Exploration of Jovian System by ESA-JUICE Mission: Participation of Japanese Teams. JUICE JAPAN (Chief: Y. Saito[1] [saito@stp.isas.jaxa.jp], Associate scientists; M. Fujimoto[1], S. Sasaki[2], J. Kimura[3], Instrument chief Co-Is: N. Namiki[4], Y. Kasai[5], Y. Kasaba[6], K. Asamura[1], and more than 100 members), [1]The Institute of Space and Astronautical Science, JAXA, Sagamihara, Japan, [2]Departent of Earth and Space Science, Osaka Univ., Toyonaka, Japan, [3]ELSI, Tokyo Institute of Technology, Meguro-ku, Tokyo, Japan, [4]PERC, Chiba Institute of Technology, Tsudanuma, Japan, [5]National Institute of Communications and Information Technology, Koganei, Japan, [6]Tohoku University, Sendai, Japan

Introduction: JUICE (Jupiter Icy Moon Explorer) is the ESA's first Large-class mission of Cosmic Vision 2015-2025 program. It will be launched in 2022 and will reach Jupiter in 2030 (Fig. 1). JUICE will continuously observe the atmosphere and magnetosphere of Jupiter. Using multi-flybys with Callisto, JUICE will not only map the whole surface of Callisto but also change orbital inclination. It will twice fly by Europa. JUICE will finally enter orbit around Ganymede in 2032, where it will study the icy surface and internal structure, especially its subsurface ocean, which is one of atrractive fields for astrobiology in the solar system. Ganymede would have molten metallic core generating intrinsic magnetic field. JUICE will observe the unique magnetic and plasma interactions of Ganymede with Jupiter's magnetosphere.

The discussion for the international collaboration for Jupiter mission between ESA and Japan (JAXA) started from 2006 and International Jupiter Mission Working Group started at JAXA in 2007. The initial plan was that JAXA will take a role on the magnetosphere spinner JMO (Jupiter Magnetosphere Orbiter) and JMO would be launched and transported together with ESA's main orbiter[1)]. The original plan "Laplace" was similar to the framework of the Bepi-Colombo Mercury mission, where JAXA's magnetosphere orbiter (MMO: Mercury Magnetospheric Orbiter) is launched the ESA's main orbiter (MPO: Mercury Planetary Orbiter).

In October 2007, Laplace was selected as one of future ESA scientific missions Cosmic Vision (2015-2025). Then NASA which had been studied Europa mission (after JUNO) participated in the Jupiter mission planning. From 2008, JAXA will take a role on the magnetosphere spinner JMO (Jupiter Magnetosphere Orbiter). On the other hand, ESA will take charge of JGO (Jupiter Ganymede Orbiter) and NASA will be responsible for JEO (Jupiter Europa Orbiter). A Europa lander is also studied by Russian Space Agency. At this moment, EJSM and Titan Saturn System Mission (TSSM), are candidates for so-called Outer Planet Flagship Mission. In February 2009, NASA and ESA decided to continue the study of EJSM for the primary candidate of the Outer Planet Flagship Mission. Launches of EJSM spacecraft would be expected in 2020 (or early 2020's).

Following NASA's 2011 decadal survey and budget, a joint mission including Europa orbiter became unlikely to start in the proposed timeframe, unless JEO would be significantly descoped. Then JGO proposer group of ESA is investigating the possibility of a European-led mission, where two Europa flybys and high-inclination orbits are complimented prior to the insertion into the orbits around Ganymede. JGO was renamed with JUICE (Jupiter Icy Moon Explorer).

The model payload of JUICE consists of 10 state-of-the-art instruments plus one experiment that uses the spacecraft telecommunication system with ground-based receivers [2)]. This set of instruments is capable can satisfy all of the mission's science goals, from in situ measurements of Jupiter's atmosphere and plasma environment, to remote observations of the surface and interior of the three icy moons, Ganymede, Europa and Callisto through flybys and orbits. The model payload of JUICE includes the following 11 instruments:

Remote sensing package
- Narrow angle camera,
- Wide angle camera,
- Visible / IR hyper-spectral imaging spectrometer,
- UV imaging spectrometer,
- Sub-mm wave instrument,

Geophysical package
- Laser altimeter,
- Ice penetrating radar,
- Magnetometer,

In situ observation package,
- Particle package – Ion neutral mass spectrometer,
- Radio and plasma wave instrument,
- Radio science instrument / Ultra-stable oscillator.

