Indian Journal of Traditional Knowledge
Vol. 13(4), October 2014, pp. 716-724

Vedic mythology of solar eclipse and its scientific validation

S Santhosh Kumar[1]* & R Rengaiyan[2]

[1]Department of Physics, Avvaiyar Government College for Women, Karaikal–609 602, UT of Puducherry, India;

[2]Department of Physics, Aringar Anna Government Arts College, Karaikal – 609 605, UT of Puducherry, India

*E-mail: santhosh.physics@gmail.com

Received 21.10.13, revised 21.04.14

Rig Veda, the oldest one among the four *Vedas*, pronounces the phenomenon of the *Solar eclipse* in a mythical language. During the eclipse, the eclipse induced gravity waves causes a reduction in Ozone layer concentration in the stratosphere which allows more cosmic radiations of different wavelengths, to the surface of the earth. The research carried out about the radiations received during the past eclipses and its influence on seawater reveal the scientific knowledge behind *Rishi Atri*'s dispelling of darkness by the four Rigs, given in *Pancavimsa Brahmana*. Hence, for the first time, the eclipse event is differentiated into a four stage process, as per our recent findings on the change in Oceanic *p*H. The influence of solar eclipse on living organisms, especially, the erratic behaviour of animals, birds and marine organisms to eclipse is addressed. This new scientific finding supports strongly the Vedic predictions of eclipse and the traditional practices of Indians especially *Hindus*, which differ from region to region.

Keywords: Solar eclipse, Cosmic radiation, Seawater, *Rig veda*, Traditional practice

IPC Int. Cl.[8]: G01, G05, G21, G01T, G21H 7/00, F26F 3/28, C02F, B63J 1/00

Recent scientific explorations in Astronomy are wrapped up with the predictions of *Rishis* in the *Indian Vedic period*. India is rich in its tradition and culture and is known for its traditional values. India's rich *Vedic scripts* pronounce the process of eclipse in the language of metaphor. Among the four *Vedas* namely *Rig, Yajur, Sama* and *Atharva*, in the oldest Vedic text, *Rig Veda, Rishi Atri* dispelled the darkness caused by eclipse, by chanting four mantras. Since the ancient *Vedas* are written in the language of metaphor the process of eclipse is connected with Lords, demons, etc. In the scientific view, the eclipse is a celestial process happening often and which helps the scientists to gather information regarding the astronomic and climatic changes, and even the influence of cosmic radiation on earth's surface. Investigating the solar radiation changes during the process of eclipse will explore even the present understanding of eco-balance since the world is composed of matter and light.

The animals/birds can identify the natural calamities/events even before its occurrence, it is believed so. The reasons are said to be different for different events, for example, humidity change before rain is felt by animals /birds. Similarly the death rate is low for animals /birds compared to humans during Tsunami or earthquake, which indicates the capacity to identify/feel the forthcoming event, i.e. they are getting disturbed due to the atmospheric or earth's magnetic field change. In the event of eclipse also the erratic behaviour of such organisms are reported many. The marine organisms are also hide themselves from the exposure to Sun. All studies, past and present, concluded that these changes are similar to night time chemistry. But in *Rig Veda*, *Rishi Atri* pointed out that this is entirely different than the night time behaviour. Hence, we conceived the concept of radiational cause to the behavioural changes of living organisms during eclipse. This paper tries to answer the questions arise regarding the cause of behavioural changes of living organisms and explains how our scientific findings coincides with the predictions of *Vedic Astronomy*.

Astronomy in Indian Veda

Ancient India's contributions in the field of astronomy are well known and well documented. The earliest references to astronomy are found in the *Rig Veda*, dated 2000 BC-5000 BC. The ancient

*Corresponding author

Indian astronomy emerged in 500 AD and culminated in original findings like, the calculation of occurrences of eclipses, Earth's circumference, theorizing about gravity, determining the Sun as a star, determining the number of planets in the Solar System, etc. The earliest concept of a heliocentric model of the solar system, i.e. the Sun is at the centre and the Earth is orbiting it, is found in several Indian Vedic Sanskrit texts. For example, according to *Aitareya Brahmana* (c. 9th–8th century BC), "*The Sun never sets nor rises*", which indicates that the Sun is stationery (hence the Earth is moving around it) and *Yajnavalkya* (c. 9th–8th century BC) also recognized that the Earth is round and believed that the Sun is "*the centre of the spheres and is much larger than the Earth*".

Many Indian astronomers like *Aryabhata* and *Bhaskara* had formulated ideas about gravity and gravitation in the early middle ages. The cosmological time cycles have been explained in the *Surya Siddhanta*. The Indian astronomer-mathematician *Aryabhata* (476–550), in his work *Aryabhatiya*, propounded a mathematical heliocentric model in which the Earth was taken to be spinning on its axis and the periods of the planets were given with respect to a stationary Sun. After that, *Bhaskara* (1114-1185) explained more about it and mentioning in his treatise *Siddhanta-Shiromani*, about the law of gravity, and different planets orbit the sun with different velocities. The ancient Indian astronomers had also recognized that stars are same as the Sun, that the Sun is center of the universe (solar system) and that the circumference of the Earth is 5,000 *Yojanas*. (one *Yojana* = 7.2 km), which is close to the actual figure obtained by the modern scientific methods (40,075 km), which is only 10% difference.

