Astronomy in Ancient, Medieval and Early Telescope Era of India
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Session 02
Pre-Siddhantic Astronomy

As I mentioned that first few minutes I will use the software with me for explaining the ideas of positional astronomy. What I will show you that the real sky as you see, observe from Kanpur campus at different times, how it was 6,000 years back, how it will be tomorrow, all these things you can get. So I think then after those ideas of movement of the sun, planet and the stars clear, we will move onto the topic.

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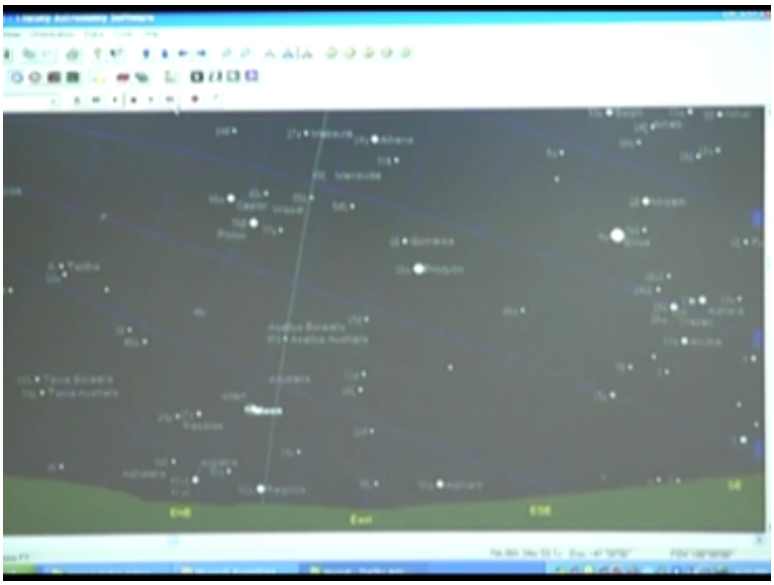

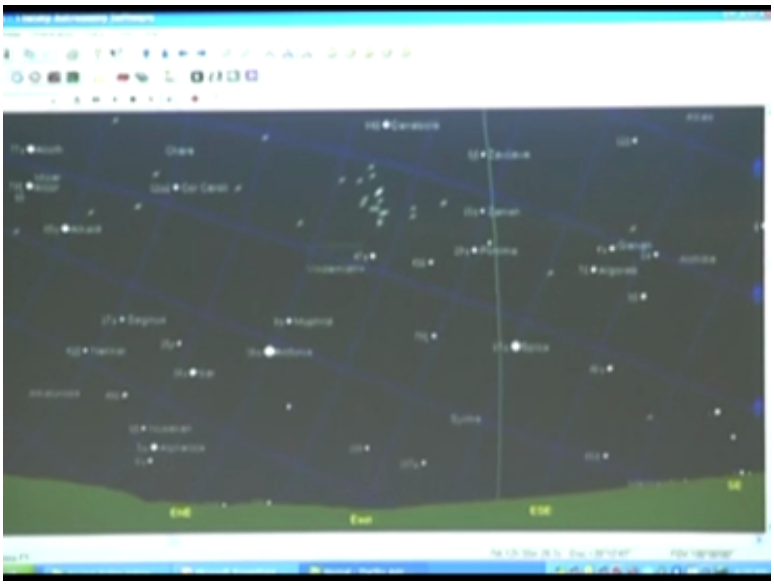

Say I think, batti ko thoda bandh kariye. If, you see that if you look towards east, you see the stars, planets, everything goes. And at from latitude 23 degree north, it will appear to be like this. So and this line, these lines are actually the various meridian lines. These are the longitudes or meridians. And the other lines are the latitude lines. And this is the ecliptic as you can see, this line is ecliptic. The cricket sound is actually the software cricket because it is nighttime.

And say for example, if I give the time as 21st March 2015 for example, you know it is the vernal equinox period. So what will be the location of the sun? Sun will be at the intersection of the ecliptic and the celestial equator.

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Celestial equator is this line which is starting directly here and goes. And this line is the ecliptic. This is sun. So computers can do many things. I can rotate the solar system in the opposite direction. So I can see now I think sun is going to set in the west. So this is the sun, you can see it is on the ecliptic, directly on the ecliptic. And most of the planets you will find will be around these two. Okay, now let us go back to nature. So this is approximately a time we will find, I can adjust the time and you will get the idea. Say I want to go to the vernal equinox day, so that means it will be March 21st. Okay, so you see that then sun will be at the junction point as you know already.

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So junction point, and this is the ecliptic. And this is the, and you will see that sun will rise exactly on the east. That is very important because it is an equinoctial day, is not it? 21st March. Because it is on the celestial equator and of course on the ecliptic. So you will find and this is the ecliptic. And you will find when it meets this position east, you will find sun is there. And this is I think Saturn. All the planets you will find, Jupiter. You will find they are very near to this ecliptic because they are all in one plane in which they revolve around the sun.

So you will see that sun will rise at exactly on the east. Similarly you will find that when on the winter solstice day, sun will be on the southernmost end. And again on the summer solstice day, it will be on the northernmost end. Because the location of the sun is already on the ecliptic and wherever ecliptic is meeting the horizon, the sun will rise there. So I think that particular junction point I was mistaken, I think some of you should have told me that you are wrong, sun is not going to rise there, sun is going to rise there now.

Because that junction point was when in the Dakshinayan period, you could see that it was the, ecliptic was coming from north to south. And date I gave as 21st March, so it is the vernal equinoctial point. Now you will find the vernal equinoctial point and sun will rise there. Yeah, can you see? Sun is rising. So this is equinoctial day. Similarly if you give your summer solstice day, you will find it will rise exactly on the, the sun will be extreme end.

That means it will be the extreme left hand side used, that means extreme north and sun is there. So this is the extreme point of the ecliptic. Now if you, this is you are observing the whole thing from latitude of 23 degrees north. You can change that also and then you can see that if you are on the equator, how it will look.

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So if you make 0 latitude, now you see that celestial equator is straight going like that, blue line. And this is the ecliptic and they are symmetrical. Now you are getting the whole thing is rotating as if it is from going in the vertical direction because you are on the equator. And this way you can see many things and I will show you. Now this is the present situation, so there is nothing unusual about it. You can see that all the planets are on the ecliptic or very near the ecliptic, sun is always there. You have seen also that how the equinoctial point or the solstice points can be seen here. Now suppose you want to see the northern direction, that means if you see towards the pole……

"Professor-student conversation starts."

Student: Particular formal definition of this?

Professor: Formal definition of this, there was actually very recent in precedency college a project was given to the students and one student came to me that did sun rises in the east, an article on that, so I found that it is very interesting. Really speaking, east direction is where the

celestial equator meets your horizon, that is the exact point east. But sun does not rise there, that is the problem.

So now you see if I am at the, our latitude we should correct because we are at Kanpur. Otherwise sitting at equator, you cannot see the north pole so easily. Yeah, if you see the northern direction, you will see the whole sky is rotating about one point where we have a very nice star, we call it Polaris, is not it? And if I go to say 6,000 years before, how it will look? You will find because these are important. I will come to the discussion of the pre-siddhantic astronomy. Some of these things you will find will come there and that is why it is better that you see how it was actually.

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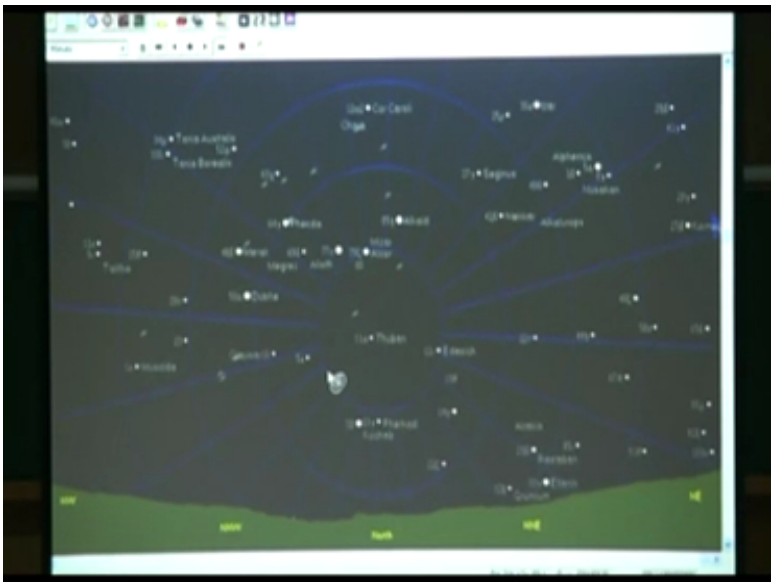

Suppose if I now give the date as minus 4,000 something, that means BC, oh that you find that there is nothing like a north pole, is not it? Or north pole star, pole star. That point which is actually imaginary point where the axis of rotation of earth meets the celestial dome, there is no star. So you will see when I come to the description of the Pre-Vedic or other, yes, early Rig Vedic description, it matches this.

When you come to approximately at a later time, then you find there is a pole star, is not it? That is Thuban. And at that time all the civilizations they used this particular star as the indicator of the northern directions. Even the major pyramids of the Egypt or the orientation of the major

structures in Harappan and Mohenjodaro, those settlements, they were matching these. Now when you again go to later period, can you identify where is our actual pole star at that time?

Where is Polaris? This is Polaris, this is the pole star. Actually the (())(10:08), these lines joining, Egyptians they used that as the northerly direction at when it is just vertical. And that of course is a different lecture, I do not want to go into that, it will take time. But now let us see what happens when we go to a later period, say 1500 BC, Mahabharata times say. Again you find that truly speaking there is no pole star.

And when you again come to a much later period, then gradually we are getting Polaris nearer but still not as a pole star. But when we come to more recent time, or then you again get the pole star not exactly but more or less. And if you come to current time, 19th century, it is very much near the, so you can see these are the things which you will find, I will show very soon when I discuss.

But I have, now you have some better idea than yesterday that exactly what positional astronomy indicates, what is the ecliptic, the sun's rising point at different times of the year and so on. Now of course, again I will, I am not showing here the intersection point of the celestial equator and the ecliptic, two very important points, the vernal equinoctial point, that also shifts. It can be easily seen but there is, then where the vernal equinox is there today, 3,000 years back it was a different point.

That is why Indian scientists or rather astronomers, they used the nirayana system to avoid confusion by suitably choosing a particular time or year as the 0 precision year. But that means which year the vernal equinox was at the point, at the beginning point of the sign Aries. But the western system is always using the vernal equinoctial point, so it shifts. Okay, now I think let us start our today's topic. I will come back to this software again later. I need it for some very interesting things later.

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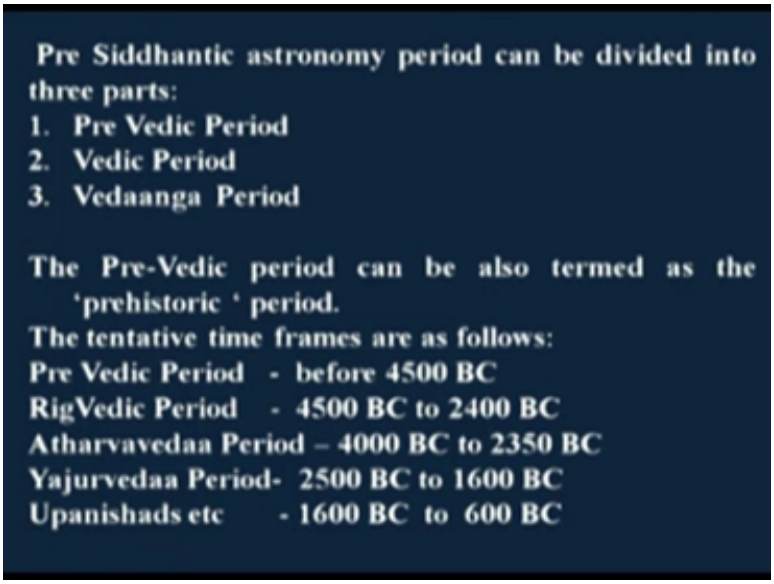

As I told that pre-siddhantic astronomy again can be divided into three main periods. One is Pre-Vedic period, Pre Rig Vedic period actually in a sense. Second will be the Vedic period and last will be Vedanga period. Vedanga, Puranic and all those periods. The Pre-Vedic period also many people you can call it as pre-historic time. That means it is pre-historic and almost in the border of proto-historic. So the tentative time frames which have been told by many scholars who did research in the recent times, not the 19th century research.

