The Importance of BLAST

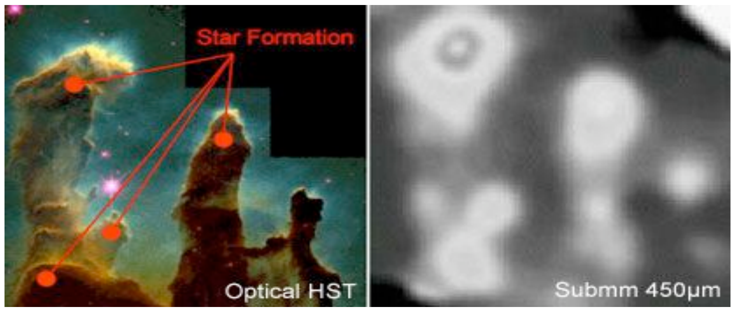
What is BLAST?

BLAST stands for ***B***alloon-borne, ***L***arge ***A***perture, ***S***ubmillimeter ***T***elescope. This unique telescope is one of the most sophisticated scientific balloon payloads ever, sensitive in gathering light at submillimeter wavelengths. This allows BLAST to observe the birth of stars in some of the most ancient galaxies in the Universe, all while dangling at the top of the atmosphere beneath an enormous NASA high-altitude balloon.

Why is the science of BLAST important?

The scientific work done by the balloon-borne telescope BLAST is the next step in answering one of humankind's most basic questions: How did the Universe come to be?

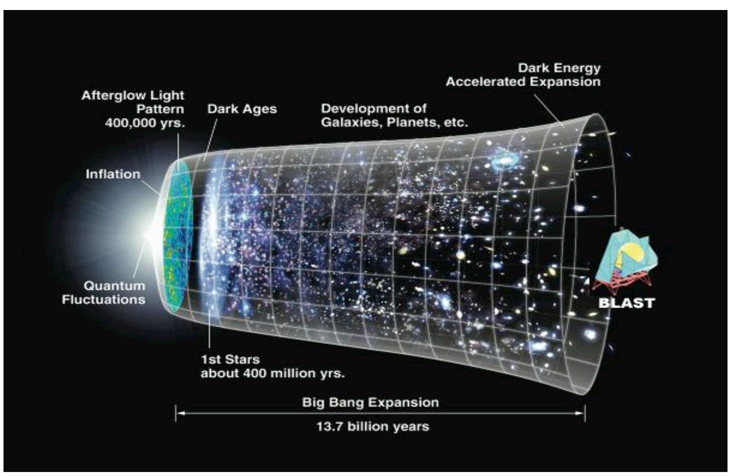
Sure, we know there was a Big Bang, but then what? How did this mysterious, cataclysmic event lead to the universe we see today? Scientists have built many satellites and telescopes to help them peer into the past. The Hubble telescope gave us these now famous images (at right) showing massive clouds of dust in which stars were formed in our own galaxy.



On the left is a very famous picture taken by the Hubble telescope, showing regions of a galaxy where stars are being born. This image shows light in the optical range. That's why the colors look so brilliant. However, it's hard to tell what's happening inside of these plumes of dust. The image on the right is of the very same star-forming regions, only this picture captured light in the submillimeter range. This is what BLAST can show us.

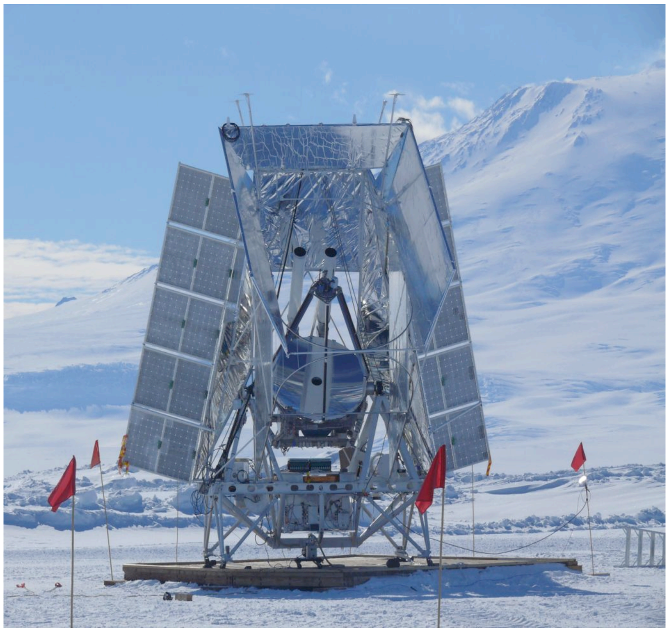
Now imagine entire, primeval galaxies completely enshrouded in this dust, forming stars five hundred times faster than in our own galaxy. Very little of the light that Hubble can see escapes these clouds. Only a telescope like BLAST can gather the light from this haze and tell us what is going on inside these ancient galaxies.