In the original version of the *Valmiki Ramayana*, a vivid description of a total solar eclipse is given in the first 15 *slokas* of the 23rd *sarga* of the *Aranyakandam*, and mentioned as *Rahu* is the cause, but in the *Atharvaveda*, (13.2.16-18, 28) the description of *Ketu* is found and is more suited for a comet, but *Rahu* is nowhere mentioned in the *Rig, Sama* and *Yajurveda*.

In those days, the Full Moon and the New Moon were referred to as *Raka* and *Sinivali*, respectively (*Sayana Bhasya*, and *Rigveda* 2.33.8). The cause of the eclipses (in Sanskrit - *grahanam*) is ascribed to a demon, called *Svarbhanu*, striking the Sun with darkness. It invoked *Rishi Atri* (the human son of *Lord Brahma*, as per *Veda*), who repelled its darkness by chanting four *Rik mantras* (*Rigveda* 5.40.5-6), which is in harmony with our findings of four stages of the eclipse process in context with its radiation effects.

Eclipse in Vedic Period

Almost all scripted wars witnessed an eclipse, either solar or lunar eclipse. Few of them are, (i) The final battle of a 5 yr war between *Alyattes II* of Lydia and *Cyaxares* of the Medes, ended abruptly due to a total solar eclipse on May 28, 585 BC according to Herodotus (1.74)[1] (ii) In the Peloponnesian War between the Athenians and Syracusans[2], a lunar eclipse was witnessed on August 28, 413 BC. (iii) In 2159 BC, the Chinese emperor Chun King put to death the royal astronomer brothers *Hsi* and *Ho* when they failed to predict the eclipse of October 22, 2134 BC[3] (iv) The European Emperor Louis was so perplexed by the five minutes of totality he witnessed during the eclipse of May 5, 840, and he died shortly thereafter. The fighting for his crown ended three years later which divided Europe into the three major areas, as we know today, France, Germany, and Italy[4].

The date of an eclipse referred to in the Bible is known for certain: "`And on that day,' says the Lord God, *`I will make the Sun go down at noon, and darken the Earth in broad daylight'*." (*Amos* 8:9) "That day" was June 15, 763 B C and which was confirmed by an Assyrian historical record known as the *Eponym Canon*. On the day of Ibrahim's death, the sun eclipsed and the people said that the eclipse was due to the death of Ibrahim (the son of the Prophet). But Allah's Apostle said, *"The sun and the moon are two signs amongst the signs of Allah. They do not eclipse because of someone's death or life. So when you see them, invoke Allah and pray till the eclipse is clear"*. Similarly India's greatest *Idhikasas,* namely *Valmiki Ramayana and Mahabharatha* also quoted the description of eclipse and the tradition and practice in those days.

A solar eclipse occurred on June 15, 763 B C allowed Thiele to fix every other name in the complete Assyrian lists of rulers from 891 to 648 B C and he was able to double check his accuracy with the canon of Ptolemy (70-161 A D)[5]. Ptolemy provided a large number of solar, lunar and planetary positions with their dates, and over 80 of these have been verified by modern astronomers[6]. *Thus the calculation of predated eclipse events helps to trace the old*

historical events and the rulers' period. Even though many more eclipse events were witnessed in early scripts, almost all of them are from 600 B C onwards. The first Chinese report of eclipse is dated around 2134BC. It is very important to note here that the eclipse event is witnessed and scripted in India during Vedic period itself.

Rig Veda is a very old *Sanskrit* language text of religious and historical significance in India. The dating of Vedas has been a matter of major controversy but many astronomical observations in the *Vedic texts*, suggesting that some parts of *Vedas* are between 2000 BC to 5000BC. *Rishi Atri* was the first to predict solar eclipses and calculate their durations; the *Rig Veda* and the *Pancavimsa Brahmana* witness this.

Vedas are compilation of *suktas* or hymns from many different *Rishi's* over a vast span of historical time as evidenced by different astronomical references there in. *Vedavyasa*, long time ago, bundled various thousands of *Vedic hymns*, generated over long periods previous to his time, into different groups called *Rig, Yajur, and Sama* etc much after their creation. *Rig Veda*, as we now know, 1017 *suktas* consisting of nearly 10800 '*Rik`s*' or *hymns*. Many of *Rig Veda* chapters or *Mandalas* are associated with one *Rishi* or his family, clearly suggesting a period of many generations of contributors to the texts. Fifth *Rig Veda Mandala* called *Atri Mandala* is associated with *Rishi Atri*. In this chapter, the 40th *sukta* and 5th *Rik*, *Rishi Atri* describes a total solar eclipse, as follows:

5.040.05a yát tvā sūrya svàrbhānus támasāvidhyad āsuráḥ
5.040.05c ákṣetravid yáthā mugdhó bhúvanāny adīdhayuḥ
5.040.06a svàrbhānor ádha yád indra māyā́ avó divó vártamānā aváhan
5.040.06c gū́ḷhám sū́ryaṃ támasāpavratena turíyeṇa bráhmaṇāvindad átriḥ
5.040.07a mā́ mām imáṃ táva sántam atra irasyā́ drugdhó bhiyásā ní gārīt
5.040.07c tvám mitró asi satyárādhās taú mehā́vataṃ váruṇaś ca rā́jā
5.040.08a grā́vṇo brahmā́ yuyujānáḥ saparyán kī́riṇā devā́n námasopaśíkṣan
5.040.08c átriḥ sū́ryasya diví cákṣur ā́dhāt svàrbhānor ápa māyā́ aghukṣat
5.040.09a yáṃ vaí sū́ryaṃ svàrbhānus támasāvidhyad āsuráḥ
5.040.09c átrayas tám ánv avindan nahy ànyé áśaknuvan

Rig Veda- HYMN XL. 5.

As per the translation in English by Ralph T H Grifith, in the first verse, as the shadow of the moon starts covering a large part of the sun the red tinge of the solar chromosphere becomes visible and *Rishi Atri* describes this as the color of red sheep[7]. When the full solar eclipse takes effect and only the corona can be seen, he describes this as the color of silver sheep. When the shadow starts receding from the sun the reddish effect is again seen. Finally when the eclipse is completely over the sun is restored to its original bright luster, which *Rishi Atri* calls the colour of white sheep. The fifth stanza of the *hymn* says that all the creatures were frightened and were in a terrible condition during the total solar eclipse. Also he said that the darkness at the time of full solar eclipse is totally different from what the normal darkness is. Only birds and animals get distracted by such kind of darkness.

Astronomy was quite advanced in *Vedic era*. The event of solar eclipse was described as *Svarbhanu*, a demon, had trapped the Sun and the whole earth was dark. *Rig Veda* also says that *Svarbhanu* was not from the heaven but he was from the earth. It itself explains two concepts: (i) *Svarbhanu* (Moon) is associated with earth, i.e. it is the natural satellite of the earth and (ii) it does not have its own brightness and only reflects the light of sun ('*bhanu'* – Sun; '*Swarbhanu*' – lighted by Sun). Thus *Rishi Atri* says the truth about the Moon and the solar eclipse that *Swarbhanu* (Moon) comes between the sun and the earth and because of that the solar eclipse takes place.

Science of Solar eclipse

The solar eclipse being a rare natural phenomenon gives an opportunity to investigate how the ionising radiations react to the material surface of the earth due to the fast solar radiation changes. A huge quantity of shorter wavelength radiations are expected to reach the earth's surface during solar eclipse since the disturbance of the heat balance along the supersonic travel of the trajectory of the Moon's shadow could generate eclipse-induced gravity waves[8-10], which results a reduction in the stratosphere ozone layer concentration[8,11-13]. Several measurements of solar radiation were carried out since 1960; recent works of Zerefos *et al*.[13,14] focussed on the study of eclipse-induced changes in the spectral solar irradiance at the earth's surface, the effect of multiple scattering on sky brightness, and the wavelength dependence of the limb darkening effect, etc. The radiations in shorter wavelengths (350 nm) are generally influenced more by the eclipse, and at large eclipse percentages (>85%), it slowly decreases as the eclipse approaches its maximum compared to that of the longer wavelengths[14]. Hence, one can expect more shorter wavelength radiations during partial eclipse, which is less studied. The environmental effects of solar

eclipse had been mainly focussed on meteorological parameters, photochemistry[15], boundary layer physics, total columnar ozone, gravity waves, and ionospheric parameters. Zerefos *et al*. pointed out a characteristic artificial decrease of total ozone during solar eclipse[13], which allows more radiations to pass through. India had a total solar eclipse on 22 July 2009, which was visible over the central India, while a partial eclipse in southern part, and an annular eclipse on 15 January 2010, and the study conducted on seawater during these events is analysed giving emphasis to solar radiation and Vedic concepts. The influence of solar eclipses on cloudiness, i.e. 'eclipse clouds', has been observed just before the beginning of the total solar eclipse, as reported by Hanna[16] and remains dissipated up to the maximum eclipse period. Kolev *et al*. observed a continuous decrease in wind speed without any significant change in direction during the solar eclipse of 11 August 1999[17]. Founda *et al.* also reported a similar effect of observations during the solar eclipse on 29 March 2006[18]. As per our observations recorded at the study location Karaikal, (latitude 10^o 55' N and longitude 79^o 52' E),U T of Puducherry, India, during the past annular eclipse, there was a shift in wind direction 20^o towards south (from 250^o to 230^o SW) but no change in the wind speed. This shift in wind direction may be mainly due to the change in pressure gradient force during eclipse.

Experiment

Emphasis was given on the response of seawater to the abrupt changes of solar radiation during eclipse. This work also aims at delineating the different types of radiations reaching the earth's surface and the possible effects on seawater.