The Pre-Vedic period is before 4500 BC, Rig Vedic period is this. Then Atharvaveda period is this. Yajurveda period is this and Upanishads et cetera. Puranic literature also comes here. Now of course it has been done, it violates the theory of Max Muller's Aryan Invasion and now many indications are coming that the Rig Vedic period and the Harappan period, they are contemporaneous. And so I think this may look bit strange but that is what you will see why Rig Veda has been dated like that. We will come to that. The descriptions in Rig Veda itself will lead to this date.

Now the pre-historic period, I told something yesterday. The earliest settlements or township we have discovered in the subcontinent is at Mehergarh which has been dated by archeologist as 6500 BC and that was considered to be one of the largest settlement in antiquity. No settlement so old has been found anywhere else so far.

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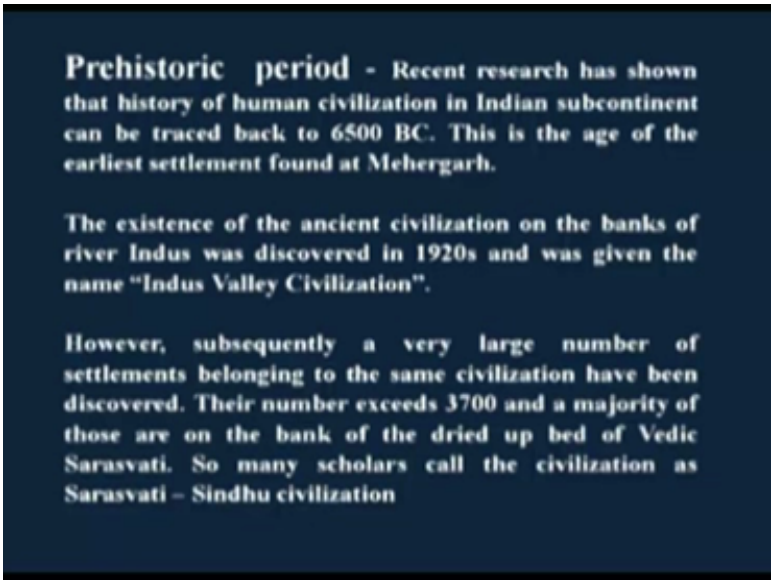

The existence of ancient civilization on the banks of river Indus was discovered in 1920s, you all know that and I was given the name Indus Valley civilization very obviously. However subsequently in the later period particularly starting from 1950s, you know what happened that there in the Rajasthan, they are many legends that there used to be many towns, many cities et cetera but it is all desert now.

Hearing all these things, Diwan he requested Pandit Jawaharlal Nehru immediately after independence of India to grant some fund to the archaeological survey so that they can really find out whether there is any truth behind these legends and rumors. So the first Director General of archaeological survey of India, that Indian Director General after independence was Amalananda Ghosh. So he was granted a project by Pandit Nehru, first prime minister, of 10,000 rupees.

He was given a big zip and some assistance. One of them was Debala Mitra, also quite well known. And they then investigated and found out lots of settlements under the sand. Subsequently of course many Harappan settlements, Harappan settlement I mean settlement under, of that civilization has been discovered. Very large number, the number now, the settlements belonging to Harappan civilization more than 3,700. And majority of them are actually on a dried bed of river which now many or most of the scientist are identifying with the Lord's river Sarasvati.

I am quite sure professor, Michele Danilo gave a lecture here, is not it? So you might have listened to him, his book is also wonderful. But the research on Sarasvati started in the 19th century itself and lots of scholars both from Europe and in India, they have researched on that. And Michele Danilo's book is one of the excellent one I would say. So many are nowadays calling that Vedic Sarasvati, rather civilization as Sindhu Sarasvati civilization and like that.

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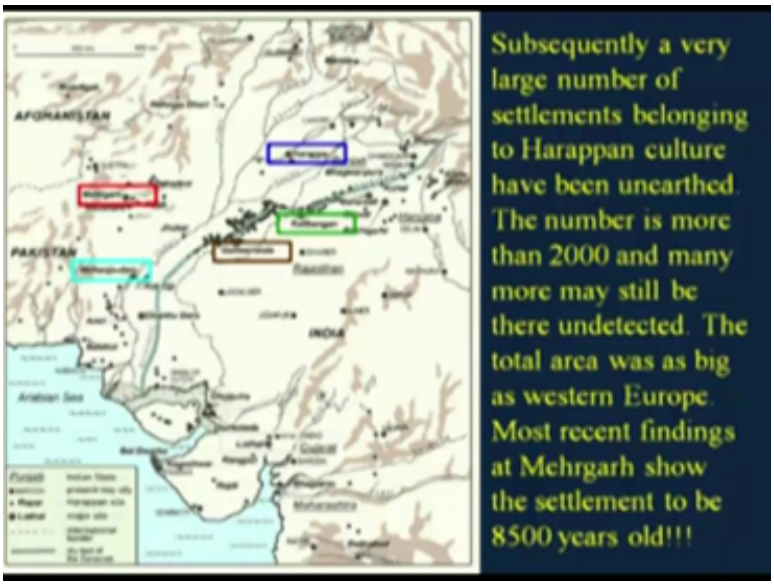

So this is quickly I am quite sure Danilo also showed you that this is actually now the region which was covered by Harappan civilization. So almost the whole area is like major part of Western Europe. It is pretty large, this the Harappa and Mohenjodaro were the initial discoveries. But then Mehergarh is here, then this is Ganeriwala, then Kalibangan is a major site. Dholavira is here, then I think Lothal is somewhere here. So many sites have been found. One of the site here, Kunal, site here, now they are finding settlements which have been dated by carbon dating to more than 5,000 BC.

And very interesting thing I think Danilo's book says, that the later Harappan period all the sites were shifting to the east because of the onset of the arid climate, rainfall change. There is a major change in climate and the whole area was becoming a desert.

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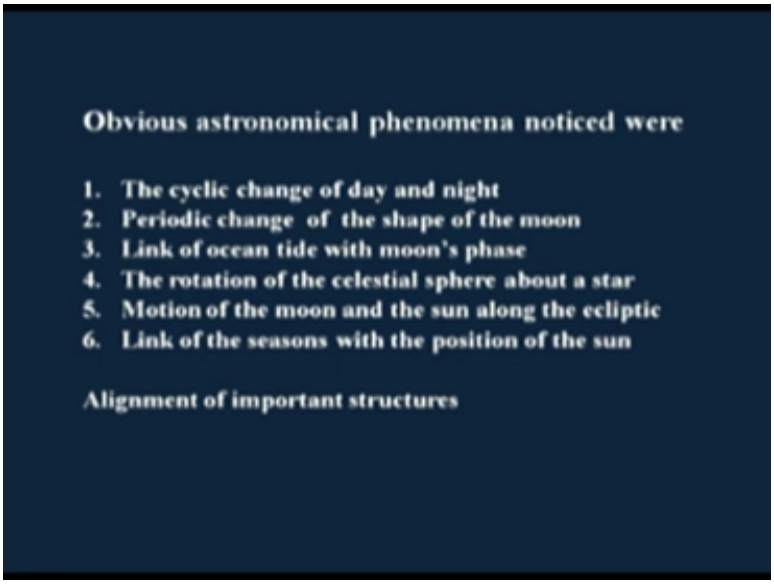

Anyhow, so the obvious astronomical phenomena in those days, Harappan civilization was a very developed civilization. Most of the Harappan cities are much better than Kanpur city I can tell you that. The cycle, the change of day and night is something quite obvious. Even in above region we will realize that. Periodic changes of the shape of the moon also attracted the attention which is also pretty obvious.

Link of the ocean tide with moon's phase was also familiar to the people who were living near the coastal regions. The rotation of the celestial sphere about one star or near about one star was also noticed. That is they found that it is rotating about one point which is not moving much. Then the motion of the moon and the sun along the ecliptic was noticed later that they are shifting their position in the background of the fixed star.

And then link of the seasons with the positions of the sun, that also they found out after long observation. And they also aligned some important structures based on astronomical directions and so on.

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Now as I just showed you that about 3,000 BC we had a pole star like Thuban as I showed you. But subsequently again it shifted and there was no pole star till about 1500 or 1600 or 1700 AD really speaking. Again we had another pole star. So this thing was also noticed by the people that there is a star which could be used for making northerly direction.

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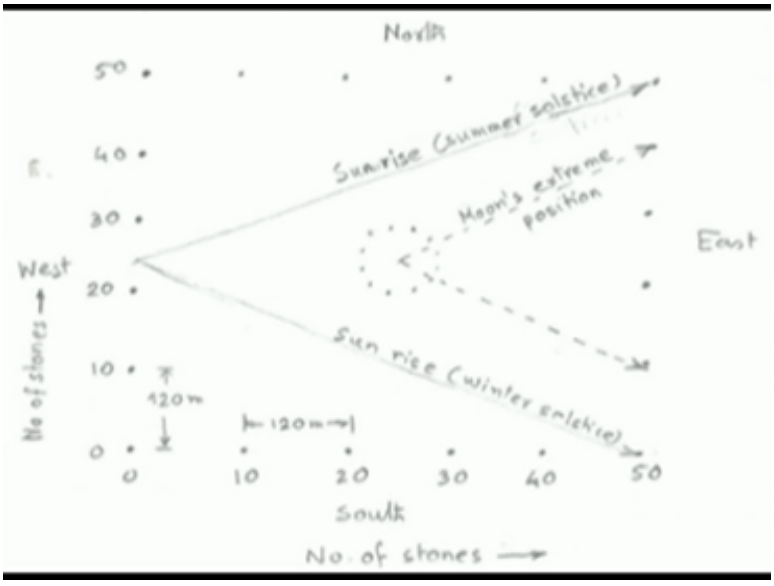

Now I think the earliest evidence of some astronomical observation is found at a place called Anand Sagar I told you yesterday in Andhra Pradesh or now Telangana. So what they have found the stones have been kept, large stone at a gap of about 120 meter. And so therefore there are, all

they have in total 50 stones and each stone was I think, 10 stones, 120 means each stone about 12 meters and in a square shaped.

So from this point there is something, some marking et cetera. Now you see this is the west direction, this is the east. And this direction was considered to be the sunrise on the summer solstice day. It is pretty obvious, if you see that this is equal to 1 and this is half, is not it? So this angle is theta, tan theta is equal to 0.5, so how much is theta? About 26 degrees I think something like that.

And at that latitude when you are in, on equator, the extreme distance of the sun in summer solstice is 23.5 degrees. But as you move towards north, the extreme point shifts towards north and here it will be around 25-26 degrees. So really speaking the sun will appear to rise along this direction in summer solstice day. Similarly on the winter solstice, the sun will appear to rise on this side of the horizon.

Similarly here the moon's extreme position, moon where varies little bit this way, that way, so they also had some stone and they thought that these are the indicators of extreme positions of the moon which is of course less correct. But these were quite reasonably correct. And few other, this is not like Stonehenge, not that publicized, so you may not have heard about it. But this is very early observatory you may say in the pre-historic time.

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Then I think as I mentioned that one of the interesting thing it is found, that is in Kashmir valley. The name of the place I just want to tell. The rock art at called Burzahom in Kashmir. So the figure with two suns, a hunter killing a deer, a dog. The two suns almost side by side have been interpreted as the sun and a supernova because otherwise it is impossible. Supernova is the only thing which can be visible even being near sun.

And examining the David Green's online supernova catalogue, it is found that supernova occurred near the ecliptic so that it can be seen near the sun around 5,000 BC. So it is about 7,000 years old, some observation which was recorded by because it must have been very unusual thing. So even if you today, you find tomorrow morning that there is another sun near the sun, you are going to put it on your diary or your computer or laptop. Everywhere you will say that you will put it in your Facebook, I am quite sure of that.

So I think this is one of the earliest thing and date also matches that around 7,000 years back there was a supernova very near the ecliptic so that it could be seen very near the sun. Because sun moves along the ecliptic, so at some day it will be very near the supernova because it is visible for couple of weeks.

