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A proposed concept about stars: The energy creation, colour and formation

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Abstract Stars have been theoretically and empirically studied. Earlier knowledge reveals that stars like the sun are a sea of mainly hydrogen and they undergo fusion to produce mainly helium, there by releasing a huge amount of energy in the form of light: but what is evident in our night sky from the idea of characteristic flame of elements when they burn seem to collapse what was earlier erected. The hydrogen gases do not only fuse to form helium but also other lighter elements like lithium, beryllium, boron etc. which burn with a characteristic different flame. More so, stars are made up of fuels that may engage in nuclear and non-nuclear reactions for light and other electromagnetic energy to be generated with a characteristic colour which is reflective of the flame produced by constituent(s) element(s). Probably, heavier elemental isotopic fuels like krypton, xenon, radon, caesium, francium, radium, plutonium, neptunium, uranium etc: could burn and break into lighter isotopes, accompanied by energy in the form of light and other electromagnetic radiation. In addition, non-nuclear reactions also generate some of the energy we see in the form of light, example hydrocarbons like the oxyacetylene and non-hydrocarbons like dicyanoacetylene. Finally, stars are formed when molecular clouds of interstellar gas and dust (nuclear and non-nuclear fuels) are fused into a large mass by gravity in a region in space; triggered into flame thermally or otherwise by elemental or atomic or compound flammable fuel(s) like francium, hydrogen, caesium, methane, uranium, chlorinetriflouride, Heptanitrocubane etc.

Keywords Star, Light, Characteristic-flame, Fusion, Fission, Creation, Colour and Formation.

Introduction

There are billions of stars in our universe. They are believed by astrologers to control our affairs here on earth. They are the natural fountain of light in our universe aside lightening during thunder storms. However these stars radiate some other electromagnetic particles/wave in addition to light but they are not visible.

The sun is a star in our galaxy – the Milky Way. All stars are luminous unlike other celestial bodies like the moons and planets. Stars are diverse in sizes. They are categorized into: giant, medium and dwarf stars. The sun is a medium star.

Stars are an ocean of light. Stars like our sun produce their light by expending billions of cubic metres of gases; mainly hydrogen through fusion. This process releases a huge volume of energy to the earth in the form of light. They double as the major source of energy in the planets and the entire universe – since light is a form of energy and other forms of electromagnetic radiations which they generate are energetic. They all have their life span after which they seize to shine or produce light (including other electromagnetic radiations) and this occurs when they have drained their voluminous content of fuel(s).

In the night sky, when the stars are easily visible; it is perceivable that the colours of light which these stars radiate are strikingly different. However, the radiations from the mass majority of them seem to be similar, that is white or proximately white. Earlier knowledge revealed that these stars like our sun are a sea of mainly hydrogen and they undergo fusion to produce mainly helium, there by releasing a huge amount of energy in the form of light: but what is evident in our night sky from the characteristic flame of gases when they burn seem to collapse what was earlier erected. The hydrogen gases do not only fuse to form helium but may also fuse to generate other lighter gases like lithium, beryllium, boron etc. that burns with a characteristic different flame from that of helium.

Also, since fusion and fission are both energy realizing reactions, it is possible that heavier isotopes of gases at standard temperature and pressure like krypton, xenon and radon could burn and break into lighter isotopes and accompanied by positron or electron or neutrino or other lighter elements (or isotopes) or any combination of the afore-listed and energy in the form of light as well with different characteristic flames depending on the product. This may be rare unlike the former in the scientific universe, but it is a subject to further research.

In addition to earlier knowledge about star formation: they are formed when molecular clouds of interstellar gas and dust are fused in a large mass by gravity in a region in space. The fused dense mass may be triggered into flame thermally or otherwise by flammable fuels or elements or atoms. This triggers nuclear reactions in the form of fusion and fission and other non-nuclear reactions as well that are exothermic and generate the light we see.

This study seeks to empirically inquire about stars so as to draw a verdict and put forward a new concept of the energy creation, colours and formation of stars, which may answer some questions about these shiny heavenly hot objects.

