Eta Carainae - A Puzzling Star On Its Way To Hypernova

June 11, 1999 Minneapolis, Minnesota Over the past year, a star in the Caraina Constellation of the Southern Hemisphere has doubled in brightness. How a star that is 7,500 light years away from earth could brighten so dramatically baffles astronomers. In fact, of all the stars that can be seen with the naked eye from earth - none are as mysterious and confusing as Eta Carinae. If you live in southern Texas, southern Florida or Hawaii, you can barely see the star peeking up a little above the horizon straight south in June. It has a reddish-orange color and was completely invisible to the naked eye only a few years ago.

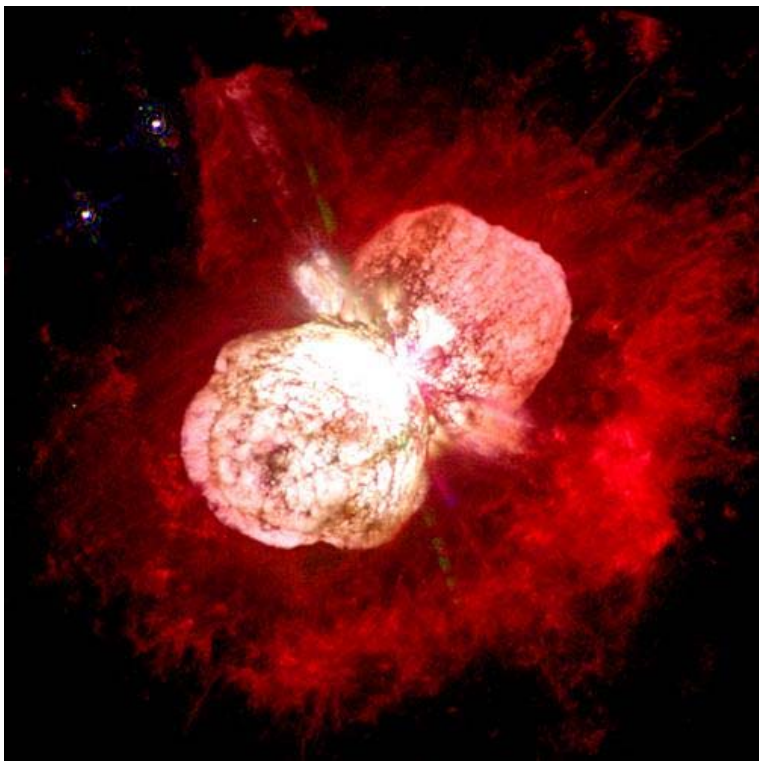

Photo Credit: Jon Morse, Ph.D., Center for Astrophysics and Space Astronomy and NASA, University of Colorado, Boulder.

How much more Eta Carainae will brighten - and will it actually explode into a hypernova - are unknowns. But one astronomer who devotes his research to massive stars like the unpredictable Eta Carainae is Dr. Kris Davidson, Professor of Astronomy at the University of Minnesota in Minneapolis.

I talked to him today about his interest in studying Eta Carainae even before the recent and sudden brightening.

Interview:

Kris Davidson, Ph.D., Professor of Astronomy, Univ of Minnesota, Minneapolis, Minnesota:
"Eta Carainae is a very strange and extreme object. We can see about 6,000 stars with the naked eye, more or less. And generally speaking, we understand all of them. We understand enough about how stars work that any astronomers talking about any mysteries of naked eye stars are talking about specialist details. Eta Carainae is the exception. It's the naked eye star that we just don't understand.

First, it's extremely bright. To see it from a distance of 7500 light years - that's quite a thing right there. Most of the stars we see are much closer. But 150 years ago, it blew up. It became one of the brightest stars in the sky for about 20 years. It looked almost like a supernova explosion, but the star survived. It seems to involve some type of instability we just haven't figured out yet in an extremely massive star.