"Professor-student conversation starts."

Student: Sir, you said that supernova here little bit?

Professor: No, not this. This drawing is not that. I have not put that. As I mentioned that it is a rock art from Kashmir. This is actually a shilp from Harappan settlement.

"Professor-student conversation ends."

Now many they have interpreted this as the seven reaches because two major persons work on this. It is Asko Parpola and Ashfaque. So I think according to Parpola who is a Scandinavian scholar, very well-known scholar, he identified this as 7 sages at the bottom of the shilp with the seven stars of Saptarshi Mandal which is a very prominent consideration. Most of us who are not aware of the others, but Saptarshi Mandal, Cassiopeia and Orion, we all understand, we know that.

But of course, Ashfaque thinks that this seven or the seven stars of the constellation or rather asterism Krittika, I will show you Krittika later. And Krittika was a very important star because you will see, another I will show with the SAP software. Long back during the Vedic period, Krittika used to rise exactly in the east and it was mentioned, how the sages noticed all these things is that the sages were not like IIT students or faculty members. They used to get up very early in the morning, go near the bank of a river or a tank for all kinds of sacrifices and offerings.

They used to call it as Brahma muhurta, and they used to see the helical rising of the stars and others. Helical rising means the heavenly bodies which rise just before sun comes up and everything becomes light, you cannot see anything after that. So there they saw that this particular (const) your asterism used to rise exactly in the east. They have mentioned it, you will see later when I go to the astronomy part. Because it was the deity of fire, the Krittika and fire was a very important thing.

Even today, many people bear the title Agnihotri. It was a very pious and important occupation to maintain the fire with purity. You do not have a matchbox and you just do that, it was not possible. So this he thinks, Ashfaque, he thinks that it is the seven stars of asterism Krittika but that is beside the point. Now as I mentioned yesterday there are some bones and stone pieces with 30 marks of different length showing the phases of the moon in the lunar month. That have been also we found.

So astronomy was definitely a part of life, it has to be because such advanced civilization cannot do without the astronomical thing. Particularly it was an agriculture based civilization as you all know. And agriculture means dependence on season. And flooding of Nile used to be a very, not Nile, falling of this river Nile or Indus sorry used to be a very important part. Actually Mohenjodaro has been lavished by the flood of Indus, many times it has been recorded.

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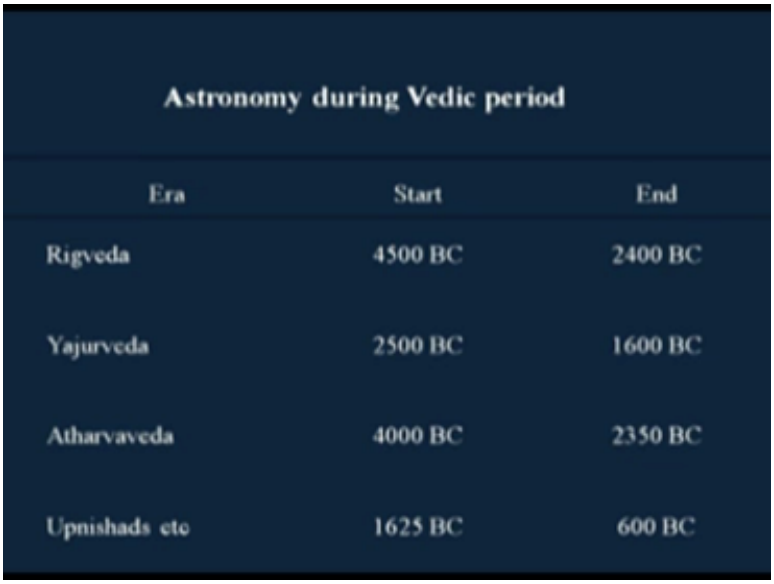

Now I think let us go to the astronomy during the Vedic period because Pre Vedic period that is Harappan and others we have not been able to read the script, so we cannot decide that much. The astronomy during the Vedic period again can be divided into four parts. The Vedic period includes Rig Veda which starts at 4500 BC and ends at 2400 BC. Yajurveda is there. Atharvaveda has a long period because its particular nature was such it was for a longer period. And Upanishads came later.

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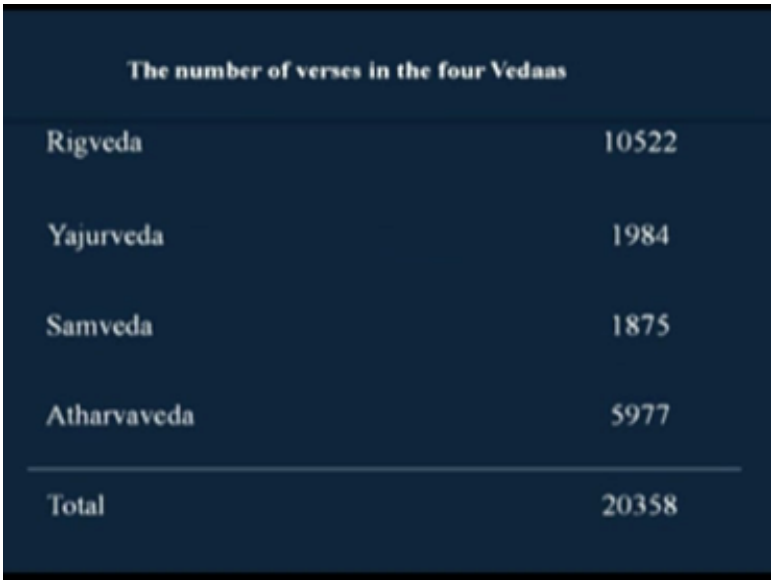

The number of verses in the four Vedas, these are some common general knowledge Indians should have because you must be very proud being an Indian to have the oldest possible literature in the whole world. Rig Veda is considered by everybody in the world to be the oldest literature we have. And the reason why it has survived though many other texts we have lost, primarily because its religious connotation.

Whenever something is religious, you protect it. So Rig Veda and the other Vedas have survived primarily because they were considered to be of religious significance. Rig Veda has 10,522 verses; Yajurveda, 1,984 verses; Samveda, 1,875; and Atharvaveda, 5,977. In total the four Vedas contains 20,358 verses.

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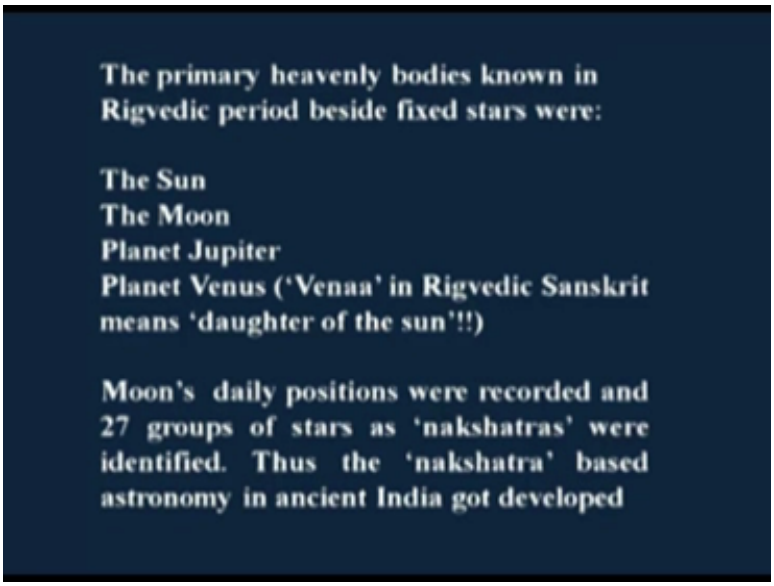

Now the important thing what I think I will mention here that this Vedic literature there are many astronomical references and other kinds of descriptions which help us to date them and I will show you. Now the primary heavenly bodies which were known in Rig Vedic period which the mention we find, the sun, the moon, planet Jupiter and planet Venus. And in Rig Vedic Sanskrit planet Venus was called Venaa meaning daughter of the sun.

And whether it is the same Venaa which has become Venus in Hellenistic astronomy we do not know but it is a very interesting coincidence. The moon's daily positions were recorded and 27 groups of stars as I mentioned yesterday which were called nakshatras were identified and thus the nakshatra based astronomy in ancient India became developed. Now the and the study of the

astronomical references in Rig Veda indicates that the sages were aware of a few astronomical facts, that also you should mention here.

There is one sun. Earlier there was confusion because sun is rising every day, is it the same sun? Because there are many civilizations where it was considered there is not one sun. Sun is going down, getting cleaned et cetera and it is coming up next day. But Rig Veda it is, that Vedic period it was known to the sages that are the only sun. And it is also mentioned that it supplies all energy and life to us. The moon's luminosity was because of the reflected sunlight is also there.

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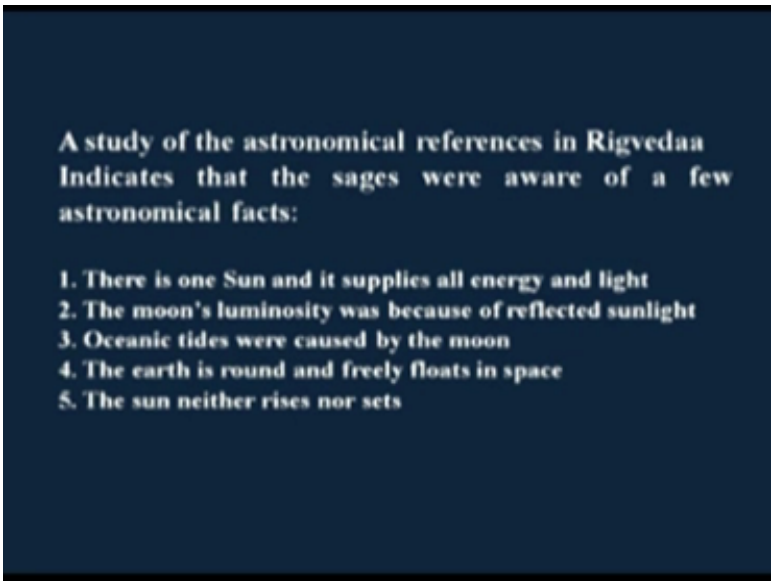

Oceanic tides were caused by the moon, of course it is not very difficult because if the moon's phase you see the tidal phenomena, so they also noticed that. Earth is round and freely floating in space was also another knowledge the Vedic sages knew. And it is also mentioned that sun neither rises nor sets. Now before I go further what will be important to say that what are the kinds of Rig Vedic references, astronomical references in Rig Veda and how you use those for dating.

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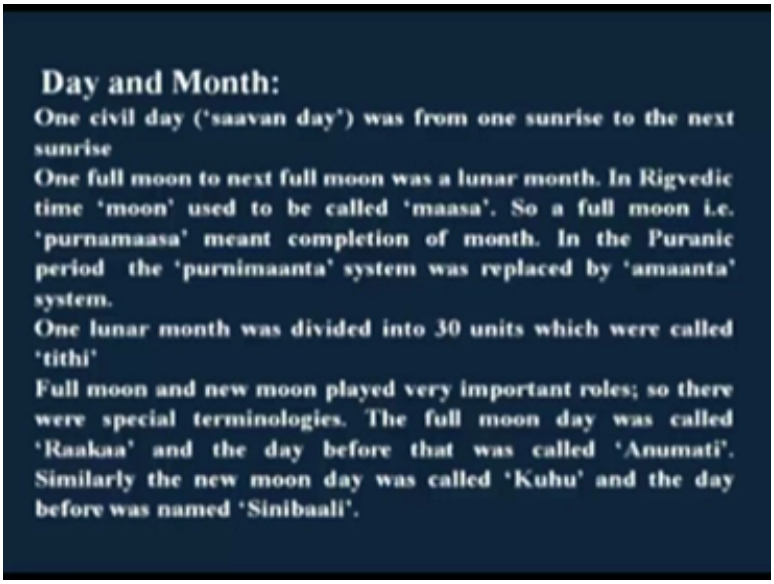

So I think let us go to that. You see they are day and month which is described in Veda. One civil day or called savanna day was from one sunrise to the next sunrise. And I mentioned in the last class that it is slightly longer than a true period of revolution of the earth because if you take a fixed star in the sky, I use this board quickly.

