Poster # 029.09

Helioseismic Analysis of Mode Parameters in the Source Regions of CMEs

S. de Wet[1], S. C. Tripathy[2], K. Jain[2], R. Clark[2], and F. Hill[2]

[1]Rice University, Houston, TX, USA [2]National Solar Observatory, Tucson, AZ, USA

Abstract

We apply ring-diagram technique to high-resolution Global Oscillation Network Group (GONG) Dopplergrams in order to examine the source regions of halo coronal mass ejections (CMEs). We study the changes in acoustic mode parameters such as line width and amplitude before, during, and after CMEs. The CMEs were chosen to have a wide variety of source regions, including active regions, filament regions, and trans-equatorial filament regions. We find that regions associated with low magnetic flux that produce CMEs have shorter line widths than corresponding quiet regions. This implies a longer lifetime or slow damping process for the oscillation modes. We suggest that this characteristic could be useful in modeling CMEs or forecasting regions in which CMEs may occur.

Motivation

The mechanisms of CME initiation are still a theoretical challenge.

One possible process is the cancellation of the photospheric magnetic flux by velocity convergence towards the neutral line. Observational evidence of this has been found in a couple of cases by measuring horizontal velocity from the MDI magnetograms by applying LCT.

Local helioseismology is a powerful diagnostic tool to study the mode parameters and flow fields beneath the solar surface.

Data and Analysis

The data consists of GONG++ Dopplergrams for regions approximately 15º by 15º in heliographic longitude and latitude, tracked for 1664 minutes.

We use the standard ring diagram analysis (Hill, 1988) pipeline for GONG++ data to obtain power spectra for the solar oscillations over the selected region.

The spectra are fitted to a symmetric profile model which considers peaks to be Lorentzian (Haber *et al.*, 2001).

Locations and occurrence times of the CMEs are taken from the catalog of Zhou, *et al.* (2006).

In all, we examine 48 CMEs that occur from September 2001 and December 2003. CMEs are all taken from within 30º of the disk center to avoid foreshortening effects, and are chosen from a wide variety of source regions, including active regions, filament regions, and trans-equatorial filament regions.

Each CME region is compared to a quiet region located at the same heliographic latitude and occurring during the same Carrington rotation as the CME itself.