Second, in addition to being unstable, Eta Carainae from its brightness and its power appears to be the most powerful - and therefore, the most massive star - in our neck of the woods, in our part of the galaxy. It radiates something like 4 million times as much light as the sun. And that's extreme. There just aren't any other stars that definitely do more than that. And it weighs about 100 times as much as the sun does. And that also is extreme. There are no other stars that we are certain are more massive than that.

So, it's a combination of instability, extreme amount of power, extremely high mass - it puts it on the very limit of everything we know about stars.

WHAT HAPPENED MOST RECENTLY THAT SHOCKED YOU AND OTHER ASTRONOMERS?
Recently, it seems to be brightening. Now, the problem with that is not just that we didn't expect it to brighten. It's that we thought we had good reasons why it wouldn't. The story is really that it was unstable - it was flickering a lot before that terrific explosion 150 years ago. It's a lot like a geyser. When you see a geyser beginning to go off, or a volcano. You can see hints that it's going to happen - burbling, you know. Puffing away. It looks unstable.

Well, then it blew up 150 years ago. It did a few other things before 1900. And since that time it's been relatively quiet. And on the geyser and volcano analogy, that's just to be expected. When a thing blows up, it gets steady for awhile after that when it stabilizes.

We thought Eta Carainae had stabilized. It's becoming slowly brighter over many decades, many years, but that's only because the dust is clearing away from its previous explosion. However, in the past two years - space telescope data that we've obtained has shown that at some wavelengths, the central star in it has doubled in brightness within about a year. This is just completely unprecedented and shocks us for a couple of reasons. One, it was unexpected, as I just said, and two, the way it's brightening doesn't make sense. It's brightening at all wavelengths and a non-technical interpretation of that is that it seems to be actually increasing the amount of power it's producing. Usually when one of these stars gets brighter, it's just because it's gotten to a different temperature where we can see it better without changing the actual amount of power coming out. And Eta seems to be actually increasing the amount of power it" radiating. Well, that just doesn't make sense with any theories we have. We didn't expect this to happen. The other stars that are vaguely like Eta Carainae, but not as extreme never do this. And yet it does seem to be doing this. We are just completely puzzled by it.

DO YOU HAVE ANY HYPOTHESIS ABOUT WHAT COULD BE GENERATING SUCH AN INTENSE INCREASE IN POWER?
I have sort of a technical hypothesis, and that is - after the big explosion 150 years ago, it left the star in a state where the energy trapped inside it was distributed all wrong, in a funny way. There were bubbles of extreme amounts of energy trapped inside this star. Stars are so big that it takes hundreds or even

thousands or even millions of years for the energy to leak out. And my suspicion - and it's just a quarter baked idea - is that maybe a sort of bubble, a region of extra energy that got trapped after the big explosion - has now reached the surface and it's just puffing out.

BECAUSE IT'S SUCH A BIG STAR.
That's right. There is an alternative idea and that is the dust around it is clearing very rapidly so we can see it better suddenly. But that's not an easy idea, because the dust doesn't just clear by itself that fast. Something would have to destroy the dust and if something destroys it - well, the only thing we know that could do that is the star and we're right back to the idea that the star has increased in power so it can destroy the dust.

SO, IN A WAY IT IS AS IF ETA CARAINAE HAS SINCE 150 YEARS AGO APPEARED TO NOVA, IN A WAY, AND THEN WE'RE IN 1999 - AND IT APPEARS TO BE IN A SLOW NOVA BURST OF LIGHT AGAIN.
Could be. That's one of the interpretations. We'll know in a few months. But in the meantime, it's behaving sort of like that's what's happening. I don't think this means it's going to become a supernova. In fact, there are some theories about very massive stars like Eta Carainae in which they don't even become supernova - they become something much more dangerous called a hypernova. But hose are largely speculations. A hypernova releases a tremendous blast of gamma rays that can be seen clear across the universe by modern equipment.

WE'VE HAD A COUPLE OF EXAMPLES OF THAT, I THINK, IN JUST THE LAST SEVERAL MONTHS.
That's right. There have been some famous gamma ray bursters, they are called, that happened far, far away - not just in another galaxy far away as the phrase puts it, but really far away - a large fraction of the distance across the visible universe.