Earlier studies on the ozone concentration reveal that considerable reduction in ozone concentration during partial eclipse and total eclipse[11-13], which is the major phenomenon for the observation of more radiations of shorter wavelength on the earth. Many observational evidences on the formation and propagation of eclipse-induced gravity waves at different atmospheric heights were reported[9,10]. Zerefos *et al*. pointed out that the eclipse-induced cooling of the ozone layer in the stratosphere is the main source of gravity waves propagating both upwards and downwards[19]. Measurements of total column of ozone using Brever Spectrophotometers have revealed that there was a reduction of 30-40 DU total ozone on the day of eclipse, 29 March 2006, than the day before at Athens[14]. Such a reduction in surface O_3 may be due to decreased efficiency of the photochemical O_3 formation[15].

The seawater from Bay of Bengal, the eastern coast of India, with *p*H 8.1 (which is the average oceanic *p*H) is subjected in this study to find the influence of solar radiation on the *p*H(power of Hydrogen) of seawater under the exposed condition since major part of the earth is covered by sea. *p*H is a measure of the acidity or alkalinity of a substance and is one of the stable measurements in seawater. Ocean water has an excellent buffering system with the interaction of carbon dioxide and water so that it is generally always at a *p*H of 7.5 to 8.5. In this context, a three stage experiment is conducted: (i) Sample at exposed condition during solar eclipse, (ii) normal days and (iii) Sample at non-exposed condition. Simultaneously, the changes in the meteorological parameters are also recorded for better understanding of other influencing parameters. Since the said location had a partial eclipse on July 22, 2009, we were able to detect the abrupt change of solar radiation and its effect on sea water. The change in pH value is recorded accurately with a calibrated pH meter containing a glass electrode with temperature compensation controls, during the eclipse event and a few days prior to and after the eclipse, but on 15 January 2010 (annular), it was recorded well before the beginning of the eclipse, at 30 sec. resolution. The DI-PH101 model (Deep) *p*H meter with resolution ±0.01*p*H of operating voltage 230VAC is used in this experiment. A two-point calibration procedure is followed. The electrode is rinsed with distilled water and placed it in the *p*H=7.0 buffer solution. After showing a stabilized value it is adjusted to read *p*H of 7.0. The electrode is removed and rinsed it again with distilled water and then placed in *p*H=4.0 buffer solution, and adjusted to read *p*H of 4.0. Then it is placed again in the *p*H of 7.0 after rinsing, and noted weather the reading is 7.0. Until it shows the *p*H of 7.0 this procedure is repeated and thus calibrated the equipment. The temperature control knob is set at 25^oC.

The percentage of solar disk covered by the moon's umbral shadow was calculated using a high resolution telescope with curved grid lines. The meteorological factors like air temperature and the light intensity are recorded continuously during the eclipse period. The wind speed and wind direction are recorded using

anemometer and wind wane respectively, of Cyclone Detection Radar Station, Karaikal.

Discussion

It is obvious to mention here that the study of celestial events is not only the modern scientific interest but from the *Vedic period* (2000 BC), since exploring the truth behind the natural events is a noble quality of human being in all time.

Most of the traditional practices in India had originated from *Vedas*. Due to the difficulty in providing proof to the mantras/hymn in Veda, it is pronounced as Myth. Hence, *Vedic myth* became ancient Indian tradition.

Water appears to act as the Earth's sensory organ for the cosmic cycles. Dr. Theodor Schwenk has investigated the subtle effects of the cosmos on water, and has clearly showed the variations in water response to changes in planetary constellation and also found that moving water acts as a receiver, while still water preserves the received information[20]. In his experiments he vibrated water at regular intervals, before, throughout and after a solar eclipse. The wheat grains that used water shaken during the eclipse had a stunted growth, whereas the growth was normal to the water shaken before and after the eclipse, and which was confirmed afterwards using other techniques.

Lawrence Edwards had also carried out fascinating work on how the shape of tree and flower buds change their shape to the planetary alignment change[20]. For example the planet Mars influences the oak, Venus the birch, the cherry is influenced by the Sun, etc. Thus water is receptive to cosmic influence and conveys its information to all living organisms, because they are all largely composed of water.

The experiments performed during the past two eclipses at the said location, Karaikal in India offered an interesting result of significant decrease in pH of seawater on the day of eclipse than normal days. On the day of total solar eclipse, 22 July 2009, the observed value of *p*H reveals a considerable reduction of 20% of the difference between the normal and seawater, which is plotted in Fig.1. This observed change in *p*H value raised the curiosity and interest of continuous assessment of this study and hence the experiment is repeated on the day of annular eclipse, 15 January 2010. Even an hour before the eclipse event the *p*H value seems decreased from normal day value and reached its maximum reduction when the moon's umbral shadow on the solar disc was 45% and when the eclipse percentage was maximum, the decrease in *p*H value is minimum. A second minimum is recorded when the solar disc was released around 40% during the end of the eclipse event. Hence, the effect of solar eclipse on radiation exists even well before the beginning of the eclipse and the drastic decrease of *p*H value observed during partial maximum prolonged even after the end of the eclipse. It is stated in *Vedas* that the inauspicious period of eclipse actually begins about four *praharas* before a solar eclipse and three *praharas* before a lunar eclipse, (*prahara* being the unit of time equivalent to one-eighth of a day). This entire period of an eclipse was represented as the *parvakala*. Indian Hindus take bath both before and after this *parvakala* as a belief that which will erase the unholy shadow of *Rahu* and avoid its ill-effects. During the complete process of eclipse a raise in *p*H value between the two minima [Fig. 2, (iii)] is observed and hence the full process is divided into four stages namely, normal to first minimum (N_{1M}), first minimum to central maximum ($1M_{CM}$), Central Maximum to second minimum (CM_{2M}) and second minimum to normal ($2M_N$). *Atri's* dispelling of the darkness by the four *Riks* in four steps (Sec.3): the first part of the darkness he repelled became a reddish sheep (solar chromosphere), the second part he repelled became a

