitational escape velocity for the diminished mass of the black hole. Thus, in additions to gamma rays, relativistic protons and electrons are ejected from gamma ray burst events to recycle H atoms throughout the cosmos [63,64]. The production of protons and electrons is consistent the composition of cosmic rays comprising protons followed in abundance by electrons [65,66] with no heavy nuclei. Trace amounts of other light nuclei such as deuterium and helium nuclei are believed to be secondary elements [67]. The absence of heavy nuclei rules out mass ejection as the source of the cosmic rays where in heavy nuclei are observed, predominantly from supernovas [68-69].

Using the IceCube Neutrino Observatory, a massive detector in Antarctica, the IceCube collaboration searched for neutrinos emitted from 300 gamma ray bursts and found no evidence of a correlation between neutrino events and GRBs disproving the theory held for over15 years that high-energy neutrinos are produced with the corresponding cosmic rays from GRBs [70]. However, the absence of neutrino production with the production of cosmic rays is consistent with relativistic proton and electron production from gamma rays of GRBs according to Eq. (32.173).

The cosmic ray particles spread to distant locations where they remain local whereas the gamma rays that are not converted to particles may be recycled by capture in other blackholes. Rather than being particles with non-zero rest mass, neutrinos such as the electron neutrino and the electron antineutrino are special types of photons as given in the Neutrino section. Massless neutrinos travel at light speed for all observers. Neutrinos and antineutrinos may also annihilate each other in black holes wherein the annihilation energy is recycled during the GRB. Neutrinos may also be absorbed by molecular hydrinos comprising a spin ½ molecular orbital and each converted to two photons as given in the Neutrino section.

As shown *supra.* concerted H(1/p) decay is *a source of nonthermal γ-ray bursts from solar, interstellar and other regions.* In addition to those corresponding to Eq. (32.172), another source of nonthermal γ-ray bursts from interstellar regions [71] is the conversion of matter to photons of the Planck mass-energy, which may also give rise to cosmic rays. When the gravitational potential energy density of a massive body such as a blackhole equals that of a particle having the Planck mass as given by Eqs. (32.22-32.32), the matter may transition to photons of the Planck mass given by Eq. (32.31). In the case of the Planck mass, the gravitational potential energy (Eq, (32.30)) is equal to the Planck, electric, and magnetic energies which equal mc^{2} (Eq. (32.32)), and the coordinate time is equal to the proper time (Eqs. (32.33-32.34) and Eq. (32.43)). However, the particle corresponding to the Planck mass may not form since its gravitational velocity (Eq. (32.33)) is the speed of light.

> *The limiting speed of light eliminates the singularity problem of Einstein's equation that arises as the radius of a blackhole equals the Schwarzschild radius. General relativity with the singularity eliminated resolves the paradox of the infinite propagation velocity required for the gravitational force in order to explain why the angular momentum of objects orbiting a gravitating body does not increase due to the finite propagation delay of the gravitational force according to special relativity [72].*

Thus, it remains a photon. Even light from a blackhole will escape when the decay rate of the trapped matter with the concomitant spacetime expansion is greater than the effects of gravity that oppose this expansion. The annihilation of a blackhole may be the source of *gamma ray bursts*. As discussed supra. gamma-ray bursts (GRBs) are the most energetic phenomenon known that can release an explosion of gamma rays packing 100 times more energy than a supernova explosion [73]. Cosmic rays are the most energetic particles known, and their origin is also a mystery [74]. In 1966, Cornell University's Kenneth Greisen predicted that interaction with the ubiquitous photons of the cosmic microwave background would result in a smooth power-law cosmic-ray energy spectrum being sharply cutoff close to $5\,X\,10^{19}\;eV$. However, in 1998, Schwarzschild reported [75] that the *Akeno Giant Air Shower Array (AGASA) in Japan has collected data that show the cosmic-ray energy spectrum is extending beyond the Greisen-Zatsepin-Kuzmin (GZK) cutoff.* According to the GZK cutoff, the cosmic spectrum cannot extend beyond $5\,X\,10^{19}\;eV$, but AGASA, the world's largest air shower array, has shown that the spectrum is extending beyond without any clear sign of cutoff. Similarly, the Utah Fly's Eye had detected cosmic rays with energy up to $3\,X\,10^{20}\;eV$ [76,77]. *Photons, each of the Planck mass, may be the source of these inexplicably energetic cosmic rays* corresponding to tremendous power and concomitant spacetime expansion. The Planck mass conversion of matter into energy may also be the unprecedented X-ray power of the ultraluminous pulsar: NuSTAR [78]. The gamma ray burst energy supports H production to recycle matter as given *supra*.

