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

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Introduction

- 3 methodologies, 2 data sets, 20 years of observations:

	NSO		SU		CfA	
	sym.	asym.	sym.	asym.	sym.	asym.
GONG	$\surd$	$\star$	$\times$	$\times$	$\surd$	$\surd$
MDI+HMI	$\times$	$\times$	$\surd$	$\surd$	$\surd$	$\surd$

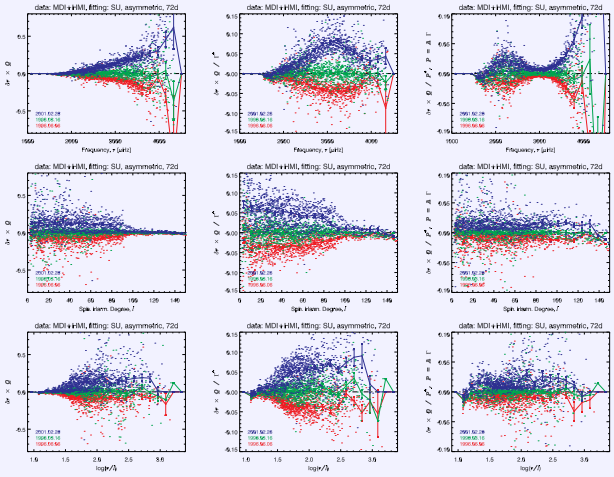
$\star$: preliminary results, tables not available.

- Raw mode comparisons
  - Frequency
    - Scaling
    - Attrition
    - Singlets to multiplets reduction
    - Change of mean weighted frequency
  - Line-width, Asymmetry
- Rotation inversion comparison
- Conclusions

Frequency

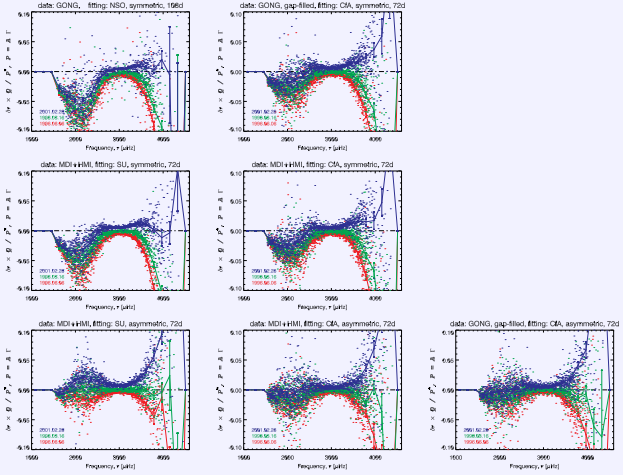
- $\delta\nu$: change wrt to time, hence activity;
- Raw $<\delta\nu>$ sensitive to mode set, *i.e.*: $\{n, \ell\}$
- Weighted mean frequency shift:
  - relative mode mass ($Q_{n,\ell}$): mass of volume sampled;
  - by uncertainty ("tradition"), why?
  - More physical scaling: line-width (Γ) or power ($P = A\Gamma$)
- Weighting does not remove dependency on either ν, ℓ or $\log(\nu/L)$.
- Mode attrition complicates comparisons (need common mode set).

Frequency Scaling



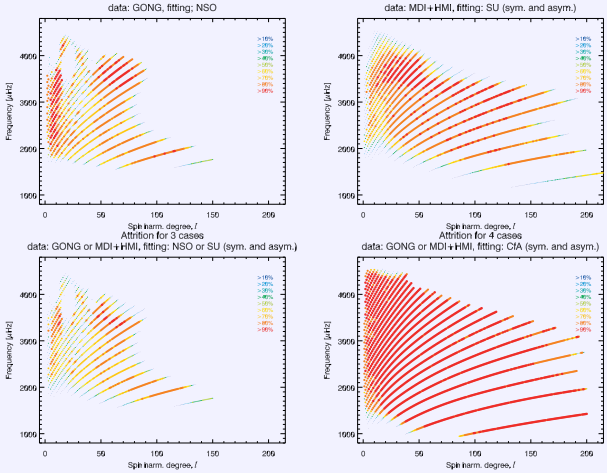
- Scaled frequency changes for 3 epochs and 3 weightings: Q, Q/Γ & Q/P

Frequency Comparison



- Scaled frequency changes, $(\delta\nu Q/P)$, as measured by 7 different fitting method.

