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ATMOSPHERIC LYMAN-ALPHA EMISSIONS (ALAE) (E017)

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The Atmospheric Lyman-Alpha Emissions (ALAE) experiment is designed to measure atomic hydrogen and deuterium in the terrestrial atmosphere. The development of the instrument is a joint effort of the Service d'Aeronomie du CNRS in France and the Institut d'Aeronomie Spatiale in Belgium.

The detecting technique is based on the capability of atomic hydrogen and deuterium to absorb the intense solar Lyman-α radiation at 121.6 nm and to re-emit this radiation in a different direction. Since the wavelengths of the deuterium and hydrogen Lyman-α lines are very close, specific absorption cells (Fig. I-1) are used to discriminate between the atmospheric deuterium and hydrogen emissions. Light entering the instrument falls on a rotating mirror used for pointing toward different atmospheric regions. When the hydrogen cell is activated, almost all Lyman-α emission from atomic hydrogen is absorbed and the grating eliminates all other atmospheric emissions from other constituents. By switching the deuterium cell successively on and off, the photomultiplier can detect the weak atmospheric deuterium emission. Various combinations of the status of both cells during the mission allow observations of the atmospheric deuterium layer, the atomic hydrogen geocorona, and the Lyman-α interplanetary medium. The mass of the instrument (Fig. I-2) is 12.5 kg and its dimensions are 685 x 300 x 320 mm.

Atomic hydrogen in the Earth's atmosphere results essentially from the evaporation of liquid water at ground level followed by an upward transport of water vapor to altitudes where it is dissociated by solar ultraviolet radiation. Atomic hydrogen then becomes an atmospheric component involved in numerous chemical reactions and is capable of escaping the Earth's gravitational field. Since liquid water also contains a small fraction of molecules in which one hydrogen atom is replaced by one deuterium atom, which is twice as heavy, it is reasonable to suspect the presence of a small amount of deuterium in the upper atmosphere.

In 1983, the ALAE experiment (ES017) discovered three new features during the Spacelab 1 mission. For the first time, an atomic deuterium layer was detected around 110 km altitude (Fig. I-3) with an intensity of 330 Rayleighs (1 Rayleigh = 10^6 photons cm^{-2} s^{-1}). Auroral emissions of atomic hydrogen were monitored on the dayside as well as on the nightside. A hot, unexplained emission outside of the auroral region was observed during the last day of the mission. These results indicate the flexibility of the instrument and its potential capability to investigate a wide range of geophysical phenomena. The technique could be adapted to other planetary missions in order to evaluate the ratio between deuterium and hydrogen which is a fundamental quantity necessary for the understanding of the time evolution of water on a planet.