The Universe is oscillatory in matter, energy, and spacetime without the existence of antimatter due to the existence of only matter during production and the relationship of particle production versus photon production to spacetime contraction and expansion given by Eq. (32.140). During the expansion phase, ***the arrow of time runs forward*** to lower mass and higher entropy states whereas, during collapse, ***the arrow of time runs backwards*** relative to the case of the universe in a state of expansion. Recent particle physics experiments demonstrate that the decay of kaons and antikaons follows a law that is not symmetric with respect to time reversal [39]. The data reveals that there is a microscopic arrow of time, in addition to the thermodynamic and cosmological arrows.

Before the expansion phase begins, the Universe evolves to higher mass and lower entropy states. Thus, biological organisms such as humans, which rely on the spontaneity of chemical reactions with respect to the forward arrow of time cannot exist in the contracting phase of the Universe. And, compared to the period of the Universe, the ***origins of life*** occurred at a time very close to the beginning of the expansion of the Universe when the direction of the spontaneity of reactions changed to the direction of increasing entropy and the rate of the increase in entropy of the Universe was a maximum.

The origin of the microwave background radiation (CMBR) as the power from the Universe rather than from a Big Bang creation event is demonstrated by the absence of the shadows in the CMBR required for the Big Bang model [36]. As shown in the Power Spectrum of the Cosmic Microwave Background section, when the Universe reaches the maximum radius of the time harmonic variation in the radius of the Universe, (Eq. (32.150)), it is radiation filled. Since the photon has no gravitational mass, and spacetime expansion is determined by photon production the energy density or radiation is uniform. As energy converts into matter the power of the Universe may be considered negative for the first quarter cycle starting from the point of maximum expansion as given by Eq. (32.150), and spacetime contracts according to Eq. (32.140). The gravitational field from particle production travels as a light wave front. As the Universe contracts to a minimum radius, the gravitational radius given by Eq. (32.147), constructive interference of the gravitational fields occurs. The resulting slight variations in the density of matter are observed from our present r-sphere. As shown in the Power Spectrum of the Cosmic Microwave Background section, the cosmic microwave background radiation is an average temperature of 2.725 K, with deviations of 30 or so μK in different parts of the sky representing these slight variations in the density of matter. By this mechanism, the production of particles over time from a photon-filled Universe gave rise to centers that eventually aggregated by gravitational attraction into a hierarchy of more massive structures to eventually form the large-scale structure of the cosmos.

Galaxies formed during the collapsing stage of the evolution of the Universe wherein the mass perturbations occurred due to gravity wave interference as demonstrated by the DASI and WMAP data as shown in the Power Spectrum of the Cosmic Microwave Background section. These perturbations resulted in collapsing gas clouds that formed quasars. Then each of these quasars erupted into a supernova and formed a blackhole. The expelled gas eventually formed galaxies. The observation of a blackhole in the center of each galaxy is consistent with the origin of galaxies from a quasar supernova [79, 80]. Furthermore, since angular momentum must be conserved in the rotation of the founding quasar and the resulting blackhole and galactic rotating stars, a linear relationship of the plot of the velocity of the outer stars of a given galaxy to the blackhole mass is expected. This ratio called sigma is indeed observed to be linear [79,80].

The Universe is oscillatory with a finite minimum radius, the gravitational radius. Thus, stellar and celestial structures evolve on a time scale that is greater than the observed time of expansion. ***Stars exist which are older than the elapsed time of the present expansion*** as stellar evolution occurred during the contraction phase [81,82]. Galaxy evolution also occurred during the contraction phase as revealed by high-redshift radio galaxies and galaxies associated with extremely distant, luminous quasars that date back to the beginning of the expansion [46, 47]. The Gemini Deep Deep Survey confirmed the predicted existence of old galaxies at the beginning of the expansion at 10 billion light years and further directly disprove the Big Bang theory of cosmology [83-85]. These results were confirmed by a spectroscopic redshift survey that probed the most massive and quiescent galaxies back at 10 billion light years [86,87]. It was found that a significant fraction of the massive old galaxies observed over all of time since the expansion were in place in the early Universe. This is also shown by the Hubble Ultra Deep Field (HUDF) given in Figure 32.10. A definitive validation of the classical predictions is provided by the Keck survey for gravitationally lensed Lyα emitters that found galaxies back at over 13 billion light years [88]. The absence of red dwarf stars that contain no metals is another indication of the ancient nature of the universe that is much older than the 10 billion years of expansion. Further confirmation of the older age of the universe is the existence of the brightest quasar in the early universe powered by the most massive black hole yet known [89] and that dust, a signature of an old galaxy, has been observed in a young universe [90]. Furthermore, the recent unanticipated Webb telescope images confirm additional GUTCP predictions of fully formed galaxies and old galaxies at the beginning of the expansion of the universe that disprove the long held metaphysical Big Bang and related theories of cosmology [91-94]. Specifically, the Webb's First Deep Field shown in Figure 32.11 produced by NASA's James Webb Space Telescope shows the absence of signatures predicted by Big Bang cosmology in the deepest and sharpest infrared image of the distant universe to date. In fact, even massive old blackholes [95,96] and carbon molecules [97] are observed to the beginning of expansion, 13.7 B light years from present-day Earth.

