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Canadian, international scientists' precarious experiments trace star origins

Apr 8, 2009

VANCOUVER, B.C. — A two-tonne telescope, dangling beneath a 33-storey balloon 60 kilometres above the earth, has given a team of international researchers a glimpse at the birth of stars and maybe even the origins of the universe.

It was a cheap alternative to a satellite mission that produced invaluable information for the international team of researchers, which included astronomers and astrophysicists from the University of British Columbia and the University of Toronto.

In a study to be published Thursday in the journal Nature, the team says their precarious experiments helped them track half the starlight in the universe to a galaxy several billion light years away.

"We would like to know where and when all the stars in the universe formed," said Douglas Scott, from the University of British Columbia.

"The universe was dark and then it was light and stars like our own sun were born. We'd like to know how common is the sun? How unusual is the Milky Way Galaxy? We'd really like to track the cosmic star formation history."

But those questions posed some problems.

The ancient stars born in dark clouds of dust millennia ago did give off sub-millimetre light. Unfortunately, that light cannot travel through air and is invisible to not just the naked eye, but even to powerful telescopes on earth.

So researchers built a sub-millimetre camera. But that camera was no good to them from the ground.

"You can't even see across the street with a sub-millimetre camera," said Barth Netterfield, whose University of Toronto team put together the experiment, did the electronics and the software as well as the analysis.

"They're not going to do any good on the ground. You've got to get out of the atmosphere."

That left few options. It costs about $100 million to launch a payload aboard a satellite. A balloon, on the other hand, cost about $1 million. It was, as they say, a no-brainer.

Canadian scientists at UBC and the University of Toronto helped to construct much of the hardware and software for the project, which also included researchers from the United States and the United Kingdom as well.

After a test flight in New Mexico, BLAST - the Balloon-borne Large-Aperture Sub-millimetre Telescope - took flight in northern Sweden in 2005 and in December 2006 in Antarctica.

The mission was not without its casualties.

BLAST crashed upon landing in 2006, scattering debris over 200 kilometres of Antarctic ice. The parachute didn't come off and the telescope was dragged across unforgiving landscape in high winds.

"That was a rather stressful couple of days," said Netterfield.

Researchers spent days combing the area from a plane, looking for a data needle in a high-tech debris haystack. Somewhere amongst what was left of the tonnes of twisted metal and shards was a data goldmine 30 centimetres in diameter and a metre long.

"It was pretty heartbreaking," said Gaelan Marsden, a UBC graduate student at the time. He'd been in Antarctica for six weeks but had returned to Vancouver by the time of the crash.

Against the odds, the pilot of the search flight spotted the data canister from the air. Trained mountaineers had to retrieve it from the crevasse where it had ended up.

The metal discs were battered and broken. The team wasn't sure the information could be retrieved.

"Everything we'd spent five or six years working on was on those discs," Scott said. "That was very nerve-wracking figuring out whether we still had the data or not."

They did.

It took two years to analyze the data from the BLAST, along with data collected from NASA's Spitzer Space Telescope.

What BLAST did was look back at the peak of star formation in a galaxy seven-to 10-billion years ago, when the universe was just a few billions years old.

The Nature article is one of eight in what will be just the first round of research to emerge from the experiments, which took place during three separate flights.

The inquiries that started with BLAST will continue next month, on the European Space Agency's Herschel satellite launching next month. BLAST is also being rebuilt, and Netterfield hopes the telescope will be ready for launch again next winter.

There's a lot more work to do.

"Now that we have the images and we have catalogues of objects, we can use telescopes of other wavelengths to really figure out exactly what kind of galaxies we're seeing and how far away they are, when we're seeing light coming from them," Scott said.

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Researchers launch a two-tonne telescope high above the atmosphere using a 33-storey balloon in Antarctica in 2006. THE CANADIAN PRESS/HO

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MARK HALPERN/BLASTTHEMOVIE.COM

The BLAST balloon is inflated and prepared to launch.

The Balloon-borne Large-Aperture Sub-millimeter Telescope (BLAST) uncovered dust-enshrouded galaxies that hide about half of the starlight in the Universe.

"Over the last decade, sub-millimetre telescopes on the ground have produced several 'black and white' images no larger than the size of a fingernail at the end of your outstretched arm," said Ed Chapin, a post-doctoral fellow at UBC. "In a single 11-day flight BLAST has taken a huge leap forward, producing colour images the size of your hand."

Documentary

• The BLAST project was filmed for a documentary. Visit blastthemovie.com for details.

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Balloon-borne telescope reveals secrets of space

Updated Sun. Apr. 12 2009 7:38 AM ET

CTV.ca News Staff

A powerful balloon-borne telescope is helping to pull back the curtain on previously unseen corners of the universe -- and Canadian researchers have played a key role in the project.

Cosmologist Barth Netterfield, of the University of Toronto, helped develop the technology along with researchers from the University of British Columbia.

He told CTV's Canada AM the powerful telescope was carried outside of the Earth's atmosphere by a balloon.

Once in position it recorded new information about how stars are formed, by capturing sub-millimetre light that is normally absorbed by Earth's atmosphere, and can't be seen by the human eye.

