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A Balloon-Borne Telescope System for Optical Remote Sensing of Planetary Atmospheres and Plasmas

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A ground-based telescope which is mostly located in the mid to low latitudes can not observe a planet longer than ten hours a day by. On the other hand a telescope floating in the polar stratosphere can continuously monitor planets for more than 24 hours. Thin, clear and stable air of the stratosphere makes it possible to observe planets in a condition free from cloud with fine seeing and high atmospheric transmittance. Moreover, a balloon-borne telescope system is less expensive compared with a huge terrestrial telescope or a direct planetary probe mission. Targets of a balloon-borne telescope system will extend over various atmospheric and plasma phenomena on almost all the planets, i.e., a sodium tail of Mercury, lightning, airglow and aurora in the atmospheres of Venus, Jupiter and Saturn, escaping atmospheres of the Earth-type planets, satellite-induced luminous events in Jovian atmosphere, etc. The first experiment will be performed in June, 2006 at Sanriku Balloon Center (SBC) in Japan. The target is global dynamics of the Venusian atmosphere by detecting cloud motion in UV and NIR imagery. A 300 mm F30 Schmidt-Cassegrain telescope is installed at the bottom of the gondola, which is isolated from a balloon by a decoupling mechanism. A pair of control moment gyros (CMGs) or a torquer mounted at the top of the gondola controls azimuthal attitude of the gondola so that a solar cell panel faces to the sun with an accuracy of about 0.1 deg. The two-axis gimbal mount of the telescope guides an object within a field-of-view of a guide telescope. The field-of-view of the telescope covers elevation angles from 0 deg to 70 deg. Tracking error beyond the ability of the gondola attitude and gimbal mount controls is detected by a position sensitive photomultiplier tube and corrected by the two-axis moving mirror installed in an optical system. This mirror corrects tracking error of angle displacement less than 1mrad and frequency less than 100 Hz. The optical path is divided into three paths with different colors: the first one with wavelengths less than 450 nm, the second one with 550-630 nm, and the last one more than 750 nm. The first and last paths are utilized for imagery of UV and NIR with bandpass filters and CCD video cameras, respectively. The second path is for tracking error detection. Video signals from the CCD cameras are transmitted by analog modulation telemetries to the

ground for real-time monitor and at the same time recorded in onboard digital video recorders, which will be recovered after landing. Commands are up-loaded and status and house-keeping data are down-loaded through a PCM code telemetry. During the level-flight a balloon altitude of 32 km will be maintained by an auto-ballast system and a flight time as long as several weeks is expected. The system is under production as of February, 2006, and the first experimental flight is scheduled in June, 2006 at SBC. After confirming the performance of the system by the test experiment it will be put into a full-scale operation in the polar regions. Keywords: Planet, Balloon, Telescope, Remote Sensing, Polar Regions