

## Tutorial: Atomic and molecular processes, and weakly ionized plasma

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This presentation is a tutorial talk for the sub-session 8 'Atomic and molecular processes, and weakly ionized plasma'. This sub-session will focus on the following topics: (1) ionization, dissociation and recombination processes, (2) chemical process, (3) radiation process, (4) discharge processes, (5) atmospheric emission, (6) protoplanetary disk, (7) plasma elementary process, (8) plasma diagnosis, (9) plasma spectroscopy, (10) particle measurement, (11) interaction between ionized and neutral atmospheres. The electron temperature of a fusion plasma is distributed broadly; it is as high as 10 keV at the center, while it is below 10 eV in the periphery. The presence of molecules is important in edge plasma regions, where the electron temperature is lower than 1 eV. For full understanding of the properties of a fusion plasma, it is therefore necessary to take into account atomic and molecular processes involving a wide variety of species ranging from molecules and to highly charged ions. The importance of atomic and molecular processes should be also emphasized in the astrophysical context. For example, microscopic processes such as, a) radiative heating/cooling of gas and, b) gas heating/cooling due to chemical reactions and chemical evolution, are controlling the macroscopic dynamics of plasma. Although most of the gaseous media in the universe are highly ionized plasma, understanding the physics of weakly ionized plasma is required in the study on evolution of in protoplanetary disks around new-born stars. The recent progress in the theoretical research of the disks shows that the interplay between microscopic processes of weakly ionized plasma and macroscopic magnetohydrodynamics is playing an important role in the formation of planets. The upper region of the Earth's and planets' atmosphere is ionized by the solar radiation, and a region of the weakly ionized plasma, ionosphere, is formed. In the ionosphere, the interactions between the ionized and neutral atmospheres affect on the electric current system and dynamics of the both atmospheres, and produce various phenomena. In the lower part of the ionosphere, the atomic and molecular processes are complex and important. But many questions on the mechanisms are still unsolved because of the difficulties of the observations in this region. Recent research topics studied in the Physical Society of Japan, the Astronomical Society of Japan, and the Society of Geomagnetism and Earth, Planetary and Space Sciences will be introduced, and new scientific progresses that are expected to be achieved under the collaboration of the scientists in these three societies will be discussed.