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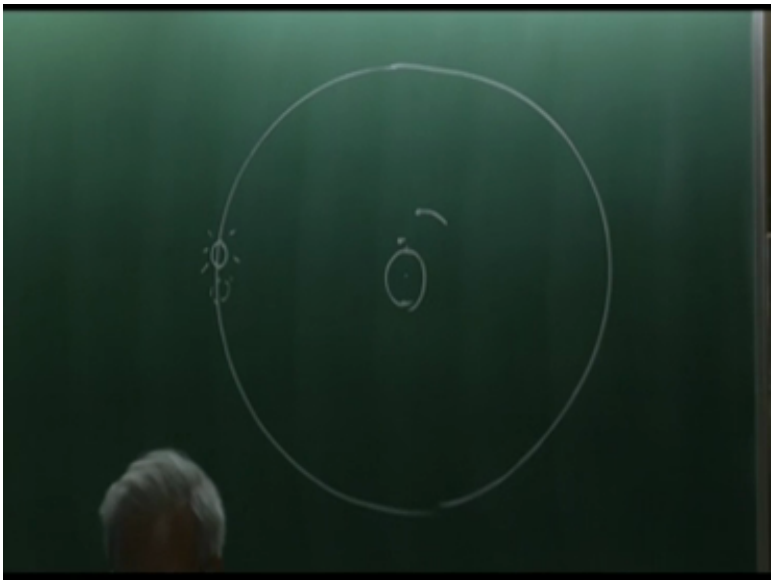

This is earth and this is sun. So it is rotating and say this is the point where you are. So if sun remains fixed, when you find one sunrise to another sunrise it is exactly your period of rotation. But by that time sun has moved here, so you have to rotate sun little bit extra to get the next

sunrise, is not it? Very obviously. That is why these two periods are somewhat different. The sidereal rotation period of the earth and the sunrise to sunrise, a civil day, they are not the same time, it is very clear from this. This is called the savanna day.

One full moon to next full moon was a lunar month and again I told you that it is slightly more than the period in which moon makes a rotation around the earth, that means going from this one set of fixed stars in the sky, coming back to the same set of fixed stars. That period is less than one full moon to another full moon, that also I explained. Is it necessary to explain it again?

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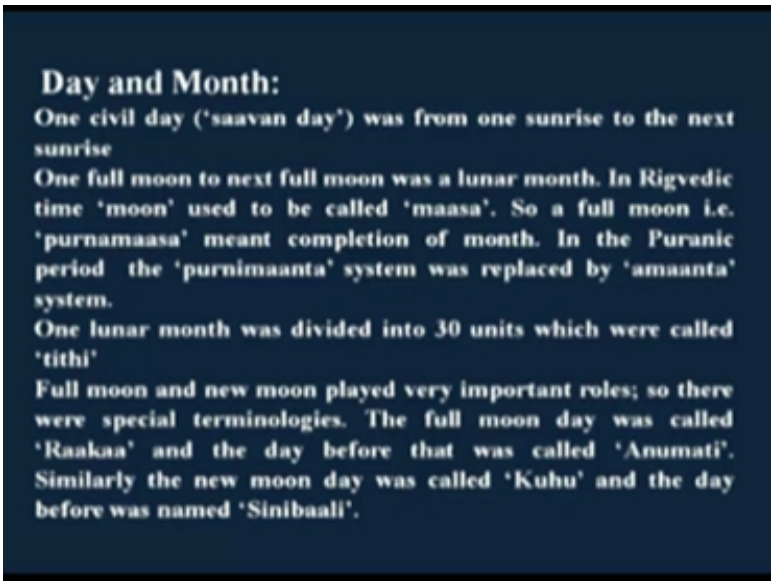

So therefore the lunar month, full moon to full moon and in Rig Veda time the moon used to be called maasa. So a full moon that is a purnamaasa meaning a completion of a month because the full moon to next full moon. And that is why we get the word purnima, purnamaasa and ultimately the maasa also became the word for the month. So this purnimaanta system that one purnima to next purnima, this is the purnimaanta system for lunar month, was changed in the subsequent period from amanta system, that means one new moon to next new moon.

One lunar month was divided into 30 units, that is called tithis, that is also typically Indian system. And full moon and new moon played very important roles in everything. So what they did, now full moon is actually an instance of time, is not it? Full moon indicates a position of the moon exactly opposite to sun but it is an instantaneous phenomena. Full moon cannot be a whole

night thing. So to indicate that point what they did, they treated the purnima and new moon, that means the amavasya as 2 days.

So the full moon day used to call raakaa and day before that used to be called anumati. And the junction between the two was the real full moon. Similarly new moon was again two days, the day before used to call Sinibaali and the next day they used to call Kuhu. And Sinibaali and Kuhu's junction point was the real amavasya. So they are very particular about these two things and that was the Vedic system of identifying the moment of real full moon and real new moon.

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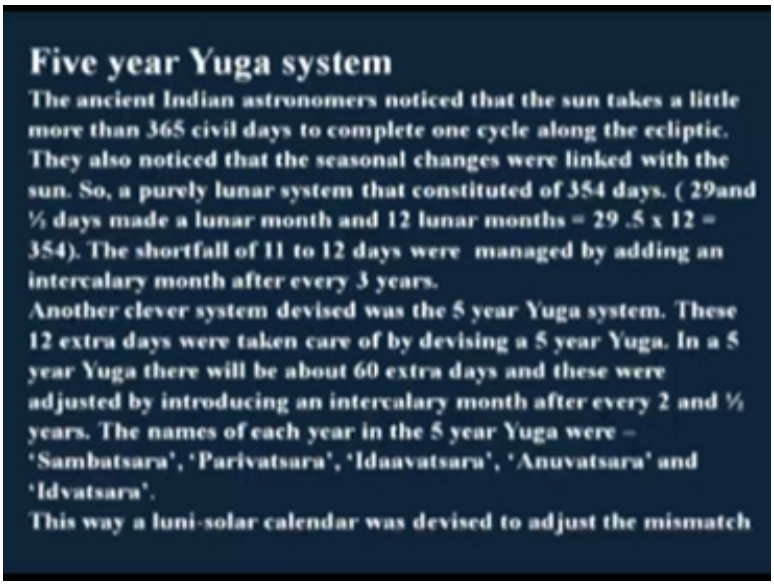

Now Five Year Yuga system is a very interesting thing. So therefore if you are an astronomer of that type……

"Professor-student conversation starts."

Student: I want to make one question, sir.

Professor: Yeah, please.

Student: Sir, the new this, it takes longer than, I mean than solar. Suddenly they cannot change with the……

Professor: I will come to that only now.

Student: But then they suddenly moving towards the orbital motion of the……

Professor: No, no, that did not know, no.

Student: Not required?

Professor: No, no. They thought that all those things are really moving. If somebody is taking more time, somebody is taking less time, it is his business. The real kinematics they did not know. So I think you will find now, I will come to that as you are saying that this created a problem for Indian astronomers and it became a far more complicated thing than the other systems.

"Professor-student conversation ends."

Now ancient Indian astronomers noticed that the sun takes a little more than 365 civil days to complete one cycle along the ecliptic. So I think they approximately will find in Vedanga Jyotisha it is considered as 366 days. But they knew it is more than 365 days but less than 366 days. They also noticed that the seasonal changes were linked with the sun's position, they noticed that. So a purely lunar system which constituted of 354 days, that is 29.5 day is a lunar month and multiplied by 12 is 354 days, civil days.

Since the lunar day is 30 days, that is a month but actually it is 29.5 days, solar day. So total number of civil days in 30 or 12 lunar month is only 354 days. So therefore it does not match. Just now as Professor Verma is saying that the total period of the moon and total period of the sun, they are not commensurate, they do not match. And that makes the difficulty. In the Islamic calendar they depend completely on the lunar system, no question of bringing sun. It is very pure system.

Only thing what happened that things keep on rotating. Say throughout the year, you will find that Muharram is in summer or sometime it is in spring, sometime it is in the autumn time. In the Hellenistic astronomy or the western or European system it is purely dependent on sun. So their calendar is purely solar, again no problem. In India we made the system very complicated because our dependence on sun was there because of the season and dependence on moon was there because of all our performance, sacrifices, all kinds of festival, everything depended on lunar calendar.

Even today everything is done based on lunar calendar, tithi et cetera. So therefore they had to develop a luni-solar system combining the two. The earliest thing what they did, remember these were all happening 5,000 years back. So the shortfall of 11 to 12 days how do you manage? Actually it is 366 but with the moon you are getting 354. So what they did that they consider a five year yuga system. In five year yuga what will happen, how many extra days you will get in the solar system? 60. And in, so what they did that they added two extra intercalary months in a five year yuga period.

So they developed first the yuga system, they meant a five year, five solar year period where you have 32 lunar months. And that is how they managed matching the two. In this period both the systems had some integral number of rotations and we could manage. And these 12 extra days were taken care of by the five year yuga. 60 extra days they introduced, after two and half years of your yuga they will put one extra month.

Even now in Indian calendar to match the lunar and solar system, we put intercalary month and they are called Mal Maas, you might have heard about it. So it has special significance, you do not do things in that month. And at the end of the five year yuga system, they will add another 30 days month. So that way whole thing matches. And for that purpose the name of each year in a five year yuga they gave the five, first year of the yuga system was Samvatsara, next was Parivatsara, next Idaavatsara, then Anuvatsara and Idvatsara.

These were the five years in a five year yuga system. Then again the cycle will repeat, that was the system in the Vedic period, they did. And luni-solar calendar was devised to adjust this mismatch as Professor Verma is saying that how they managed. This is the way because they needed both the solar system or solar calendar, they also needed the lunar thing.

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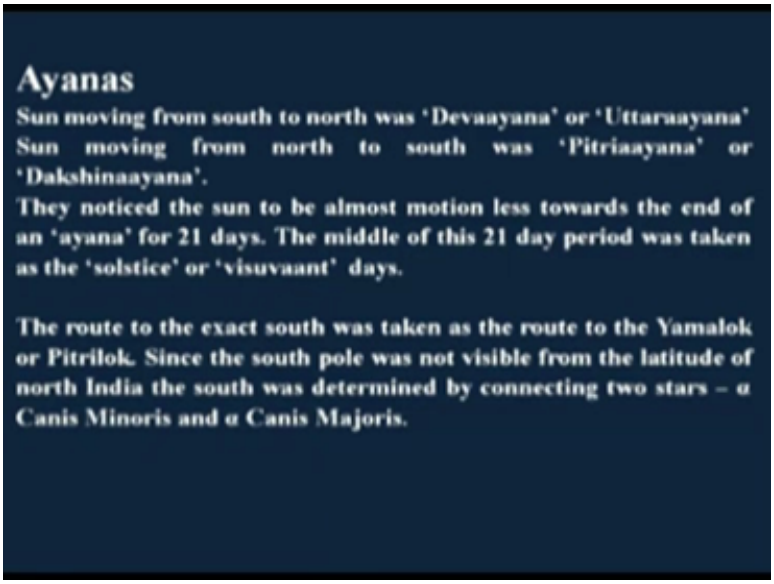

Next is also there also they define Ayanas. The sun moving from south to north is called the Uttarayana. You are seeing that ecliptic, that intersection point of the ecliptic with the horizon it moves, shifts like that, is not it? So when it is going in this way, it is the Uttarayana when sun is there. And when the intersection point moves in this direction and sun is there, then that is the Dakshinayana. And in the original time, they used to call as Devayana which is from south to north from winter to summer or Uttarayana and the other used to be called Pitriayana or Dakshinayana.

There is another version of course that they say that from vernal equinox to autumn equinox was called as Uttarayana or (pitri) Devayana and next was called, and the they noticed that sun comes from say south to north. Near the end it stops, that is why it is called solstice in English or Greek also. So they found it is about 21 days, it looks almost immovable. So the 11th day of that stationary period, they treated as the solstice day whether it is winter solstice or summer solstice. They used to call this as visuvaant days.

The root to the exact south, southerly direction was considered as Pitriaayana or direction towards Yamaloka. People go, after their death they go towards south. And you will find that such, you see in Rig Veda, it says passed by a secure path beyond the two spotted four-eyed dogs, the progeny of Sarama and join the wise pitrs who rejoice fully with Yama. So Yama's dakshin dhurv is known in our tradition.