Attrition



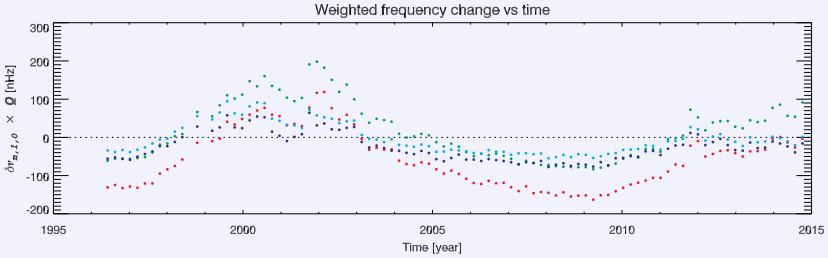
- Mode attrition for different fitting methodologies

Singlets to multiplets reduction

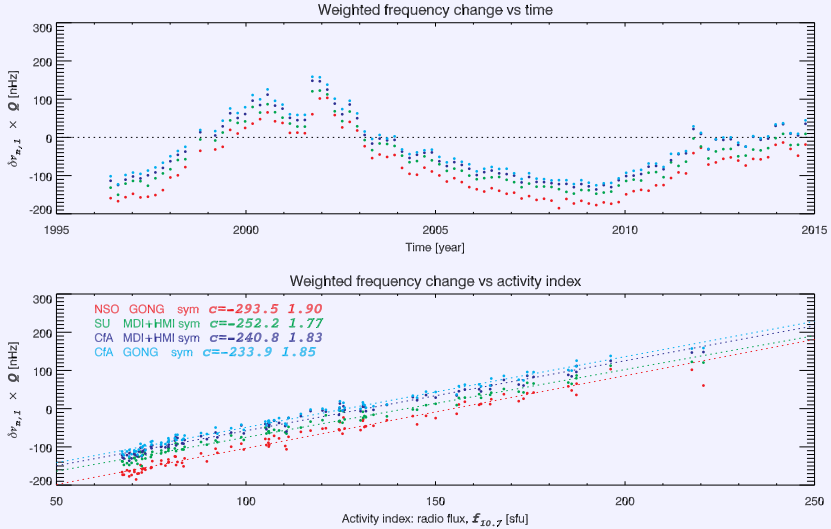
$$\nu_{n,\ell,m} = \Sigma_i c_i \beta_m^{\ell}(i) \rightarrow \begin{cases} \nu_{n,\ell} & = & c_0 \beta_0^{\ell}(0) \\ \text{or} & & \\ \nu_{n,\ell,0} & = & \Sigma_i c_i \beta_0^{\ell}(i) \end{cases}$$

- 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?).

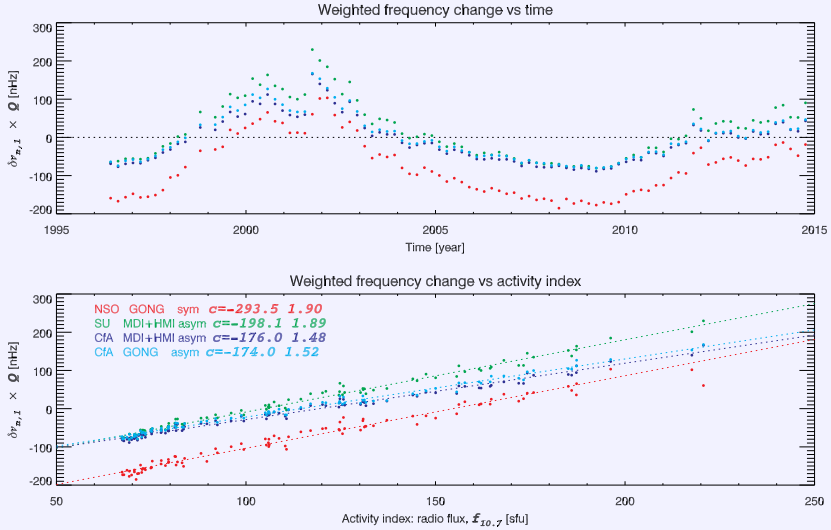
Change of frequency, $\delta\nu_{n,\ell,0}$



