Precision Spectroscopy 2019: Rotation, Magnetic Activity and Lithium

Sunspots rotation periods through the solar activity cycles

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• SN data

- Daily ⇒ high dispersion; understanding the complexity; day-scale analyses.
- Smoothed ⇒ visualization of the cycle's shape;



Data: WDC-SILSO, Royal Observatory of Belgium, Brussels







Cycle overlay





• Cycle overlay



Function: Hathaway (2015)

• Butterfly Diagram

Can we distinguish differential rotation using SN ?



Data: Royal Observatory, Greenwich - USAF/NOAA Sunspot Data



Reference points:

• maxima and minima

Criteria:

- significance level 0.01%
- consistent peaks



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• Rotation periods through solar cycle



• Rotation periods through solar cycle





• Rotation periods through a individual cycle



• Flux modulation



Recent work

• Attempt to find signals of differential rotation



Very similar study w/ different conclusions

• Conclusions

- We identify signs of differential rotation using periodograms of SN and correlations with spots latitude.
- We have demonstrated that the rotation inferred from sunspots is significantly different at the maximum and minimum of the solar cycle.
- And were able to correlate period and latitude along a cycle.



Thank you!







Hathaway, D.H. Living Rev. Sol. Phys. (2015)

Morris Brett M., The solar benchmark: rotational modulation of the Sun reconstructed from archival sunspot records (**2019**)

WDC-SILSO, Royal Observatory of Belgium, Brussels

Royal Observatory, Greenwich - USAF/NOAA Sunspot Data, available on: <<u>https://solarscience.msfc.nasa.gov/greenwch.shtml</u>>

Jacob T. **VanderPlas**, Understanding the Lomb-Scargle Periodogram, ApJS 236,16 (2018).



range: 3 months



range: 4 months



range: 6 months



range:9 months



range: 1 year



range: 1.5 year