So southerly direction they had to also find out and they have given a method for that. That method says that the two red-eyed dogs as I was mentioning, if you add these two stars, they will indicate an exactly southerly direction. And these two stars are called Alpha Canis Minoris and Alpha Canis Majoris.

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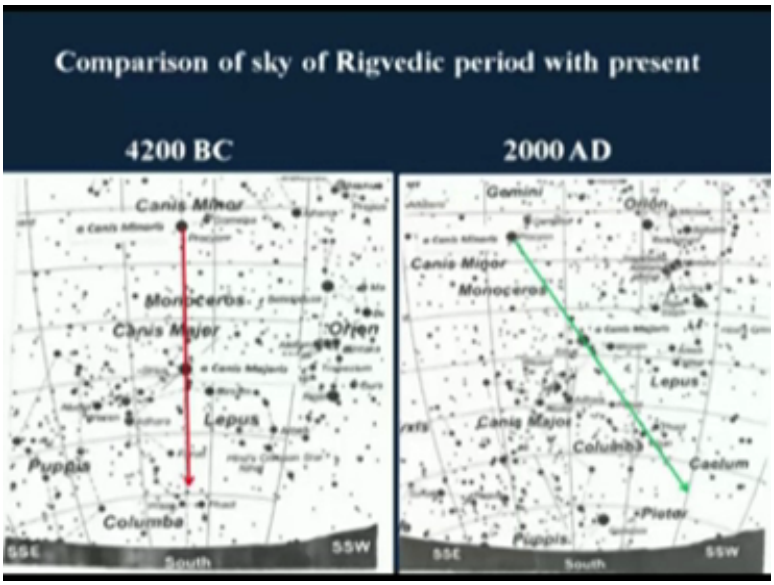

Like this. Say 4,200 BC the star, I will show you the actual thing also. This is Alpha Canis Minoris and Alpha Canis Majoris which is Sirius. If you join these two, it is almost exactly towards south. South pole is not visible from the northern hemisphere from this latitude. But these two star if you join, they will indicate exactly southerly direction as mentioned in Rig Veda. Now if you do that 2000 AD, this is the Alpha Canis Minoris and this is Alpha Canis Majoris. If you join, it does not indicate towards south.

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So if you, we go back to our this thing which is this and let us see now, the time we will put at which we will give 4200. Okay, 4200 BC we have reached. Computer is a wonderful thing. So now you see that if you give the rotation, you will find the Alpha Canis Majoris and Minoris, they will be pointing exactly to the south. Let us see whether we do it or get it or not. We have to identify the two stars. Moment you see Orion, you can see that you are nearing that. And longitude, meridian lines are not very nicely visible here after projection. So this is you are looking towards the south pole.

This is the ecliptic, I think we are approaching that. We have to identify, this is Orion, is not it? Orion constellation. And once you, because those two stars are near Orion, I think this is Alpha Canis Majoris and just a moment. I have to stop the universe.

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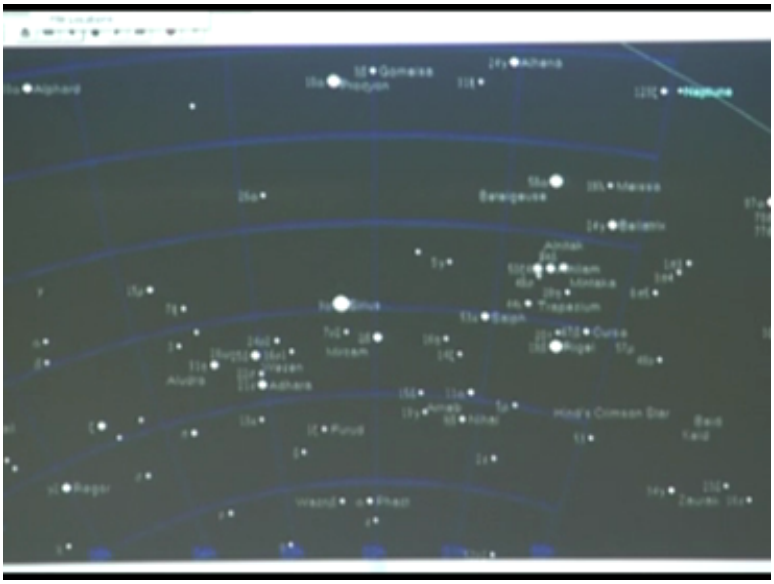

Yeah. You see this is Alpha Canis Minoris and this is Alpha Canis Majoris here, you join the two, it goes exactly to the south. And that was mentioned in Rig Veda but then it is possible only such an old time. And today the situation is very different. Of course, somebody may say that it was all a hoax, I do not do it.

“Professor-student conversation starts.”

Student: Specific names for these?

Professor: They do not say names because in those days they say that four-eyed dogs, two spotted four-eyed dogs because there also there, that is why Yamaraja is associated with a dog. And the problem is the coincidence that here also in Hellenistic astronomy it is being called as dog. Canis means dog. So how come that this connection is there, that is also very interesting.

“Professor-student conversation ends.”

So 2000 AD if you go, you will find that situation is very different. Now here this is Alpha Canis Minoris and this is Alpha Canis Majoris. If you add the two, I think it does not indicate towards south at all. So this is also very important clue that how old the observation is when it was recorded. Now if you say that people did it deviously by back-calculating, I think that kind of logic does not hold because nobody will do that. But this is something which is there. I think let us see the what next we get in Rig Vedic texts or Vedic text.

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Now come to month and season, when the whole solar tropical year was divided into seasons. In the Rig Veda initially only three seasons were mentioned. In later text of Rig Veda there were three seasons were, five seasons were mentioned. Towards the end all the six seasons were mentioned and in pre-siddhantic astronomy the names of the six seasons were Vasanta, Grishma, Varsha, Sharad, Hemant and Shishira. These were the names. In the most early text of Rig Veda Vasant word was not there, it was called Madhu.

And the two months of the Vasant ritu are Madhu and Madhava. Grishma means shukra and shuchi. Varsha is Nabhas and Nabhasya. Sharad is Isha and Urja. Hemanta is Sahas and Sahasya. Shishira is Tapas and Tapasya. These are the names of the months and these are the six seasons mentioned in Vedic texts.

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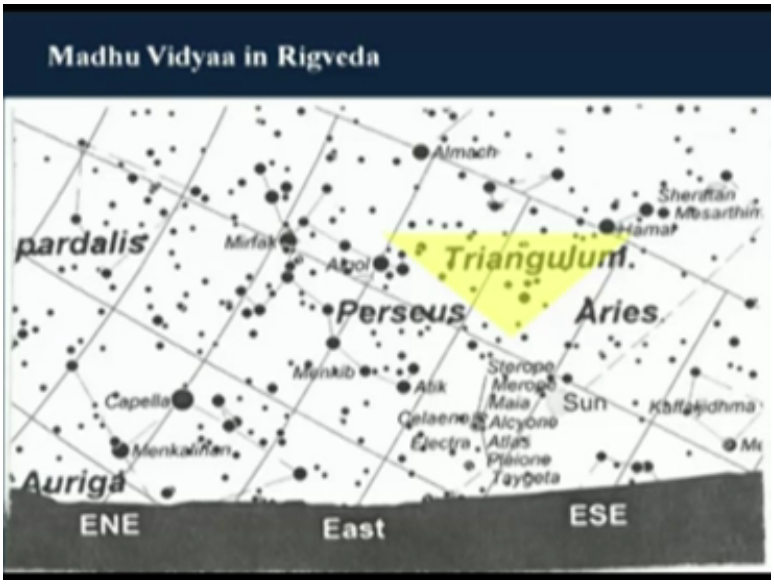

In Rig Veda again there are very important reference to Madhu-vidya they call it. Madhu-vidya is subjected knowledge by which you can identify when the onset of spring. And they say that when helically the Ashwini nakshatra will come up that Triangulum. After two months of the winter solstice day you will realize that onset of spring. That means it is one month before the vernal equinox. And it is found that around 4000 BC it used to happen. That after two months of the winter solstice, Triangulum will rise in the eastern sky heliated. I will not go into showing the software, it is taking time.

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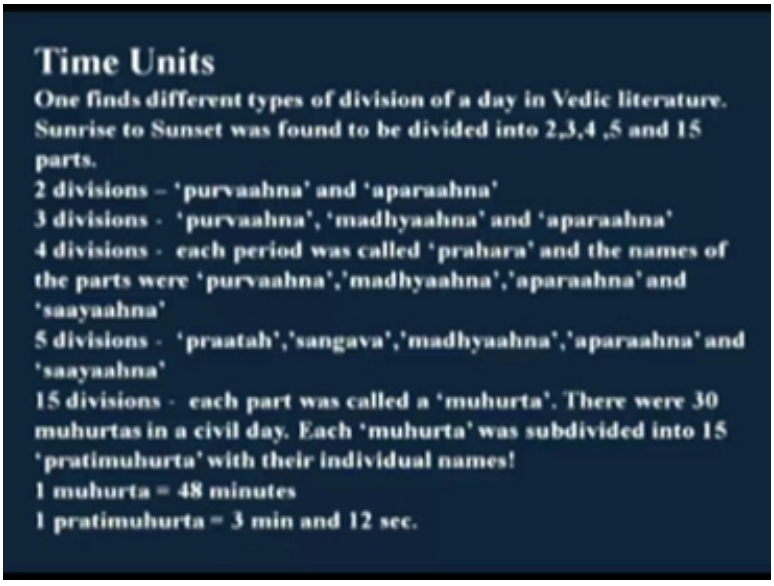

So time units in this time, Vedic text were the sunrise to sunset was found to be divided into 2, 3, 4, 5 and 15 parts. When it was 2 division, one is called purvaahna, other is aparaahna. In 3 divisions the day was called purvaahna, madhyaahna and aparaahna. And 4 divisions each period was called a prahara and the names of, that is why we have ashta-prahara, that means 24 hours. The parts were purvaahna, madhyaahna, aparaahna and saayaahna.

In five divisions the names were praatah, sangava, madhyaahna, aparaahna and saayaahna. In 15 divisions again each part was called a muhurta and there were 30 muhurtas in a civil day. Each muhurta was subdivided into 15 pratimuhurta with their individual names. So when you specify a time, come to the class on such and such tithi on this muhurta and this pratimuhurta, that was the kind of thing. Your timetable would have been like that. So one muhurta is 48 minutes and one pratimuhurta is 3 minutes and 12 seconds.

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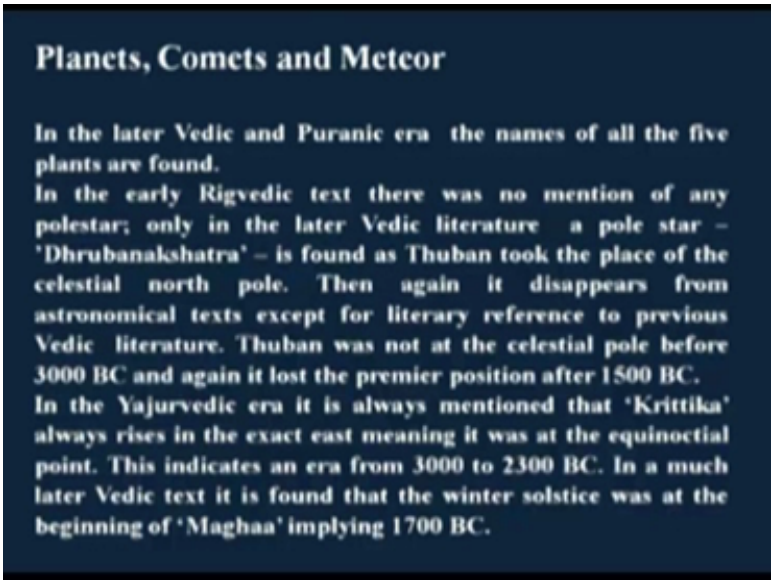

Planets, comets and meteor. In the later Vedic and Puranic era names of all the five planets are found. Initially as I mentioned on the sun, moon, and Jupiter and Venus, later Mars, Mercury and Saturn were also known. In the early Rig Vedic texts there were no mention of any pole star. You see this is very interesting. In the earliest Rig Veda no mention of any dhruva nakshatra, that means it was beyond the 4000 BC. Then there was no pole star.

