VENUS ORBITER CONCEPT WITH SATELLITE-TO-SATELLITE RADIO OCCULTATION AND SUBMILLIMETER SOUNDER. T. Imamura[1], H. Ando[1], T. Iwata[1], A. Yamazaki[1], Y. Kasai[2] and H. Sagawa[3], [1]Institute of Space and Astronautical Science, Japan Aerospace Exploration Agency (3-1-1, Yoshinodai, Chuo-ku, Sagamihara, Kanagawa 252-5210, Japan. E-mail: imamura.takeshi@jaxa.jp), [2]National Institute of Information and Communications Technology (4-2-1 Nukui-kita, Koganei, Tokyo 184-8795, Japan, Email: ykasai@nict.go.jp). [3]Faculty of Scinence, Kyoto Sangyo University (Motoyama, Kamigamo, Kita-ku, Kyoto, 603-8555, Japan. Email: sagawa@cc.kyoto-su.ac.jp).

Introduction: JAXA's Venus orbiter Akatsuki aims to explore the atmospheric dynamics of Venus by multi-wavelength imaging observations [1]. The Venus orbit insertion maneuver conducted in December 2010 failed due to a malfunction in the propulsion system, and the spacecraft entered an orbit around the Sun with a period of 203 days. Although most of the fuel still remains, the orbital maneuvering engine was found to be broken. We decided to use the reaction control system for future orbital maneuvers, and three minor maneuvers were successfully conducted in 2011 to reach Venus in 2015. The Venus orbit insertion maneuver is scheduled for early December in 2015.

Given the planned start of the observation by Akatsuki in one year, we are studying a future Venus orbiter mission focusing on cloud physics and atmospheric chemistry. The primary mission payloads will be a sub-satellite and a sub-millimeter sounder.

Venus' atmospheric/cloud chemitry: The chemical and dynamical processes that control cloud formation and the stability of atmospheric composition are still unclear [2]. This is firstly attributed to the lack of observations of key radicals driving catalytic cycles such as ClO and HO_2 and key reservoirs such as HCl and $ClONO_2$. The abundance O_2, which determines the ways of the oxidation of SO_2 to H_2SO_4 (main component of clouds) and the reduction to S_x (possible condensation nuclei for cloud formation), is also unknown. The fluid dynamics that exchange air between the photochemically-driven upper atmosphere and the thermochemically-driven lower atmosphere across clouds are also key processes controlling the atmospheric composition and cloud formation.

New orbiter condept: The goal of the mission will be to understand photochemistry, cloud physics and vertical transport processes inside and above clouds. Satellite-to-satellite radio occultation using a sub-satellite (approximate weight: 50 kg) enables three-dimensional observations of the temperature field and the H_2SO_4 vapor distribution (Figs. 1 and 2). Data assimilation using those temperatures and munerical models would allow reproduction of the four-dimensinal dynamical field. A sub-millimeter sounder, which will be developed based on the heritages of SMILES onboard ISS and SWI onboard JUICE, measures abundances of key trace gases both in limb- and nadir-veiwing geometry. Having UV and near-IR cameras and infrared spectrometers would enhance the outcome. We also consider studies of atmospheric escape based on the observation of the composition in the lower thermosphere by the sub-millimeter sounder and the observation of the three-dimensional ionospheric density by satellite-to-satellite radio occultation.

References: [1] Nakamura, M., et al. (2011) *Earth Planets Space, 63,* 443-457. [2] Mills, F. P.. et al. (2007) *Exploring Venus as a Terrestrial Planet, 32, Geophysical Monograph Series, 176,* 73-100.
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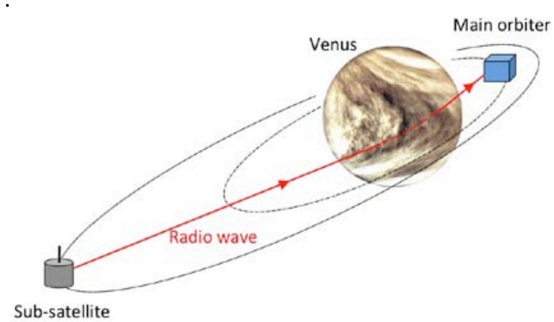

Fig. 1: Schematic of satellite-to-satellite radio occultation in the Venus orbiter mission concept

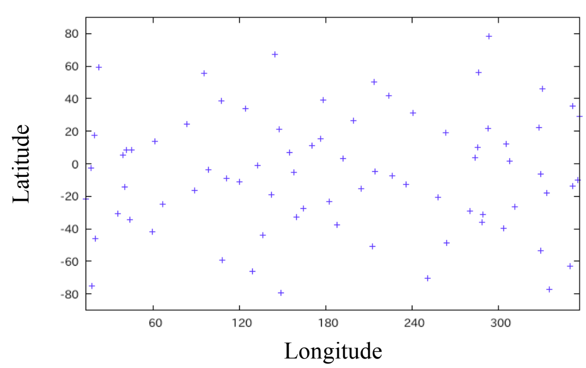

Fig. 2: An example of the distribution of observation points in satellite-to-satellite radio occultation in four days in the coordinate system rotating with the super-rotation. The orbital inclination is 80 degrees and the pericenter altitude is 400 km for both satellites, and the apocenter altitude is 2500 km for the main orbiter and 17500 km for the sub-satellite.