The Radio and Plasma Wave Investigation (RPWI) for JUICE: Contributions from Japan

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RPWI [PI: J.-E. Wahlund (IRF-Uppsala, Sweden)] on the ESA JUICE mission to Jupiter (launch: 2022) consists of Langmuir probe and electromagnetic wave measurements. It will provide the basic information of the exospheres, surfaces, and conducting subsurface oceans of Ganymede, Europa and Callisto and their interactions with surrounding Jovian magnetosphere.

RPWI has put special efforts into the design in order to have the following capabilities: (1) First to determine the properties, dynamics and the electrically conducting state of the cold plasma (<100 eV, and possibly dusty) that originates from the ionization of the dense exospheres of the icy Galilean moons, and its effect on these moons icy surfaces; (2) First to determine the electro-dynamic coupling via electric currents, Alfven waves, electric acceleration structures and plasma waves that transfer energy and momentum between different particle populations in Ganymede’s magnetosphere as well as in the induced induced fields coupling to their conducting subsurface Oceans; (3) First to determine the state and dynamics of the Jovian magnetosphere, and how this variable and rotating magnetosphere transfer energy and momentum to the space environments around the icy Galilean moons, with special emphasis on the mechanisms of the electro-dynamic coupling in this interaction; (4) First to determine the location of source regions of the radio emissions within the Jovian domain and to determine the properties of those emissions, such as polarization, to characterize the source regions;

We also do possible sciences coordinated with others for the possible access to the subsurface ocean. (5) RPWI first provide the precise density and temperature of cold plasma and electric fields in Jovian system. Exhaust plumes from cracks on icy moons will also be detected, as well as micron sized dust migrating in these plumes and their interactions. It can provide the global conductivity and current estimations of icy satellite ionospheres, which contributes to the estimation of those characteristics of the conductive subsurface oceans below the non-conductive icy crust. (6) RPWI also first provides the highly resolved information of Jovian radiation emitted from Ganymede and Jupiter including lightning activity, by the first 3-axis E-filed measurement. As a byproduct, reflected Jovian emission can be expected from the boundary of crust (ice) and subsurface ocean (conductive water). It could observed by RPWI like the Lunar surface reflection in terrestrial auroral kilometric radiation seen by Kaguya Lunar Radar Sounder. RIME (Radar for Icy Moons Exploration) on JUICE uses 9 MHz radar pulse by 16 m tip-to-tip antenna and tries to detect the ocean under ˜10 km icy crust. Since the frequency of Jovian radiation is wider, from several 100 kHz to several 10s MHz, RPWI can potentially provide complementary information of RIME, including the vertical distributions of conductivity and permittivity in the icy crust.

RPWI sensors consist of 4 Langmuir probes (LP-PWI) for determination of the vector electric field up to 1.6 MHz and cold plasma properties (including active measurements by LP sweeps and mutual impedance sounding) up to 1.6 MHz, a tri-axial search coil magnetometer (SCM) for determination of the vector magnetic field up to 20 kHz, and a tri-dipole antenna system (RWI) for monitoring of radio emissions (80 kHz - 45 MHz). From Japan, we will provide the RWI preamp and its High Frequency receiver with the onboard software, modifying from the BepiColombo PWI and ERG PWE developments. We will also provide Software Wave-Particle Interaction Analyzer (SWPIA) function to RPWI DPU, for the onboard quantitative detection of electromagnetic field - ion interactions, modifying from the ERG SWPIA developments. We are now developping the first hardware for the preliminary integration test by all members from Jan to March 2016. Long voyage starts till the end of this mission.