AND STILL BEING ABLE TO AFFECT OUR SATELLITES.
That's right. There was another one that did happen in our galaxy. It was just a little thing. It's called a magnetar. It was just a little burst of gamma rays and that was enough to temporarily disable the electronics aboard several spacecraft.

If Eta Carainae, for example, ever became a hypernova - and some people imagine it might some time in the next 30,000 years - we don't have to worry about next week - if it ever did that, it is conceivable according to some theories that the burst of gamma rays would be sufficient to disable actually most spacecraft now in use that happen to be on that side of the earth when it happened.

HOW SAFE ARE WE SITTING ON THE SURFACE OF THE EARTH ROTATING AROUND THIS PARTICULAR SUN IN THIS PARTICULAR ARM OF THE GALAXY IN RELATIONSHIP TO STARS OUT THERE THAT POTENTIALLY COULD BURST MORE?
That's another fascinating question. I've never looked into it in detail myself, but I've talked with other people who've looked at the question a little bit. It looks as if we're pretty safe because of the earth's atmosphere. The earth's atmosphere protects us very well against gamma rays and x-rays. It's kind of like being under 30 feet of water - that's good shielding. And we can judge from the geological record, the biological record, that life has been on earth for a long time without being seriously disturbed. So, a very colorful and rather amusing way to put it was given by one expert about a year ago when I was talking about Eta Carainae and he was saying, "Eta Carainae - the star we were talking about earlier - might become a hypernova. That's just somebody's idea. And he said he was going to give some public talks about whether it was going to be dangerous for us if Eta Carainae 7,500 light years away from us were to become a hypernova and bombard us with gamma rays. And his amusing way of putting it was, "We're probably safe."

Anyway, I wouldn't lose any sleep over it. I am far more worried about being hit by a passing asteroid than having a gamma ray burst that can penetrate earth's atmosphere. But the idea of knocking out satellites is a completely different one - they are not shielded the way we are.

THAT COULD BE A MAJOR PROBLEM?
Yeah, believe it or not, the earth's atmosphere is much much thicker for gamma rays than the metal that is on any spacecraft.

THIS PARTICULAR STAR HAS SURPRISED YOU ALREADY IN 150 YEARS. SO IT SEEMS TO ME THAT WHAT YOU HAVE DESCRIBED IS THAT IT'S THE MOST UNPREDICTABLE STAR THAT WE ARE WATCHING.
That's right. There are other stars that are just as mysterious, but almost all of them are mysterious because they are very faint and very far away or hidden behind thick clouds of dust in the galaxy, so we can't study them very well. Eta Carainae is bright. We can study it easily. And yet, its behavior just never matches what we predict for it. It just never behaves itself. It's very extreme.

CAN PEOPLE IN AUSTRALIA AND THE SOUTHERN HEMISPHERE NOW CLEARLY SEE THIS STAR AS IT BRIGHTENS BEING DIFFERENT IN THE NIGHT SKY?
That's right. It's not a bright star yet. The story is basically this: about 30 years ago you couldn't see Eta Carainae at all with the naked eye. It was just too faint. The dust around it from the explosion has cleared and two years ago someone with good eyes out on the desert in Australia on a really dark sky could just see Eta Carainae barely. Now, as far as I can tell, the recent brightening has made it appreciably easier to see. And so I'd say now, you still have to go out to a dark sky. But now a person with ordinary eyes could see it.

If it continues to brighten, it will become relatively easy to see. We're not predicting it will become one of the brightest stars in the sky again, but that could happen. If what's been happening lately continues, it will become a fairly easy thing to see. That's an amazing statement for an object that far away.

More Information:

For more information about the mysterious Eta Carainae and more photographs, visit the Hubble Space Science Telescope web site at **http://www.stsci.edu** and the Home Page of astronomer Jon Morse at the Center for Astrophysics and Space Astronomy, University of Colorado. His web site shown below.

Websites:

http://casa.colorado.edu/~morsey

http://www.stsci.edu

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