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Solar Oscillations in CO at 4.6 Microns

W. Livingston

National Solar Observatory, PO Box 26732, Tucson, AZ 85726, USA

S. Solanki

Institute of Astronomy, ETH-Zentrum, CH-8092 Zurich, SWITZERLAND

K. Muglach

Space Science Dept, ESTEC, ESA, Box 299, 2200 AG Noordwijk, The NETHERLANDS

L. Wallace

Kitt Peak National Observatory, Box 26732, Tucson, AZ 85726, USA

Abstract. The fundamental band lines of CO originate in the solar temperature minimum and lower cool parts of the chromosphere. We have observed velocity and intensity oscillations of CO in the quiet Sun (disk center), sunspots (umbrae), and plage. We have also looked for CO oscillations in the Sun-as-a-star. We compare the power spectra of these various features, noting well separated 3 min and 5 min peaks. While we do not yet have the required S/N to measure the Sun-as-a-star component, it appears we are close, based on out-of-focus as well as full disk data. Further observations are planned.

1. Introduction

The CO vibration-rotation fundamental band transitions at 4.66 μm sense the extremely cool (4000K) gas in the solar chromosphere. Resolved disk observations of velocity and intensity have been studied by several workers (Uitenbroek, Noyes, & Rabin 1994; Leifsen 1994; Solanki et al. 1996). It is found that the center disk quiet Sun power spectra display periodicities, mainly at 3.3mHz (5 minutes) in velocity and 5mHz (3 minutes) in line depths. Curiously, in cool umbrae, the line depths are comparable to the quiet Sun, and show little power at 3.3mHz, but a dominant peak at 4-7mHz. Oscillations in plage are weak and occur mainly at 3.3mHz. Figure 1a compares the intensity power of these three disk components from our sample of observations (see Solanki et al. 1996 for details).

The work reported here addresses the question of what the CO oscillation signal would be for the Sun-as-a-star, and what S/N, or sensitivity, would be required to see it. Leifsen and Maltby (1990) reported a very strong signal of 0.8% in full disk observation intensity variation in a broad-band at 2.23 μm,

but no one has been able to duplicate these results. We have approached the problem by making a series of observations with the solar image out-of-focus by varying degrees and finally by observing the Sun-as-a-star, all at 4.66 μm in CO.

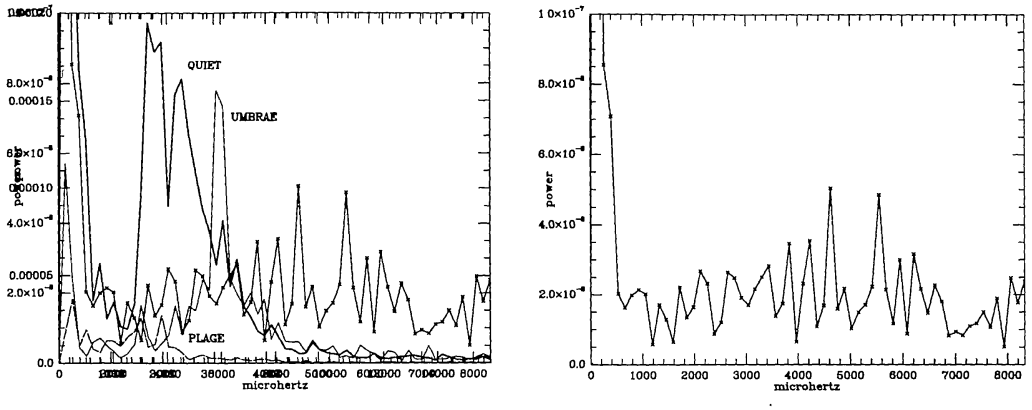

Figure 1. (a-left): Samples of average power spectra of solar disk features. (b-right): Average of 3 full disk intensity observations.

2. Observations

We employ the 13.5 m spectrometer of the McMath-Pierce Telescope on Kitt Peak. Our detector is a simple InSb diode with an InAs filter for order selection. Instrumental details are given in the references of Solanki et al. 1996. Resolved disk data were taken using the East Aux feed with its 0.37 m image in-focus, and out-of-focus by 0.5, 1.0, and 2.0 m. Full disk data were taken using the main 2.0 m heliostat feeding a flat so as to deliver a 'pinhole' image of the Sun on the grating. A scan sequence consisted of 29 grating cycles taking 1 minute of time; an observation was made up of 128 such sequences. Analysis of the spectra was by the DECOMP program.

3. Results

For these disk averaging observations the CO line depth signal is much greater than the Doppler velocity. We have plotted intensity power vs. fractional disk area and extrapolate to full disk. The intercept occurred at a power level of approximately 10^{-8}. In Figure 1b, we present the average intensity power from 6 hours of full disk observations. This has a peak noise of about 2×10^{-8}. Our conclusion is that we are approaching adequate S/N, but are not quite there.

References

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