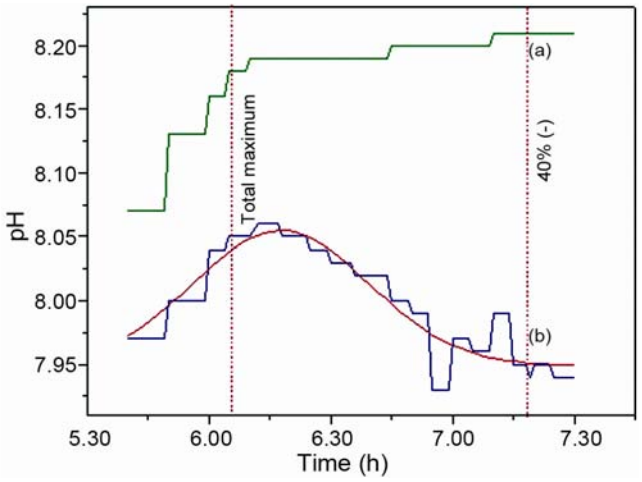

Fig. 1—Comparison of solar radiation induced H^+ ion activity in seawater during (a) normal day and (b) partial solar eclipse event on 22 July 2009. The reduction in *p*H value during eclipse is around 20% of the difference between the ordinary water (*p*H 7.5) and seawater (*p*H 8.5). The vertical dotted line is the time of maximum eclipse occurrence, at which the ionisation of seawater started due to the shorter wavelength rays reaching the earth's surface.

silvery sheep (solar corona), the third part again became a reddish one, and the fourth a white sheep (regaining the original colour). Thus the coincidence of our results [Fig. 2 (iii) & (iv)] as a four stage process of eclipse is in excellent agreement with the *Vedic* prediction, first time in this field.

The higher plasma frequency of the profilogram, i.e. the Total Ozone Concentration (TOC) in the ionosphere during eclipse[21] [Fig.2 (i)] and the change in stratosphere, particularly, the O_3 concentration during the eclipse event[22] [Fig.2(ii)] are compared with the effect of recorded *p*H value of seawater[23] [Fig.2(iii)] and the *Vedic* predictions [Fig.2(iv)], and are in good agreement among each other, i.e. the change in ionosphere, stratosphere, seawater and Vedic predictions respectively (The first part (i) of Fig. 2 is taken from Ref. 21 and the second part (ii) if from Ref. 22).

The O_3 concentration is decreased or a depletion region is formed at the partial maximum (≈ 45% of eclipse) due to gravity induced waves, and at the eclipse maximum the O_3 layer becomes wider/thicker than the normal level [Fig.2 (i)] in the shadow region[8-13]. Hence the penetration of short range cosmic rays are reduced to a maximum level and the reduction in *p*H value is minimum[14,23], and, thus the prediction of *Rishi Atri* that a silvery sheep, (close to the normal emission of the Sun - corona) matches well with our results. At the partial maximum, i.e. around 45% of the eclipse both at the beginning and end of the event, the reduction in *p*H is maximum due to the formation of depletion region in the O_3 layer, which was pronounced in *Rig Veda* as a Reddish Sheep (inner atmosphere of the burning globe - chromosphere) which is far away from the normal emission. Such formation of depletion region in the O_3 layer allows more short range cosmic radiations to reach the surface of the earth and hence causes a maximum reduction in *p*H value of seawater.

After an hour of the eclipse, the seawater started regaining its original state. This may be due to the fact that the influence of decrease of shorter wavelength radiations as the eclipse approaches its maximum compared to longer wavelengths. This is in correlation with Tzanis *et al*. that the solar radiation started to increase after the eclipse totality, while the surface ozone concentration started to increase about one hour later and returned to its ordinary behaviour several minutes after the end of the eclipse[12]. A decrease in light intensity (the total luminous flux