A retrospect of literatures on stars concerning their energy creation, colours and formation

A lot of research literatures have been published about stars. This section is a retrospective light of existing star literatures on their energy creation, colours and formation.

Energy (light) creation by stars

The most apparent astrophysical fact is that stars emit electromagnetic radiations and hence are continuously losing energy to their surroundings. The mean rate at which the energy is emitted in the form of radiation, per unit mass of star is not very large. For instance, the sun emits radiation at only 2 x 10^{-10} J per Kg per sec, which is much less than 1 per cent of the rate of heat generation during animal metabolism. On the other hand, we know from geological evidence that the sun has been emitting radiations at approximately its present rate for several billions of years [1].

Chemical sources of energy production could not supply the observed energy emission of a star for more than a few thousand years. The gravitational energy gained by gradual contraction of a star is more important source of energy, but if this were the only source, our sun could not be older than 2 x 10^{17} years. On the other hand, many exothermic nuclear reactions liberate energies of several Mev per nucleon, or about 10^{9} J per Kg, such nuclear reactions could sustain the energy loss of the sun for about 10^{11} years and are the only type of reactions which supply a sufficiently large amount of energy [1].

Stars create their energy through nuclear fusion processes. Proton-proton fusion is the dominant mechanism of generation of energy for stars like the sun which have internal temperatures less than fifteen million Kelvin. The predominant mechanism for more massive stars, which can achieve higher temperatures, is the carbon cycle fusion. Older stars which are collapsing at the centre, with temperatures that can exceed one hundred million Kelvin, can initiate the helium fusion process called the triple-alpha process. However, for the nuclear synthesis of elements heavier than iron, another class of nuclear reactions is responsible.

The enormous luminous energy of the stars originates from nuclear fusion processes in their cores. Depending on the mass and age of a star, the energy may emanate from proton-proton fusion, helium fusion, or the carbon cycle. At a short time length, close to the end of the luminous lifetime of stars, heavier elements up to iron may fuse, but the fusion of elements more massive than iron would absorb energy rather than release it, since the iron group is at the peak of the binding energy curve. The iron group is the roof in terms of energy yielded by fusion; heavier elements are created in the stars by another class of nuclear reactions. This nuclear synthesis of elements heavier than iron consumes energy rather than supplies it [2].

As afore-captured, live stars create their energy via some form of fusion, which is by summing smaller atoms to beget bigger atoms. The way this releases energy is that heavy atoms (until you get to iron, Fe) weigh slightly less than the constituent atoms. The extra mass (Δm) from Einstein's famous equation: $E = \Delta mc^2$ is converted and released as energy.

Also as earlier spelt out, there are many types of fusion processes, but the main ones during normal stellar life is some variation of turning hydrogen into helium. In the sun and the like stars, this is generally achieved via a summation of the different PP chains, so-branded because they all start with combining two protons. The CNO cycle takes over as the main energy producer, in more massive stars. Some fusional processes dominate over others in different stars because the probability of the collision coming about is dependent upon the temperature.

After a star has completely drained out its voluminous supply of hydrogen fuel, if it is massive enough it will be able to fuse heavier elements together, such as helium, silicon, and oxygen. The more massive a star, the higher the attainable core's temperature and pressure, and so the more massive elements it can fuse together. A star cannot fuse elements beyond iron. This is because, up until iron, fusion will release energy; but fusing elements heavier than iron requires energy to be input, which causes the star to collapse due to its own weight [3].

Colours of stars

When we watch the night skies, the stars appear much similar. Some stars are brighter than others but they all seemingly appear white. If the stars are observed via a twin of binoculars, some appear to be different in the light of colours. Many stars appear quite orange in colour and some have a blue/white tint. The colour of a star is a function of its temperature and invariably its size. Stars vary in colours ranging from orange through white to blue. The colour is a mirror of the temperature of the surface of the star [4].

