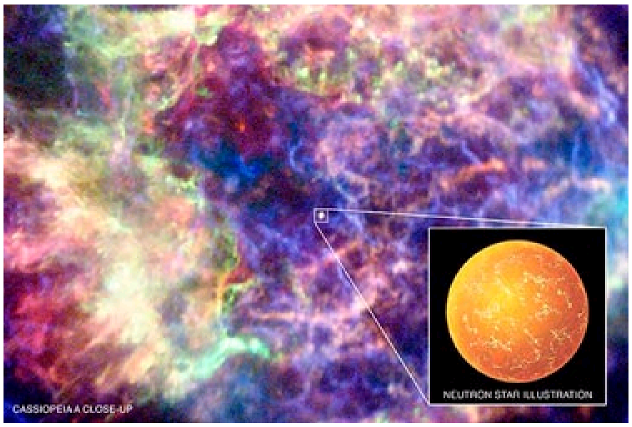
Carbon swaddles baby neutron star

Nov 4, 2009 6 comments



Cassiopeia A as seen by Chandra

Physicists in Canada and the UK have had a rare glimpse at the atmosphere of a neutron star just 330 years after it was formed in a violent explosion. Instead of resembling more mature neutron stars, which are surrounded by hydrogen, this baby star is blanketed in carbon gas – a discovery that could provide important new insights into the evolution of neutron stars.

Craig Heinke of the University of Alberta and Wynn Ho of Southampton University came to this conclusion by reinterpreting observations of the neutron star Cassiopeia A, which were made over the past 10 years by the Chandra X-ray Observatory.

Located about 11,000 light-years away, the star is believed to have formed in the remains of a supernova that was observed about 330 years ago, making it the youngest known neutron star. Such stars are created from the collapsed cores of massive stars that have exploded in a supernova. They retain much of their former mass but shrink to around 20 km in diameter, giving them densities comparable to atomic nuclei.

'It's not expected'

"The gravitational field is so strong that the star tends to stratify," Heinke explained. The lightest elements should rise to the surface, as seen in mature neutron stars, which have an outer atmosphere of hydrogen. "This is the first time we've seen a carbon atmosphere on top of a neutron star," Heinke said. "It's not expected."

Earlier studies of X-rays emitted by Cassiopeia A suggested that the star's radius is much smaller than expected – assuming it had a hydrogen atmosphere. Heinke and Ho tried to resolve this problem by modelling a helium atmosphere, but that failed to produce a convincing match with the X-ray spectrum. The scientists then tried carbon without much hope of success, but discovered that neutron stars with diameters ranging from 8–17 km and a carbon atmosphere would produce the observed radiation.

"It modelled it perfectly and produced a radius in the right range," Heinke recalled. "It worked out much better than we expected." The scenario also suggests that this neutron star has a 1.6×10^6 K effective surface temperature, with the gaseous carbon atmosphere lying just 10 cm thick around it.

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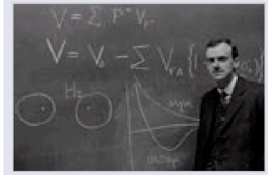

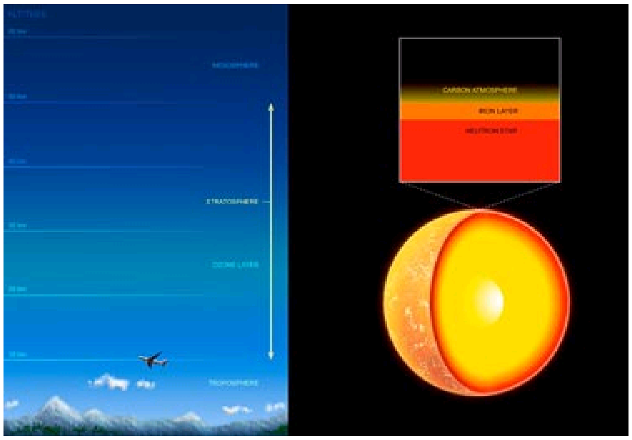

Swaddled in carbon

The spin on electronics!
The Royal Society
Jul 27, 2009

Mellowing with age

The researchers believe that the absence of hydrogen in Cassiopeia A is related to the extremely high temperatures associated with a supernova. While the internal temperature of a neutron star is in the million-Kelvin range, that is low compared with the billions of Kelvin immediately after a supernova. "At this extremely hot time in its life, nuclear fusion on the surface fuses all of the hydrogen and helium into carbon," Heinke told *Physics World*.

However as time progresses, the immense gravitational field of Cassiopeia A should draw in lighter elements that are present in the surrounding supernova remnant. Heinke predicts that around 1000 to 2000 years after the supernova, the star will cool to below fusion temperatures and then allow these elements to precipitate on the surface – eventually producing the familiar hydrogen atmosphere.

Well formed models

Although Heinke's theory has not been disputed by other astronomers, it will be difficult to further substantiate because of a lack of other similar-aged neutron stars to compare against. Not surprisingly, Heinke says that a search for such stars is high on his agenda.

George Pavlov at Penn State University says that there is little to dispute in Ho and Heinke's findings. However, Pavlov, whose data and modelling of the Cassiopeia A the pair reinterpreted, does not consider the idea proved yet either. He asks: "Why carbon? You are more likely to burn off the hydrogen and leave helium. But it is this that makes it interesting to me. It is an unusual finding."

This research appears in the latest edition of *Nature*.

About the author

Andy Extance is a freelance science journalist based in Exeter, UK.

6 comments

Add your comments on this article

1 **QuantumZD447251**
Nov 5, 2009 12:27 AM

What else then?

