Sun-Earth Day Podcast Transcript

(Technology Through Time)

Issue #63 Eclipse!

In ancient China, the solar and lunar eclipses were regarded as heavenly signs that foretold the future of the Emperor. The ancient Chinese believed that solar eclipses occurred when a legendary celestial dragon devoured the Sun.

I'm Troy Cline and in today's podcast we'll be hearing from Dr. Sten Odenwald, the chief author and editor of the Sun-Earth Day Technology Through Time series. In today's show Sten will talk about the latest Technology Through Time Mystery called, "Eclipse!". He'll also touch on how our ideas about eclipses have changed over the centuries.

Now before we get started I want to encourage you to take look at the Technology Through Time archive where you'll find several other eclipse related articles, images and resources. As a quick tip I would specifically recommend the 2006 series. You can find all of that information including past Technology Through Time articles at sunearthday.nasa.gov.

So let's get started with a question to Sten about the upcoming total solar eclipse.

[TROY]
Many people around the planet are preparing to witness the total solar eclipse on August 1, 2008. Why are eclipses still so interesting to us today?

[STEN]
Well Troy, the reason that eclipses are still so fascinating to us today is that their just spectacular. They're dramatic. I mean if even if you're non-scientists, a non-astronomer and what have you, you watch one of these eclipses and you can't help but to really get affected in a deep and profound way. People have been affected by eclipse for literally thousands of years. In the most extreme behavior I'm sure there were human sacrifices involved but I think for the largest part, people have just stood in awe and watched as the sun in the middle of the day all of the sudden went away and you were thrown into darkness for a few minutes.

They're interesting to astronomers today for a whole bunch of different reasons. They let us make measurements on the position of the moon and it's orbit. These very accurate positions then let us predict eclipses in the distant future and in the distant past as well. So the more eclipses we watch as astronomers and make measurements of the them, the more precise our forecasting models become as a result. Also, I don't think there's a single astronomer that can't watch a total solar eclipse with or without technology and not be struck by the beauty of the corona, the occasional red prominence that might burst forth on the limb of the

moon….and the social circumstances that also surround the event. So yes they are extremely interesting to us today for even more reasons than they used to be over the past millennia.

[TROY]
How have our about ideas about eclipses changed over the centuries?

[STEN]
Well it's an interesting question because there have been some very profound changes, not just over the centuries but over the millennia. One can imagine that in the distant past eclipse were not necessarily seen as physical phenomena as much as they were seen as metaphysical or religious phenomena. This was certainly the case in ancient China where it was believed that total solar eclipses were nothing less than a celestial dragon actually taking a chomp out of the sun disk.

The sun also played an important role in ancient Egyptian religions. It was one of the chief deities. Curiously enough though, the ancient Egyptians didn't leave behind very many records that actually discussed total solar eclipses, even though in metaphysical terms the event must have been just as traumatic as it was for the ancient Chinese to suddenly see an important deity or element of their daytime sky being 'vanished' by some dark entity of some sort.

In recent centuries, certainly since the renaissance period when scientific observations became more detailed and critical, total solar eclipse went through a progressive phase of people looking at them more and more carefully. The advent of telescopes by Galileo and the astronomers that worked with telescopes from then on, gave us a growing legacy of ever more detailed pictures, actually sketches, of the solar corona seen during most of the eclipses in the 19th century. So we have a long legacy of those sorts of observations. Ideas about the actual eclipse itself, that dates essentially from the first century A.D. or there abouts, when it was realized that the reason we have eclipses is not because the sun itself blacks itself out, but because the moon move across the disk of the sun and progressively shuts out more and more of it's light, was realized fairly early on in the last 200 year period that eclipses were the result of celestial mechanics. Basically, by knowing the precise orbit of the moon and it's timing, you too could predict when the next total solar eclipse would occur. So eclipses became a fairly mechanical or should I say celestial mechanical phenomenon by the beginning g of the last few thousand years even before we started with detailed telescopic observations. So there's been a, if you would call it a progressive change, ah, you might even think of it as basically a complete 'see' change as to how we observe eclipses and think about them going from the mythological to the scientific interpretation.