Using state-of-the-art detectors, BLAST has picked up the faintest rays of light emanating in the submillimeter band of the electromagnetic spectrum from these star-forming galaxies. Just as night vision goggles can create a thermal picture in the dark, BLAST will create thermal maps detecting thousands of these early galactic nurseries.



The mature Universe we see today had a birth (the Big Bang) and an adolescence (the formation of galaxies). Earlier experiments studied the birth (including the Nobel Prize-winning satellite COBE). BLAST is one of the first experiments to tackle the study of the adolescence of our Universe. By understanding how galaxies formed billions of years ago, we also gain understanding of the physical parameters that govern the Universe we know today.

Why are balloon telescopes important?



Large unmanned helium balloons provide NASA with an inexpensive means to place payloads into a space environment. The unique capabilities of this program are crucial for the development of new technologies and payloads for NASA's space flight missions. They also offer essential training for the next generation of scientists. Many important scientific observations are made with these instruments.

At this time, there is no other ground-based or space-based instrument as sensitive as BLAST in measuring submillimeter light from the most ancient galaxies.

Often telescopes launched on balloons are the precursors of much more ambitious and expensive satellite telescopes. The more nimble, less bureaucratic balloon projects may be both competing and collaborating with their more massive and expensive satellite counterparts.

The simpler balloon telescopes are developed and deployed more quickly than the satellites, potentially scooping the initial science goals. However, the balloon projects also provide a service for the satellites, charting new science territory and testing new equipment for their larger counterparts whose greater sensitivity may eventually supercede the earlier balloon-borne results.

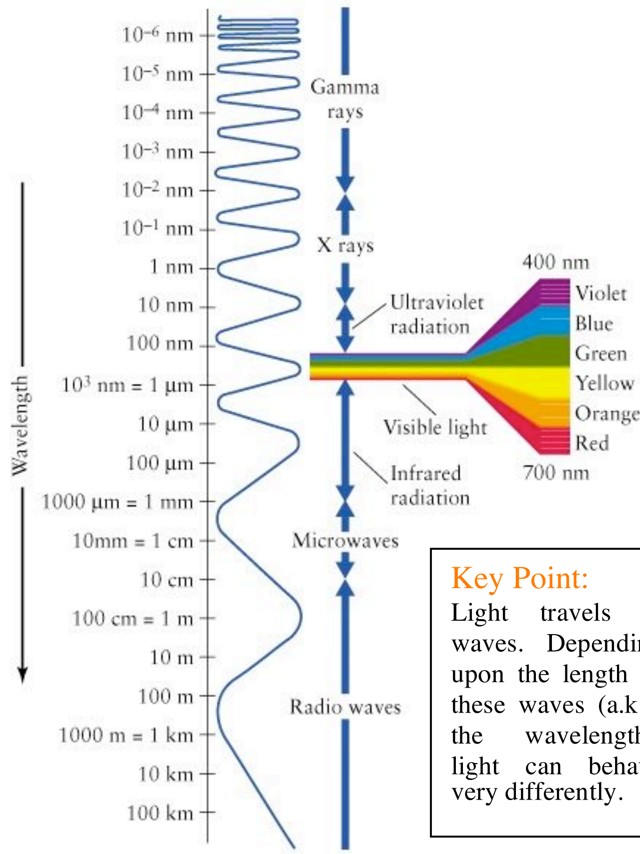
Numerous balloon flights provided the initial technology and observational techniques used in the Nobel Prize-winning COBE satellite which first mapped the Cosmic Microwave Background – a remnant of the Big Bang which birthed our Universe.

