# Achieving Your Vision

## *SWAS*

Ball Aerospace & Technologies Corp.'s radio astronomy instrument for the Submillimeter Wave Astronomy Satellite (SWAS) studies nurseries where stars are born. Launched in 1998 from a Pegasus XL, SWAS collects data in the radio wave region of 487 to 557 GHz and provides the first space-based observations of submillimeter wavelength emissions of molecular oxygen, water, carbon monoxide and neutral carbon atoms.

**Ball Aerospace & Technologies Corp.**
Aerospace Systems Division
1600 Commerce Street
Boulder, Colorado 80306
http://www.ballaerospace.com

(303) 939-6100
Fax: (303) 939-6104
E-mail: info@ball.com

The elements from submillimeter wave emissions are found in large, "cold" clouds of dust in space between stars and galaxies. The clouds collapse from their own gravitational attraction and heat up from -450 °F (5.4 kelvin) to about -405 °F (30.4 kelvin) as they collapse. These processes are believed to fuse the molecular elements to form stars.

About the size of an office desk, SWAS consists of a 24-inch diameter Cassegrain telescope that collects the submillimeter radiation and directs it to a dual-channel, heterodyne receiver. The receiver converts the incoming high-frequency (487 to 557 GHz) radiation to lower frequencies (1.4 to 2.8 GHz) for analysis by an acousto-optical spectrometer (AOS).

The AOS converts the spectral distribution of radio frequency signals to a spatial distribution of laser light by directing a beam from a gallium-aluminum-arsenide laser diode through an acousto-optical modulator. The light diffracted by the modulator is then imaged on a 1x1, 450-element, charge-coupled device array.

For maximum sensitivity, the receiver is cooled by passive radiators to a temperature of -190 °F (170 kelvin) to reduce internally generated electronic noise. A set of three compound parabolic sun-shades protects the passive coolers from Earth and solar radiation. The unique shape of these Winston cones provides a maximum view to cold space for the radiators with a minimum size shade.

*The SWAS instrument provides the first space-based observations of submillimeter wavelength emissions.*

Ball Aerospace provided the SWAS instrument to the Smithsonian Astrophysical Observatory (SAO). Millitech Corporation provided the front-end submillimeter receiver under subcontract to Ball. The University of Cologne, Germany, supplied the AOS back-end. NASA/GSFC provided the spacecraft and instrument integration into it.

A team of seven universities and government agencies is performing scientific direction and mission data analysis and interpretation. Dr. Gary Melnick at SAO heads the team that includes: the University of Massachusetts, Amherst; Cornell University; the University of Cologne, Germany; the Johns Hopkins University; the National Air and Space Museum; and NASA/Ames Research Center.

SWAS represents Ball Aerospace's latest contribution to the Explorer-class missions. Its predecessors include the Infrared Astronomical Satellite (IRAS), launched in 1983, the first space-based, cryogenically cooled infrared sensor; and the superfluid helium dewar for the Cosmic Background Explorer (COBE), launched in 1989.

IRAS produced the first extensive maps of the universe in the infrared wavelengths, chronicling more than 250,000 new sources. COBE confirmed the existence of the "3K background," an infrared emission that suffuses the universe and originates from the Big Bang – the explosion that is thought to have created the universe 15 billion years ago.

Ball Aerospace will also further studies in infrared astronomy with the Space Infrared Telescope Facility (SIRTF). Ball Aerospace is responsible for the cryogenic subsystem, telescope assembly, and two of the three instruments on SIRTF, which is a part of NASA's Great Observatories series.