Figure 32.10. The Hubble Ultra Deep Field (HUDF) shows mature galaxies at the time of the beginning of the expansion of the Universe. The "Big Bang" is NOT observed. This image is a composite of two separate images taken by the Hubble's Advanced Camera for Surveys (ACS) and the Near Infrared Camera and Multiobject Spectrometer (NICMOS), the result of over eleven and a half days of exposure. It contains an estimated ten thousand galaxies. Released on 9 March 2004. Courtesy of NASA, ESA, S. Beck with STScI and the HUDF Team.

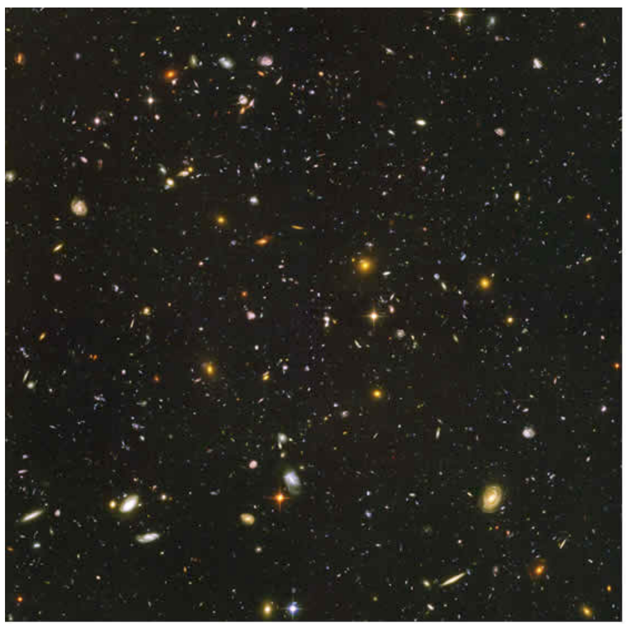
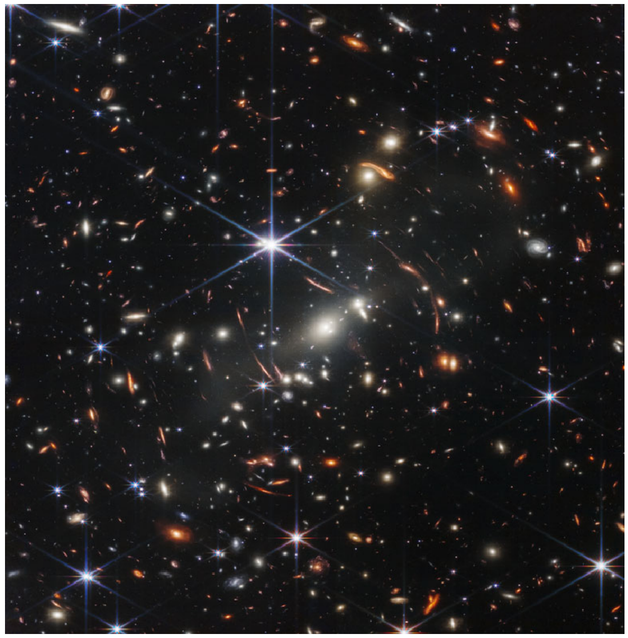


Figure 32.11. NASA's James Webb Space Telescope has produced the deepest and sharpest infrared image of the distant universe to date. Known as Webb's First Deep Field, this image of galaxy cluster SMACS 0723 is overflowing with detail. Credits: NASA, ESA, CSA, STScI. Released on July 11, 2022. Mature galaxies are observed at the time of the beginning of the expansion of the Universe. The "Big Bang" is NOT observed.