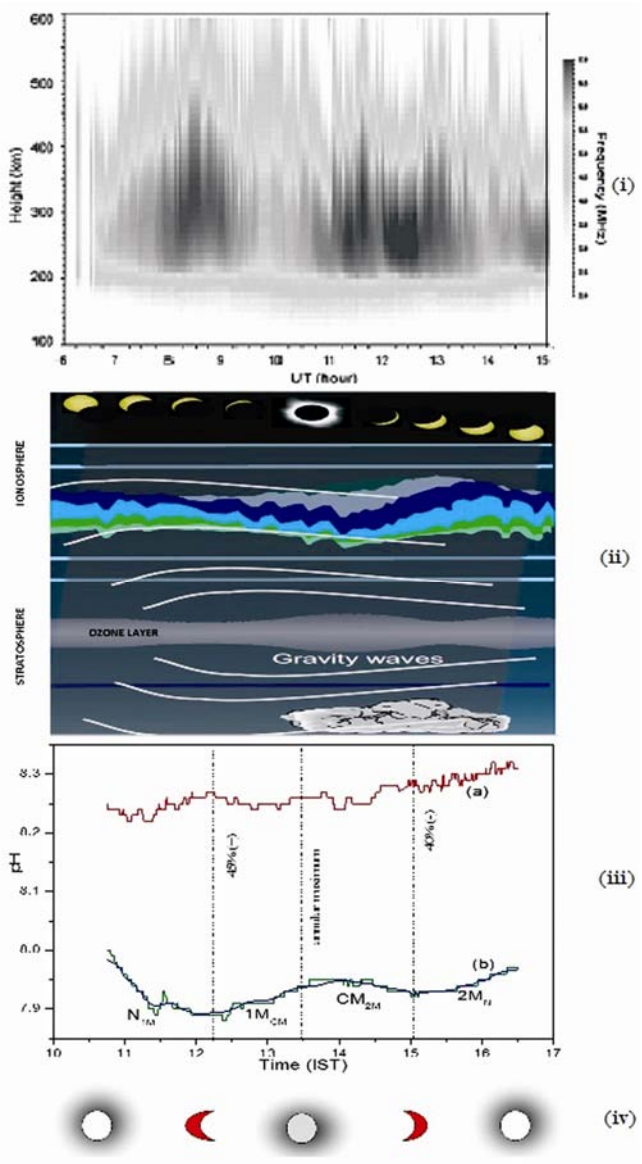

Fig. 2—*p*H variation of seawater with respect to the stratospheric change and the Vedic prediction, (i) Ionospheric change during solar eclipse (reproduced with permission from Ref. 33), (ii) Stratospheric change during solar eclipse (reproduced with permission from Ref.34), (iii) Comparative plot of Variation of *p*H in seawater during (a) normal day and (b) annular solar eclipse under exposed condition on 15 January 2010 (dashed line shows the % of eclipse; (+) symbol for approaching eclipse maximum and (-) symbol for towards the end of process) (hrs refers IST), (iv) Pictorial representation of four stages of solar eclipse as per *Rig Veda*.

incident on the earth's surface per unit area) of 10,000 Lux and a decrease in surface air temperature of 6°C are recorded during the annular maximum.

Search for the scientific reason of decreasing *p*H value perceived the influence of ionising radiations reaching the surface of the earth during eclipse.

Zhaobing *et al*. observed that irradiation of drinking water using gamma rays reduces its *p*H value[24]. During the partial solar eclipse of Oct. 1995, we have detected huge gamma counts at the eclipse maximum by gamma ray spectrometric experiments with NaI(Tl) scintillator. By comparing our earlier detection and measurements with the report of Zhaobing *et al*., it is obvious that among the shorter waves, gamma rays influences more in the reduction of *p*H value in seawater[24]. These gamma rays are reaching the earth's atmosphere due to the gravity wave induced reduction in ozone concentration, as explained before. The low energy gamma rays (≈ 1.24 MeV) reaching the surface of the earth are not passing through matter, as such these will not penetrate deep into the sea, instead are absorbed by the upper layer of the seawater and the particles get excited[25]. Due to the close association of *p*H value with salinity, this reduction in *p*H value of seawater in the surface layer during solar eclipse causes a critical change in the behaviour of marine organisms that they move to deeper region during this period. After few hours of the eclipse event these organisms come to their normal behaviour since the seawater regains its original state after few hours of the end of the eclipse. Hence the effect of the solar eclipse started before few *praharas* of the eclipse event and lasts for few *praharas* after the end of the process, as stated in *Vedas*.

Sudden Ionospheric disturbances (SIDs)' can be generally caused by either GRBs or Solar eclipse events. When the Earth lies in the path of the tightly beamed burst of energy, the atmosphere is slammed with massive doses of radiations and a sudden increase in ionisation occurs due to GRBs, while the obscuration of Sun by moon causes an opposite effect and hence a decrease in critical frequency (Total Electron Content) is expected. The Total Ozone Concentration (TOC) in the ionosphere during eclipse[21] also showed a similar effect to that of *p*H change in seawater, that is, the higher plasma frequency of the profilogram [Fig. 2(i)] is in vertical line with the depletion regions of Ozone layer in the Stratosphere [Fig.2(ii)] and which also corresponds to the dip in *p*H curve [Fig.2 (iii)], which provide a link between ionosphere-stratosphere and biosphere. Such effects are now interrelated with the *Vedic* predictions of *Rishi Atri*, who enchanted four mantras (*Riks*) during eclipse [Fig. 2(iv)], may be to protect the people from the harmful radiations.

