# GONG SPECTRA IN THREE OBSERVABLES: WHAT IS A P-MODE FREQUENCY?

J. HARVEY, F. HILL, R. KOMM, J. LEIBACHER, B. POHL
AND THE GONG

*National Solar Observatory*
*Tucson, Arizona, USA*

## 1. Introduction

The Global Oscillation Network Group (GONG) is an international, community-based helioseismology project conducting a detailed study of the internal structure and dynamics of the Sun. GONG is operating a six-station network of full-disk solar imagers exploring the range from $\ell = 0$ to about $\ell = 200$. Full network operation began in October 1995. The observation duty cycle has averaged about 87% over the first 684 days of full operation, and single-site data loss due to instrument down time is less than 2%. The data management group is processing the network data at pace with the collection rate. Here we present a comparison of spectra obtained in Doppler velocity, total spectral intensity, and modulation (a mixture of equivalent width and magnetic field strength).

## 2. What is a P-Mode Frequency?

A comparison of GONG month 16 (36 days) $m$-averaged, wavelet-denoised spectra for three different $\ell$ values and two frequency ranges in the three observables is shown in Figure 1. It is obvious the modes observed in velocity and intensity have the previously known reversal of asymmetry but, more surprisingly, they also show apparently different central frequencies. While this difference is small but non-zero in the five-minute band, it can be as large as 50 $\mu$Hz close to the acoustic cut-off frequency. Modulation and velocity spectra are more similar than velocity and intensity spectra. However, there are differences between modulation and velocity spectra. For example, there is a visible peak in velocity at $\ell = 20$, $\nu \approx 2.59$ mHz which has no counterpart in modulation.

The large apparent differences in the central frequencies of the p-modes observed in velocity and intensity raise the question of just how to define a p-mode frequency. Clearly, the physics of the oscillation determining the real central frequency in the sun cannot depend on the quantity we observe from the earth. Instead, the observable differences probably arise from at least three effects. First, the details of the source mechanism of the p-modes, particularly the location of the source with respect to the cavity trapping the modes, can change both the apparent acoustic line asymmetry



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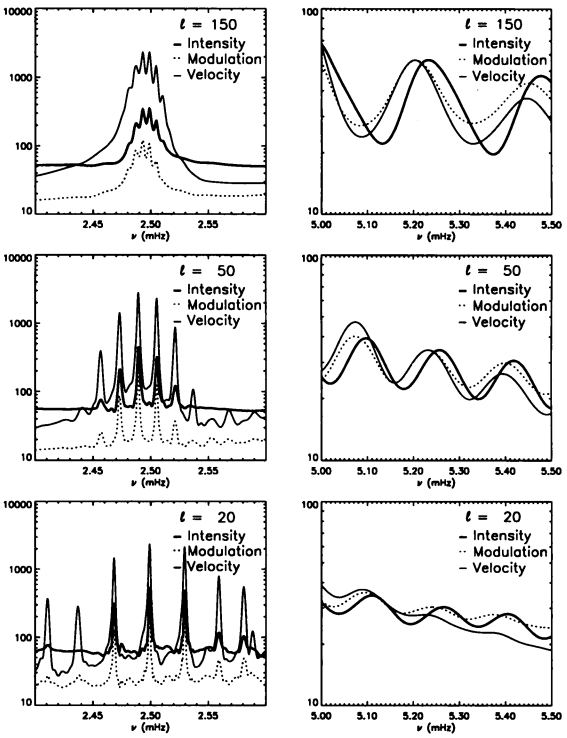


*Figure 1.* $m$-averaged GONG spectra observed in velocity, intensity, and modulation.

and frequency (Jefferies 1997). Second, there is a different spatial leakage signature for each of the three observables due to their different center-to-limb behaviors. Finally, there are different levels of solar noise in the three observables. While the comparison between velocity, intensity, and modulation is currently poorly understood, simultaneous modelling of all three types of spectra already in progress will greatly improve our ability to accurately measure the solar oscillation frequencies.

## 3. Acknowledgements

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## References

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