In addition to detailed seamless observation and characterization of a unique moon Ganymede, for more than two years between 2030 and 2032. On May 2, 2012, JUICE was selected as the first ESA cosmic vision L-class mission.

Participation of Japanese Groups: As for JMO plan by JAXA, it turned out that relatively low-cost solar power sail could not transport a magnetosphere orbiter with enough science payload in mass and size. Orbits around Jupiter would be restricted. Anyway it is difficult for JAXA to launch the outer planet mission by itself to meet the time constraint for co-operative ob-

servation with JUICE.Therefore direct collaboration with European groups/team should be necessary for Japanese scientists to participate in this attractive Jupiter system mission.

After the selection of JUICE in May 2012, six Japanese groups were invited to participate in the mission as Co-Is with instrument development for model payloads. There were also invited scientific Co-I candidates without instrument developments.

Following these invitations, on 25th June, the steering committee of ISAS/JAXA recommend the overall participation of Japanese scientist group with instrument developments should be supported by ISAS/JAXA after very careful examinations.

Six teams prepared their proposals to ISAS and also collaborated to submit AO proposals in October together with PI candidate teams. In total 31 proposals were submitted for AO (from Europe and US). The result of AO was announced on February 2013, and 11 proposals (10 PIs from Europe and 1 PI from US). And four of Japanese team partners were selected for the official JUICE instruments. These are GALA, SWI, PEP, and RPWI. Moreover three Japanese scientists are invited to participate in the initial scientific analysis as Co-Is of JANUS and J-MAG.

GALA is a laser altimeter for studying the tidal deformation of Ganymede and the morphology and topography of the surfaces of the icy moons. Detection of subsurface ocean is the important target.

SWI is a sub-millimeter wave instrument to investigate the temperature structure, composition and dynamics of Jupiter's stratosphere and troposphere, and the exospheres and surfaces of the icy moons.

PEP is a plasma package with sensors to characterize the plasma environment in the Jovian system. PEP will measure density and fluxes of positive and negative ions, electrons, exospheric neutral gas, thermal plasma and energetic neutral atoms in the energy range from <0.001 eV to >1 MeV. The composition of exospheres of icy moons will be measured with a resolving power of more than 1000.

RPWI is a radio plasma wave instrument to characterize the radio emission and plasma environment of Jupiter and its icy moons.

JANUS is an optical camera to study global, regional and local morphology and processes on the moons, and to perform mapping of the clouds on Jupiter.

J-MAG is a magnetometer to characterize the Jovian magnetic field, its interaction with the internal magnetic field of Ganymede, and to study subsurface oceans of the icy moons.

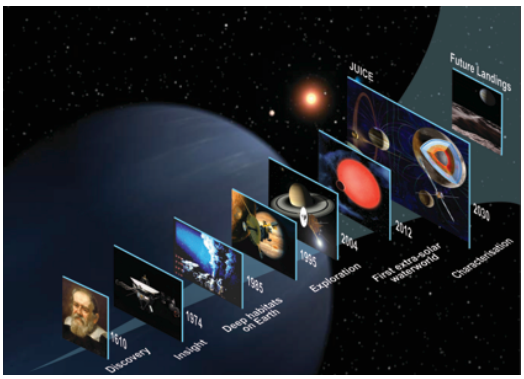

Fig. 1 Schematic picture of JUICE mission (ESA).

References: [1] Blanc, M. et al.: LAPLACE: A Mission to Europa and the Jupiter System for ESA's Cosmic Vision Programme, *Experimental Astronomy*, **23** (2009), pp.849-892. [2] JUICE: Exploring the emergence of habitable worlds around gas giants (Yellow Book), ESA/SRE(2011)18