Our sun is very much an average mid range star with a temperature of about 6000 ^{0}C and is classified as a yellow dwarf. Blue or even blue/green stars are normally giant young stars which are very active or even hyper-active and are very hot up to 50,000 ^{0}C. They are all young because they do not live very long. They live very active short lives and die young usually in a massive explosion called a super nova. White through white-blue stars are more powerful, bigger and hotter than our sun with surface temperatures up to 12,000 ^{0}C and generally live longer than blue stars but not as long as our sun will [5].

Yellow stars are in their mid life and are normal average stars. They are normally form twice the mass (mass is the stuff they are made of), down to about one tenth of the mass of our sun. Orange to red stars have expended most of their hydrogen fuel and are approaching the end of their lives. Because the fuel (hydrogen burning – fusion) is running out, the waste product has built up in the centre of the star. Helium can only burn in large stars so the nuclear furnace has developed into a shell above the helium central core. As there is not so much of the star left above the nuclear furnace shell there is less gravitational force to hold in the outer regions. The nuclear reaction will actually become fiercer and the outer part of the stars gets pushed out by the increased radiation and blows up like a balloon. The star develops into a huge red giant with a diameter large enough to engulf all the planets in our solar system out to mars, if it was at the position of our sun. With the heat spread over this huge surface area, the surface will become quite cool for a star, between 2500 ^{0}C and 4000 ^{0}C [6].

The red dwarf is another type of red star. This is a very small star, perhaps as small as one hundred of the mass of our sun. Even through large telescope, dwarfs are hard to behold since they are small and dim, only the closest to us as are visible. Table 1 shows the flame colours of stars and their respective burning temperature with spectral class [6].

Table 1: Flame colours of stars and their respective burning temperatures

Colour of star/ Type	Temperature (^{0}C)	Spectral class
Green/White **Giant very hot active stars**	36000+	Type W & O
Blue **Very hot helium star**	28600+	Type B
White **Large hot stars**	10700+	Type A
Yellow/White **Stars larger & brighter than sun**	75000+	Type F
Yellow **Like our sum**	6000+	Type G
Orange **Cooler stars**	4800+	Type K
Orange/Red **Old dying stars**	3400+	Type M
Red **Cool carbon stars**	2500+	Type N & S

Also, the table below shows the approximate colour and temperature range for stars including their spectra class [4].

Table 2: Colour -Temperature range for stars.
Colours are for Main Sequence (V) mid-Spectral Class

Spectral Class	O	B	A	F	G	K	M
Temperature (K)	50,000 - 28,000	28,000 - 10,000	10,000 - 7,500	7,500 - 6,000	6,000 - 4,900	4,900 - 3,500	3,500 - 2,000
Colour	Blue	Blue-white	White	White-yellow	Yellow	Orange	Red

Besides the normal stars which are just hotter than ordinary ones, there are other types of stars. Some vary in brightness, some blow off great clouds of dust and some stars burn helium or carbon instead of hydrogen. Giant stars are very hot and also burn their fuel very fast, while medium size stars like our sun are very young and they tend to be very active and hot. These giant stars shine white or blue. Old stars become bloated into giants so they produce and spread over a large surface area and appear cooler. They shine with a red colour much like when an electric fire element is cooling down. Very small stars appear cooler and red because they do not produce so much heat [6].

Basically, the colours of stars are a function of their temperature. Older stars have higher temperature compared to younger ones. The colours of the stars range from red to blue. The hotter a star: the more its colour edges towards blue. All stars appear white to us because they are very far from us and their light is dimmed because of the large distance. Our sun is sort of orange in the sixties. A smaller Betelgeuse is Red while a larger star, Sirius is Yellowish-white in colour [5].

However, our sun is white not yellow. It appears yellow because of the atmosphere of the Earth. Photons in the higher end of the spectrum – blue, indigo and violet – are more likely to be scattered away, while the lower end of the spectrum – red, orange and yellow – are less easily scattered. When the Sun is close to the horizon, you see it distorted the more, by the Earth's atmosphere, scattering away the bluer photons and making it appear red. This phenomenon is easily noticeable when sunlight is passed through a prism. It gets scattered into violet, indigo, blue, green, yellow, orange and red which together make up the white light [5].