DARK MATTER

In addition to fusion reactions in stars, hydrino transitions to lower energy hydrino states, and high-p-state H(1/p) decay are sources of power that contributed to the CMBR. These power sources also contribute to spacetime expansion as matter is converted into energy. As given in the Disproportionation of Energy States section, classical physical laws predict that atomic hydrogen may undergo a catalytic reaction with certain species, including itself, that can accept energy in integer multiples of the potential energy of atomic hydrogen, $m \cdot 27.2$ eV, wherein m is an integer. The predicted reaction involves a resonant, nonradiative energy transfer from otherwise stable atomic hydrogen to the catalyst capable of accepting the energy. The product is H(1/p), fractional Rydberg states of atomic hydrogen called "hydrino atoms," wherein n = 1/2, 1/3, 1/4,…, 1/p ($p \leq 137$ is an integer) replaces the well-known parameter n = integer in the Rydberg equation for hydrogen excited states. Each hydrino state also comprises an electron, a proton, and a photon, but the field contribution from the photon increases the binding energy rather than decreasing it corresponding to energy desorption rather than absorption. Since the potential energy of atomic hydrogen is 27.2 eV, $m\ H$ atoms serve as a catalyst of $m \cdot 27.2\ eV$ for another $(m+1)$th H atom (See BlackLight Process section). For example, a H atom can act as a catalyst for another H by accepting 27.2 eV from it via through-space energy transfer such as by magnetic or induced electric dipole-dipole coupling to form an intermediate that decays with the emission of continuum bands with short wavelength cutoffs and energies of $m^2 \cdot 13.6\ eV\ \left(\frac{91.2}{m^2}\ nm\right)$. The continuum radiation band at 10.1 nm and going to longer wavelengths for theoretically predicted transitions of H to lower-energy, so called "hydrino" state H(1/4), was observed only arising from pulsed pinch gas discharges comprising some hydrogen and oxygen as an oxide, first at Brilliant Light Power, Inc. (BLP) and reproduced at the Harvard Center for Astrophysics (CfA) [98-104]. HOH was shown to be the catalyst in these pinch plasma continua as well as in the 10-30 nm EUV continuum observed from plasma having essentially no field. The latter plasma was formed by igniting a solid fuel source of H and HOH catalyst by passing an ultra-low voltage, high current through the fuel to produce an explosive plasma [98]. Moreover, $m\ H$ catalyst (Eqs. (5.48-5.61)) was identified to be active in astronomical sources such as the Sun, stars, and interstellar medium wherein the characteristics of hydrino product match those of the dark matter of the Universe [98]. Hydrogen continua from transitions to form hydrinos matches the emission from white dwarfs, provides a possible mechanism of linking the temperature and density conditions of the different discrete layers of the coronal/chromospheric sources, and provides a source of the diffuse ubiquitous EUV cosmic background with the 10.1 nm continuum matching the observed intense 11.0-16.0 nm band in addition to resolving other cosmological mysteries [98-106]. Given the seeding by the anisotropic gravitational forces in a contracting Universe, expansion of the Universe depends on the rate of energy release, which varies throughout the Universe; thus, clusters of galaxies, huge voids, and other ***large features which are observed*** [107-111] are caused by the interaction between the rate of energy release with concomitant spacetime expansion and gravitational attraction. Hydrogen-type atoms and molecules comprise most of the visible matter of the Universe, and hydrino comprises the much more abundant dark matter. The distinction between hydrogen and hydrinos with respect to the interaction with electromagnetic radiation and release of energy by transitioning to lower energy states (See Disproportionation of Energy States section) also has an influence on the formation of large voids and walls of matter. Lower-energy atomic hydrogen atoms, hydrinos, each have the same mass and a similar interaction as the neutron. According to Steinhardt and Spergel of Princeton University [112], these are the properties of dark matter that are necessary for the theory of the structure of galaxies to work out on all scales. The observation that galaxy clusters arrange themselves as predicted for cold dark matter except that the cores are less dense than expected is explained. Hydrinos further account for the observation that small halos of dark matter are evaporated when they approach larger ones and that dark matter is easily influenced by black holes, explaining how they grew so large.

Laboratory EUV continuum results [98] offer resolution to many otherwise inexplicable celestial observations with (a) the energy and radiation from the hydrino transitions being the source of extraordinary temperatures and power regarding the solar corona problem, the cause of sunspots and other solar activity, and why the Sun emits X-rays [104], (b) the hydrino-transition radiation being the radiation source heating the WHIM and behind the observation that diffuse H emission is ubiquitous throughout the Galaxy requiring widespread sources of flux shortward of $912\ \AA$, and (c) the identity of dark matter being hydrinos.

