On the Temporal Changes of Helioseismic Properties Derived with Different Mode Fitting Techniques

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Modes Comparison

- 3 methodologies, 2 data sets:

	NSO		SU		CfA	
	sym.	asym.	sym.	asym.	sym.	asym.
GONG	√	⋆	×	×	√	√
SU	×	×	√	√	√	√

⋆: preliminary results, tables not available.

- Raw $<\delta\nu>$ sensitive to mode set, *i.e.*:$\{n,\ell\}$
- Weighted mean frequency shift:
  - ▷ relative mode mass ($Q_{n,\ell}$): mass of volume sampled;
  - ▷ by uncertainty ("tradition"), why?
  - ▷ More physical scaling: line-width (Γ) or power ($P = A\Gamma$)

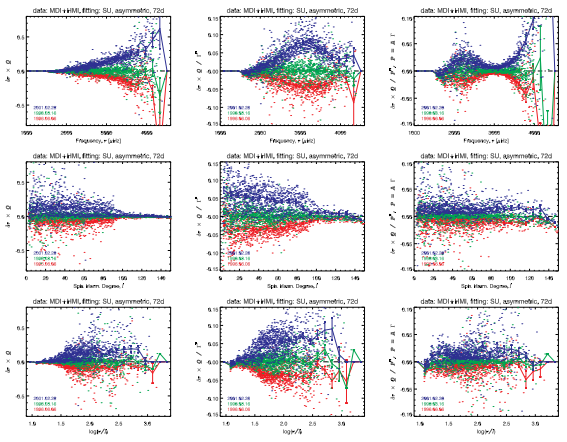

Fig. 1: *Example of weighted frequency changes for 3 epochs and 3 different weightings: Q, Q/Γ & Q/P, versus ν, ℓ or $\log(\nu/L)$. The dots are the raw values, lines are binned quantities.*

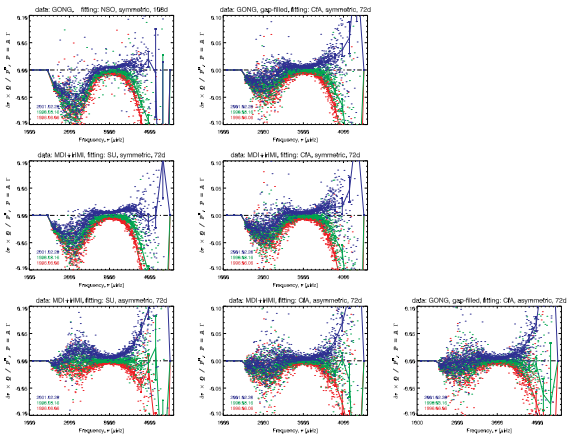

Fig. 2: *Example of weighted frequency changes, $\delta\nu Q/P$), as measured by 7 different fitting method.*

- Very different dependence between symmetric and asymmetric fits.

Attrition

- Weighting does not remove dependency on either ν, ℓ or $\log(\nu/L)$.
- Mode attrition complicates comparisons (need common mode set).

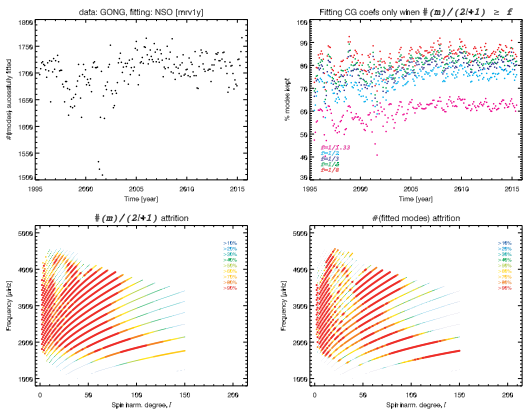

Fig. 3: *Number of fitted modes and mode attrition for GONG data fitted by NSO.*

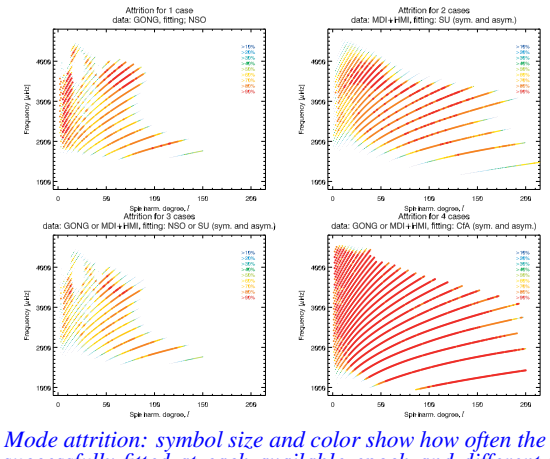

Fig. 4: *Mode attrition: symbol size and color show how often the mode was successfully fitted at each available epoch and different fitting methodologies simultaneously.*

- Very different attrition patterns.