Then I think the dhruva nakshatra is found as Thuban, it took place of the celestial north place. Then again for some time dhruva nakshatra was then in the Vedic text. Again in the subsequent

text, it disappears from astronomical literature. And only it comes as a reference to your previous dhruva nakshatra. So you see that it was not there, then it was there and then again it vanished. So it very nearly nicely matches these days with these kinds of planetarium software, you can really match all those things nicely.

The Thuban was not at the celestial pole before 3000 BC or 3500 BC and again it lost its premiere position after 1500 BC. In the Yajurvedic era it is always mentioned that Krittika rises in the exact east meaning it was at the equinoctial point because equinoctial, all the nakshatras must be on ecliptic, is not it? And to rise something exactly on the east it must be also on the celestial equator.

So for a nakshatra to rise exactly on the east, it means what? It has to be on the ecliptic and also on the celestial equator. That means the vernal equinoctial point or one of the equinoctial point. But if it is atomic equinoctial point, it will go beyond 1500 BC, that is not a very logical time. So within the logical period, it is found that it was in the vernal equinoctial point. And exactly in this way you will find it happened around 3000 to 2300 BC using the software. I am leaving this thing with the computer and Amit will have it. Any student want it, you can give it to them.

So in a much later Vedic text it is found that the winter solstice was at the beginning of Maghaa nakshatra implying 1700 BC. This is the way the researchers now they have the chronology of the Vedic and Puranic text they have done.

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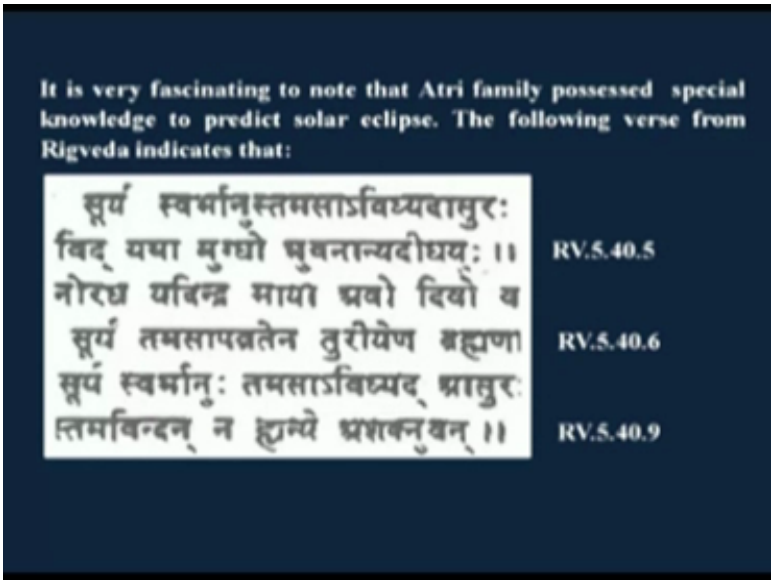

And this is also very fascinating to note that Atri family possessed a special knowledge to predict solar eclipse. Actually it is also mentioned in Rig Veda that they also saw one annular solar eclipse on the summer solstice day. And Professor PC Sengupta, he was a professor of Indian astronomy in Calcutta University. So he did lot of research and found, sorry, that this happened, I will discuss this later when I discuss at the end the antiquity of this. I will not spend time now because I have quite a lot things to discuss.

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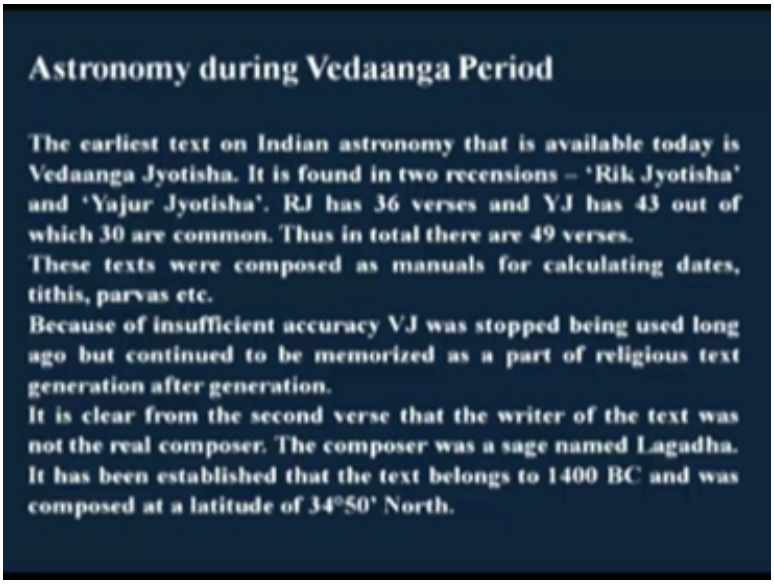

So astronomy during Vedanga period now. The earliest text in Indian astronomy which is available today is called Vedanga Jyotisha, you can find that book. Anyone who is interested, you can find. And it is found in two recensions, one is called Rig Jyotisha, another is Yejur Jyotisha. Now how it has remained? Why it has not been lost is because it was considered as a part of Veda. That is why it is called Vedanga.

And the people have kept it memorizing because it is a part of a religious text. That is how a scientific text has survived the onslaught of time. So in Rig Jyotisha it has 36 verses and Yejur Jyotisha has 43 out of which 30 are common with the Rig Jyotisha. So in total there are 49 verses. And from 19th century the European, sorry I have to, they have, they had lot of difficulty because these are nothing but mathematical algorithms. You can easily get Vedanga Jyotisha and you can see. But ultimately lot of effort, they could gradually decide for all of them.

They found these are nothing but algorithms on the basis of which all the meanings have been discovered and it has been understood. Because of insufficient accuracy Vedanga Jyotisha has very rough model. It was stopped being used long long back but it was memorized because as a part of (Vedang) Veda or Vedanga. That is why it has survived. And this is, it has been now dated, that means again from the astronomical references that it was written around 1400 BC. And the location where it was also done because you can find out from the time of the relative the period of the daylight and period of the night on the winter solstice day and summer solstice day it is described.

And from that they found it is 34 degrees 50 minutes north which matches with the Punjab region where the Vedas were really composed. It is not in central Asia or someplace many people tell.

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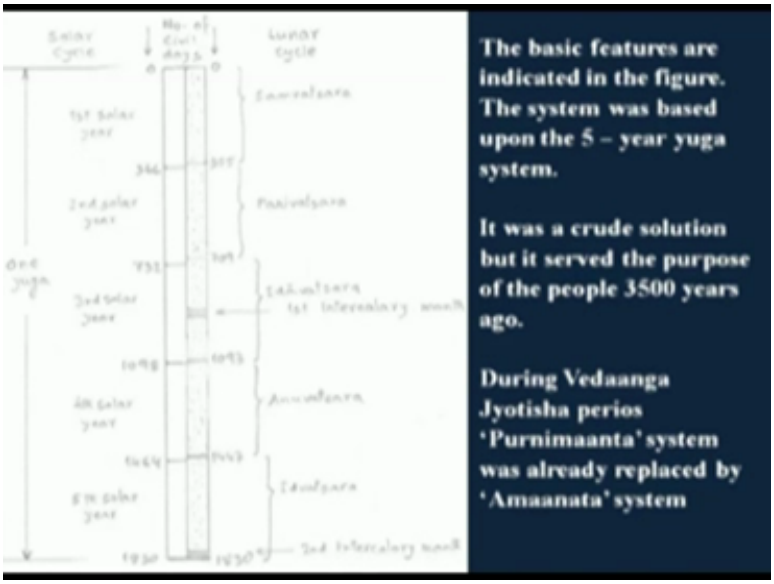

So this is the way they matched the basic framework. The five year yuga system you can see. So lunar cycle is on this side and solar cycle on this side and you can see the first intercalary month they have added here. And the second intercalary month they have added. And so the total number of civil days they have matched. Number of civil days in a solar cycle of 5 yuga system is how much it is that? 1,830 and similarly on the lunar cycle also you will find that it is 1,830.

So that is the way they matched the two lunar cycle and solar cycle. And as you see that this is how they tried to solve but of course it is not accurate because again those timings are not exact. There are fractional thing, so it changes. And the, it was a crude solution but it survived their purpose 3500 years ago. And during Vedanga Jyotisha period purnimanta system was already replaced by the amanta system.

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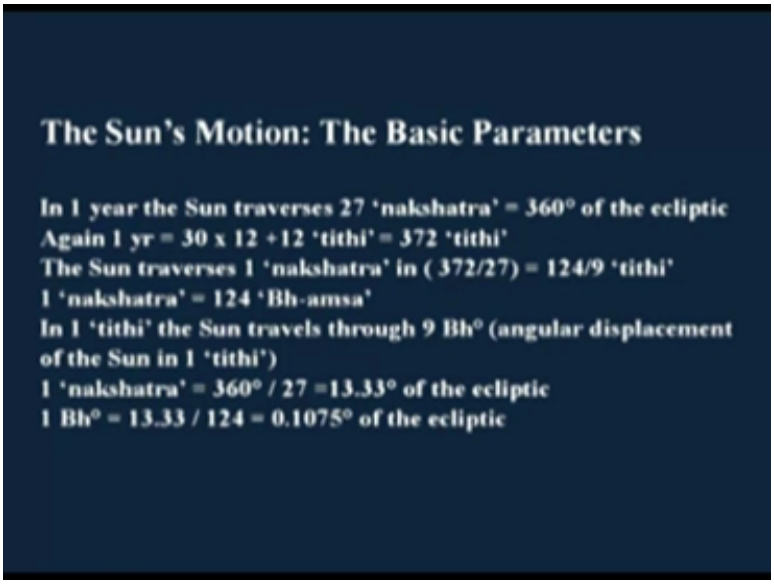

The sun's motion, that was two major calculations are given in Vedanga Jyotisha. One is the sun's motion, other is the moon's motion. You have to calculate both, the relative position of the sun and moon. In one year, sun traverses 27 nakshatras. If you consider the, if you do not take the precision of the equinox, precision of the equinox makes the tropical year and sidereal year slightly different because by the time sun comes back to approximately same position the axis of the earth has rotated slightly, maybe a fraction of a degree or fraction of a minute actually.

So therefore just before that the winter, if you start from winner solstice, the next winter solstice will be slightly before that because earth's axis has rotated slightly in the western direction. So that small difference is there but I think it is quite obvious they really did not notice that. They treated tropical year that when sun comes from one vernal equinoctial point to next vernal equinoctial point because it was easier for them to identify equinoctial point and solstice points obviously.

So this and during the whole ecliptic, because that was their only reference line ecliptic along which the moon, sun, all the planets move. 360 degree of ecliptic it took 27 nakshatras and again one year were how many lunar months? 30 lunar months. So 30 lunar day, sorry, 12 months and 30 lunar day or tithi in every lunar month, so 30 into 12 plus 12. Why this plus 12 tithis come? Because there were extra days. When you take lunar month which is 29.5 days, civil days, so again it does not match. So they had to add this 12.

So total number of tithis in a civil year or solar year is 372 tithis. So the sun traverses one nakshatra in so many tithis divided by 27, so therefore this, 124 by 9 tithi. And one nakshatra they divided again. This is a spatial division, they divided into bhamsa, 124 bhamsa. And that is one nakshatra span and one nakshatra is approximately 13.3 degrees. So in one tithi the sun travels through 9 bhamsa, that is the angular displacement of sun in one tithi. One nakshatra is 370 degrees by 27, so 13.33 of the ecliptic. So one bhamsa is 13.33 degrees by 124, 0.1075 degree of the ecliptic. That was the spatial division, yeah.

“Professor-student conversation starts.”

Student: There was another nakshatra. It was not 27th, it is a bit more, right? Some Abhijit.

Professor: That was temporarily they did but there is lot of confusion. It was used, 28 only for a very short period, then it was dropped again because nothing was very accurate. They are all the time trying to manage with integer numbers but it does not work. They are so, so therefore sometime it is there, sometime it is not there.

“Professor-student conversation ends.”