Stars appear to be exclusively white at first glance. But if one looks carefully, a range of colours is observed: blue, white, red, and even gold. In the winter constellation of Orion, a beautiful contrast is seen between the red Betelgeuse at Orion's "armpit" and the blue Bellatrix at the shoulder. What causes stars to exhibit different colours remained a mystery until two centuries ago, when Physicists gained enough light of the nature of light and the properties of matter at immensely high temperatures [7].

Specifically, it was the physics of blackbody radiation that enabled us to understand the variation of stellar colours. Shortly after blackbody radiation was understood, it was noticed that the spectra of stars look extremely similar to blackbody radiation curves of various temperatures, ranging from a few thousand ^{0}C to ~50,000 ^{0}C. The obvious conclusion is that stars are similar to blackbodies, and that the colour variation of stars is a direct consequence of their surface temperatures [7].

Cool stars (i.e., Spectral Type K and M) radiate most of their energy in the red and infrared region of the electromagnetic spectrum and thus appear red, while hot stars (i.e., Spectral Type O and B) emit mostly at blue and ultra-violet wavelengths, making them appear blue or white [7].

Stars are dense hot balls of gas so their spectra similar to that of a perfect thermal radiator, which produces a smooth continuous spectrum. (Although, stars are not perfect thermal radiators, their spectra are similar enough to the smooth continuous spectrum for what follows.) Therefore, the colour of stars depends on their temperature---hotter stars are bluer and cooler stars are redder. You can observe the star through different filters to get an approximate temperature. A filter allows only a narrow range of wavelengths (colours) through. By sampling the star's spectrum at two different wavelength ranges (``bands''), you can determine if the spectrum is that for a hot, warm, cool, or cold star. Hot stars have temperatures around 60,000 K while cold stars have temperatures around 3,000 K [8].

Formation of Stars

Stars are born within the clouds of dust and scattered throughout most galaxies. A familiar example of such as a dust cloud is the Orion Nebula, revealed in vivid detail in the adjacent image, which combines images at visible and infrared wavelengths measured by NASA's Hubble Space Telescope and Spitzer Space Telescope [9]. Turbulence deep within these clouds gives rise to knots with sufficient mass that the gas and dust can begin to collapse under its own gravitational attraction. As the cloud collapses, the material at the centre begins to heat up. This is known as a protostar, it is this hot core at the heart of the collapsing cloud that will someday become a star. Three-dimensional computer models of star formation predict that the spinning clouds of collapsing gas and dust may break up into two or three blobs; this would explain why the majority of the stars in the Milky Way are paired or in groups of multiple stars [9].

As the cloud collapses, a dense, hot core forms and begins gathering dust and gas. Not all of this material ends up as part of a star — the remaining dust can become planets, asteroids, or comets or may remain as dust. In some cases, the cloud may not collapse at a steady pace [9].

In another light, stars are formed inside relatively dense concentrations of interstellar gas and dust known as molecular clouds. These regions are extremely cold (temperature about 10 to 20K, just above absolute zero). At these temperatures, gases become molecular meaning that atoms bind together. CO and H_2 are the most common molecules in interstellar gas clouds. The deep cold also causes the gas to clump to high densities. When the density reaches a certain point, stars form [10].

Since the regions are dense, they are opaque to visible light and are known as dark nebula. Since they don't shine by optical light, we must use infrared and radio telescopes to investigate them. Star formation begins when the denser parts of the cloud core collapse under their own weight/gravity. These cores typically have masses around 10^4 solar masses in the form of gas and dust. The cores are denser than the outer cloud, so they collapse first. As the cores collapse they fragment into clumps around 0.1 parsecs in size and 10 to 50 solar masses in mass. These clumps then form into protostars and the whole process takes about 10 millions years [10].