BLAST is one of the most ambitious balloon projects to date. It is the precursor of the SPIRE instrument on the upcoming international HERSCHEL satellite (estimated cost $1 billion). While SPIRE benefits from the risks BLAST takes with its early tests of the technology, BLAST enjoys the distinction of being the first to make groundbreaking measurements of submillimeter light from the thousands of new galaxies it discovers.

The Science of BLAST

What's the difference between BLAST and the telescope I use for stargazing in my back yard?

The main difference between BLAST and other telescopes is what it can help you see. Light comes in many different varieties, only a small portion of which is our every-day, visible light. Light can also come in the form of X-rays, radio waves, and microwaves, each with dramatically different wavelengths. Indeed, each color we see is a packet of light, moving toward our eyes at a slightly different wavelength. BLAST has the ability to detect light at relatively long, submillimeter wavelengths. Roughly speaking, this means that the light BLAST detects has a wavelength between a tenth of a millimeter and one millimeter. This wavelength is longer than infrared, but shorter than radio waves.

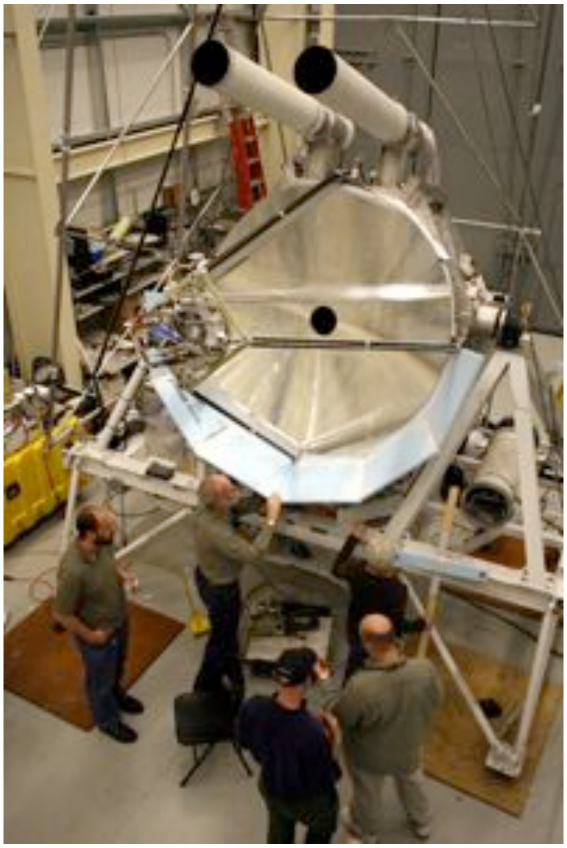


Key Point:
Light travels in waves. Depending upon the length of these waves (a.k.a. the wavelength), light can behave very differently.

BLAST is also different from your home telescope because it weighs 4000 pounds, takes 4 computers to run, and can operate autonomously for 11 days while dangling from a 40 million cubic foot balloon at 130,000 feet above Antarctica. And, unlike your home telescope, it costs about $10 million.

Why do you need to hang BLAST from a balloon? Can't it work from the ground?

Not really. The Earth's atmosphere absorbs most of the submillimeter radiation from distant galaxies. If we want to detect it, we need to get above the atmosphere. The only way to get above all of the Earth's atmosphere is to head into space. Unfortunately, sending a telescope up into space is expensive (hundreds of millions of dollars) and takes a long time (8-15 years) to develop and fly. The next best option is to get above *most* of the Earth's atmosphere. Attaching the telescope to an enormous balloon and floating it to the top of the atmosphere makes it possible for the submillimeter light to reach the detectors. This can be accomplished within 2-7 years for a fraction of the cost of a satellite.