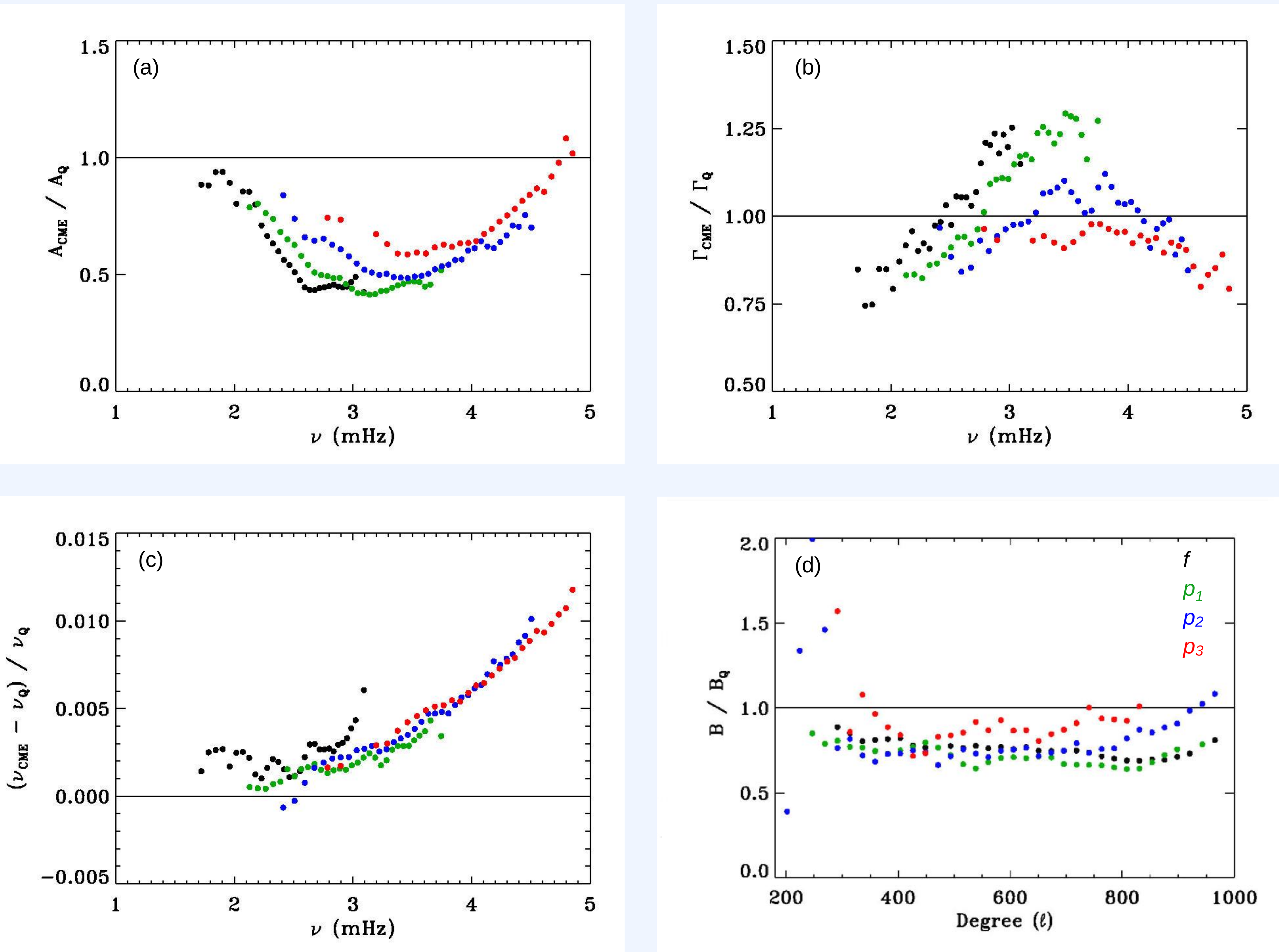

Figure 1. Changes in (a) ratio of the peak power, (b) ratio of half-width (c) relative frequency differences, and (d) ratio of the background power between the CME region of December 19, 2002 (B_{av} = 119 G) and the quiet region of December 12, 2002 (B_{av} = 3 G), both located at N22W12.