As per NASA TP 2001-209990 report on the total solar eclipse of 2002 December 04, ships and boats offer an opportunity for considerable mobility during the critical moment of the eclipse, which supports our findings of reduction in *p*H. The very recent report of Sharma *et al*., states that the change in meteorological parameters and the photochemical ozone formation during eclipse are more or less similar to the behaviour of night time chemistry[15]. As a conclusion of our study, the darkness effect due to eclipse is not similar to the night time darkness, instead predominant short range radiations are also reaching the surface of the earth, particularly gamma rays. Studies concerning behavioural changes of animals, such as fishes, birds, rodents, and chimbanzees responded rapidly during total solar eclipse[26-29]. The studies on fresh water fishes during the 1980 solar eclipse in India reveals that all the studied species almost stopped gulping air, became sluggish, and sheltered to the bottom, and such changes during solar eclipse are related with the activities appropriate for sunset[26]. It is known that, *p*H can affect the ionization of the amino acid side chain which in turn change the secondary, tertiary and quaternary structure of the protein molecule. This will alter the active site and consequently its action. The change in *p*H of the medium or environment leads to alteration in the shape of the enzyme since each and every enzyme is characterized by an optimum *p*H, at which the specific enzyme functions most actively[30,31]. Such structural changes in enzyme have an effect on ionic binding which is necessary to drive chemical reaction. In biological systems an unexpected change in *p*H can have a major effect downstream. Hence, as per our findings, it may be viewed in the context of radiation and *p*H change during eclipse[32]. It was described by *Rishi Atri* also in *Rig Veda* that the darkness at the time of full solar eclipse is totally different from the normal darkness. Hence this new finding may probe a new gateway to the study of behavioural changes of marine organisms during eclipse, in the context of change in *p*H. Hence the traditional practices of India, from Vedic period to today, that is taking bath before and after eclipse, fasting during eclipse, covering food, well and drinking water, etc. are scientifically valid practices.

Summary and conclusion

India's rich Vedic tradition has a powerful influence in the field of astronomy and the eclipse

events are well documented. Finding the truth of such predictions explored new findings in the context of eclipse causing radiation effects. During solar eclipse, reduction in ozone concentration is formed because of gravity waves due to the change in pressure gradient force. The ozone depression allows ionizing radiation in addition to non-ionizing rays in the short period of eclipse. These rays have a wide range of effects on humans and aquatic and terrestrial ecosystems. However the role of ionizing radiation, such as gamma rays, during this process is less studied. Here, we report that, the gamma rays are reaching the earth's surface during eclipse, which reduced the *p*H of seawater when exposed to solar radiation. It is to be noted here that this observation is during eclipse partial maximum in both the event of total and annular eclipses, in the coastal area; where the seawater influences the effect of eclipse, especially on meteorological parameters. Our results are the first one reported about the influence of gamma rays during solar eclipse in the *p*H value of sea water. The results discussed will probe a gateway to a new approach of the behavioural studies of marine organisms in the context of *p*H value during eclipse period and may add an additional parameter in the geophysical studies of polar region. The minima and maxima obtained in the pH curve corresponds to the four stage process of eclipse, quoted in *Vedic scripts*, and this result may be the first scientific evidence to the four *Riks* of *Rishi Atri* in *Rig Veda*.

Acknowledgement

The permission granted by Dr. Petra K Knizova to reproduce the 1st part of Fig. 2 and Dr. E. Gerasopoulos to reproduce the second part of the Fig. 2, is greatly acknowledged.

References

1 Thomas D Worthen, "Herodotus's Report on Thales's Eclipse", *Electronic Antiquity*, Vol. 3.7,1997.

2 Thucydides, *The Pheloponnesian War*, translated by Rex Warner, (Harmondsworth), 1972.

3 Henkel FW, "The Chinese astronomers, Hi and Ho", *The Observatory*, 17 (1984) 361-361.

4 Michael J Carlowicz & Ramon E Lopez, *Storms from the Sun: The emerging science of space weather*, Joseph Henry Press, 2002, 35.

5 Thiele R Edwin, *The Mysterious Numbers of the Hebrew Kings: A Reconstruction of the Chronology of the Kingdoms of Israel and Judah*, (Willam B. Eerdmans Pub. Co, Grand Rapids, MI), 1951, 41-42.

6 Goldstein R Bernard, Saving the Phenomena: The background to Ptolemy's planetary theory, JHA, (1997) xxviii.

7 Griffith & Ralph T H, *The Hymns of the Rigveda*, 2nd edn, Kotagiri, Nilgiri, 1986.

8 Eastman John A & Stedman Donald H, Variations in the ambient ozone concentration during the 26 February 1979 solar eclipse, *Atmospheric Envir*, 14 (1980) 731-732.

9 Seykora E J, Bhatnagar A, Jain RM & Streete J L, Evidence of atmospheric gravity waves produced during the 11 June 1983 total solar eclipse, *Nature*, 313 (1985) 124-125.