How do we know this is happening if it takes so long and is hidden from view in dark clouds? Most of these cloud cores have infrared sources, evidence of energy from collapsing protostars (potential energy converted to kinetic energy). Also, where we do find young stars (see below) we find them surrounded by clouds of gas, the leftover dark molecular cloud. And they occur in clusters, groups of stars that form from the same cloud core [10].

Protostars: once a clump has broken free from the other parts of the cloud core, it has its own unique gravity and identity and we call it a protostar. As the protostar forms, loose gas falls into its centre. The in-falling gas releases kinetic energy in the form of heat and the temperature and pressure in the centre of the protostar goes up. As its temperature approaches thousands of degrees, it becomes a IR source. Several candidate protostars have been found by the Hubble Space Telescope in the Orion Nebula [10].

During the initial collapse, the clump is transparent to radiation and the collapse proceeds fairly quickly. As the clump becomes denser, it becomes opaque. Escaping infrared radiation is trapped, and the temperature and pressure in the centre begin to increase. At some point, the pressure stops the in-fall of more gas into the core and the object becomes stable as a protostar [10].

The protostar, at first, only has about 1% of its final mass. But the envelope of the star continues to grow as in-falling material is accreted. After a few million years, thermonuclear fusion begins in its core, and then a strong stellar wind is produced which stops the in-fall of new mass. The protostar is now considered a young star since its mass is fixed, and its future evolution is now set [10].

Flames and flame test

Colour and temperature of a flame are dependent on the type of fuel involved in the combustion, as, for example, when a lighter is held to a candle. The applied heat causes the fuel molecules in the candle wax to vaporize. In this state they can then readily react with oxygen in the air, which gives off enough heat in the subsequent exothermic reaction to vaporize yet more fuel, thus sustaining a consistent flame. The high temperature of the flame causes the vaporized fuel molecules to decompose, forming various incomplete combustion products and free radicals, and these products then react with each other and with the oxidizer involved in the reaction. Sufficient energy in the flame will excite the electrons in some of the transient reaction intermediates such as CH and C_2, which results in the emission of visible light as these substances release their excess energy (see spectrum below for an explanation of which specific radical species produce which specific colours). As the combustion temperature of a flame increases (if the flame contains small particles of un-burnt carbon or other material), so does the average energy of the electromagnetic radiation given off by the flame [11].

Other oxidizers besides oxygen can be used to produce a flame. Hydrogen burning in chlorine produces a flame and in the process emits gaseous hydrogen chloride (HCl) as the combustion product. Another of many possible chemical combinations is hydrazine and nitrogen tetroxide which is hypergolic and commonly used in rocket engines. Fluoropolymers can be used to supply fluorine as an oxidizer of metallic fuels, e.g. in the magnesium/teflon/viton composition [11].

Flame colour depends on several factors, the most important typically being black-body radiation and spectral band emission, with both spectral line emission and spectral line absorption playing smaller roles. In the most common type of flame, hydrocarbon flames, the most important factor that determines colour is oxygen supply and the extent of fuel-oxygen pre-mixing, which determines the rate of combustion and thus the temperature and reaction paths, thereby producing different colour hues [11].

In a laboratory under normal gravity conditions and with a closed oxygen valve, a Bunsen burner burns with yellow flame (also called a safety flame) at around 1,000 °C (1,800 °F). This is due to incandescence of very fine soot particles that are produced in the flame. With increasing oxygen supply, less black body-radiating soot is produced due to a more complete combustion and the reaction creates enough energy to excite and ionize gas molecules in the flame, leading to a blue appearance. The spectrum of a premixed (complete combustion) butane flame on the right shows that the blue colour arises specifically due to emission of excited molecular radicals in the flame, which emit most of their light well below ~565 nanometers in the blue and green regions of the visible spectrum [11].

