SPACE PLASMA PHYSICS SCIENCE OPPORTUNITIES FROM THE MOON SURFACE. I. Dandouras[1], R. A. Bamford[2], G. Branduardi-Raymont[3], J.-Y. Chaufray[4], D. Constantinescu[5], J. De Keyser[6], Y. Futaana[7], B. Grison[8], H. Lammer[9], A. Milillo[10], R. Nakamura[9], E. Roussos[11], M. G. G. T. Taylor[12], and J. Carpenter[12], [1]Institut de Recherche en Astrophysique et Planétologie, Université de Toulouse / CNRS / CNES, Toulouse, France (Iannis.Dandouras@irap.omp.eu), [2]Rutherford Appleton Laboratory, Chilton, UK, [3]Mullard Space Science Laboratory / UCL, Holmbury St Mary, UK, [4]Laboratoire Atmosphères, Milieux, Observations Spatiales / IPSL, Paris, France, [5]Technische Universität Braunschweig, Braunschweig, Germany, [6]Royal Belgian Institute for Space Aeronomy, Brussels, Belgium, [7]Swedish Institute of Space Physics, Kiruna, Sweden, [8]Institute of Atmospheric Physics / CAS, Prague, Czechia, [9]Space Research Institute / OEAW, Graz, Austria, [10]Institute for Space Astrophysics and Planetology / INAF, Rome, Italy, [11]Max Planck Institute for Solar System Research, Göttingen, Germany, [12]ESTEC / ESA, Noordwijk, The Netherlands.

The Moon, during most part of its orbit around the Earth is directly exposed to the solar wind. Due to the absence of a substantial intrinsic magnetic field and of a collisional atmosphere, it is the ideal environment to study galactic cosmic rays (GCRs), solar wind and solar energetic particles (SEPs), and Jovian energetic electrons. This environment is typical of deep space. During 5–6 days every orbit, however, the Moon crosses the tail of the terrestrial magnetosphere. It is then exposed not to the solar wind but to the terrestrial magnetotail plasma environment, offering the possibility to study in-situ magnetotail dynamics and its dependence on solar and geomagnetic activity. It is then also very well situated to study atmospheric escape from the Earth into space, in the form of heavy ions upwelling from the terrestrial ionosphere and then transported and lost into the deep magnetotail. When the Moon gets again outside of the magnetotail, terrestrial magnetosphere dynamics can be monitored through remote sensing, using a variety of magnetospheric imaging techniques (ENA imaging, solar wind charge exchange X-rays, plasmasphere EUV imaging, or exosphere Lyman-α imaging).

The lunar environment also offers a unique opportunity to study the Moon surface-bounded exosphere, its dynamics, its coupling with the surface and with space plasmas (solar wind and the terrestrial magnetotail plasma), and its escape into space. Such interactions are ongoing on all atmosphere-less bodies in the Solar System.

The Moon surface offers also exciting possibilities for studying energetic ion implantation in the lunar regolith, solar wind implantation or neutralization and reflection from the regolith, solar wind interaction with crustal magnetic anomalies, lunar pick-up ion generation, or lunar surface electrostatic charging and dust levitation, just to mention few examples.

In preparation of the scientific opportunities offered by the Deep Space Gateway, that will be assembled and operated in the vicinity of the Moon, we have formed an ESA topical team to prepare and to support the definition of payload studies in the field of space plasma physics. These include measurements that can be performed either from the Deep Space Gateway platform, or from instrumented cubesats released from the platform and placed into low-lunar orbits, or directly from the Moon surface, that will be presented here.