THE SUN: THE CLOSEST STAR TO THE HUMAN CIVILIZATION

'Have you ever wondered about the true nature of the Sun that unmistakably covers your sky, each and every day with radiance and vitality? After reading through this, the perspective with which you look at this familiar red giant will change, forever.'

Prologue

1. For millenniums, with its vital and unapproachable form, The Sun, the most luminous object in our sky, has been the focus of admiration and worship of the human civilisation. Scientific and technological breakthroughs that took place in the last few centuries have enabled us to have a better understanding of the nature of the Sun. Nevertheless, the findings made with scientific approach by no means degrade the prominence and influence of the Sun on mankind and Earth. Rather, it complements the ancient beliefs and confirms the eminent role played by the Sun in formation and existence of our planet as well as its ecosystem.

2. Considering the prominence of this colossal inferno in shaping up the destiny of mankind and the Earth itself, this article makes an attempt to give a brief outline of the nature of our Sun. For the easy reference, the subject is covered under separate headings: The Sun and the Life on Earth, Nature of the Sun, Energy Generation Process and the Probable Destiny of the Sun.

The Sun and the Life on Earth

3. The significance of the Sun, as the source of all the energy forms we consume on Earth, is a well-known fact for many of us. In day to day life, all of us sense the warmth and light of the Sun without which we are unable to survive. Apart from that, as correctly explained in elementary school books, if we track down the history of the rest of the energy sources such as hydro power, fossil fuels, wind power etc., they all converge back to the energy received from Sun.

4. However, equally significant yet very less recognized fact is that, if not for the Gravity of the Sun, Earth would not have become a stable life supporting platform as it is today. In fact the Gravitational Force of the Sun is what keeps our planet at the right distance from it to receive precise amount of radiation energy, for the sustenance of life on Earth. With too little Gravity, we would have been at a greater distance from the Sun experiencing an Ice Age where as with too much of Gravity, the Earth would have been an inferno much closer to the Sun, with no life forms on it.

Nature of the Sun

5. A fact, which is unknown to many, is that the Sun is yet another star in the vast wilderness of space. In actual physical perspective, the Sun is a massive blazing inferno with fierce environmental conditions (see figure 1). It traverses the space accompanying its planetary system around a much higher scale stellar structure known as the Milky Way Galaxy that contains over 200 - 400 billion stars as per the present calculations.

6. Similar to anything in our known environment, the Sun is also in the process of continuous evolution (see figure 2). As per present day scientific calculations, it has been formed approximately 4.5 billion years ago. Over a period of billions of years, the Sun has

evolved to its present state and during the next few billion years it will change to a totally different entity. Fortunately for the next generations to come, the Sun is at a very stable state of its evolution as at present and will remain to be so, at least for another few billion years.

7. The mass of the Sun is estimated to be about 1.9 million-trillion-trillion kilograms (i.e. approximately 2 followed by 30 zeroes of kilograms) and it is equivalent to about 330,000 times that of our home planet – Earth. Unlike the matter on Earth, the mass of the Sun is consumed at a prodigious rate due to processes that are responsible for the colossal energy output of the Sun. As per the present rate of activity that takes place on the Sun, it is estimated that on average in each second, the Sun loses approximately five (5) billion kilograms of its mass as energy.

8. The average diameter of the Sun at its present stage is approximately 1.4 million kilometres, which is about 109 times that of Earth. This means about 1.3 million earth sized planets could be contained within the volume of the Sun.

9. The chemical composition of the Sun is dominated by Hydrogen followed by Helium. The percentage composition of Hydrogen is in the order of 75 % and that of Helium is 23 %. Rest of the mass consists of a minute percentage of heavier elements. With the extreme environmental conditions related with the prodigious energy generation substances on the Sun do not exist in much familiar liquid or solid states. Under these exorbitant conditions, matter transits to other forms, which we do not consciously come across in our earthly environments.

10. The colossal mass of the Sun is responsible for the overwhelming gravitational forces exerted by it, over a vast expanse of the space. This gravitational force is responsible for the formation and existence of our solar system as it is today. Again it is a very significant factor which will determine the future and the fate of the Sun.

11. With the vigorous processes that take place within, the average surface temperature of the Sun is around 5800 Kelvin. Towards the centre or the core of the Sun, the temperature level rises up to incredible 15.6 million Kelvin. Again the temperature of the atmosphere of the Sun varies from 5800 Kelvin at Photosphere to around 1 million Kelvin at the Corona or the outer atmospheric layer which extends for millions of kilometres.

12. Due to the immense mass as well as the extreme temperature conditions, the estimated pressure prevailing at the core of the Sun is somewhere around 250 billion times the pressure at mean sea level of the Earth.

13. Intense temperature and pressure conditions associated with the towering energy output, leads to enormous amount of electromagnetic disturbances on the Sun. Effects of such are felt at distances even many billions of kilometres away from the Sun. One such phenomenon which is commonly known as Solar Winds causes disturbances even at the Earth's surface and affects our electronic and power equipment from time to time.

Energy Generation Process

14. At the present evolution stage of the Sun, the dominating energy generation mode is a sub atomic level reaction process that is scientifically known as Nuclear Fusion.

This nuclear process takes place under extreme temperature conditions of tens of millions of centigrade where Hydrogen atoms virtually fuses together to form higher order element – Helium. The estimated energy output density is in the order of 90 to 300 gigajoules per converted gram of Hydrogen. With this prodigious amount of energy generation process it is estimated that in every second approximately 386 billion billion megawatts of energy is produced within the core of the Sun.