Frequency

Singlets to multiplets reduction

$$\text{since } \nu_{n,\ell,m} = \Sigma_i c_i \beta_m^\ell(i) \rightarrow \begin{cases} \nu_{n,\ell} & = c_0 \beta_0^\ell(0) \\ \text{or} & \\ \nu_{n,\ell,0} & = \Sigma_i c_i \beta_0^\ell(i) \end{cases}$$

- ▷ The quantity $\Delta_\nu^0 = \nu_{n,\ell} - \nu_{n,\ell,0}$ is a *strong* function of ν and solar activity.
- ▷ Explains *past* discrepancy between $<\delta\nu_{n,\ell,0}>$ (CfA) and $<\delta\nu_{n,\ell}>$ (NSO & SU).
- ▷ Adopted $<\delta\nu_{n,\ell}>$ (which quantity means what?).

Change of mean weighted frequency

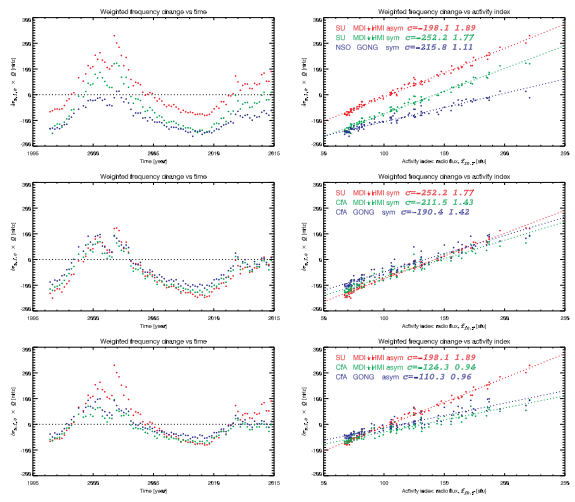

Fig. 5: *Change of mean weighted frequency, using $<\delta\nu_{n,\ell,0}Q>$ (CfA & NSO fitting, i.e., using NSO's $\nu_{n,\ell,m}$ values).*

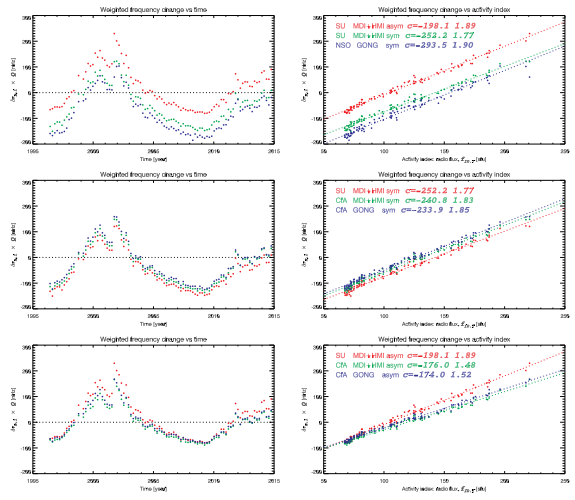

Fig. 6: *Change of mean weighted frequency, using $<\delta\nu_{n,\ell}Q>$ for* all *fitting.*

- Much better agreement when using consistently $<\delta\nu_{n,\ell}>$;
- my symmetric fit matches NSO's and SU's magnitude;
- my asymmetric fit leads to a small decrease in the magnitude of change.

Line-width

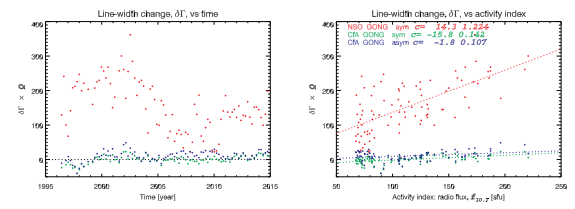

Fig. 7: *Mean change of weighted line-width, $\delta\Gamma Q$, when fitting GONG data (NSO & CfA).*

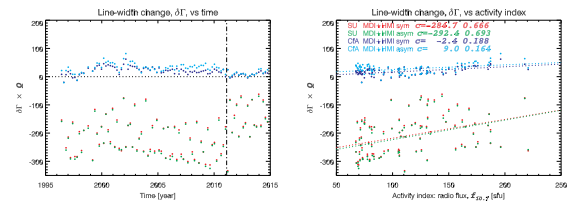

Fig. 8: *Mean change of weighted line-width, $\delta\Gamma Q$, when fitting MDI+HMI data (SU & CfA). Vertical line indicates transition from MDI to HMI.*

- Inconsistent results between data and methods.

Asymmetry

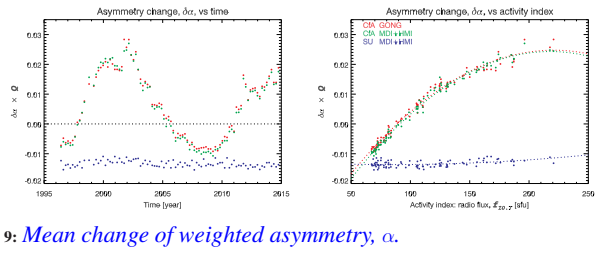

Fig. 9: *Mean change of weighted asymmetry, α.*

- Inconsistent results between methods, consistent results between data (CfA).