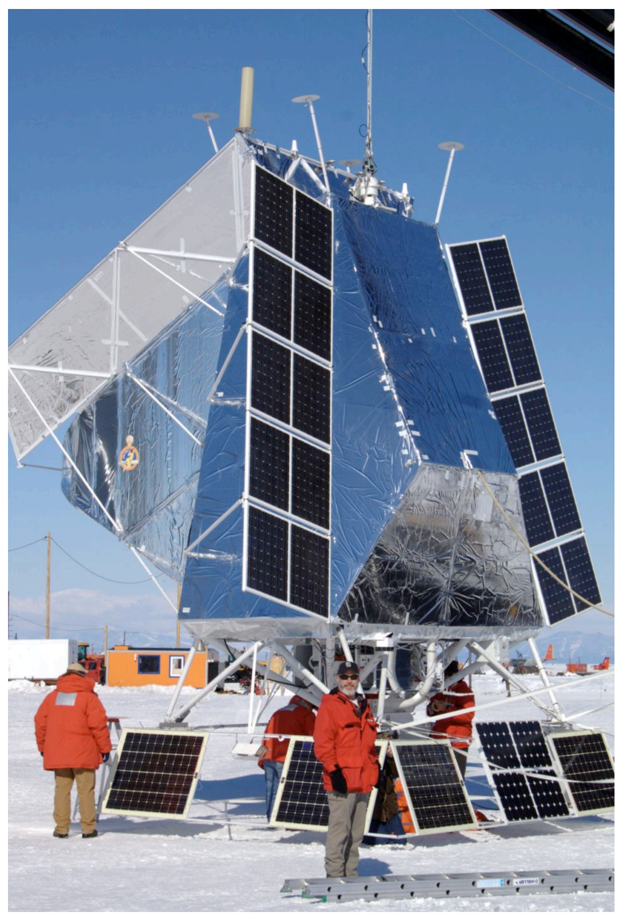
What's so special about submillimeter radiation?

BLAST researchers are mainly interested in learning more about how the earliest galaxies and stars were formed. But, by their very nature, the stars forming in early galaxies are hard to see. Stars are formed inside massive clouds of dust and gas, so looking into these cloudy delivery rooms can be problematic. Luckily, star births are fiery events. The heat from the newborn stars warms the dust which then emits submillimeter radiation, a form of light. This radiation is the only clue we have to early galaxy formation and therefore our own solar system's formation. In order to detect these galaxies, you must build a submillimeter telescope.

How do we know these stars are being formed in the oldest galaxies in the universe?

Though it sounds strange, when you look further out into space, you are actually looking further back in time. Light travels incredibly fast, but it only seems instantaneous at short distances on the Earth. Light from distant galaxies can take millions of billions of years to reach us. The further out we look into space, the longer that light has had to travel to reach our eyes. We are literally seeing the light of events that happened in the past. When we look at galaxies in the farthest reaches of space, we don't see what's happening with them today, we are viewing their activity from billions of years ago. In this way, we can develop a timeline for the evolution of the Universe.

Key Point:
The further out into space we look, the further back in time we can see.



How **BLAST** Works

How exactly does a 4,000 lb telescope point itself at ancient galaxies and gather their faint light while dangling beneath an enormous helium balloon?

Lift Off

After all the instruments have been tested and installed for flight, BLAST is attached to a massive launch vehicle to wait patiently while the balloon is inflated. The helium-filled balloon is made of material similar to plastic grocery bags. The enormous balloon takes two hours to inflate before it is released into the air. The launch vehicle must maneuver the payload until the balloon is floating directly overhead. Then it releases BLAST so that the balloon can take it to the top of the atmosphere.

Taking Aim

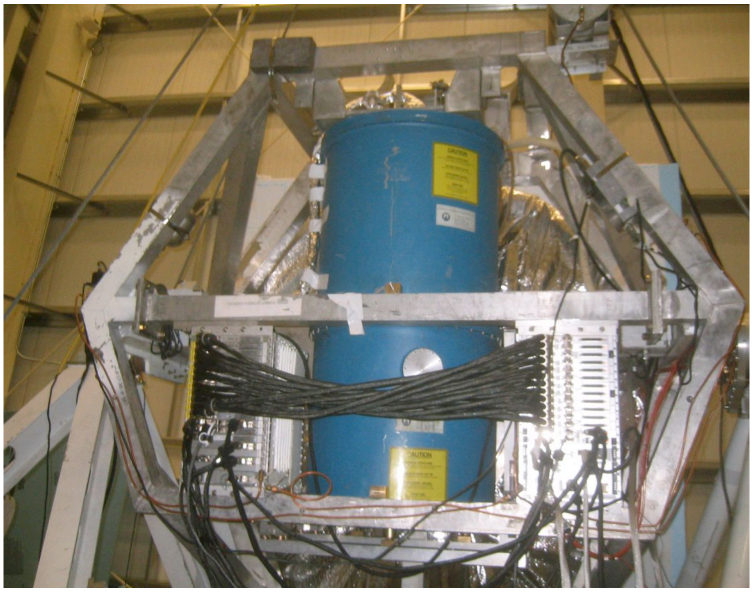
Once floating in the sky, BLAST needs a way to orient itself and point the telescope in the right direction. Like the first sea-faring explorers, BLAST relies on the stars for its navigation. On top of the main mirror are two star cameras (the long white tubes). These cameras take pictures of stars whose positions in the sky are well known. BLAST's computers can then analyze these reference points and, through a series of motors and gyroscopes, adjust its position accordingly.

