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Ultraviolet Auroral and Airglow Observations of the Giant Planets

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UV auroral and airglow emissions of the giant planets (i.e., Jupiter, Saturn, Uranus, and Neptune) have been studied from Earth-orbiting satellites (e.g., IUE, HST, FUSE), flyby spacecraft (e.g., Pioneer, Voyager), and orbiting spacecraft platforms (e.g., Galileo, Cassini). While auroral processes are highly variable, the typical total emitted UV auroral power is ~2-10 TW from Jupiter, ~40-50 GW from Saturn and Uranus, and ~100 MW from Neptune. Airglow emissions are much steadier but are considerably less intense. The primary UV emissions arise from ambient H and H_2 excited by precipitating particles (aurora) or photoelectrons and resonant scattered sunlight (airglow). Very energetic auroral particles can penetrate to beneath the homopause, resulting in signature absorptions by hydrocarbon species—particularly CH_4, C_2H_2, and C_2H_6. Likewise, Rayleigh-scattered sunlight at longer UV wavelengths also shows the effect of hydrocarbon absorption. The emissions at different UV wavelengths provide unique information about the physical processes operating in the atmospheric regions where the emissions originate. For example, resonance lines (such as Lyα) have very large scattering cross sections (e.g., ~10^{-13} cm^2 at line center), making them very sensitive probes of upper atmospheres. Here we review our current understanding of auroral and airglow emissions from Jupiter, Saturn, Uranus, and Neptune, as revealed through UV observations.