15. The energy produced is emitted in the form of radiation to the outer space and it covers the whole range of the electromagnetic spectrum. We, at the surface of the Earth which is at an average distance of 150 million kilometres from the Sun, receive its energy mainly in the form of light and heat, at a rate of about 1388 watts per square meter.

16. Furthermore this immense energy output is the stabilising factor of the physical state of the Sun. The radiation energy virtually allows the Sun to expand against the massive contracting effect of its gravitational pull. As per present calculations, the Hydrogen reserve of the Sun will last approximately for another 4 to 5 billion years, to maintain the stability of the Sun. However when the fuel reserve is exhausted, the Nuclear Fusion process with Hydrogen will decline, allowing the gravitational forces to dominate. This will initiate the terminal phase of our Sun.

Future and the Fate of the Sun

17. Due to many unknown and complex factors, the state of the humankind as well as the solar system after many billions of years is beyond the grasp of the wildest imagination of today. However with the help of the scientific tools as well as with a bit of imagination, the ultimate fate of the Sun could be visualised for the time being, after neglecting the effects of many unknown parameters.

18. When the Hydrogen reserve of the Sun becomes scarce, the gravitational force dominates and the matter on the Sun will be further compressed initiating a Nuclear Fusion process of heavier elements, i.e. from Helium to Carbon in the periodic table. These processes will give out prolific amount of energy for a shorter period of time comparatively to the main Hydrogen burning phase. During this period the Sun may produce a quantum of energy which may be in the order of many thousand times than that at present.

19. With these extravagant energy outbursts, the Sun will expand itself so much that it will wrap the solar system within it. In this process even the outer planets of the solar system - if at all they are still there will be destroyed with the fury of the Sun.

20. However, after exhaustion of the higher order elements up to the level of Carbon, the energy generating process will gradually cease, leaving the Sun- now highly rich with Carbon to collapse and shrink. Over a period of many millions of years, the Sun will finally cool down to form an inactive stellar entity termed as a White Dwarf.

21. What should be very clearly emphasised at this moment is the fact that, even though the end of the Sun seems so shattering, it is an event which is yet too far to be of our greatest of concerns considering the cosmic time scales.

Epilogue

22. With many discoveries made in the recent history, mankind has been able to complement the perception with which their ancestors beheld the Sun – the vital force behind the making of the Earth and its ecosystem.

23. In the preceding sections of this article, a brief outline was given on the Prominence of Sun on Humankind, Properties of the Sun and Mechanics of the Energy Generation Process as well as the Probable Destiny of the Sun.

24. The knowledge shared at this level undoubtedly will set a firm and interesting base for a deeper venture into the universe. The understanding of our universe will allow us to appreciate the wonders of nature, which we are blessed with. Again it allows us to perceive our nature relative to the monumental background, which has set the seed for the fabrication of our destiny.

25. With a knowledge and technology that is beyond the wildest imagination of today, our future generations will conquer the universe and whatever lies beyond. Still for all their memories will always carry the distant echo of the Sun and its Solar System, which had been the cradle of life for humankind.

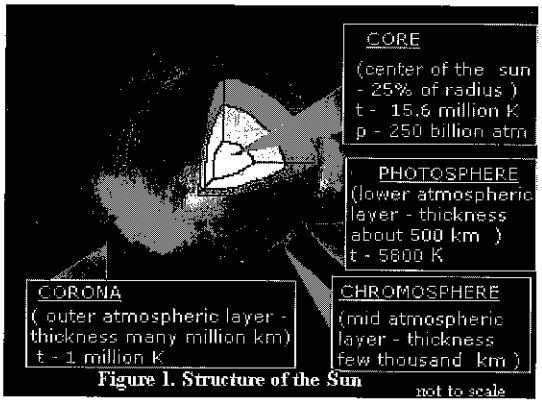

Figure 1. Structure of the Sun not to scale

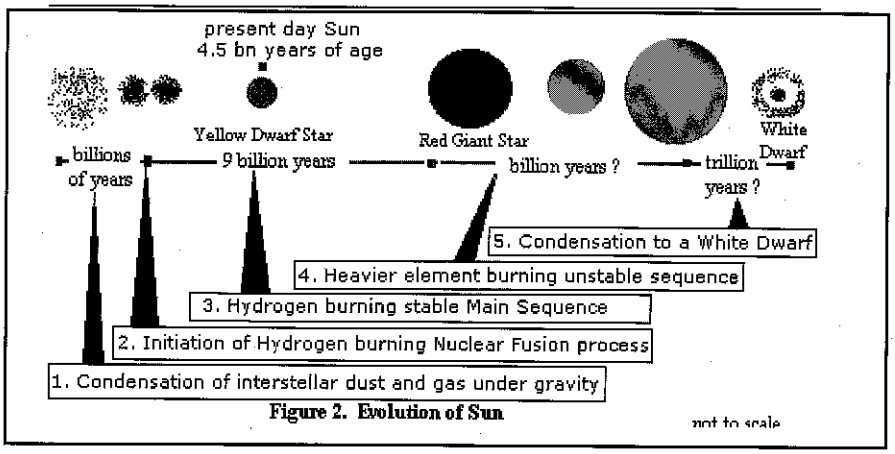

Figure 2. Evolution of Sun not to scale

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Wing Commander VN Pandithasekera RSP BSc[Defence]
HOD, Aeronautical Engineering
Kotelawala Defence University