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So the 27 nakshatras in Vedanga Jyotisha which are mentioned I will not read, 27 names are there, you all are familiar. All the punjikas like say Ashwini, Rohini, Punarvasu, then and the modern names are also I have given. The original nakshatra and the modern names like Ashwini

is Aries. This Rohini is Taurus and Punarvasu is something here. Maghi is Leonis, Hasta is (()) (63:19), Vishaka is Libra and so on.

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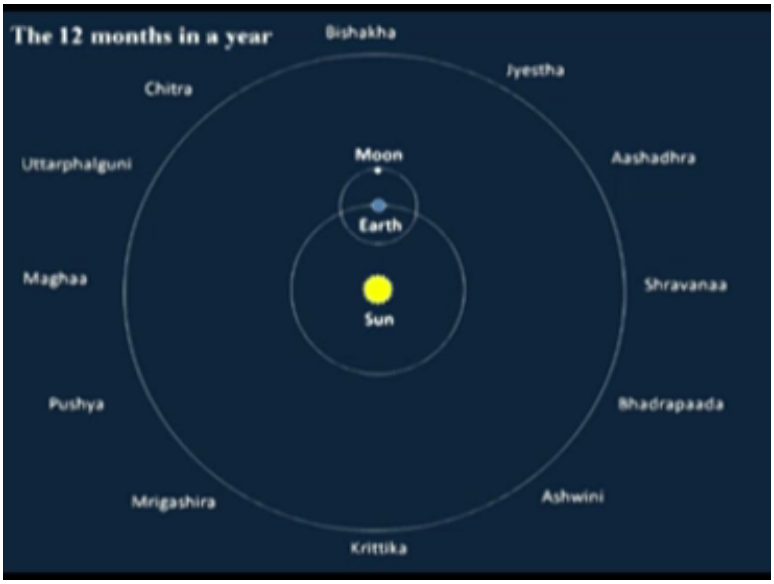

Now I come to the 12 months in a year, how they managed to name them, identify them. As I mentioned in the last class itself that they gave the name of the month based on that which nakshatra the moon is having its full moon shape. And they found this system they started and we have stuck to the same names though we do not follow the same methodology. Say when the full moon is again Vishaka nakshatra, the name of that month they gave Vishaka, Vaishak.

Then when the next full moon takes place, it is against the nakshatra Jyeshtha, so the month name is Jyeshtha. So that way you get the names, Ashadha, Shravana, Bhadra, Ashwin, Kartik, Agrahayana, Paus, Magh, Falgun, and Chaitra. The 12 names in Indian system it is very scientifically given whereas in the western astronomy the names of the months are not that. And distribution of time you all know that why February has 28 days, you do not know. Augustus wanted that, Julius and Augustus they both wanted to have at least 31 days in their month. So there they consumed some extra days there, so the place where it had to be taken away was February. So I think this is the system Indian, earliest Indian system of identifying the months.

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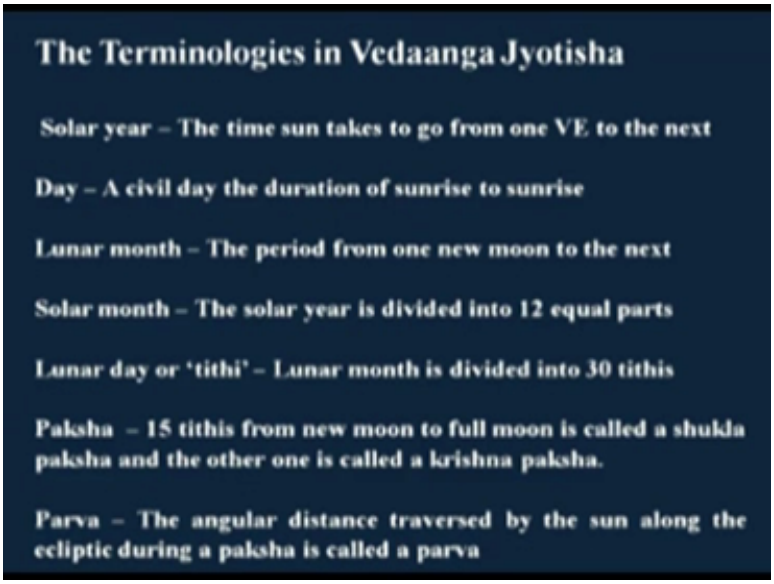

So the terminologies in Vedanga Jyotisha. Solar year, the time sun takes to go from one vernal equinox to the next. Day is a civil day, the duration of sunrise to sunrise. Lunar month, the period from one new moon to the next new moon. Solar month, the solar year is divided into 12 equal parts, that is all. It was not of much use, they did not use this much. Lunar day or tithi was very important because that was which was visible directly. Lunar month is divided into 30 tithis. Paksha is 15 tithis from new moon to full moon is called shukla paksha and the next one is called krishna paksha.

And there is another term is parva, it is the angular distance which is traversed by the sun along the ecliptic during a paksha is called the parva. So paksha is a temporal thing, parva is a spatial thing, that you have to keep in mind.

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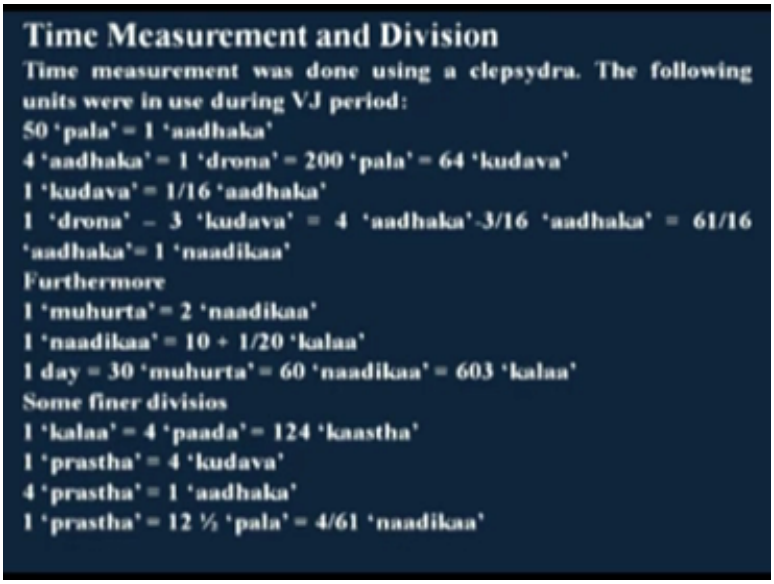

Time measurement and division. Time measurement was done using a clepsydra. The following units were in use during Vedanga Jyotisha period. 50 pala is one aadhaka. 4 aadhaka is 1 drona, that is equal to 200 pala equal to 64 kudava. 1 kudava is 1 by 16 aadhaka. Do not ask me questions. 1 drona is 3 kudava is equal to 4 aadhaka minus 3 by 16 aadhaka is 61 by 16 aadhaka is 1 naadikaa. Further there are other units like 1 muhurta is 2 naadikaa.

1 naadikaa is equal to 10 plus 1 by 20 kalaa. 1 day is 30 muhurta as I mentioned earlier that is 60 naadikaa, that is 603 kalaa. Some final divisions: 1 kalaa is 4 paada, that is 124 kaastha. 1 prastha is 4 kudava, 4 prastha is 1 aadhaka, 1 prastha is 12.5 pala or 4 by 61 naadikaa.

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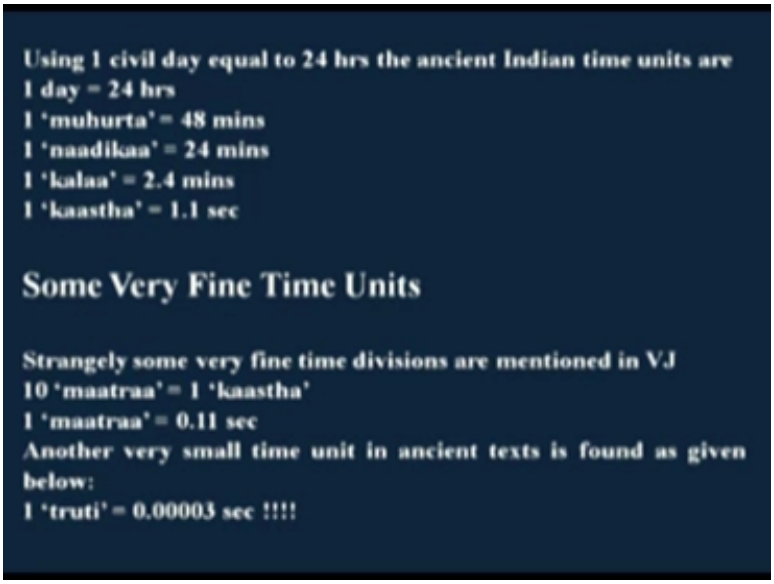

Then using 1 civil day equal to 24 hours in modern time, ancient Indian time units are like this: 1 day is 24 hours, 1 muhurta is 48 minutes, 1 naadikaa is 24 minutes, 1 kalaa is 2.4 minutes, 1 kaastha is 1.1 second. And some still very finer units of time are mentioned in Vedanga Jyotisha, one that says 10 maatraa is 1 kaastha. That means 1 maatraa is 0.11 second. Another very small time unit in ancient text is found as truti, that is 0.00003 second, it is not known for what purpose they had this unit. These are the time units, they are all mixed up you can see.

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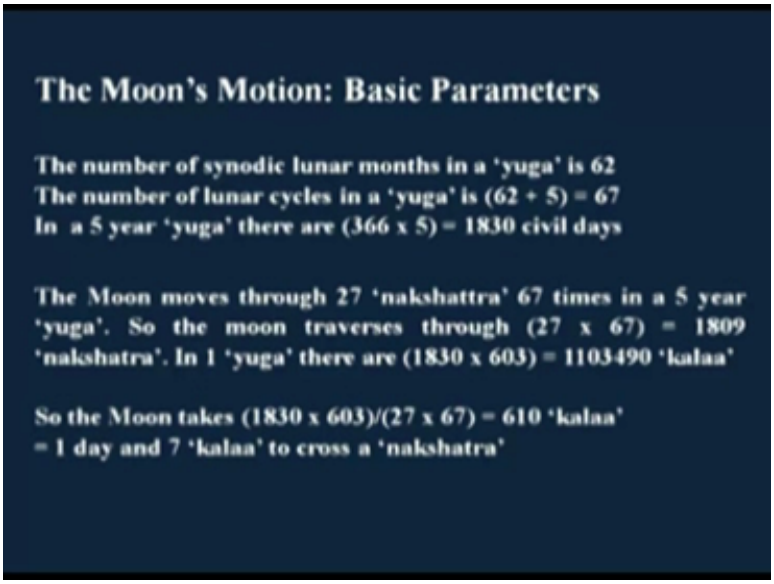

And the moon's motion or the basic parameter how they did, that these are the sun and moon's motion, they are most important. The number of synodic lunar months in a yuga is 62. And number of lunar cycles in a yuga will be 62 plus 5 extra because of the extra time they had. So in total 67 lunar cycles in a yuga of 5 years. So in a 5 year yuga there are 366 number of days in a year, into 5, 1,830 civil days or savanna din. The moon moves through 27 nakshatras 67 times in a 5 year yuga.

So the moon traverses through 27 into 67 or 1,809 nakshatras in 1 yuga. So in 1 yuga there are 1,830 into 603 kalaas because each nakshatra spans with 603 kalaas. So the moon takes 1,830 into 603 divided by 27 into 67 or 610 kalaa in one day and 7 kalaa, 1 day and 7 kalaa to cross a nakshatra. So this is the way they tried to work with the moon's motion.

