

# Understanding the OH Meinel Band Emissions on the Terrestrial Planets

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The OH Meinel band emissions, originating from vibrationally excited hydroxyl radicals, OH(v), represent some of the most important airglow features in the Earth's upper atmosphere. Such emissions were also observed on the night side of Venus during the Venus Express mission [Piccioni *et al.*, A&A 483, L29-L33 (2008)]. Data obtained by CRISM (Compact Reconnaissance Imaging Spectrometer for Mars) aboard the MRO (Mars Reconnaissance Orbiter) revealed OH(v) emissions in the nightglow of Mars [Clancy *et al.*, Icarus 226, 272-281 (2013)]. Modeling studies have shown that the predicted OH(v) emission intensities can vary dramatically depending on the nature of the vibrational relaxation mechanism assumed [e.g., García Muñoz *et al.*, Icarus 176, 75-95 (2005)]. Despite several investigations, the details of all the relevant OH(v) relaxation kinetics and pathways are not well understood.

Our recent studies demonstrated a previously unknown, efficient pathway for vibrational relaxation of OH(v) by O atoms that couples the mesospheric OH(v) emissions with the CO<sub>2</sub> 4.3-micron emission and resolves a long-standing problem of severe discrepancies between model predictions and observations of the 4.3-micron emission in the Earth's atmosphere [Panka *et al.*, ACP 17, 9751-9760 (2017); Kalogerakis *et al.*, GRL 43, 8835-8843 (2016)]. This recent breakthrough development highlights the importance of investigating the mechanistic details of OH(v) collisional energy transfer.

We will discuss our efforts to investigate OH(v) vibrational relaxation relevant to the atmospheres of the terrestrial planets. Important areas of interest are the key OH(v) vibrational relaxation rate constants at temperatures relevant to the altitude of the emission layer and the pathways of OH(v) vibrational energy relaxation. The Meinel OH(v) emissions can be used as an indicator of atmospheric composition, variability, circulation, gravity waves, and as a probe of local temperature. A detailed understanding of the sources and sinks of these emissions is a prerequisite before they can be reliably used as a proxy for the aforementioned processes.

Keywords: OH Meinel band emission, Nightglow, vibrational relaxation, Terrestrial planets