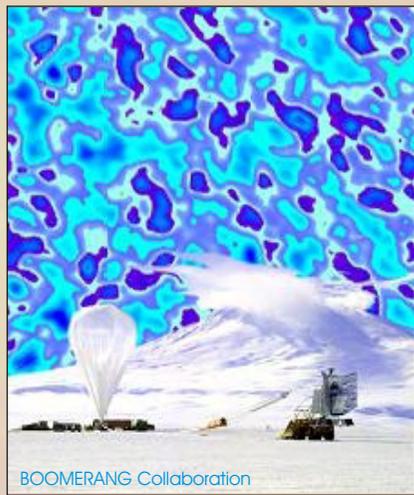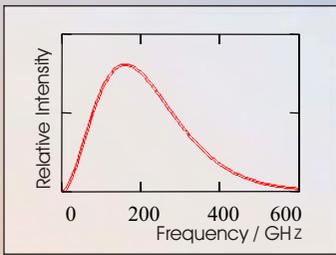# Cold in Space

The temperature of outer space

Outer space is full of Cosmic Microwave Background (CMB) radiation, a remnant of energy from the Big Bang fireball, 15 billion years ago. The frequency distribution of the intensity corresponds to *black-body radiation* at a temperature of 2.728 K.

The BOOMERANG telescope shown ready for launch by balloon in Antarctica, has observed minute temperature fluctuations in the CMB radiation from different directions in space. The fluctuations indicate the structure of the early Universe and are shown as they would appear in the sky to a camera sensitive to microwave radiation.

BOOMERANG Collaboration

The coldest place in the universe?

The Boomerang Nebula lies 5,000 light-years away, seen here in starlight reflected from dust. The boomerang shaped cloud appears to have been created by a high-speed wind of gas and dust blowing from an aging central star at speeds of over 300,000 miles per hour. The rapid expansion cooled the nebular gas to about 1 K, the coldest known region in the distant Universe.

JPL/ESO

The Boomerang Nebula

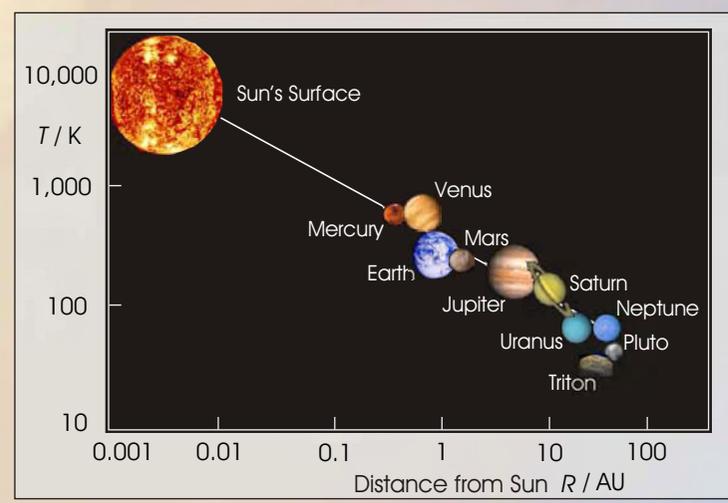## The coldest place in the solar system

The surface of Triton, a moon of Neptune, consists of ice, solid nitrogen and methane at a temperature of only 35 K (-238°C). The photograph from Voyager 2 shows the nitrogen-ice cap on the south pole of Triton. Cold volcanoes are erupting, perhaps from liquid nitrogen below the surface.

Triton

NASA/JPL
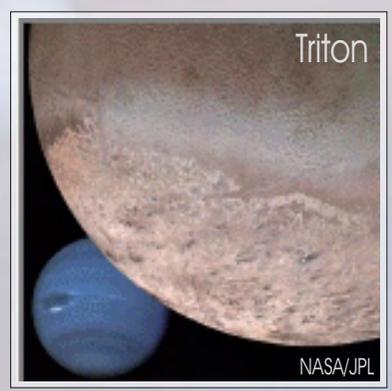
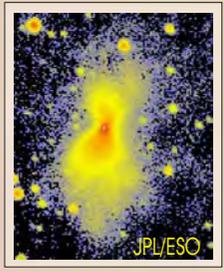Montage of Neptune and Triton

The solar system

The luminosity of the Sun is 3.8×10^{26} W from its surface at 5800 K. The radiation intensity at the Earth's orbit, the Solar Constant, is 1370 W m^{-2}. Energy is absorbed and reradiated to maintain the Earth at an average 15°C (289 K).

1 AU = 149,600,000 km

AU: An astronomical unit is the mean distance between the Earth and the Sun.

The radiant solar flux is proportional to $1/R^2$. The radiated power is proportional to T^4. Hence the absolute temperatures of the planets are approximately proportional to $1/\sqrt{R}$.

Background: The Solar System - Bill Arnet (www.nineplanets.org) - NSSDC