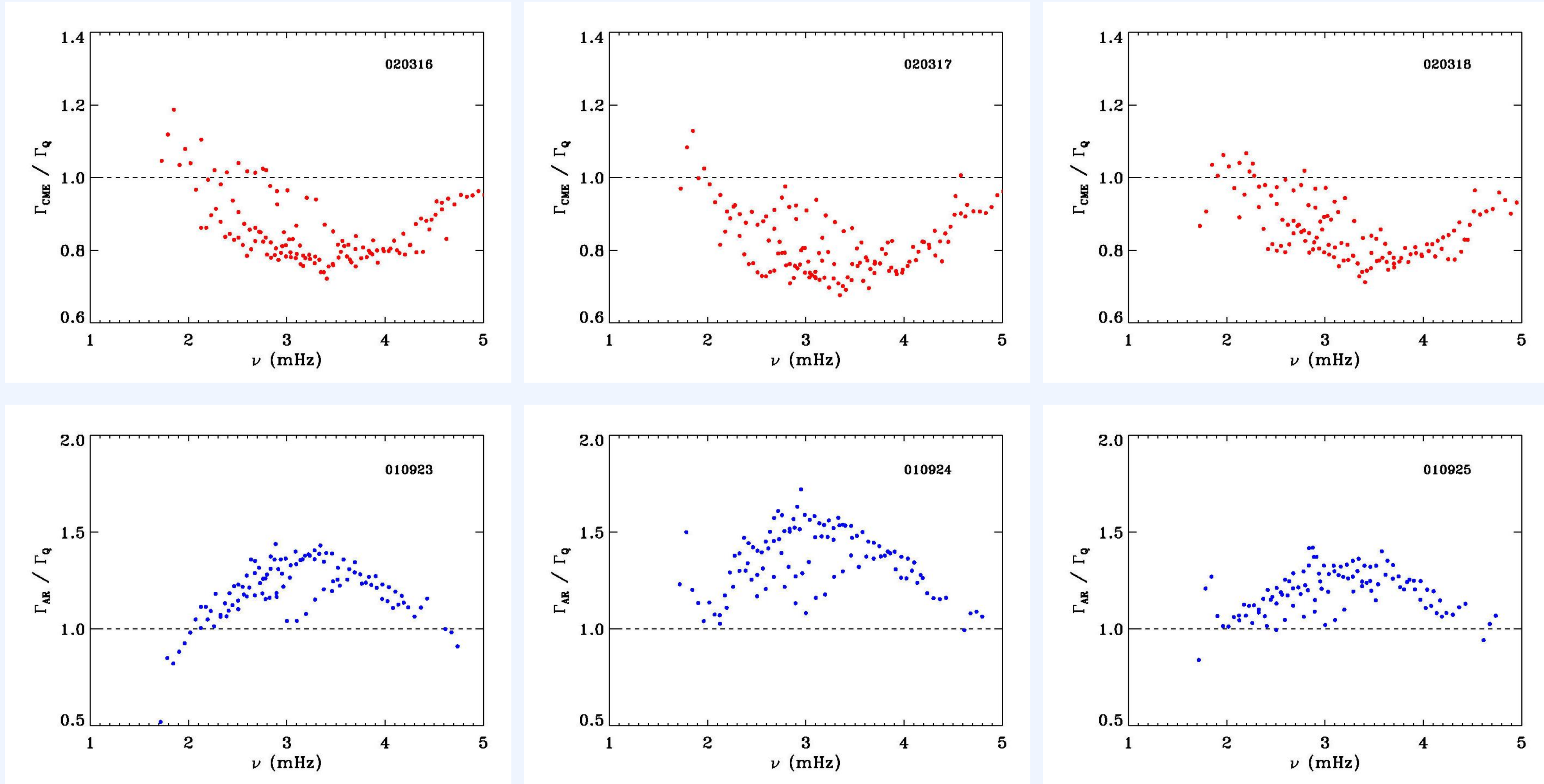

Figure 2. Top panels show the changes in half-width as a ratio between a CME and quiet region for three consecutive days. The CME occurred on March 17, 2002 at S0W10. The bottom panels show the changes corresponding to an active region NOAA 9628 located at S22.5E15 on September 23, 2001.