The colder part of a diffusion (incomplete combustion) flame will be red, transitioning to orange, yellow, and white as the temperature increases as evidenced by changes in the black-body radiation spectrum. For a given flame's region, the closer to white on this scale, the hotter that section of the flame is. The transitions are often apparent in fires, in which the colour emitted closest to the fuel is white, with an orange section above it, and reddish flames the highest of all. A blue-coloured flame only emerges when the amount of soot decreases and the blue emissions from excited molecular radicals become dominant, though the blue can often be seen near the base of candles where airborne soot is less concentrated [11].

Specific colours can be imparted to the flame by introduction of excitable species with bright emission spectrum lines. In analytical chemistry, this effect is used in flame tests to determine presence of some metal ions. In pyrotechnics, the pyrotechnic colorants are used to produce brightly coloured fireworks [11].

When looking at a flame's temperature there are many factors which can change or apply. An important one is that a flame's colour does not necessarily determine a temperature comparison, because black-body radiation is not the only thing that produces or determines the colour seen; therefore it is only an estimation of temperature [11]. Here are other factors that determine its temperature:

- Adiabatic flame; i.e., no loss of heat to the atmosphere (may differ in certain parts).
- Atmospheric pressure
- Percentage oxygen content of the atmosphere.
- The fuel being burned (i.e., depends on how quickly the process occurs; how violent the combustion is.)
- Any oxidation of the fuel.
- Temperature of atmosphere links to adiabatic flame temperature (i.e., heat will transfer to a cooler atmosphere more quickly).
- How stoichiometric the combustion process is (a 1:1 stoichiometricity) assuming no dissociation will have the highest flame temperature... excess air/oxygen will lower it and likewise not enough air/oxygen.

In fires (particularly house fires), the cooler flames are often red and produce the most smoke. Here the red colour compared to typical yellow colour of the flames suggests that the temperature is lower. This is because there is a lack of oxygen in the room and therefore there is incomplete combustion and the flame temperature is low, often just 600–850 °C (1,112–1,562 °F). This means that a lot of carbon monoxide is formed (which is a flammable gas) which is when in fire and arson investigation there is greatest risk of back draft. When this occurs combustible gasses, already at or above flash point of spontaneous combustion, are exposed to oxygen, carbon monoxide and superheated hydrocarbons combust and temporary temperatures of up to 2,000 °C (3,632 °F) occur. Flame temperatures of common items include a candle at 1,400 °C (2,600 °F), a blow torch – at around 1,600 °C (2,900 °F) a propane torch at 1,995 °C (3,620 °F), or a much hotter oxyacetylene combustion at 3,000 °C (5,400 °F) [11].

Flame Test

A flame test is an analytic procedure used in chemistry to detect the presence of certain elements, primarily metal ions, based on each element's characteristic emission spectrum. The colour of flames in general also depends on temperature; see flame colour [12].

The test involves introducing a sample of the element or compound to a hot, non-luminous flame, and observing the colour of the flame that results. The idea of the test is that sample atoms evaporate and since they are hot, they emit light when being in flame. Bulk sample emits light too, but its light is not good for analysis. Bulk sample emits light primarily due to motion of the atoms; therefore its spectrum is broad, consisting of a broad range of colours. Separate atoms of sample present in flame can emit only due to electronic transitions between different atomic energy levels. Those transitions emit light of very specific frequencies, characteristic of chemical element itself. Therefore, the flame gets the colour, which is primarily determined by properties of the chemical element of the substance being put into flame. The flame test is a relatively easy experiment to set up, and thus is often demonstrated or carried out in science classes in schools [12].

The flame test is relatively quick and simple to perform, and can be carried out with the basic equipment found in most chemistry laboratories. However, the range of elements positively detectable under these conditions is small, as the test relies on the subjective experience of the experimenter rather than any objective measurements. The test has difficulty detecting small concentrations of some elements, while too strong a result may be produced for certain others, which tends to cause fainter colours to not appear [12].

Although the flame test only gives qualitative information, not quantitative data about the proportion of elements in the sample, quantitative data can be obtained by the related techniques of flame photometry or flame emission spectroscopy. Flame Atomic absorption spectroscopy Instruments, made by e.g. PerkinElmer or Shimadzu, can be operated in emission mode according to the instrument manuals. The Table 2 below shows the characteristic colour of flames of some element [12].