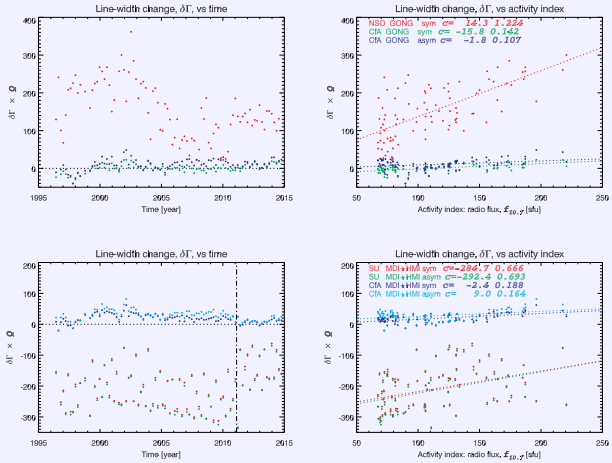
Change of frequency, $\delta\nu_{n,\ell}$, symmetric profiles



Change of frequency, $\delta\nu_{n,\ell}$, asymmetric profiles

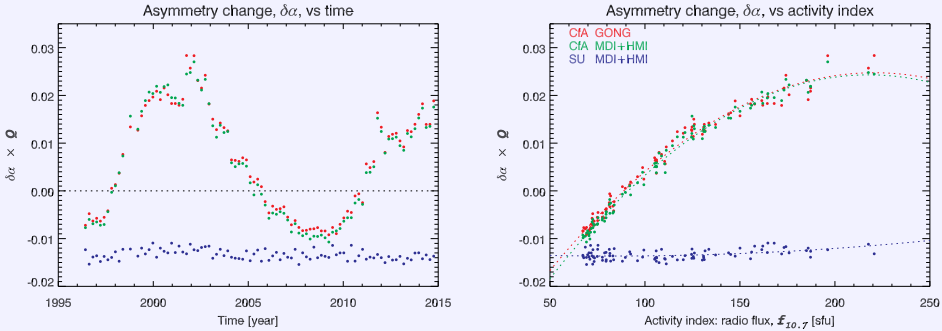


Line-width



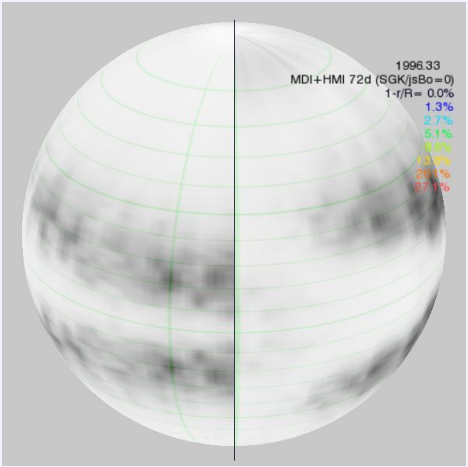
- Top: GONG data (NSO & CfA), bottom: MDI+HMI data (SU & CfA)

