SPACE EXPLORATION SYMPOSIUM (A3)
Mars Exploration – Part 1 (3A)

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DESIGN, FABRICATION AND TESTING OF A LYMAN ALPHA PHOTOMETER FOR D/H STUDIES OF MARS UPPER ATMOSPHERE

Abstract

One of the best approaches to study the atmospheric gas escape mechanism of low magnetic field planets such as Mars is to measure the ratio of Deuterium to Hydrogen. Temporal and spatial distribution profiles of D/H ratio of these planetary atmospheres will give us information about their evolution process. For this purpose, the development of a Lyman Alpha Photometer (LAP) has been taken up for measuring the Deuterium to Hydrogen ratio from the Lyman α emission from any planetary object. The instrument consists of two gas absorption cells- one each for Hydrogen and Deuterium - with tungsten filament heater for thermal dissociation of molecules into atoms which will absorb their characteristic Lyman α line. These cells are aligned in series with a photo multiplier tube detector. The instrument field of view is restricted to close to zero degrees and the incoming UV radiation is focused on to the detector by a Magnesium flouride lens and is filtered through a Lyman α (122 nm) narrow band optical filter. The gas cells also are covered with VUV transparent MgF2 windows in the optical path direction. The instrumentation development involves design and fabrication of high purity gas cells of Hydrogen and Deuterium with tungsten filaments, evaluation of detector sensitivity, life tests on the filaments to survive the full mission life, UHV compatibility of the gas cells, spectral absorption characterization and calibration of the gas cells as a function of gas temperature and pressure and laboratory test and evaluation of the fully assembled instrument by simulating the space conditions. The tungsten filament specifications are generated based on a design to produce enough thermal heat for gas dissociation, long life cycle duration and low power consumption. Several technical issues related to the realization of UHV compatible gas absorption cells such as maintaining ultra pure gas environment in the cell, optical window mounting and UHV electrical

feedthrough for heating filaments have been successfully overcome through continuous evacuation and high temperature baking for long hours. The Hydrogen and Deuterium gas cells have been characterized in a VUV spectrometer. A specially designed UHV test facility shall be used for characterizing the instrument against standard Hydrogen and Deuterium Lyman α sources which are also used for calibrating the instrument. In this paper, the test and evaluation results of various sub- systems at different stages of development and their impact on the instrument sensitivity and data reliability shall be discussed.