Table 2: Some elements and their characteristic colour of flames

Symbol	Name	Colour
Al	Aluminium	Silver-white, in very hot such as an electric arc, light blue
As	Arsenic	Blue
B	Boron	Bright green
Ba	Barium	Pale/Apple green
Be	Beryllium	White
Bi	Bismuth	Azure
Ca	Calcium	Brick red
Cd	Cadmium	Brick red
Ce	Cerium	Blue
Co	Cobalt	Silver-white (sometimes reported as bluish-green)
Cr	Chromium	Silver-white (sometimes reported as bluish-green)
Cs	Caesium	Blue-Violet
Cu(I)	Copper(I)	Bluish-green
Cu(II)	Copper(II) (non-halide)	Green
Cu(II)	Copper(II) (halide)	Blue-green
Ge	Germanium	Pale blue
Fe(II)	Iron(II)	Gold, when very hot such as an electric arc, bright blue, or green turning to orange-brown
Fe(III)	Iron(III)	Orange-brown
Hf	Hafnium	White
Hg	Mercury	Red
In	Indium	Indigo/Blue
K	Potassium	Lilac
Li	Lithium	Carmine; invisible through green glass
Mg	Magnesium	(none), but for burning Mg metal Intense White
Mn (II)	Manganese (II)	Yellowish green
Mo	Molybdenum	Yellowish green
Na	Sodium	Intense yellow; invisible through cobalt blue glass
Nb	Niobium	Green or blue
Ni	Nickel	Silver-white (sometimes reported as colourless or bluish-green)
P	Phosphorus	Pale bluish green
Pb	Lead	Blue/white
Ra	Radium	Crimson red
Rb	Rubidium	Red-violet
Sb	Antimony	Pale green
Sc	Scandium	Orange
Se	Selenium	Azure blue
Sn	Tin	Blue-white
Sr	Strontium	Crimson to Scarlet, yellowish through green glass and violet through blue cobalt glass
Ta	Tantalum	Blue
Te	Tellurium	Pale green
Ti	Titanium	Silver-white
Tl	Thallium	Pure green
V	Vanadium	Yellowish Green
W	Tungsten	Green
Y	Yttrium	Carmine, Crimson, or Scarlet
Zn	Zinc	Colourless (sometimes reported as bluish-green)
Zr	Zirconium	Mild red

New concept of energy creation and colours of stars with their formation

In the retrospective literatures which our focus lighted on earlier; the burning temperature of a star was commonly and basically the sole factor responsible for the colour of the stars and nuclear fusion of the predominant element contained in stars – hydrogen was generally and majorly the only means of energy (light) creation by stars.

The different elements as earlier highlighted burn with different characteristic flames in a flame test, none-the-less at different temperatures. However the temperature is not the major determinant factor of the colours of the stars; the burning element(s) and the quantity; generate the colours with a characteristic flame viewed in our night heaven. For example; a fusion of the two hydrogen isotopes may result in either deuterium or tritium or helium or lithium or beryllium or boron or carbon etc. All this element burn with different characteristic flames, hence generate the variety of colours of the stars. In addition as earlier inferred from flames and flame test, the presence of oxidants such as oxygen or anti-oxidant such as hydrogen also has a force that bears on the colour of the stars. The predominant fused element(s) of each star to a vast extent is responsible for its colour as it burns. None-the-less as earlier pointed out, these elements burn at different temperatures.

Most science research literatures have reported that the major elemental content of the stars is hydrogen or other lighter gases. However in a new light, heavier gases like krypton, xenon and radon or other heavy elements (radioactive) can be the elemental constituent of stars. If these elements comprise stars, owing to the temperature which some of them burn, it is possible that some of this element engage in thermonuclear reaction in the form of fission.