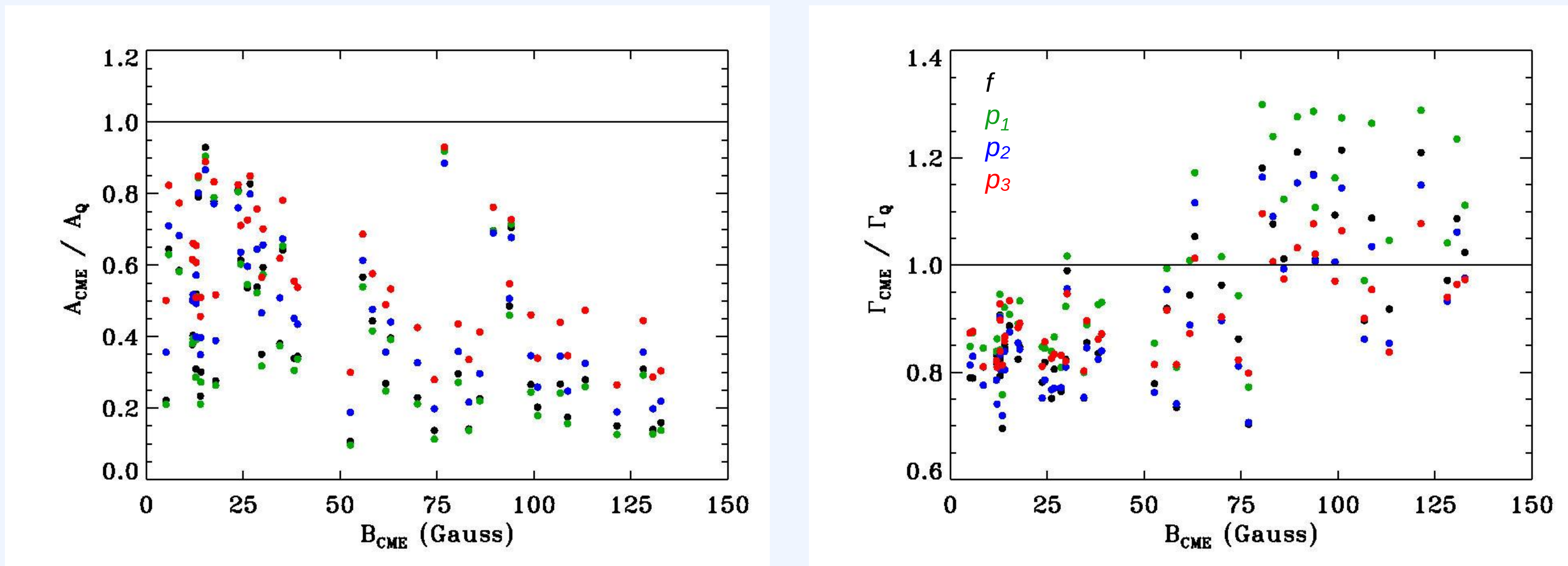

Figure 3. Frequency averaged ratio of amplitude (left) and half-width (right) for 48 CME regions as a function of magnetic flux calculated from Kitt Peak Synoptic magnetograms by averaging the unsigned magnetic flux over the same regions as the CME. The *f*-modes are averaged in the frequency range of 2500-2750 μHz, and the *p*-modes in the range of 3000-3500 μHz. The linear correlation coefficients for *f*, p_1, p_2, and p_3 modes are of the order of -0.42. -0.43,-0.53, and -0.59 for amplitude and 0.71, 0.76, 0.74, and 0.66 for half-widths respectively.

Results and Conclusions

We find that regions associated with low magnetic flux that produce CMEs have **shorter line widths** than corresponding quiet regions.

This is supported by data exploring the temporal evolution of CMEs (Fig. 2) and from a large collection of CMEs (Fig. 3).

The shorter line width implies a longer lifetime or slow damping process for the oscillation modes of CMEs.

This is opposite to the result for active regions, in which line widths are greater than the corresponding quiet regions.

This characteristic could be useful in modeling CMEs or forecasting regions in which CMEs may occur.

References

Haber, D., Hindman, B. W. Toomre, J., *et al.*, 2002, *Astrophys. J.*, **570**, 885.
Hill, F., 1988, *Astrophys. J.*, **333**, 996.
Zhou, G. P., Wang, J. X., and Zhang, J., 2006, *Astron. Astrophys.*, **445**, 1133.

Acknowledgements

This work is carried out through the National Solar Observatory Research Experiences for Undergraduate (REU) site program, which is co-funded by the Department of Defense in partnership with the National Science Foundation REU Program. This work is supported by NASA Grant NNG 05HL41I. NSO/Kitt Peak magnetograms used here are produced cooperatively by NSF/NOAO; NASA/GSFC, and NOAA/SEL. This work utilizes data obtained by the Global Oscillation Network Group (GONG) Program, managed by the National Solar Observatory, which is operated by AURA, Inc. under a cooperative agreement with the National Science Foundation. The data were acquired by instruments operated by the Big Bear Solar Observatory, High Altitude Observatory, Learmonth Solar Observatory, Udaipur Solar Observatory, Instituto de Astrofísica de Canarias, and Cerro Tololo Interamerican Observatory.