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B 会場 ：11/25　PM1 （13:15-15:15）
13:55〜14:15

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Long-duration continuous observation of planets by the circumpolar stratospheric telescope FUJIN

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It is essentially important to capture temporal and spatial variations for a long period for understanding phenomena in planetary atmospheres and plasmas. A balloon-borne telescope FUJIN has been developed for a long-duration continuous observation of planets from the polar stratosphere which is the ideal place for an optical observation of planets. It will be possible to utilize FUJIN as a quasi-permanent observatory floating in the stratosphere, if a durable super-pressure balloon is available. This paper describes an overview of FUJIN and expectation for practical application of the super-pressure balloon.

The initial goal of the FUJIN project is to achieve success with a short flight, lasting about half a day, over Australia [Imai et al., 2023]. In this experiment, a zero-pressure balloon will be sufficient to meet the flight requirements.

The next step for FUJIN is to aim for long-term continuous observation of planets through a polar orbit experiment. Potential locations for balloon experiments include the Arctic and Antarctic regions. For experiments in the Arctic region, the balloon will be launched from ESRANGE in Kiruna, Sweden. The scenarios considered include a 1-2 day flight within the Scandinavian Peninsula during the period when the stratospheric wind direction changes and wind speed weakens, as well as a polar orbit flight or part of its route during summer or winter, when the east-west wind speed is stable. The polar orbit flight could last up to about two weeks. For experiments in the Antarctic region, a flight circling the continent during summer is envisioned, similar to the Polar Patrol Balloon experiment previously conducted at Showa Station.

Except for experiments confined to the Scandinavian Peninsula, all of these scenarios can utilize super pressure balloons. Unlike zero-pressure balloons, where the flight duration is limited by the amount of helium gas and ballast, the use of super pressure balloons greatly increases the freedom of the experiment. This also allows for the possibility of multiple circumnavigations in the polar jet stream.

As a conceptual idea, there is also the vision of a semi-permanent floating observatory in the stratosphere using super pressure balloons. In the stratosphere near the poles, high-pressure or low-pressure vortices (polar vortices) form depending on the season. Since the horizontal wind speed at the center of a polar vortex is zero, a balloon could be floated there to remain stationary at the center of the vortex. If a gondola, lifted into the stratosphere by a super pressure balloon, is equipped with a propulsion mechanism to actively move horizontally in the air, it could be moved to the center of the polar vortex, realizing a floating observatory. This floating observatory would be launched at the appropriate time of year and would take about a month to move to the center of the polar vortex. It would then conduct regular observations of various celestial bodies and, after six months to a year, would be brought back to its home base over a period of about a month for recovery. The recovered gondola would undergo maintenance and be prepared for the next flight. In this scenario, the super pressure balloon would need to be durable enough to last for more than a year.

A floating observatory would offer far better seeing conditions than large telescopes installed at high altitudes on the ground, allowing observations under conditions with almost no infrared absorption from water vapor or carbon dioxide. Additionally, it would benefit from regular maintenance services on the ground, something that is not possible for satellite telescopes. The practical application of highly durable super pressure balloons is a key technology for realizing a floating observatory.

References

Imai et al.: Spectroscopic and Imaging Observation of the Venus Atmosphere by a Balloon-Borne Stratospheric Telescope FUJIN-2, JESA / 33rd ISTS, 2023.