If carbon is not being produced and we are seeing the star wrong what else could it be? and what is the closest Neutron star, (age wise), we have to compare it to?

Reply to this comment | Offensive? Unsuitable? Notify Editor

2 **Oliver K. Manuel**
Nov 6, 2009 3:44 PM
United States

H (91%) & HE (9%) SWADDLE CLOSEST NEUTRON STAR

Quote:

> *Originally posted by* ***QuantumZD447251***
> If carbon is not being produced and we are seeing the star wrong what else could it be? and what is the closest Neutron star, (age wise), we have to compare it to?

Congratulations! The realization that neutron stars are at the core of other stars is a great step forward.

Several years ago it was discovered that our closest neutron star is swaddled in the two most lightweight elements, H (91%) and He (9%).

Kuroda and Myers combined Th,U,Pu age dating to show that the explosive event that produced the neutron star occurred 5 Gy (5 x 10^9 or 5 billion) years ago at the birth of the solar system [See Fig. 1, p. 173 of Radiochimica Acta 64 (1994) 167-174].

This event will be discussed in a Yahoo Group that Kirt Griffin recently established on "Neutron Repulsion: An Alternative Energy,"

neutron_repulsion@yahoogroups.com

To subscribe to this group, send an e-mail to neutron_repulsion-subscribe@yahoogroups.com

With kind regards,
Oliver K. Manuel

Reply to this comment | Offensive? Unsuitable? Notify Editor

3 **Oliver K. Manuel**
Nov 9, 2009 8:13 PM
United States

THIS WOLF IN SHEEP'S CLOTHING . . .

. . . is the beginning of the end of the illusion that the inside of a star is like its surface.

Quote:

> *Originally posted by* ***QuantumZD447251***
> If carbon is not being produced and we are seeing the star wrong what else could it be? and what is the closest Neutron star, (age wise), we have to compare it to?

The sheep is ordinary atomic matter - like you and me and our surroundings [1].
The interior is exotic nuclear matter - energized by repulsive N-N interactions [2].

1. Alan McRobert, "A Magnetar in Sheep's Clothing," Sky & Telescope (February 2008)
tinyurl.com…yanr9vf

2. Kirt Griffin's Yahoo Group, "Neutron Repulsion: An Alternative Energy,"
neutron_repulsion@yahoogroups.com

To subscribe, send an e-mail to: neutron_repulsion-subscribe@yahoogroups.com

With kind regards,
Oliver K. Manuel

Reply to this comment | Offensive? Unsuitable? Notify Editor

4 **unitygain**
Nov 6, 2009 11:17 PM
United States

Serendipity, eh, Oli?

Reply to this comment | Offensive? Unsuitable? Notify Editor

5 **Oliver K. Manuel**
Nov 7, 2009 4:11 AM
United States

OTHER REMARKABLE COINCIDENCES!

Quote:

> *Originally posted by* ***unitygain***
> Serendipity, eh, Oli?

1. In 1913 Aston produced lightweight neon - and thus found evidence for isotopes of neon (atoms of different mass) - by diffusion through pipe clay [F. W. Aston, British Assoc. Adv. Sci. Reports 82 (1913) 403].

2. On 26 December 1934 a meteorite filled with neon from the Sun fell on Fayetteville, AR - almost two years before I was born.

3. In 1960 I was a new graduate student and Professor Paul Kazuo Kuroda gave me the meteorite to analyze.

4. In 1964 I analyzed neon in the Fayetteville meteorite and discovered that the isotopes of solar-wind implanted neon had been sorted by mass. tinyurl.com…ydtv6x4

5. In 1969 lightweight neon was found implanted by the solar-wind into surfaces of lunar dirt and breccias that were returned by the first Apollo Mission to the Moon [Lunar Sample Preliminary Examination Team, Science 165 (1969) 1211].

6. It still took another 14 years for us to finally realize that the Sun itself is sorting atoms by mass and moving lightweight neon - like Aston first saw in 1913 - to the surface of the Sun, together with copious amounts of lightweight elements like H and He.

Fate (Serendipity, Coincidence) has been kind to us, unitygain, but I have been very slow to learn.

With kind regards,

Oliver K. Manuel

Reply to this comment   Offensive? Unsuitable? Notify Editor

6 **Oliver K. Manuel**
Nov 8, 2009 7:47 PM
United States

Quote:

> *Originally posted by* ***Oliver K. Manuel***
>
> Quote:
>
> > *Originally posted by* ***unitygain***
> > Serendipity, eh, Oli?
>
> . . . . .
>
> 2. On 26 December 1934 a meteorite filled with neon from the Sun fell on Fayetteville, AR - almost two years before I was born.
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> 3. In 1960 I was a new graduate student and Professor Paul Kazuo Kuroda gave me the Fayetteville meteorite to analyze.
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> 4. In 1964 I analyzed neon in the Fayetteville meteorite and discovered that the isotopes of solar-wind implanted neon had been sorted by mass. tinyurl.com…ydtv6x4
>
> . . . . .
>
> With kind regards,
> Oliver K. Manuel

Here is a photograph of the Fayetteville meteorite:

tinyurl.com…ycuzdkm

The dark regions are compacted soils, like the lunar breccia returned by the Apollo Mission to the Moon in 1969,

Neon implanted by the solar wind into the surfaces of fine grained material in lunar soils, lunar breccias and the dark regions of the Fayetteville meteorite is mass fractionated, like the neon that Aston discovered in 1913 after letting neon diffuse through clay pipe.

With kind regards,
Oliver K. Manuel

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