Amplitude and Background

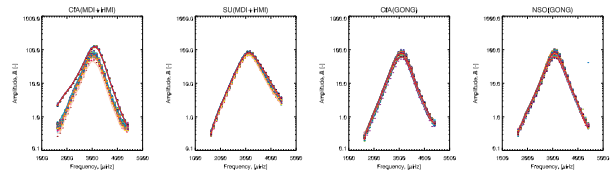

Fig. 10: *Change of amplitude, A*

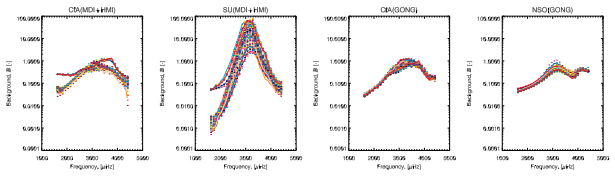

Fig. 11: *Change of background, B*

- Inconsistent results, both for A and B.

Rotation Inversions Comparison

Propagation Diagrams

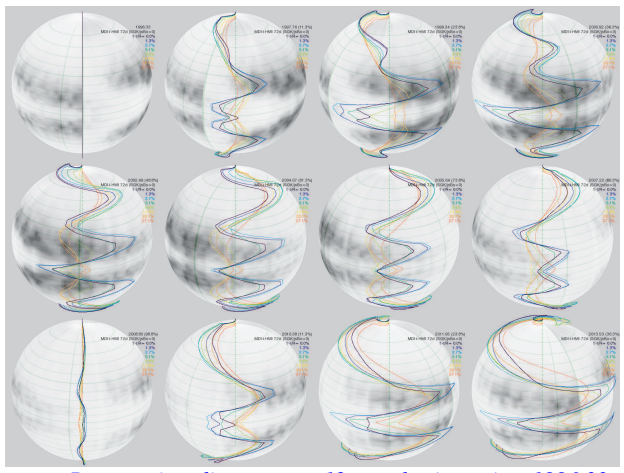

Fig. 12: *Propagation diagrams at 12 epochs (covering 1996.33 to 2013.53, or all of Cycle 23 and first third of Cycle 24), when inverting splittings resulting from my fitting to MDI+HMI data.*

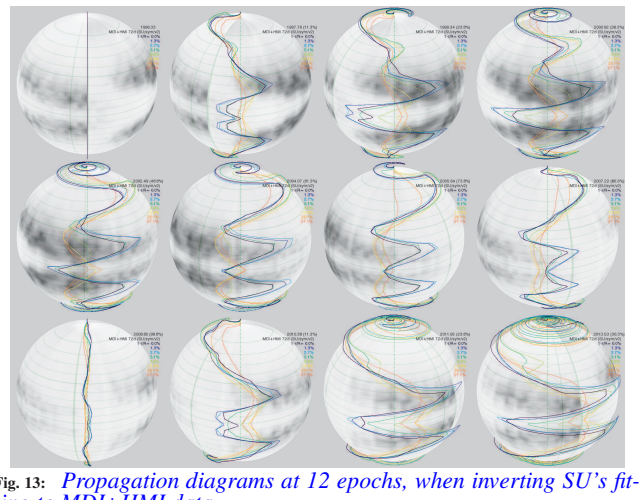

Fig. 13: *Propagation diagrams at 12 epochs, when inverting SU's fitting to MDI+HMI data.*

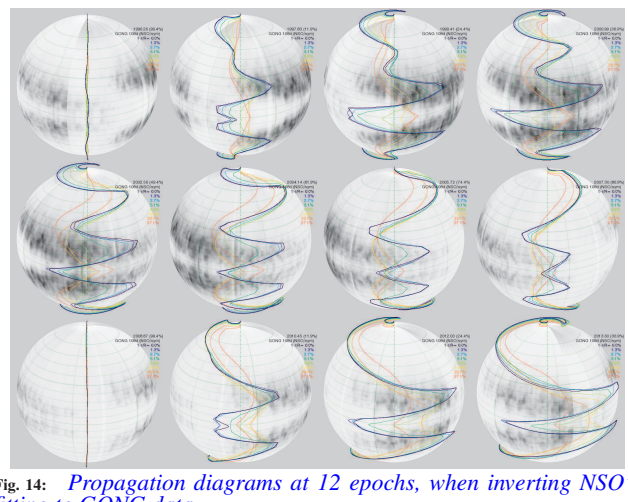

Fig. 14: *Propagation diagrams at 12 epochs, when inverting NSO's fitting to GONG data.*

- Cycle 24 is different from Cycle 23;
- un-physical twist at high latitudes when inverting SU's or NSO's results.

Acknowledgments

This work utilizes data obtained by the Solar Oscillations Investigation - Michelson Doppler Imager project on SOHO, a project of international cooperation between ESA and NASA. It also 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. HMI data courtesy of NASA and the HMI consortium; HMI is supported by NASA contract NAS5–02139 to Stanford University. SGK was supported by NASA grants NNG05GD58G and NNX15AL65G and NSF grant AGS-1037834.