Stars also comprise plasmas of hydrogen with surfaces comprised of essentially dense atomic hydrogen permissive of multi-body H interactions to propagate transition of H to H(1/(m +1)) wherein $m\ H$ serves as the catalyst. Such transitions are predicted to emit EUV continuum radiation according to Eqs. (5.48-5.61). The emission from white dwarfs arising from an extremely high concentration of hydrogen is modeled as an optically thick blackbody of ~ 50,000 K gas comprising predominantly hydrogen and helium. A modeled composite spectrum of the full spectral range from 10 nm to >91.2 nm with an abundance He/H=10^{-5} from Barstow and Holberg [105] is shown in Figure 10 of Ref. [99] Figure 22 of Ref. [104]. Albeit, while white dwarf spectra can be curve fitted using stratification and adjustable He and H column densities and ionization fractions to remove some inconsistencies between optical and EUV spectra [113] and independent measurements of the latter, matching the spectrum at the short wavelengths is problematic. Alternatively, combining the laboratory-observed emission continuum bands gives a spectrum with continua having edges at 10.1 nm, 22.8, nm, and 91.2 nm, a match to the white dwarf spectrum [104]. However, the proposed nature of the plasmas and the mechanisms are very different. The emission in our studies is assigned to hydrino transitions in cold-gas, optically thin plasmas absent any helium. White-dwarf and celestial models may need revision and benefit from our discovery of high-energy H continua emission.

For example, there is no existing physical model that can couple the temperature and density conditions in different discrete regions of the outer atmosphere (chromosphere, transition region, and corona) of coronal/chromospheric sources [114]. Typically, the corona is modeled to be three orders of magnitude hotter than the surface that is the source of coronal heating seemingly in defiance of the second law of thermodynamics. Reconciliation is offered by the mechanism of line absorption and re-emission of the $m^2 \cdot 13.6\ eV$ (Eq. (5.57)) continuum radiation. The 91.2 nm continuum to longer wavelengths is expected to be prominent (less attenuated than the 10.1 nm and 22.8 nm bands) and is observed in the solar extreme ultraviolet spectrum as shown in Figure 23 of Ref. [104] and Ref. [114] despite attenuation by the coronal gas. High-energy-photon excitation is more plausible than a thermal mechanism with T~10^6 given the 4000 K surface temperature and the observation of the CO absorption band at 4.7 μm in the solar atmosphere wherein CO cannot exist above 4000 K [115]. Considering the 10.1 nm band as a source, the upper limit of coronal temperature based on excitation of about 10^6 K is an energy match. In addition to the temperature, another extraordinary observation is that although the total average energy output of the outer layers of the Sun is $\cong 0.01\%$ of the photospheric radiation, local transient events can produce an energy flux that exceeds the photospheric flux [116]. The energy source of the latter may be magnetic in nature, but identity of the highly ionizing coronal source is not established, nor has the total energy balance of the Sun been reconciled. Noble Laureate Bahcall who worked to resolve the Solar Neutrino Problem, posited that the possibility of a revolutionary discovery of a new source of energy in the Sun based on a prior undiscovered process is an open question [117]. That $m\ H$ catalyzed hydrino transitions occur in stars and the Sun [118] as evident by corresponding continua in its spectrum resolves the solar corona problem, the cause of sunspots and other solar activity, and why the Sun emits X-rays [48, 104]. H(1/p) reactions also resolve the Solar Neutrino Paradox and thereby dispatches the quantum mechanical theory of neutrino oscillations which is based on the false postulate that neutrinos have mass. Neutrinos are massless spin ½ photons that travel at light speed according to classical physical laws (Neutrinos section) and the Standard Model. Specifically, ***Eq. (32.173), Eq. (5.119) of the Hydrino Catalyzed Fusion (HCF) and Proton Decay section, predicts the relative number of electron to muon neutrinos being 1/3 and 2/3 of the total, respectively. The predicted electron and muon neutrino ratios match solar neutron observations by detectors such as the Homestake Solar Neutrino Experiment, GALLEX, SAGE, Sudbury Solar Neutrino Observatory, and Kamiokande and Super-Kamiokande detectors [117]. The results do not match the Standard Solar Model prediction of an electron neutrino intensity 3 times higher than observations with no muon neutrinos observed***.

$$\begin{array}{ccccc}
\gamma + p^{+} \rightarrow n & + & \pi^{+} & + & \pi^{0} \\
 & & \downarrow & & \downarrow \\
 & & \mu^{+} + \nu_{\mu} & & 2\gamma \\
 & & \downarrow & & \\
 & e^{+} + \nu_{e} + \bar{\nu}_{\mu} & & & \\
 & \downarrow e^{-} & & & \\
 & 2\gamma & & &
\end{array} \qquad (32.173)$$

wherein γ is a gamma ray, p^{+} is the proton, n is the neutron, π^{+} is the positive pion, π^{0} is the neutral pion, μ^{+} is the positive muon, ν_{μ} is the muon neutrino, ν_{e} is the electron neutrino, e^{+} is the positron, e^{-} is the electron, and $\bar{\nu}_{\mu}$ is the muon antineutrino.