Gathering Radiation

Star formation is an explosive process, and the resulting heat is absorbed as radiation by nearby dust and gas clouds. These stellar gases warm up to about 30 degrees above absolute zero. In order to detect this radiation, which is a form of light, a specialized telescope and detector system, or bolometers, must be used.

BLAST's main mirror is about 6 feet across and is made of aluminum. The telescope focuses light onto a cryogenic receiver which keeps the specialized detectors at a temperature of 0.3 degrees above absolute zero. This ultra cool temperature is required to make the detectors as sensitive as possible to the cold clouds of gas.

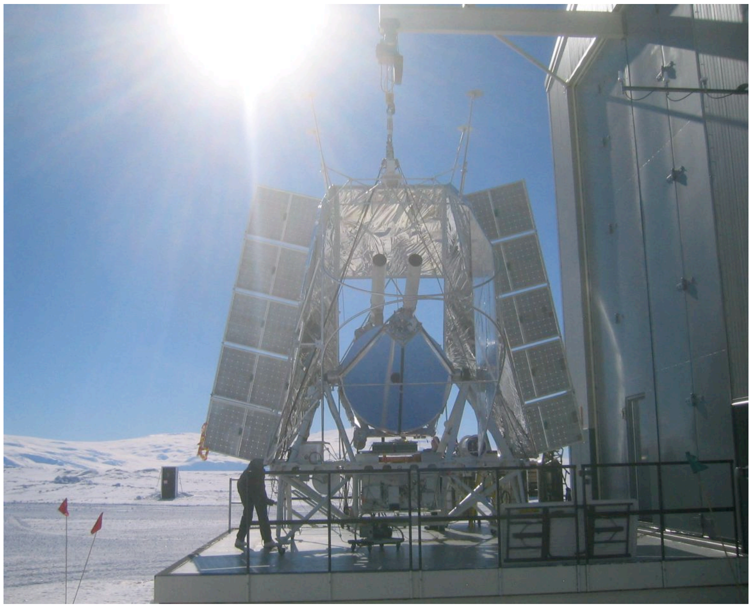
Once the data has been collected, a computer will then synthesize these faint signals into a larger picture or map of the early galaxy distribution on the sky.



Harnessing Power

With instruments that are sensitive to both light and heat, BLAST needs to be careful never to point directly at the Sun—doing so would essentially burn out the equipment. However, BLAST does use the Sun's heat to power the entire instrument.

BLAST takes advantage of the Sun's continuous presence during the summers at the North and South Poles. By flying only in constant daylight, BLAST not only ensures a steady source of power but a flight at a stable altitude. If the Sun were to set during the flight, the helium in the balloon would cool and it would drop to a lower altitude. At sunrise, the helium would heat and the balloon would rise.



Coming Down

When it is time to land, a remote-controlled system separates BLAST from the balloon. A parachute then opens to help slow the telescope's plummet. It takes about 45 minutes for BLAST to reach the ground. The parachute detaches itself from the gondola and the precious hard drive, containing all of the data, waits to be recovered.

Key Words:

Bolometers – the sensors that detect sub-millimeter light.
Gondola – the large metal structure that holds the telescope, motors, and computers.
Payload – anything dangling from the balloon.
Star Cameras – cameras that BLAST uses to orient itself in the sky.