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Conceptual design study of Far UV IFS and HRS on HWO for exoplanets and solar system bodies

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Earth-like planets have been detected in the habitable zone of low-mass stars. However, transit spectroscopy requires extremely high precision to observe the thin layer of lower atmosphere of a small terrestrial planet, and at present no atmospheres of terrestrial exoplanets have been detected. On the other hand, strong XUV radiation of low-mass stars may cause the far-extended upper atmospheres. We investigate the possibility of detecting the upper atmospheres of terrestrial exoplanets by transit spectroscopy with future ultraviolet space telescopes, LAPYUTA and Habitable Worlds Observatory (HWO). There are several atomic and ionic emission lines (H, C, N, and O) in the far UV spectral range which will be helpful for understanding the surface environment of the exoplanet especially in case the lower atmosphere cannot be detected. In addition, icy moons in the solar system have water plumes. H and O atoms are generated by dissociation and could be detected by far UV imaging spectroscopy.

We performed a conceptual design study on a high-resolution spectrograph (HRS) and an integral field spectrograph (IFS) for far UV as potential contribution to HWO by JAXA. We are developing a large-format high-efficiency funnel microchannel plate (MCP) for photon counting for LAPYUTA mission, 60-cm FUV space telescope under study by JAXA. In design, HRS is composed of a collimator mirror, an echelle grating, a cross disperser, and a large MCP detector. The spectral resolution of HRS can be > 120,000 with the spectral range of 100-180 nm, which covers H, C, N, and O atomic emission lines and C and N ionic emission lines. IFS is composed of an image slicer, 75 gratings and 2 MCP detectors, which enables the field of view is >3 arcsec x 3 arcsec with the spatial resolution of 0.02”/pix and R > 5000 with the spectral range of 94-174 nm.

In this presentation, we introduce our study on exoplanets and solar system bodies, conceptual design study of IFS and HRS for HWO, and current status of UV technology development.