[TROY]

For astronomers, what are the most interesting features of total solar eclipses?

[STEN]
Well Troy, I think that the most interesting feature is of course the one that dazzles us the most and that is the solar corona. Solar scientists look at the corona as an important ingredient to the sun's outer layers. The shape of the corona is determined in large measure by magnetic field changes and rearrangements on the surface of the sun which lead to the heating of the gases. The corona is about between 1 and 2 million degrees hot compared to the surface which is only 5500 to 6000 degrees hot depending on what temperature scale you use….and it's understood that the corona is part of an energy balance process that goes on between magnetic energy that goes on between magnetic energy and heating of the plasma. So scientists are still very fascinated and curious about the solar corona and of course that is the most dazzling ingredient to total solar eclipses that one observes.

Secondarily, if you have a very good eye or a very good telescope, you can often see prominences and other types of a detailed structure around the darkened limb of the moon and those are also of keen interest to astronomers in this day. We're trying to understand the sun and its outer surface in as much detail as we can because that helps us predict for instance when the next solar storm is gonna occur and a lot of the essential physics that go on in that kind of a process.

[TROY]
What are the most important things we know about the sun today that we didn't know one hundred years ago?

[STEN]
This is a very good question because it points out just how our advancement of our understanding of the sun has increased so phenomenally just in literally the past hundred years. I think the most important things that we know about the sun today that weren't even guessed at as much as 200 years ago, was the reason why the sun shines. We know that today that's about nuclear energy particularly hydrogen fusion that goes on in the core of the sun that continues to make the sun a stable star for quite a few billion years, that's really the chief thing that we know about the sun, the most important thing.

Secondarily we know things about surface features like sunspots, we know things about he corona, prominences and other types of structures and phenomena that we see on the surface that weren't even appreciated 200 years ago. Sunspots were identified but there was no understanding why the sun had them. Today we understand all of he surface features from the convectives cells we see and call granulation cells to sunspots, flares, prominences, the corona itself as essentially the embodiment of magnetic activity in the outer layer of the

sun itself. That entire paradigm of thinking about solar activity in terms of a magnetic process that underlies it is something that is extremely recent and in fact is something that we're still working out today.

If you go and look at our Technology Through Time essays in 2005, these series of essays were about ancient observatories and modern observatories. That was followed in 2006 by essays that discussed when the first discovery of the corona, sunspots and so on were made and what those circumstances were. In 2007 we did a series of essays that talked basically about solar physics, what are sunspots, what makes a sunspot happen, what is a solar flare and sort of delving into the underlying physics as we understand it… of different solar phenomena. So if want to go back to and look at the Technology Through Time website, you will surely find a number of interesting essays that capture really in pretty good terms what we know about the sun during the last hundred years that are for the most part unique to the last hundred years of research.

[TROY]
Is there anything we don't know today that we would like to know about the Sun?

[STEN]
This of course is a very important questions because it highlights the fact that literally the more we that we understand about something, the more new questions that we can ask about it that , ah, become a puzzle in their own right. For instance, we know quite a bit about the solar interior, nuclear fusion and those sorts of processes, but we don't understand quite so well is the whole process that involves magnetic fields and their interaction with the heated gases and plasmas near the solar surface. We have a variety of models, many of which are sophisticated enough to be run on super computers that follow the detailed motions of magnetic fields and their transformations and how that changes the surface of the sun. But there's still quite a lot details about the magnetic energy conversion process that we don't understand. Currently we call it magnetic reconnection. That really is the phenomenon of choice, the mechanism of choice, that physicists use to convert magnetic energy into heating gases near the surface of the sun and even heating the corona itself. There's a lot of physics that goes on in that process that we can sketch out on that back of an envelope and we can try to implement in computer, but we really don't have enough observations from the sun itself to tell us exactly how the sun is doing that particular trick. So really, the key thing that we don't really understand about he sun today is the way its magnetic energy is turned into heat and light and solar storms and activity.

[TROY]
I hope you enjoyed this Sun-Earth Day Highlights podcast. We are very interested in hearing your questions and comments. If you have something to say, just send an email to sunearthday@gmail.com . If selected we'll share it on one of our upcoming podcasts!

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