Also it is possible that non-nuclear reactions also generate some of the energy we see in the form of light. For example, flammable fuel from hydrocarbon compounds and the like (dicyanoacetylene and ozone: non-hydrocarbons) that burn under gravity with temperatures of about 5000 ^{0}C and above can exothermically as well generate huge amount of energy in the form of light. This may be true if we watch some of this hydrocarbons burn like the oxyacetylene. However, this may be rare in our science universe, but it is subject to further research.

In 2000, experiments by NASA confirmed that gravity plays an indirect role in flame formation and composition. The common distribution of a flame under normal gravity conditions depends on convection, as soot tends to rise to the top of a flame (such as in a candle in normal gravity conditions), making it yellow. In microgravity or zero gravity environment, such as in orbit, natural convection no longer occurs and the flame becomes spherical, with a tendency to become bluer and more efficient. There are several possible explanations for this difference, of which the most likely is the hypothesis that the temperature is sufficiently evenly distributed that soot is not formed and complete combustion occurs. Experiments by NASA reveal that diffusion flames in microgravity allow more soot to be completely oxidized after they are produced than do diffusion flames on Earth, because of a series of mechanisms that behave differently in microgravity when compared to normal gravity conditions. These discoveries have potential fuel efficiency buttress why non-radioactive fuel can also be responsible for the energy creation of stars in the form of light [11].

Stars are formed when molecular clouds of interstellar gas and dust (nuclear and non-nuclear fuel) are fused in a large mass by gravity in a region in space. Despite the extremely cool temperatures in space at times, the fused dense mass may be triggered into flames thermally (that is thermonuclear and thermo-non-nuclear reactions) or otherwise by flammable fuel or elements, for example francium, hydrogen, caesium, methane, uranium, chlorinetriflouride, Heptanitrocubane etc. This rise nuclear reactions in the form of fusion and fission and other non-nuclear reactions as well.

Summary and Conclusion

Earlier knowledge says that these stars are a sea of mainly hydrogen and they undergo fusion to produce mainly helium, there by releasing a huge amount of energy in the form of light: but what is evident in our night sky from the characteristic flame of gases when they burn seem to collapse what was earlier erected. The hydrogen gases do not only fuse to form helium but also other lighter gases like lithium, beryllium, boron etc. that burns with a characteristic different flame from that of helium. More so, these stars are made up of other gases, liquid and solids fuels that may engage in nuclear and non-nuclear reaction for light energy to be produce with a characteristic colour which a reflection of the flame produce by constituent(s) element(s).

Also, since fusion and fission are both energy realizing reactions, it is possible that heavy isotopic gaseous elements at standard temperature and pressure like krypton, xenon and radon or heavy isotopic liquid elements at standard temperature and pressure like bromine and mercury and heavy isotopic solid elements at standard temperature and pressure like caesium, rubidium, francium, gallium, thorium, radium, plutonium, neptunium, uranium etc could burn and break into lighter isotopes and accompanied by positron or electron or neutrino or other lighter elements (or isotopes) or any combination of the afore-listed and energy in the form of light as well with different characteristic flame depending on the product(s). This may be rare unlike the former in the

scientific universe, but it is subject to further research.
Also it is possible that non-nuclear reactions also generate some of the energy we see in the form of light. For example, flammable fuel from hydrocarbon compounds and the like from non-hydrocarbon compounds; for example dicyanoacetylene and ozone that burn under gravity with temperatures of about 5000 ^{0}C and above can exothermically as well generate huge amount of energy in the form of light. This may true if we watch some of this hydrocarbons burn like the oxyacetylene or the aforementioned non-hydrocarbons: dicyanoacetylene and ozone.
Finally, stars are formed when molecular clouds of interstellar gas and dust (nuclear and non-nuclear fuel) are fused in a large mass by gravity in a region in space. The fused dense mass despite its cold temperature many a time may be triggered into flame thermally or otherwise by flammable fuel or elements/compounds like francium, hydrogen, caesium, methane, uranium, chlorinetriflouride Heptanitrocubane etc. This triggers nuclear reactions in the form of fusion and fission and other non-nuclear reactions as well.

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