The laboratory EUV continuum results [98-104] have further implications for the resolution of the identity of dark matter and the identity of the radiation source behind the observation that diffuse $\mathrm{H}\alpha$ emission is ubiquitous throughout the Galaxy and widespread sources of flux shortward of 912Å are required [119]. The identity of dark matter has been a cosmological mystery. It is anticipated that the emission spectrum of the extreme ultraviolet background of interstellar matter possesses the spectral signature of dark matter. Labov and Bowyer designed a grazing incidence spectrometer to measure and record the diffuse extreme ultraviolet background [119]. The instrument was carried aboard a sounding rocket, and data were obtained between 80Å and 650Å (data points approximately every 1.5Å). Several lines including an intense 635Å emission associated with dark matter were observed [119] which has considerable astrophysical importance as indicated by the authors:

> "Regardless of the origin, the 635Å emission observed could be a major source of ionization. Reynolds (1983, 1984, 1985) has shown that diffuse H emission is ubiquitous throughout the Galaxy, and widespread sources of flux shortward of 912Å are required. Pulsar dispersion measures (Reynolds 1989) indicate a high scale height for the associated ionized material. Since the path length for radiation shortward of 912 $\AA$ is low, this implies that the ionizing source must also have a large-scale height and be widespread. Transient heating appears unlikely, and the steady state ionization rate is more than can be provided by cosmic rays, the soft X-ray background, B stars, or hot white dwarfs (Reynolds 1986; Brushweiler & Cheng 1988). Sciama (1990) and Salucci & Sciama (1990) have argued that a variety of observations can be explained by the presence of dark matter in the galaxy which decays with the emission of radiation below 912Å.
> The flux of 635Å radiation required to produce hydrogen ionization is given by $F = \zeta_H / \sigma_\lambda = 4.3\,X\,10^{4}\,\zeta_{-13}\ photons\ cm^{-2}s^{-1}$, where ζ_{-13} is the ionizing rate in units of $10^{-13}s^{-1}$ per H atom. Reynolds (1986) estimates that in the immediate vicinity of the Sun, a steady state ionizing rate of ζ_{-13} between 0.4 and 3.0 is required. To produce this range of ionization, the 635Å intensity we observe would have to be distributed over 7% - 54% of the sky."

The 63.5 ± 0.47 nm line [119] matches a hydrino transition predicted for H undergoing catalysis with H (m=1) as the catalyst giving rise to a concerted energy exchange of the total energy of 40.8 eV with the excitation of the He $1s^2$ to $1s^1 2p^1$ transition. The predicted 63.3 nm emission associated with dark matter was observed with the addition of hydrogen to helium microwave plasma as shown previously [102]. An alternative assignment suggested by Labov and Bowyer [119] is the 63.0 nm line of O V requiring a large-scale non-thermal source of ionization. Continuum radiation from transitions to low-level hydrino states can provide this radiation. Indeed, the observation of the 63.3 nm line is also associated with the presence of an interstellar X-ray background.

The first soft X-ray background was detected and reported [121] about 25 years ago. Quite naturally, it was assumed that these soft X-ray emissions were from ionized atoms within hot gases. Labov and Bowyer also interpreted the data as emissions from hot gases. However, the authors left the door open for some other interpretation with the following statement from their introduction:

> *"It is now generally believed that this diffuse soft X-ray background is produced by a high-temperature component of the interstellar medium. However, evidence of the thermal nature of this emission is indirect in that it is based not on observations of line emission, but on indirect evidence that no plausible non-thermal mechanism has been suggested which does not conflict with some component of the observational evidence."*

The authors also state "if this interpretation is correct, gas at several temperatures is present." Specifically, emissions were attributed to gases in three ranges: $5.5 < \log T < 5.7$; $\log T = 6$; $6.6 < \log T < 6.8$. Observations in the ultraviolet with HST and FUSE [122] and also XMM-Newton [123] confirm these extraordinary temperatures of diffuse intergalactic medium (IGM) and reveal that a large component of the baryonic matter of the Universe is in the form of WHIM (warm-hot ionized media) [122,123]. The mysteries of the identity of dark matter, the observed dark interstellar medium spectrum, the source of the diffuse X-ray background, and the source of ionization of the IGM [122,123] are resolved by the formation of hydrinos that emit

EUV and X-ray continua depending on the state transition and conditions; the continua create highly ionized ions that emit ion radiation of non-thermal origin; the hydrino transition H to H(1/2) results in a 63.3 nm line [102,120], and He^+ acting as a catalyst of 54.4 eV ($2 \cdot 27.2\ eV$) pumps the intensity of helium ion lines such as the 30.4 nm line [100, 102].