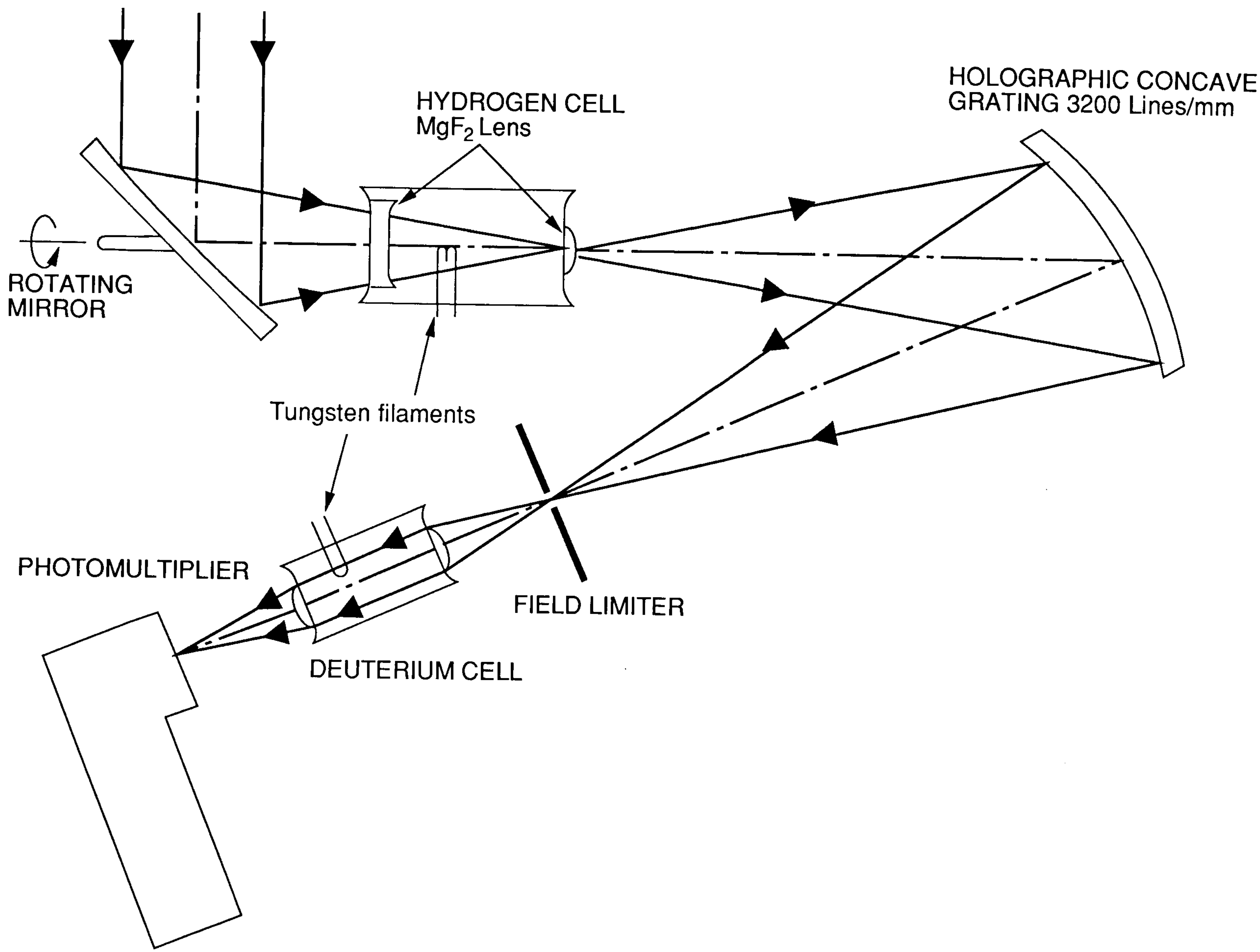

Figure I-1. ALAE instrument schematic.

