Probing the Earth's Upper Atmospheric Processes using Visible Light – Current Activities at University of Massachusetts Lowell

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There is a long history of inferring various photochemical and dynamic processes in the upper atmosphere through ground-based optical remote sensing. A dramatic example is aurora, which is produced by the interaction of charged particles from the Sun with the atmospheric gases. Discounting weather impediments, these observations are typically restricted to two weeks centered around the New Moon times, when the background signal from the sky is low enough to allow statistically significant measurements.

We have developed tools and techniques to overcome this last obstacle to round-the-clock observations of aurora and airglow, emissions from the sky due to various photochemical process driven by the Sun. Unlike aurorae, which are highly variable emissions usually seen near the polar regions and are produced by energetic charged particles, airglow is omnipresent and far less episodic.

We have developed a series of long-slit imaging spectrographs to observe key signatures of airglow and auroral emissions from the upper atmosphere – O I 5577Å, O I 6300Å, Hα 6563Å and Hβ 4861Å. The latest implementation of such a spectrograph called, HiT&MIS, was recently used to observe airglow emissions during the total solar eclipse of April 08, 2024 from North Hero, Vermont.

Subsequently, HiT&MIS was deployed in Kiruna, Sweden, in support of a sounding rocket experiment to study OH emissions. The instrument has been observing the northern sky continuously till the observatory was shut down for the summer holidays. HIRISE, an earlier version of this family of instrument, observed an aurora at 3 PM from in late October, under the Boston Sun.

Along with pursuing these ground-based observational campaigns, we have developed new tools and technologies to study upper atmospheric phenomena from high-altitude balloons. These are small experiment packages designed for upper atmospheric studies. In addition to providing important scientific insights, they demonstrate their suitability for space-based applications.

Each of these experiments involve students and young professionals in meaningful, hands-on roles. In this talk, I will provide an overview of our activities on solar-terrestrial interactions.