As shown in the Disproportionation of Energy States section, the products of the catalysis reactions (e.g. Eqs. (5.48-5.51)) have binding energies of $m \cdot 27.2\ eV$, such that they may further serve as catalysts. Thus, further catalytic transitions may occur: $n = \frac{1}{3} \rightarrow \frac{1}{4}, \frac{1}{4} \rightarrow \frac{1}{5},$ and so on. Thus, lower-energy hydrogen atoms, *hydrinos*, can act as catalysts by resonantly and nonradiatively accepting energy of $m \cdot 27.2\ eV$ from another H or hydrino atom (Eq. (5.24)). Such disproportionation reactions of hydrinos are predicted to give rise to features in the X-ray region. As shown by Eqs. (5.40-5.43) the reaction product of HOH catalyst is $H\left[\frac{a_H}{4}\right]$. A likely transition reaction in hydrogen clouds containing H_2O gas is the transition of a H atom to $H\left[\frac{a_H}{17}\right]$ wherein $H\left[\frac{a_H}{4}\right]$ serves as a catalyst to give a broad peak having a short wavelength cutoff at $E = 3481.6\ eV;\ 0.35625\ nm$. A broad X-ray peak with a 3.48 keV cutoff was recently observed in the Perseus Cluster by NASA's Chandra X-ray Observatory and by the XMM-Newton [124,125] that has no match to any known atomic transition. The 3.48 keV feature assigned to dark matter of unknown identity by BulBul et al. [124] matches the $H\left[\frac{a_H}{4}\right] + H\left[\frac{a_H}{1}\right] \rightarrow H\left[\frac{a_H}{17}\right]$ transition and further confirms hydrinos as the identity of dark matter.

Evidence for EUV emission from hydrino transitions also comes from the interstellar medium (ISM) since it provides a source of the diffuse ubiquitous EUV cosmic background. Specifically, the 10.1 nm continuum matches the observed intense 11.0-16.0 nm band [105,106]. Furthermore, it provides a mechanism for the high ionization of helium of the ISM and the excess EUV radiation from galaxy clusters that cannot be explained thermally [124]. Moreover, recent data reveals that X-rays from distant active galactic nuclei sources are absorbed selectively by oxygen ions in the vicinity of the galaxy [125]. The temperature of the absorbing halo is between 1 million and 2.5 million Kelvin, or a few hundred times hotter than the surface of the Sun. The corresponding energy range is 86 eV to 215 eV which is in the realm of the energy released for the transition of H to H(1/4). Additional astrophysical evidence such as the observation that a large component of the baryonic matter of the Universe is in the form of WHIM (warm-hot ionized media) in the absence of a conventional source and the match of hydrinos to the identity of dark matter was presented previously [126,127]. The latter case is further supported by observations of signature electron-positron annihilation energy.

Dark matter comprises most of the mass of the Universe as well as intra-galactic mass [128,129]. The characteristic spectral signatures and properties of hydrino match those attributed to the dark matter of the universe. High-p-state H atoms decay according to the reaction given by Eq. (32.171) to produce characteristic 511 keV annihilation energy, π^0, and photoneutron capture emission observed from a broad array of astrophysical environments such as interstellar medium, supernova remnants (SNRs), molecular clouds, galaxy clusters, and other sources as well as solar flares and thunderstorms are assigned to decaying dark matter as given in the H Atom Decay and Production Cycle Drive the Oscillatory Spacetime Expansion-Contraction Cycle of the Universe section and in the Hydrino Catalyzed Fusion (HCF) and Proton Decay section [49-62]. The Universe is predominantly comprised of hydrogen and a small amount of helium. These elements exist in interstellar regions of space, and they are expected to comprise most of the interstellar matter. However, the observed constant angular velocity of many galaxies as the distance from the luminous galactic center increases can only be accounted for by the existence of nonluminous weakly interacting matter, dark matter. It was previously accepted that dark matter exists at the cold fringes of galaxies and in cold interstellar space. This has since been disproved by the observation of Bournaud et al. [128,129] that demonstrated that galaxies are mostly comprised of dark matter, and the data persistently supports that dark matter probably accounts for most of the universal mass.

