is mounted on three Spacelab pallets. A supply module, called an igloo, provides a pressurised compartment for subsystems providing services such as cooling, electrical power and commanding and acquiring data from the instruments.
The European Space Agency's instrument-pointing system weighs about 5,000kg and can point the three ultraviolet telescopes to within 2arc-sec and hold them on target to within 1.2arc-sec. An image-motion compen-sation system is required to provide addition-al pointing stability for two of the ultra-violet telescopes.

COMPENSATION

The telescopes are affected by crew move-ment in the cabin and by Shuttle thruster firings, so a gyrostabiliser senses any motion which could disrupt stability and informs the image-motion compensation system. This computes commands for the telescopes' sec-ondary mirrors which make automatic ad-justments to improve stability to less than larc-sec. The X-ray telescope is mounted on its own two-axis pointing system, (TAPS). The four telescopes are expected to make up to 300 specific observations of targets during the almost nine-day STS 35 mission. Columbia will be launched from Pad 39A at the Kennedy Space Center during a window lasting 2h 24min. At T-6h the external tank will be filled with liquid hydrogen and oxygen for the first time since the May 30 Astro launch was aborted when hydrqgen gas leaked.
Columbia will make a direct ascent into a

28.45°-inclination, 348km-high orbit. The launch will be at night so that most of the passes over the South Atlantic, where the Earth's radiation belts dip low, will be in daylight when the minimum of observations are scheduled.

During the flight, the crew will be divided into Red and Blue teams, with Brand as mission "overlord". Each team will work a 12h shift, observing two to three objects during a 30min "night". More than 80h of observations are planned, particularly of 140 specific targets selected from a list submitted by the principal investigators. If fuel-cell levels are acceptable, the mission can be extended by a day.
The crew will operate the ultra-violet tele-scopes and instrument pointing system from the Orbiter aft flightdeck, whicb has win-dows overlooking the payload bay. The flightdeck is equipped with two Spacelab keyboard and display units, one for the pointing system and the other for instrument operations. Using two screens, the crew will be able to see the objects being viewed by two telescopes and monitor data being transmit-ted from them.

The Shuttle will be pointed in the correct direction for observations by either Brand or pilot Guy Gardner. More than 240 attitude changes are planned during the mission. Mission specialists, astronomers Jeff Hoffman and Bob Parker and astrophysicist Mike Lounge, will lock the pointing systems onto the targets and Durrance and Parise will operate the instruments.
Observations will last from 10min to just

Space Shuttle cargo configuration

over an hour per target. Astro will be the first mission to be controlled from the Marshall Space Flight Center's Spacelab Operations Control Center, although flight operations will still be directed by Houston and the X-ray telescope controlled from the Goddard Space Flight Center.
The Hopkins Ultra-iolet Telescope (HUT)
is the first major instrument capable of studying far-ultra-violet and extreme ultra-violet radiation from a wide variety of sources. Its 900mm-aperture paraboloid mirror is coated with the rare element iridi-um capable of reaching these extremes of radiation.
A grating within a spectrograph separates the light, like a rainbow, into its component wavelengths and scientists will use different apertures to accomplish various observation goals. The longest "slit" in the grid provides a field of view of 2arc-min, about /jjth the apparent diameter of the Moon. HUT is expected to provide 300,000s of data on nearly 200 objects, 1,000 times more data than provided by sounding rocket missions.

POLARISATION
The Wisconsin Ultra-violet Photo- Polarime-ter Experiment (WUPPE) is designed to measure polarisation and intensity of ultra-violet radiation from celestial objects. Any star, except for our Sun, is so distant that it appears as only a point of light and surface details cannot be seen. If the light from objects is polarised, scientists can tell some-thing about the source's geometry, the physi-cal conditions at the source and the reflecting properties of tiny particles in the interstellar medium along the radiator's path.
WUPPE has a 500mm-diameter primary mirror and is fitted with a spectropolari-meter, an instrument that records both the spectrum and the polarisation of ultraviolet light gathered by the telescope. Light will pass through polarising filters before reach-ing the detectors.
The Ultraviolet Imaging Telescope (UIT) from the Goddard Space Flight Center is to provide deep, wide-field images in a wave-length never observed before, hopefully giving clear views of spiral galaxies, clusters, white dwarfs and other objects. UIT is a powerful combination of telescope, image intensifier and camera. The 3,80mm-diameter telescope, with a 40arc-min field of view, has two selectable cameras mounted behind the primary mirror. Each camera has a six-position filter wheel, a two-stage magnetic-ally focused image tube and a 70mm film transport fibre-optically coupled to each image tube.
The film transport can take 2,000 expo-sures and each image frame will be digitised to form 2,048 pixels, then analysed further by
computers. A 30min exposure will record a
blue star of 25th magnitude, 100 million
times fainter than the faintest star visible to
the naked eye.
The Broad-Band X-ray Telescope (BBXRT)

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