10 Singh L, Tyagi TR, Somayajulu YV, Vijayakumar PN, Dabas RS, Loganandham B, *et al*., A multi-station satellite radio beacon study of ionospheric variations during solar eclipses, *J Atmos Solar-Terrestrial Physics*, 51 (1989) 271-278.

11 Chudzynski S, Czyzewski A, Ernst K, Pietruczuk A, Skubiszak W, *et al*., Observation of ozone concentration during the solar eclipse, *Atmos Res*, 57 (2001) 43-49.

12 Tzanis C, Varotsos C & Viras L, Impacts of the solar eclipse of 29 March 2006 on the surface ozone concentration, the solar ultraviolet radiation and the meteorological parameters at Athens, Greece, *Atmos Chem Physics*, 8 (2008) 425-430.

13 Zerefos C S, Balis D S, Zanis P, Meleti C, Bais A F, *et al*., Changes in surface UV solar irradiance and ozone over the Balkans during the eclipse of 11 August 1999, *Adv Space Res*, 27(12) (2001) 1955-1963.

14 Kazadzis S, Bais A, Kouremeti N, Blumthaler M, Webb A, *et al*., Effects of total solar eclipse of 29 March 2006, *Atmos Chem Physics*, 7 (2007) 5775-5783.

15 Sharma S K, Mandal T K, Arya B C, Saxena M, Shukla D K, *et al*., Effects of the solar eclipse on 15 January 2010 on the surface O_3, NO, NO_2, NH_3, CO mixing ratio and the meteorological parameters at Thiruvanathapuram, India, *Annales Geophysicae*, 28 (2010) 1199–1205.

16 Hanna E, Meteorological effects of the solar eclipse of 11 August 1999, *Weather*, 55 (2000) 430-446.

17 Kolev N, Tatarov B, Grogorieva V, Donev E, Simenonov P, *et al*., Aerosol lidar and in situ ozone observations of the planetary boundary layer over Bulgaria during the solar eclipse of 11 August 1999, *Int J Remote Sensing*, 26 (2005) 3567-3584.

18 Founda D, Melas D, Lykoudis S, Lisaridis I, Garasopoulos E, *et al*., The effect of the total solar eclipse of 29 March 2006 on meteorological variables in Greece, *Atmos Chem Physics*, 7 (2007) 5543-5553.

19 Zerefos C S, Garasopoulos E, Tsagouri I, Psiloglou B E, Belehaki A, *et al*., Evidence of gravity waves into the atmosphere during the March 2006 total solar eclipse, *Atmos Chem Physics*, 7 (2007) 4943-4951.

20 Lawrance Edward, *The Vortex of Life*, (Floris Press, Edinberg), 1993.

21 Knizova P K & Mosna Z, *Acoustic–Gravity Waves in the Ionosphere During Solar Eclipse Events, Acoustic Waves - From Microdevices to Helioseismology*, Prof. Marco G. Beghi (Ed.), ISBN: 978-953-307-572-3, In Tech, 2011.

22 Gerasopoulos E, Zerefos C S, Tsagouri I, Founda D, Amiridis V, *et al*., The total solar eclipse of March 2006: overview, *Atmos Chem Physics*, 8 (2008) 5205–5220.

23 Santhosh Kumar S & Rengaiyan R, Influence of solar eclipse on seawater, *Nat Sci*, 3 (2011) 69-74.

24 Zhaobing Guo, Zheng Zheng, Chunhui Gu & Dengyong Tang, Radiation removals of low-concentration halomethanes in drinking water, *J Hazardous Mat*, 164(2-3) (2009) 900-903.

25 Tsypin S G, Kukhtevich V I & Yu A Kazansky, The penetration of gamma-rays through water, iron, lead and combination of iron and lead, *J Atomic Energy*, 1 (1956) 217-220.

26 Pandey K & Shukla J P, Behavioural studies of freshwater fishes during a solar eclipse, *Environ Biol Fishes*, 7 (1982) 63-64.

27 Elliott J A & Elliott G H, Observations on bird singing during a solar eclipse, *Canadian Field-Naturalist*, 88 (1974) 213-217.

28 *Advani R*, Behaviour of rodents during *solar eclipse*, *J Bombay Nat Hist Soc*, 78 (1981) 551-552.

29 Branch J E & Gust D A, Effect of solar eclipse on the behavior of a captive group of chimpanzees (*Pan troglodytes*), *Am J Primatol*, 11 (1986) 367–373.

30 Ann S McDermid, Ailsa S McKee & Philip D Marsh, Effect of environmental pH on enzyme activity and growth of Bacteroides gingivalis W50, *Infection Immun*, 56 (1988) 1096-1100.

31 Ram Kumar Tripathi, Chintamani Chaya Devi & Abburi Ramaiah, pH dependent interconversion of two forms of tyrosinase in human skin, *Biochem J*, 252 (1988) 481-487.

32 Santhosh Kumar S, Why Birds/Animals Fly/Run Away to Solar Eclipse?, *Curr Adv Environ Sci*, 2 (2014) 11-14.