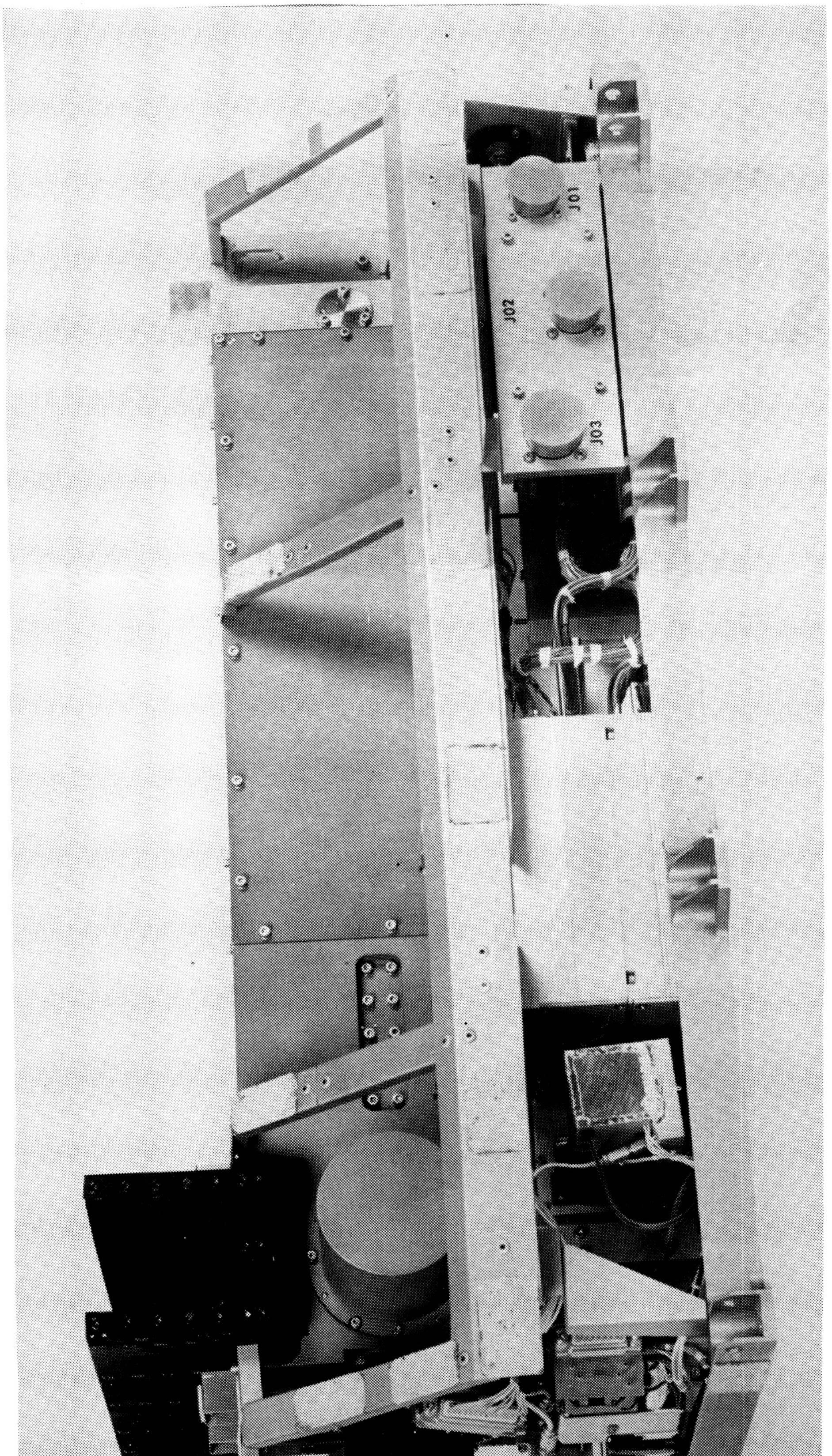

Figure I-2. Photograph of flight instrument.

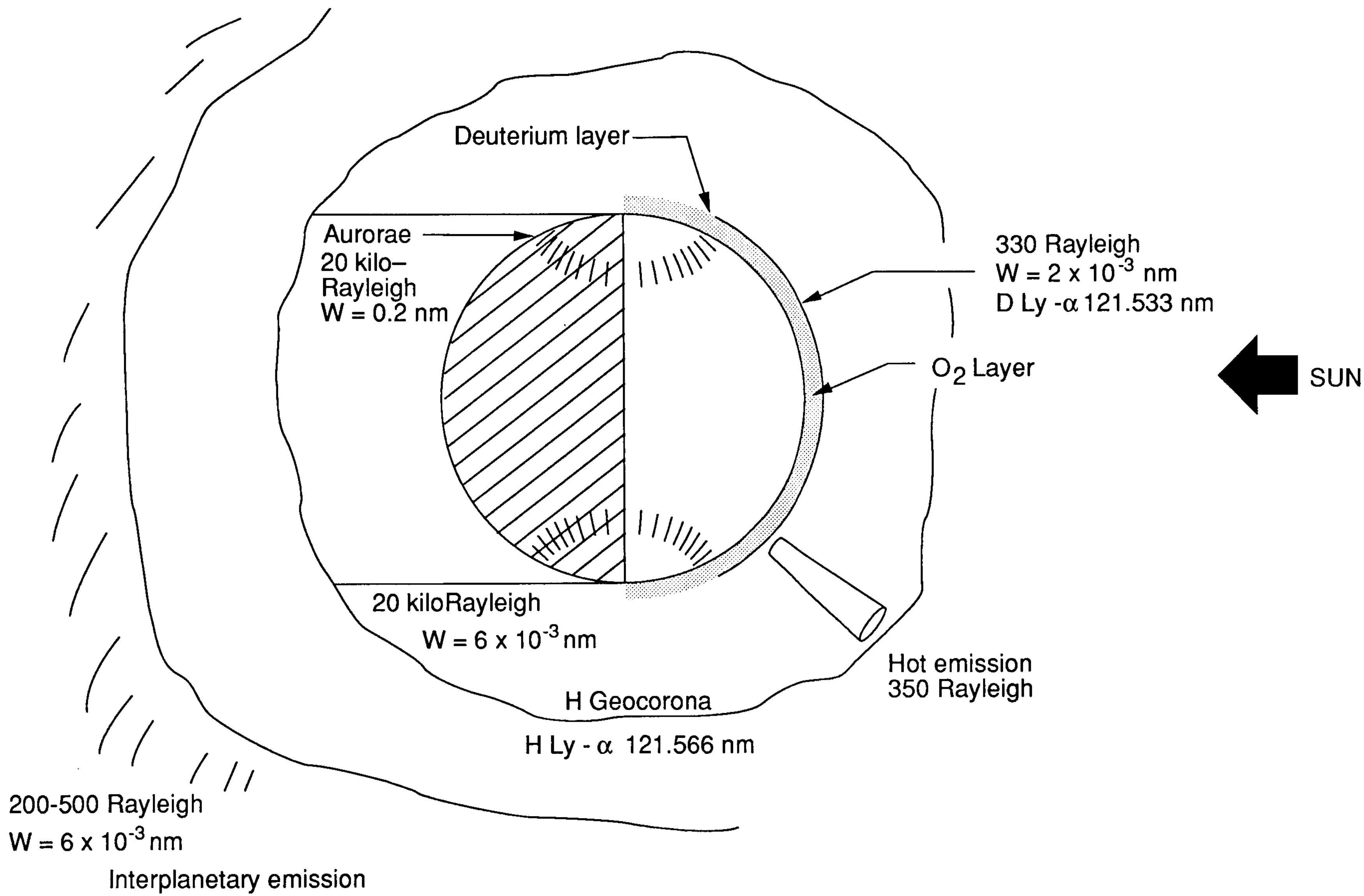

Figure I-3. Emission source for ALAE.