In addition to EUV continuum emission from the formation of hydrino matching the observed EUV background observed all over the universe, the continuum band of solar corona, and the continuum bands of white dwarf stars as well as providing the source of ionization of the solar corona and interstellar media as an alternative mechanism to thermal ionization, molecular hydrino as a component of the inventory of the dark matter of the universe resolves the source of the Diffuse Interstellar Bands (DIBs). Specifically, the molecular hydrino rotational lines match the Diffuse Interstellar Bands (DIBs). Diffuse interstellar bands (DIBs) are absorption features seen in the spectra of astronomical objects in the Milky Way and other galaxies caused by the absorption of light by the interstellar medium. Development of many theories to assign the approximately 500 bands observed to date in ultraviolet, visible, and infrared wavelengths [130] have been futile as the nature of the absorbing material (the 'carrier') became a crucial problem in astrophysics. An essential challenge is that the central wavelengths do not correspond with any known spectral lines of any ion or molecule. It is widely believed by DIBs researchers that the existence of sub-structure is caused by molecules, particularly large molecules such as polycyclic aromatic hydrocarbons and other large carbon-bearing molecules. Specifically, it is held that the substructure results from band heads in the rotational band contour and from isotope substitution in these large molecules. The existence of molecular hydrino presents another possibility especially given that it is the best candidate for the identity of dark matter. It is remarkable, that eight-one emission lines recorded by Raman spectroscopy on Ni foils run in the SunCell® and GaOOH:H_2(1/4):H_2O match those of DIBs [48]. The assignment of all the 380 DIBs listed by Hobbs [130] to $H_2(1/4)$ rotational transitions with spin-orbital splitting and fluxon sub-splitting are given in the Appendix of Mills [48].

The best evidence yet for the existence of dark matter is its direct observation as a source of massive gravitational mass evidenced by gravitational lensing of background galaxies that does not emit or absorb light as shown in Figure 32.12 [131]. There has been the announcement of some unexpected astrophysical results that support the existence of hydrinos. In 1995, Mills published the GUTCP prediction [132] that the expansion of the Universe was accelerating from the same equations that correctly predicted the mass of the top quark before it was measured. To the astonishment of cosmologists, this was confirmed by 2000. Mills made another prediction about the nature of dark matter based on GUTCP that may be close to being confirmed. Bournaud et al. [128,129] suggest that dark matter is hydrogen in dense molecular form that somehow behaves differently in terms of being unobservable except by its gravitational effects. Theoretical models predict that dwarfs formed from collisional debris of massive galaxies should be free of nonbaryonic dark matter. So, their gravity should tally with the stars and gas within them. By analyzing the observed gas kinematics of such recycled galaxies, Bournaud et al. [128,129] have measured the gravitational masses of a series of dwarf galaxies lying in a ring around a massive galaxy that has recently experienced a collision. Contrary to the predictions of Cold-Dark-Matter (CDM) theories, their results demonstrate that they contain a massive dark component amounting to about twice the visible matter. This baryonic dark matter is argued to be cold molecular hydrogen, but it is distinguished from ordinary molecular hydrogen in that it is not traced at all by traditional methods, such as emission of CO lines. These results match the predictions of the dark matter being hydrino.

Figure 32.12. Dark matter ring in galaxy cluster. This Hubble Space Telescope composite image shows a ghostly "ring" of dark matter in the galaxy cluster Cl 0024+17. The ring is one of the strongest pieces of evidence to date for the existence of dark matter, a prior unknown substance that pervades the Universe. Courtesy of NASA, M.J. Jee and H. Ford (Johns Hopkins University).

Additionally, astronomers Jee at al. [133] using data from NASA's Hubble Telescope have mapped the distribution of dark matter, galaxies, and hot gas in the core of the merging galaxy cluster Abell 520 formed from a violent collision of massive galaxy clusters and have determined that the dark matter had collected in a dark core containing far fewer galaxies than would be expected if dark matter was collsionless with dark matter and galaxies anchored together. The collisional debris left behind by the galaxies departing the impact zone behaved as hydrogen did, another indication that the identity of dark matter is molecular hydrino. Moreover, detection of alternative hypothesized identities for dark matter such as super-symmetry particles such as neutalinos has failed at the Large Hadron Collider; nor, has a single event been observed for weakly interacting massive particles or wimps at the Large Underground Xenon (LUX) experiment [134]. The HADES search for dark matter eliminated the leading candidate, "Dark Photon" or U Boson, as a possibility. This failure also undermines the Standard Model of particle physics [135].

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