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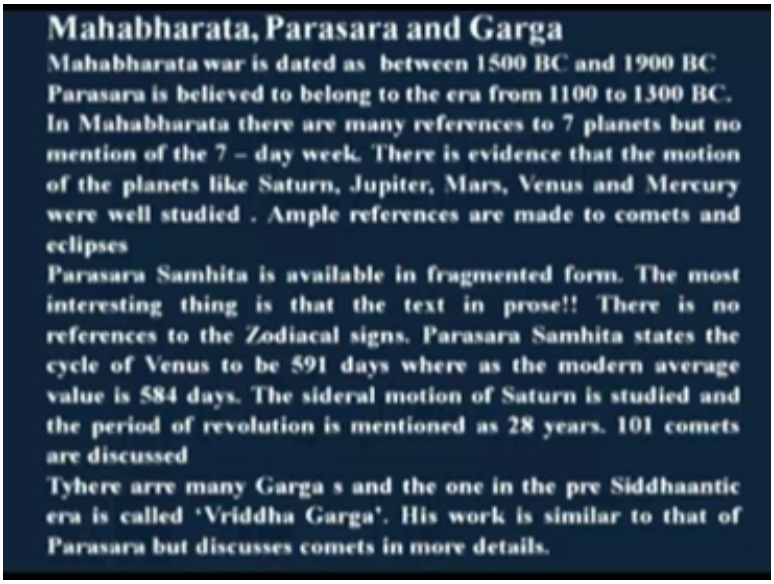

In Mahabharata that is the much later period, they it is found that all the planets are mentioned. Even the retrograde motions are observed, that is called vakri. Mangal is in vakri, that is mentioned. And Garga was subsequent to Parasara, so Mahabharata is dated between 1500 to 1900 BC. Parasara is believed to belong to 1100 to 1300 BC and Garga is little bit later. In Mahabharata there are many reference to 7 planets but no mention of the 7-day week. There is evidence that the motion of the planets like Saturn, Jupiter, Mars, Venus and Mercury were well studied. And ample differences are made to comets and eclipses.

Parasara Samhita is available in fragmented form. Actually all Vedas used to have, each Veda two major part, samhita and Brahmana. Samhita used to be with the philosophical part, Brahmana used to be the more practical parts. So Parasara Samhita is available in fragmented form and the most interesting thing is that the text is in prose, that is a very unique thing. It is very unusual to get a prose from text in ancient literature.

There is no reference to the zodiacal signs. And Parasara Samhita states that the cycle of Venus to be 591 days whereas modern average value is 584 days, only 7 days difference. And sidereal motion of Saturn is studied and the period of revolution is mentioned is 28 years which is also very correct. Yeah....

"Professor-student conversation starts."

Student: (())(70:57) there is no positional system.

Professor: Uhh….?

Student: There is the update document system, plus (())(71:05).

Professor: Number system in…..?

Student: There is positional (())(71:08) system.

Professor: I am not getting you.

Student: Decimal system is not there.

Professor: Maybe most probably. They are not, no decimal things. Decimal came much later from the Bakhshali Manuscript which is found in Mathematics, experts must be here.

Student: Is there (())(71:24)?

Professor: No, I do not think so. Maybe they used only integers. That is why you will find, when I come to even Siddhantic text, you will find that they always used large number of yugas which were nothing but the LCM kind of thing.

"Professor-student conversation ends."

So but I think it was a very crude system, you can realize that 5,000 years back the observation was very crude observation. It served their purpose identifying the seasons, et cetera and taking care of the various sacrifices et cetera, the (())(71:56) this, that. That is to be there, it is to satisfy. They are not worried about the setting, sending and satellite orbit so that they have to be very accurate. That is why it is very peculiar how, why they had such a small time unit. That is of course much later, Vedanga Jyotisha, much much 3,000 years later.

So I think 101 comets are discussed and actually it was found that they also identified some comets came back again and again. And since the period of comets are pretty large, their observation periods must have been very large. They used to name the comet after that astronomer who used to identify them and also identify their period.

So I will finish it here, the session 2 and I have kept something to tell you. Now the details of moon's motion I have not discussed today because it is slightly complicated and involve. So I thought that the book is there and those who are interested in getting more direct and hands onto the calculation procedures. Otherwise here just numbers et cetera, you will not like, people will start leaving. So I think that it is better you consult the book. There you will find I had given. Also not the real detailed calculation but whatever is understandable to a common man, you are not really an astronomer, not that trend in that.

So for when the real calculation procedures of panchang's et cetera, you have to really do that. For this I have actually simplified form, I have given from Vedanga Jyotisha whatever I could extract. And there are text from Vedanga Jyotisha, you can read. They are nothing but algorithms. Each verse is an algorithm and tomorrow's class I will discuss something that how Indian astronomers developed a compression technology. You are nowadays, you do compression technology in computer.

Their compression technology was fantastic and tomorrow you will be amazed to see what they did. That is something I want to tell. And what happened I think, what happened is after Vedanga Jyotisha there is a dark period. Not any major text is found, whether it was there and lost is also not known. The reason may people suspect that around 600 BC, the rise of Buddhism. And in Buddhism astrology used to have not at all very favorable position. So what happened, the churcha that is the pursuit of astrology was more or less gone.

And astronomy's main motivation or aim was astrology. Otherwise why, who cares for the movement of those heavenly bodies. So since the astrology had a very low and subdued or rather almost static position and the kings and others who are mostly following Buddhism, they did not sponsor quote astronomers. And therefore for a long period, there was no, not much activity. And apart from that many people feel, I do not know about Quran et cetera, that means those. Because in Indian ancient his time, they are all mixed up.

Whether Quran has actual description of events or their stories, it is a very confusing thing. But we never had the system of writing history. The reason also is there. Megasthenes's book if you read, I have gone through, I found many amazing things in Megasthenes and Arrian's description of ancient India. I think 4th century AD they came, BC they came I think. So they said, Megasthenes mentions that in India society is very peculiar.

Here they do not create big structure in memory of a human being or a man or a king. They say that Indian say that a person should be remembered by his good deals not by a big structure. That is why you will find that only the Buddhist stupas started being erected much later. But no king like whether it is Ashoka or Chandragupta, you will not find a big memorial, nothing is there. He also mentioned that society who were the most protected part of the society, not the teachers but the farmers. The rule was that if anyone injures a farmer or hampers or brings any physical injury to a farmer, the sentence was a death sentence.

Even during the work, the enemies of the opposition will not touch a real farmer. So they are so careful about the food security. And today the number of suicides of farmers and because of love affairs that is what is being told by some ministers, so I think that shows the maturity of the Indian society even before 5th century, 6th century BC. And perhaps that is why since the erecting a structure in memory of a king or a big man was not in the philosophy of India, ancient India, they never recorded also because history means what? This king won this war, this king dies, this king took the throne. This is history we read, is not it?

So that kind of history was not done and whatever was written I think we consider them as Puranic texts and their mythology. So it is a very difficult thing, that is why ancient India's history is very difficult to extract in a very depend or acceptable way, acceptable to particularly

the western style historians. So after Mahabharata, Mahabharata war is considered to be a landmark thing or historical event where lots of things got destroyed, kingdoms, kings all died.

And it was also there was a deluge by Dwarka, there was a physical and major tectonic articles. So because of the major clashes, wars, big fight, lot of death, and also many physical happenings, things were very disturbed and not much thing we hear. Only thing we hear about this that Parikshit did that, who did the Parikshit or Sarpayaga. So actually whole Mahabharata is told as a story to get rid of that sin because of killing snakes.

So there is a shlok in puran you will find. From Parikshit to Nanda, Mahapadananda. You know Nanda vansh, the last one was Dhana Nanda who was killed by Chandragupta. And there are 10 generations, the first one is called Dhana Nanda. Dhana Nanda is very special person. You find his name in history and also in Puran. Something like the number e, you find an equation in one side, e and one side trigonometry.

So it is something which connects trigonometry and algebra. The only thing is e, so Dhana Nanda is the only link who is mentioned in puran, puranic literature, Vishnupuran it is there. And he is also mentioned in history, so he was 1,500 or 1,050 that is there is a controversy. So javat Parikshito janma javat Nanda visheshnam, panchadashotaram sahastra panchadash, Sanskrit is I do not remember. So they say that it is, in one version it is 1,050 years and another version 1,500 years. So this has been analyzed very critically by Bankim Chandra in his Krishna Charitra. It is a very fantastic book. It has been translated in Hindi also and you can read it.

It is excellent book, real critical almost I will say, almost scientific analysis of the whole thing. So there is a reference that how many, how much time passed from Parikshit. After that there was a dark period. Parikshit to Mahapad, Dhana Nanda or Mahapad Dhana Nanda was either 1,050 or 1,500 years. And then 10 generations you come to Chandragupta's period, Alexander. That way you can link the historical period with puranic period or proto-historic period. So but there was a very dark period, not much is known about that time.

And maybe that is why astronomy also suffered a dark period like that. Then again we find an extremely glorious period of Indian astronomy, we call it Siddhantic period. It is important for me to tell you why the names have come. Siddhant means it has nothing special connection with

astronomy, it is very clear. Siddhant means a decision or final thing. So the siddhant texts were considered as the final texts. That is why they are called siddhantas.

This siddhanto, that siddhanto and so on. And something which is not a siddhanto, they call this pre-siddhantic. Like which is not linear, we call non-linear in a similar way. So Siddhantic astronomy we will start in the second, actually it started in 2nd century AD but it got maturity in the 4th century and 5th century AD at the time of Aryabhatta-I. And that I will start tomorrow's session. If you have any short, brief question, we can spend a minute or so.

"Professor-student conversation starts."

Professor: Yeah, please.

Student: Considering Vedas (())(82:44)

Professor: Rig Veda, I think it is there. This all analysis was done by a major scholar who published this in the 1940s who was professor of Sanskrit and also astronomy, Indian astronomy, Sengupta. Rig Veda is the earliest, this is 4,500 BC, they have done it using the astronomical references. So it towards the end, last session there is a part, I will discuss on the antiquity of Indian. There I will discuss how they have done this. I will come to that.

Student: This is latest chronological order of the Vedas?

Professor: Yeah, that is what I could find, yeah. Yes…..?

Student: Mahendra, academic.

Professor: Yeah, Mahendra.

Student: Yeah, so what about this yuga, kaliyuga, satyuga?

Professor: That I will come, that is in Siddhantic astronomy. That is tomorrow we will start that.

Student: Sir, in Indian we had……

Professor 2: Wait, wait. I will go so that things are organized. It is showing up.

Student: Sir, you said that in Rig Vedic astronomy it was found that partly drama.

Professor: Uhh…..?

Student: It was found that partly drama.

Professor: Yeah, that is what mentioned somewhere.

Student: So do you know how difficult it is? Because……

Professor: They found some shloka definitely.

Student: They found some…..?

Professor: Some shloka verse where it is mentioned earth is round.

Student: I mean, how did they prove it?

Professor: Who proved? That Rig Vedic people?

Student: Uhh.

Professor: They may not……

Student: So in the history we are taught that (())(84:32) called as he who proved that earth is round but it is also mentioned in Greek……

Professor: Much before that, even I think Greek astronomers even 600 BC they knew earth is round. And they also knew it is not cylindrical, it is spherical. There are, actually I used to give a course here long back. There I used to give all these things that how they found out the size of the, relative size of the earth, relative size of the, there also I gave all the reasons how they found out.

Student: How did they find out?

Professor: I do not know, I have not read Rig Veda, please. Actually my difficulty, I do not have access to the principal sources because I do not know Sanskrit. So I have to depend on the translated things.

Student: They should have done some experimental analysis?

Professor: Observation only. Here normally what happen, when you travel north or south, you find new stars. Yeah.

Student: Sir, in Indian system the current period is somewhere around 2072.

Professor: Uhh, 2000…..?

Student: As per the Indian system

Professor 2: Vikram samvat.

Student: Uhh, the current period is somewhere around 2072, the present year.

Professor: 2072, what?

Student: The 2052 is right.

Professor: But which era you are using this because so many eras are there. Shaka era or Islamic calendar they call Hijra era. Some era you have to find, fix the, otherwise you cannot say.

Student: No sir, if you take the Indian calendar……

Professor 2: What?

Professor: What?

Student: Sakabda.

Professor: Sakabda is there, Bangabda is there.

Professor 2: He is probably avoiding that one.

Student: Vikram samvat.

Professor: Yeah, I will come to those things tomorrow. Siddhantic astronomy, I will come to the various eras which were there. One era, the earliest thing which was used by Aryabhatta I was Kali era, that 3017 BC kind of thing. So but subsequent astronomers use different era, one is vikram samvat and the latest one was some Kerala astronomers they also used.

Student: If you go by that logic, if we see, identify these celestial bodies, so in that software if you report that 2072, positions may change.

“Professor-student conversation ends.”