Asymmetry

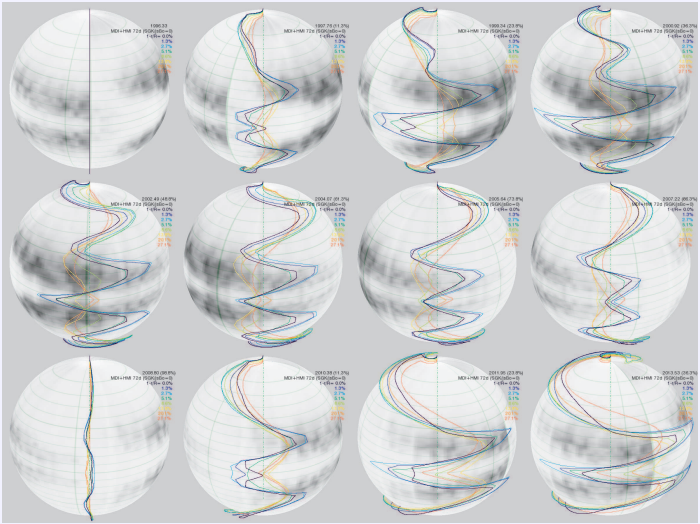


- Mean change of weighted asymmetry, $\delta\alpha\, Q$

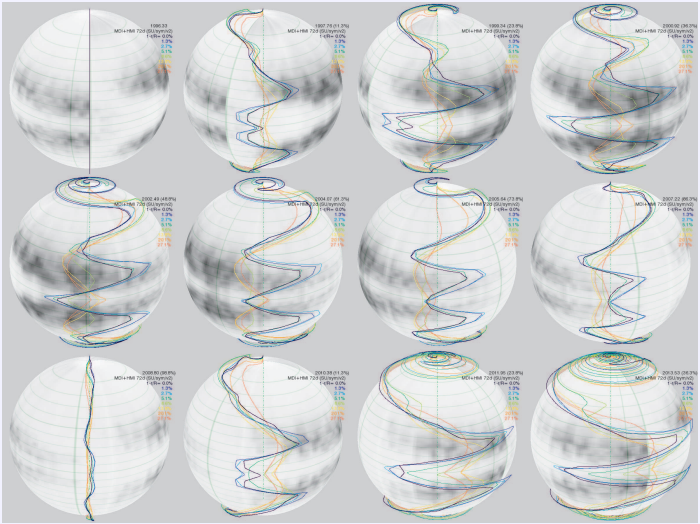
Propagation Diagrams: my fitting to MDI+HMI



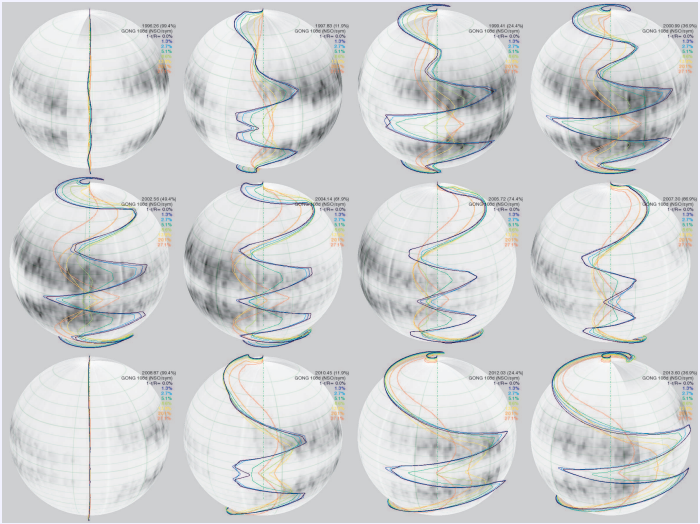
Collage: my fitting to MDI+HMI



Collage: SU's fitting to MDI+HMI



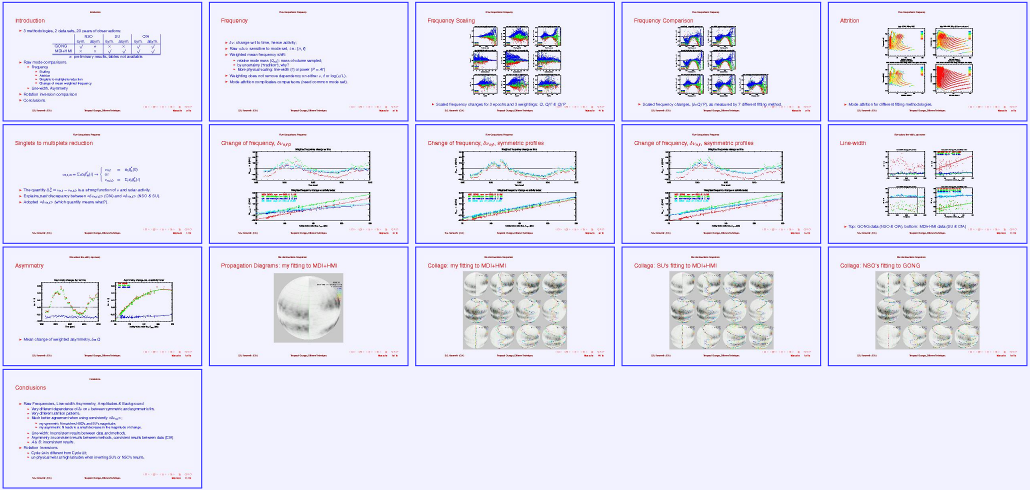
Collage: NSO's fitting to GONG



Conclusions

- Raw Frequencies, Line-width Asymmetry, Amplitudes & Background
  - Very different dependence of $\delta\nu$ on ν between symmetric and asymmetric fits.
  - Very different attrition patterns.
  - 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: Inconsistent results between data and methods.
  - Asymmetry: inconsistent results between methods, consistent results between data (CfA)
  - *A* & *B*: inconsistent results.
- Rotation Inversions
  - Cycle 24 is different from Cycle 23;
  - un-physical twist at high latitudes when inverting SU's or NSO's results.

The End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