"Really cold things in interstellar space give off what's called sub-millimetre light. It's a colour of light your eyes can't see," Netterfield said.

"The problem is that sub-millimetre light can't make it through the Earth's atmosphere, so you have to get out of the atmosphere. So what we do is fly a balloon 39-kilometres high."

Scientists from around the world began working on the Balloon-borne Large-Aperture Sub-millimeter Telescope (BLAST) in 2000. It flew twice, in 2005 and 2006, launching into space from the Antarctic.

The U of T and UBC teams developed the technology used to control the telescope as it hung from the balloon.

Massive amounts of information were collected in those two flights. The team has been analyzing that data for several years, and has now released the results in a paper published today in the journal "Nature."

In the "Nature" paper, the team reported that the telescope found hundreds of new, previously unknown galaxies, and could describe them in finer detail than ever before.

"You couldn't see them before because they were shrouded in dust. But the sub-millimetre telescope BLAST, when it's out of the atmosphere, you can go in and look at these galaxies," Netterfield said.

Within the Milky Way, Earth's galaxy, BLAST has identified areas where stars are beginning to form, and even what Netterfield described as "stellar nurseries" where stars are being born.

He said new stars warm up from a frigid -263 C to around -230 C - that temperature change releases enough light to be visible to BLAST.

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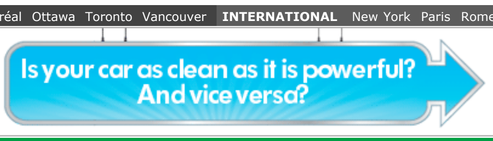

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Balloon telescope's star vision

By Jonathan Amos
Science reporter, BBC News

A helium balloon took BLAST 35km above Antarctica in 2006

The "baby-boomer Universe" has been seen in unprecedented detail by a telescope slung beneath a balloon.

The BLAST experiment only flew twice and was destroyed on its final mission, but its observations and technology have had a major impact on astronomy.

The telescope probed an epoch in cosmic history some 7-10bn years ago when star formation was prolific.

Scientists tell Nature magazine that BLAST's data will help them understand better how the Universe has changed.

"In the distant Universe, galaxies look very different. They're much more massive, forming stars at a very high rate of thousands per year. If you look at our own Milky Way Galaxy today, it forms perhaps just four stars a year," explained Dr Enzo Pascale who led the Cardiff University, UK, team working on the project.

Astronomers established in the 1980s and 1990s that the cosmos was extremely bright at far infrared and sub-millimetre wavelengths - at least as bright as it appears at the optical wavelengths we can detect with our eyes or with a telescope such as Hubble.

Scientists suspected this light, which covered the entire sky, was coming from distant, very luminous galaxies where countless new suns were bursting into life from within huge clouds of very dusty gas.

But it was a difficult question to address because our own atmosphere actually absorbs this type of radiation and makes ground observations extremely tricky.

With the high-flying Balloon-borne Large-Aperture Sub-millimeter Telescope (BLAST), scientists had the means to get above this problem and try to detect the individual source galaxies.

In its Nature paper, the BLAST project team reports that the telescope identified hundreds more target galaxies than had previously been seen and could describe them in finer detail than ever before.

The team says the peak of the Far Infrared Background radiation, as it has become known, is indeed related to distant "starburst" galaxies - objects that are being seen when the Universe was about a third of its present age.

"It pins completely the origin of the infrared background on star and galaxy formation," said Dr Pascale.

Looking at the sedate cosmic neighbourhood we inhabit today, it is hard to appreciate just how different conditions were in the young, bustling Universe.

"These early galaxies would have crashed together, and this crashing would have stimulated a huge amount of star formation in that new galaxy that's being created," explained Dr Mark Devlin, BLAST group leader from the University of Pennsylvania, US.

"That's where these ultra-luminous galaxies came from; it's quite spectacular."

BLAST was destroyed in the Antarctic when it was dragged for 200km along the ice by a parachute that failed to detach properly on landing.

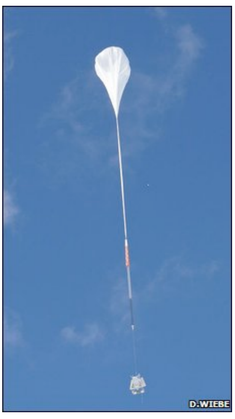
The story, though, does not end there. The sub-millimetre camera on BLAST was a forerunner for the one being launched on 6 May on the European Space Agency's flagship Herschel observatory.

The billion-euro space telescope will travel some 1.5 million km from Earth to enjoy the very best observing conditions. The astronomical satellite is expected to identify many thousands of starburst galaxies.

"We've shown what's out there and what you should be looking for. Herschel will really go and nail it," said Dr Devlin.

"It will be a much more stable instrument, observing over a much longer period of time, over larger areas; and will go deeper."

In addition to the universities of Cardiff and Pennsylvania, the BLAST project called on the expertise in the universities of Brown, Toronto, Puerto Rico, Miami, and British Columbia; and the Jet Propulsion Laboratory in California, and the Laboratoire APC in Paris.



BLAST is carried above an obscuring atmosphere for this type astronomy

The Herschel space telescope should see many more galaxies

The Herschel space observatory will launch on 6 May

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